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Chapter 1
Introduction

Ahmed Bounfour and Tsutomu Miyagawa

Abstract This chapter discusses the issue of intangibles' research and policy agenda relevance, in the specific context of innovation growth and market failure. It first reviews the importance of intangibles from the economic growth perspective, building on recent works in economics and management. It poses the importance of refining the research and policy agenda, especially by considering the issue of intangibles complementarities, as a perspective for better delineating their contribution to economic growth and firm's performance.

Keywords Knowledge-based capital • Complementarities • Market failure • Boundaries of the firm • Stakeholders • Organizational capital • Intellectual capital • Intangibles • Management practices

1.1 The Emergence of Intangibles as a Major Source of Innovation and Economic Performance

The information and communication technology (ICT) revolution, which started to take shape in the 1990s, has dramatically altered the way firms do business and has changed the sources of productivity growth in countries around the world. Before the ICT revolution, the manufacturing sector was the driving source of productivity growth, with such growth propelled by the accumulation of tangible assets and research and development (R&D). On the other hand, the service sector was seen as a low productivity sector. However, the ICT revolution has shown that not only the

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manufacturing sector but also the service sector can be a sector spurring growth, with firms such as Amazon, Google, and Facebook expanding rapidly. These developments have led economists and policy makers to reconsider the concept of innovation and extend it beyond the traditional perspective associating it with R&D activities to also include non-R&D items such as software, databases, design, brands, organizational capital, etc. Since the ICT revolution, such intangibles have appeared to be key drivers of innovation and productivity growth.

According to the OECD report *New Sources of Growth: Knowledge-Based Capital* (OECD 2013), in most OECD countries intangibles (i.e., knowledge-based capital) account for 5–11 % of GDP. The report further shows that the impact of intangibles on productivity growth is greater than that of tangibles. This means that in order to understand productivity growth and hence economic growth overall in the knowledge economy, a better understanding of intangible investment is indispensable. At the same time, a host of new issues arise. For instance, one of the major issues resides in delineating both the intrinsic complementarities of intangibles and their complementarities with tangible factors. Understanding how the nature of intangibles affects economic growth and innovation is of key importance.

Furthermore, various deep-seated social and economic transformations are underway, which call for a redesign in business models, innovative strategies, and national systems of innovation—in all of these, intangibles play a critical role. The associated shift in the paradigm of innovation brings to the fore important issues for innovation policy, especially with regard to the assessment of knowledge flows beyond traditional boundaries of the firm, and highlights the need to define policy instruments aligned with the new innovation environment. This new innovation environment also raises questions with regard to new organizational designs and the importance of intermediary forms of value creation through innovation based on knowledge markets, networks, communities, etc. Thus, intangibles have important implications in two closely related dimensions: their contribution to economic growth and their role in shaping new forms and spatial patterns of transactions and knowledge flows. These two dimensions have to be considered jointly, especially from the perspective of defining of a research policy agenda for the twenty-first century.

From an analytical point of view, and especially when the issue of innovation is concerned, the emergence of intangibles raises important questions, including the following:

- How can the measurement of intangibles be improved?
- To what extent do intangibles play a critical role in economic growth and productivity?
- What is the relationship between levels of investment in intangibles and levels of outcomes?
- What specific contributions do specific types of intangibles (such as investment in R&D, design, brand formation, information systems, and organization design) make to growth and innovation?

– Are there idiosyncratic approaches and policies to be considered for specific countries (e.g., emerging versus OECD countries)?
– How to deal with issues related to complementarities and the bundling of intangibles?
– Do intangibles specifically suffer from specific market failures which need to be described by free market mechanisms?
– In a dynamic competitive environment, what kind of innovative strategies can firms deploy? What kind of stakeholders influences these strategies?
– What should new innovation strategies and policy agendas going beyond the traditional focus on R&D activities look like?
– These questions are of considerable interest to a variety of institutions, to governments, and to corporate executives, and form the subject of considerable academic debate. Against this background, the project on "Empirical Research on Intangible Investment in Japan" at Gakushuin University in Tokyo held a workshop on intangibles, innovation, and economic growth in December 2012 attended by scholars in the fields of economics and management science as well as researchers at policy research institutions. The present volume provides a compilation of the key papers presented at the workshop. The papers are organized into three topic areas: the measurement of intangibles, market failure, and innovation performance.

1.2 Overview of Chapters

1.2.1 Measurement and Valuation of Intangibles

Understanding the productivity slowdown experienced by developed economies during the 1990s has provided a challenge for both economists and national accountants. While all industries started to extensively integrate computing and software into their production processes, economic performance and related productivity improvements did not match expectations. One potential explanation, proposed by Nakamura (2001), is that traditional measures of economic activity failed to take certain forms of assets, namely, intangible assets, into account. Economists have long regarded R&D activities as investment (rather than as an expense). In national accounting manuals, however, R&D spending appeared as investment only in the 2008 version of the System of National Accounts (SNA) (United Nations 2009). This gap between accounting practices and applied research widened when Corrado et al. (2009) (referred to as CHS hereafter) proposed a list of intangible items that should be considered as assets due to their lifespan and their ability to remain in the production process. While the national accounts include software, databases, artistic originals, and mineral exploration in the gross fixed capital formation (GFCF) account, CHS proposed to extend this list to R&D, advertising, organization capital, continuous training, and financial innovation.

Estimations of "new" intangible capital (i.e., items not considered as investment in the SNA) have been conducted for several countries such as the United States (CHS 2009), the United Kingdom (Marrano et al. 2009), Korea (Chun et al. 2012), Japan (Fukao et al. 2009), the Netherlands (Rooijen-Horsten et al. 2008), France (Delbecque and Bounfour 2011), and Sweden (Edquist 2011). These studies suggest that intangible investment may amount to as much as 11 % of GDP and that its effect on productivity and growth, although highly heterogeneous across countries, is far from negligible.

Although the measurement approach developed by CHS has been followed by several researchers at the aggregate level, the measurement of each type of intangible asset should be reexamined. In the chapter titled "On Advertising and Firm Performance," Leonard Nakamura not only argues that expenditures on advertisement should be included in GDP as investment like R&D expenditures but also points out that subsidies from the advertising industry to recreation services industries should be included in GDP in addition to expenditures on advertising. Considering these two types of expenditures as intangible investment, he estimates that two-thirds of advertising costs should be included in GDP.

At the industry level, the three major questions that arise are the following. First, what are industries' investment and innovation patterns, and how do such patterns differ across industries? Second, how does intangible capital contribute to value creation? And third, what are the implications of the answers to these questions in terms of innovation policy?

In fact, although innovation could arise in all industries, it might take heterogeneous forms and should be clearly identified. Moreover, such analytical work needs reliable intangible capital data at the industry level. While there is a large literature on the contribution of R&D or ICT to industry-level innovation, there are few industry-level analyses on, for example, the relative contribution of all types of intangibles (notable exceptions are Crass et al. 2010; Edquist 2011; Miyagawa and Hisa 2013).

Two chapters in this book contribute to the industry-level analysis of intangibles. "Intangibles and Value Creation at the Industry Level: Delineating Their Complementarities" by Delbecque, Bounfour, and Barreneche adds to the small number of studies measuring intangibles at the industry level (16 French industries). Conducting panel estimations of industry-level production functions that include intangible assets, they show that intangibles make a significant positive contribution to output. Based on an original approach to complementarities, they also find several complementarities between intangible assets and other production factors.

Next, the chapter here on "Intangible Assets and Investments at the Sector Level: Empirical Evidence for Germany" by Crass, Light, and Peters measures intangibles for six sectors in Germany following the industry classification employed by CHS (2009). Their growth accounting analysis, which includes their estimates of investment in intangibles, shows that such investment has made a substantial contribution to German labor productivity growth. Moreover, they find that, of the six sectors, the contribution of intangible investment has been largest in the manufacturing sector.

Another area of key importance is the modeling, measuring, and valuing of intangibles at the firm level. The resource-based view (Barney 1991; Wernerfelt 1984) as well as the dynamic capabilities approach (Teece et al. 1997) particularly emphasizes the importance of firm heterogeneity and organizational knowledge processes for value creation. Against this background, Bounfour (2003) developed an integrated approach to the management of intangibles and their dynamic valuation and reporting. Lev (2001), on the other hand, developed an analytical framework for understanding the intrinsic nature of intangibles, as well as the modalities of value creation. Teece (1986, 2002, 2009) provided an overall framework for analyzing the management of intellectual capital, based on considerations of the intrinsic nature of knowledge assets, especially in relationship to the appropriability regime.

In this volume, the chapter by Miyagawa, Takizawa, and Edamura titled "Does the Stock Market Evaluate Intangible Assets? An Empirical Analysis Using Listed Firm Data in Japan" measures intangibles at the firm level for listed firms in Japan based on the classification by CHS. They examine whether the stock market reflects the value of intangibles and show that for firms in ICT-related industries this is the case.

1.2.2 Emerging Practices and Market Failure

New innovations such as the ICT revolution have changed the way organizations and human resources are managed. In response, new management practices are emerging that are consistent with the requirements of a knowledge-based economy. Such practices, in turn, can be considered as intangible assets. However, external and internal market failures that firms face often prevent them from employing best management practices and investing effectively in intangibles.

1.2.2.1 Market Failure and Risk Analysis

The impact of capital market imperfections on firms' investment has been addressed in the literature by using internal cash flow sensitivity as a proxy for market imperfections and asymmetry of information. However, only a small number of studies have addressed the issue of market failure for intangibles, and these mainly focus on R&D (Hall 1992; Hao and Jaffe 1993; Bond et al. 1999; Bloch 2005; Fee et al. 2009; Aghion et al. 2012; Borisova and Brown 2013). Research is even scarcer in the case of other components of intangibles such as marketing or branding (a notable exception being Fee et al. 2009). These studies attest to the importance of market imperfections for investment in R&D, especially for SMEs and rapidly growing firms.

The chapter by Morikawa titled "Financial Constraints in Intangible Investments: Evidence from Japanese Firms" extends the concept of financial constraints on R&D investment to investment in intangibles as a whole. He shows that intangible investment is more sensitive to financial constraints than tangible investment. In addition, this sensitivity is more serious for young and small firms.

1.2.2.2 Market Failure, Organizational Practices, and Business Modeling

Market failure concerns not only transactions and investments in specific intangibles, but also the adoption of specific organizational practices and modeling. Bloom and Van Reenen (2007) examined the effects of management practices on firms' performance based on interview scores. Their estimates showed that productivity differences can be explained by differences in managerial scores in four advanced countries (United Kingdom, United States, France, and Germany). The analysis has been extended recently to Japan. Kurokawa and Minetaki (2006), Kanamori and Motohashi (2006), and Shinozaki (2007) analyzed the effect of organizational reform resulting from ICT investment on firm performance. Meanwhile, for the United States, Brynjolfsson et al. (2002) highlighted the importance of organizational capital as a complementary asset for ICT investment and value creation. Further, Lev et al. (2009), using sales, general and administrative expenses as a proxy for the investment level in organizational capital, provide evidence of the importance of organizational capital in value creation and management performance. Finally, Bounfour (2011) developed a framework for measuring firms' maturity in managing organizational capital based on a taxonomy articulated around two components: strategic capabilities (e.g., dynamic capabilities, improvisational capabilities) and operational capabilities.

The chapter by Miyagawa, Lee, Kim, Jung, and Edamura titled "Has the Management Quality in Korean Firms Caught up with That in Japanese Firms? An Empirical Study Using Interview Surveys" follows the approach employed by Bloom and Van Reenen (2007) to compare the managerial capabilities—an intangible asset—of Korean and Japanese firms. They construct management scores that represent organizational capital and human capital within a firm based on interview surveys on management practices in Korea and Japan. Their results show that the gap between Japan and Korea in management quality as represented by the management scores has declined dramatically.

Using the data for Japan from same survey, Kawakami and Asaba in their chapter titled "How Does the Market Value Management Practice? Decomposition of Intangible Assets" examines whether organizational and human resource capital are reflected in firms' stock market valuation. They show that firms' human resource management has a significant impact on firms' valuation, although the impact is smaller than that of R&D or advertising.

David Teece's chapter—Intangible Assets and the Theory of the Firm extends the analysis of organizational capital by considering two types of capabilities, namely, ordinary capabilities, which, in his words, "can be measured against best practices with some effort," and dynamic capabilities, which allow the firm "to develop conjectures about the evolution of consumer preferences, business problems and technology." This perspective allows to clearly differentiate static and dynamic perspectives of organizational capital.

1.2.3 Intangibles, Innovation, and Firm Performance

The role of intangibles as determinants of firms' performance has been the subject of numerous studies, some of which were mentioned above. While these studies use different ways to measure firm performance, with some focusing on value creation and others concentrating on productivity or market value, many have shown that intangibles play an important role. Examples include the study by Lev (2001), which focuses on the role of intangibles in global value creation, and that by Brynjolfsson et al. (2002), which focuses on specific items (R&D, branding, organizational practices, ICT investment). As seen above, there are a large number of issues surrounding the link between intangibles and firm performance. The present volume picks out one of them, the effects of complementarities among intangibles and other assets.

Building on the work of Topkis (1978) and Aoki (1984), Milgrom and Roberts (1995) and their collaborators paved the way for a new approach to considering intangibles within a firm, arguing that intangibles should be considered jointly rather than separately. Specifically, they argue that intangibles are heterogeneous and combinatory in nature and should be analyzed from this perspective (Athey, and Roberts 2001; Milgrom and Roberts 1995; Roberts 2004). Understanding the complementarities between intangibles, for example by defining a set of bundles that is the most relevant for firm performance, is one major task that researchers need to address.

In this volume, two chapters, by Gu and Li and by Dutz discuss the complementary effects of intangibles on economic performance. "Innovations in Information Systems and Valuation of Intangibles" by Gu and Li focuses on two types of intangibles: traditional intangibles such as R&D activities, and advertising and information systems. They show that the traditional intangibles contribute to innovation in information systems. They also find that this contribution is also recognized by market analysts.

Dutz's chapter titled "Resource Reallocation and Innovation: Converting Enterprise Risks into Opportunities" makes a similar argument to Gu and Li in the sense that intangibles promote innovation. However, he focuses on the role that intangibles play in reducing various risks associated with innovation. Based on this, he argues that government policies in developing countries promoting entrepreneurial experimentation, skill upgrading, and joint learning through global collaboration contribute to economic development.

1.3 Concluding Remarks

The research and policy agenda with regard to intangible assets is undergoing continuous change. With this volume, we intend to provide the reader with a set of empirical and theoretical studies aiming to shed light on some of the key issues related to the nature of intangibles and their impact on innovation and economic growth. One of the key aspects of intangibles is the issue of market failure, the understanding of which needs to be further refined. The securitization of intangibles, for example, could help to boost entrepreneurship and hence economic growth and job creation, and how to create a market for such securities is an area that warrants further research. We also need to better understand the complementarities of intangibles, their volatility and risk nature. Finally, we need to consider intangibles in the economy as a whole, especially by considering those intangibles not so far dealt with in existing models such as intangibles in the public sector and the intangibles of territories.

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References

Aghion, P., Askennazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit constraints and the cyclicality of R&D investment: Evidence from France. *Journal of the European Economic Association, 10*, 1001–1024.

Aoki, M. (1984). *The co-operative game theory of the firm*. Oxford: Oxford University Press.

Athey, S., & Roberts, M. (2001). Organizational design: Decision rights and incentive contracts. *American Economic Review: Papers and Proceedings, 91*, 200–205.

Barney, J. (1991). Firm resources and sustainable competitive advantage. *Journal of Management, 17*, 99–120.

Bloch, C. (2005). R&D investment and internal finance: The cash flow effect. *Economics of Innovation and New Technology, 14*(3), 213–223.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*, 1351–1408.

Bond, S., Harhoff, D., & Van Reenen, J. (1999). *Investment, R&D and financial constraints in Britain and Germany* (IFS Working Paper 99-5).

Borisova, G., & Brown, J. R. (2013). R&D sensitivity to asset sale proceeds: New evidence on financing constraints and intangible investment. *Journal of Banking and Finance, 37*, 159–173.
Bounfour, A. (2003). *The management of intangibles: The organisation's most valuable assets*. London: Routledge.
Bounfour, A. (Ed.). (2009). *Organisational capital: Modelling, measuring and contextualising* (Routledge studies in innovation, organizations and technology). London: Routledge.
Bounfour, A. (2011). *Le capital organisationnel, principes, enjeux, valeur*. Paris: Springer.
Brynjolfsson, E., Hitt, L. M., & Yang, S. (2002). *Intangible assets: Computers and organizational capital* (Paper 138). Center for eBusiness @ MIT.
Chun, H., Fukao, K., Hisa S., & Miyagawa, T. (2012). Measurement of intangible investment by industry and its role in productivity improvement utilizing comparative studies between Japan and Korea (RIETI Discussion Paper Series 12-0-037).
Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *Review of Income and Wealth, 55*(3), 658–660.
Crass, D., Licht, G., & Peters, B. (2010). *Intangible assets and investments at the sector level: Empirical evidence for Germany* (COINVEST Discussion Paper, December 2010).
Delbecque, V., & Bounfour, A. (2011). *Intangible investment: Contribution to growth and innovation policy issues* (European Chair of Intellectual Capital Management Working Paper 2011-1A).
Edquist, A. (2011). Intangible investment and the Swedish manufacturing and service sector paradox (IFN Working Paper 863).
Fee, C. E., Hadlock, C. J., & Pierce, J. R. (2009). Investment, financing constraints, and internal capital markets: Evidence from the advertising expenditures of multinational firms. *Review of Financial Studies, 22*, 2361–2392.
Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to economic growth. *Review of Income and Wealth, 55*, 717–736.
Hall, B. H. (1992). Investment and research and development at the firm level: Does the source of financing matter? (NBER Working Paper 4096).
Hao, K. Y., & Jaffe, A. B. (1993). Effect of liquidity on firms' R&D spending. *Economics of Innovation and New Technology, 2*, 275–282.
Kanamori, T., & Motohashi, K. (2006). Centralization or decentralization of decision rights? Impact on IT performance of firms (RIETI Discussion Paper Series 06-E-032).
Kurokawa, F., & Minetaki, K. (2006). How can IT raise productivity linked with workplace re-organisation and human capital in Japan. *Economic Analysis, 178*, 54–95 (in Japanese).
Lev, B. (2001). *Intangibles: Management, measurement and reporting*. Washington, DC: Brookings Institution Press.
Lev, B., Radhakrishnan, S., & Zhang, W. (2009). Organizational capital. *Abacus, 45*(3), 275–298.
Marrano, G. M., Haskel, J., & Wallis, G. (2009). What happened to the knowledge economy? ICT, intangible investment, and Britain's productivity record revisited. *Review of Income and Wealth, 55*(3), 686–716.
Milgrom, P., & Roberts, J. (1995). Complementarities and fit: Strategy, structure and organizational change in manufacturing. *Journal of Accounting and Economics, 19*(2–3), 179–208.
Miyagawa, T., & Hisa, S. (2013). Estimates of intangible investment by industry and productivity growth in Japan. *Japanese Economic Review, 64*, 42–72.
Nakamura, L. (2001). *What is the U.S. gross investment in intangibles? (At least) one trillion dollars a year!* (Federal Reserve Bank of Philadelphia Working Paper 01-15).
OECD. (2013, May). New sources of growth: Knowledge-based capital.
Roberts, J. (2004). *The modern firm: Organizational design for performance and growth*. Oxford: Oxford University Press.
Rooijen-Horsten, M., van den Bergen, D., & Tanriseven, M. (2008). *Intangible capital in the Netherlands: A benchmark* (Discussion Paper 08001). Statistics Netherlands.

Shinozaki, A. (2007). Effective reforms with information technology: Logit model analysis on business process reengineering, business unit restructuring, and human resource management. *The Economic Analysis, 179*, 36–54 (in Japanese).

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*(6), 285–305.

Teece, D. J. (2002). *Managing intellectual capital: Organizational, strategic, and policy dimensions*. Oxford: Oxford University Press.

Teece, D. J. (2009). *Dynamic capabilities & strategic management: Organizing for innovation and growth*. Oxford: Oxford University Press.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.

Topkis, D. M. (1978). Minimizing submodular function on a lattice. *Operations Research, 26*(2), 305–321.

United Nations. (2009). *System of national accounts*. New York: United Nations.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171–181.

Chapter 2
Advertising, Intangible Assets, and Unpriced Entertainment

Leonard I. Nakamura

Abstract This paper addresses two aspects of advertising: its role in supporting entertainment and news, and its role as an investment. I argue that in both roles advertising's contribution to output is being undermeasured in the national income accounts. In some cases one unit of nominal advertising input should be counted as two units of real output. In rough orders of magnitude, I argue that it is plausible that two-thirds of advertising expenditure represents unmeasured contributions to output, and the level of real GDP should be increased accordingly.

Keywords Advertising • Entertainment • Intangible • Measurement

2.1 Introduction

Advertising is treated in the national accounts of most countries as an intermediate input which does not appear directly in output. Broadcast television and radio are treated as unpriced byproducts of advertising and also do not appear directly in output. Furthermore, although advertising apparently can have longlived impacts on profits, advertising expenditures are not treated as investment.

Belatedly following Borden's classic 1942 treatment of advertising, I shall argue that when entertainment is a joint product with advertising, it should be included as

The views expressed here are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. This paper is available free of charge at http://www.philadeliafed.org/econ/wps/index.html. Thanks to Frank Wykoff and participants at the SSRCH International Conference on Index Number Theory and the Measurement of Prices and Productivity and seminars at the Philadelphia Fed, the Sveriges Riksbank, and Villanova University for valuable comments. Victoria Geyfman provided excellent research assistance.

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real output, even when its price is zero. This argument is an empirical claim that the combination of entertainment and advertising can be unusually productive—I shall argue that one unit of input of this type can produce two units of real output, one unit both nominal and real, the other a rise in the real output that occurs via a decline in the price deflator for the relevant recreation category.

Advertising and entertainment have long been intertwined as products. Borden (1942) estimated the net contribution of advertising to newspapers, magazines, and radio in 1935 accounted for $380 million (out of total advertising expenditure of $1.32 billion) in a year when GDP was $73.3 billion. These contributions increased the entertainment and information available to consumers relative to the prices paid.

Take as an example an actor who chooses between performing in a TV series or making a movie. Both are work in which the actor is paid to entertain consumers, but the movie is counted as part of personal consumption expenditure, while the TV performance is not, because the latter is paid for by commercials and not by the consumers. If the real impact of this entertainment should be included in GDP, then advertising that is bundled with entertainment or news is different from advertising that stands alone (for example, direct mail). I argue that it is possible to interpret advertising bundled with entertainment is unusually socially beneficial. The manufacturer of the good being advertised is producing a joint product: entertainment and the advertised product. This is equivalent to the manufacturer's adding more quantity or a free gift to a product without raising its price, and similarly results in an increase in private utility.

This social benefit is relevant to arguments about advertising and the efficiency of product diversification (Grossman and Shapiro 1984). Grossman and Shapiro built on work by Salop to suggest that informative advertising is excessive under oligopoly and monopolistic competition. A more robust conclusion has been that there are two countervailing forces in product differentiation—differentiation may be insufficient because the consumer obtains surplus and differentiation may be excessive because the producer may steal surplus from rival producers. When advertising is bundled with entertainment, a third factor should be considered. The private benefit to the advertiser is less than the social benefit, which includes the entertainment. This is an additional argument that differentiation may be undersupplied when advertising is involved.

Why attempt to bring a free good under the aegis of the national accounts? How does it differ from air? The difference is that air is not produced privately, nor is it bid away from alternative uses, whereas TV or radio entertainments are. In this sense, broadcasts are like government expenditures on public parks, but they are unusual because they also have a private purpose and are privately supplied.

Using this analogy, one could impute nominal income and consumption to households and to consumers, paralleling the NIPA treatment of owner-occupied housing services and the forgone interest on bank deposits. In those cases, however, the household possesses a capital good that provides a return. In the case of advertising supported entertainment, the output is being provided by a firm. I thus believe that it is more reasonable to have this private-sector-supported entertainment appear in the accounts as a larger real output and a reduced price.

I shall also argue that a portion of advertising should be considered investment—capitalized and depreciated rather than expensed. This argument has been made for decades (e.g. Weiss 1969; Bloch 1974). Schmalensee (1989) noted the strong, positive relationship between the advertising/sales ratio and industry level profitability and that this stylized fact had proven unusually robust since it was first reported by Comanor and Wilson (1967). Recent evidence continues to suggest that advertising can be an important and durable source of profitable product differentiation (Nevo 2001). However, several papers have argued that the depreciation rate for advertising varies sharply across industries and is typically more rapid than for R&D or tangible investment (Peles 1971; Bublitz and Ettridge 1989; Hall 1993).

In this article, the main focus is on the impact of advertising on entertainment and news, and I build on Borden's (1942) estimates to create a time series of such contributions from 1935 to 2002. I argue that properly accounting for entertainment and investment would increase real GDP by 1.5 % and nominal GDP by about 0.8 %, although both of these estimates are admittedly very approximate.

In the remainder of the paper I sketch the possible implications for national income accounting of this view of advertising and its role in the economy. I set forth numerical estimates based on published data and the extant literature, but these estimates are meant to be suggestive of orders of magnitude only. I briefly address the modeling issues that underlie these measures before concluding.

2.2 A Sketch of Theory

Let us begin by examining advertising in a one-period model with free entry and without fixed capital (all economic costs will be time costs of labor). Direct advertising (that is, without entertainment or news, as in Grossman and Shapiro) enters into GDP as part of the fixed expenses associated with a differentiated product. The marginal utility of the differentiated product is equal to its price, which just covers fixed cost under free entry. For a differentiated product with fixed cost $F = F_0 + A$ (where F_0 represents nonadvertising fixed costs, say research and development, and A is the advertising cost of informing consumers of the good's existence) and marginal per unit cost c_d (labor costs) and output q_d, the price $p_d = F/q_d + c_d$, and output $p_d q_d$ = resource cost = $F + c_d q_d$.

From the perspective of the national income accounts, the aggregate consumer expenditure on output $y_d = p_d q_d$ is reflected in personal consumption expenditures in that amount for the advertised good. This is equal to the total cost of producing the goods, including the fixed costs. Advertising is one of the intermediate costs of producing the advertised good.

Investment. In a multiperiod model, it is possible that fixed costs may be incurred prior to consumption. If the fixed costs are incurred at time t but production and consumption occur at time $t+1$, and if—as is currently the case in national income accounting—the fixed costs are expensed, then in period t this industry will show a loss of F, zero output, and F labor costs. Then in period t + 1, in equilibrium, the advertising firm must spend $c_d q_d$ and consumers will pay $F(1 + r) + c_d q_d$. Measured output will be $F(1 + r) + c_d q_d$, with $F(1 + r)$ recorded as corporate profit and $c_d q_d$ as labor income. Thus in period t output and profit are understated, while output and profit are overstated in period t + 1, as a result of the failure to capitalize and depreciate fixed costs.

Now consider the case of advertising with entertainment. In this case, the non-entertainment costs associated with direct advertising are reduced by the entertainment, which draws consumers to the advertisers' messages. Payments to entertainers or other content producers enable the entertainers to produce a consumer product: entertainment. At the same time, these payments substitute for the payments that would otherwise have gone to direct advertising costs. The full value of the advertisers' costs still is covered by the differentiated product being advertised, but in addition, a new consumption good—entertainment—is produced. Part of F is being spent to produce entertainment M.

The case is directly analogous to a joint product in which a rise in the value of one product (advertising) reduces the price paid for the other product (entertainment) while not changing its real value. Nevertheless, we must be cautious since the consumer does not pay directly for the entertainment.

A simple example to illustrate the point is as follows.

Model of entertainment good Let M be a monopoly entertainment good that may be supported by advertising. The measure one household/consumers supply their unit labor inelastically and jointly own the shares of the firm supplying the monopoly entertainment good. With a specific piece of media that is small with respect to income, we can approximate the utility of the aggregate of consumers by

$$U(z, M) = z + bM\text{-}1/2\ M^2\text{-}a_U M$$

where z is the numeraire good (produced one for one by labor, which thus has a unit wage), and M is the units sold of the medium in question, which we shall consider to be a newspaper. Here $b > 0$ is a parameter representing the utility of the newspaper, and $a_U > 0$ is a parameter representing the disutility of advertising to readers when advertising is present in the publication, and equal to zero if advertising is not present. Demand can be shown to be $M = b - a_U - p$, where p is the price charged for the newspaper.

The newspaper has labor costs of publication c_M per unit sold, and sells the publication at a price $p \geq 0$, receiving α per unit from advertisers but also paying a labor cost of α' per unit for the direct costs of including advertising in the paper. Thus the newspaper's profit will be equal to:

$$\Pi = \left(p + \alpha - \alpha' - c\right)(b - a_u - p)$$

Then it is easy to show that if $\alpha - \alpha' \geq b - a_u + c_M$, then the equilibrium price is $p = 0$ (assuming newspapers cannot be sold at a negative price) and quantity $M = b - a_u$. Advertisers pay $\alpha(b - a_u)$. Profit of the publisher is $\Pi = (\alpha - \alpha' - c_M)(b - a_u) > (b - a_u)^2$ since $(\alpha - \alpha' - c_M) > (b - a_u)$. Consumer utility is $U = 1 - (b - a_u)(c_M + \alpha') + \frac{1}{2}(b - a_u)^2$. Direct advertising costs are $\alpha'(b - a_u)$, while $c_M(b - a_u)$ is to be shared between advertising and content. If the disutility of advertising a_u is great, this would show up in a small audience. For television and radio, the direct costs of advertising and transmission appear to be generally small relative to the entertainment advertising support, that is, relatively small c_M and α'. These distribution costs are larger for magazines and newspapers, and thus contribute to the generally positive prices for these publications.

That being said, in this example the value of the entertainment good (as measured by publisher profits) is larger than $(b - a_u)^2$ while the direct utility to consumers is ½ $(b - a_u)^2$. Thus unlike the case when consumers pay for the entertainment, direct utility may be less than the payment to the entertainer. In this case, it is possible that the entertainment support from advertising measured as I have may overstate its contribution to consumer welfare. It is thus important to have calculations such as those by Noll et al. to verify that the contributions to consumer welfare are in line with my advertising contribution estimates.

In the absence of advertising, the publisher charges $p = ½ (c_M + b)$ and $M = ½ (b - c_M)$. Resource costs are ½ $c_M(b - c_M)$. Utility $U = 1 + \frac{3}{8}(b - c_M)^2$. Consumer expense is $pM = 1/4\ (b^2 - c_M^2)$. It can be shown that direct utility exceeds consumer payments.

Measuring real output. A formal way to measure this gain in utility is to deflate nominal expenditures with a price index based on an expenditure function that gives the nominal expenditure corresponding to a given level of utility. Such a price index will be lower in the periods in which the newspaper is available at zero price. Thus the constant utility price level falls, and real output is higher when the newspaper exists compared to when it does not, although it does not enter into the expenditure basket of the individual.

Caveats Persuasive advertising—advertising that shifts utility functions (as in Dixit and Norman 1978)—fits less easily into a national accounting framework. Stigler and Becker (1977) question whether mental or emotional associations suggested by an advertisement should be considered as changing the utility function or changing the product. They argue the latter. One way of viewing their argument is to draw a parallel with scientific research on the value of a drug (say, the blood-thinning properties of aspirin). Although no physical change has occurred to the drug, the perceived nature of the product has changed, raising its utility for the buyer. Similarly, taking a course on Shakespeare changes the perceived nature of theatrical performances and changes consumer demand. If by appending an emotional association to a product the advertiser of the product raises demand for it, then the product has changed and demand for it may change while the utility function remains stable. Under this interpretation, advertising can be treated as informative.

Another case that challenges the treatment I recommend is the case of gratitude toward the sponsor. In sponsoring a product, the advertiser may count on the consumer's gratitude raising the consumer's willingness to pay for the advertiser's product as a means of indirectly paying for the entertainment. In this case, the utility of the differentiated product is less than the price paid by the consumer, so that the real value of the entertainment has been at least partially accounted for in the consumer payment for the differentiated product, and it would be incorrect to increase the total real value of consumption by the value of the entertainment. This effect would not negate the consumer surplus calculation in the experiment in which cable TV payments are used to infer the value of TV broadcasts.

Finally, as a practical matter, including these changes in the national income accounts does not have much impact on long-run measures of inflation or growth, only levels. Advertising has been roughly the same proportion of GDP for a long time. These issues are more important as aids in more deeply understanding advertising and intangible output.

2.3 Advertising and Media

In this section I develop estimates of the advertising contribution to entertainment, using Borden's conceptual framework. Borden separated media receipts from advertising into two parts: a portion that represents the costs of reproducing and distributing the advertising message itself, and a portion that reduces the cost of the entertainment to the customer.

I begin with the Coen (2005) estimates, a consistent annual data series going back to 1935 of gross advertising expenditures—advertisers' expenditures rather than media revenues. I relate these to recent data from the Service Annual Survey, which provide net advertising revenues of the media, a better base for calculation of the advertising contribution. Then I discuss Borden's (1942) calculations of the proportion of net advertising revenues that support entertainment and news and provide some sketchy, more modern data.

Coen's estimates of gross advertising expense Relatively complete annual aggregate data on U.S. advertising expenditures by medium are available primarily from two sources: Robert Coen's estimates (1935 to present) and the U.S. Census Bureau's Annual Surveys of Service Industries (1998 to present). These data are gathered from advertising agencies and from information sector firms—the media. Data from the investing firms—the purchasers of advertising—are more scanty. Coen, who is director of forecasting for the advertising firm of Universal McCann, has made detailed estimates by type of media extending back to 1935. These early estimates have their roots in Neil Borden's study (1942) for the Harvard Business School that was funded in part by the widow of Alfred Erickson, one of the founders of Universal McCann. Borden's statistics are benchmarked by detailed estimates he made for 1935, using the 1935 Census of Business.[1] Coen's data appear to represent estimates of the total *gross* costs of advertising expenditures on media, including expenditures on advertising production, and commissions to advertising agencies and media purchasing agents.[2]

Coen's historical statistics are summarized in Table 2.1, which provides decade average data in nominal terms from the 1940s to the 1990s. As a percent of nominal GDP, the decade averages fluctuate between 1.6 and 2.3 %. It is this expenditure for advertising—the out-of-pocket expenses of producers and sellers of products—which may have an investment component.

If we omit expenditures on direct mail, outdoor display advertising, the yellow pages, and miscellaneous expenditures, the remainder is the part I am considering to be potentially supporting news and entertainment: advertising in newspapers, periodicals, television including cable, and the Internet. These fluctuate between 1 and 1.4 % of GDP.

Service Annual Survey data on net media advertising revenue The U.S. Census Bureau's Service Annual Survey for Information Sector Services makes available recent data on revenues and expenses of newspaper, magazine, and database publishers, radio and television broadcasters, and cable TV operators. Table 2.2 gives data on advertising revenues and receipts from customer payments for subscriptions and individual copies. The data here on advertising revenues are *net* of costs of advertising agency commissions and so forth. Generally speaking, the data are about four-fifths of the comparable figures from Coen (Table 2.3). These net revenue data are the more appropriate source for calculating advertising's support to entertainment.

Borden's estimates of advertising contribution to entertainment and news The portion of the entertainment medium's revenue that is directly allocable to the cost of distributing the advertiser's message ought not to be counted as a contribution to entertainment. This is an aspect of advertising on which Borden was able to obtain considerable data in making his estimates for 1935 of the entertainment and news contribution of advertising. The question is, how much of advertising expenditures on a magazine or radio program pays for the content or program, and how much pays for the transmission of the advertising message itself?

Borden divides media expenses into (1) content or program costs, such as music royalty payments or payments to performers, that were clearly entertainment or news, (2) costs of soliciting advertising that were clearly advertising costs, and

[1] Unfortunately, the 1935 Census of Business does not appear to have fully captured small businesses, so, for example, local newspapers appear to be undercounted. Coen has corrected for some of these biases in his estimates.

[2] However, these do not appear to include all marketing expenditures, as they appear to represent mainly expenditures associated with media and do not include such items as celebrity sponsorships or pharmaceutical company detailing to physicians. It is difficult to know where to draw the line between advertising and sales expense; in practice, payments to media are usually singled out.

Table 2.1 Coen advertising expenditures data, by media, nominal, 1935–2002 million $

	1935–39	1940–49	1950–59	1960–69	1970–79	1980–89	1990–99	2000–02
1. Newspapers	810	1,144	2,836	4,399	8,881	23,826	36,714	45,779
2. Periodicals	235	535	1,164	1,835	2,894	7,241	12,051	15,940
3. Yellow Pages[a]	0	0	0	0	0	0	10,392	13,532
4. Radio	150	395	601	918	2,123	6,040	11,523	18,678
5. Broadcast TV	0	6	883	2,460	5,924	19,835	32,332	41,917
6. Cable TV	0	0	0	0	0	0	6,487	15,829
7. Internet	0	0	0	0	0	0	502	5,678
8. Direct Mail	318	431	1,252	2,243	4,372	14,727	31,541	45,128
9. Outdoor	40	78	179	187	355	875	1,281	5,162
10. Other	385	634	1,689	2,934	6,002	11,533	22,140	30,903
11. Total Advertising	1,938	3,222	8,605	14,976	30,551	84,076	164,962	238,545
12. Entertainment and News (1,2,4,5,6,7)	1,195	2,079	5,485	9,612	19,823	56,942	99,608	143,821
13. Contribution to entertainment and news[b]	461	805	2,258	4,153	8,960	26,503	47,602	70,761
Percent of GDP								
14. Total Advertising	2.27 %	1.58 %	2.13 %	2.09 %	1.84 %	2.07 %	2.25 %	2.35 %
15. Contribution to entertainment and news	0.54 %	0.40 %	0.56 %	0.58 %	0.54 %	0.65 %	0.65 %	0.70 %
16. Advertising Investment (one-third of (15))	0.76 %	0.53 %	0.71 %	0.70 %	0.61 %	0.69 %	0.75 %	0.78 %
17. Unmeasured contribution to GDP: (16) + (17)	1.30 %	0.92 %	1.27 %	1.28 %	1.15 %	1.34 %	1.40 %	1.48 %

Source: Author's calculation and Coen, R. "Bob Coen's historical advertising statistics," at http://www.universalmccann.com/ourview.html

[a]Before 1990, included in Other

[b]Equals 0.6 times sum of (4), (5), (6), and (7) plus 0.4 times (1) plus 0.2 times (2)

(3) production costs which he split based on the relative proportion of published pages or broadcast time devoted to content.

In the case of newspapers, for example, he used a survey of 23 daily newspapers to estimate that 35 % of revenues came from circulation and 65 % from advertising. The survey also suggested that content was 65 % of the linage, while advertising was 35 %. And it showed that expense directly attributable to editorial and news was 17 %, while advertising sales salaries and other direct advertising expense was 8 %. All other costs were 75 %. Allocating "all other costs" using the ratio of content linage to advertising linage implied that total content expenses were 65.75 % of the total, while advertising expenses were 34.25 % of total expenses. Since expenses were 93 % of revenues, advertising expenses were 32 % of total revenues, while advertising revenues were 65 % of total revenues.

Table 2.2 Media revenues from customers and advertisers, 1998–2002, Service Annual Survey data

	1998	1999	2000	2001	2002
Newspapers: Joint revenues	41,435	44,331	47,371	42,698	42,861
Circulation	8,592	8,818	9,149	9,474	9,628
Advertising	32,843	35,513	38,222	33,224	33,233
Magazines: Joint revenues	30,703	32,732	33,812	34,493	34,087
Circulation	13,948	14,912	14,397	16,031	16,175
Advertising	16,755	17,820	19,415	18,462	17,913
Directories and databases	11,163	12,088	12,840	13,422	13,326
Circulation	1,274	1,409	1,682	2,206	2,163
Advertising	9,889	10,679	11,158	11,215	11,162
Radio Advertising	10,901	12,254	13,921	12,424	13,380
Broadcast TV Advertising	29,121	31,031	34,937	30,718	33,611
Cable TV	47,098	53,403	59,287	63,981	68,648
Subscription and pay per view	39,064	43,636	47,278	51,756	54,823
Advertising	8,034	9,767	12,009	12,225	13,825
All media	170,421	185,839	202,168	197,736	205,913
Direct consumer payments	62,878	68,775	72,506	79,467	82,789
Advertising	107,543	117,064	129,662	118,268	123,124
Advertising as proportion of joint revenues from customers and advertisers					
Newspapers (%)	79	80	81	78	78
Periodicals (%)	55	54	57	54	53
Databases (%)	89	88	87	84	84
Cable TV (%)	21	22	25	24	25
All media (%)	63	63	64	60	60

Source: U.S. Census Bureau, Service Annual Survey, *Information Sector Services, 2002*

Table 2.3 Advertising revenues of selected media: data from US Census Bureau Service Annual Survey as proportion of Coen data

	1998	1999	2000	2001	2002
Newspapers (%)	74	76	78	75	75
Periodicals (%)	114	113	112	119	120
Broadcast Television (%)	74	78	78	79	80
Cable Television (%)	78	78	78	78	85
Radio (%)	72	71	72	70	71
Totals of selected media (%)	79	81	81	81	82

Source: Tables 2.1 and 2.2

This allowed him to estimate that roughly 50 % of the advertising revenue was a contribution to content. Similar calculations showed that 28 % of magazine advertising and 73 % of radio advertising was a contribution to entertainment and news content.

More recent data on advertising's contribution to media Over time the ratios underlying these estimates have evolved. Newspaper advertising now accounts for 80 % of revenue, and circulation for only 20 %. This suggests that the contribution rate to newspapers may have increased.

Radio At the time of Borden's calculation, commercial-sponsored radio broadcasts accounted for only 35 % of broadcast time, and direct advertising sales costs were only 5 % of expenses. By contrast, in the 1970s, commercial radio stations' commercial-sponsored broadcasts were generally 100 % of broadcast time, and direct advertising sales costs were roughly 20 % of expenses of radio broadcasters. Thus commercial radio stations' support to broadcasts has fallen, possibly to 60 % of revenues.

Broadcast television was not a significant source of advertising until the 1950s. Television networks and stations in the late 1970s, according to FCC data, devoted more than 50 % of their expenses to programming costs and about 10 % to direct selling costs. At that time, advertising was limited in TV prime time to 6 min/h according to Goettler (1999). These data would imply 80–90 % of advertising revenues supported content. At that point, while radio may have fallen below Borden's estimates, commercial television broadcasts appear to have been somewhat above them.

The National Association of Broadcasters' rule limiting commercial time on TV was declared a violation of antitrust laws in 1981. Since then, the proportion of TV prime time devoted to commercials has risen considerably, and in 1996, commercial time was 15.35 min/h in prime time according to Goettler (citing the Commercial Monitoring Report). Thus advertising time has risen from 10 % of prime time to over 25 %. On the other hand, the proportion of television expenses devoted to programming has remained high. The Service Annual Survey's data on expenses do not give advertising sales expenditures nor total programming costs, but 40 % of expenses in 2001 and 2002 were for broadcast rights and music license fees, not including network and station productions, such as news broadcasts, which alone may account for 10 % of TV revenues. So it is likely that program costs continue to account for over half of the advertising revenues of TV. Attributing something like 70–75 % of advertising revenues to support for content in current TV would seem reasonable.

My new estimates I do not have the data to reproduce Borden's detailed work on advertising's contribution to entertainment. But based on my limited data, it does not seem wholly inaccurate to use his estimates, applying his radio ratio of 75 % to all broadcasting, including TV, cable TV, and Internet advertising. This may somewhat overestimate the contribution in recent years. I base my estimates of advertising expense on Coen's long historical data series, which I reduce by 20 % to make the Coen data on gross advertising expense approximate the Service Annual Survey's estimates of net advertising revenue as suggested by Table 2.3. Thus the ratios I apply to Coen's data are 40 % for newspapers, 20 % for magazines, and 60 % for broadcasting (I used round numbers to emphasize the limited quantitative basis for these estimates). I arrive at an overall entertainment advertising contribution of $410 million for 1935, somewhat larger than Borden's $380 million estimate. The primary cause of the difference is that Coen has a somewhat larger estimate of local newspaper advertising than Borden in 1935.

Table 2.4 Unmeasured advertising contributions to media in relation to measured personal consumption expenditures, 1935–2002

	Contribution to all media, ratio to measured PCE for recreation goods and services (%)	Contribution to newspapers and periodicals, ratio to measured PCE of magazines, newspapers and sheet music (%)	Contribution to TV, radio, and Internet, ratio to measured PCE of recreation services (%)
1935–39	14.7	71.7	10.1
1940–49	12.1	57.6	13.7
1950–59	15.7	73.9	28.9
1960–69	15.5	77.2	34.5
1970–79	12.7	63.5	31.9
1980–89	14.2	68.4	34.6
1990–99	11.8	63.8	27.9
2000–02	11.7	62.2	28.9

Source: Bureau of Economic Analysis and author's calculations

The resulting entertainment contribution numbers vary from about 0.4 to 0.7 % of GDP (Table 2.1). As a proportion of measured personal consumption expenditures on recreation, it has varied from 11 to 16 %. It is interesting to note that while the advertising contribution has risen modestly relative to nominal GDP as a whole, it has fallen relative to personal consumption expenditures for recreation.

At a more disaggregated level, we can assign the advertising contribution to newspapers and magazines to the PCE detailed expenditure category of "magazines, newspapers, and sheet music," part of the major product category "other nondurables." Acknowledging the contribution to magazines and newspapers would make this category between one-half and three-quarters larger in real terms (Table 2.4 and Fig. 2.1). The TV and radio broadcasts, together with advertising contributions to cable TV and the Internet, would naturally fall into recreation services and might best be placed with all other recreation services. Doing so would make the major product category of recreation services larger in real terms by one-tenth to one-third.

Noll et al.'s measures of consumer surplus for broadcast TV Are the size of these quantitative estimates of entertainment reasonable? The development of community antenna (cable) TV gives us the econometric evidence to estimate the consumer surplus from the most important source of advertising entertainment, broadcast TV. Noll et al. (1973), using data from 1969, estimated the consumer surplus from broadcast TV. They estimated the willingness to pay for the basic TV service portion of cable TV by exploiting variation in the local availability of over-the-air broadcasts. A preliminary finding was that in areas with little or no over-the-air TV, 80 % of households were willing to pay $5 per month for no-frills cable access to those stations. This was approximately equal to the per viewer cost of TV

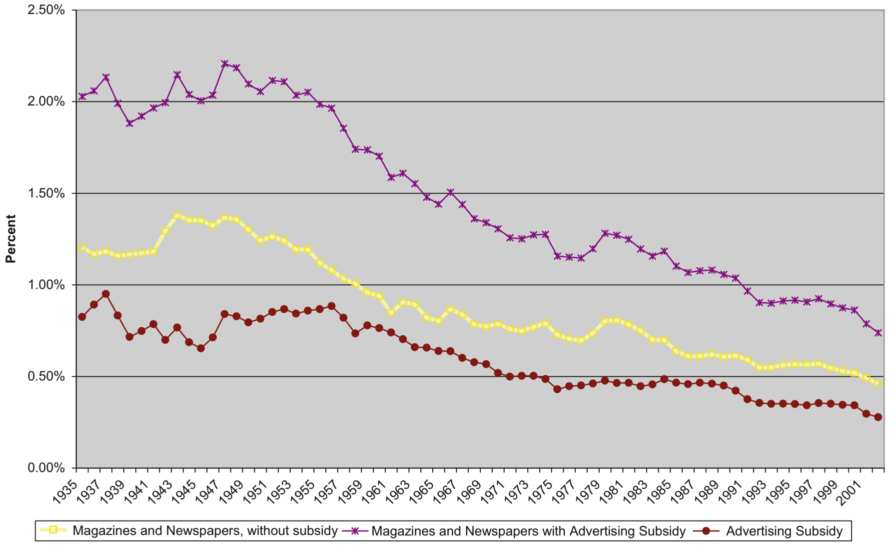

Fig. 2.1 Real consumption of magazines and newspapers as proportion of total PCE

paid by advertisers.[3] Even without estimating a sloped demand curve, the minimum consumer surplus was equal to TV revenues.

From a parameterized model, they estimated consumer surplus from the broadcasts of three TV networks as being 5.1 % of household income in 1969 (Table 2.5); personal income in nominal terms was $779 billion, so the consumer surplus was $39.7 billion. My estimate of the nominal entertainment contribution from advertising for TV in that year is $2.2 billion; for all media the contribution is $5.6 billion. Thus the consumer surplus from TV was a large multiple of the entertainment contribution to TV in 1969 and, indeed, was seven times the entire advertising contribution to all media.

The 1950s rise of TV watching amid a decline in purchases of recreational services The impact of advertising contributions on the time series of real recreation services from 1935 to 2002 is substantial. One clear fact is that television viewing rose very rapidly between 1950 and 1960 (Fig. 2.2). About half the rise in total viewing time of TV over the past five decades took place in that period.[4]

[3] There were 62.2 million households in 1969. Eighty percent of these times $60 a year is approximately $3 billion. Coen's data give $3.6 billion spent by advertisers on TV; net TV revenues were probably about $3 billion.

[4] These data splice together data on annual viewing hours for 1984–2000 from Veronis Suhler Stevenson published in the 1994, 1999, and 2003 Statistical Yearbooks, with average viewing per day data for 1984 and earlier from A.C. Nielsen from the Statistical Abstract. The two series do not agree in 1984; the former gives 1,520 h/year, which is 29.2 h/week, while the latter gives 6.96 h/day. I forced the Nielsen data to equal the Veronis Suhler Stevenson data in 1984.

Table 2.5 Estimated consumer surplus as percent of household income from selected levels of free television service, network affiliated stations, 1969

Number of stations	Total surplus	Marginal surplus
1	2.6	2.6
2	4.06	1.46
3	5.07	1.01

Source: Noll et al. (1973), Appendix A, Table A-2

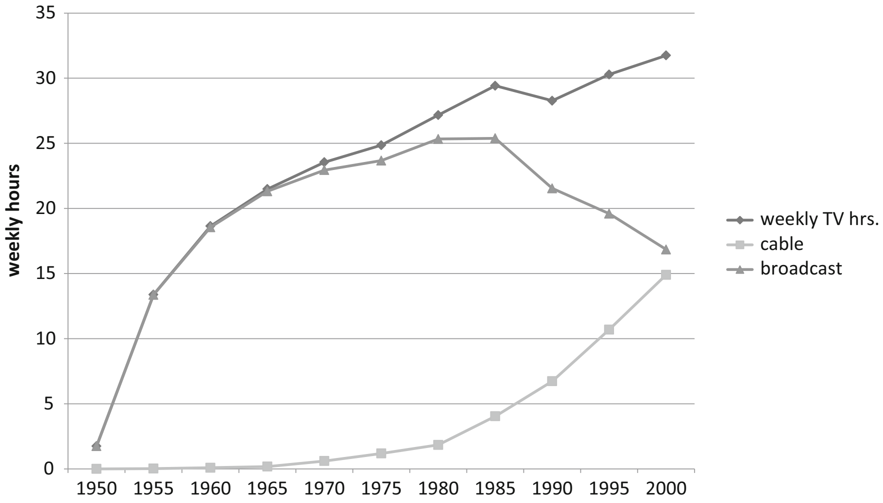

Fig. 2.2 Cable and broadcast TV weekly viewing hours

Figure 2.3 shows that the percentage of personal consumption expenditures represented by recreation services was falling during the 1950s.[5] This is anomalous, in that per capita real incomes rose in this period, and recreation services, as a luxury good, would be expected to expand. This anomaly is further evidence that the rise of free alternative entertainment influenced consumer behavior. Once we add in the advertising contribution, the decline disappears. Indeed, were we to include a larger proportion of broadcast advertising expenditures in recreation services, as the consumer surplus measures might suggest, the expected increase in proportion of real recreation services would appear. Put another way, consumers during this period acted as if they were switching from alternative sources of entertainment to television. That suggests, as do the data on consumer surplus, that consumers placed a substantial valuation on TV entertainment (Table 2.6).

[5] World War II rationing may account for the high ratio of recreation services expenditure in the mid-1940s.

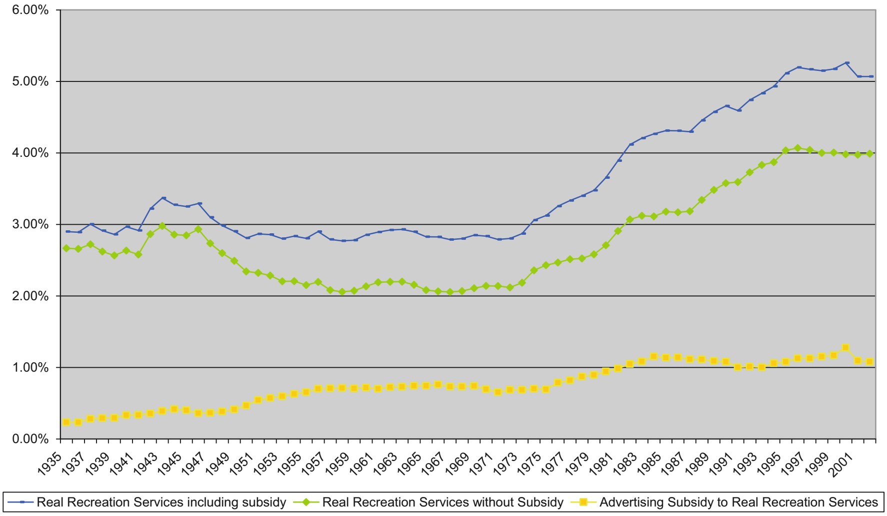

Fig. 2.3 Recreation services as proportion of personal consumption expenditures with and without subsidy

2.4 Advertising as an Investment

The treatment of advertising as an investment would be directly analogous to investment in durable goods. In the national accounts, investments in tangible goods and in software are treated as part of gross domestic final product, while material and labor inputs to production are treated as intermediate goods. Similarly, in a monopolistic competition environment (Dixit and Stiglitz 1977; or Grossman and Shapiro 1984) fixed expenditures to differentiate a product such as advertising may be treated as investments if their costs are amortized over several periods and more appropriately as intermediate goods if their costs are covered in current output.

Advertisements that introduce a new model of car may well be intended to have an impact extending over the life of the model, that is, over several years. For example, advertising to introduce a TV show may continue to influence viewing of reruns of DVD sales years later. Advertising expenditures for repeat purchase goods such as cereals, beer, toothpaste, or drugs similarly plausibly have long lives.

It is equally evident that some portion of advertising expenditure is intended to be immediately expensed. For example, advertisements of automobile clearance sales or zero-interest financing are likely to have only a short-term impact on sales. Indeed, such advertising may well be accompanied by short-term *declines* in future auto sales and profitability and in *current* equity prices.

Indirect estimates of the component of corporate advertising expenditures that should be counted as investment are typically obtained using regressions of advertising against measures of contemporaneous corporate market value, or future

Table 2.6 Real personal consumption, total, recreation services, and recreation services with advertising contribution included, annualized growth rates (2000 chained dollars)

	Measured real personal consumption expenditures (%)	Measured recreation services (%)	Recreation services with advertising contribution (%)
1935–39	4.4	3.5	4.1
1940–49	4.1	3.9	4.3
1950–59	3.7	1.8	3.2
1960–69	4.4	4.6	4.7
1970–79	3.5	5.6	5.6
1980–89	3.3	6.4	6.2
1990–99	3.3	4.7	4.6
2000–03	3.5	3.4	2.9

Source: Bureau of Economic Analysis and author's calculations

profits or sales. In these regressions, a short-run negative correlation of advertisement expenditure and equity or profits will likely reduce the apparent life of average advertising expenditure by mixing negative effects and positive ones in individual firm and panel regression analysis as in Peles; Bublitz and Ettredge; and Hall. The fact that Peles and Bublitz and Ettredge find lower lives for durables (that have strong cyclical components) than for nondurables is indicative of this possibility.

From the perspective of investment only the positive effects should be counted. At the same time, advertising that is intended to have only short-run benefits for the advertiser should not be counted as investment. It thus seems appropriate to consider that some fraction of advertising be considered investment. The Hall study gives a point estimate of advertising's impact on market value being about one-third, implying that one-third of advertising is being treated by equity holders as a capital expenditure and not a current expense.

If we use Hall's one-third of advertising expenditures as an estimate, then the investment component of advertising varies from 0.5 to 0.8 % of GDP. Total unmeasured contributions of advertising to GDP would be roughly two-thirds the size of advertising expenditures, and from 0.9 to 1.5 % of GDP (Table 2.1, line 18).

2.5 Summary

This note has argued that there are two unmeasured contributions of advertising to output: as an investment and as a support to entertainment and news. The role of advertising as an investment has been the subject of substantial controversy. Yet over the years repeated studies have shown that there is some durable market power due to advertising. Hall's estimate—that one-third of advertising expenditure is investment—is a plausible benchmark, but this estimate ought to be updated with additional data.

My estimates for the entertainment support value of advertising are equally approximate. I have argued that a substantial proportion of advertising expenditures on entertainment and news creates a positive contribution to consumer surplus and that this ought to be counted in GDP. In particular, doing so helps make the time series on real recreation services closer to the true overall impact on the U.S. consumer of radio and television. These two underappreciated values of advertising imply that two-thirds of advertising might be viewed as an unmeasured contribution to real output.

References

Bloch, H. (1974). Advertising and profitability: A reappraisal. *Journal of Political Economy, 82* (2 pt. 1), 267–286.

Borden, N. (1942). *The economic effects of advertising*. Chicago: Irwin.

Bublitz, B., & Ettridge, M. (1989). The information in discretion outlays: Advertising, research and development. *Accounting Review, 64*, 108–124.

Coen, R. Bob Coen's historical advertising statistics. Downloaded May 2005, from http://www.universalmccann.com/ourview.html

Comanor, W. S., & Wilson, T. A. (1967). Advertising, market structure and performance. *Review of Economics and Statistics, 51*, 423–440.

Dixit, A. K., & Norman, V. (1978). Advertising and welfare. *Bell Journal of Economics, 9*, 1–17.

Dixit, A. K., & Stiglitz, J. E. (1977). Monopolistic competition and optimum product diversity. *American Economic Review, 67*, 297–308.

Goettler, R. (1999, August) *Advertising rates, audience composition, and competition in the network television industry* (Carnegie Mellon GSIA Working Paper 1999-E28).

Grossman, G. M., & Shapiro, C. (1984). Informative advertising with differentiated products. *Review of Economic Studies, 51*, 63–81.

Hall, B. (1993). The stock market value of R&D investment during the 1980s. *American Economic Review, 83*, 259–264.

Hirschey, M., & Weygandt, J. J. (1985). Amortization policy for advertising and research and development expenditures. *Journal of Accounting Research, 23*, 326–334.

Kothari, S. P., Laguerre, T. E., & Leone, A. J. (2002). Capitalization versus expensing: Evidence on the uncertainty of future earnings from capital expenditures versus R&D outlays. *Review of Accounting Studies, 7*, 355–382.

Nevo, A. (2001). Measuring market power in the ready-to-eat cereal industry. *Econometrica, 69*, 307–342.

Noll, R. G., Peck, M. J., & McGowan, J. T. (1973). *Economic aspects of television regulation*. Washington, DC: Brookings Institution.

Peles, Y. (1971). Rates of amortization of advertising expenditures. *Journal of Political Economy, 79*, 1032–1058.

Schmalensee, R. (1989). Inter-industry studies of structure and performance. In R. Schmalensee & R. D. Willig (Eds.), *Handbook of industrial organization* (Vol. 2, pp. 951–1009). New York: North-Holland.

Stigler, G. J., & Becker, G. S. (1977). De Gustibus Non Est Disputandum. *American Economic Review, 67*, 76–90.

Weiss, L. W. (1969). Advertising, profits, and corporate taxes. *Review of Economics and Statistics, 51*(4), 421–430.

Chapter 3
Intangibles and Value Creation at the Industrial Level: Delineating Their Complementarities

Vincent Delbecque, Ahmed Bounfour, and Andrés Barreneche

Abstract This paper investigates the effect of intangible assets on value creation for 16 French industries from 1980 to 2007. This work is based on original intangible investment data build from the French national accounts and encompassing a wide variety of assets. Our research yields several results. First, data analysis shows that, despite common thought, manufacturing industries are more intangible intensive than service industries. Second, by estimating aggregate and industry-level production functions, we find that the contribution of intangible assets is highly heterogeneous across industries. While the car industry, consumption good industry and financial services use these assets efficiently, the picture is less clear for other industries. Finally, an analysis in terms of complementarities is proposed, leading to delineating possible combinatory intangibles , contributing to value creation.

Keywords Complementarities • Fractional polynomial function • Industry-level • Intangible capital

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The views and arguments expressed in this publication do not necessarily reflect those of the OECD or of the governments of its member countries.

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3.1 Introduction

The productivity slowdown experienced by developed economies during the 1990s has been challenging for both economists and national accountants. While all industries started to extensively integrate computing and software into their production processes, economic performance and related productivity did not match expectations. One potential reason proposed by Nakamura (2003) was that the measurement of the economy was not accounting for all forms of capital and more precisely, intangible capital. R&D capital has long been considered as an asset (rather than an expense) by economists. In national accounting manuals however, R&D spending only appeared as an investment in the 2008 version of the System of National Accounts (SNA) (United Nations 2009). This gap between accounting references and applied research has widened when Corrado et al. (2005) (CHS, thereafter) proposed a list of intangible items that could be considered as assets due to their lifespan and their ability to remain in the production process. While the national accounts include software, database, artistic originals, and mineral exploration in the Gross Fixed Capital Formation account (GFCF), CHS propose to extend this list to R&D, advertising, organisation capital, continuous training and financial innovation.

Estimations of "new" intangible capital have been implemented in several countries such as the US (CHS 2005, 2009), the UK (Giorgio-Marrano et al. 2009), Japan (Fukao et al. 2009; Chun et al. 2012), the Netherlands (Rooijen-Horsten et al. 2008), France (Delbecque and Nayman 2010), Sweden (Edquist 2009). Referring to these studies, intangible investment could amount up to 11 % of GDP and its effect on productivity and growth, although highly heterogeneous across countries, is far from negligible.

Macro estimations and analyses are interesting in comparing structures and performance across countries (World Bank 2010). However, heterogeneity arising within countries (i.e. across industries) is challenging and requires attention in order to properly assess intangible assets efficiency as well as appropriate innovation policy tools (Delbecque and Bounfour 2011). Indeed, while innovation goals are set at the national level or supra-national level (the Lisbon agenda applies to all EU countries), industry specificities may require more disaggregate evaluation and policy tools. Industries differ not only in production processes but also in inputs requirement. In addition, given the multiple forms of innovation, the detailed analysis of distinct intangible assets as well as asset combination has to be addressed (Laranja et al. 2008).

Industry level analysis raises three questions. First, what are industries' investment and innovation patterns, and how do they differ between industries? Second, how does intangible capital contributes to values creation? Third, what are the implications in terms of innovation policy?

Indeed, although innovation could arise in all industries, it might take heterogeneous forms and should be clearly identified. Moreover, such analytical work needs reliable intangible capital data at the industry level. Contributions of R&D or ICT at the industry level is extensively covered by the literature. To our knowledge however, industry-level analyses have hardly been launched regarding the relative contributions of traditional intangibles and new intangibles, except by Crass et al. (2010) and Edquist (2011).

We contribute to the empirical literature by implementing an industry-level analysis on French data. Based on French national statistics data, we estimate intangible investment for 16 industries, including public administrations. Using homogeneous data allows for reliable and comparable information across industries and items. We then assess the contribution of intangible capital alongside with tangible capital and labour on manufacturing and service industries separately as well as on individual industries.

The paper is organised as follows. Section 3.2 presents the data collection and industry investment features. Section 3.3 implements an advanced statistical analysis of assets combination. Section 3.4 analyses the contribution of intangibles to value creation before concluding.

3.2 Intangible Investment and Capital

3.2.1 Methodology for Investment Estimations

Relying on the Corrado et al. (2005) measurement framework, and following Delbecque et al. (2012), we build industry-level intangible data based on the French input/output table from the INSEE (Institut National de la Statistique et des Etudes Economiques). The CHS framework identifies 12 intangible items that could be capitalised, including *software*, *database*, *R&D*, *copyrights and licence costs*, *architecture and engineering design*, *mineral exploration*, *advertising, market research*, *organisation capital* (acquired and internally produced), *financial innovation* and *continuous training*. 9 out of 12 items are directly identified in the French National Accounts either as investment or as intermediate consumption at the 118 crossed industry and products input/output tables. Just as CHS differentiates acquired and internally produced organisation capital, we propose to evaluate internally produced *advertising* and *architecture and engineering design*.

We use three data sources so as to build the intangible figures for France. First, we rely on the Final Uses table[1] detailing the Gross Fixed Capital Formation for intangible items that are capitalised accordingly with the SNA recommendations, namely software, copyrights and licence costs, architecture and engineering design (acquired) and mineral exploration. These four items are available at several levels of industry aggregation in the French national accounts. We thus rely on these data without any further investigation.

[1] Final Uses include final consumption, exports and gross fixed capital formation. Added to intermediate consumption they equal the total resources made of total production and imports.

Second, we estimate potential investment data from the input/output tables (I/O, thereafter) also provided by the INSEE. At the most detailed level, I/O tables track the intermediate consumption for 118 goods and services from which we extract consumption data for database, R&D, purchased advertising, market research and purchased organisation capital. We assume that a share of intermediate consumption could relate to investment rather than current expense and give rise to capital formation and accumulation. Each of these items is estimated following either general principals of national accounting within the SNA framework or research and technical studies related to the given topic.

R&D investment will enter the French national accounts in 2014 with the next SNA implementation and it is currently measured more systematically than other intermediate consumption in a specific "satellite account". This specific measurement is based on R&D expenditures data collected through an annual census amongst all innovative firms and public administrations. These data include labour and non-labour costs related to R&D activities. Based on these data we estimate investment in R&D as the total amount of intermediate consumption of R&D products (NACE 73 rev.1) from I/O tables (27,261 million Euros in 2007 at the aggregate level) as well as the production of R&D by public administrations that are recorded as consumption for final use (mostly universities) in the national accounts (8,767 million Euros in 2007). As we aim at avoiding double-counting, we exclude intra-industry purchases namely, R&D producers acquiring R&D products (3,061 million Euros in 2007).

Investment in advertising (NACE 74.40) and market research (NACE 74.12) is estimated with both I/O tables from the national accounts as well as complementary sources. As assumed by CHS, a share of total spending in advertising is aiming to build brand value that will last over time. The related amount should thus be recorded as investment rather than expenditures. Rooijen-Horsten et al. (2008), in evaluating advertising investment propose to exclude expenses with short-term effects such as classified advertising and promotion. Based on the *Institut de Recherche et d'Études Publicitaires* (IREP) and *FrancePub*,[2] classified advertising could amount 18 % of adverting expenses published in the press (2.5 % of total advertising) and expenses related to promotion amounted 15.6 % of total advertising in 2007. Total spending in advertising and market research recorded in I/O tables equals 30,070 million Euros in 2007. We subtract intra-industry consumption in order to avoid double-counting that can arise with sub-contracting, we also separate market research expenses and apply the "investment share" to the remaining amount. In 2007, following these assumptions, investment in advertising amounted 17,280 million Euros in 2007. Investment in market research is calculated as the total consumption of market research products minus intra-industry trade. It was valued 2,070 million Euros in 2007.

[2] IREP and FrancePub are two major French advertising industry organisations collecting detailed data from communication firms.

Although the System of National Accounts recommends including "large databases" in the GFCF account, the French national accounts measures this item only partially in the software account (Bounfour 2008). Indeed, the INSEE measures investment in databases produced internally through the evaluation of software GFCF using employment data. However, acquisition of databases is still considered as a current expense. We thus assume that the entire amount spent on acquiring databases, except intra-industry consumption, could be capitalised. In 2007 this investment amounted 1,120 million Euros for the whole economy.

Prescott and Visshser (1980) call *organisation capital* the ability of the firm to properly match individuals, groups and tasks or the way the organisation of the firm fits the production process. According to Black and Lynch (2005) and Caroli and Van Reenen (2001), organisation is also linked to the efficiency of vertical communication within firms. CHS propose to proxy acquired organisation capital with the spending on consulting activities (NACE 74.14) "Business and management activities". In 2007, the national accounts recorded a total intermediate consumption of 26,090 million Euros. Given the lack of foundation for this measurement we first assume that the entire amount could be capitalised.

The remaining items are neither directly measured in the Final Uses table nor in the I/O tables. The estimation of internally produced assets (organisation capital, advertising, architecture and engineering design and financial innovation) are based on employment data. The rationale for this methodology is linked to the SNA, the OECD (OECD 2010) and the French national accounts. The SNA and the OECD recommend measuring an investment at its market value when the asset is traded. Otherwise, it shall be valued based on production cost. Following these guidelines, the INSEE estimates own account production of software, i.e., the production of software by non-computing firms that is used internally. This investment is calculated as the total labour costs related to computing programming and engineering (including social contributions) added to non-labour costs implied by the programming activity (INSEE 2009).

Using employment data from the *Enquête Emplois en Continu* (EEC) collected by the INSEE we estimate own account production of organisation capital, advertising, architecture and engineering design and financial innovation following the principles implemented for the software items.

The EEC is a quarterly survey filled by households covering information on employment and employees characteristics, such as net wages, qualification, job (French classification PCS[3]), firm industry classification (four digit NACE rev.1) amongst other. Responses obtained are then weighted to match the whole working population and the annual census.

Following CHS, the own-account organisation capital is calculated as the labour and non-labour cost of managers. The two-digit PCS 23 is the equivalent category in the French classification for managers in firms with more than ten employees.

[3] Professions et Catégories Socioprofessionnelles, see http://www.insee.fr/fr/methodes/default.asp?page=definitions/nomencl-prof-cat-socio-profes.htm

The wage data provided by the survey excludes social contribution. We apply the same rate as the one used by the INSEE for own-account software production, 108 % of net wage. Moreover, the INSEE estimates that the non-labour cost of production (equipment related to the production) could amount 85 % of wage cost. We use the same assumption in the estimation of internally produced assets. In 2007, the EEC counts 156,800 manages with an average net wage of 4,543 Euros for the whole economy. CHS further assume that managers could spend only 50 % of their time working on organisation improvement. However, this assumption still needs to be assessed.

Although CHS only account for purchased advertising, a significant part of advertising and communication production is build internally to the firm. Consequently, we also measure own-account advertising using the same rules as described previously. We extract advertising and communication related activities from the EEC, namely advertising managers (PCS 375a), public relation and communication managers (PCS 375b) and advertising and communication assistants (PCS 464a). In 2007, these categories included 44,290 workers with an average net wage amounting 2,355 Euros. For the whole economy, internally produced advertising equals 1,833 million Euros or around 10 % of total advertising investment.

The architecture and engineering design produced internally is estimated using the same principles. We shortlisted the following occupations likely to perform design outside the design sector itself, namely:

- Engineers and executives in buildings and civil engineering (PCS 382a)
- Architects employed (PCS 382b)
- Engineers and executives in electricity or professional electronics (PCS 383a)
- Design and technical assistants in graphic arts, fashion and decoration (PCS 465a)
- Designers in and civil engineering (PCS 472a)
- Cartographers and surveyors (PCS 472b)
- Designers in mechanics and metal work (PCS 474a).

In 2007, these categories represent 333,084 employees earning 2,619 Euros on average. With our assumptions, the architecture and engineering design for own-account could reach 15,225 million Euros. This amount is almost as high as the acquisition of architecture and engineering design products recorded as GFCF in the national accounts (21,435 million Euros).

CHS consider financial innovation as an investment and this assumption finds some support in the pre-2008 crisis literature. Dynan et al. (2005) highlight the role of such innovation in smoothing consumption and investment. Although defining real innovation in financial products is a difficult task (Tufano 2002), we propose an estimation based on labour cost following Hunt (2008) and similarly to Delbecque et al. (2012). With this methodology, the value of financial innovation is assumed to equal the labour costs related to research activities in financial institutions, namely economic, financial and trade research managers (PCS 372a) and surveyors (PCS 387d). In 2007, 3,337 employees were involved in these activities earning 4,615

Euros per month on average. Investment in financial innovation could then be valued 270 million Euros. Using a different methodology, CHS find much larger results on the US economy. However, the labour cost method has been implemented in the several countries (Giorgio-Marrano et al. 2009; Corrado et al. 2012) and lead to results close to ours.

Continuous training in France is funded by central and local administrations and firms. Government training expenses are recorded in the government accounts and amounted 4,261 million Euros in 2007. Training for firms' employees can be implemented by the firm itself or by training centres financed through dedicated taxes. The amount spent or collected for continuous training is thus recorded in the tax forms and available at the two-digit NACE level. In 2007, firms funded 11,977 million Euros form the training schemes.

Each of the items presented are available at several level of industry disaggregation in the Final Uses table, I/O tables, EEC or tax forms. However, all these sources use different industry classification codes. Most of the data come from the I/O tables in the French NES classification[4] (Nomenclature Economique de synthèse). In order to build comparable industry aggregates across items, and for the purpose of this study we use the first level of the NES rev.1 classifications and collect data for 16 industries. The level-1 NES classification is comparable to the level-1 NACE rev1 classification.

3.2.2 Building Time Series and Intangible Capital Stocks

The French national accounts provide detailed I/O tables for years 1999–2008. Consequently, we apply the methodology described previously to this period of time. Before 1999 the national accounts detail intermediate consumptions for 40 categories of product and service since 1980 within which items presented above are aggregated in upper categories. In order to estimate intangible investment back we assume constant share of items of interest in upper categories. In other words, we apply aggregate categories annual growth rates to underlying intangible items. Investment in purchased advertising, market research, purchased organisation capital and database are backcast using this method for the period 1980–1998. All the remaining items (including R&D) are measured individually back to 1980.

While most studies use aggregate value-added prices as deflators for intangible investment, we use specific service price indexes in order to calculate real values for investment. Indeed, value-added prices are not appropriate since service prices have grown at a fastest pace than the rest of the economy since the late 1990s.

Intangibles already recorded as investment in the national accounts are given in both nominal and real terms. The other items are deflated using individual service

[4] See INSEE: http://www.insee.fr/en/methodes/default.asp?page=nomenclatures/nes2003/nes2003.htm

prices. These indexes are available at the same product levels as the I/O tables and final uses tables. From 1999 to 2008 each item is deflated using its own price index while before 1999, investment is deflated using aggregate price indexes as follows:

$$i_n = i_n^C \frac{1}{P_n}$$

with n denoting each intangible item, i_n^c the current value of intangible investment of item n and p_n the price index for item n or its upper category if prior to 1999. We use the *adult and other education not elsewhere classified* (NACE 80.42) price index to deflate continuous training. Finally, we build intangible capital stocks using perpetual inventory method as follows:

$$I_{n,t} = i_{n,t} + I_{n,t-1}(1 - \delta)$$

where $I_{n,t}$ is the capital stock of item n at time t and δ_n is the annual depreciation rate of the stock of item n (Table 3.1). Depreciation rates for intangibles already capitalised are given by the national statistics within the SNA framework. For the remaining items, we rely on CHS (2009) and Giorgio-Marrano et al. (2009) assumptions. Depreciation rates for new intangible items may be somehow debatable. Consequently, in the following econometric exercise, we test the sensitivity of the results to the change in intangible depreciation rates. However, we assume equal depreciation rate across industries for each item.

3.2.3 Tangible Capital, Value-Added and Labour

Tangible capital stocks, value-added and labour data are provided by the STructural ANalysis (STAN) database from the OECD. The database provides us with NACE one-digit industry level deflated tangible capital stocks and value-added as well as total labour (including self-employment) given in full time equivalent. These data are originally collected from national statistics offices by the OECD. Data are available since 1980–2007 on an annual basis.

As intangible capital data and OECD data use different classification and different levels of aggregation, we first aggregate intangible investment data at the French NES 16-industry level and transpose the NACE classification into NES in order to merge properly the two datasets. Although we waste detailed information when aggregating industries, that allows for clearer picture in data description. Moreover, the aggregation level of data in the STAN database does not allow for more detailed information.

Table 3.1 Intangible data sources and assumptions

Item	Data source	Assumed share of investment in total spending	Depreciation rate of asset	Already in the French GFCF account	Available in the NA back to 1980
Software (produced and purchased)	GFCF account	–	0.32	Yes	Yes
Database	I/O tables	100 %	0.32	No	No
Artistic originals	GFCF account	–	0.2	Yes	Yes
Architecture and engineering design	GFCF account	–	0.2	Yes	Yes
Mineral exploration	GFCF account	–	0.2	Yes	Yes
R&D	I/O tables	100 %	0.2	No	Yes
Advertising (purchased)	I/O tables	80 %	0.6	No	No
Advertising (produced)	Enquête Emploi (labour survey)	50 % of total cost	0.6	No	Yes
Market research	I/O tables	100 %	0.6	No	No
Organisation capital (purchased)	I/O tables	50 %	0.4	No	No
Organisation capital (produced)	Enquête Emploi (labour survey)	20 % of total cost	0.4	No	Yes
Continuous training	Training tax forms	90 % of total training cost declared	0.4	No	Yes
Financial innovation	Enquête Emploi (labour survey)	20 % of total cost	0.2	No	Yes

Source: Delbecque and Nayman (2010), Giorgio-Marrano et al. (2009)

3.3 Stylised Facts

It has long been argued that the increase in service activities in total production of developed economies would lead to a joint increase in so-called “knowledge-intensive” or “intangible” inputs in the economy. The rationale being that service industries could be more intangible intensive than manufacturing industries. This holds true in absolute terms for some service industries, such as the business

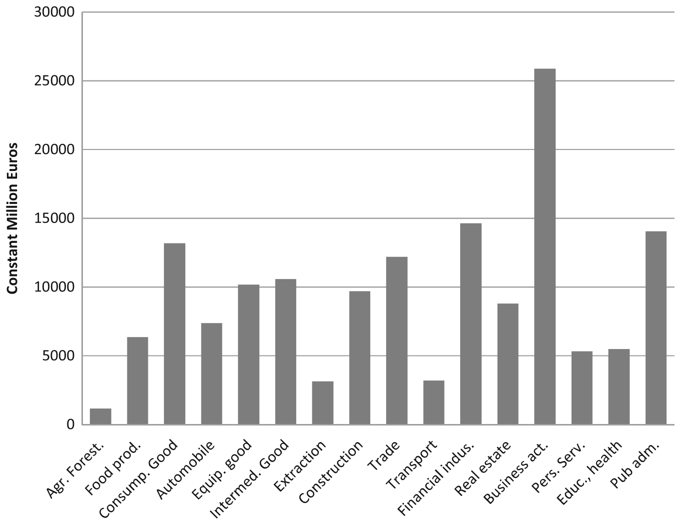


Fig. 3.1 Intangible investment in 2007 (constant million Euros)

activities industry (NACE 74)[5] or the financial services industry (NACE J) compared to other manufacturing industries (Fig. 3.1).

However in relative terms, the picture is very different. When expressed in share of value-added, intangible investment in service industries are particularly low compared to manufacturing industries (Fig. 3.2).

The car industry, the intermediate goods industry and the consumption good industry are particularly intensive in intangible investment. More surprisingly, while service industries are supposed to be more intangible than tangible intensive our data do not support this view. In service industries (wholesale and retail trade, financial services, business activities and personal services) the budget dedicated to intangible investment is comparable to the amount invested in tangible capital. Meanwhile, in manufacturing industries (except extractive activities), investment in intangible capital is at least equal to investment in tangible capital, up to six times higher in the consumption good industry.

When expressed in terms of investment per employee the picture is, again, slightly different. Differences in investment relative to labour are less pronounced than in the previous picture, still, the manufacturing industry is more capital intensive than other industries (Fig. 3.3).

These first figures give a overall view of investment at the industry level and particularly concerning the distribution between tangible and intangible investment.

[5] As mentioned in Sect. 3.1 industries are categorised following the French NES classification. In order to ease the reading, we relate these industries to the closest corresponding NACE industries.

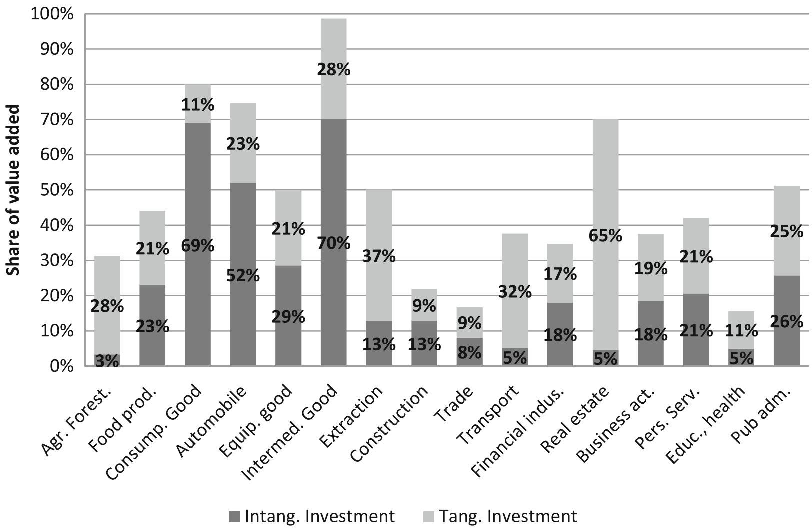


Fig. 3.2 Tangible and intangible investment in share of value-added in 2007 (constant terms)

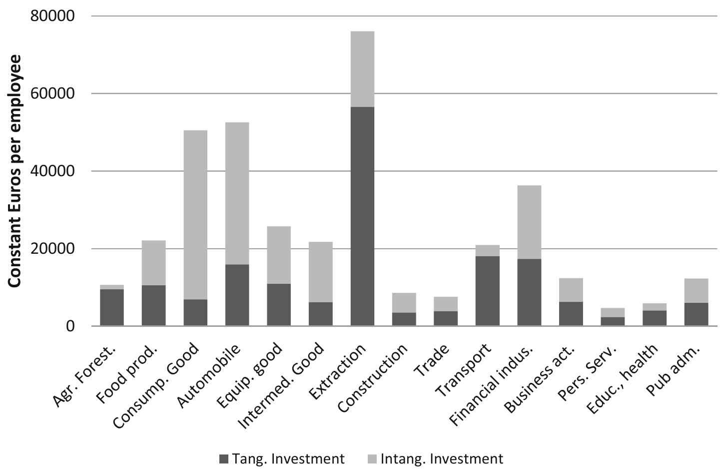


Fig. 3.3 Tangible and intangible intensity relative to labour input in 2007 (The real estate industry is not displayed on this figure. Tangible investment in the real estate industry is particularly high since it invests massively buildings for renting.)

We now go more in detail into the structure of investment at the 16-industry level. For each industry, we detail the share of each item in total intangible investment (Fig. 3.4). As shown in Fig. 3.4, investment structure is highly industry-specific. Manufacturing industries invest mainly in R&D, while relatively less in software and organisation compared to service industries. This yields two implications. First, when intangible investment is treated as an homogeneous

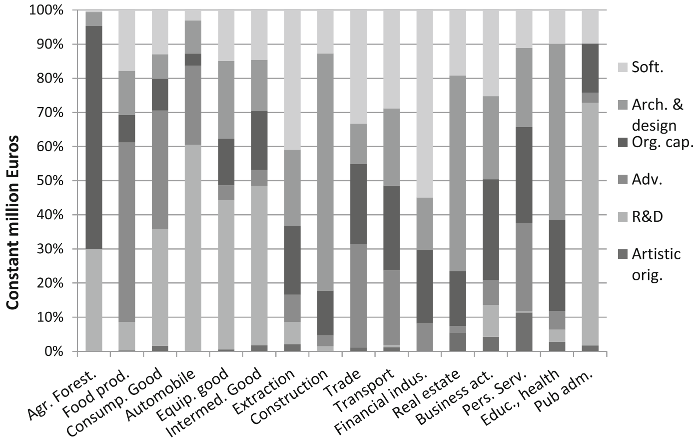


Fig. 3.4 Industry structure of intangible investment in 2007

aggregate much information are missing since it is made of several different items. Second, when dealing with investment performance, the industry-level analysis is of particular interest since investment structure differ widely across industries.

In dynamic terms, intangible investment has been increasing since 1980 in all industries. However, differences in growth path emerge between some of them. The dynamics of intangible investment in the automobile industry shows specific trends. While, automobile industry was as intangible intensive as the consumption good and intermediate good industries until the mid 1990s, it has been decreasing (relative to value-added) by 25 % between 1993 and 2000. This sharp fall is mainly due to a comparable decrease in R&D investment by the car industry during the 1990s (Figs. 3.5 and 3.6).

One mechanical explanation for this trend is the strong increase in output and value-added in the car industry during these years (+60 % between 1996 and 2000), consequently, as investment grew slower than value-added, the ratio decreased. However, it also shows that despite a strong rise in value creation, the investment in innovative products and processes in the French car industry has not been boosted.

The increasing trend of intangible investment is also clear in the service industry. The financial industry has experienced a strong rise in investment during the 1990s, mainly due to the increase in computer software in the production process. Personal services industry is also increasingly intangible, more than all other service industries.

The business activity industry displays a slightly different picture. Intangible investment has risen faster than in the other industries during the 1980s but has remained constant relative to value-added since the early 1990s.

So far we have characterised intangible items individually. However, complementarities and combinations between assets could arise and thus need to be assessed. We now draw a more detail picture of intangible assets running a principal component analysis in order to highlight combined characteristics amongst items.

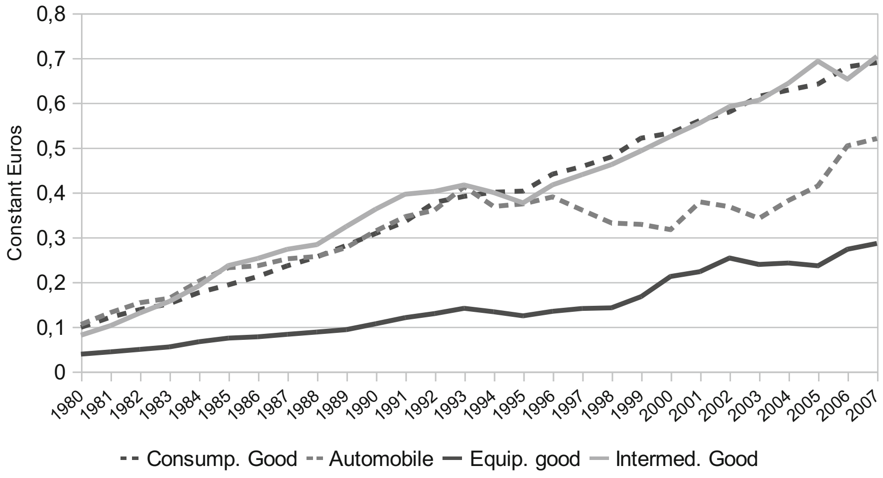


Fig. 3.5 Intangible investment relative to value-added in main manufacturing industries. Source: authors' calculation

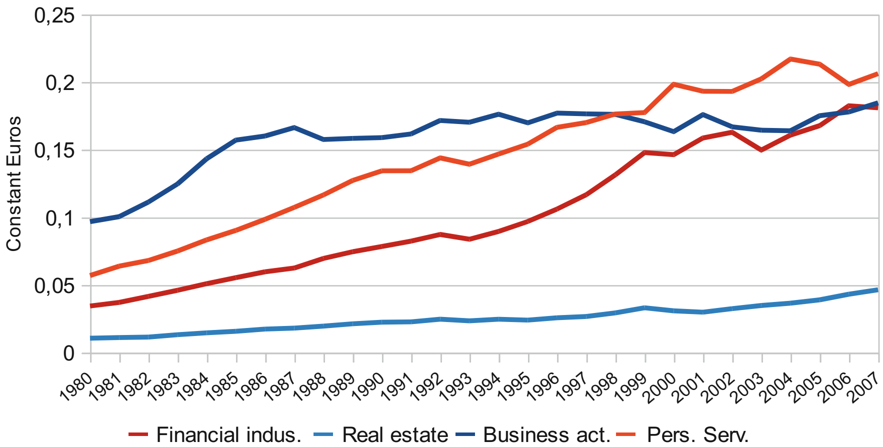
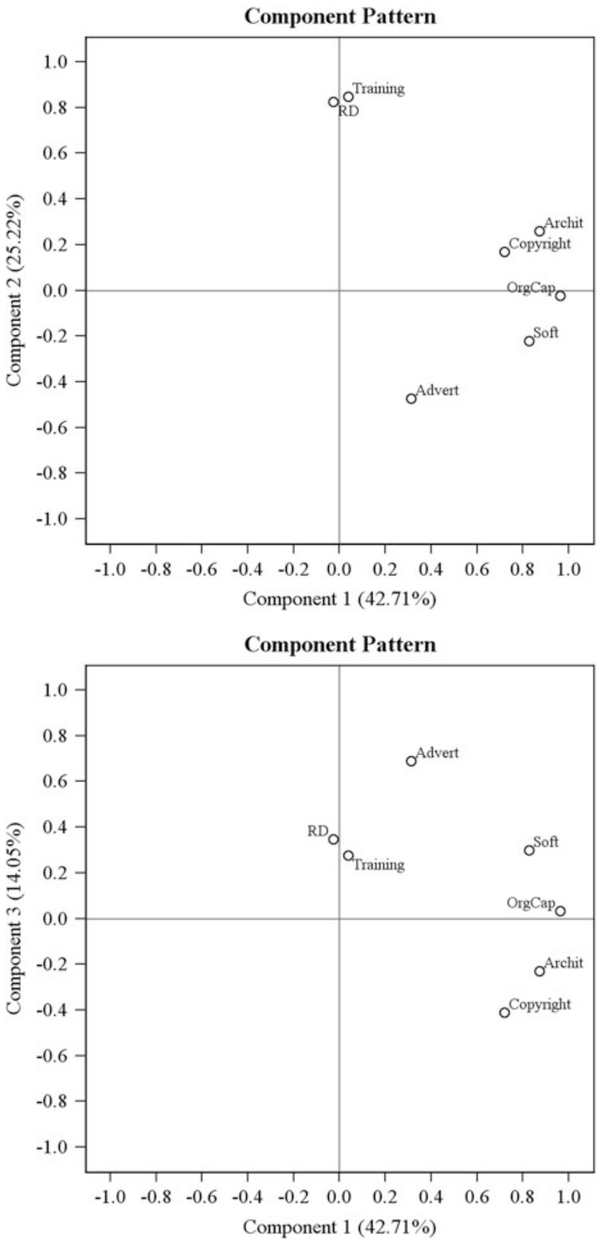


Fig. 3.6 Intangible investment in share of value-added in main service industries. Source: authors' calculation

Using the partial correlation matrix (accounting for partial effect of time trend) we find that the first three principal components account for more than 80 % of total dispersion (Appendix 1).

All variables have positive coefficients in the first principal component (PC, thereafter). However, advertising and R&D have very low coefficients in this index. Advertising is the most important items of the second component with a very high coefficient (0.83), followed by software. The third component is mainly based on

Fig. 3.7 Overall principal component analysis



the R&D item, again with a very high coefficient (0.94). Following, we define three indexes, an overall index, an advertising index and an R&D index.

Figures 3.7 and 3.8 display the individual dispersion on the first and second principal component and the first and third principal component respectively.

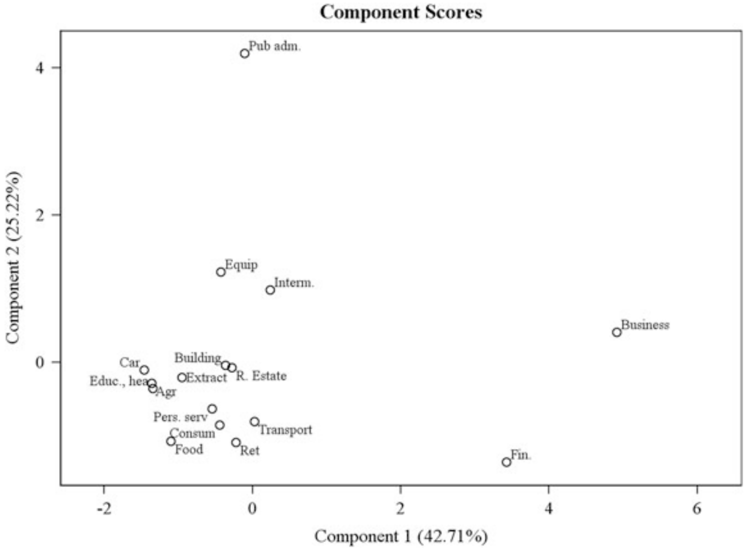


Fig. 3.8 Plot of industries on the first principal plane. Source: authors' calculation

On the first principal plane, the business services industry is high on the first axis due to high overall innovation index followed by other service industries (Trade, real estate, financial services, public administration or personal services). Owing to this ranking, the car industry, the extraction industry, equipment, intermediate and consumption good industries are little innovative due to the small weight of R&D in the overall index.

On the second axis displaying advertising index, food industry, consumption goods industry and trade industry rank high due to large advertising assets. Financial services and personal services also have high score due to significant investment and assets in software.

The second principal plane displays the industry dispersion on the first and the third component. The vertical axis represents R&D-driven innovation index. There is a clear distinction between manufacturing industries (consumption goods, intermediate goods, equipment goods and cars) ranking high on the axis and service industries taking smaller values. However, public administration, as mentioned in the previous section, is large contributor to total R&D investment and has the largest score on the third index.

3.3.1 Identifying Asset Complementarities

The results from the previous section provide an understanding of how intangible assets affect output in sectors. The principal-component analysis ensures the independence of factors to enable our regression analysis. This procedure evades the inspection of asset complementarity; on whether tangible and intangible assets have combinatory effects that enable further production. According to Roberts (2004), complementarities involve the interactions among changes in different production factors. They give rise to system effects in which the whole is larger than the sum of its parts. When an exogenous effect increases or decreases the attractiveness of increasing an input, its complementary assets tend to move together in the same direction. This gives rise to systematic patterns in how inputs change upon exogenous effects. This section explores complementarities in intangible capital and how these contribute to value creation.

Complementarity is closely linked to the mathematical concepts of superadditivity or suppermodularity (Milgrom and Roberts 1990). Superadditivity models how an adding an activity when in the presence of another activity has incremental effect upon performance as to performing the activity in isolation (Cassiman and Veugelers 2006). Teece (1986) recognized the role of complementarities assets such as marketing and manufacturing and how the lack of these two assets raised the suitability of licensing available patents.

Under the traditional econometric analysis, researchers test of interactions between two variables by including a term corresponding to the product of the explanatory variables which are considered to be complementary. For example if, in the log-linear form of the production function [Eq. (3.6), next section], intangible and tangible capital were suspected to provide complementarities, we would include the term $\sigma(\log K * \log I)$.

$$\log Y = \log A + \alpha \log \mathrm{L} + \beta \log \mathrm{K} + \gamma \log \mathrm{I} + \sigma\left(\log K * \log I\right) \tag{3.1}$$

The reach of this standard analysis is highly limited. It assumes a linear distribution in the interaction (a constant σ slope) through all levels of the explanatory factors (K and I). In our context, it does not consider the possibility of a variable combined effect of intangible capital at different levels of tangible capital. As we would like to clarify whether complementarities make it more relevant to invest in certain assets at determined levels observed in other assets, we require a more in-depth analysis.

Royston and Sauerbrei (2004) proposed a fractional polynomial (FP) method to investigate interactions between predictors. An FP function with one power term *p1*, expressed as $\beta_1 x^{p1}$, is referred as an FP1 function. The power term is chosen from the set $S = (-2, -1, -0.5, 0, 0.5, 1, 2, 3)$, where x^0 corresponds to log x (Royston and Altman 1994). An FP2 function with two power terms *p1* and *p2*, expressed as $\beta_1 x^{p1} + \beta_2 x^{p2}$. Likewise, for FP2 functions the powers are selected from the S set. In this paper, we use FP1 functions in order to avoid overfitting our estimations. The MFPIgen algorithm described in Royston and Sauerbrei (2009) estimates the following function:

$$Z = \beta_1 x^{p1} + \beta_2 y^{p2} + \beta_3 x^{p1} y^{p2} \tag{3.2}$$

Table 3.2 Testing for interactions (complementarities)

Variable 1	Function variable 1	Variable 2	Function variable 2	P-value
Labour	x^{-2}	Tangible	Linear	**0.0008**
	x^3	Advertising	x^{-2}	**0.0019**
	x^{-2}	Design	Linear	0.1637
	x^{-2}	OC	x^3	0.5543
	x^3	R&D	Linear	**0.0033**
	Linear	Software	Linear	**0.0035**
Tangible	Linear	Advertising	x^{-2}	**0**
	Linear	Design	Linear	**0**
	Linear	OC	Linear	**0.0071**
	Linear	R&D	x^3	**0**
	Linear	Software	x^3	**0.006**
Advertising	x^{-2}	Design	Linear	0.0178
	x^3	OC	x^2	**0**
	x^{-2}	R&D	x^{-1}	0.0737
	x^3	Software	x^3	0.0257
Design	Linear	OC	x^3	0.2078
	Linear	R&D	Linear	**0**
	Linear	Software	Linear	**0.0009**
OC	x^2	R&D	x^{-2}	0.9306
	x^2	Software	Linear	0.5532
R&D	Linear	Software	x^3	0.0108

Note: P-values lower than 1 % are in bold. Variables with logarithmic transformation

It produces specific estimates for each of the p1 and p2 combinations available in *S* and selects the best fit according to a likelihood-ratio test of interaction. This methodology was first introduced and implemented in the field of medicine for the analysis of clinical trials (for example Nash et al. 2008; Cooke et al. 2008).

Following the implementation guidelines found in Royston and Sauerbrei (2009), we estimate asset complementarities under the autoregressive panel specification presented in the previous section.

$$Y_{t,i} = \beta_1 A_{1,i}{}^{p1} + \beta_2 A_{2,i}{}^{p2} + \beta_3 A_{1,i}{}^{p1} A_{2,i}{}^{p2} + F(Y_{t-1,i} + A_{3,i} + \ldots + A_7) \quad (3.3)$$

For each pair of assets (A), a possible interaction is tested following the MFPIgen algorithm and Eq. (3.3) while considering the linear effects of the remaining variables.

Table 3.2 below contains the results. The first column indicates the first variable to be tested for complementarity, while the second shows the best fitted function. The third and fourth column shows the second variable and its best fitted function. The fifth column displays the p-value of the likelihood test for interaction between the two variables (first and third columns in the table). The table points toward several non-linear functions. Since the variables take only positive variables a power of −1 or −2 indicates a decreasing effect which tends to 0, the latter more rapidly than the former. A squared or cubic power expresses a growing effect

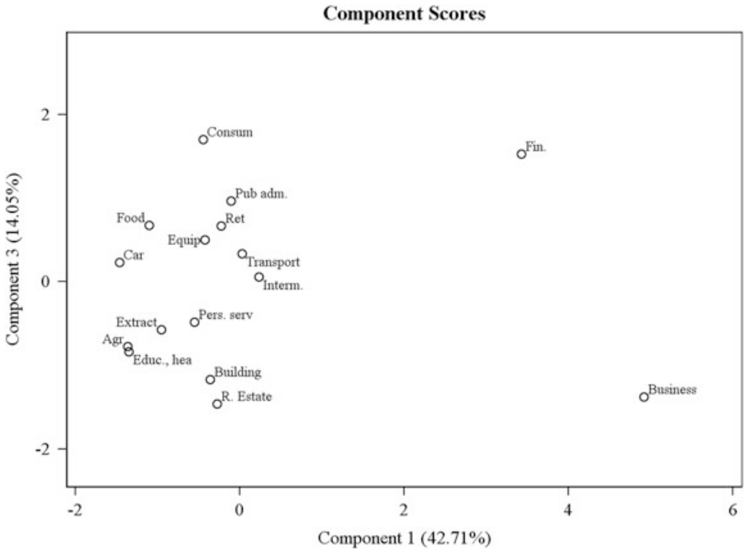


Fig. 3.9 Plot of industries on the second principal plane. Source: authors' calculation

(naturally the third power describes faster growth). Since most of interactions are non-linear, coefficients are omitted in the table as their interpretation is non-trivial. Significance evidence (p-value < 1 %) was found for complementarities between labour and the following investments: tangible assets, advertising, R&D and software. For tangible investment, we find that all intangible expenditures are significant. Conversely, only a few complementarities were found between intangibles, these are: Advertising—Organizational Capital, Design—R&D and Design—Software.

In order to understand the impact of these complementarities upon production in industries, we employ sliced plots for the significant relations. The sets of plots are found in Figs. 3.9 and 3.10. Each figure contains plots for relations reporting p-values lower than 1 %. We cover them from left-to-right and top-to-bottom. The first plot shows the different relations between labour and production at four different levels of tangible investment seen in the sample: 20 % (solid line), 40 % (dashed line), 60 % (dotted line), and 80 % (dot-dash line). The different lines indicate a varying contribution of labour to production as tangible investment increases. In particular, we remark that, at low levels of tangible investment, the amount of production associated to labour is more limited as to higher levels of tangible investment. This suggests that these inputs are positively complementary.

Other plots follow the same structure, although they display different relationships. The second plot shows that advertising investment enhances the contribution of labour to production. The third plot displays a different kind of complementarity between tangible and advertising investment. Instead of an upwards displacement in the contribution of tangible investment to production, we note a shift in the slope.

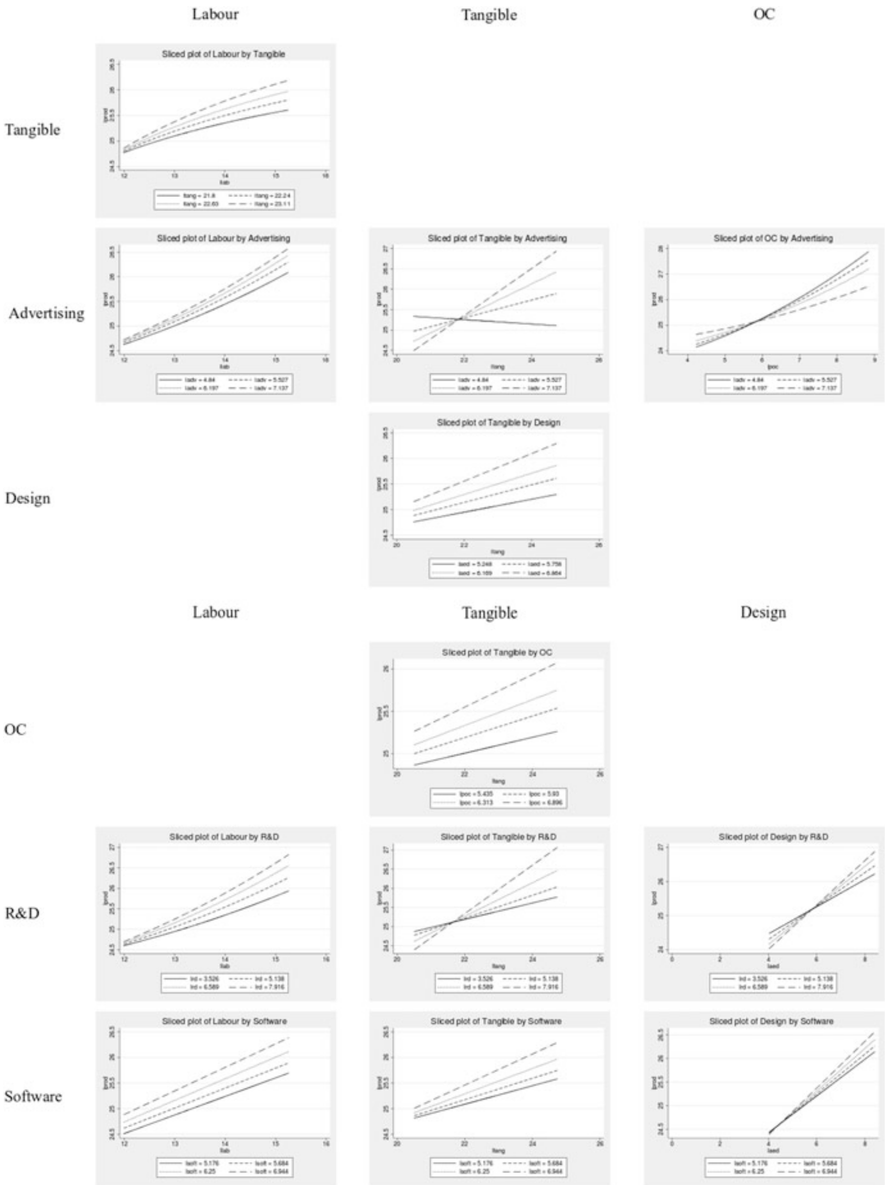


Fig. 3.10 Sliced plots for interactions with $p < 1\ \%$

This indicates that higher levels of advertising investment are inefficient when tangible investment is low. On the other hand, at about 3.5 billion Euros of investment in tangible assets, higher levels of advertising expenditures increase the contribution of tangible investment towards production.

Advertising and Organizational Capital provide a distinct type of interaction: as the former increases, the latter's slope (depicting the contribution towards production) decreases. Contributions of Organizational Capital improve only at the lowest levels of investment, while moderate and high level of investment produce less outputs. This result suggests that these two types of intangibles substitute rather than complement each other. Industries that weigh heavily on advertising rely less in Organizational Capital.

The last plot in Fig. 3.9 shows a positive displacement and shift in the effect of Tangible investment and output, as a result of increasing expenditures in Architecture and Engineering Design. These two assets are therefore highly complementary. Not only does added design investment provide an initial displacement in returns from tangible assets, but also are marginal increases in the latter yield additional returns. This result can be interpreted as follows: investing in design renders tangible investment more efficient in production.

A similar complementarity is observed in the first plot in Fig. 3.10. The output associated to tangible investment moves and pivots upward as investment in organizational capital increases. This suggests that the latter intangible makes the use of physical assets more productive and efficient. Conversely, in the following graph we note that R&D investment only rotate the slope of labour-production. This indicates that R&D yields mainly an efficiency effect towards the outcome of labour.

The next plot can be interpreted similarly as to the tangible-advertising relationship. R&D pivots the tangible curve at a middle point rather than the start. This proposes that, at higher R&D investments, poor expenditures in tangible assets are counterproductive. Gains in production of additional R&D investments are observed in industries whose tangible expenditures exceed 3.5 billion Euros. This reflects the idea that industries that rely less on tangible assets require less R&D. R&D and design are complementary in the same way (see next plot), additional investments in the former only make sense when they are matched with enough efforts in the latter.

Software investment displays two types of complementarities. On one hand, it makes labour and tangible investments both more productive (upwards shift) and efficient (steeper slope). This superior performance reflects a significant support of computer applications in business activities. On the other, although design investments do not display an upward shift, they do become more efficient when backed-up by software expenditures. This indicates a relevant role in computer systems and applications as Computer Assisted Design (CAD) in the output of design investment.

Although this methodology provides several indication of complementarities, our setup does not allow it to be tested for robustness. In particular, it is possible for the estimations to suffer from endogeneity: possible feedback effects between non-independent assets present in Eq. (3.3). To overcome this issue and analyze the role of intangibles in production, we use the PCA to model productivity in the following section.

3.4 Intangible Investment and Performance

We now turn to the analysis of factor contribution to growth. To that aim we explicitly estimate a Cobb-Douglas production function using labour and tangible capital as well as intangible capital as input factors. The Cobb-Douglas production function type has long been used in innovation analysis (see for instance Hall and Mairesse 1995 or Hall et al. 2009) and despite its simple form, allows for direct interpretation in terms of contribution to value creation.

Although intangible investment and capital is increasing in industries production processes, the contribution of such investment has to be assessed. We thus propose to evaluate input factors contribution to value added accounting for industry-specificities as well as intangible asset diversity. So far, innovation policies have mainly been focusing on R&D as the main innovation driver, excluding de facto other type of innovation more related to processes than products (Moncada-Paternò-Castello et al. 2010). Moreover, not accounting for industries specificities would lead to inappropriate, even, counterproductive policies.

In the CHS framework, we assume that value-added (Y) results from a combination of not only labour (L) and tangible capital (K) but also intangible capital (I):

$$Y = F(L, K, I) \tag{3.4}$$

We implement a three-factor Cobb-Douglas production function in order to characterise production patterns[6]:

$$Y = AL^{\alpha}K^{\beta}I^{\gamma} \tag{3.5}$$

Using the log-linear form of the production function:

$$\log Y = \log \mathrm{A} + \alpha \log \mathrm{L} + \beta \log \mathrm{K} + \gamma \log \mathrm{I} \tag{3.6}$$

where α, β and γ are parameters to be estimated.

Applying Ordinary Least Squares (OLS) to a panel dataset would yield inconsistent results since it would not account for industry-heterogeneity. The common Fixed-effects panel data allows for individual specific trends that can be interpreted as productivity factors.

However, in the case of production functions, both the output and the input variables are persistent over time and should modelled as autoregressive:

$$\Delta y_{i,t} = \Delta y_{i,t-1}\rho + \Delta X_{i,t}\beta + \Delta\epsilon_{i,t}$$

Following Blundell and Bond (2000) we compare estimations results from OLS, fixed effects panel data, difference GMM (Arellano and Bond 1991) and system

[6] Note that we do not assume any restriction on returns to scale.

Table 3.3 Production function estimation using aggregate intangible capital

	Pooled	Within	GMM Dif 2	GMM Dif 3	GMM Sys 2	GMM Sys 3
L	**0.332**	**0.475**	**0.881**	**0.738**	**0.398**	**0.366**
	(0.034)	***(0.042)***	***(0.122)***	***(0.138)***	***(0.173)***	***(0.182)***
K	**0.134**	**0.024**	0.026	0.032	0.079	0.108
	(0.022)	***(0.012)***	*(0.040)*	*(0.038)*	*(0.114)*	*(0.118)*
I	**0.143**	**0.096**	**0.204**	**0.173**	**0.329**	**0.316**
	(0.033)	***(0.057)***	***(0.036)***	***(0.037)***	***(0.066)***	***(0.070)***
Time Series	28	28	28	28	28	28
Cross-Sections	16	16	16	16	16	16
CRS	<0.001	<0.001	0.46	0.72	0.02	0.03
AR(1)	–	–	−1.44	−2.19	−2.37	−1.54
			(0.92)	*(0.99)*	*(0.99)*	*(0.12)*
AR(2)	–	–	1.52	0.86	1.16	0.68
			(0.06)	*(0.19)*	*(0.12)*	*(0.49)*
Sargan (*p-value*)	–	–	0.00	0.18	0.00	0.00

CRS test: under H_0 $\beta_L + \beta_K + \beta_I = 1$
Sargan test under H_0 instruments are not correlated with errors
Coefficients significant at the 10 % level in bold

GMM (Blundell and Bond 2000). While fixed effects do account for individual heterogeneity, it ignores dynamic panel data biases (Nickell 1981; Bond 2002). Difference GMM introduced by Arellano and Bond (1991) use explanatory variables lagged levels as instruments in order to estimate unbiased equations in first differences. However, in some cases these instruments may be weak and system GMM would perform better instrumenting levels with differences and differences with lagged levels.[7]

3.4.1 Panel Data Estimations

We first estimate the contributions of labour, tangible capital and intangible capital as an aggregate (Table 3.3). Although biased, OLS estimates yield plausible results with a larger contribution of labour (0.33) compared to tangible and intangible capital (0.13 and 0.14). We do not impose the returns to be constant and OLS estimates lead to reject CRS assumption. Following, the within transformation using industry fixed effects find a larger contribution of both labour and intangible capital compared to OLS and weaker contribution of tangible capital.

We then apply the Arellano-Bond difference GMM and Blundell-Bond System GMM using alternatively lag t-2 and lag t-3 variable in level as instruments for first-differences. The Sargan test performed for the four estimations would prefer the

[7] See Blundell and Bond (2000) and Roodman (2009) for complete discussion on GMM estimators.

Table 3.4 Production function estimation using detailed intangible capital

	Pooled	Within	GMM Dif 2	GMM Dif 3	GMM Sys 2	GMM Sys 3
L	**0.373**	**0.408**	**0.566**	**0.851**	**0.291**	**0.316**
	(0.037)	***(0.047)***	***(0.299)***	***(0.206)***	***(0.043)***	***(0.072)***
K	−0.014	0.012	−0.030	0.036	−0.043	−0.090
	(0.029)	*(0.012)*	*(0.088)*	*(0.062)*	*(0.070)*	*(0.100)*
Soft.	**0.262**	**−0.221**	0.001	0.029	0.038	0.085
	(0.069)	***(0.062)***	*(0.084)*	*(0.079)*	*(0.116)*	*(0.101)*
R&D	−0.049	**0.060**	**0.846**	**0.389**	**−0.051**	**−0.059**
	(0.043)	***(0.033)***	***(0.259)***	***(0.234)***	***(0.025)***	***(0.022)***
Adv.	**−0.124**	**0.178**	**−0.291**	−0.156	−0.074	**−0.101**
	(0.019)	***(0.054)***	***(0.139)***	*(0.160)*	*(0.052)*	***(0.057)***
Org.	**−0.280**	−0.099	0.004	−0.079	−0.015	−0.089
	(0.074)	*(0.132)*	*(0.136)*	*(0.147)*	*(0.139)*	*(0.147)*
Training	0.012	0.053	−0.073	−0.039	−0.004	−0.009
	(0.021)	*(0.025)*	*(0.102)*	*(0.074)*	*(0.059)*	*(0.100)*
Archit.	**0.165**	0.039	−0.216	0.027	**0.334**	**0.356**
	(0.033)	*(0.153)*	*(0.152)*	*(0.190)*	***(0.107)***	***(0.194)***
Copy.	**0.039**	−0.035	−0.099	−0.037	0.015	0.025
	(0.008)	*(0.023)*	*(0.046)*	*(0.037)*	*(0.035)*	*(0.043)*
R^2	0.99	0.98				
F-Test Fixed effects	–	<0.001				
Time Series	28	28	28	28	28	28
Cross-Sections	16	16	16	16	16	16
AR(1)			1.25	0.47	0.09	0.24
			(0.10)	*(031)*	*(0.93)*	*(0.81)*
AR(2)			1.72	1.90	1.63	1.16
			(0.04)	*(0.02)*	*(0.10)*	*(0.24)*
Sargan (*p-value*)			0.08	0.53	0.00	0.00

Coefficients significant at the 10 % level in bold. Sargan test under H_0 instruments are not correlated with errors

difference GMM with a t-3 lag for the instruments. However, the non-significant coefficient for tangible capital highlights the sensitivity of results using instruments. The estimated contribution of labour is well above the previous estimations and should be considered carefully. Intangible capital again has a large and significant positive contribution. The test for constant returns to scale concludes on the positive.

Following, we estimated functions detailing each intangible asset individually. As all assets are supposed to interact and bundle together we include all intangibles simultaneously in the estimation. However these estimations face large collinearity issues since intangible items are highly correlated. This results in an increase in estimators standard deviations leading to insignificant coefficients.

Again, the difference GMM seems to perform better compared to the system GMM with coefficients for labour ranging from 0.56 to 0.85. The detailed results on intangibles (Table 3.4) yield significant results on the positive contribution of R&D to value added although very high compared to previous results in the literature.

Table 3.5 Production function estimation using intangible indexes

	Pooled	Within	GMM Dif 2	GMM Dif 3	GMM Sys 2	GMM Sys 3
L	**0.308**	**0.326**	**1.299**	**0.975**	**0.518**	**0.485**
	(0.035)	***(0.044)***	***(0.190)***	***(0.158)***	***(0.239)***	***(0.227)***
K	**0.192**	**0.051**	−0.015	0.001	0.335	0.425
	(0.029)	***(0.013)***	*(0.044)*	*(0.036)*	*(0.263)*	*(0.289)*
Non-technology index	**0.128**	**0.059**	**−0.065**	**−0.083**	**0.094**	**0.107**
	(0.019)	***(0.008)***	***(0.034)***	***(0.027)***	***(0.058)***	***(0.047)***
Tech. Innov. and Human capital index	**−0.110**	**−0.005**	**0.394**	**0.194**	−0.258	−0.172
	(0.026)	***(0.012)***	***(0.174)***	***(0.118)***	*(0.234)*	*(0.201)*
Communication index	0.002	−0.013	**0.219**	**0.125**	**0.416**	**0.504**
	(0.036)	*(0.015)*	***(0.081)***	***(0.079)***	***(0.230)***	***(0.284)***
R^2	0.99	0.98				
F-Test Fixed effects	–	<0.001				
Time Series	28	28	28	28	28	28
Cross-Sections	16	16	16	16	16	16
AR(1)			1.07	0.59	−0.34	−0.55
			(0.14)	*(0.27)*	*(0.73)*	*(0.58)*
AR(2)			1.72	2.45	−0.55	−0.70
			(0.43)	*(0.01)*	*(0.58)*	*(0.48)*
Sargan (*p-value*)			0.39	0.82	0.00	0.00

Coefficients significant at the 10 % level in bold. Sargan test under H_0 instruments are not correlated with errors

We now try to identify the performance of intangible complementarities using previous results from the PCA analysis. Table 3.5 shows the contribution of Labor and Tangible assets, along with the factor indices identified in Sect. 3.2. The GMM difference estimations show positive contributions from technological innovation & human capital and communication intangibles, and a negative contribution of non-technology assets.

3.5 Conclusions

Using national account data, we estimate new data covering intangible investment and capital for 16 industries in France for the period 1980–2007. In that we intend to characterise and deepen the understanding of innovation patterns at a disaggregate level. First, we extensively document structures and trends in intangible items across industries during the period. Second, we analyse the contribution of several intangible assets jointly with tangible capital and labour accounting for industry heterogeneity and finally, we estimate the performance of intangible assets combinations.

This work provides several valuable results. Intangible investment and innovation characteristics are highly industry-specific. While manufacturing industries are intensive in R&D and engineering design, service industries invest massively in computer software and organisation. This brings evidence on the fact that R&D is not the only type of innovation and that other intangibles should be considered, especially in the service industry. Moreover, trends in investment differ across industries.

We gather evidence supporting the notion of asset complementarity. We report several non-linear interactions between assets. These complementarities are mainly couples involving intangibles with labour and physical assets. In particular, we find that labour and tangible assets are associated to higher levels of production when intangible investment is higher. Some combinations were counter-productive, e.g., low tangible investment and high advertising. This indicates that industries with relatively lower investments in physical capital require less advertising expenditures. Future works should employ more advanced analytical techniques to disentangle these complementarities and identify robust relationships within assets.

Turning to the analysis of assets contribution to value creation, again, we find that intangible capital as a whole has had a greater contribution to value added compared to tangible capital during the period. However, results may be interpreted cautiously since the GMM estimations yield non-significant results for tangible capital coefficients.

The joint effect of intangible assets is not clear since collinearity arise in the regression when including several assets simultaneously. However, assessing each intangible asset independently is not appropriate since all assets are supposed to combine and interact.

In order to solve this issue and assess assets complementarities,, we use endogenous composite innovation indexes build from a principal component analysis. This tool has two main benefits. First, the indexes obtained are not correlated with other variables. Second, it provides empirical indexes built from industry-specific intangible assets structure. Amongst the three indexes obtained we find a strong positive effect of technology innovation (including mainly R&D and training) while communication innovation could have a smaller impact and non-technology innovation (excluding R&D) would yield negative returns.

These findings yield three conclusions. First, analysing intangible capital and investment at a disaggregated level is of prime interest since heterogeneity arises and needs to be addressed. Second, the introduction of "new" intangible assets in both the national and the firm accounting system has to be developed further since it contributes to value creation. Third, firms' innovation practices should also focus on performance driving assets and asset combination. As shown by our results innovation in "non-technology" only assets yields unproductive results while combining technological innovation and human capital is highly value creative.

Table 3.6 Eigenvalues of the partial correlation matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	2.98954313	1.22407444	0.4271	0.4271
2	1.76546869	0.78210975	0.2522	0.6793
3	0.98335894	0.31103701	0.1405	0.8198
4	0.67232193	0.29277975	0.0960	0.9158
5	0.37954218	0.19721738	0.0542	0.9700
6	0.18232480	0.15488449	0.0260	0.9961
7	0.02744031		0.0039	

Source: Authors calculation

Appendix 1: Principal Component Analysis

We run a principal component analysis on the whole industry sample in order to characterise intangible assets across industries and to compare industries based on assets combinations. The three first component account for more than 80 % of total data dispersion. We thus concentrate on these components. All items enter the first component positively with very low scores for R&D and advertising. We call this index "Overall innovation index". The second index, called "Communication vs. technological innovation") is mainly made of advertising and software with a positive signs and design and R&D with negative signs. Industries having large values of R&D assets for instance will have small score in this index. The third index is mostly R&D innovation (Tables 3.6 and 3.7).

Appendix 2: Collinearity Diagnostics

We use the condition index proposed by Belsley et al. (1980) in order to test for potential collinearity between input factors in the different specifications. On empirical basis, Belsley (1993) states that with maximum condition indexes taking values between 1 and 10, no collinearity occurs. When condition index equals 30 to 100 potentially severe collinearity issues arise. Besides, high values of variance proportions (above 0.5) associated to high condition indexes show which variables tend to be collinear.

Appendix 3: Other Data

In order to get a clearer picture of industry composition, we display a chart with industry-level value-added (Fig. 3.11). Service industries are the highest contributors to total value-added in absolute terms.

Table 3.7 Eigenvectors

	1st PC	2nd PC	3rd PC				
	Non-technology index	Technology index	Communication index	4th PC	5th PC	6th PC	7th PC
Adv.	0.181531	−0.356181	0.694194	0.520398	0.187515	0.209022	−0.092788
Arch. & eng. design	0.504877	0.195371	−0.231130	−0.060666	−0.048402	0.791020	−0.147555
Artistic Orig.	0.415559	0.126233	−0.414066	0.619083	0.163394	−0.288463	0.383084
Org. Cap.	0.557090	−0.019079	0.032546	−0.143060	−0.088302	−0.479983	−0.655423
R&D	−0.016084	0.619458	0.350651	0.230678	−0.658334	−0.051362	0.061666
Soft. & database	0.477902	−0.166340	0.301896	−0.489800	−0.112464	−0.103762	0.624084
Training	0.021387	0.638176	0.279403	−0.169293	0.694225	−0.059983	0.000825

Source: Authors calculation

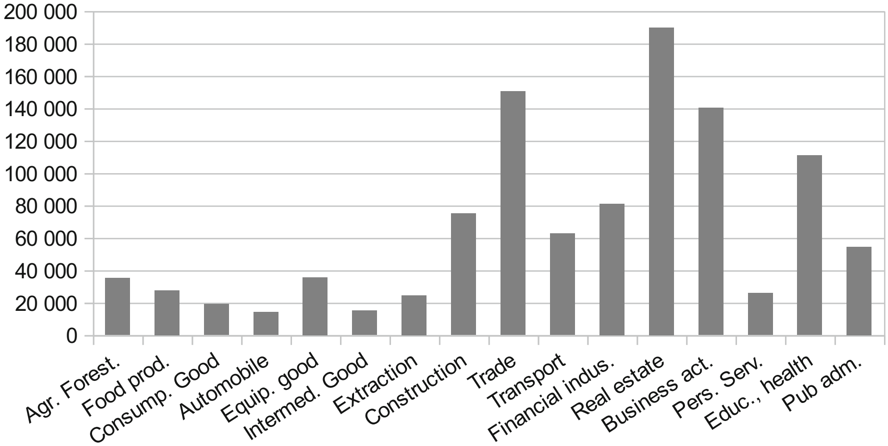


Fig. 3.11 Value added in 2007 (constant million Euros). Source: OECD STAN

References

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*(2), 277–297.

Belsley, D. (1993). Econometrics: A package for doing econometrics in Mathematica. In H. R. Varian (Ed.), *Economic and financial modeling with Mathematica*. New York: Springer-Verlag.

Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential observations and sources of collinearity*. New York: John Wiley and Sons.

Black, S., & Lynch, L. (2005). Measuring organizational capital in the new economy. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 205–236). Chicago: University of Chicago Press. National Bureau of Economic Research, Inc.

Blundell, R., & Bond, S. (1999). *GMM estimation with persistent panel data: An application to production functions* (IFS Working Papers W99/04). Institute for Fiscal Studies.

Blundell, R., & Bond, S. (2000). GMM estimation with persistent panel data: An application to production functions. *Econometric Reviews, 19*(3), 321–340.

Bond, S. R. (2002). Dynamic panel data models: A guide to micro data methods and practice. *Portuguese Economic Journal, 1*, 141–162.

Bounfour, A. (2008). *Organisational capital: Modelling, measuring and contextualising* (Routledge studies in innovation, organizations and technology). London: Routledge.

Caroli, E., & Van Reenen, J. (2001). Skill-biased organizational change? Evidence from a panel of British and French establishments. *The Quarterly Journal of Economics, 116*(4), 1449–1492. MIT Press.

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science, 52*, 68–82.

Chun, H., Kyoji, F., Shoichi, H., & Miyagawa, T. (2012). *Measurement of intangible investments by industry and its role in productivity improvement utilizing comparative studies between Japan and Korea* (RIETI Discussion Paper Series 12-E-037).

Cooke, C. R., Kahn, J. M., Caldwell, E., Okamoto, V. N., Heckbert, S. R., Hudson, L. D., et al. (2008). Predictors of hospital mortality in a population-based cohort of patients with acute lung injury. *Critical Care Medicine, 36*(5), 1412–1420.

Corrado, C., Hulten, C., & Sichel, D. (2005). Measuring capital and technology: An expended framework. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy*. Chicago: University of Chicago Press. NBER Books.

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *Review of Income and Wealth, 55*(3), 661–685.

Corrado, C., Haskel, J., Iommi, M., & Jona-Lasinio, C. (2012). *Intangible capital and growth in advanced economies: Measurement and comparative results* (CEPR Discussion Papers 9061). C.E.P.R. Discussion Papers.

Crass, D., Licht, G., & Peters, B. (2010, December). *Intangible assets and investments at the sector level: Empirical evidence for Germany* (COINVEST Discussion Paper).

Delbecque, V., & Bounfour, A. (2011). *Intangible investment: Contribution to growth and innovation policy issues* (European Chair of Intellectual Capital Management Working Paper 2011-1A).

Delbecque, V., Le Laidier, S., Mairesse, J., & Nayman, L. (2012). L'évaluation des investissements incorporels en France: Méthodes et premiers résultats. *Economie et Statistique, 450*, 3–27.

Delbecque, V., & Nayman, L. (2010, September). *Measuring intangible capital investment: An application to the "French data"* (CEPII, Working Paper 2010-19).

Dynan, K., Elmendorf, D., & Sichel, D. (2005). Can financial innovation help to explain the reduced volatility of economic activity? *Finance and economics discussion series*, Board of Governors of the Federal Reserve System.

Edquist, H. (2009). *Intangible investment and the Swedish manufacturing and service sector paradox* (IFN Working Paper No. 863). Stockholm: Research Institute of industrial economics (IFN).

Edquist, A. (2011). *Intangible investment and the Swedish manufacturing and service sector paradox* (IFN Working Paper No. 863).

Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to economic growth. *Review of Income and Wealth, 55*, 717–736.

Giorgio-Marrano, M., Haskel, J., & Wallis, G. (2009). What happened to the knowledge economy? ICT, intangible investment, and Britain's productivity record revisited. *Review of Income and Wealth, 55*(3), 686–716.

Hall, B., & Mairesse, J. (1995). *Exploring the relationship between R&D and productivity in French manufacturing firms* (NBER Working Papers 3956). National Bureau of Economic Research, Inc.

Hall, B., Mairesse J., & Mohnen, P. (2009). *Measuring the returns to R&D* (NBER Working Papers 15622). National Bureau of Economic Research, Inc.

Hunt, R. (2008, May). *Business method patents and US financial services* (Working Papers 08-10). Federal Reserve Bank of Philadelphia.

Insee. (2009). Les Équilibres ressources-emplois des services marchands. *Notes Méthodologiques détaillées de la Base 2000*, no. 17

Laranja, M., Uyarra, E., & Flanagan, K. (2008). Policies for science, technology and innovation: Translating rationales into regional policies in a multi-level setting. *Research Policy, 37–5*, 823–835.

Milgrom, P., & Roberts, J. (1990). The economics of modern manufacturing: Technology, strategy, and organization. *American Economic Review, 80*, 511–528.

Moncada-Paternò-Castello, P., Ciupagea, C., Smith, K., Tübke, A., & Tubbs, M. (2010). Does Europe perform too little corporate R&D? A comparison of EU and non-EU corporate R&D performance. *Research Policy, 39*(4), 523–536.

Nakamura, L. (2003). A trillion dollars a year in intangible investment and the new economy. In J. R. M. Hand & B. Lev (Eds.), *Intangible assets*. Oxford: Oxford University Press.

Nash, D., Katyal, M., Brinkhof, M. W. G., Keiser, O., May, M., Hughes, R., et al. (2008). Long-term immunologic response to antiretroviral therapy in low-income countries: Collaborative analysis of prospective studies. *AIDS, 22*(17), 2291–2302.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society, 49*(6), 1417–1426.

OECD. (2010). *Handbook on deriving capital measures of intellectual property products*. Paris: OECD.

Prescott, E., & Visscher, M. (1980). Organization capital. *Journal of Political Economy, 88*(3), 446–61.

Roberts, J. (2004). *The modern firm: Organizational design for performance and growth*. Oxford: Oxford University Press.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal, 9*(1), 86–136. StataCorp LP.

Rooijen-Horsten, M., van den Bergen, D., & Tanriseven, M. (2008). *Intangible capital in the Netherlands: A benchmark* (Discussion Paper 08001). Statistics Netherlands.

Royston, P., & Altman, D. G. (1994). Regression using fractional polynomials of continuous covariates: Parsimonious parametric modelling. *Applied Statistics, 43*, 429–467.

Royston, P., & Sauerbrei, W. (2004). A new approach to modelling interactions between treatment and continuous covariates in clinical trials by using fractional polynomials. *Statistics in Medicine, 23*, 2509–2525.

Royston, P., & Sauerbrei, W. (2009). Two techniques for investigating interactions between treatment and continuous covariates in clinical trials. *The Stata Journal, 9*(2), 230–251.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*, 285–305.

Tufano, P. (2002). Financial innovation. In G. Constantides & R. Stulz (Eds.), *The handbook of the economics of finance*. Amsterdam: North Holland.

United Nations. (2009). *System of national accounts*. New York: United Nations.

World Bank. (2010). *The changing wealth of nations: Measuring sustainable development in the new millennium*. Washington, DC: The World Bank.

Chapter 4
Intangible Assets and Investments at the Sector Level: Empirical Evidence for Germany

Dirk Crass, Georg Licht, and Bettina Peters

Abstract This paper investigates the role intangible capital plays for economic growth in different sectors in Germany. It consists of two major parts. In the first part, we aim at measuring investment in intangibles at the sector level. We shed light on differences across sectors but also compare these figures with investment in physical capital and with investment in intangibles in the UK as European benchmark. The second part explores the role of intangible assets for stimulating growth at the sector level by performing growth accounting analyses. We find that German firms have boosted investments in intangible capital from 1995 to 2006 by 30 %. Furthermore, results reveal differences in the investment patterns among the UK and Germany. In nearly all sectors investments in design and computerized information are larger in the UK. In contrast, German firms invest a higher proportion of gross output in R&D in all sectors, and advertising is also more common except for the sector trade and transport. Intangible assets have stimulated labour productivity growth in all sectors. The contribution varies between 0.17 (construction) and 0.59 (manufacturing) percentage points. In manufacturing, financial and business services innovative property capital is the most influential type of intangible capital for

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labour productivity, followed by economic competencies and computerized information. In all other sectors, economic competencies play the most prominent role for labour productivity growth.

Keywords Intangible assets • Economic growth • Sector

4.1 Introduction

In Europe, policy has acknowledged that nowadays knowledge has become a key factor for firms to survive and grow in the increasingly globalised economy. This had already found expression in the last decade in the Lisbon agenda that aimed to make the EU "the most competitive and dynamic knowledge-driven economy by 2010" and also in the current EU2020 strategy that emphasizes that growth should be smart, sustainable, and inclusive. Smart growth means developing economies based on knowledge and innovations. Thus strengthening the efficiency and competitiveness of firms in the knowledge driven economy is a major challenge that the EU economies are currently confronted with.

A key characteristic of knowledge is its intangible nature which makes it hard to measure its amount, quality or effects. Furthermore, investments in such intangible knowledge assets may take place in very different forms. In a recent work, Corrado et al. (2005, 2009; henceforth CHS) propose how to define and measure intangible assets. They distinguish three broad categories of intangibles: Business investment in computerized information, innovative property and economic competencies: Computerized information consists of investments for computer software and computerized databases. Innovative property reflects scientific knowledge embedded in patents, licences, and general know-how (not patented) on the one hand but also the non-scientific innovative and artistic content in commercial copyrights, licences, and designs on the other hand. This is captured by the following five components: expenditure for R&D in natural and social sciences, mineral exploration, copyright and licences, new product development costs in the financial industry and spending on new architectural and engineering designs. Finally, economic competencies involve investments aimed at raising productivity and profitability other than software and R&D. Corrado et al. specified such economic competencies as value of brand names and other knowledge embedded in firm-specific human and structural organizational resources.

Using the CHS approach, recent evidence at the macro level has shown the importance of investment in intangible assets for economic growth in many countries around the world. However, it has also been revealed that many European countries are lagging behind the US figures. For instance, Corrado et al. (2009) report investments in intangible assets that amount to 11.7 % of GDP in the US. Investment in intangibles is even larger than the investment in physical capital. Fukao et al. (2009) reported a corresponding proportion for the Japanese economy of 11.2 % for the period 2000–2005. Within Europe, the UK invests the highest proportion of GDP for intangible assets, but which is still roughly 1.5 percentage points below the US (10.1 %; Marrano and Haskel 2006). In other European countries it is even less: 9 % in Sweden (Edquist 2011), 7.0 % in Germany (Crass et al. 2010), 6–7 % in France (Delbecque and Nayman 2010), 5.2 % in Spain and Italy (Hao et al. 2009). A similar pattern emerges for the contribution of intangible assets to growth. In the US, investment in intangible assets has stimulated labour productivity growth by 0.84 percentage points, whereas the contribution in European countries varies between 0.6 and 0.2 percentage points (0.58 in UK, 0.53 in Germany, 0.34 in Italy and 0.19 in Spain). One exception is Sweden where intangible capital has accounted for 1.8 percentage points of the labour productivity growth rate.

There might be different reasons why European countries are lagging behind and which might lead to quite different policy conclusions. On the one hand European firms might invest less in knowledge capital than their US competitors within the same industry. Another explanation of why these figures differ across countries might be because of varying industry structures in these countries and the fact that industries[1] might behave differently in terms of the amount and composition of intangible investment. Of course, it might also be a mixture of both. The empirical evidence, however, on how much sectors invest in which type of intangible asset and how this affects economic growth at the sector level, is scarce up to now. In a recent study, Goodridge et al. (2012) provide evidence that the ratio of intangible investment to value added is highest in the manufacturing sector in the UK. This finding was corroborated by Niebel et al. (2013) for a larger set of ten European countries. In a cross-country comparison of Japan and South Korea, Chun et al. (2012) likewise find that the share of intangible investment in value added is higher in Japan for many industries with the exception of some service sectors. For Japan, they furthermore estimate the impact of intangible capital on total factor productivity (TFP). Their results show that intangible capital has stimulated productivity growth in manufacturing after the IT revolution, i.e. for the period 1996–2008. Distinguishing between the three components of intangible capital, it turns out that innovative property was the main driver of productivity growth in manufacturing whereas economic competences and, somewhat surprising, computerized information did not foster TFP growth. In contrast to their findings for the later period, they did not find any significant productivity effects in manufacturing for the earlier period 1980–1995. Likewise their findings did not suggest a positive effect for service industries in Japan. For Europe, Niebel et al. (2013) likewise show a significant effect of intangible capital on productivity growth in manufacturing. For services, their results also indicate a positive productivity effect though their results are less robust across different specifications. Their estimated output elasticities of intangibles range between 0.1 and 0.2. These values are lower than those found in studies using aggregate data. But they are larger than the factor compensation share of intangible capital. This is usually seen as an indicator for the

[1] In the following, the terms sector and industry are used interchangeably.

existence of spillovers of intangible capital or unmeasured complementarities between tangible and intangible capital. Not in general, but for ICT capital and firm-specific human capital (training), O'Mahony and Peng (2011) provided industry-level evidence for the complementarity hypothesis.

This chapter investigates the role intangible capital plays for economic growth in different sectors in Germany. It consists of two major parts. In the first part, we aim at measuring spending and investment in intangibles at the sector level. We will provide different data sources, shed light on differences across sectors but also compare these figures with investment in physical capital and with investment in intangibles in other countries. In the second part, we explore the role of intangible assets for stimulating growth at the sector level by performing growth accounting analyses.

Section 4.2 presents data sources for each category of intangible assets as well as their availability at the sector level and over time in Germany. We will furthermore show the development of investment in intangibles at the sector level. Whereas the first three subsections discuss figures for each single category, Sect. 4.2.4 will condense the information by looking at the three main broad categories innovative property, economic competencies and computerized information, i.e. their sharing out among sectors and their development within sectors over time. Subsequently, Sect. 4.3 will compare investments in intangible assets with those in tangible capital in German sectors. In order to internationally assess investments in intangible assets in German industries, we will compare our results with sector-level figures from the UK in Sect. 4.4. Section 4.5 will examine the role of intangible capital in explaining productivity growth at the sector level by performing growth accounting analyses. Besides studying industry-level sources of economic growth, we will trace the sources of aggregate productivity growth and input factor growth to their industry origins. Section 4.6 finally summarizes our main findings.

4.2 Measurement of Intangible Investment by Category and Sector

This study follows the methodological framework set up by Corrado et al. (2005). We furthermore follow Gil and Haskel's (2008) breakdown of industries for the UK. That is we exclude all non-business sector categories (public administration, education, health, personal services, private households and extra-territorial). For the remaining business sector (BuSec), we distinguish six main industries of interest. Using the European-wide industry classification NACE Rev. 1.1, we define: (1) Agriculture, fishing & mining (in the following: *Agriculture & mining*, *AgMin*, NACE: A,B,C), (2) manufacturing (*Mfr.*, NACE: D); (3) electricity, gas & water (in the following: *Utility*, NACE: E), (4) construction (*Cons*, NACE: F), (5) wholesale and retail, hotels and restaurants, transport and communications (in the following: *trade & transport*, *RetHtTrn*, NACE: G, H, I) and (6) financial

Table 4.1 Industry share in gross output, value added and labour, 1997–2006

	1	2	3	4	5	6
Industry share in	AgMin	Mfr.	Utility	Cons.	RetHtTm	FinBsSvc
Gross output	0.022	0.439	0.027	0.072	0.220	0.219
Value added	0.018	0.294	0.028	0.062	0.231	0.367
Labour	0.045	0.285	0.011	0.102	0.348	0.209

Notes: Presented are average annual industry shares. Data: EU KLEMS. Own calculation

intermediation and business services (*FinBsSvc*, NACE: J, K). For some but not all time series a more detailed industry breakdown would have been available.

To give an overview of the importance of each of the industries, Table 4.1 depicts the share in aggregate gross output, value added and labour input (hours worked). The figures show that in Germany manufacturing makes up the largest share in aggregate gross output. Nearly 44 % of total gross output has been produced by manufacturing in the period 1997–2006, followed by the sectors trade & transport and financial & business services, both having a share of about 22 %. On the contrary, the financial & business service sector present the largest proportion in value added (37 %). Its share is roughly 7 and 13.5 percentage points higher than the value added share of manufacturing and trade & transport, respectively. Compared to manufacturing and financial and business services, the sector trade & transport is more labour-intensive. We can observe the highest share of total hours worked in the sector trade & transport (35 %), followed by manufacturing (28.5 %) and financial & business services (21 %). The industry share of construction amounts to 6–10 %, depending on the indicator. The other two sectors are rather small with a share of 2–3 %.

Figure 4.1 demonstrates that the annual growth rates in value added per hour worked indeed vary quite a lot across sectors in Germany. The open question that we address in this study is to what extent does intangible capital (or do other factor inputs) account for these differences and to what extent do sector differences translate to aggregate productivity growth?

In the following, we present data sources and estimated time series for different categories of intangible assets for the six industries. With respect to data sources, this work draws on previous work done at the macro level in Germany (see Crass et al. 2010). Crass et al. performed various sensitivity analyses for measuring intangible capital in Germany using alternative data sources, in particular for measuring new development costs in the financial industry, brand equity, and firm-specific human capital. All data sources are described in more detail with respect to data availability, main advantages and drawbacks in Crass et al. Hence, we also refer the interested reader to this paper for further information.

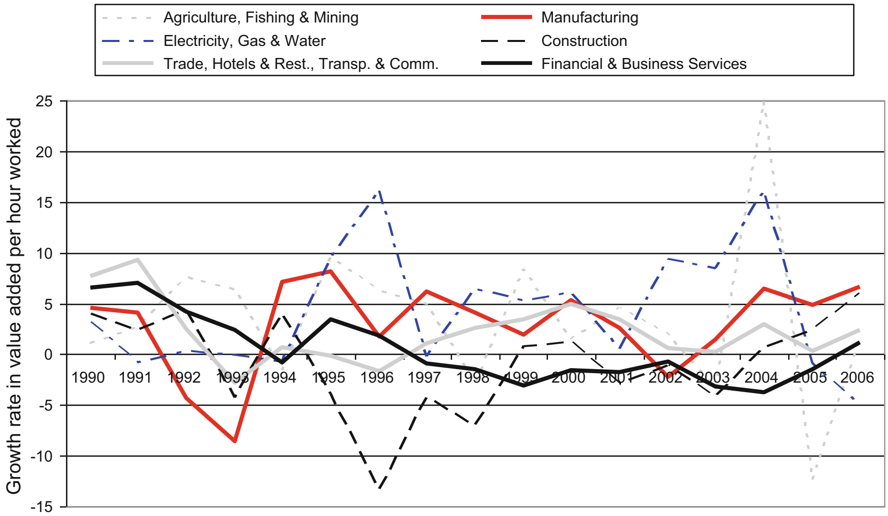

Fig. 4.1 Annual growth rates in value added per hour worked by industries, 1991–2008. Source: EU KLEMS Nov 2009 Release, own calculation

4.2.1 Computerized Information

The first category, computerized information, reflects knowledge embedded in computer programs and computerized databases. Therefore, computerized information is made up of two components, the investment in purchased and own account computer software and the investment in new computerized databases.

4.2.1.1 Investment in Own Account Computer Software

Compared to most of the other intangible assets, computer software is already viewed as investment in the German national accounts. For own account computer software we use data provided by the EU KLEMS November 2009 Release. EU KLEMS publishes estimates of the investments in software at the industry level in Germany for the period 1991–2007.[2] In case where figures were not available in EU

[2] At EU KLEMS, the following industry breakdown is given based on the industry classification NACE Rev. 1.1: NACE A-B (agriculture & fishing), C (mining and quarrying), D (manufacturing that is further split into the NACE industries 15–16, 17–19, 20, 21–22, 23, 24, 25, 26, 27–28, 29, 30–33, 34–35, 36–37), E (electricity, gas and water supply), F (construction), G (wholesale and retail trade, further broken down into 50, 51 and 52), H (hotels and restaurants), I (transport and storage, further broken down into 60-63 and 64), J (financial intermediation), K (real estate, renting and business activities, further split into 70 and 71–74) as well as the public and private sector (75, 80, 85, 90, 95, 99). However, for comparability reasons we have consolidated the information into the six industries. Note software investment carried out in the public and private household sector like community social and personal services has been excluded.

KLEMS using the six-industry classification (for instance for sector agriculture and fishing (A-B) and mining (C) which we summarize to A-C), the aggregation of indices across sectors has been done using a Tornqvist-weight. This procedure applies to sector 1, 5 and 6. As in Corrado et al. (2005, 2009) we have furthermore assumed that 100 % of software spending can be regarded as investment.

Table 4.11 in the Appendix depicts the distribution of software investment across sectors in Germany. In total, investment in software has been more than doubled from 8 bn € in 1991 to nearly 18 bn € in 2007 with a slight slump after the new economy boom within the period 2002–2004. However, a more detailed look at the figures reveals that the development turns out to be quite different across industries. In construction, for instance, investment in software declined over time leading to a fall in the proportion of software investment accounted for by this sector from 4.7 to 1.9 %. On the other side, financial and businesses services boosted their software investment from 1.6 bn € in 1991 to 6.0 bn € in 2007 (with a peak of 6.2 bn € in 2001). As a consequence, the proportion of software investment undertaken by this sector has increased from 20 to 34 %. Though manufacturing firms have raised their investment in software as well (from 3.5 to 5.7 bn €), they have lost in terms of relative importance. The proportion of software investment that is carried out in manufacturing has declined from 44 to 32 %. Software investment in trade & transport has also increased leading to a share in overall investment that fluctuates around 25 %.

4.2.1.2 Investment in New Computerized Databases

Information for new computerized databases is gathered from the German turnover tax statistics. The overall expenditure for new databases is measured by the sales of NACE class 72.4. Unfortunately, this data source does not contain information about the customers of sector 72.4. Following Gil and Haskel (2008), we distribute the overall expenditure across the six sectors using yearly input-output tables provided by the German Federal Statistical Office. Since input-output tables are only available at the two-digit level in Germany, we use industry 72 as proxy. As was done previously in the case of software, we consider all spending as investment. Table 4.11 shows that the investment in new computerized databases constitute only a very small fraction of the overall amount invested in computerized information in Germany. But the investment in computerized databases has significantly increased over the course of the past decade. We though do not observe a continuous rise but a rather strong slump after the new economy boom in the period 2003–2005 from which the German economy has recovered from 2006 onwards. Interestingly, this picture emerges in all sectors to more or less the same extent implying that the distribution across industries remains quite stable over time. More than half of the investment in new databases (around 56 %) is made in the financial and business service sector and just around one fifth in manufacturing.

4.2.2 Innovative Property

The second broad category of intangible assets summarizes investments in innovative property. It covers the amount firms invest in research and development, mineral exploration, copyright protected work, licences and new designs.

4.2.2.1 Scientific Research and Development

Compared to other types of intangible capital, data on business enterprise research and development (R&D) expenditure have been collected for many years already, following the guidelines set out by the Frascati manual (OECD 2002). Data have been taken from ANBERD.[3] As suggested by CHS, we consider total spending on R&D as investment. Table 4.12 in the Appendix illustrates the development of R&D investment by sector in Germany for the period 1991–2008. While R&D investment was rather stable up to the mid-1990s, we do observe a steady increase since then. The overwhelming majority of scientific R&D is conducted in manufacturing. Roughly 90 % of scientific R&D was carried out in this sector. The proportion of R&D performed in manufacturing has fallen over time while it has increased in business related services from 1.7 % in 1991 to 9.4 % in 2008. In absolute figures, R&D mounted from 0.46 bn € in 1991 to 4.3 bn € which corresponds to a rise by more than 800 %. However, these figures should be taken with care since in part they reflect an artificial development which is due to the fact that the coverage of service firms within the R&D surveys has been improved a lot since the end of the 1990s.

4.2.2.2 Mineral Exploration

Mineral exploration should capture all costs involved in the process of finding ore which can be exploited in the future and which will thus lead to sales in the future. Expenditure on current exploitation should not be included. Information stems again from the German turnover tax statistic. The sales of category "test drilling and boring" (45.12) are counted as expenditure on mineral exploration. An industry breakdown is not necessary. We follow Gil and Haskel (2008) and classify expenditure on mineral exploration as belonging to sector Agriculture, Fishing & Mining. Furthermore, we follow CHS and view all spending on mineral exploration as investment. Table 4.13 depicts the amount of investment. Mineral exploration is the least important type of intangible investment in Germany. Less than 0.2 bn € is spent for it though it has significantly gone up since the mid-1990s.

[3] In Germany, the R&D survey is conducted by the Stifterverband. It feeds the Analytical Business Enterprise Research and Development database (ANBERD).

4.2.2.3 Copyright and Licence Costs

Information-sector industries like book publishers, motion picture producers, sound recording producers, and broadcasters also spend a lot of money for developing and introducing new products. This spending for new product development is usually not regarded as scientific R&D and thus not included in R&D figures. Assuming that new product investment by the information sector usually leads to a copyright or licence, CHS suggest a category of intangible asset that is called copyright and licence costs. They estimated copyright and licence costs by twice the new product development costs of the motion picture industry (source: Motion Picture Association). Hao and Manole (2008) used data from Screen digest whereas Marrano and Haskel (2006) make use of information from the national accounts in the UK. In Germany, the national accounts only provide a combined figure on investment in immaterial assets which consists of software and database, copyright and licences, livestocks, economically useful plants and costs for the transfer of undeveloped sites (Statistisches Bundesamt 2010). Since we cannot identify copyright and licence costs separately from the national accounts, we therefore estimate the costs using the category "motion picture and video production" (NACE 92.11) of the German turnover tax statistic.[4] In the industry classification NACE Rev 1.1 92.11 is assigned to services (recreational, cultural and sporting activities) while publishing is assigned to manufacturing. Gil and Haskel (2008) decided to relate total spending to the manufacturing sector and we follow this approach. We treat all spending for copyright and licences as an investment. Table 4.13 illustrates the development of estimated copyright and licence costs over the period 1992–2008. They have increased up to 1998 but have experienced a significantly fall off since then from 6.8 to 3.7 bn € in 2008.

4.2.2.4 Development Costs in the Financial Industry

The financial industry also spends a lot of money for developing and introducing new financial products. As for the information-sector industries, most of these outlays for new product development are usually not regarded as scientific R&D and are thus not included in R&D figures. Nakamura (2001) proxied new product development costs in the financial services industry as a proportion of the non-interest expenses of banks and non-depository institutions. He assumed 50 % without giving a sound economic explanation. Corrado et al. (2009) broadened the coverage to include other financial institutions (security and commodity brokers and other financial investments and related activities). Since there is no broad

[4] For comparison, based on national accounts Hao et al. (2009) estimated copyright and licence costs to be roughly 4.94 bn € in Germany in 2004. We estimate costs of roughly 4 bn €. The national accounts estimated gross investment in immaterial goods in the private sector at 22.9 bn € (Statistisches Bundesamt 2006), taken into account that software already accounted for 16 bn €, the upper limit for copyright and licences is 6.9 bn €.

survey data in the US on the resources banks and insurance companies devote to new product development, they proposed as a rudimentary guess to use as proxy a share of 20 % of all intermediate purchases reported in the BEA‘s data on gross output and value added by industry. In contrast to the US, the Community Innovation Surveys (CIS) provide data on innovation expenditure in the financial industry for all European countries. The methodology is based on the Oslo manual (OECD and Eurostat 2005). The German contribution to the CIS is the Mannheim Innovation Panel (MIP) which is carried out annually (see Peters and Rammer 2013). As an alternative to the proxies used in the literature we therefore estimate the development costs using the innovation expenditure in the financial industry. Innovation expenditure is related to new products and processes. Process innovations are often associated with the acquisition of new machines which are counted as tangible capital at the same time. To avoid double counting we subtract the expenditure which is related to the acquisition of new machines for product and process innovations from total innovation expenditure. Following CHS, new product development costs of the financial industry developing new products are considered as investment. We furthermore relate these costs completely to the sector financial intermediation and business services.

The time series on investment in financial services innovation is illustrated in Table 4.13. Between 1995 and 1999, German banks and insurances have raised their investments in innovation from 3.9 to 6.6 bn €. In the last decade, however, we observe a continuous fall off and in 2008 investment for innovation were even below the figures for 1995. The steep increase around the millennium can be explained by new opportunities that emerged at that time due to new information and communication technologies (e.g. internet banking, telephone banking, etc.). It turns out that CIS data leads to considerable smaller estimates of investment in financial services innovation than the alternative measure. In 1995 our estimate is just 47 % of that of Hao and Manole (2008). This proportion has even fallen to 25 % in 2008.

4.2.2.5 New Architectural and Engineering Design

Following Corrado et al. (2009) we measure new architectural and engineering design as half of the turnover of the architectural and design industry (NACE class 74.2). Turnover data are derived from the German turnover tax statistics. Like for databases, we have to allot sales to the six industries using input-output tables (based on industry 74). This provides us with an estimate of investment in new architectural and engineering design at the sector level. As Table 4.14 shows, the amount firms invested in new architectural and engineering designs was rather stable over the period 1992–2004, ranging between 18 and 19 bn €. This rather stable development is surprising since we expected the increasing trend to outsource design activities to be reflected in the time series. Since 2004, however, we observe a continuous increase up to 22 bn € in 2008. The figures also reveal that the distribution across sectors is very stable over time. In part this might be due to the fact that we use input-output tables to get sector-level estimates. 37–39 % of all investment for new designs has been undertaken by manufacturing firms. The proportion is even slightly higher in financial and business services at about 40–42 %. Roughly 1.8 % of this intangible item is produced by agriculture & mining and utility, respectively. Trade and transport account for 14 %.

4.2.3 Economic Competencies

The third and final broad category is economic competencies. It includes spending on strategic planning, spending on redesigning or reconfiguring existing products in existing markets, investments to retain or gain market share, and investments in brand names. How we measure them at the sector level will be explained in the following subsections.

4.2.3.1 Brand Equity

Corrado et al. (2005, 2009) propose a broad conceptualization of marketing activities by including both *advertising* and *market research*. Advertising expenditure is seen as the firm's primary investment into brand equity. We use data on external (purchased) gross advertising expenditure published by the Central Association of the German Advertising Industry (ZAW). Gross advertising expenditures comprise net revenues of the media firms (distribution costs of advertising) and production costs of advertising, excluding half of the advertisement on newspapers. Firms may not commission all advertising activities to outside media firms but some of them may be carried out in-house as well. Based on information gathered within the MIP, we estimate that own-account advertising outlays make up roughly 15 % of external advertising expenditure. Purchased market research is estimated using the sales of industry 74.13.1 reported in the German turnover tax statistics. Unlike all previous studies we exclude 74.13.2 which is related to research for public opinion polling since these outlays do not increase brand equity. Whereas Corrado et al. (2005, 2009) assumed that own-account market research equals purchased market research we use the same 15 % premium as for advertising. To get sector level estimates, we furthermore have to distribute total expenditure for both intangible assets to the six industries using input-output tables (using industry 74). Finally, we get from spending to investment figures by assuming that 60 % of the outlays can be considered as investment while the rest is viewed as short-term focussed (see Landes and Rosenfield 1994; Corrado et al. 2009). Table 4.15 presents investment in brand equity in Germany by sector. German firms have increasingly invested in brand equity up to 2000. Maybe not surprisingly, investments have gone down with the beginning of the recession in 2001. Since 2004 we can see a slight recovery, however, even in 2008 the investment was still below the 2000 value. Due to the fact that we are forced to use input-output tables at the two-digit industry level, we estimate the same (and rather stable) distribution across industries as for new architectural and engineering design. In particular, we estimate that about 38 % of the investment in marketing is done in manufacturing, 14 % in trade and transport and 41 % in financial and business services.

4.2.3.2 Firm-Specific Human Capital

The costs of employer-provided worker training are the second important ingredient of economic competencies. Investment in firm-specific human capital consists of initial vocational training and continuing vocational training. We use the reports on the financing of education to calculate the costs of initial vocational training in the business sector.[5] Expenses for continuing vocational training comprises direct and indirect costs. Direct costs include operating expenses for organizing and running further training whereas indirect costs reflects the costs of the continued payment of wages if the further training takes place within normal working hours. We make use of the Mannheim Innovation Panel (MIP) to estimate direct (internal and external) costs of continuing vocational training at the two-digit industry level. We calculate the indirect costs of continuing vocational training by using the proportion of direct costs to total costs which is on average 35 % (see Werner 2006). We furthermore follow CHS and assume that total spending has investment character. Table 4.15 illustrates overall investment in firm-specific human capital by sector. The German business sector has invested between 30 and 35 bn € each year in initial and continuing vocational training. Manufacturing accounted for roughly one third of the investment in firm-specific human capital. This proportion is slightly higher than its proportion in labour input (see Table 4.1). Its share has increased from 32 to 37 % in 1998 but has dropped since then to 30 % in 2006. The reverse pattern can be observed for financial and business services. Their share amounts to 35 % at the beginning and end of the period but has fallen in between to 29 %. Though trade & transport is the most labour intensive sector, only around one fourth of total investment in firm-specific human capital is performed in this sector. The figures elicit that this share is quite stable over time in Germany. Construction accounted for 4 % and utility for 2–3 %.

4.2.3.3 Organizational Structure

The final intangible item is aimed at capturing organizational capital which is also viewed as an important driver for gaining competitive advantage. Investment in organizational capital includes outlays for purchased organizational structure as well as expenditure for own-account organizational structure. To measure

[5] Until 2007, these reports had been published by the Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung—BLK. The German Federal Statistical Office has taken on the job of publishing the report from 2008 on.

investment in purchased organizational structure, we follow Gil and Haskel (2008) who suggested employing the revenues of the management consulting industry. That is, we use sales of the management consulting industry (74.14.1) provided by the German turnover tax statistics. Using sales for a specific industry again implies that we do not have an industry breakdown and therefore employ the input-output table (for industry 74) to get sector-level estimates for the six industries. Like previous studies, we furthermore assume that 80 % of purchased organizational structure expenditure can be considered as investment. The most salient finding that can be gauged from Table 4.16 is that investment in purchased organization structure has more than doubled within 14 years. It has been raised from 8 bn € in 1994 to 20 bn € in 2008 with a severe slump in the recession period between 2001 and 2004. Since we use the same input-output-table information to allot the investment onto the sectors, the distribution across sectors is the same as for architectural and engineering design or marketing investment. Future research would benefit a lot if more detailed three-digit input-output tables are available.

Admittedly, the expenditure on *own-account organizational structure* is only roughly measured. We follow the general approach of Corrado et al. (2009) and assume that 20 % of a manager's time is spent on organizational building activities. Thus 20 % of the managers' earnings can be considered as spending on own-account organizational structure. Data sources on managers' earnings can be gathered from Table 4.9. Since an industry breakdown is not available, we applied once more input-output table (using industry 74), and thus we implicitly assume that the breakdown is the same for investment in purchased and own-account organizational structure. Table 4.16 depicts the development over the period 1991–2007. Investment in own account organizational structure has been continuously increased whereas the distribution across sectors has remained rather stable.

4.2.4 Summary: Computerized Information, Innovative Property and Economic Competencies

Having presented data and figures on intangible investment for each category at the sector level, this section condenses the information by looking at the three broad categories computerized information, innovative property and economic competencies and their distribution across industries in Germany. Since *computerized information* mainly consists of investment in software, findings are similar as in Sect. 4.2.1. Most strikingly, firms have intensified their efforts to invest in computerized information by nearly 100 % in the period 1994–2007 as can be seen from Fig. 4.2 and Table 4.10. At the same time, a shift has taken place from manufacturing towards business services. The share of software investment that is accounted for by manufacturing has declined from 36 to 32 % whereas it has increased in the service sector industries. The increase in software investment was particularly strong in financial and business sector services in the first half of the period. In

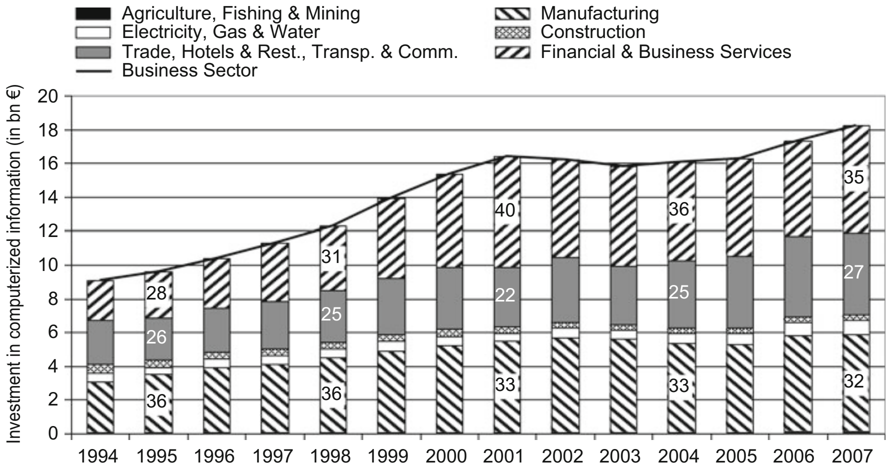

Fig. 4.2 Distribution of computerized information by industries, 1994–2007. Sources: See Table 4.9, own calculation

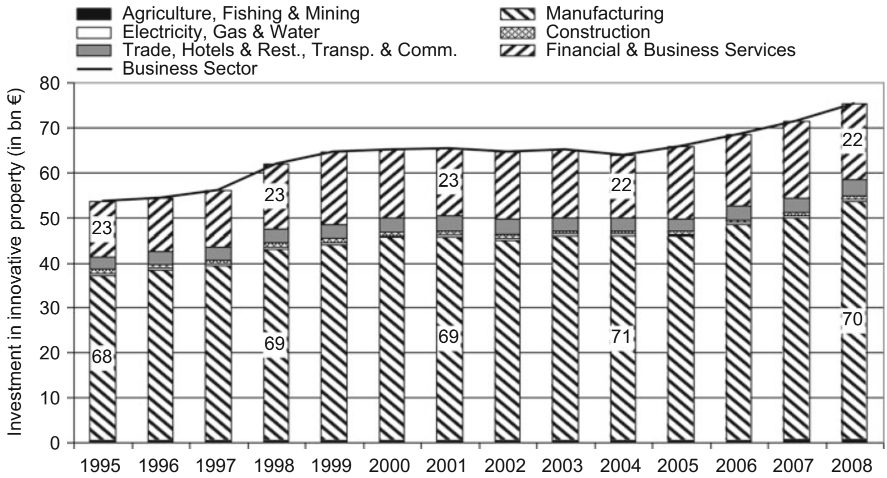

Fig. 4.3 Distribution of innovative property across industries, 1995–2008. Sources: See Table 4.9, own calculation

the meantime, firms in trade and transport have caught up. They account for 27 % of all software investment in Germany.

Innovative property is highly concentrated in two industries, manufacturing and financial and business services as it is shown in Fig. 4.3. The overall trend in investment in innovative property is increasing. From 1995 to 2008 investment in innovative property has grown by 40 %. This trend can be observed in all sectors to

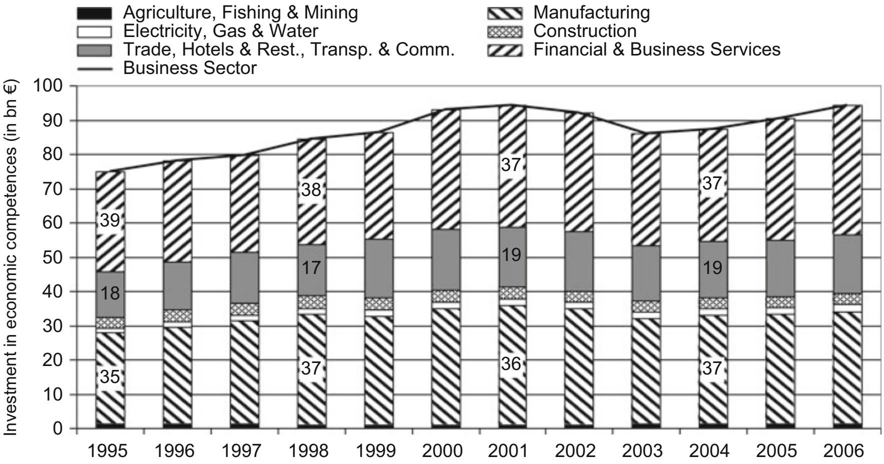

Fig. 4.4 Distribution of economic competencies across industries, 1995–2006. Sources: See Table 4.9, own calculation

more or less the same extent since the distribution across industries is nearly unaltered over time. Around 70 % of total investment in innovative property is carried out in manufacturing, predominately in terms of scientific R&D. But the share of financial and business services is non-negligible. They make up around 22 % of innovative property investment in the German economy, mainly for new design and financial services innovation.

Investments in *economic competencies* are less concentrated across sectors than those in innovative property as can be seen from Fig. 4.4. Furthermore, the distribution across industries is quite stable over the period which is in part due to way how we estimate sector-level investment using input-output tables. If at all, the share of manufacturing and trade & transport has slightly increased whereas it has dropped for financial and business services. 35–37 % of all investments aimed at improving economic abilities have been carried out in manufacturing. Financial and business service firms accounted for nearly the same amount. Around one fifth of the investment in economic competencies has been carried out in firms operating in trade & transport.

Finally, Fig. 4.5 delineates the relative importance of each intangible item within the industries. We use the year 2004 as reference year. In the German business sector, around 38 % of the investments in intangible capital are related to scientific R&D, another 10 % to investments in software and databases. However, roughly half of the investment in intangible capital is devoted to improving economic competencies (52 %), a category that is not accounted for by national accounts. The relative importance of different types of intangible assets varies quite a lot across sectors. In manufacturing, firms direct 39 % of their investments in intangibles to economic competencies. This share is above 60 % in all other industries, being highest in construction with 78 %. Manufacturing firms do not only perform

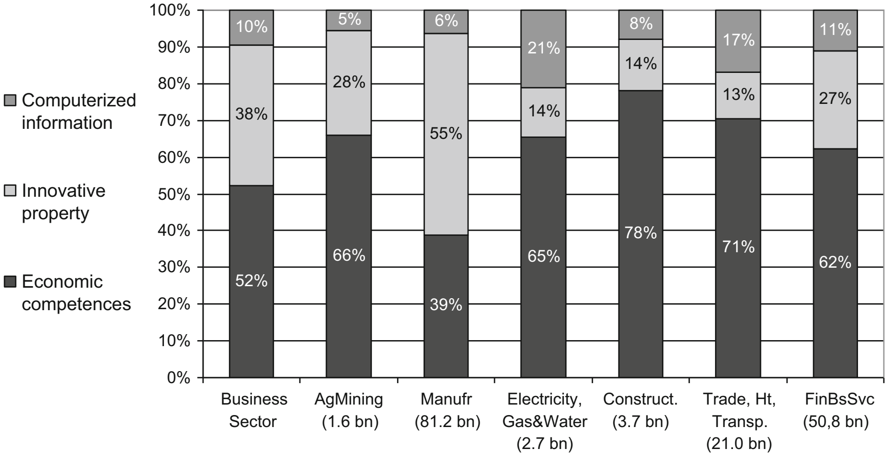

Fig. 4.5 Distribution of intangible investments by sector, 2004. Sources: See Table 4.9, own calculation

most of the R&D, but R&D is likewise the most important type of intangible asset in this sector. Investments in innovative property make up 55 % of all intangible investment. Compared to other intangible assets, innovative property is far less important in financial and business services (27 %) and agriculture and mining (28 %). In the other three sectors innovative property accounts for about 13–14 % of intangible investment. We can observe a strong variation in the relative importance of software and databases, ranging from 5 % in agriculture and mining to 17 % in trade and transport and even 21 % in utility. Although most of the investment in software and databases are performed by firms in manufacturing and financial and business services, computerized information constitutes only a relatively small proportion in intangible investment in these industries (manufacturing: 6 %, financial and business services: 11 %).

4.3 Comparison of Tangible and Intangible Investment Across Sectors in Germany

This section is aimed at comparing intangible investment with tangible investment in German industries. Over the period 1995–2006, that is the period for which we have complete data, investment in intangible capital has grown from 138.6 to 180 bn € in the German business sector. This implies an increase by 30 % (see Fig. 4.6). This raise was disproportionately high in computerized information and innovative property. The figure also suggests that investment in intangibles react to business cycles. The increase was particularly strong in the boom period 1998–2000 whereas firms have cut investments in the recession period 2001–2004 by

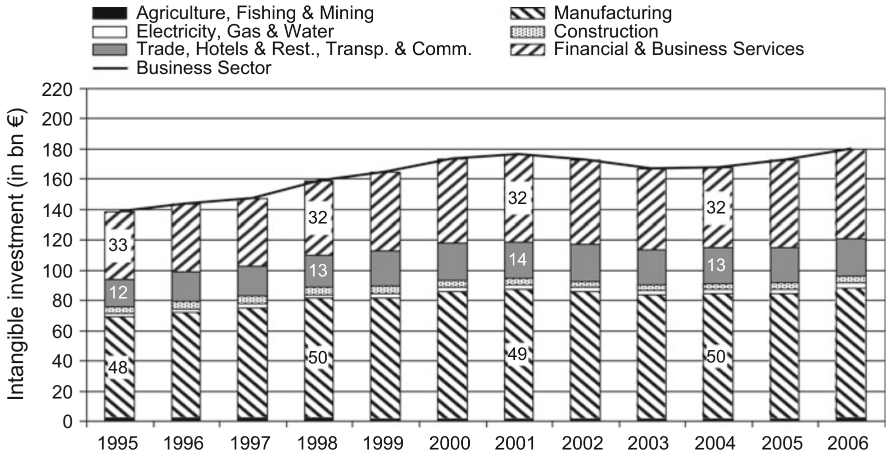

Fig. 4.6 Investment in intangible assets by sector, 1995–2006. Source: Table 4.9, own calculation

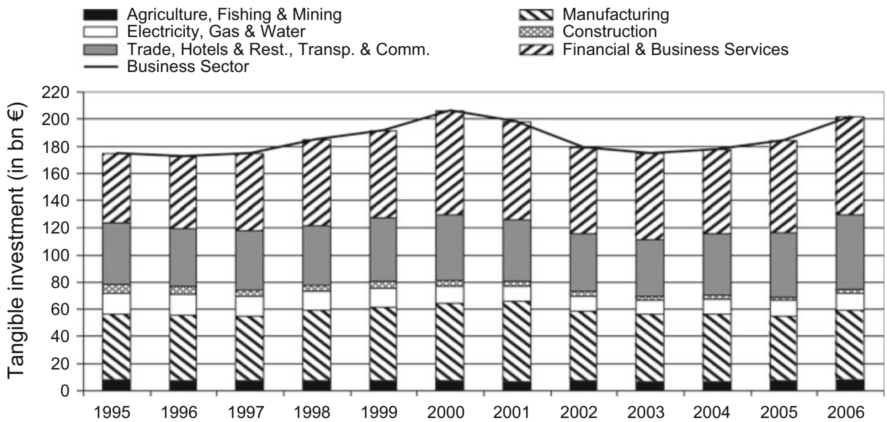

Fig. 4.7 Tangible investment by sector, 1995–2006. Source: EU KLEMS Nov 2009 Release, own calculation

nearly 5 %. However, with the slight recovery from 2005 onwards, investments in intangibles have accelerated again. The figure furthermore shows a stable distribution across industries over time. Nearly half of the investment in intangibles is done by manufacturing firms. This industry proportion is much higher than the share of manufacturing in gross output, value added or for instance in labour input. Financial and business services account for about one third of all intangible investments.

These figures can be directly compared to the development of tangible investment in Fig. 4.7. Tangible investment is defined as the nominal gross fixed capital formation provided by EU KLEMS. It comprises investments in computing

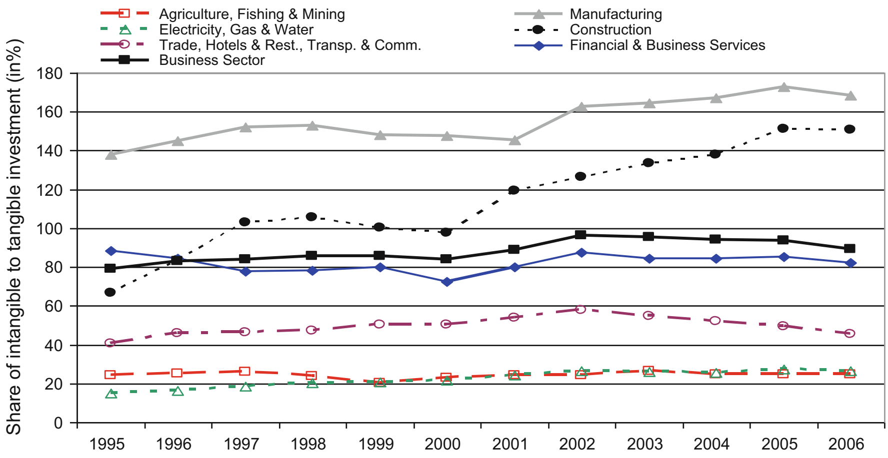

Fig. 4.8 Share of intangible to tangible investments by sector, 1995–2006. Source: Intangible investment: see Table 4.9, tangible investment: EU KLEMS Nov 2009 Release, own calculation

equipment, communications equipment, transport equipment, other machinery and equipment, and total non-residential investment in the business sector (but without software). Tangible investment has also increased over the period (+15 %) but to a far lesser extent than intangible investment. On the other hand, tangible investment were also cut in the recession period and even more so than intangible investments (−15 % between 2000 and 2003). Tangible investment had started to increase again from 2004 onwards but had not reached the 2000 level in 2006. Compared to intangible investments we see more variation in the industry shares over time. In 1995, 27 % of investment in tangible capital was allotted to manufacturing. This proportion has fallen to 25 %. Similarly, the contributions of utility, construction and agriculture and mining have declined. In contrast, financial and business services have gained importance (29–36 %).

Figure 4.8 illustrates the relation between intangible and tangible investment at the sector level. Differences in the dynamics of both types of investment over time find expression in an increasing relation of intangible to tangible investment. For the whole business sector, the proportion has increased from 80 to 89 %. The figures further highlight the outstanding position of intangible capital in manufacturing where intangible investment is significantly larger than tangible investment. Intangible investment has even gained importance as it share has climbed from 138 to 168 %. Though firms in the financial and business service sector have expanded their investment for intangible capital, the importance relative to tangible capital is nearly unaltered. It fluctuates around 80 % over the period. In the sector trade & transport, intangible investments have grown faster than tangible investments, leading to a rise in the proportion from 40 to 58 %. It turns out that this was a short-term effect and that this proportion has fallen again to 45 %. Rather surprising is the development of the ratio of intangible to tangible investment in construction.

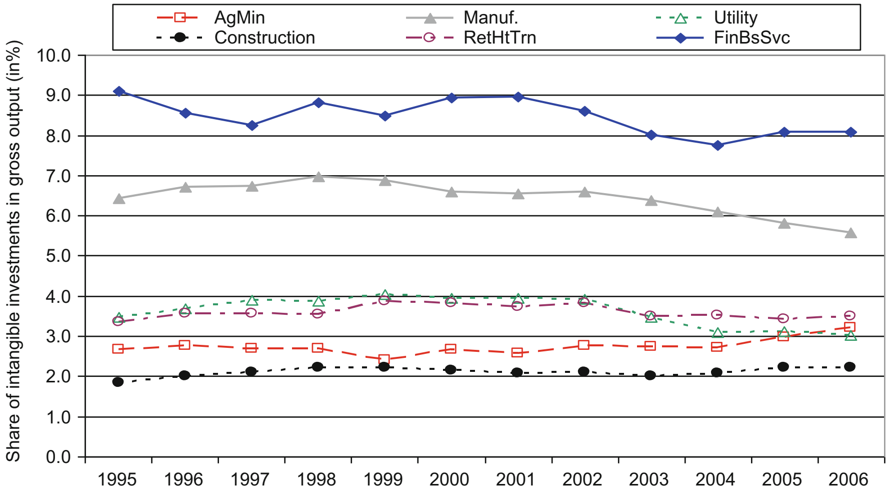

Fig. 4.9 Intangible investment as a share of industry gross output, 1995–2006. Source: Intangible investment: see Table 4.9, gross output: EU KLEMS Nov 2009 Release, own calculation

It has increased from 67 to 151 %. This can be explained by a sharp decline in tangible investment figures reported by EU KLEMS (from 6.8 to 2.9 bn €) whereas the intangible investment turned out to be stable at 3–4 bn € each year.

4.4 Intangible Investment as Share of Industry Gross Output and Value Added

The previous sections have shown that investments in intangibles have increased in absolute terms and have also gained importance compared to tangible capital. Figure 4.9, however, reveals that the share of intangible investment in gross output has fallen in the two largest sectors, manufacturing and financial and business services. In the latter industry, which spends the highest proportion on intangible investment throughout the whole period, it has declined from 9.1 to 8.1 %. A similar downward trend is observed in manufacturing where the share dropped from 7 % in 1998 to 5.6 % in 2006. A similar picture emerges for financial and business services when we relate intangible investment to value added (from 14.3 to 13.4 %), see Fig. 4.10. In manufacturing, the share of intangible investment to value added has increased until 1998 and has fallen afterwards. In 2006 it has reached a comparable level than in 1995 (15 %). In terms of gross output, financial and business services spend the highest proportion on intangible investment. In terms of value added manufacturing is ranked first. In the other four sectors intangible investments make up a significantly smaller proportion of gross output. It varies around 2 % (construction), 3 % (agriculture & mining) and 3.5 % (trade & transport, utility). The

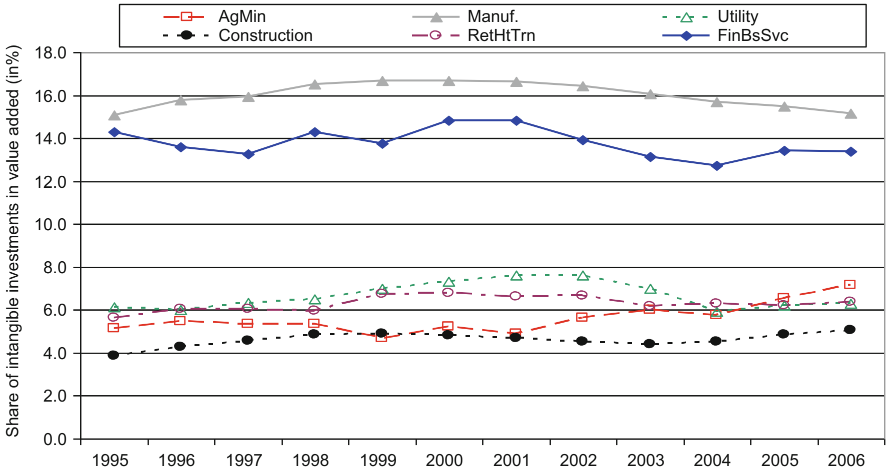

Fig. 4.10 Intangible investment as a share of industry value added, 1995–2006. Source: Intangible investment: see Table 4.9, value added: EU KLEMS Nov 2009 Release, own calculation

same holds for the share in value added which ranges between 4 and 7.5 % for the four sectors.

4.5 Comparing Intangible Investment at the Sector Level in Germany and the UK

To evaluate intangible investments in German sectors, we compare figures with industry-level findings for another large European country, the UK (see Gil and Haskel 2008).[6] Before showing sector-level results, we first present total investment in intangibles by asset class in 2004 as a share of the gross output. Figure 4.11 reveals salient differences at the macro level for both countries. Investment in intangibles represents 7 % of gross output in the UK (10.1 % of GDP, Marrano & Haskel 2006). The share is thus significantly higher than in Germany with 5.1 % (7.0 % of GDP, Crass et al. 2010). On the other hand, the business sector in Germany invests twice as much as the UK in R&D (1.2 % compared to 0.55 %). In contrast, the UK invests a significantly larger proportion in software, design, firm-specific training and own-account organizational structure.

[6] In order to ensure comparability of intangibles we follow Marrano and Haskel (2006) and calculate UK investment figures by assuming that 60 % and 80 % of expenditures on advertising and own-account organizational structure are investment, respectively. Investment in new architectural and engineering designs is calculated using the authors' instruction to multiply expenditure by 50% to obtain investment (Gil and Haskel 2008).

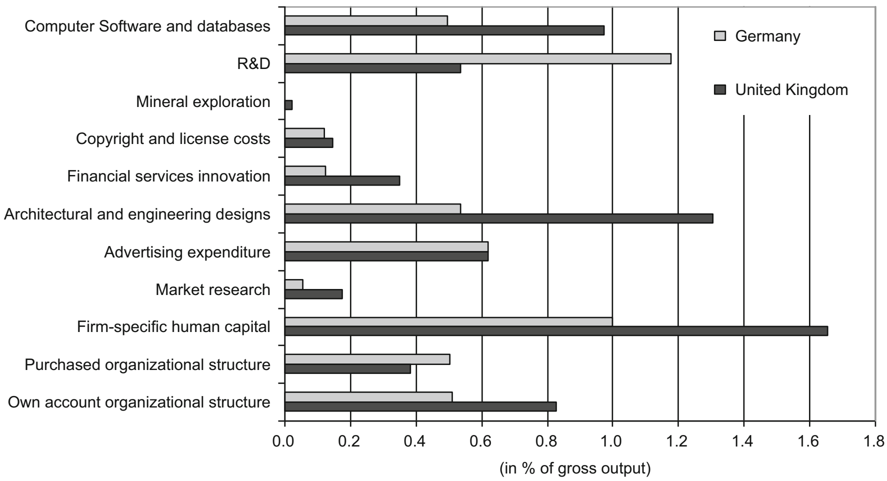

Fig. 4.11 Intangible investment as share of gross output in Germany and the UK, by category in 2004. Source: Germany: see Table 4.9, UK: Gil and Haskel (2008), own calculation

How can these differences be explained? Methodological differences might be one explanation. For some asset categories a trade-off exists between more accurate data sources and international comparability (see Crass et al. 2010). Deviations exist for instance with respect to new architectural and engineering designs. The UK figure does not only include purchased designs but also own-account investment in new architectural and engineering designs (Gil and Haskel 2008). If we exclude own-account investments, the findings are much more similar across both countries (0.94 % in the UK and 0.87 in Germany). An alternative data source and methodology was also used for new product development costs in the financial industry. While our figures rely on survey data, the UK figures are estimated as 20 % of financial services industry's intermediate purchases (Gil and Haskel 2008). The same is true for intangible investments in firm-specific human capital.

On the other hand, in all four categories service sectors make up an import contribution. Since services present a larger proportion in the UK business sector than in Germany, these differences might also be explained by differences in industry structure. A comparison of investment in intangibles at the sector level provides information about this. Except for utility, Table 4.2 shows that the UK share of intangible investment is larger in all sectors. When comparing manufacturing firms, we can ascertain that German firms invest a higher proportion of gross output in R&D (2.6 % vs. 2.0 %) and in advertising (0.6 vs. 0.5 %). UK manufacturing firms, on the other hand, have a significantly stronger orientation towards investment in new designs. But they also invest a higher proportion of gross output in software, organizational structure, firm-specific human capital and copyright and licences. Similar differences in investment strategies can be detected in financial and business services. The proportion German firms invest in R&D is four times larger than that in the UK. In contrast to manufacturing, they also invest a

Table 4.2 Intangible investment in Germany and the UK as share of gross output and by sector in 2004

	AgMin		Mfr		Utility		Cons		RetHtTrn		FinBsSvc	
	GER	UK	GER	UK	GER	UK	GER	UK	GER	UK	GER	UK
Computer software and databases	0.2	0.2	0.4	0.7	0.6	0.6	0.2	0.2	0.6	1.1	0.9	1.5
Computerized databases	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R&D	0.2	0.0	2.6	2.0	0.1	0.0	0.0	0.0	0.1	0.1	0.4	0.1
Mineral exploration	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copyright and licence costs	0.0	0.0	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Financial services innovation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1
Architectural & engineering design	0.5	0.6	0.5	1.9	0.3	0.6	0.3	1.3	0.4	0.8	1.1	1.4
Advertising expenditure	0.6	0.1	0.6	0.5	0.4	0.1	0.3	0.2	0.4	0.7	1.2	0.8
Market research	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.1	0.3
Firm-specific human capital	0.3	0.9	0.8	1.1	1.0	0.1	0.7	1.3	1.3	2.3	1.5	1.8
Organizational structure (p)	0.5	0.3	0.5	0.7	0.3	1.2	0.3	0.0	0.3	0.3	1.0	0.3
Organizational structure (oa)	0.5	0.2	0.5	0.7	0.3	0.1	0.3	0.5	0.3	0.9	1.0	1.1
Total	2.8	3.0	6.1	8.3	3.1	2.9	2.1	3.6	3.5	6.4	7.8	8.4

Source: Germany: see Table 4.9, UK: Gil and Haskel (2008), own calculation

significantly larger proportion of gross output in purchased organizational structure. UK firms in financial and business services outperform their German counterpart with respect to investments in software, design, firm-specific human capital, market research, own-account organizational structure and financial service innovations. Another striking finding is that UK firms in trade & transport demonstrate a higher share in all asset classes.

Comparing different asset classes, we find that investment in new architectural and engineering design is consistently higher across all sectors in the UK. Computerized information is around two times larger in UK manufacturing, financial and business services and trade & transport (similar shares in other three sectors). On the other hand, German firms invest a higher proportion of gross output in R&D in all sectors. Advertising is also more common in Germany except for the sector trade & transport.

4.6 Contribution of Intangible Assets for Growth at the Sector Level

This section highlights the contribution of intangible assets for stimulating growth at the sector level by performing growth accounting analyses for the six industries. The methodology we used to perform growth accounting at the sector level is based on the 'direct aggregation across industries' approach that is described by Jorgenson et al. (1987) and Jorgenson et al. (2005, 2007) and that is also used in Clayton et al. (2009). This approach allows us to study industry-level sources of economic growth as well as to trace the sources of aggregate productivity growth and input factor growth to their industry origins. In the following Sect. 4.6.1, we will explore the methodology in more detail. Section 4.6.2 sets out the data that we used to perform growth accounting and Sect. 4.6.3 illustrates our empirical results.

4.6.1 Methodology

4.6.1.1 Decomposition of Growth in Real Gross Output at the Industry Level

Assuming that we have production data at the sector level, the starting point is the decomposition of industry growth. At the industry level, growth in capital, labour, intermediate inputs and total factor productivity contributes to growth in real gross output ($\Delta \ln Y_j$). The growth contribution of capital is equal to the growth in capital services in industry j ($\Delta \ln K_j$) weighted by the capital input share ($\overline{v}_{K,j}$). Capital services are defined as the productive inputs, per period, that flow to production from a capital asset (OECD 2001). Capital services differ from capital stocks because short-lived assets such as equipment and software provide more services per unit of stock than long-lived assets such as land. The flow of capital services is more appropriate as capital input in the production analysis than the capital stock (Jorgenson and Griliches 1967). The capital input share $\overline{v}_{K,j}$ is defined as the average (over a 2-year period) proportion of capital compensation to gross output in industry j. Similarly, the contribution of labour can be calculated as the growth in labour quality services ($\Delta \ln L_j$) times the labour input share ($\overline{v}_{L,j}$) which is measured as the average labour compensation in gross output in industry j. The contribution of intermediate inputs to growth in industry gross output is given by $\overline{v}_{X,j} \cdot \Delta \ln X_j$ where $\Delta \ln X_j$ measures the growth rate in intermediate inputs and $\overline{v}_{X,j}$ is the share of intermediate inputs in industry gross output.[7] The contribution of total factor productivity is simply the growth rate of TFP ($\Delta \ln TFP_j$). That is, we can decompose growth in industry real gross output into the following sources:

$$\Delta \ln Y_j = \overline{v}_{K,j} \cdot \Delta \ln K_j + \overline{v}_{L,j} \cdot \Delta \ln L_j + \overline{v}_{X,j} \cdot \Delta \ln X_j + \Delta \ln TFP_j \tag{4.1}$$

In the empirical analysis below, we furthermore allow for heterogeneous labour and capital. That is, we differentiate between different types of capital assets and labour inputs. With respect to capital we separately calculate the contribution of tangible and intangible capital. We furthermore decompose tangible capital into ICT capital and non-ICT capital. Types of intangible capital assets correspond to

[7] $\overline{v}_{X,j}$ is equal to 1-$\overline{v}_{L,j}$-$\overline{v}_{K,j}$.

the categories introduced in Sect. 4.2. The question is then how to measure capital services. Under the assumption of a strict proportionality between capital services and capital stocks for each heterogeneous asset, the growth of total capital services in industry j ($\Delta \ln K_j$) can be calculated as a translog index (i.e. a Tornqvist index) of different types of capital assets (see Jorgenson 1963 and Jorgenson and Griliches 1967). That is, $\Delta \ln K_j$ is a weighted average of the growth rates of each capital stock $\Delta \ln K^{St}_{k,j}$, where the superscript St indicates that we mean the capital stock and k denotes the type of capital:

$$\Delta \ln K_j = \sum_k \overline{w}_{k,j} \cdot \Delta \ln K^{St}_{k,j} \tag{4.2}$$

The weight $\overline{w}_{k,j}$ reflects the proportion of capital income of asset k in total capital income in industry j, averaged over a 2-year period. Capital income of asset k is usually calculated as the capital stock of asset k times the rental price of capital k (user costs of capital).

Accordingly, growth in labour services in industry j are estimated as a labour-income weighted average of the growth rates of each type of labour input l:

$$\Delta \ln L_j = \sum_l \overline{w}_{l,j} \cdot \Delta \ln L_{l,j} \tag{4.3}$$

4.6.1.2 Decomposition of Real Value Added Growth at the Industry Level

Since at the aggregate level, output growth is usually based on growth in value added instead of growth in gross output, we additionally provide the decomposition of industry value added growth. Using the definition of value added, we can also write Eq. (4.1) in the following way:

$$\Delta \ln Y_j = \overline{v}_{VA,j} \cdot \Delta \ln VA_j + \overline{v}_{X,j} \cdot \Delta \ln X_j \tag{4.4}$$

Equation (4.4) states that industry growth in gross output can be decomposed into the contribution of value added and intermediate goods. $\overline{v}_{VA,j}$ denotes the 2-year average share of value added in gross output in industry j. Equalizing Eqs. (4.1) and (4.4), we can identify the sources of real value added growth in industry j:

$$\Delta \ln VA_j = \frac{\overline{v}_{K,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln K_j + \frac{\overline{v}_{L,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln L_j + \frac{1}{\overline{v}_{VA,j}} \Delta \ln TFP_j \tag{4.5}$$

Growth in real value added in industry j is fed by the weighted contribution of industry capital, labour input and TFP. The weights on capital (labour) account for the share of capital (labour) income in gross output in industry j and for (the inverse of) the share of industry value added in industry gross output.

4.6.1.3 Aggregate Real Value Added Growth and Industry Contributions

Depending on the assumptions about industry value added functions and factor mobility and factor prices, one yields alternative measures for aggregate value added. We use the 'direct aggregation across industries' approach that is the least restrictive approach. This approach only assumes that a value added function exists in each industry, but it does not assume that these are identical across industries. We furthermore allow input factors such as capital and labour to be mobile across industries and factor prices to be different across industries.[8] It can be shown that in this case, the growth rate in aggregate real value added ($\Delta \ln VA$) has to be calculated as the weighted sum of industry real value added growth rates:

$$\Delta \ln VA = \sum_j \overline{w}_j \cdot \Delta \ln VA_j = \sum_j CT_{VA,j} \tag{4.6}$$

$CT_{VA,j} = \overline{w}_j \cdot \Delta \ln VA_j$ measures what industry j contributes (CT) to aggregate real value added growth. Summing up all contributions across industries gives the aggregate growth rate. The weight w_j reflects the share of industry j's nominal value added in aggregate nominal value added,[9] and it is thus a measure of the relative size of industry j. $\overline{w}_j$ is average share of a 2-year period, that is:

$$w_j = \frac{P_{VA,j} \cdot VA_j}{\sum_j P_{VA,j} \cdot VA_j} \qquad \textit{and} \qquad \overline{w}_j = 0.5\left(w_{j,t} - w_{j,t-1}\right)$$

4.6.1.4 Decomposition of Real Value Added Growth at the Aggregate Level

The methodology not only allows us to identify the industry origins of aggregate growth but also to identify what change in aggregate growth is due to capital input, labour input and TFP. Inserting Eq. (4.5) into Eq. (4.6), we end up with the following decomposition of real value added growth:

[8] Alternatives are the aggregate production function approach and the production possibility frontier approach. The first approach assumes the existence of an aggregate production function. This function exists under the strong assumptions that (1) the industry gross output function is separable in value added (VA) and intermediate inputs; (2) the VA functions are—up to a scalar multiplier—identical across industries; (3) the functions that aggregate heterogeneous capital and labour are identical in all industries and (4) that each type of capital and labour must have the same factor price in all industries. If these assumptions are fulfilled, aggregate VA is the unweighted sum of industry VA. The second approach relaxes the restriction that the industry VA functions must be the same across industries. Aggregate VA is then a weighted sum of industry VA.

[9] See Table 4.1. Two-year averages of these industry shares in values added serve as weights for summing up the growth rates of industry value added.

$$\Delta \ln VA = \sum_j \overline{w}_j \cdot \left(\frac{\overline{v}_{K,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln K_j + \frac{\overline{v}_{L,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln L_j + \frac{1}{\overline{v}_{VA,j}} \Delta \ln TFP_j \right)$$

$$\Delta \ln VA = \sum_j \overline{w}_j \cdot \frac{\overline{v}_{K,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln K_j \quad + \quad \sum_j \overline{w}_j \cdot \frac{\overline{v}_{L,j}}{\overline{v}_{VA,j}} \cdot \Delta \ln L_j \quad + \quad \sum_j \overline{w}_j \cdot \frac{1}{\overline{v}_{VA,j}} \Delta \ln TFP_j$$

$$\Delta \ln VA = \sum_j CT_{K,j} \quad + \quad \sum_j CT_{L,j} \quad + \quad \sum_j CT_{TFP,j} \tag{4.7}$$

$$\Delta \ln VA = CT_K \quad + \quad CT_L \quad + \quad CT_{TFP} \tag{4.8}$$

The last equation illustrates the decomposition of aggregate value added growth. It can be traced back to the contribution of capital input (CT_K), labour input (CT_L) and TFP (CT_{TFP}). The total contribution of capital input (CT_K) is the sum of the industry contributions of capital input across all industries. To put it differently, $CT_{K,j}$ measures what industry j contributes to aggregate capital input. It is calculated as the growth of capital services in industry j weighted by the average capital compensation to gross output in industry *j*, the average proportion of gross output to value added in industry j and the relative size of industry *j*'s value added in aggregate value added. Similarly, $CT_{L,j}$ and $CT_{TFP,j}$ show how much each industry contributed to aggregate labour input and aggregate TFP.

4.6.2 Industry Data

In order to perform an industry growth decomposition that accounts for intangible capital, we need production data at the sector level. We make use of EU KLEMS output data that provides information on gross output, value added and intermediate inputs, both in real and nominal values as well as corresponding price deflators. Intermediate inputs consist of material, energy and services. Data are available from 1970 onwards, but since we have complete data on intangibles only for the period from 1995 to 2006, we are restricted to this period.

EU KLEMS capital data also allow us to account for heterogeneous capital and labour. It provides time series on nominal *investment* (nominal gross fixed capital formation), differentiated by the following types of capital: computing equipment (IT), communications equipment (CMT), software (SOFT), transport equipment (TraEq), other machinery and equipment (oMach) and non-residential investment (oCon).[10] From the list it follows that the term capital that is already accounted for in EU KLEMS numbers on gross output and value added is a combination of mostly tangible capital and one category of intangible capital (software). The use of disaggregate capital time series, however, allows us to strictly define tangible capital (IT, CMT, TraEq, oMach, oCon) and intangible capital (software plus the

[10] We do not take into account investments in residential structures.

other categories explored in Sect. 4.2) and to modify numbers on aggregate gross output or value added, once when we only incorporate tangible capital and in a second version in which we account for all types of intangible capital. EU KLEMS data also deliver *price deflators* and nominal and real *capital stocks* for each type of asset (IT, CMT, SOFT, TraEq, oMach, oCon) and it provides time-constant estimates of (geometric) depreciation rates for each capital asset. In most cases the depreciation rate for one asset is constant across industries. In some cases, however, the rates differ across industries. For industries 1, 5 and 6 we then use an average rate (see Table 4.17). In order to build intangible capital stocks, we use investment data for each type of intangible assets and employ the perpetual inventory method. The underlying depreciation rates are also set out in Table 4.17 (see Corrado et al. 2009). As price deflator, we use the implicit value added deflator for each type of intangible asset.

Basic data on capital income at the sector level, needed for calculating weights in the growth accounting analysis, is also taken from EU KLEMS capital data. It publishes capital compensation by type of asset k = IT, CMT, TraEq, oMach, oCon, SOFT. We use the sum of capital compensation for assets k = IT, CMT, TraEq, oMach, oCon as a measure for capital income of tangible capital.

One problem that we are confronted with is the fact that we neither do observe capital compensation for intangible capital in total nor for each type of intangible asset. Hence, we also lack information on total capital income. To solve this problem, we employ the following procedure. Starting point is the fact that capital compensation of asset k can be calculated as its rental price times the capital stock. The rental price or user cost of capital consists of the nominal rate of return ror_k (reflecting the opportunity cost of holding the asset k) plus the nominal cost of depreciation for asset k and minus the nominal gain from holding the asset for each accounting period, i.e. the capital gain (see Azeez Erumban 2008). For each capital asset, we already possess information on capital stocks and depreciation rates. We furthermore estimate capital gains for each asset by using a 3-year moving average of the change in capital prices. However, what about the rate of return? In order to get an estimate of the rate of return, we use the suggestion by Hall and Jorgenson (1967). That is, we assume that the rate of return is unknown but constant across all assets ($ror_k = ror$). Under this assumption, we can estimate the common rate of return as the total capital income minus the sum of depreciation costs over all assets plus the sum of capital gains for all assets and finally divided by the total nominal capital stock. Having an estimate for the rate of return of asset k ($ror_k = ror$), we can then use the above formula to estimate the rental price of each asset k and subsequently the capital income for each type of capital. Note that we have two estimates of the rate of return (ror). In version one, we assume that total capital income equals the capital compensation for tangible capital. In version two, in which we account for intangible assets, total capital income is estimated as the income for tangible capital plus the sum of investments for intangible capital as an estimate for the compensation of intangible capital.[11]

Finally, in order to measure the growth of total labour services and the growth in labour services per hour worked, we extract data on total labour costs and total hours worked from EU KLEMS output data (November 2009 release). The EU KLEMS March 2008 release provides time series on heterogeneous labour input, i.e. labour compensation and hours worked for 18 different groups of labour. Employees and self-employed persons are differentiated according to their educational degree (high-, medium- and low-skilled), gender and their age (below 29, 30–49 and above 50).[12]

Complete data for all time series are available for the years 1995–2006. Since we take a 2-year period average for the weights and measure capital gains within the rate of return calculation as a 3-year moving average of changes in capital prices, we lose observations and can only use the period 1997–2006 for the growth accounting. That is, the first growth rate measures changes in labour productivity between 1996 and 1997.

4.6.3 Growth Accounting Results

This section delineates the sources of economic growth at the sector level, at the aggregate level and the industry contributions to economic growth and capital and labour input.

4.6.3.1 Decomposition of Growth in Real Gross Output at the Industry Level

We start with the decomposition of growth in real gross output at the industry level (Eq. (4.1), in combination with Eqs. (4.2) and (4.3) to account for heterogeneous inputs). The upper panel of Table 4.3 describes a situation in which the growth accounting framework only includes tangible capital (assets k = IT, CMT, TraEq, oMach, oCon). In the second panel, we additionally account for intangible capital. The first row depicts the growth rate in gross output across industries. Over the period 1997–2006, gross output increased on average by roughly 2.3–3.2 % per year in four out of six industries while it declined in agriculture & mining (−0.4 %) and construction (−2.7 %). At the same time, labour input intensity has changed. That is, the number of hours worked has been reduced in most industries, except in financial and business services where we observe an average annual increase of

[11] The average rate of return in version one is 0.083 and in version two 0.086. Both are highly correlated, indicated by a correlation coefficient of about 0.986.

[12] This type of information is only available until 2005. The missing observations for 2006 are estimated based on the total labour compensation for 2006 and the share of labour compensation for each group in 2005.

Table 4.3 Contributions of different types of intangible assets to labour productivity growth (in terms of gross output) by sector, 1997–2006

	AgMin	Mfr.	Utility	Cons.	RetHtTm	FinBsSvc
Excluding intangibles						
Gross output	−0.44	2.94	2.69	−2.66	2.33	3.15
Hours worked	−3.00	−1.65	−3.69	−2.37	−0.02	3.66
Labour productivity	**2.56**	**4.59**	**6.38**	**−0.29**	**2.35**	**−0.51**
Capital deepening	−0.06	0.21	1.44	−0.03	0.33	0.44
ICT capital	0.02	0.04	0.09	0.02	0.11	0.39
Non-ICT capital	−0.08	0.17	1.35	−0.05	0.22	0.05
Intangible capital	–	–	–	–	–	–
Labour quality	−0.22	0.07	0.04	0.08	−0.01	−0.03
Intermediate input deepening	1.21	3.34	4.07	0.09	1.21	−0.22
TFP	1.62	0.97	0.83	−0.43	0.81	−0.70
Including intangibles						
Gross output	−0.45	2.91	2.72	−2.65	2.34	3.20
Hours worked	−3.00	−1.65	−3.69	−2.37	−0.02	3.66
Labour productivity	**2.55**	**4.55**	**6.41**	**−0.28**	**2.36**	**−0.46**
Capital deepening	0.16	0.83	1.86	0.13	0.59	0.87
ICT capital	0.02	0.04	0.09	0.02	0.12	0.39
Non-ICT capital	−0.06	0.20	1.39	−0.05	0.23	0.06
Intangible capital	**0.20**	**0.59**	**0.38**	**0.17**	**0.23**	**0.42**
Computerized information	**0.01**	**0.04**	**0.09**	**0.01**	**0.05**	**0.07**
Software	0.01	0.04	0.09	0.01	0.05	0.06
Databases	0.00	0.00	0.00	0.00	0.00	0.00
Innovative property	**0.07**	**0.39**	**0.07**	**0.04**	**0.04**	**0.20**
Scientific R&D	0.02	0.29	0.01	0.00	0.01	0.05
Mineral exploration	0.01	0.00	0.00	0.00	0.00	0.00
Copyright licences	0.00	0.04	0.00	0.00	0.00	0.00
Financial services innovation	0.00	0.00	0.00	0.00	0.00	0.07
Architectural & engineering design	0.04	0.06	0.06	0.04	0.03	0.09
Economic competencies	**0.12**	**0.17**	**0.23**	**0.11**	**0.15**	**0.15**
Advertising	0.03	0.03	0.03	0.01	0.02	0.00
Market research	0.00	0.00	0.00	0.00	0.00	0.00
Firm-specific human capital	0.02	0.06	0.11	0.06	0.08	0.05
Organizational structure (p)	0.03	0.03	0.04	0.02	0.02	0.04
Organizational structure (oa)	0.04	0.05	0.05	0.03	0.03	0.07
Labour quality	−0.22	0.07	0.04	0.08	−0.01	−0.03
Intermediate input deepening	1.04	3.09	3.89	0.08	1.13	−0.03
TFP	1.57	0.56	0.62	−0.57	0.66	−1.26

Notes: Reported are average annual percentages. Tangible capital includes ICT capital consisting of computing equipment and communications equipment, non-ICT capital consisting of transport equipment, other machinery and equipment and non-residential investment. Intangible capital comprises software, databases, scientific R&D, mineral exploration, copyright and licence costs, financial services innovation, purchased and own-account architectural and engineering design, advertising, market research, training and purchased and own account organizational structure. Data: See Sects. 4.2 and 4.6.2. Own calculation around 3.7 %. When we take both developments together, we get the change in labour productivity (in terms of gross output). The average annual growth rate in labour productivity was highest in utility at about 6.4 %, but likewise high in manufacturing (+4.6 %). In agriculture & mining and trade & transportation, the figures indicate a moderate growth in labour productivity of about 2.4 % and 2.6 %, respectively. Labour productivity has even been slightly slowed down in the remaining two German industries.

The decomposition of the sources of growth between primary inputs and TFP emphasizes that *intermediate inputs contributed the most to labour productivity growth in all sectors in Germany, except in financial and business services*. This pattern emerges in both panels. Looking at the lower panel, the intermediate input deepening accounts for a raise of labour productivity of about 3.9 percentage points in utility. In manufacturing, growth in intermediate inputs led to a 3.1 percentage point increase in labour productivity which is nearly 73 % of the overall increase in manufacturing. The contribution of intermediate inputs to growth is much smaller in absolute terms in the sectors agriculture & mining and trade & transport where this figure is roughly 1 percentage point. In construction intermediate inputs contributed only a negligible amount to labour productivity growth and in financial services, this effect was even negative.

A second striking result is that *growth in labour quality contributed only to a very limited extent to industry growth in labour productivity*. In both panels, the contribution never exceeds 0.08 percentage points and is even slightly negative for three out of six industries (agriculture & mining and both service sectors). Results for the UK have shown a much higher absolute and relative contribution of labour input to labour productivity, in particular for manufacturing and both service sectors (contribution varies between 0.2 and 0.3 percentage points with a smaller labour productivity growth at the same time; see Clayton et al. 2009).

When we only account for tangible capital, the contribution of capital to growth is also relatively small, except for utility (+1.4 percentage points). In manufacturing, capital deepening has induced an increase in labour productivity of about 0.2 percentage points. It is only slightly larger in the two service sectors and even slightly negative in remaining two sectors (agriculture & mining, construction). The slow-down in growth in these two sectors can be traced back to a negative contribution of Non-ICT capital whereas ICT capital has stimulated growth in all industries. Another salient result pertains to the relative importance of ICT and non-ICT capital. *Whereas non-ICT capital is much more important for generating growth in sectors such as manufacturing, trade & transport and utility, ICT has a larger contribution in the other three sectors*; in particular in financial business services where it raised annual average growth by 0.4 percentage points.

When we include intangible capital, total capital deepening gets positive and larger in all industries. It then ranges between 0.13 percentage points in construction and 1.86 percentage points in utility, manufacturing being in between with an increase of about 0.9 percentage points. *Growth in intangible assets has stimulated labour productivity growth in all sectors*. The contribution varies between 0.17 (construction) and 0.59 (manufacturing) percentage points. Compared to the UK, however, intangible capital deepening seems to be somewhat smaller in absolute and relative terms in most sectors. For instance, it amounts to 0.97 percentage points in UK manufacturing (Clayton et al. 2009), but only 0.59 percentage points in Germany. Another outstanding result is the fact that the *contribution of intangible capital in Germany was higher than that of ICT and non ICT capital separately in all German sectors, except for utility*. In manufacturing, agriculture & mining and construction, intangible capital deepening was even larger than tangible capital deepening.

Growth in TFP, defined as growth in output per unit of input, *plays a major role in explaining industry growth in labour productivity*. In manufacturing, growth in TFP boosts labour productivity growth by nearly 1 percentage point when we do not include intangible capital. This implies that roughly 21 % of labour productivity growth in this sector cannot be explained by growth in capital, labour and intermediate inputs. In trade & transport, TFP accounts for 0.8 percentage points increase in labour productivity which means 34 % of overall labour productivity growth. The role of TFP is particularly strong in agriculture & mining, which could be related to the fact that we do not account for factor input land. On the other hand, its contribution was negative in financial and business services and construction. The *inclusion of intangible capital has led to a decline in the contribution of TFP in all sectors* which implies that part of the effect of TFP in the upper panel was due to the fact that we missed intangible capital. Of course, the *reduction in the contribution of TFP turns out to be particularly strong in those industries where growth in intangible capital revives labour productivity growth to a larger extent*, i.e. in manufacturing, utility and financial & business services. Accounting for intangible capital furthermore illustrates that (except for agriculture & mining) manufacturing does not show the highest contribution of TFP growth any longer but that the effect of TFP growth is now larger in trade & transport and utility.

Table 4.3 further disentangles the contribution of intangible capital into its different components. The results reveal that growth of *innovative property capital is the most influential type of intangible capital for labour productivity in manufacturing and financial & business services*, followed by economic competencies and computerized information. *In all other sectors,* growth of intangible capital that measures *economic competencies play the most prominent role for labour productivity growth*, followed by innovative property capital and computerized information.

The contributions of *innovative property capital* show the highest variance across industries. They range from a 0.39 percentage points increase in labour productivity in manufacturing to a 0.04 percentage points increase in trade & transport. Innovative property capital thus accounts for 65 % of the total contribution of intangible capital in manufacturing. The lion's share (0.29 percentage points or a share of 49 %) can be allotted to the growth in scientific R&D. In manufacturing, a rise in labour productivity of about 0.06 percentage points, which corresponds to a share of 9.6 % of intangible capital deepening, is due to new architectural and engineering designs. The contribution of innovative property capital in manufacturing (0.39) is roughly twice as big as in the financial and business service sector

(0.2). Growth in intangible capital based on new architectural and engineering designs is by far the most important source of growth (0.09 percentage points) among intangible assets in this sector, followed by financial service innovations (0.07) and scientific R&D (0.04). As a general result, architectural and engineering designs are the most important component of innovative property capital in all sectors, except in manufacturing.

The growth contributions of *economic competencies* are less spread across industries than those of innovative properties. Economic competencies have raised labour productivity growth between 0.11 (construction) and 0.22 (utility) percentage points. In manufacturing these competencies have stimulated growth by roughly 0.17 percentage points. Among economic competencies, not all types of assets are equally important. Growth in firm-specific human capital has contributed the most in four out of six sectors (manufacturing, utility, construction and trade& transport), followed by own-account as well as purchased organizational capital. Regarding the size of these effects, note that the contribution of firm-specific human capital turned out to be higher than that of new architectural and engineering design in all four industries. In the remaining two sectors (financial & business services and agriculture & mining) own-account organizational capital was the most important source of growth among economics competencies. Compared to firm-specific human capital and organizational capital, growth in branding capital (advertising) was associated with a relatively smaller increase in labour productivity growth. It was roughly 0.03 percentage points in manufacturing, utility and agriculture & mining, and more or less negligible in the other three sectors.

The *contribution of growth in intangible capital related to investments in computerized information is relatively small in all sectors*. It never exceeds 0.1 percentage points. Within computerized information, software is decisive whereas the role of database is negligible.

In order to account for the effect that business cycle conditions were quite different across the period 1997–2000, we perform the growth accounting for various sub-periods. Table 4.4 splits the sample into three periods: the first period 1997–2000 was characterised by an economy-wide boom period. On the contrary, the period 2000–2003 was marked by a recession, whereas the economy experienced an economic upswing again in the period 2003–2006. This is also reflected by the figures on labour productivity growth, except for utility and agriculture & mining in which we observe highest growth rates in the second period. The results confirm much of what has been said so far, but they also reveal some interesting new insights: The main results can be summarized as follows:

- The contribution of intangible capital to growth turned out to be positive in all sub-periods in all sectors, except for financial & business services in the third period.
- In most sectors, including manufacturing and the two service sectors, the absolute increase in labour productivity growth due to intangible capital has been declined over the three periods. This decrease can be observed for each

Table 4.4 Contributions to labour productivity growth (in terms of gross output) by sector and sub-periods (1997–2000, 2001–2003, 2004–2006)

	AgMin			Mfr.			Utility			Cons.			RetHtTm			FinBsSvc		
	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06
Excluding intangibles																		
Labour prod.	**1.31**	**4.07**	**2.72**	**6.11**	**0.92**	**6.25**	**4.71**	**9.13**	**5.87**	**−1.71**	**−3.24**	**4.55**	**3.53**	**0.67**	**2.43**	**0.15**	**−2.03**	**0.14**
Capital deep.	−0.12	−0.10	0.07	0.29	0.14	0.17	1.85	1.58	0.74	−0.10	−0.10	0.14	0.36	0.27	0.36	0.83	0.22	0.14
ICT capital	0.02	0.02	0.02	0.05	0.03	0.02	0.12	0.09	0.06	0.02	0.01	0.02	0.15	0.08	0.09	0.60	0.30	0.18
Non-ICT capital	−0.15	−0.13	0.05	0.23	0.11	0.15	1.73	1.49	0.69	−0.13	−0.11	0.13	0.21	0.19	0.27	0.22	−0.09	−0.03
Intang. cap.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Labour quality	−0.35	−0.01	−0.24	0.02	0.20	0.02	0.04	0.10	−0.02	0.05	0.15	0.04	−0.08	0.14	−0.08	−0.06	0.16	−0.19
Intermed. deep.	−0.07	3.37	0.76	4.59	0.72	4.31	2.34	6.23	4.22	−0.68	−2.06	3.26	1.96	−0.08	1.50	0.34	−1.53	0.35
TFP	1.86	0.81	2.13	1.21	−0.14	1.76	0.49	1.21	0.92	−0.98	−1.23	1.10	1.29	0.34	0.65	−0.96	−0.88	−0.16
Including intangibles																		
Labour prod.	**1.31**	**4.05**	**2.69**	**6.01**	**0.98**	**6.19**	**4.78**	**9.13**	**5.87**	**−1.71**	**−3.21**	**4.54**	**3.58**	**0.65**	**2.44**	**0.29**	**−2.14**	**0.22**
Capital deep.	0.11	0.09	0.31	1.38	0.52	0.42	2.56	2.01	0.79	0.21	−0.09	0.25	0.83	0.45	0.40	1.92	0.38	−0.04
ICT capital	0.02	0.02	0.02	0.06	0.03	0.02	0.13	0.09	0.06	0.02	0.01	0.02	0.16	0.09	0.09	0.62	0.31	0.17
Non-ICT capital	−0.13	−0.10	0.08	0.30	0.12	0.14	1.79	1.54	0.70	−0.14	−0.11	0.12	0.23	0.20	0.27	0.23	−0.09	−0.03
Intangible cap.	**0.22**	**0.16**	**0.22**	**1.02**	**0.37**	**0.25**	**0.64**	**0.38**	**0.04**	**0.32**	**0.01**	**0.11**	**0.44**	**0.16**	**0.03**	**1.07**	**0.16**	**−0.19**
Comp. info.	0.01	0.01	0.01	0.06	0.03	0.01	0.13	0.08	0.03	0.03	0.01	0.00	0.07	0.04	0.03	0.13	0.07	−0.02
Software	0.01	0.01	0.01	0.06	0.03	0.01	0.13	0.08	0.03	0.03	0.01	0.00	0.07	0.03	0.03	0.12	0.06	−0.02
Databases	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Innov. prop.	0.08	0.05	0.06	0.60	0.27	0.21	0.12	0.06	0.01	0.08	0.01	0.02	0.07	0.04	0.01	0.45	0.10	−0.01
Scientific R&D	0.02	0.01	0.01	0.42	0.22	0.18	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.00	0.06	0.04	0.04
Min. expl.	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copy. & lic.	0.00	0.00	0.00	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fin serv. inno.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.02	−0.03
Arch. & engin. design	0.04	0.03	0.04	0.10	0.04	0.02	0.09	0.06	0.00	0.07	0.01	0.02	0.06	0.02	0.01	0.21	0.04	−0.02
Econ. comp.	0.12	0.10	0.15	0.35	0.07	0.03	0.39	0.23	0.00	0.22	−0.01	0.09	0.30	0.09	0.00	0.49	0.00	−0.16
Advertising	0.03	0.02	0.05	0.07	−0.01	0.00	0.08	0.02	−0.02	0.03	−0.03	0.01	0.04	0.00	0.00	0.08	−0.05	−0.05

(continued)

Table 4.4 (continued)

	AgMin			Mfr.			Utility			Cons.			RetHtTm			FinBsSvc		
	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06	97–00	01–03	04–06
Market research	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Firm-specific Human cap.	0.01	0.03	0.02	0.13	0.03	0.01	0.15	0.12	0.05	0.09	0.02	0.05	0.17	0.06	−0.01	0.15	−0.01	−0.04
Orga. struct. (p)	0.03	0.02	0.04	0.07	0.02	0.01	0.07	0.04	−0.01	0.04	−0.01	0.01	0.04	0.01	0.01	0.11	0.01	−0.03
Orga. struct. (oa)	0.04	0.03	0.04	0.09	0.03	0.01	0.08	0.06	−0.01	0.05	0.01	0.01	0.05	0.02	0.00	0.16	0.04	−0.04
Labour quality	−0.36	−0.01	−0.24	0.02	0.20	0.02	0.04	0.10	−0.03	0.05	0.15	0.04	−0.08	0.14	−0.08	−0.06	0.16	−0.19
Intermed. input deep.	−0.08	3.13	0.44	4.08	0.85	4.03	2.01	6.06	4.23	−0.69	−1.91	3.08	1.80	−0.04	1.41	0.37	−1.07	0.46
TFP	1.64	0.85	2.18	0.53	−0.59	1.73	0.17	0.97	0.87	−1.28	−1.36	1.17	1.03	0.10	0.71	−1.94	−1.61	−0.01

Notes: See Table 4.3

single component of intangible capital. It is particularly strong for economic competencies and less so for innovative property and computerized information.
- But still, intangible capital deepening was higher than ICT capital deepening or non-ICT capital deepening in all three periods in manufacturing, agriculture & mining and construction. In both service sectors, however, this pattern has changed over time and ICT capital deepening (financial business services) and non-ICT capital deepening (trade & transport) have become more important than intangible capital deepening from 2001 onwards.
- Though the growth in labour productivity was similar in magnitude in manufacturing in the boom period 1997–2000 and in the upswing period 2003–2006, the sources of growth differ quite a lot. Besides intermediate input deepening, intangible capital was the second most important source of growth in the first period that has stimulated growth by 1 percentage point whereas the contribution of TFP was relatively small (+0.5). In the third period, however, the upswing is much more supported by growth in TFP (+1.7) than by intangible capital (+0.25). But also the contribution of tangible capital has declined (from +0.36 to +0.16).
- In all sectors, the contribution of labour quality to growth in labour productivity was highest in the recession period.

4.6.3.2 Decomposition of Real Value Added Growth at the Industry Level

Since growth accounting at the aggregate level is based on a value added concept, Table 4.5 additionally depicts the decomposition of growth in real value added at the industry level. Growth in real value added in industry j is the weighted sum of industry capital, labour input and TFP growth. The weights on capital (labour) account for the share of capital (labour) income in gross output in industry j and for (the inverse of) the share of industry value added in industry gross output.

Most of the results with respect to the sources of growth in value added are qualitatively the same as before for growth in gross output. In a nutshell, the most salient results are the following:

First, the contribution of intangible capital to growth turned out to be positive in all sectors. It is highest in manufacturing where it raised growth by 1.44 percentage points. That is, intangible capital accounts for nearly 40 % of labour productivity growth (based on value added). In the other five industries, intangible capital deepening ranges roughly between 0.35 and 0.7 percentage points and its relative importance is lower.

Second, the former result that intangible capital deepening is more important than ICT and non-ICT capital deepening, respectively, is confirmed for most industries (manufacturing, agriculture & mining, construction, financial & business services). In the first three of the sectors, the contribution of intangible capital was even larger than that of overall tangible capital. In trade & transport, non-ICT capital deepening turned out to be slightly more important. In financial & business

Table 4.5 Contributions to labour productivity growth (in terms of value added) by sector and type of intangible assets, 1997–2006

	AgMin	Mfr.	Utility	Cons.	RetHtTm	FinBsSvc
Excluding intangibles						
Labour productivity growth	**2.90**	**3.73**	**4.60**	**−0.85**	**2.13**	**−0.54**
Capital deepening	−0.12	0.61	2.81	−0.06	0.63	0.83
ICT capital	0.05	0.11	0.18	0.04	0.21	0.73
Non-ICT capital	−0.17	0.50	2.63	−0.10	0.42	0.10
Intangible capital	–	–	–	–	–	–
Labour quality	−0.47	0.22	0.07	0.18	−0.02	−0.06
TFP	3.48	2.90	1.71	−0.96	1.53	−1.31
Including intangibles						
Labour productivity growth	**3.09**	**3.65**	**4.65**	**−0.77**	**2.16**	**−0.69**
Capital deepening	0.34	2.03	3.37	0.29	1.02	1.40
ICT capital	0.05	0.10	0.17	0.04	0.21	0.64
Non-ICT capital	−0.12	0.49	2.53	−0.11	0.41	0.09
Intangible capital	**0.41**	**1.44**	**0.67**	**0.36**	**0.40**	**0.67**
Computerized information	**0.03**	**0.10**	**0.15**	**0.03**	**0.08**	**0.11**
Software	0.03	0.09	0.15	0.03	0.08	0.10
Databases	0.00	0.00	0.00	0.00	0.00	0.00
Innovative property	**0.13**	**0.95**	**0.12**	**0.09**	**0.07**	**0.33**
Scientific R&D	0.03	0.71	0.02	0.01	0.01	0.07
Mineral exploration	0.03	0.00	0.00	0.00	0.00	0.00
Copyright licences	0.00	0.10	0.00	0.00	0.00	0.00
Financial services innovation	0.00	0.00	0.00	0.00	0.00	0.11
Architectural & engineering design	0.08	0.14	0.10	0.08	0.06	0.15
Economic competencies	**0.25**	**0.40**	**0.40**	**0.24**	**0.25**	**0.24**
Advertising	0.06	0.06	0.05	0.02	0.03	0.00
Market research	0.00	0.00	0.00	0.00	0.00	0.00
Firm-specific human capital	0.04	0.15	0.20	0.13	0.14	0.07
Organizational structure (p)	0.07	0.08	0.06	0.04	0.04	0.06
Organizational structure (oa)	0.08	0.11	0.08	0.06	0.05	0.11
Labour quality	−0.44	0.18	0.07	0.17	−0.02	−0.05
TFP	3.19	1.44	1.21	−1.23	1.16	−2.04

Notes: See Table 4.3

services, the contribution of ICT capital was nearly as large as that of intangible capital.

Third, in manufacturing and financial & business services the growth of innovative property capital is the most influential type of intangible capital for labour productivity. In manufacturing the main source of intangible capital deepening can be again traced back to scientific R&D (it accounts for 75 %) whereas it is new architectural and engineering design in financial and business services. In both sectors, innovative property is followed by economic competencies and computerized information is bottom of the list. In all other sectors, the main source of intangible capital deepening can be allotted to the growth in economic competencies. It is followed by innovative property capital and computerized information.

Fourth, with respect to the relative importance of specific types of economic competencies, the same picture emerges as before: Growth in firm-specific human capital has contributed the most in four out of six sectors (manufacturing, utility, construction and trade& transport), followed by own-account as well as purchased organizational capital. In the remaining two sectors growth in own-account organizational capital was the most important source of growth among economics competencies.

Furthermore, the inclusion of intangible capital reduces the contribution of TFP growth significantly in five out of six sectors (the exception being agriculture & mining). The reduction in the contribution of TFP turns out to be particularly strong in those industries where growth in intangible capital revives labour productivity growth to a larger extent. But still, TFP growth plays the most important role for growth in labour productivity based on value added in manufacturing, agriculture & mining and trade & transport. For instance, in manufacturing, TFP growth raised labour productivity growth by 1.4 percentage points. This corresponds to roughly 40 % of the overall increase in labour productivity. On the contrary, the effect of TFP growth was negative on labour productivity in financial and business services and construction.

Finally, growth in labour quality contributed only to a small extent to industry growth in labour productivity based on value added. The contributions are slightly larger compared to when we use gross output to measure labour productivity, in particular for manufacturing and construction.

4.6.3.3 Decomposition of Real Value Added Growth at the Aggregate Level

Using the direct aggregation approach, we calculate aggregate value added growth as weighted sum of industry value added growth and investigate the sources of aggregate growth using Eq. (4.8). Table 4.6 displays the contributions of capital, labour quality and TFP to aggregate growth with (upper panel) and without (bottom panel) accounting for intangible capital.

Note that treating expenditure for intangible goods as intermediate input instead of long-term investment generally implies that we underestimate labour productivity and overestimate the contribution of total factor productivity to labour productivity growth. In the period 1997–2000 we clearly observe these two biases. In the period 2001–2006, however, we would overestimate labour productivity growth when we neglect intangible capital. But in all periods the inclusion of intangible capital leads to a significant reduction in the contribution of TFP to labour productivity growth. Overall, it declined from 1.1 to 0.26 percentage points.

In the period 1997–2006 the average annual labour productivity growth was nearly 1.8 %. The most important contribution to growth stems from intangible capital deepening. It accounts for 0.84 percentage points or nearly half of the

Table 4.6 Contributions to aggregate labour productivity growth, 1997–2006

	97–00	01–03	04–06	Total
Excluding intangibles				
Value added growth	2.55	0.35	2.51	1.88
Hours worked	0.41	−0.01	−0.30	0.07
Labour productivity growth	**2.14**	**0.36**	**2.81**	**1.81**
Capital deepening	0.93	0.47	0.52	0.67
ICT capital	0.43	0.24	0.17	0.30
Non-ICT capital	0.50	0.23	0.35	0.37
Intangible capital	–	–	–	–
Labour quality	−0.06	0.39	−0.13	0.05
TFP	1.28	−0.50	2.42	1.09
Including intangibles				
Value added growth	2.81	0.01	2.47	1.87
Hours worked	0.41	0.04	−0.29	0.09
Labour productivity growth	**2.40**	**−0.03**	**2.75**	**1.78**
Capital deepening	2.49	0.93	0.64	1.47
ICT capital	0.39	0.21	0.15	0.27
Non-ICT capital	0.51	0.22	0.31	0.36
Intangible capital	**1.58**	**0.50**	**0.19**	**0.84**
Labour quality	−0.05	0.35	−0.12	0.05
TFP	−0.04	−1.31	2.23	0.26

Notes: See Table 4.3

overall growth in labour productivity. However, what was already evident at the industry level transferred to the aggregate level: The absolute and relative contribution of intangible capital deepening has declined over time. While labour productivity growth was mainly backed by intangible capital deepening in the boom period 1997–2000, intangible capital contributed only to a small extent to the economic upswing in 2003–2006. Growth in TFP was the main source of labour productivity growth in this period.

Compared to tangible capital, it turns out that the contribution of intangible capital was larger in the overall period (+0.84 compared to +0.64 percentage points). However, this was mainly due to the boom period 1997–2000. Between 2001 and 2003 tangible and intangible capital contributed to a similar extent to labour productivity growth (+0.43 and +0.5). In the upswing phase 2003–2006, tangible capital deepening, however, was more important as source of growth than intangible capital (+0.46 compared to +0.19). In the latter period, we even observe that non-ICT capital stimulated growth more than intangible capital and that ICT capital deepening was nearly as large. Overall, the results reveal a decline over time in the absolute contribution of ICT capital and intangible capital whereas we do not observe this pattern for non-ICT capital.

Table 4.7 Industry contributions to aggregate growth (excluding intangibles), 1997–2006

	Excluding intangibles													
	AgMin		Mfr.		Utility		Cons.		RetHtTm		FinBsSvc		Business sector	
	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %
Value added														
VA weight	0.024		0.336		0.032		0.074		0.270		0.264			
VA growth	2.898		3.730		4.598		−0.847		2.133		−0.542			
CT to agg. VA growth	0.071	*3.9*	1.255	*69.4*	0.138	*7.6*	−0.086	*−4.8*	0.576	*31.9*	−0.146	*−8.1*	1.808	*100.0*
Total capital														
Capital weight	0.002		0.077		0.019		0.011		0.055		0.106			
Capital growth	−1.418		2.737		4.853		−0.354		3.112		1.974			
CT to agg. capital growth	−0.003	*−0.5*	0.204	*30.6*	0.089	*13.4*	−0.007	*−1.1*	0.170	*25.5*	0.213	*32.0*	0.666	*100.0*
Thereof:														
CT to agg. ICT cap. growth	0.001	*0.3*	0.037	*12.5*	0.006	*2.0*	0.003	*1.0*	0.058	*19.7*	0.190	*64.4*	0.295	*100.0*
CT to agg. non-ICT cap. growth	−0.005	*−1.3*	0.167	*45.0*	0.083	*22.4*	−0.010	*−2.7*	0.112	*30.2*	0.024	*6.5*	0.371	*100.0*
CT to intangible cap. growth	–				–		–		–		–		–	
Labour quality growth (LQG)														
Labour quality weight	0.022		0.259		0.013		0.063		0.216		0.158			
Labour quality growth	−0.507		0.275		0.159		0.211		−0.029		−0.097			
CT to agg. LQG	−0.011	*−20.0*	0.073	*132.7*	0.002	*3.6*	0.014	*25.5*	−0.006	*−10.9*	−0.017	*−30.9*	0.055	*100.0*
TFP														
TFP weight	0.051		1.003		0.063		0.170		0.507		0.501			
TFP growth	1.565		0.970		0.833		−0.430		0.814		−0.699			
CT to agg. TFP growth	0.072	*6.6*	0.977	*89.9*	0.047	*4.3*	−0.092	*−8.5*	0.412	*37.9*	−0.342	*−31.5*	1.087	*100.0*

Notes: Presented are average annual industry contributions. Data: See Sects. 4.2 and 4.6.2. Own calculation

Table 4.8 Industry contributions to aggregate growth (including intangibles), 1997–2006

	Including intangibles													
	AgMin		Mfr.		Utility		Cons.		RetHtTm		FinBsSvc		Business sector	
	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %	abs.	in %
Value added														
VA weight	0.022		0.354		0.030		0.068		0.255		0.270			
VA growth	3.086		3.650		4.646		−0.766		2.158		−0.691			
CT to agg. VA growth	0.069	*3.9*	1.291	*72.7*	0.132	*7.4*	−0.074	*−4.2*	0.549	*30.9*	−0.190	*−10.7*	1.777	*100.0*
Total capital														
Capital weight	0.003		0.125		0.018		0.013		0.064		0.131			
Capital growth	2.538		5.882		5.549		1.574		4.090		2.744			
CT to agg. capital growth	0.007	*0.5*	0.716	*48.7*	0.101	*6.9*	0.020	*1.4*	0.260	*17.7*	0.365	*24.8*	1.469	*100.0*
Thereof:														
CT to agg. ICT cap. growth	0.001	*0.4*	0.035	*13.2*	0.005	*1.9*	0.003	*1.1*	0.052	*19.6*	0.169	*63.8*	0.265	*100.0*
CT to agg. non-ICT cap. growth	−0.003	*−0.8*	0.173	*47.5*	0.076	*20.9*	−0.010	*−2.7*	0.105	*28.8*	0.023	*6.3*	0.364	*100.0*
CT to intangible cap. growth	0.009	*1.1*	0.508	*60.5*	0.020	*2.4*	0.027	*3.2*	0.103	*12.3*	0.172	*20.5*	0.839	*100.0*
Labour quality growth (LQG)														
Labour quality weight	0.019		0.229		0.012		0.056		0.190		0.140			
Labour quality growth	−0.507		0.275		0.159		0.211		−0.029		−0.097			
CT to agg. LQG	−0.010	*−20.8*	0.064	*133.3*	0.002	*4.2*	0.012	*25.0*	−0.005	*−10.4*	−0.015	*−31.3*	0.048	*100.0*
TFP														
TFP weight	0.045		0.886		0.055		0.150		0.447		0.442			
TFP growth	1.565		0.556		0.620		−0.570		0.657		−1.262			
CT to agg. TFP growth	0.072	*27.5*	0.511	*195.0*	0.030	*11.5*	−0.106	*−40.5*	0.294	*112.2*	−0.539	*−205.7*	0.262	*100.0*

Notes: Presented are average annual industry contributions. Data: See Sects. 4.2 and 4.6.2. Own calculation

4.6.3.4 Industry Contributions to Aggregate Labour Productivity Growth and to Capital, Labour and TFP Deepening

Finally, the direct aggregation approach allows us to investigate the industry contributions to value added growth (using Eq. (4.6)) and to capital, labour and TFP deepening (using Eq. (4.7)). Tables 4.7 and 4.8 present the industry contributions when we exclude and include intangible capital into the growth accounting framework. For each sector and indicator (value added, capital, labour and TFP) the weight, growth rate and the sector contribution to the aggregate figure is displayed.

With respect to value added, the lion's share can be allotted to manufacturing. 73 % of aggregate value added growth stems from manufacturing despite its share in aggregate value added being just around 35 %. A second important source of aggregate value added growth originates in trade & transport (roughly 31 %). On the contrary, construction and financial & business services have contributed negatively to value added growth.

Regarding the contribution of labour quality, we also find manufacturing on the top of the list though its relative size in labour is smaller than for instance for trade & transport. With respect to ICT capital deepening the leading sector contribution stems from financial & business services. Around 64 % of the contribution of ICT capital to labour productivity growth comes from this sector. The second largest contributor to ICT capital deepening is trade & transport (19 %), followed by manufacturing (13 %). Regarding non-ICT capital deepening, the industry contributions are much more evenly spread across industries. The major contributor is manufacturing. Its contribution (48 %) is again larger than the weight manufacturing possesses in the level of aggregate value added. Trade & transport is second on the list (29 %), followed by utility (21 %).

Intangible capital deepening stems to a large extent from high growth rates in intangibles in manufacturing. 60.5 % of the contribution of intangible capital to labour productivity can be traced back to manufacturing. The financial and business services sector is the second largest contributor to intangible capital deepening (21.5 %). Another 12 % originates in trade & transport.

Aggregate TFP growth is mostly accounted for by manufacturing and trade & transport. Utility and agriculture show also a positive but relatively small contribution whereas the financial & business service sector and construction even negatively contribute to aggregate TFP growth.

4.7 Conclusion

Knowledge investment has become a key factor for firms around the world to gain competitive advantage and firms across different sectors are likely to differ in their strategies to invest in intangible capital. This study was aimed at shedding light on the role of intangible assets for growth at the sector level in Germany. The assessment was done by comparing efforts across countries (to be precise with the UK) and by calculating their contribution to industry growth in labour productivity.

Our results show that German firms have intensified their efforts to invest in intangible capital. In absolute terms, investment has grown from 138.6 to 180 bn € over the period 1995–2006 which corresponds to a growth rate of 30 %. This increase was not continuous but followed the overall economic development. We furthermore showed that intangible investment gained importance relative to tangible investment. Its share increased from 80 to 89 %. Despite this positive trend, we have to ascertain that the increase in gross output was even larger. That is, the share of intangible investment in gross output has fallen in the two largest sectors, manufacturing (from 6.7 to 5.6 %) and financial and business services (from 9.1 to 8.1 %).

In Germany, nearly half of the investment in intangibles is carried out by manufacturing firms. This industry proportion is much higher than the share of manufacturing in gross output, value added or for instance in labour input. The outstanding position of intangible capital in manufacturing is also documented by the fact that this sector invests more in intangible than tangible capital and that this proportion has even climbed from 138 to 168 %. Financial and business services account for about one third of all intangible investments. Though firms in this sector have expanded their investment for intangible capital the importance relative to tangible capital is nearly unaltered (around 80 %).

In particular, German firms have expanded their investment in computerized information by nearly 100 %. At the same time, a shift has taken place in investment in software and databases from manufacturing towards business services. Despite this intensification, the share of computerized information in overall investment in intangibles remains rather small. Software and databases account for 10 % in the business sector in 2004. This share, however, varies across industries between 5 % in agriculture & mining and 21 % in utility, manufacturing is at the lower end (6 %) and financial and business in the mid (11 %).

Investment in innovative property makes up 55 % of all intangible investment in 2004. It has also demonstrated a positive trend though it has been less marked than in computerized information. From 1995 to 2008 investment in innovative property has grown by 40 %. The investments are highly concentrated in two industries, namely manufacturing and financial and business services. Manufacturing firms do not only perform most of the investment in innovative property in general and R&D

in specific, but innovative property is likewise the most important type of intangible asset in this sector (55 %). Compared to other intangible assets, innovative property is far less important in financial and business services (27 %) and trade and transport (28 %).

Investments in economic competencies have increased by 25 %. They are less concentrated across sectors and the distribution across industries is quite stable over the period. The relative importance of economic competencies varies quite a lot across sectors. Manufacturing firms direct 39 % of their investments in intangibles to economic competencies. This share is above 60 % in all other industries, being highest in construction with 78 %.

Compared to the UK, the share of intangible investment in gross output is smaller in all sectors in Germany except for utility. A more differentiated picture, however, can be drawn when we look at distinct asset classes. For instance, manufacturing firms in Germany invest a higher proportion of gross output in R&D and in advertising whereas investment in new designs, software, organizational structure, firm-specific human capital and copyright and licences are higher in the UK. In general, investment in new architectural and engineering design is consistently higher across all sectors in the UK. Computerized information is around two times larger in UK manufacturing, financial and business services and trade & transport (similar shares in other three sectors). On the other hand, German firms invest a higher proportion of gross output in R&D in all sectors. Advertising is also more common in Germany except for the sector trade & transport.

The decomposition of the sources of growth between primary inputs and TFP emphasizes that intermediate inputs contributed the most to labour productivity growth in all sectors in Germany, except in financial and business services. Growth in labour quality contributed only to a very limited extent to industry growth in labour productivity. The contribution of tangible capital to growth is also relatively small, except for utility. Whereas non-ICT capital is much more important for generating growth in sectors such as manufacturing, trade & transport and utility, ICT has a larger contribution in the other three sectors. Extending the growth accounting framework, we corroborate that growth in intangible assets has stimulated labour productivity growth in all sectors. The contribution varies between 0.17 (construction) and 0.59 (manufacturing) percentage points. Compared to the UK, however, intangible capital deepening seems to be somewhat smaller in absolute and relative terms in most sectors in Germany. The contribution of intangible capital turns out to be higher than that of ICT and non ICT capital separately in all German sectors, except for utility. Growth in TFP plays a major role in explaining industry growth in labour productivity but its contribution decreases when we include intangible capital in all sectors.

The results further highlight hat growth of innovative property capital is the most influential type of intangible capital for labour productivity in manufacturing and financial & business services, followed by economic competencies and computerized information. In all other sectors, growth of intangible capital that measures economic competencies plays the most prominent role for labour productivity growth, followed by innovative property capital and computerized information. The absolute contribution of growth in intangible capital related to investment in computerized information is relatively small in all sectors.

But it is also worthy to compare the relative contribution. In manufacturing, for instance, innovative property accounts for 55 % of intangible investment, but for 65 % of the total contribution of intangible capital. In the financial and business service sector this deviation is even more pronounced. 27 % of intangible investments are allotted to innovative property which accounts for nearly 50 % of the growth contribution of intangible capital. The growth contribution is likewise comparably high for computerized information. In financial and business services this item makes up 11 % of intangible investment, but 16 % of its growth contribution. In manufacturing, the corresponding shares are 5 and 6.7 %. In contrast, economic competencies are relatively less growth-enhancing. In manufacturing, they account for 39 % of intangible investment, but only for 28 % of the total contribution of intangible capital. In financial and business services this difference is even larger. 62 % of intangible investment is allotted to economic competencies. But they make up only 35 % of the growth contribution of intangible capital.

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Table 4.9 Data sources

Investment item	Sources	Calculation	Industry breakdown availability	Period available
Computerized information				
Software	EU KLEMS Nov 2009 Release	Calculated by EU KLEMS	Industry breakdown available in EU KLEMS Nov 2009	1991–2007
Databases	Destatis: Turnover tax statistics	Turnover of NACE 72.4	Input-Output Table (K72)	1994–2008
Innovative property				
Scientific R&D	EUROSTAT: ANBERD	Calculated by ANBERD	Industry breakdown available in ANBERD data	1991–2006
Mineral exploration	Destatis: Turnover tax statistics	Turnover of NACE 45.12	No breakdown	1994–2008
Copyright licences	Destatis: Turnover tax statistics	Turnover of NACE 92.11	Input-Output Table (K92)	1992–2008
Financial services innovation	Mannheim Innovation Panel (MIP)	Extrapolation of innovation expenditures to the total population of enterprises in the financial industry.	No breakdown	1995–2007
Architectural & eng. design	Destatis: Turnover tax statistics	Turnover of NACE 74.2	Input-Output Table (K74)	1992–2008
Economic competencies				
Advertising	Central Association of the German Advertising Industry (ZAW) & Mannheim Innovation Panel (MIP)	Gross advertising expenditure (ZAW) plus 15 % for own-account marketing expenditures (MIP)	Input-Output Table (K74)	1991–2008
Market research	Destatis: Turnover tax statistics	Turnover of NACE 74.13	Input- Output Table (K74)	1994–2008
Firm-specific human capital	Mannheim Innovation Panel (MIP)	Extrapolation of training expenditures	Industry breakdown available in MIP data	1995–2006
Organizational structure (p)	Destatis: Turnover tax statistics	Turnover of NACE 74.14.1	Input-Output Table (K74)	1994–2008
Organizational structure (oa)	Destatis: Structure of earnings survey 2006 (wage bill of salaries of senior managers in the private sector) & EU KLEMS Nov 2009	20 % of managers' compensation	Input-Output Table (K74)	1991–2007

Notes: Destatis denotes the German Federal Statistical Office
Source: own representation

Table 4.10 Investment in intangible assets in the business sector, 1994–2008 (bn Euro)

Type of investment	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Computerized information															
Software	9.0	9.5	10.3	11.1	12.1	13.6	15.0	15.9	15.7	15.5	15.8	16.0	16.8	17.7	n.a.
Databases	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.6	0.3	0.3	0.3	0.6	0.5	0.7
Innovative property															
Scientific R&D	25.9	26.8	27.2	28.9	30.3	33.6	35.6	36.3	36.9	38.0	38.4	38.6	41.1	43.0	46.1
Mineral exploration	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Copyright licences	3.4	3.9	4.4	4.5	6.8	5.8	5.4	5.1	4.0	4.3	4.0	4.1	3.8	3.5	3.7
Financial services innovation	n.a.	3.9	3.6	4.2	5.8	6.6	5.5	4.9	5.1	4.7	4.0	4.9	4.4	4.4	3.2
Architectural & engineering design	18.9	19.0	19.1	18.3	18.8	18.5	18.5	18.9	18.4	17.8	17.4	18.2	19.1	20.3	22.2
Economic competencies															
Advertising	17.9	18.9	19.4	20.0	20.8	21.7	22.9	21.7	20.4	19.9	20.2	20.4	20.9	21.2	21.2
Market research	2.1	1.9	1.8	1.5	1.4	1.5	1.3	1.3	1.4	1.5	1.8	1.6	1.6	1.7	1.8
Firm-specific human capital	n.a.	30.3	32.5	32.2	33.9	30.6	33.0	34.5	35.7	32.1	32.5	34.2	35.6	n.a.	n.a.
Organizational structure (p)	8.3	9.0	9.8	11.0	13.2	17.0	19.5	20.4	18.1	16.1	16.4	17.6	19.3	20.0	19.8
Organizational structure (oa)	14.2	14.7	14.8	14.9	15.2	15.5	16.2	16.5	16.5	16.5	16.6	16.6	16.9	17.4	n.a.
Total investment in intangibles	n.a.	138.2	143.1	146.9	158.6	164.8	173.4	176.2	172.9	166.9	167.4	172.6	180.1	n.a.	n.a.

Notes: n.a.: figure not available. All figures in bn Euro

Source: German turnover tax statistics, Mannheim Innovation Panel (MIP), German Structure of Earnings Survey 2006, EU KLEMS Nov 2009 Release, Input-Output Table, ZAW, own calculation

Table 4.11 Investment in software and databases by industries, 1994–2007

	Business sector	AgMin bn €	%	Mfr. bn €	%	Utility bn €	%	Cons. bn €	%	RetHtTrn bn €	%	FinBsSvc bn €	%
Investment in computer software													
1991	8.09	0.07	*0.9*	3.53	*43.7*	0.34	*4.2*	0.38	*4.7*	2.17	*26.8*	1.60	*19.7*
1992	8.59	0.08	*0.9*	3.45	*40.1*	0.37	*4.3*	0.44	*5.1*	2.47	*28.8*	1.78	*20.8*
1993	8.79	0.07	*0.8*	2.99	*34.0*	0.44	*5.0*	0.49	*5.6*	2.80	*31.9*	1.99	*22.7*
1994	8.97	0.07	*0.8*	3.00	*33.5*	0.48	*5.3*	0.50	*5.6*	2.65	*29.5*	2.27	*25.3*
1995	9.48	0.09	*0.9*	3.41	*36.0*	0.39	*4.1*	0.44	*4.6*	2.51	*26.4*	2.64	*27.9*
1996	10.27	0.09	*0.9*	3.77	*36.7*	0.52	*5.0*	0.41	*4.0*	2.60	*25.3*	2.89	*28.1*
1997	11.14	0.08	*0.7*	4.04	*36.2*	0.52	*4.7*	0.38	*3.4*	2.78	*25.0*	3.35	*30.1*
1998	12.14	0.08	*0.7*	4.41	*36.3*	0.53	*4.3*	0.39	*3.2*	3.00	*24.7*	3.73	*30.7*
1999	13.60	0.09	*0.7*	4.76	*35.0*	0.54	*4.0*	0.43	*3.2*	3.24	*23.8*	4.54	*33.4*
2000	15.01	0.09	*0.6*	5.08	*33.8*	0.50	*3.3*	0.45	*3.0*	3.61	*24.0*	5.29	*35.3*
2001	15.90	0.08	*0.5*	5.27	*33.2*	0.50	*3.2*	0.36	*2.3*	3.44	*21.6*	6.25	*39.3*
2002	15.68	0.09	*0.6*	5.46	*34.8*	0.57	*3.6*	0.37	*2.4*	3.74	*23.9*	5.44	*34.7*
2003	15.54	0.09	*0.6*	5.45	*35.1*	0.56	*3.6*	0.33	*2.1*	3.40	*21.9*	5.71	*36.8*
2004	15.84	0.09	*0.6*	5.21	*32.9*	0.59	*3.7*	0.31	*2.0*	3.94	*24.9*	5.70	*36.0*
2005	16.00	0.09	*0.6*	5.15	*32.2*	0.66	*4.2*	0.30	*1.9*	4.21	*26.3*	5.58	*34.9*
2006	16.76	0.11	*0.7*	5.61	*33.4*	0.76	*4.5*	0.33	*2.0*	4.63	*27.6*	5.33	*31.8*
2007	17.68	0.11	*0.6*	5.66	*32.0*	0.83	*4.7*	0.33	*1.9*	4.76	*26.9*	5.99	*33.9*
Investment in databases													
1994	0.11	0.00	*0.3*	0.03	*25.0*	0.00	*1.3*	0.00	*0.8*	0.02	*21.9*	0.05	*50.8*
1995	0.12	0.00	*0.2*	0.03	*23.1*	0.00	*0.9*	0.00	*0.7*	0.02	*19.5*	0.07	*55.6*
1996	0.14	0.00	*0.2*	0.03	*23.2*	0.00	*0.9*	0.00	*0.7*	0.03	*19.4*	0.08	*55.7*
1997	0.15	0.00	*0.2*	0.03	*23.3*	0.00	*0.9*	0.00	*0.7*	0.03	*19.4*	0.08	*55.7*
1998	0.14	0.00	*0.2*	0.03	*23.6*	0.00	*0.9*	0.00	*0.6*	0.03	*20.0*	0.08	*54.6*
1999	0.30	0.00	*0.1*	0.07	*22.8*	0.00	*1.0*	0.00	*0.6*	0.06	*20.3*	0.17	*55.3*

(continued)

Table 4.11 (continued)

	Business sector	AgMin bn €	%	Mfr. bn €	%	Utility bn €	%	Cons. bn €	%	RetHtTrn bn €	%	FinBsSvc bn €	%
2000	0.35	0.00	*0.1*	0.08	*22.5*	0.00	*0.9*	0.00	*0.5*	0.07	*20.9*	0.19	*55.1*
2001	0.48	0.00	*0.1*	0.10	*21.4*	0.00	*0.9*	0.00	*0.4*	0.10	*20.7*	0.27	*56.5*
2002	0.55	0.00	*0.1*	0.12	*22.3*	0.01	*0.9*	0.00	*0.4*	0.12	*21.2*	0.30	*55.1*
2003	0.25	0.00	*0.1*	0.05	*20.3*	0.00	*1.0*	0.00	*0.4*	0.05	*19.8*	0.15	*58.5*
2004	0.26	0.00	*0.1*	0.05	*21.1*	0.00	*1.0*	0.00	*0.4*	0.05	*21.0*	0.15	*56.4*
2005	0.30	0.00	*0.1*	0.06	*20.5*	0.00	*0.9*	0.00	*0.4*	0.06	*21.0*	0.17	*57.1*
2006	0.58	0.00	*0.1*	0.12	*20.3*	0.01	*0.9*	0.00	*0.4*	0.12	*20.7*	0.33	*57.6*
2007	0.54	0.00	*0.1*	0.11	*20.3*	0.01	*0.9*	0.00	*0.4*	0.11	*20.7*	0.31	*57.6*
2008	0.73	0.00	*0.1*	0.15	*20.3*	0.01	*0.9*	0.00	*0.4*	0.15	*20.7*	0.42	*57.6*

Source: See Table 4.9. Own calculation

Table 4.12 Investment in scientific R&D by industries, 1991–2008

	Bus. Sector	AgMin		Mfr.		Utility		Cons.		RetHtTrn		FinBsSvc	
	bn €	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%
1991	26.25	0.22	*0.9*	25.20	*96.0*	0.14	*0.5*	0.09	*0.3*	0.14	*0.5*	0.46	*1.7*
1992	26.58	0.25	*1.0*	25.39	*95.5*	0.12	*0.4*	0.08	*0.3*	0.19	*0.7*	0.56	*2.1*
1993	25.93	0.24	*0.9*	24.64	*95.0*	0.09	*0.3*	0.06	*0.2*	0.24	*0.9*	0.65	*2.5*
1994	25.91	0.18	*0.7*	24.65	*95.1*	0.10	*0.4*	0.07	*0.3*	0.23	*0.9*	0.68	*2.6*
1995	26.82	0.15	*0.6*	25.54	*95.3*	0.11	*0.4*	0.07	*0.3*	0.22	*0.8*	0.71	*2.6*
1996	27.19	0.15	*0.6*	26.00	*95.6*	0.10	*0.4*	0.08	*0.3*	0.23	*0.8*	0.62	*2.3*
1997	28.91	0.15	*0.5*	27.02	*93.5*	0.09	*0.3*	0.09	*0.3*	0.24	*0.8*	1.31	*4.5*
1998	30.32	0.15	*0.5*	28.49	*94.0*	0.10	*0.3*	0.09	*0.3*	0.39	*1.3*	1.10	*3.6*
1999	33.62	0.15	*0.4*	30.55	*90.9*	0.11	*0.3*	0.09	*0.3*	0.54	*1.6*	2.19	*6.5*
2000	35.59	0.19	*0.5*	32.49	*91.3*	0.08	*0.2*	0.07	*0.2*	0.54	*1.5*	2.21	*6.2*
2001	36.33	0.14	*0.4*	32.84	*90.4*	0.06	*0.2*	0.05	*0.1*	0.96	*2.6*	2.28	*6.3*
2002	36.94	0.15	*0.4*	33.55	*90.8*	0.06	*0.2*	0.05	*0.1*	0.93	*2.5*	2.20	*6.0*
2003	38.03	0.10	*0.3*	34.58	*90.9*	0.08	*0.2*	0.03	*0.1*	0.56	*1.5*	2.68	*7.0*
2004	38.36	0.11	*0.3*	34.93	*91.0*	0.08	*0.2*	0.03	*0.1*	0.52	*1.4*	2.69	*7.0*
2005	38.65	0.11	*0.3*	34.52	*89.3*	0.10	*0.2*	0.03	*0.1*	0.29	*0.8*	3.60	*9.3*
2006	41.14	0.11	*0.3*	37.04	*90.0*	0.10	*0.2*	0.03	*0.1*	0.35	*0.9*	3.52	*8.6*
2007	43.02	0.12	*0.3*	38.16	*88.7*	0.13	*0.3*	0.06	*0.1*	0.44	*1.0*	4.11	*9.5*
2008	46.06	0.13	*0.3*	41.00	*89.0*	0.13	*0.3*	0.06	*0.1*	0.45	*1.0*	4.29	*9.3*

Source: See Table 4.9. Own calculation

Table 4.13 Investment in non-scientific R&D by industry, 1991–2008

	AgMin	Manufacturing	FinBsSvc
	Mineral exploration	Copyright & licences	Financial services innovation
1991	n.a.	n.a.	n.a.
1992	n.a.	2.9	n.a.
1993	n.a.	3.1	n.a.
1994	0.05	3.43	n.a.
1995	0.07	3.92	3.91
1996	0.09	4.41	3.63
1997	0.09	4.52	4.18
1998	0.11	6.82	5.84
1999	0.09	5.76	6.57
2000	0.10	5.36	5.53
2001	0.08	5.11	4.88
2002	0.08	4.01	5.09
2003	0.10	4.29	4.73
2004	0.08	3.96	4.01
2005	0.11	4.08	4.87
2006	0.11	3.79	4.39
2007	0.13	3.53	4.40
2008	0.15	3.67	3.19

Source: In bn €. See Table 4.9. Own calculation

Table 4.14 Investment in new architectural and engineering design by industry, 1992–2008

	Bus. Sector	AgMin		Mfr.		Utility		Cons.		RetHtTrn		FinBsSvc	
	bn €	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%
1992	17.24	0.31	*1.8*	6.39	*37.0*	0.30	*1.8*	0.65	*3.8*	2.66	*15.4*	6.93	*40.2*
1993	18.05	0.32	*1.8*	6.47	*35.8*	0.33	*1.8*	0.74	*4.1*	2.68	*14.8*	7.52	*41.7*
1994	18.86	0.33	*1.7*	6.85	*36.3*	0.35	*1.8*	0.84	*4.4*	2.80	*14.8*	7.70	*40.8*
1995	18.98	0.36	*1.9*	7.17	*37.8*	0.34	*1.8*	0.80	*4.2*	2.50	*13.2*	7.81	*41.1*
1996	19.09	0.36	*1.9*	7.34	*38.5*	0.35	*1.9*	0.86	*4.5*	2.56	*13.4*	7.62	*39.9*
1997	18.32	0.33	*1.8*	7.21	*39.4*	0.36	*1.9*	0.85	*4.6*	2.52	*13.8*	7.05	*38.5*
1998	18.77	0.33	*1.7*	7.22	*38.5*	0.38	*2.0*	0.79	*4.2*	2.51	*13.4*	7.53	*40.2*
1999	18.50	0.26	*1.4*	7.23	*39.1*	0.39	*2.1*	0.78	*4.2*	2.56	*13.8*	7.28	*39.3*
2000	18.55	0.28	*1.5*	7.22	*38.9*	0.34	*1.8*	0.71	*3.8*	2.59	*14.0*	7.41	*40.0*
2001	18.94	0.27	*1.4*	7.37	*38.9*	0.36	*1.9*	0.65	*3.4*	2.59	*13.7*	7.71	*40.7*
2002	18.44	0.27	*1.5*	7.07	*38.3*	0.37	*2.0*	0.56	*3.0*	2.50	*13.5*	7.67	*41.6*
2003	17.81	0.30	*1.7*	6.71	*37.7*	0.31	*1.8*	0.54	*3.0*	2.36	*13.3*	7.58	*42.6*
2004	17.42	0.30	*1.7*	6.62	*38.0*	0.30	*1.7*	0.53	*3.0*	2.46	*14.1*	7.22	*41.4*
2005	18.17	0.30	*1.7*	6.81	*37.5*	0.30	*1.7*	0.56	*3.1*	2.55	*14.1*	7.65	*42.1*
2006	19.06	0.36	*1.9*	7.08	*37.2*	0.31	*1.6*	0.61	*3.2*	2.64	*13.9*	8.06	*42.3*
2007	20.31	0.38	*1.9*	7.54	*37.2*	0.33	*1.6*	0.65	*3.2*	2.82	*13.9*	8.59	*42.3*
2008	22.19	0.42	*1.9*	8.24	*37.2*	0.36	*1.6*	0.71	*3.2*	3.08	*13.9*	9.38	*42.3*

Source: See Table 4.9. Own calculation

Table 4.15 Investment in marketing and human capital by industry, 1994–2008

	B. Sector	AgMin		Mfr.		Utility		Cons.		RetHtTrn		FinBsSvc	
	bn €	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%
Investment in brand equity													
1994	19.99	0.34	*1.7*	7.26	*36.3*	0.37	*1.8*	0.89	*4.4*	2.96	*14.8*	8.16	*40.8*
1995	20.84	0.40	*1.9*	7.87	*37.8*	0.37	*1.8*	0.88	*4.2*	2.75	*13.2*	8.57	*41.1*
1996	21.17	0.40	*1.9*	8.14	*38.5*	0.39	*1.9*	0.95	*4.5*	2.84	*13.4*	8.45	*39.9*
1997	21.50	0.39	*1.8*	8.46	*39.4*	0.42	*1.9*	1.00	*4.6*	2.96	*13.8*	8.27	*38.5*
1998	22.22	0.39	*1.7*	8.55	*38.5*	0.45	*2.0*	0.94	*4.2*	2.98	*13.4*	8.92	*40.2*
1999	23.16	0.33	*1.4*	9.06	*39.1*	0.49	*2.1*	0.97	*4.2*	3.20	*13.8*	9.11	*39.3*
2000	24.22	0.37	*1.5*	9.42	*38.9*	0.44	*1.8*	0.92	*3.8*	3.38	*14.0*	9.68	*40.0*
2001	23.03	0.33	*1.4*	8.96	*38.9*	0.43	*1.9*	0.78	*3.4*	3.15	*13.7*	9.38	*40.7*
2002	21.82	0.32	*1.5*	8.37	*38.3*	0.44	*2.0*	0.66	*3.0*	2.95	*13.5*	9.07	*41.6*
2003	21.40	0.37	*1.7*	8.06	*37.7*	0.38	*1.8*	0.65	*3.0*	2.84	*13.3*	9.11	*42.6*
2004	21.99	0.38	*1.7*	8.36	*38.0*	0.38	*1.7*	0.66	*3.0*	3.10	*14.1*	9.11	*41.4*
2005	21.98	0.36	*1.7*	8.24	*37.5*	0.36	*1.7*	0.67	*3.1*	3.09	*14.1*	9.26	*42.1*
2006	22.45	0.42	*1.9*	8.34	*37.2*	0.37	*1.6*	0.72	*3.2*	3.11	*13.9*	9.49	*42.3*
2007	22.90	0.43	*1.9*	8.51	*37.2*	0.37	*1.6*	0.73	*3.2*	3.18	*13.9*	9.68	*42.3*
2008	22.97	0.43	*1.9*	8.53	*37.2*	0.37	*1.6*	0.73	*3.2*	3.18	*13.9*	9.71	*42.3*
Investment in human capital													
1995	30.30	0.40	*1.3*	9.73	*32.1*	0.70	*2.3*	1.32	*4.3*	7.33	*24.2*	10.82	*35.7*
1996	32.47	0.35	*1.1*	10.61	*32.7*	0.75	*2.3*	1.39	*4.3*	8.10	*24.9*	11.27	*34.7*
1997	32.17	0.30	*0.9*	11.52	*35.8*	0.81	*2.5*	1.38	*4.3*	8.09	*25.2*	10.06	*31.3*
1998	33.86	0.21	*0.6*	12.64	*37.3*	0.81	*2.4*	1.63	*4.8*	8.07	*23.8*	10.49	*31.0*
1999	30.63	0.17	*0.5*	9.87	*32.2*	0.68	*2.2*	1.45	*4.7*	9.44	*30.8*	9.03	*29.5*
2000	32.95	0.16	*0.5*	10.64	*32.3*	0.63	*1.9*	1.32	*4.0*	9.32	*28.3*	10.87	*33.0*
2001	34.54	0.24	*0.7*	11.59	*33.5*	0.77	*2.2*	1.38	*4.0*	9.25	*26.8*	11.31	*32.7*
2002	35.69	0.27	*0.8*	12.07	*33.8*	0.86	*2.4*	1.49	*4.2*	9.83	*27.5*	11.17	*31.3*
2003	32.14	0.20	*0.6*	10.70	*33.3*	0.84	*2.6*	1.39	*4.3*	9.28	*28.9*	9.73	*30.3*
2004	32.49	0.18	*0.6*	11.13	*34.3*	0.90	*2.8*	1.41	*4.3*	8.95	*27.6*	9.91	*30.5*
2005	34.21	0.24	*0.7*	10.99	*32.1*	1.08	*3.2*	1.49	*4.4*	8.67	*25.3*	11.73	*34.3*
2006	35.63	0.22	*0.6*	10.81	*30.3*	1.18	*3.3*	1.52	*4.3*	9.07	*25.4*	12.82	*36.0*

Source: See Table 4.9. Own calculation. Marketing consists of investment for advertising and market research

Table 4.16 Investment in organizational capital by industry, 1991–2008

	B. sector	AgMin		Mfr.		Utility		Cons.		RetHtTrn		FinBsSvc	
	bn €	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%	bn €	%
Investment in purchased organizational capital													
1994	8.26	0.14	*1.7*	3.00	*36.3*	0.15	*1.8*	0.37	*4.4*	1.22	*14.8*	3.37	*40.8*
1995	9.03	0.17	*1.9*	3.41	*37.8*	0.16	*1.8*	0.38	*4.2*	1.19	*13.2*	3.71	*41.1*
1996	9.79	0.18	*1.9*	3.77	*38.5*	0.18	*1.9*	0.44	*4.5*	1.31	*13.4*	3.91	*39.9*
1997	11.02	0.20	*1.8*	4.34	*39.4*	0.21	*1.9*	0.51	*4.6*	1.52	*13.8*	4.24	*38.5*
1998	13.22	0.23	*1.7*	5.09	*38.5*	0.27	*2.0*	0.56	*4.2*	1.77	*13.4*	5.31	*40.2*
1999	16.99	0.24	*1.4*	6.64	*39.1*	0.36	*2.1*	0.71	*4.2*	2.35	*13.8*	6.68	*39.3*
2000	19.52	0.30	*1.5*	7.59	*38.9*	0.36	*1.8*	0.74	*3.8*	2.73	*14.0*	7.80	*40.0*
2001	20.36	0.29	*1.4*	7.92	*38.9*	0.38	*1.9*	0.69	*3.4*	2.79	*13.7*	8.29	*40.7*
2002	18.13	0.27	*1.5*	6.95	*38.3*	0.37	*2.0*	0.55	*3.0*	2.45	*13.5*	7.54	*41.6*
2003	16.14	0.28	*1.7*	6.08	*37.7*	0.29	*1.8*	0.49	*3.0*	2.14	*13.3*	6.87	*42.6*
2004	16.36	0.28	*1.7*	6.22	*38.0*	0.28	*1.7*	0.49	*3.0*	2.31	*14.1*	6.78	*41.4*
2005	17.62	0.29	*1.7*	6.60	*37.5*	0.29	*1.7*	0.54	*3.1*	2.48	*14.1*	7.42	*42.1*
2006	19.28	0.36	*1.9*	7.16	*37.2*	0.31	*1.6*	0.62	*3.2*	2.67	*13.9*	8.15	*42.3*
2007	19.98	0.37	*1.9*	7.42	*37.2*	0.33	*1.6*	0.64	*3.2*	2.77	*13.9*	8.45	*42.3*
2008	19.77	0.37	*1.9*	7.35	*37.2*	0.32	*1.6*	0.63	*3.2*	2.74	*13.9*	8.36	*42.3*
Investment in own account organizational capital													
1991	12.58	0.25	*2.0*	4.79	*38.1*	0.23	*1.8*	0.41	*3.2*	2.00	*15.9*	4.91	*39.0*
1992	13.60	0.24	*1.8*	5.04	*37.0*	0.24	*1.8*	0.51	*3.8*	2.10	*15.4*	5.46	*40.2*
1993	13.88	0.24	*1.8*	4.97	*35.8*	0.26	*1.8*	0.57	*4.1*	2.06	*14.8*	5.78	*41.7*
1994	14.23	0.25	*1.7*	5.17	*36.3*	0.26	*1.8*	0.63	*4.4*	2.11	*14.8*	5.81	*40.8*
1995	14.72	0.28	*1.9*	5.56	*37.8*	0.26	*1.8*	0.62	*4.2*	1.94	*13.2*	6.06	*41.1*
1996	14.80	0.28	*1.9*	5.69	*38.5*	0.27	*1.9*	0.66	*4.5*	1.99	*13.4*	5.91	*39.9*
1997	14.89	0.27	*1.8*	5.86	*39.4*	0.29	*1.9*	0.69	*4.6*	2.05	*13.8*	5.73	*38.5*
1998	15.19	0.27	*1.7*	5.85	*38.5*	0.31	*2.0*	0.64	*4.2*	2.04	*13.4*	6.10	*40.2*
1999	15.54	0.22	*1.4*	6.08	*39.1*	0.33	*2.1*	0.65	*4.2*	2.15	*13.8*	6.11	*39.3*
2000	16.22	0.25	*1.5*	6.31	*38.9*	0.30	*1.8*	0.62	*3.8*	2.26	*14.0*	6.48	*40.0*
2001	16.51	0.24	*1.4*	6.42	*38.9*	0.31	*1.9*	0.56	*3.4*	2.26	*13.7*	6.72	*40.7*
2002	16.47	0.24	*1.5*	6.32	*38.3*	0.33	*2.0*	0.50	*3.0*	2.23	*13.5*	6.85	*41.6*
2003	16.50	0.28	*1.7*	6.22	*37.7*	0.29	*1.8*	0.50	*3.0*	2.19	*13.3*	7.02	*42.6*
2004	16.59	0.28	*1.7*	6.30	*38.0*	0.28	*1.7*	0.50	*3.0*	2.34	*14.1*	6.87	*41.4*
2005	16.58	0.27	*1.7*	6.21	*37.5*	0.27	*1.7*	0.51	*3.1*	2.33	*14.1*	6.98	*42.1*
2006	16.89	0.32	*1.9*	6.27	*37.2*	0.28	*1.6*	0.54	*3.2*	2.34	*13.9*	7.14	*42.3*
2007	17.40	0.33	*1.9*	6.46	*37.2*	0.28	*1.6*	0.55	*3.2*	2.41	*13.9*	7.36	*42.3*

Source: See Table 4.9. Own calculation

Table 4.17 Depreciation rates for growth accounting

Asset	Depreciation rate
Intangible assets	
Software	0.315
Databases	0.315
Scientific R&D	0.2
Mineral exploration	0.2
Copyright licences	0.2
Financial services innovation	0.2
Architectural and engineering design	0.2
Advertising	0.6
Market research	0.6
Firm-specific human capital	0.4
Organizational structure	0.4
Tangible assets	
Computing equipment (IT)	0.315
Communications equipment (CT)	0.115
Transport equipment (TraEq)	
Agriculture, Fishing & Mining	0.170
Manufacturing	0.177
Electricity, Gas & Water Supply	0.191
Construction	0.195
Trade, Hotels & Rest., Transp. & Comm.	0.190
Financial & Business Services	0.190
Other machinery and equipment (OMach)	
Agriculture, Fishing & Mining	0.129
Manufacturing	0.109
Electricity, Gas & Water Supply	0.094
Construction	0.139
Trade, Hotels & Rest., Transp. & Comm.	0.126
Financial & Business Services	0.146
Non-resident structures (OCon)	
Agriculture, Fishing & Mining	0.024
Manufacturing	0.033
Electricity, Gas & Water Supply	0.023
Construction	0.034
Trade, Hotels & Rest., Transp. & Comm.	0.029
Financial & Business Services	0.038

Appendix: Tables (Tables 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, and 4.17)

References

Azeez Erumban, A. (2008). *Capital aggregation and growth accounting: A sensitivity analysis* (EU KLEMS Working Paper 25). Groningen.

Chun, H., Fukao, K., Shoichi, H., & Tsutomu, M. (2012). *Measurement of intangible investments by industry and its role in productivity improvement utilizing comparative studies between Japan and Korea* (RIETI Discussion Paper Series 12-E-037). Research Institute of Economy, Trade and Industry (RIETI).

Clayton, T., Dal Borgo, M., & Haskel, J. (2009). *An innovation index based on knowledge capital investment: Definition and results for the UK market sector* (IZA Discussion Paper No. 4021). Bonn.

Corrado, C., Haltiwanger, J., & Sichel, D. (2005). Measuring capital and technology: An expanded framework. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 11–46). Chicago: University of Chicago Press.

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and economic growth. *The Review of Income and Wealth, 55*(3), 661–685.

Crass, D., Licht, G., Peters, B., & Sofka, W. (2010). *Time series estimates of intangible investments – Sensitivity analysis for Germany.* Mannheim.

Delbecque, V., & Nayman, L. (2010). *Measuring intangible capital investment: An application to the French data* (Working Papers 2010-19). Paris: CEPII research center

Edquist, H. (2011). Can investment in intangibles explain the Swedish productivity boom in the 1990s? *Review of Income and Wealth, 57*(4), 658–682.

Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to economic growth. *Review of Income and Wealth, 55* (3), 717–736.

Gil, V., & Haskel, J. (2008). *Industry-level expenditure on intangible assets in the UK*. http://www.coinvest.org.uk/bin/view/CoInvest/CoinvestGilHaspaper.

Goodridge, P., Haskel, J. & Wallis, G. (2012). *UK innovation index: Productivity and growth in UK industries* (CEPR Discussion Papers 9063). London.

Hall, R., & Jorgenson, D. W. (1967). Tax policy and investment behaviour. *American Economic Review, 57*(3), 391–414.

Hao, J., & Manole, V. (2008). *Intangible capital and growth – An international comparison*. Paper prepared for the 30th General Conference of the International Association for Research in Income and Wealth, http://www.iariw.org.

Hao, J., Manole, V., & van Ark, B. (2009). *Intangible capital and growth – An international comparison*. Coinvest Deliverable D3.6: Paper quantifying figures on time-series estimates dating back to 1980 for Germany, Brussels.

Jorgenson, D. W. (1963). Capital theory and investment behaviour. *American Economic Review, 53*(2), 247–259.

Jorgenson, D. W., & Griliches, Z. (1967). The explanation of productivity change. *The Review of Economic Studies, 34*(3), 249–283.

Jorgenson, D. W., Gollop, F. M., & Fraumeni, B. M. (1987). *Productivity and U.S. economic growth*. Cambridge: Harvard University Press.

Jorgenson, D. W., Ho, M. S., & Stiroh, K. J. (2005). Growth of U.S. industries and investments in information technology and higher education. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 403–478). Chicago: University of Chicago Press.

Jorgenson, D. W., Ho, M. S., Samuels, J. D., & Stiroh, K. J. (2007). Industry origins of the American productivity resurgence. *Economic Systems Research, 19*, 229–252.

Landes, E. M., & Rosenfield, A. M. (1994). The durability of advertising revisited. *Journal of Industrial Economics, 42*, 263–276.

Marrano, G., & Haskel, J. (2006). *How much does the UK invest in intangible assets?* (Queen Mary University of London Working Paper 578). London.

Nakamura, L. (2001). *What is the US gross investment in intangibles? (At least) one trillion dollars a year!* (Federal Reserve Bank of Philadelphia Working Paper No. 01-15).
Niebel, T., O'Mahony, M., & Saam, M. (2013). *The contribution of intangible assets to sectoral productivity growth in the EU* (ZEW Discussion Paper 13-062). Mannheim.
O'Mahony, M., & Peng, F. (2011). *Intangible training capital and productivity in Europe* (MPRA Paper 38648).
OECD. (2001). *Measuring capital: OECD manual*. Annex 1 Glossary of Technical Terms Used in the Manual, Paris.
OECD. (2002). *Frascati manual: Proposed standard practice for surveys on research and experimental development*. Paris: OECD.
OECD and Eurostat. (2005). *Oslo manual – Guidelines for collecting and interpreting innovation data* (3rd ed.). Paris: OECD.
Peters, B., & Rammer, C. (2013). Innovation Panel surveys in Germany. In F. Gault (Ed.), *Handbook of innovation indicators and measurement* (pp. 135–177). Cheltenham: Edward Elgar.
Statistisches Bundesamt. (2006). *Wirtschaft und Statistik 9/2006*. Wiesbaden.
Statistisches Bundesamt. (2010). *Wirtschaft und Statistik 1/2010*. Wiesbaden.
Werner, D. (2006). Trends und Kosten der betrieblichen Weiterbildung – Ergebnisse der IW-Weiterbildungserhebung 2005. In IW-Trends, 33. Jg., Nr. 1, S. 17–33.
ZAW Zentralverband der deutschen Werbewirtschaft. (1991–2008). *Werbung in Deutschland*. Berlin: Verlag edition ZAW.

Chapter 5
Does the Stock Market Evaluate Intangible Assets? An Empirical Analysis Using Data of Listed Firms in Japan

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Abstract Following Corrado et al. (Review of Income and Wealth 55:658–660, 2009), we measure intangible assets at the listed firm level in Japan. Compared to the conventional Tobin's Q, the revised Q including intangibles is almost 1 on average, as suggested by Hall (Brookings Papers on Economic Activity 1:73–118, 2000 and American Economic Review 91:1185–1202, 2001). The standard deviation of the revised Q is smaller than that of the conventional Q. Estimation results

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based on Bond and Cummins (Brookings Papers on Economic Activity 1:61–124, 2000) show that greater intangible assets increase firm value. In particular, in the IT industries, on average Tobin's Q is higher than that in the non-IT industries, and the stock market reflects the value of intangibles in the IT industries. These results suggest that the government should adopt policies that promote investment, including intangibles in the IT industries, and change in industry structure in Japan.

Keywords Tobin's Q • Intangible asset • IT industries • Price cost margin • External finance dependence

5.1 Introduction

In the 1990s, new types of firms such as Amazon and Google were founded and grew rapidly under the IT revolution. There are several characteristics of these firms. As Brynjolfsson (2004) pointed out, they developed new software, invested in human capital, and formed organizational structures that enabled faster decision-making. Due to the success of these firms, economists have paid attention to the role of intangible assets on firm performance and firm value. Corrado et al. (2009) measured comprehensive intangible investment including software investment, investment in human capital, and reform in organizational structure, and showed the significant contribution of intangible assets to US economic growth. Following Corrado et al. (2009), the positive effects of intangible assets on economic growth were found in the advanced countries.[1]

At the firm level, there have been several studies on the effects of R&D investment, which is a part of intangible investment on firm performances and firm value.[2] However, Hall (2000, 2001) pointed out that after the IT revolution, the stock market may be evaluating not only R&D stocks but also other types of intangible assets positively. To examine the determinants of firm value after the IT revolution, we need to measure a broader concept of intangible assets beyond R&D assets like Corrado et al. (2009).

Thus, in our paper, we measure comprehensive intangible assets following Corrado et al. (2009) by using data of Japanese listed firms. Based on our measurement, we examine the relationship between firm value and intangible assets, and estimate Tobin's Q using not only intangible but also tangible assets. From the

[1] Intangible investment was measured at the aggregate level by Marrano et al. (2009) for the UK, Fukao et al. (2009) for Japan, Delbeque and Bounfour for France and Germany, Hao et al. (2008) and Piekkola (2011) for the EU countries, Barnes and McClure (2009) for Australia, and Pyo et al. (2010) for Korea. At the sectoral Level, Miyagawa and Hisa (2013) measured intangible investment and showed positive effect on productivity growth.

[2] Griliches (1981) started to examine the relationship between and R&D and market valuation. In a similar framework to ours which we explain below, Hall (1993) and Hall and Oriani (2006) considered not only R&D and but also other intangibles, they focused on the effect of R&D on the market valuation.

above studies, we find that the mean value of Tobin's average Q becomes close to 1 and its variance becomes small when we consider intangible assets, as Hall (2000, 2001) expected. We also find that intangible assets are positively correlated with firm value. The estimation results show that the accumulation of intangible assets significantly increases firm value. The effect is particularly pronounced and significant in the IT related industries.

Our study consists of six sections. In the next section, we review the existing literature on the measurement of intangible assets and how intangible assets are evaluated in the stock market. In the third section, we explain how we measure intangible assets. In the fourth section, we examine several features of Tobin's Q that take intangible assets into account. In the fifth section, we examine the effects of intangible assets on firm value by estimating a standard average Tobin's Q. In the last section, we summarize our findings.

5.2 Intangible Assets and Firm Value: A Literature Review

Hall (2000, 2001) pointed out that the Tobin's Q in the US consistently exceeded 1. He subsequently argued that as adjustment costs of tangible investment are accumulated as intangible assets within a firm, the gap between Tobin's Q and 1 is accounted for intangible assets.[3] To examine Hall's proposition, Brynjolfsson et al. (2002) estimated firm value using non-IT capital and IT capital, and found that the coefficients of IT capital were much greater than those of non-IT capital. Then, they argued that these large coefficients were affected by intangible assets, complementary to IT capital. Cummins (2005) and Miyagawa and Kim (2008) estimated firm value using not only non-IT capital and IT capital but also with R&D capital and advertisement capital. Although Cummins (2005) did not find a higher than normal rate of return for intangible assets, Miyagawa and Kim (2008) obtained the opposite results to Cummins (2005).

Although Cummins (2005) and Miyagawa and Kim (2008) focused on R&D capital and advertisement capital, Lev and Radhakrishnan (2005) recognized a portion of sales, general and administrative expenditures as organizational capital. By estimating the difference between market value and book value using organizational capital, they found that organizational capital significantly contributed to market value. Hulten and Hao (2008) estimated firm value of pharmaceutical companies by R&D capital, and organizational capital measured from sales, general and administrative expenditures, and showed that both of these types of intangible assets contributed to increasing firm value.

Abowd et al. (2005) constructed their own measure with respect to quality of human capital from employer-employee datasets. They estimated firm value by obtaining Compustat data using the measure of quality of human capital, and found

[3] Hall uses the term 'e-capital' instead of organization capital.

that their measure was positively correlated with the value of the firm. Bloom and Van Reenen (2007) also constructed their own management score taking organizational management and human resource management into account, using their interview surveys. They showed that this management score was positively correlated with Tobin's Q. Görzig and Görnig (2012) measured intangible assets by estimating the share of labor costs of IT, R&D, and management and marketing employees. Once they considered intangible assets, they showed that the dispersion of rate of return on capital was reduced dramatically.

5.3 Measurement of Intangible Assets in Japanese Listed Firms

Although previous studies have shown the contribution of intangible assets to firm value, they did not capture comprehensive intangible assets like Corrado et al. (2009). Therefore, among intangible assets classified by Corrado et al. (2009), we measure five types of intangibles; software, R&D, brand equity, firm specific human capital, and organizational change. This concept of intangibles is broader than that of previous studies.[4]

Corrado et al. (2009) classified intangible assets into three categories: computerized information, innovative property, and economic competencies. Software investment is a part of investment in computerized information consists of three types of software; custom software investment, packaged software investment, and own account software investment. R&D investment is included in investment in innovative property.[5] Investment in economic competencies consists of brand equity, firm specific human capital, and organizational change. We measure these three components depending on the data in DBJ Corporate Financial Databank. The detailed methods we use to measure the five items mentioned above for each firm are as follows:

1. Software: First, the ratio of workers engaged in information processing to the total number of employee is multiplied by the total cash earnings in order to measure the value of software investment. Then, we add the cost of information processing to this number to find total software investment. All the information is obtained from *Basic Survey of Business Activities of Enterprises* (BSBAE).

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[4] The measurement of tangible assets evaluated at replacement cost is also explained in Appendix 1.

[5] Although innovative property accounts for various items possibly including science and engineering R&D, mineral exploitation, copyright and license costs, and other product development, design, and research expenses, we measure only R&D expenditures, due to the lack of reliable data for intangibles except R&D in innovative property.

We deflate this number by the deflator for software investment in the Japan Industrial Productivity (JIP) database.[6,7]

2. Research and Development (R&D): We subtract the cost of acquiring fixed assets for research from the cost of R&D (i.e., in-house R&D and contract R&D) to estimate the value of investment into R&D. All the information is obtained from BSBAE. The output deflator for research (private) in the JIP database is used to deflate this R&D investment.
3. Brand equity: Brand equity is measured based on expenditures on advertising. The data of advertising expenses are obtained from the DBJ Corporate Financial Databank. We use the output deflator for advertising in the JIP database as the deflator for advertising investments.
4. Firm specific human capital: First, we estimate each firm's investment on firm-specific skills by multiplying (1) the total labor cost in the DBJ Corporate Financial Databank with (2) the industry-average ratio of total employee training cost to the total labor cost for each firm from the General Survey of Working Conditions and (3) the ratio of the on-the-job and off-the-job training costs for firm-specific skills to the total education cost (0.37).[8] In order to further consider the opportunity cost of the off-the-job training cost for skill improvement, we multiply the number computed in the abovementioned procedure to 2.51.[9]
5. Organizational change: Following Robinson and Shimizu (2006), who conducted a survey of the time-use of Japanese CEOs, we assume that 9 % of board members' compensation—which we can obtain from the DBJ Corporate Financial Databank—accounts for investment in organizational change. This is deflated by the output deflator for education (private and non-profit) in the JIP database.

For all five investment category data detailed above, we employ the Perpetual Inventory (PI) method, in which we use FY1995 as the base year, to construct a data series of intangible assets from FY2000. All depreciation rates used for this computation follow that of Corrado et al. (2012).[10]

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[6] In this procedure, we were not able to measure purchased software investment, which is included in the capital expenditure in the balance sheets of each firm. We ignore this part due to data limitations on capitalized software in our data.

[7] The JIP database consists of 108 industries. The website of the database is http://www.rieti.go.jp/en/database/JIP2011/index.html. Fukao et al. (2007) explain how this database was constructed.

[8] For the ratio of the job training costs for firm-specific skill to overall employee training costs, we use the results in Ooki (2003).

[9] Ooki (2003) estimates the ratio of the average opportunity cost of off-the-job training to the total employee training cost paid by firm (all industry) in 1998 as 1.51. Ooki (2003) uses the micro-data obtained from "The Japan Institute for Labor Policy and Training's Survey on Personnel Restructuring and Vocational Education/Training Investment in the Age of Performance-based Wage Systems" (Gyoseki-shugi Jidai no Jinji Seiri to Kyoiku/Kunren Toshi ni Kansuru Chosa).

[10] The depreciation rates of software, R&D, advertising, human capital and organizational change are 31.5%, 15%, 55%, 40% and 40%, respectively.

5.4 Tobin's Q with Intangibles

The conventional Tobin's Q (Q_{it}^{C}) at the firm level is measured as the ratio of firm value (V_{it}) to the replacement value of tangible assets ($(1-\delta_K)K_{it-1}$) at the initial period of t.[11]

$$Q_{it}^{C}=\frac{V_{it}}{(1-\delta_K)K_{it}} \tag{5.1}$$

where δ_k is the depreciation rate of tangible assets. We measure the conventional Tobin's Q as follows:

The conventional Tobin's Q = (Stock value + Book values of commercial paper, corporate bond, and long-term debt)/$(1-\delta_K)$ * (Replacement values of tangible assets + Inventory-Short-term debt).

As shown by Lindenberg and Ross (1981), and Hall (2000, 2001) for the US and Tanaka and Miyagawa (2011) for Japan, the standard Q expressed by (1) has persistently exceeded 1. The mean value of the conventional Tobin's Q shown in Table 5.1 is also 1.40.

Lindenberg and Ross (1981) explained the gap between the measured conventional Q and 1 as being due to monopoly rents, although they knew that unmeasured intangibles affected this gap. When we measure the Tobin's Q considering intangible assets (N_{it-1}) as measured in Sect. 5.3, the revised Tobin's Q (Q_{it}^{R}) is expressed as follows:

$$Q_{it}^{R}=\frac{V_{it}}{(1-\delta_K)K_{it}+(1-\delta_N)N_{it}} \tag{5.2}$$

where δ_N is the depreciation rate in intangible assets.

We show a revised Tobin's Q including intangible assets in Table 5.2. The mean value of the revised Tobin's Q is 0.99 which is almost equal to 1. The difference between the two mean values is significant. The standard deviation of the revised Q is smaller than that of the conventional Q, which is consistent with the results of Görzig and Görnig (2012), who showed that the dispersion of profit rates when including intangible assets is smaller than that without intangibles. The distributions of two types of Tobin's Q are shown in Fig. 5.1. We find that the revised Tobin's Q is distributed around 1 compared to the conventional one. The Kolmogorov-Smirnov test rejected the hypothesis that the two distributions are the same.

We divide all samples into two sectors: IT sectors and non-IT sectors.[12] The mean value of Tobin's Q in IT sectors is higher than that in non-IT sectors in both cases. However, the mean value of the revised Q in the IT sectors is 1.13, which is

[11] As for the derivation of the conventional Q, we follow Bond and Cummins (2000).

[12] The classification of IT industries and non-IT industries is shown in Appendix 2.

Table 5.1 Conventional Tobin's Q (all sectors)

Periods: FY2000–FY2009	
Mean	1.404
Median	1.056
Minimum	0.207
Maximum	6.933
Standard Deviation	1.146
Observations	2,939

Notes:
1. We drop the top and bottom 4 % tails of the Conventional Tobin's Q
2. Conventional Tobin's Q is calculated as follows: Conventional Tobin's Q = (Stock value + Book value of Commercial paper and Corporate bond and Long-term debt)/((1-δ_K) * Replacement value of tangible assets + Inventory-Short-term debt)
3. Revised Tobin's Q is calculated as follows: Revised Tobin's Q = (Aggregate market value + Book value of Commercial paper and Corporate bond and Long-term debt)/((1-δ_K) * Replacement value of tangible assets + (1-δ_N) * Replacement value of intangible asset + Inventory-Short-term debt))

Table 5.2 Revised Tobin's Q (all sectors)

Periods: FY2000–FY2009	
Mean	0.990
Median	0.774
Minimum	0.142
Maximum	6.238
Standard Deviation	0.742
Observations	2,939

Notes:
1. We drop the top and bottom 4 % tails of the Conventional Tobin's Q
2. Conventional Tobin's Q is calculated as follows: Conventional Tobin's Q = (Stock value + Book value of Commercial paper and Corporate bond and Long-term debt)/((1-δ_K) * Replacement value of tangible assets + Inventory-Short-term debt)
3. Revised Tobin's Q is calculated as follows: Revised Tobin's Q = (Aggregate market value + Book value of Commercial paper and Corporate bond and Long-term debt)/((1-δ_K) * Replacement value of tangible assets + (1-δ_N) * Replacement value of intangible asset + Inventory-Short-term debt))

much closer to 1 than the mean value of the conventional Q in the IT sectors. Also, the standard deviation of the revised Q in the IT sectors is reduced compared to that of conventional Q in the IT sectors (Tables 5.3, 5.4, 5.5, and 5.6).

Arato and Yamada (2012) measured aggregate intangible assets based on DBJ data. Their estimated ratio of intangible assets to tangible assets is 0.47 in the 1980s. As shown in Table 5.7, the corresponding rate of our estimates is 0.45, which is similar to that of Arato and Yamada (2012). The result shows that the ratio of intangible assets to tangible assets has not changed in Japan.

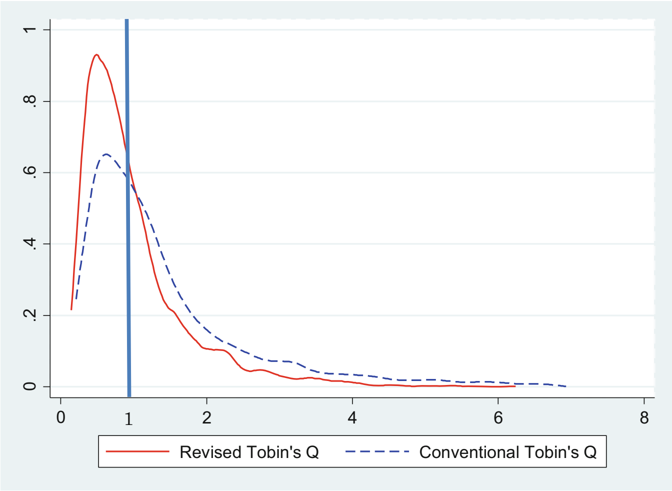

Fig. 5.1 Density of Tobin's Q

Table 5.3 Conventional Tobin's Q (IT sectors)

Periods: FY2000–FY2009	
Mean	1.710
Median	1.262
Minimum	0.207
Maximum	6.625
Standard Deviation	1.304
Observations	1,089

Table 5.4 Revised Tobin's Q (IT sectors)

Periods: FY2000–FY2009	
Mean	1.129
Median	0.880
Minimum	0.162
Maximum	5.424
Standard Deviation	0.802
Observations	1,089

Table 5.5 Conventional Tobin's Q (non-IT sectors)

Periods: FY2000–FY2009	
Mean	1.224
Median	0.944
Minimum	0.208
Maximum	6.933
Standard Deviation	1.000
Observations	1,850

Table 5.6 Revised Tobin's Q (non-IT sectors)

Periods: FY2000–FY2009	
Mean	0.908
Median	0.711
Minimum	0.142
Maximum	6.238
Standard Deviation	0.692
Observations	1,850

Table 5.7 Statistics of the ratio of intangible assets to tangible assets (N/K)

Periods: FY2000–FY2009	
Mean	0.442
Median	0.305
Minimum	0.013
Maximum	3.999
Standard Deviation	0.438
Observations	2,939

5.5 Do Intangible Assets Explain the Overvaluation of Tobin's Q?

5.5.1 The Relationship of the Conventional Tobin's Q with Intangibles

Although the revised Q is almost equal to 1 on average, the Tobin's Q in each firm deviates from 1. Thus, we econometrically check the effects of intangible assets on the variation of Tobin's Q. As we introduced in Sect. 5.2, Brynjolfsson et al. (2002), Cummins (2005) and Miyagawa and Kim (2008) estimated the effects of intangible assets on firm value. However, these studies focused on fewer components of intangibles than those classified by Corrado et al. (2009). Therefore, we examine the effect of intangibles following the classification by Corrado et al. (2009) on firm value.

Following Bond and Cummins (2000), the profit function (π) depends on tangible and intangible capital. Dividends at firm *i* (D_i) are expressed as follows:

$$D_{it} = \pi(K_{it}, N_{it}) - I_{it} - O_{it} - G(I_{it}, K_{it}) - H(O_{it}, N_{it}) \tag{5.3}$$

where I is investment in tangible assets, O is investment in intangible assets, and G and H are adjustment cost functions in tangible investment intangible investment, respectively.[13]

[13] There are two types of adjustment cost functions. The first type of adjustment cost implies additional costs associated with gross investment. The second type of adjustment cost implies that gross investment includes adjustment costs associated with accumulation of capital. In our study, we use the first type of adjustment cost function.

$$\begin{aligned} G(I_{it}, K_{it}) &= \frac{a}{2}\left(\frac{I_{it}}{K_{it}}\right)^2 K_{it} \\ H(O_{it,} N_{it}) &= \frac{b}{2}\left(\frac{O_{it}}{N_{it}}\right)^2 N_{it} \end{aligned}$$

Capital accumulation in tangible assets and intangible assets is expressed as follows:

$$\begin{aligned} K_{it} &= I_{it} + (1 - \delta_K)K_{it-1} \\ N_{it} &= O_{it} + (1 - \delta_N)N_{it-1} \end{aligned}$$

We solve the optimization problems of firm i with respect to I, and O.

$$q_{Kt} = 1 + a\left(\frac{I_{it}}{K_{it}}\right) \quad (5.4a)$$

$$q_{Nt} = 1 + b\left(\frac{O_{it}}{N_{it}}\right) \quad (5.4b)$$

where q_K and q_N are Lagrange multipliers.

When the profit function is linear homogeneous, the firm value of firm i is expressed as a linear combination of each asset (Wildasin (1984) and Hayashi and Inoue (1991)).

$$V_{it} = q_{Kt}(1 - \delta_K)K_{it} + q_{Nt}(1 - \delta_N)N_{it} \quad (5.5)$$

From Eq. (5.5),

$$q_{Kt} = \frac{V_{it}}{(1 - \delta_K)K_{it}} - q_{Nt}\frac{(1 - \delta_N)N_{it}}{(1 - \delta_K)K_{it}} \quad (5.6)$$

Substituting Eqs. (5.4a) and (5.4b) into Eq. (5.6), we obtain:

$$\begin{aligned} Q_{it}^C - 1 &= a\left(\frac{I_{it}}{K_{it}}\right) + \left\{1 + b\left(\frac{O_{it}}{N_{it}}\right)\right\}\frac{(1 - \delta_N)}{(1 - \delta_K)}\left(\frac{N_{it}}{K_{it}}\right) \\ &= a\left(\frac{I_{it}}{K_{it}}\right) + \frac{(1 - \delta_N)}{(1 - \delta_K)}\left(\frac{N_{it}}{K_{it}}\right) + b\frac{(1 - \delta_N)}{(1 - \delta_K)}\left(\frac{O_{it}}{K_{it}}\right) \end{aligned} \quad (5.7)$$

where $Q_{it}^C = \frac{V_{it}}{(1-\delta_K)K_{it}}$ is the standard average Q at firm i.

Equation (5.7) implies that the gap between the conventional Q ratio and 1 is explained by the ratio of intangible assets to tangible assets, the gross tangible investment/tangible assets ratio, and the gross intangible assets ratio.

5.5.2 Estimation Results

Based on Eq. (5.7), we estimate the following equation:

$$Q_{it}^{C} - 1 = const. + \alpha_1 \left(\frac{N_{it}}{K_{it}} \right) + \alpha_2 \left(\frac{I_{it}}{K_{it}} \right) + \alpha_3 \left(\frac{O_{it}}{K_{it}} \right) + \sum_{j=1}^{n} \beta_j X_{ijt} + \varepsilon_{it} \quad (5.8)$$

In Eq. (5.8), X_{ij} is a control variable. Lindenberg and Ross (1981) pointed out that monopoly rents explained the overvaluation of firm value. In addition, financial constraints may affect the gap between a standard Q and 1. Then, we also estimate Eq. (5.8) with a price cost margin or external finance dependence as defined by Rajan and Zingales (1998). We expect that the coefficient of external finance dependence will be negative because a greater dependence on external finance reduces firm value. The basic statistics of the variables used in our estimation are summarized in Table 5.8.

First, we estimate Eq. (5.8) by OLS. To avoid endogeneity, we take a 1-year lag for all explanatory variables except firm age. The estimation results are shown in Table 5.9. In Column (1), we focus on the effect of intangible assets on the overvaluation of the conventional Q. In this estimation, the ratio of intangible to tangible assets significantly explains the overvaluation of the Q ratio. In Column (2), we regress firm value on three variables included in Eq. (5.7). The estimation results show that all variables are positive and the ratio of intangible to tangible assets, and the tangible investment/tangible assets ratio are significant. Due to the strong correlation between intangible assets/tangible assets and intangible investment/tangible assets ratio, the coefficient of intangible investment/tangible assets ratio may be not significant.

In Columns (3) and (4), we estimate Eq. (5.8) including control variables. In Column (3), all three variables in Eq. (5.7) are positive and significant. In addition, the coefficient of external finance dependence is negative and insignificant, as we expected. In Column (4), the ratio of intangible assets to tangible assets and the price cost margin are positive and significant, while intangible and tangible investments are not significant.

Next, we estimate Eq. (5.8) utilizing the instrumental variable method. Instruments are the ratio of white-collar to total workers, and external finance dependence. The results in Table 5.10 indicate that the ratio of intangible assets to tangible assets is positive and significant in all estimations. However, the intangible investment/tangible assets ratio is negative in Columns (2) and (3). It is possible that negative coefficients of intangible investment/tangible assets are caused by the multicollinearity between intangible assets and intangible investment.

Table 5.8 Statistics of the sample

Periods: FY2000–FY2009	Q-1	N/K	I/K	O/K	CC	PCM
Mean	0.404	0.442	0.103	0.129	0.130	0.036
Median	0.056	0.305	0.086	0.088	0.099	0.031
Minimum	−0.793	0.013	−0.019	0.004	−4.830	−0.469
Maximum	5.933	3.999	0.845	1.065	2.721	0.334
Standard Deviation	1.146	0.438	0.075	0.125	0.274	0.063
Observations	2,939	2,939	2,939	2,939	2,026	2,939

Notes:
N/K indicates the ratio of intangible to tangible assets
I/K indicates the ratio of tangible to tangible assets
O/K indicates the ratio of intangible to tangible assets
CC indicates the measure of credit constraint
We calculate this measure following Rajan and Zingales (1998) as follows:
(Capital expenditures (tangible + intangible) – Cash flow from operations)/Tangible capital stock
PCM indicates the price cost margin. The price cost margin is calculated as follows:
(Operating surplus – Interest expense)/Sales

We also conduct panel estimations. As the Hausman test suggests that the random effect estimation is better than fixed effect estimation, we show the results of random effect estimations in Table 5.11. Table 5.11 shows that the ratio of intangible assets to tangible assets is positive and significant in all estimations. As the coefficient of price cost margin is also positive and significant, monopoly rents also contribute to the valuation of firm, as Lindenberg and Ross (1981) suggested.

Brynjolfsson et al. (2002), Basu et al. (2003), and Cummins (2005) emphasized that intangible assets are complementary to IT assets. Miyagawa and Hisa (2013) found that intangible investment in the IT sectors improve TFP growth. In Sect. 5.4, we found that the Tobin's Q in IT sectors is higher than that in non-IT sectors. Then, we divide all samples into those in the IT sectors and non-IT sectors and estimate Eq. (5.8) by the instrumental variable method in each sector. Table 5.12 shows that estimation results in IT sectors are similar to those in Table 5.10. The ratio of intangible to tangible assets is positive and significant in all estimations when the coefficients of intangible and tangible investments are not significant. However, in the non-IT sectors, the coefficients of the ratio of intangible to tangible assets are not necessarily significant, while the signs of the coefficients are positive in all estimations. The estimation results in Table 5.12 imply that only intangible assets in the IT industries contribute significantly to the evaluation of firm value.[14] In addition, the price cost margin is positive and significant in the IT and non-IT sectors, as can be seen in Tables 5.10 and 5.11.

As explained in Sect. 5.3, we measure five types of intangible assets; software, R&D, brand equity, firm specific human capital, and organizational change. We

[14] We also conduct OLS estimations in each sector. The estimation results are similar to Table 5.11. Although the ratio of intangible to tangible assets in the IT industries is positive and significant, the signs of this variable are inconclusive in the non-IT industries.

Table 5.9 OLS estimates of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)		(4)	
	All Sectors		All sectors		All sectors		All sectors	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.619	0.053****	0.598	0.126****	0.390	0.143***	0.724	0.121***
I/K			0.571	0.236**	1.036	0.292***	0.043	0.227
O/K			0.103	0.428	1.329	0.478***	−0.288	0.408
CC					−0.337	0.084****		
PCM							4.983	0.293****
Const.	−0.478	0.922	−0.575	0.922	−0.495	0.883	−0.723	0.878
Industry dummy	Yes		Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes		Yes	
Number of obs	2,882		2,882		2,047		2,882	
F	19.62		19.15		15.61		25.07	
Prob > F	0		0		0		0	
R-squared	0.312		0.313		0.3315		0.377	
Adj R-squared	0.296		0.297		0.3103		0.362	
Root MSE	0.918		0.917		0.87606		0.874	

Notes:
Dependent variable: Standard Tobin's Q-1
Explanatory variables: Nt/Kt indicates the ratio of intangible assets to tangible assets
It/Kt indicates the ratio of tangible investments to tangible assets
Ot/Kt indicates the ratio of intangible investments to tangible assets
CC indicates the measure of credit constraint
We calculate this measure following Rajan and Zingales (1998) as follows: (Capital expenditures (tangible + intangible) – Cash flow from operations)/ Tangible capital stocks
PCM indicates the price cost margin. Price cost margin is calculated as follows: (Operating surplus – Interest expense)/Sales
*, **, and *** indicate statistical significance at 10 %, 5 %, and 1 %, respectively

Table 5.10 Instrumental variable (IV) estimates of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.518	0.212**	3.413	0.763***	1.788	0.623***
I/K			0.924	0.315***	0.193	0.269
O/K			−9.934	2.768***	−4.146	2.261*
PCM					6.005	0.356***
Const.	−0.759	0.171***	0.161	0.445	−0.670	0.371*
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	52.06		12.27		20.75	
Prob > F	0		0		0	
R-squared	0.3196		0.1438		0.3767	
Adj R-squared	0.387		0.2286		0.4384	
Root MSE	0.8708		0.9769		0.8335	
Sargan statistic	9.624		0.488		0.409	
Chi-sq(1) P-val	0.0019		0.4847		0.5225	

Notes:
See the notes in Table 5.9
Skilled labor ratio indicates the ratio of white-color to total workers

examine what kind of assets the stock market assesses favorably. Estimation results in Table 5.13 show that the stock market assesses assets in software and firm specific human capital favorably, while the assessments of R&D, brand equity, and organizational change are inconclusive. These results imply that the stock market does not necessarily consider all components of intangibles as positive.

Figure 5.1 shows that the sample deviation from the mean value is not symmetric. In this case, quantile regression—that estimates parameters based on the error measured as a deviation from the median value in each quantile—is useful to check the robustness of our results. We separate the distribution of a conventional Tobin's Q into four quantiles and conduct quantile regression. Table 5.14 shows the estimation results of quantile regression that correspond to the OLS estimations in Table 5.9. As in Table 5.9, the firm value reflects intangible values in all estimations. In addition, intangible investment also contributes positively and significantly to the increase in firm value (Column (2)), while the coefficient of this variable is not significant in Table 5.9. As a result, the above two alternative estimations confirm the positive and significant contributions of intangible assets to firm value.

Table 5.11 Panel estimate (random effect) of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.613	0.082***	0.451	0.129***	0.595	0.125***
I/K			0.242	0.172	0.010	0.167
O/K			0.711	0.391*	0.286	0.380
PCM					4.014	0.286***
Const.	−1.203	0.986	−0.558	0.987	−0.707	0.943
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.772		0.772		0.730	
sigma_e	0.600		0.599		0.581	
rho	0.623		0.624		0.612	
Number of obs	2,882		2,882		2,882	
Number of groups	332		332		332	
	(1)		(2)		(3)	
	IT sectors		IT sectors		IT sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.666	0.110***	0.370	0.176**	0.523	0.171***
I/K			0.563	0.344	0.155	0.337
O/K			1.108	0.481**	0.666	0.469
PCM					4.860	0.565***
Const.	0.804	1.097	0.809	1.104	0.759	1.063
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.772		0.779		0.741	
sigma_e	0.738		0.733		0.712	
rho	0.523		0.530		0.520	
Number of obs	1,211		1,211		1,211	
Number of groups	135		135		135	
	(1)		(2)		(3)	
	Non-IT sectors		Non-IT sectors		Non-IT sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
Nt/Kt	0.567	0.109***	0.319	0.155**	0.453	0.149***
It/Kt			0.106	0.182	−0.082	0.176
Ot/Kt			1.148	0.498**	0.714	0.481
PCM					3.961	0.318***
Const.	−0.721	0.752	−0.666	0.736	−0.799	0.682
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.669		0.649		0.593	
sigma_e	0.544		0.544		0.524	
rho	0.602		0.587		0.562	
Number of obs	1,845		1,845		1,845	
Number of groups	202		202		202	

Notes:
See the notes in Table 5.9

Table 5.12 Instrumental variable (IV) estimates of determinants of conventional Tobin's Q-1 (IT or non-IT sectors)

	(1)		(2)		(3)	
	IT sectors		IT sectors		IT sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.887	0.264***	3.233	1.127***	2.176	1.042**
I/K			0.923	0.622	0.040	0.581
O/K			−7.598	3.691**	−4.498	3.410
PCM					4.913	0.599***
Const.	−1.012	0.355***	−0.412	0.464	−0.820	0.429*
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	777		777		777	
F	7.81		9.05		12.22	
Prob > F	0		0		0	
R-squared	0.307		0.2248		0.3432	
Adj R-squared	0.457		0.3927		0.4855	
Root MSE	0.9451		0.9996		0.92	
Sargan statistic	4.013		0.231		0.021	
Chi-sq (1) P-val	0.045		0.631		0.884	
	(1)		(2)		(3)	
	Non-IT sectors		Non-IT sectors		Non-IT sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.022	0.267	3.443	0.999***	1.369	0.752*
I/K			0.753	0.370**	0.304	0.299
O/K			−12.174	4.025***	−3.423	3.025
PCM					6.535	0.435***
Const.	-0.018	0.265	−0.078	0.307	−0.350	0.247
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	1,269		1,269		1,269	
F	13.84		10.55		21.07	
Prob > F	0		0		0	
R-squared	0.3062		0.0653		0.3996	
Adj R-squared	0.3398		0.1106		0.4287	
Root MSE	0.8257		0.9584		0.7681	
Sargan statistic	3.634		1.081		0.156	
Chi-sq (1) P-val	0.057		0.298		0.693	

Notes:
See the notes in Table 5.9
Skilled labor ratio indicates the ratio of white-color to total workers

Table 5.13 Instrumental variable (IV) estimates of determinants of Conventional Tobin's Q-1 (software, R&D, brand equity, human capital, and organizational change)

	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Software		Software		Software	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	3.676	2.050*	73.826	35.946**	47.953	23.001**
I/K			0.891	0.553	0.089	0.384
O/K			−211.792	106.955**	−133.847	68.346*
PCM					7.444	0.854***
Const.	−0.890	0.398**	−1.800	0.755**	−1.747	0.531***
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	13.1		3.67		9.42	
Prob > F	0		0		0	
Centered R2	0.2913		−1.6073		−0.3055	
Uncentered R2	0.3615		−1.349		−0.1762	
Root MSE	0.8887		1.705		1.206	
Sargan statistic	12.95		0.466		1.149	
Chi-sq (1) P-val	0.0003		0.495		0.2838	
	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	R&D		R&D		R&D	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.908	0.263***	2.797	1.334**	−0.289	1.118
I/K			0.684	0.298**	−0.016	0.266
O/K			−10.646	6.867	4.824	5.762
PCM					5.711	0.358***
Const.	−0.467	0.287	−0.598	0.309*	−0.666	0.275**
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	13.52		12.8		20.22	
Prob > F	0		0		0	
Centered R2	0.3062		0.2268		0.3877	
Uncentered R2	0.375		0.3034		0.4483	
Root MSE	0.8793		0.9283		0.8261	
Sargan statistic	4.561		4.747		2.564	
Chi-sq (1) P-val	0.0327		0.0293		0.1094	

(continued)

Table 5.13 (continued)

	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Brand equity		Brand equity		Brand equity	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	2.27	1.36*	375.95	352.43	164.59	139.15
I/K			2.18	1.90	0.47	0.70
O/K			−666.91	626.78	−291.10	247.49
PCM					7.74	1.64***
Const.	−1.27	0.60**	−2.49	1.95	−1.80	0.88**
Year dummy	Yes		Yes		Yes	
Industry dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	12.82		0.94		5.02	
Prob > F	0		0.5995		0	
Centered R2	0.2763		−8.8485		−1.3675	
Uncentered R2	0.348		−7.8728		−1.1329	
Root MSE	0.8981		3.313		1.624	
Sargan statistic	13.04		0.005		2.42	
Chi-sq (1) P-val	0.0003		0.9411		0.1198	
	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Human capital		Human capital		Human capital	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	−2.33	1.29*	36.74	9.66***	27.42	7.28***
I/K			1.90	0.49***	0.77	0.36**
O/K			−90.68	24.59***	−66.55	18.51***
PCM					8.35	0.74***
Const.	−0.20	0.33	−0.40	0.37	−0.75	0.30**
Year dummy	Yes		Yes		Yes	
Industry dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	11.03		8.49		16.02	
Prob > F	0		0		0	
Centered R2	0.1579		−0.1409		0.2251	
Uncentered R2	0.2413		−0.0278		0.3019	
Root MSE	0.9688		1.128		0.9293	
Sargan statistic	10.326		1.183		3.282	
Chi-sq (1) P-val	0.0013		0.2767		0.07	

(continued)

Table 5.13 (continued)

	(1)		(2)		(3)	
	All sectors		All sectors		All sectors	
	Organizational change		Organizational change		Organizational change	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	93.29	50.05*	2,419.06	1,860.25	22.58	598.39
I/K			1.45	0.85*	0.04	0.30
O/K			−5,773.80	4,517.08	44.18	1,453.14
PCM					5.96	0.75***
Const.	−2.20	1.01**	−3.28	1.70*	−1.44	0.61**
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio and CC		Skilled labor ratio and CC		Skilled labor ratio and CC	
Number of obs	2,040		2,040		2,040	
F	12.68		3.42		20.17	
Prob > F	0		0		0	
Centered R2	0.2677		−1.8208		0.3918	
Uncentered R2	0.3403		−1.5413		0.452	
Root MSE	0.9034		1.773		0.8234	
Sargan statistic	12.168		2.358		13.272	
Chi-sq (1) P-val	0.0005		0.1246		0.0003	

Notes:
See the notes in Table 5.9
Skilled labor ratio indicates the ratio of white-color to total workers

Table 5.14 Quantile regression of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)		(4)	
	All sectors		All sectors		All sectors		All sectors	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.709	0.042***	0.575	0.086***	0.321	0.123***	0.553	0.075***
I/K			0.764	0.160***	1.026	0.247***	0.176	0.141
O/K			0.520	0.290*	1.687	0.408***	0.403	0.253
CC					−0.218	0.071***		
PCM							4.081	0.181***
Const.	−0.309	0.063***	−0.441	0.061***	−1.885	0.431***	−0.468	0.054***
Industry dummy	Yes		Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes		Yes	
Number of obs	2,882		2,882		2,047		2,882	
Pseudo R2	0.1885		0.1907		0.2067		0.2333	

Note:
See the notes in Table 5.9

5.6 Concluding Remarks

The IT revolution has changed the growth strategy of firms. Software investment has become as important as tangible investment. Firms have focused on accumulation in human capital and restructured their organizations to be compatible with the new technology. Many economists such as E. Brynjolfsson, C. Corrado, R. Hall, C. Hulten, B. Lev, and L. Nakamura summarized these new types of expenditures as intangible investment and examined its effects on firm value. However, many studies have focused on the effects of specific components of intangible assets on firm value, because it is difficult to measure intangibles at the firm level.

Based on the classification of intangibles by Corrado et al. (2009), we measure a broader concept of intangibles than those in the previous studies using the listed firm-level data in Japan. The mean value of Tobin's Q including intangible assets is almost equal to 1, while the mean value of conventional Tobin's Q exceeds 1, as Hall (2000, 2001) suggested. The standard deviation of the revised Q is smaller than that of the conventional Q, which is consistent with the results of Görzig and Görnig (2012). These results imply that stock prices reflect the value of intangibles.

Although the results also imply that the market concludes that there are no growth opportunities of Japanese listed firms on average in the 2000s, there are still differences in Tobin's Q. The Tobin's Q in the IT industries is consistently higher than that in the non-IT industries. This difference in market value suggests that firms in the IT industries should expand their businesses, and firms in the non-IT industries should restructure their businesses. The result is consistent with Miyagawa and Hisa (2013), who argued that intangible investment improves productivity in the IT industries. The Japanese government should take growth strategies such as to promote investment including intangibles in the IT industries and to assist firms in the non-IT industries transform themselves to a business in a growth industry.

Using our measures, we examined the effects of intangibles on firm value. Estimation results following Bond and Cummins (2000) showed that greater intangible assets increase firm value. As these results are robust in the IT industries in particular, they support our policy implications. However, not all intangible assets are valued in the stock market. The values of innovative property and economic competencies are inconclusive. One possible reason for the long-term slump of the Japanese stock market is that investors are not valuing high level R&D investment and human resources in Japanese firms. The upcoming reform in accounting standards that will evaluate intangible assets will contribute to the revitalization of the Japanese stock market.

Appendix 1. Measurement of Tangible Capital Stock

1.1 Capital Stock

In reference to Hayashi and Inoue (1991), we created the dataset of tangible capital stock by assets.

We employ the Permanent Inventory (PI) method, in which we use FY1980 or FY1990 as the base year.

We create firm level data of the capital stock using six assets, (1) non-residential building, (2) construction, (3) machinery, (4) ship/vehicle/transportation equipment, (5) tool appliance equipment, and (6) other tangible assets as follows:

$$K_{it}^{m} = (1 - \delta_m)K_{it-1}^{m} + I_{it}^{m}$$

where K_{it}^{m} is the capital stock of asset m for firm i at time t, I_{it}^{m} is real investment, and δ_m is the depreciation rate. After calculating the capital stock of each asset, we estimate the real tangible capital stock, K_{it} by firm level, by adding them together as follows.

$$K_{it} = \sum_{m} K_{it}^{m}$$

In the following, we introduce the variables used in calculating the real tangible capital stock.

1.2 Nominal Investments

The nominal investment of each asset is defined as the amount of each acquisition credited against the retirement and decrease in the tangible asset by the sale of another one. While Hayashi and Inoue (1991) used the retirement and decrease valued by replacement price, we use the book value.

1.3 Capital Price by the Type of Capital Goods

In order to deflate nominal investments, we use the following price indices in "Corporate goods Price Index (CGPI)" by Bank of Japan.

"Construction material price index" for (1) non-residential building and (2) construction

"Transportation equipment price index" for (4) ship/vehicle/transportation equipment
"Manufacturing product price index" for (6) other tangible assets

For (3) machinery or (5) tool appliance equipment, we use the relevant price indices in the CGPI. At first we calculate the industry level weight for each machinery or tool using the "Fixed Capital Formation Matrix" by the Cabinet office, of the Government of Japan. We calculate the weighted average price indices using the weights and the relevant price indices in CGPI for (3) machinery or (5) tool appliance equipment.

1.4 Base Year

As the analysis period in this work is after 2000, the base year for (1) non-residential building and (2) structure (was "construction" earlier) is FY1980 and that for (3) machinery, (4) ship/vehicle/transportation equipment, (5) tool appliance equipment, and (6) other tangible assets is FY1990.

The base year for the companies that were newly listed after FY1980 or FY1990 is the very year when they were listed. As a benchmark, we took the book value of each tangible asset in the base year.

1.5 Depreciation Rate

We use the depreciation rate that Hayashi and Inoue (1991) created using Hulten and Wykoff (1979, 1981). Specifically, the rates are the following: (1) non-residential building, 4.7 % (2) construction, 5.64 % (3) machinery, 9.489 % (4) ship/vehicle/transportation equipment, 14.7 % (5) tool appliance equipment and (6) other tangible assets are both 8.838 %.

Appendix 2. Classification of IT Sectors

JIP code	IT-using manufacturing sector
20	Printing, plate making for printing and bookbinding
23	Chemical fertilizers
24	Basic inorganic chemicals
29	Pharmaceutical products
34	Pottery
38	Smelting and refining of non-ferrous metals

(continued)

JIP code	IT-using manufacturing sector
42	General industry machinery
45	Office and service industry machines
46	Electrical generating, transmission, distribution and industrial apparatus
53	Miscellaneous electrical machinery equipment
56	Other transportation equipment
59	Miscellaneous manufacturing industries

JIP code	IT-using non-manufacturing sector
63	Gas, heat supply
67	Wholesale
68	Retail
69	Finance
70	Insurance
79	Mail
82	Medical(private)
85	Advertising
86	Rental of office equipment and goods
88	Other services for businesses
92	Publishers

JIP code	IT-producing manufacturing sector
47	Household electric appliances
48	Electronic data processing machines, digital and analog computer, equipment and accessories
49	Communication equipment
50	Electronic equipment and electric measuring instruments
51	Semiconductor devices and integrated circuits
52	Electronic parts
57	Precision machinery & equipment

JIP code	IT-producing non-manufacturing sector
78	Telegraph and telephone
90	Broadcasting
91	Information services and internet based services

JIP code	Non-IT intensive manufacturing sector
8	Livestock products
9	Seafood products
10	Flour and grain mill products
11	Miscellaneous foods and related products
12	Prepared animal foods and organic fertilizers
13	Beverages
14	Tobacco
15	Textile products

(continued)

JIP code	Non-IT intensive manufacturing sector
16	Lumber and wood products
17	Furniture and fixtures
18	Pulp, paper, and coated and glazed paper
19	Paper worked products
21	Leather and leather products
22	Rubber products
25	Basic organic chemicals
26	Organic chemicals
27	Chemical fibers
28	Miscellaneous chemical products
30	Petroleum products
31	Coal products
32	Glass and its products
33	Cement and its products
35	Miscellaneous ceramic, stone and clay products
36	Pig iron and crude steel
37	Miscellaneous iron and steel
39	Non-ferrous metal products
40	Fabricated constructional and architectural metal products
41	Miscellaneous fabricated metal products
43	Special industry machinery
44	Miscellaneous machinery
54	Motor vehicles
55	Motor vehicles parts and accessories
58	Plastic products

JIP code	Non-IT intensive non-manufacturing sector
62	Electricity
64	Waterworks
65	Water supply for industrial use
66	Waste disposal
71	Real estate
73	Railway
74	Road transportation
75	Water transportation
76	Air transportation
77	Other transportation and packing
81	Research (private)
87	Automobile maintenance services
89	Entertainment
93	Video picture, sound information, character information production and distribution
94	Eating and drinking places
95	Accommodations
96	Laundry, beauty and bath services
97	Other services for individuals

References

Abowd, J. M., Haltiwanger, J., Jarmin, R., Lane, J., Lengermann, P., McCue, K., et al. (2005). The relation among human capital, productivity, and market value. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 153–203). Chicago, IL: University of Chicago Press.

Arato, H., & Yamada, K. (2012). Japan's intangible capital and valuation of corporations in a neoclassical framework. *Review of Economic Dynamics, 15*, 293–312.

Barnes, P., & McClure, A. (2009). *Investments in intangible assets and Australia's productivity growth* (Productivity Commission Staff Working Paper). Melbourne: Productivity Commission.

Basu, S., Fernald, J. G., Oulton, N., & Srinivasan, S. (2003). The case of the missing productivity growth: Or, does information technology explain why productivity accelerated in the United States but not the United Kingdom? In M. Gertler & K. Rogoff (Eds.), *NBER macroeconomics annual, 2003* (pp. 9–63). Cambridge, MA: MIT Press.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*, 1351–1408.

Bond, S., & Cummins, J. (2000). The stock market and investment in the new economy: Some tangible facts and intangible fictions. *Brookings Papers on Economic Activity, 1*, 61–124.

Brynjolfsson, E. (2004). *Intangible assets*, translated to Japanese by Diamond Inc., Tokyo.

Brynjolfsson, E., Hitt, L., & Yang, S. (2002). Intangible assets: Computers and organization capital. *Brookings Papers on Economic Activity, 1*, 137–181.

Corrado, C., Haskel, J., Jona-Lasinio, C., & Iommi, M. (2012). *Intangible capital and growth in advanced economies: Measurement and comparative results*. Presented at the 2nd World KLEMS Conference at Harvard University.

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *Review of Income and Wealth, 55*, 658–660.

Cummins, J. G. (2005). A New Approach to the Valuation of Intangible Capital. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 47–72). Chicago, IL: University of Chicago Press.

Delbecque, V., & Bounfour, A. (2011). *Intangible investment: Contribution to growth and innovation policy issues* (The European Chair on Intellectual Capital Management Working Paper Series, No. 2011-1A).

Fukao, K., Hamagata, S., Inui, T., Ito, K., Kwon, H., Makino, T., et al. (2007). *Estimation procedure and TFP analysis of the JIP database 2006 (revised)* (RIETI Discussion Paper Series 07-E-003). Tokyo: The Research Institute of Economy, Trade and Industry.

Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to economic growth. *Review of Income and Wealth, 55*, 717–736.

Görzig, B., & Görnig, M. (2012). *The dispersion in profits rates in Germany: A result of imperfect competition?* Presented at the 32nd General Conference of International Association for Research in Income and Wealth at Boston, USA.

Griliches, Z. (1981). Market value, R&D, and patents. *Economic Letters, 7*, 83–187.

Hall, B. H. (1993). The stock market's valuation of R&D investment during the 1980's. *American Economic Review, 83*, 259–264.

Hall, R. (2000). E-capital: The link between the stock market and the labor market in the 1990s. *Brookings Papers on Economic Activity, 1*, 73–118.

Hall, R. (2001). The stock market and capital accumulation. *American Economic Review, 91*, 1185–1202.

Hall, B. H., & Oriani, R. (2006). Does the market value R&D investment by European firms? Evidence from a panel of manufacturing firms in France, Germany, and Italy. *International Journal of Industrial Organization, 24*, 971–993.

Hao, J., Manole V., & van Ark B. (2008, June 10). *Intangible assets in Europe: Measurement and international comparability*. Presented at the final conference of EUKLEMS Project.

Hayashi, F., & Inoue, T. (1991). The relation between firm growth and *Q* with multiple capital goods: Theory and evidence from panel data on Japanese firms. *Econometrica, 59*, 731–753.
Hulten, C. R., & Hao, X. (2008). *What is a company really worth? Intangible capital and the 'market to book value' puzzle* (NBER Working Paper No. 14548).
Hulten, C. R., & Wykoff, F. C. (1979). *Economic depreciation of the U.S. capital stock*. Report submitted to the U.S. Treasury Department Office of Tax Analysis, Washington, DC.
Hulten, C. R., & Wykoff, F. C. (1981). The measurement of economics depreciation. In C. Hulten (Ed.), *Depreciation, inflation and the taxation of income from capital* (pp. 81–125). Washington, DC: Urban Institute Press.
Lev, B., & Radhakrishnan, S. (2005). The valuation of organization capital. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy* (pp. 73–99). Chicago, IL: University of Chicago Press.
Lindenberg, E., & Ross, S. A. (1981). Tobin's Q ratio and industrial organization. *Journal of Business, 54*, 1–32.
Marrano, M., Haskel, J., & Wallis, G. (2009). What happened to the knowledge economy? ICT, intangible investment, and Britain's productivity revisited. *Review of Income and Wealth, 55*, 661–716.
Miyagawa, T., & Hisa, S. (2013). Estimates of intangible investment by industry and productivity growth in Japan. *The Japanese Economic Review, 64*, 42–72.
Miyagawa, T., & Kim, Y. (2008). Measuring organizational capital in Japan: An empirical assessment using firm-level data. *Seoul Journal of Economics, 21*, 171–193.
Ooki, E. (2003). Performance-based wage systems and vocational education/training investment (Gyoseki-shugi to Kyoiku Kunren Toshi) (in Japanese). In K. Imano (Ed.), *Implications of performance-based wage systems for individuals and organizations (Ko to Soshiki no Seikashugi)*. Tokyo: Chuo Keizai Sha.
Piekkola, H. (2011). Intangible capital in EU 27 – Drivers of growth and location in the EU. *Proceedings of the University of Vaasa. Reports* 166.
Pyo, H., Chun, H., & Rhee, K. (2010). *The productivity performance in Korean industries (1990-2008): Estimates from KIP database*. Presented at RIETI/COE Hi-Stat International Workshop on Establishing Industrial Productivity Database for China (CIP), India (IIP), Japan (JIP), and Korea (KIP) held on October 22, 2010.
Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. *American Economic Review, 88*, 559–586.
Robinson, P., & Shimizu, N. (2006). Japanese corporate restructuring: CEO priorities as a window on environmental and organizational change. *The Academy of Management Perspectives, 20*, 44–75.
Tanaka, K., & Miyagawa, T. (2011). Oogatatousi ha kigyo pafo-mansu wo koujou saseruka? (Does large investment improve firm performance? In K. Asako & T. Watanabe (Eds.), *Econometric analyses of finance and business cycles* (pp. 191–235). Tokyo: Minerva Shobo (in Japanese).
Wildasin, D. E. (1984). The *q* theory of investment with many capital goods. *American Economic Review, 74*, 203–210.

Chapter 6
Financial Constraints on Intangible Investments: Evidence from Japanese Firms

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Abstract This paper uses Japanese firm-level data to analyze financial constraints on intangible investments. In contrast to past studies that focused almost exclusively on R&D investments, the intangible investments analyzed in this paper cover the acquisition of intangible assets as a whole. We estimate investment functions in which cash flow is used as a key explanatory variable to observe differences in the sensitivity of investments to cash flow by industry, firm size, and firm age. According to the estimation results, investments in intangible assets are more sensitive to internal capital compared with investments in tangible assets, suggesting the existence of market failure in financial markets. Financial constraint is more serious for young and small firms.

Keywords Intangible investments • Credit constraint • Cash flow • Investment function

6.1 Introduction

This paper uses Japanese firm-level panel data to analyze financial constraints on intangible investments. Studies on the role of intangible assets in economic growth have progressed rapidly. These studies have indicated that intangible assets play an

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important role in economic performance but that current levels of investment in intangible assets may be lower than the optimal level. The motivation of this study is to investigate why firms underinvest in intangible assets when these assets are effective in enhancing firm performance and to discuss policy measures for promoting intangible investments. In other words, the basic question of this paper is whether there is market failure in intangible investments.

Among intangible investments, studies on research and development (R&D) investments have indicated that the private rate of return to R&D investments is generally lower than the social rate of return and that capital market imperfection is serious for R&D investments. However, empirical studies have been extremely limited related to intangible investments other than R&D investments. Recent studies measuring aggregate-level intangible investments classify (1) software and other computerized information, (2) innovative property (scientific R&D and non-scientific R&D), and (3) economic competencies as "intangible assets." In advanced countries, the estimated share of scientific R&D in the total intangible investments is between 10 and 25 % (Table 6.1). This figure suggests that we should focus more heavily on other intangible investments, such as investments in computer software, advertising expenditures, and training expenses.

Regarding policy measures by the types of investments in practice, tax incentives for investments are concentrated in equipment and R&D investments (Table 6.2).[1] There are tax incentives for software and human capital investments in Japan, but the size of these measures is very small. Furthermore, while there are a variety of financial support programs in Japan, such as loans by the Japan Finance Corporation (JFC), financial support has focused mainly on tangible (equipment and buildings) investments. If the levels of intangible investments are lower than the socially optimal level, it is desirable to introduce or expand policy measures to stimulate such investments. However, it is difficult to plan appropriate policy tools without information on the nature and magnitude of market failure.

Within these contexts, this paper uses firm-level panel data from the Basic Survey of Japanese Business Structure and Activities (Ministry of Economy, Trade and Industry) to empirically analyze the financial constraints on intangible investments. Specifically, we estimate investment functions in which cash flow is used as a key explanatory variable to determine the sensitivity of the intangible investments to internal cash. A novel aspect of this study is that the intangible investments analyzed in this paper cover the acquisition of intangible assets as a whole, which are not limited to R&D investments.

We consider differences in the sensitivity of investments to cash flow by industry, firm size, and firm age. If there is a market failure in intangible investments caused by information asymmetry or agency problems, the sensitivity of the intangible investments to cash flow is expected to be stronger than that of the tangible (physical) investments. In addition, we expect the sensitivity to cash flow

[1] In addition to the special tax treatment, there are various R&D subsidy programs.

Table 6.1 Composition of intangible investments in the U.S., Japan, and U.K.

	(1) U.S. 2000–03	(2) Japan 2000–05	(3) U.K. 2004
1. Computerized information	14.1 %	20.3 %	16.5 %
2. Innovative property			
(a) Scientific R&D	18.8 %	25.7 %	9.5 %
(b) Non-scientific R&D	19.3 %	28.1 %	20.7 %
3. Economic competencies			
(a) Brand equity	13.1 %	10.4 %	14.1 %
(b) Firm-specific resources	34.7 %	15.5 %	39.1 %

Note: Calculated from Corrado et al. (2009), Fukao et al. (2009), and Marrano et al. (2009)

Table 6.2 Major special corporate tax measures

Tax measures	Billion yen
Special Depreciation for Innovative Equipment	55
Tax Deduction for ICT Investments	70
Tax Credit for Energy-Efficient Equipment	122
Investment Tax Credit for SMEs	250
Tax Credit for R&D Expenditure	254

Note: The figures are the annual values of tax reduction (billion yen) of the special measures for the 2010 fiscal year
Source: Ministry of Finance

to be greater among SMEs and young firms whose financial constraints are generally more severe than are those of large and mature firms.

We should note that the intangible investments in this paper are confined to those covered by the Basic Survey of Japanese Business Structure and Activities, which involves the acquisition of intangible assets defined by the current accounting standard. According to the Japanese Corporate Accounting Principles, fixed intangible assets include goodwill, patents, superficies, trademarks, and software. Except software, only purchased fixed intangible assets can be appropriated in the balance sheet. In other words, the analysis in this paper does not completely cover the intangible assets defined by Corrado et al. (2009). However, several recent studies have used accounting measures of intangible assets in firm-level empirical analysis. For example, Marrocu et al. (2012) used accounting measures of intangible assets to investigate their influence on productivity among European firms. Studies by Dischinger and Riedel (2011) and Becker and Riedel (2012) use accounting measures of intangible assets to analyze the investment behavior of multinational firms.

According to the estimation results of this paper, investments in intangible assets are more sensitive to internal cash flows compared with investments in tangible assets. In analyzing the type of firm, it can be observed that the sensitivity of intangible investments to cash flow is stronger in SMEs and young firms, which face severe constraints in external financial markets, than in large and mature firms. These results suggest the existence of a market failure in intangible investments caused by information asymmetry or a lack of well-functioning resale markets for intangible assets. One policy implication of these results is that the policies designed to remove market failure, such as improvements in financial intermediaries' ability to evaluate intangibles and the expansion of transaction markets for intellectual property rights, are socially desirable. Another implication is that investment tax credits and financial support for SMEs or young firms should focus more heavily on intangible investments.

The rest of this paper is structured as follows. Section 6.2 briefly surveys past empirical studies of liquidity constraints on investments. Section 6.3 describes the data used and the method of analysis. Section 6.4 presents and interprets the results, and Sect. 6.5 concludes with policy implications.

6.2 Literature Review

Studies on the role of intangible assets in economic growth are progressing rapidly. Recent studies, based on a framework proposed by Corrado et al. (2009), classify (1) software and other computerized information, (2) innovative property (scientific R&D and non-scientific R&D), and (3) economic competencies (brand equity and firm-specific resources) as "intangible assets." The coverage of this definition is wider than the accounting measure of fixed intangible assets.

In many advanced countries, studies have been conducted based on this framework, such as Marrano et al. (2009) in the UK, Belhocine (2009) in Canada, and Edquist (2011) in Sweden. These studies have identified the quantitative contribution of intangible assets to macroeconomic growth and productivity. In Japan, Fukao et al. (2009) conducted the representative study of this line of literature. These authors estimated that the ratio of intangible assets to GDP in Japan was 11.1 % (2000–2005 average), of which computerized information, innovative property, and economic competencies represented 2.2 %, 6.0 %, and 2.9 %, respectively. The ratio of intangible assets was lower than that of the U.S., and the recent growth rate of intangible assets in Japan was stagnant. Furthermore, Chun et al. (2012) estimated intangible investments by industry for Japan and Korea and found that the intangible investments in the service industry were far lower than were those in the manufacturing industry in Japan.

Some studies using aggregated data have demonstrated a positive relationship between intangible capital and productivity growth. Roth and Thum (2013), using cross-country data for EU countries, indicated that intangible capital explains a significant portion of the international variance in labor productivity growth. Miyagawa and Hisa (2013) estimated intangible investment in Japan at the industry level and analyzed the impacts of intangible investment on the total factor productivity (TFP) growth. Their result indicates a positive and significant effect of intangible investment on TFP growth.

Empirical studies using micro data to investigate the effects of intangible assets on firm performance are also developing rapidly. The analysis by Bloom and Van Reenen (2007), a pioneering study in this area, collected information on firm-level management practices and found that managerial practices are strongly associated with firm-level productivity.[2] In Japan, Miyagawa et al. (2010) conducted a similar survey and provided suggestive evidence on the positive relation between management practices and productivity at the firm level.[3] Although these studies do not cover all intangible investments and their focus is on organizational innovation and human resources management, they indicate that some types of intangible investment make positive contributions to firm-level productivity performance.

To summarize, these studies have shown that intangible assets play an important role in economic performance but that the current levels of investments in intangible assets may be lower than the optimal level. The purpose of this paper is to investigate why firms underinvest in intangible assets when these assets are effective in enhancing firm performance and to discuss policy measures that are desirable for promoting intangible investments.

Among intangible investments, numerous studies have been conducted on R&D investments. These studies have indicated that the private rate of return to R&D investments is generally lower than the social rate of return that includes benefits from knowledge spillovers. Underinvestment in R&D emerges as a result of the profit-maximizing behavior of firms (see, for example, Griliches 1998 for a survey). In addition, capital market imperfection stemming from information asymmetry has been shown to be serious for R&D investments (see Hall 2002 and Hall and Lerner 2010). However, for intangible investments other than R&D investments, the existence or nonexistence of market failure has not been empirically identified.

Since the release of the influential paper by Fazzari et al. (1988), numerous studies have analyzed the effect of capital market imperfections on firm investment by estimating investment functions using internal cash flow as a key explanatory variable. Hubbard (1998) and Bond and Van Reenen (2007) present excellent surveys of the literature. In these studies, investment-cash flow sensitivity has been interpreted as evidence of a credit market imperfection caused by information asymmetry.[4] A large number of empirical studies have confirmed the significance of capital market imperfections, at least for firms such as SMEs or young firms. However, most of this literature has focused only on investment in tangible (physical) assets.

A relatively small number of studies have investigated financial market imperfection in R&D investment. The studies by Hao and Jaffe (1993), Himmelberg and Petersen (1994), Bhagat and Welch (1995), Brown et al. (2009), Brown and Petersen (2009), Czarnitzki and Hottenrott (2011), Aghion et al. (2012), Brown et al. (2012), Driver and Guedes (2012), and Borisova and Brown (2013) are examples. In general, as Hall's (2002) survey summarizes, these studies find that

[2] Bloom et al. (2013) conducted a field experiment in India that indicated that adopting good management practices raises productivity.

[3] See also Miyagawa et al. (2014), which compare the management quality between Korea and Japan based on the 2008 and 2012 surveys.

[4] However, several studies cast doubt on the interpretation of investment-cash flow sensitivity as evidence of capital market imperfection (Kaplan and Zingales 1997, 2000; Gilchrist and Himmelberg 1998; Erickson and Whited 2000; Cummins et al. 2006; Chen and Chen 2012).

SMEs and start-up firms face a higher cost of capital for financing R&D investment. These studies suggest that investments in intangible assets other than R&D may also be constrained by financial market imperfections. However, empirical studies to identify the presence of financing constraints on intangible investments other than R&D investments have been scarce.[5]

6.3 Data and Methodology

The analysis in this paper uses panel data from the Basic Survey of Japanese Business Structure and Activities conducted by the Ministry of Economy, Trade and Industry (METI). This annual survey, which began in 1991, accumulates representative statistics on Japanese firms with 50 or more regular employees, including firms engaged in the mining, manufacturing, electricity and gas, wholesale, retail, and service industries. Approximately 30,000 firms are surveyed every year. The purpose of this survey is to produce a comprehensive picture of Japanese firms, including their basic financial information, composition of businesses, R&D activities, IT usage, and foreign direct investments. Because the sample firms are coded using unique perpetual numbers, we can easily construct a firm-level longitudinal data set.

The survey began collecting information on “intangible fixed assets” (stock value) in the 2003 fiscal year and added a survey item on “intangible fixed asset investments” (flow value) in the 2006 fiscal year. As mentioned earlier, this survey item indicates the acquisition of intangible fixed assets defined by the current accounting standard. In the accounting standard of Japan, intangible fixed assets include goodwill, patent, trademark, and software, among others, and intangible investments are the acquisition of fixed intangible assets. An advantage of using these data is that intangible investments cover the acquisition of various intangible assets, which are not limited to R&D-related assets. Conversely, patents produced from internal R&D and expenditures for employee training are generally not included in intangible investments because only purchased fixed intangible assets, with the exception of software, can be appropriated on the balance sheet.

According to the survey, the ratio of intangible investments to total fixed asset investments (sum of the tangible asset and intangible asset investments) is 14.8 % at the sample mean (average for 2006–2010).[6] By industry, the ratio is higher for

[5] Studies on intangible investments other than R&D have been extremely limited, but Fee et al. (2009) studied the role of cash flows in advertisement spending and found evidence supporting the advertising-cash flow relationship. Recently, Falato et al. (2013) presented evidence from a panel of U.S. corporations suggesting that intangible capital, defined as the sum of the IT capital, R&D capital, and organizational capital, is an important determinant of corporate cash holdings, suggesting financial friction in intangible investment.

[6] In the Basic Survey of Japanese Business Structure and Activities, tangible fixed assets include land.

Table 6.3 Ratio of intangible investment to total fixed asset investment by industry

Industry	Intangible investments (%)
Manufacturing	8.1
Wholesale	20.1
Retail	10.6
Information & communication	44.5
Service	18.1
All industries	14.8

Notes: Total fixed asset investments are the sum of the tangible and intangible investments. The figures are the mean value of the firms in each industry calculated from the pooled years between 2006 and 2010

information and communication (I&C) firms and service firms: the ratios are 8.1 % (manufacturing), 20.1 % (wholesale), 10.6 % (retail), 44.5 % (I&C), and 18.1 % (service) (Table 6.3). The major reason for the very high figure for the I&C industry is that software investments are large for this industry, and internally produced software is included in the fixed intangible investments. Although the composition of fixed intangible investments (flow value) is not identified in the Basic Survey of Japanese Business Structure and Activities, the value of software assets (stock value) is surveyed as part of intangible assets. According to these data, 76 % of the fixed intangible assets are made up of software in the I&C industry. In contrast, the low ratio for manufacturing firms is due to the relatively high physical investment in this industry. These figures by industry indicate that intangible assets are important factors in production for firms operating in the non-manufacturing sector.

In this paper, we estimated a standard investment function in which cash flow was used as a main explanatory variable to observe the sensitivity of investments to internal cash flow.[7] A large number of previous studies have used Q-type investment functions where Tobin's Q is interpreted as a variable of firms' investment opportunities (see Hubbard 1998; Bond and Van Reenen 2007). However, because most of the sample firms in this paper are not publicly listed firms, the market value of firms to calculate Q is not available. For this reason, we employed an accelerator-type investment model where the growth of firm sales was included as an independent variable. Among representative past studies, Fazzari et al. (1988) showed the estimation results of both the Q model and the accelerator-type investment model, and the size of the coefficients for cash flow is quite similar in both specifications. Himmelberg and Petersen (1994) and Borisova and Brown (2013) analyzed financing constraints on R&D investment and reported results replacing Tobin's Q with sales growth. The estimated coefficients for cash flow are similar in size irrespective of the proxy measures for investment opportunities.

The equations to be estimated are expressed below. Equation (6.1) shows a pooled OLS estimation, and Eq. (6.2) shows a fixed-effect (FE) estimation. The reasons for using OLS and FE are that the time-series observation period is

[7] Another possible approach to detecting financial constraints is to compare the rates of return to tangible/intangible assets.

relatively short and the cross-sectional variation contains useful information.[8] All standard errors were adjusted for clustering at the firm level, which accommodates the non-independence of errors within firms over time.

$$I_{it}/K_{it\text{-}1} = a + \beta_1 CF_{it}/K_{it\text{-}1} + \beta_2 \Delta S_{it} + \varphi_{it} + \lambda_t + \varepsilon_{it} \tag{6.1}$$

$$I_{it}/K_{it\text{-}1} = a + \beta_1 CF_{it}/K_{it\text{-}1} + \beta_2 \Delta S_{it} + \varphi_{it} + \lambda_t + \eta_i + \varepsilon_{it} \tag{6.2}$$

In these equations, I_{it}, CF_{it}, and ΔS_{it} denote fixed tangible/intangible investments, internal cash flows (net profit after tax plus depreciation), and sales growth (average of past 2 years), respectively. Investments and cash flows were normalized by the beginning-of-period total capital stock ($K_{it\text{-}1}$: tangible fixed assets plus intangible fixed assets). In addition, three-digit industry dummies (φ_{it}) were used to control for industry effects. λ_t denotes year dummies, η_i denotes firm fixed effects, and ε_{it} is an i.i.d. error term. Because the data for intangible investments were available only from the year 2006, the period of analysis is 5 years, from 2006 to 2010.[9] To avoid any bias caused by outliers, we eliminated firms for which the absolute value of cash flow or tangible/intangible investments exceeded ten times the value of total fixed assets. We restricted our sample to firms that report the values of tangible investment, intangible investment, tangible fixed asset, intangible fixed asset, net profit after tax, and depreciation.

Our interest relates to the different sensitivities to internal cash flow of tangible investments and intangible investments. We expect the sensitivity to be larger for intangible investments than it is for equipment investments. However, we should not simply compare the size of the coefficients (β_1) because the value of tangible investments is approximately four times larger than the value of intangible investments (Table 6.4).[10] Thus, we calculated the implied elasticity of investments with respect to cash flow on each type of investment and compared the estimated elasticity of tangible/intangible investments (see Himmelberg and Petersen 1994).

Then, we divided the sample by firm size and firm age to identify the different effects of internal cash flow on intangible investments. The threshold to determine SMEs is paid-up capital of 100 million yen. In corporate tax policy, "SMEs" are firms with paid-up capital equal to or less than 100 million yen, irrespective of the industry.[11] The number of observations for SMEs make up about half of the total sample. We define "young firms" as those whose age after establishment is the

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[8] In estimating investment functions, recent studies have often employed dynamic panel models to control for the endogeneity of regressors. However, when using a dynamic panel estimator, reasonably long panel data are necessary. Because we have only 5 years of observations, we used pooled OLS and FE estimators.

[9] Data on lagged total fixed assets from 2005 and data on annual sales from 2004 were used for the estimations.

[10] Brown and Petersen (2009) noted that the increase in the R&D share to total investment must be considered when evaluating the size of the cash flow coefficients over time.

[11] In the Small and Medium-sized Enterprise Basic Act, "SMEs" are defined by both the number of employees and the value of the paid-up capital, and the thresholds differ by industry.

Table 6.4 Summary statistics

Variables		Full sample		SMEs		Large firms		Young firms		Mature firms	
		Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Tangible investments/Total assets	*tinv_k*	0.172	0.374	0.165	0.390	0.180	0.356	0.228	0.483	0.126	0.241
Intangible investments/Total assets	*iinv_k*	0.045	0.230	0.036	0.206	0.055	0.253	0.081	0.327	0.015	0.077
Cash Flow/Total assets	*cflow_k*	0.373	1.058	0.373	1.056	0.374	1.060	0.570	1.413	0.210	0.576
Number of employees	*emp*	638	2,265	273	1,237	1,032	2,953	554	2,096	707	2,394
Sales growth (2 years' average)	*avgsale*	1.019	0.884	1.007	0.218	1.032	1.248	1.043	1.314	1.000	0.207
Number of observations		67,448		35,021		32,427		30,592		36,856	

Notes: Variables are for the years between 2006 and 2010 sample median (39 years) or less.[12] We expected the sensitivity to cash flow to be larger among SMEs and young firms because these firms are generally more likely to be financially constrained than large and mature firms are.

The list of the major variables and their summary statistics are shown in Table 6.4. In addition to the statistics for the full sample, the table reports separate statistics for the SME and large firm subsample and for the young and mature subsamples. We can observe a number of interesting facts from Table 6.4. On average, young firms invest more in intangible assets than mature firms do. The dispersion of the ratio of cash flow to total assets is far larger for young firms than for mature firms.

6.4 Results

Table 6.5 shows the estimation results of investment functions (1) and (2) for the full sample. We evaluated the statistical significance using cluster-robust standard errors adjusted for the non-independence of errors within firms. The coefficients of cash flow (β_1) are positive and highly significant in both OLS and FE estimations, and the sizes of the coefficients are similar in magnitude for both specifications. According to the FE estimation results, the coefficients are 0.0511 and 0.0225 for tangible and intangible investments, respectively (columns (3) and (4)). However, as mentioned, the value of the tangible investments is approximately four times greater than the value of the intangible investments (Table 6.4). The effect of cash flow on the percentage change in investments is greater for intangible investments than it is for tangible investments. The last row of Table 6.5 indicates the implied elasticities (evaluated at the sample mean) of tangible/intangible investments with respect to cash flow. According to the FE estimation results, the implied elasticity of intangible investments (0.187) is larger than that of tangible investments (0.111).[13] It is clear that intangible investments depend on internal cash flow more than tangible investments do. The following are possible reasons for the higher sensitivity of intangible investments to internal finance: (1) Information asymmetry between the borrowing firms and financial intermediaries is severe for intangible investments because of the limited ability of financial intermediaries to evaluate the profitability of investment.[14] (2) The collateral value of intangible

[12] We calculated firm age as the difference between the foundation year of the firm and the year of the survey. Listing status is another possible criterion with which to divide the sample firms, but the Basic Survey of Japanese Business Structure and Activities does not survey the listing status of respondent firms.

[13] The implied elasticity is calculated as the estimated coefficient for CF $\times$ (mean CF/mean investment).

[14] The higher risk inherent to intangible investments relative to tangible investments may exacerbate the influence of the information asymmetry.

Table 6.5 Estimation results of investment functions

	(1)	(2)	(3)	(4)
	tinv_k	iinv_k	tinv_k	iinv_k
	OLS	OLS	FE	FE
cflow_k	0.0542***	0.0259***	0.0511***	0.0225***
	(0.0039)	(0.0026)	(0.0071)	(0.0048)
avgsale	0.0176	0.0055	0.0639***	−0.0021
	(0.0149)	(0.0056)	(0.0194)	(0.0052)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	62,035	62,035	62,035	62,035
R-squared	0.0451	0.0951	0.0130	0.0483
Implied elasticities	0.118	0.215	0.111	0.187

Notes: Cluster-robust standard errors in parentheses, $***p < 0.01$. Adjusted R-squared for OLS estimates, R-squared for FE estimates. tinv_k, iinv_k, cflow_k, and avgsale denote tangible investments divided by total fixed assets, intangible investments divided by total fixed assets, cash flows divided by total fixed assets, and sales growth (past 2 years' average). The last row shows the implied elasticities evaluated at the sample means. The sample period is 2006–2010

assets is relatively low because of the lack of resale markets for intangible assets compared with real estate or equipment and machinery.

Table 6.6 shows the regression results achieved by splitting the sample firms into manufacturing and non-manufacturing firms. The sensitivity to cash flow is higher in the non-manufacturing subsample for both tangible and intangible investments. In particular, in the FE estimation result, the sensitivity of intangible investments to internal cash flow has a large positive value for non-manufacturing firms, but the sign of the coefficient is negative and insignificant for manufacturing firms. This result suggests that the financial market imperfection hinders productive investments among firms operating in the service industry, which may be related to the poor productivity performance of the service sector.

Table 6.7 shows the results for the separate estimations for the subsamples of SMEs and large firms. As explained in Sect. 6.2, "SMEs" are defined as firms with paid-up capital of 100 million yen or less. According to the FE estimation results, the sensitivity to cash flow is higher among SMEs than it is among large firms in both tangible and intangible investments. Among large firms, the implied elasticities of tangible and intangible investments are 0.089 and 0.169, respectively, but the figures are 0.137 and 0.216 among SMEs (see the last row of columns (7) and (8)). The result suggests that the degree of capital market imperfection is more severe for SMEs.

Next, we divided the sample into younger firms and mature firms to estimate investment functions. The median age of sample firms (39 years) was used as the threshold value to divide the sample. The results are presented in Table 6.8. It is clear that intangible investments among young firms are more sensitive to cash flow than are those among mature firms. According to the FE estimation results, the

Table 6.6 Estimation results by industry

	(1)	(2)	(3)	(4)
	Manufacturing	Non-manufacturing	Manufacturing	Non-manufacturing
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0788***	0.0471***	0.0089***	0.0297***
	(0.0121)	(0.0038)	(0.0030)	(0.0031)
avgsale	0.0032	0.0685***	–0.0001	0.0289***
	(0.0039)	(0.0157)	(0.0001)	(0.0074)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,198	30,837	31,198	30,837
AdjR-squared	0.0425	0.0546	0.0249	0.0840
Implied elasticities	0.117	0.131	0.172	0.194
	(5)	(6)	(7)	(8)
	Manufacturing	Non-manufacturing	Manufacturing	Non-manufacturing
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0412**	0.0542***	–0.0006	0.0289***
	(0.0188)	(0.0075)	(0.0048)	(0.0059)
avgsale	0.0667***	0.0586**	–0.0043	0.0049
	(0.0232)	(0.0266)	(0.0068)	(0.0071)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,198	30,837	31,198	30,837
R-squared	0.0014	0.0223	0.0000	0.0454
Implied elasticities	0.061	0.150	–	0.189

Notes: Cluster-robust standard errors in parentheses, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

sensitivity of intangible investments to internal cash flow is positive and significant for young firms, but the coefficient is insignificant for mature firms (Table 6.8, columns (7) and (8)). By the type of investment, the implied elasticities among young firms are about 0.136 and 0.187 for tangible and intangible investments, respectively. This result indicates that young firms face severe constraints in the external capital market to finance intangible investments.

Finally, Table 6.9 presents the results for young SMEs and mature large firms. Young SMEs are supposed to be the most financially restrained firms. According to the FE estimation results, the coefficients for cash flows are insignificant for mature large firms, but the coefficients are positive and highly significant for young SMEs (see columns (7) and (8)).

Table 6.7 Estimation results by firm size

	(1)	(2)	(3)	(4)
	SMEs	Large firms	SMEs	Large firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0598***	0.0459***	0.0243***	0.0272***
	(0.0048)	(0.0062)	(0.0030)	(0.0041)
avgsale	0.0063	0.0130	0.0083	0.0053
	(0.0278)	(0.0134)	(0.0063)	(0.0056)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,910	30,125	31,910	30,125
AdjR-squared	0.0563	0.0401	0.1035	0.0950
Implied elasticities	0.135	0.096	0.253	0.186
	(5)	(6)	(7)	(8)
	SMEs	Large firms	SMEs	Large firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0606***	0.0428***	0.0207***	0.0247***
	(0.0088)	(0.0113)	(0.0056)	(0.0078)
avgsale	0.0629	0.0634***	0.0025	–0.0058
	(0.0385)	(0.0180)	(0.0078)	(0.0070)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	31,910	30,125	31,910	30,125
R-squared	0.0201	0.0044	0.0525	0.0276
Implied elasticities	0.137	0.089	0.216	0.169

Notes: Cluster-robust standard errors in parentheses, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

6.5 Conclusion

Recent studies have shown that intangible assets play an important role in explaining economic performance and that the level of investments in intangible assets might be lower than the socially optimal level. This paper uses panel data from the Basic Survey of Japanese Business Structure and Activities to empirically analyze the financial constraints on intangible investments.

The results of the analysis can be summarized as follows:

1. Investments in intangible assets are more sensitive to internal cash flow compared with investments in tangible assets, suggesting the existence of market failure in financial markets caused by information asymmetry between lenders and borrowers or by the lack of a resale market for intangible assets.
2. The sensitivity of intangible investments to cash flow is stronger for small and young firms than it is for large and mature firms, indicating severe constraints of financing from external markets among SMEs and young firms.

Table 6.8 Estimation results by firm age

	(1)	(2)	(3)	(4)
	Young firms	Matured firms	Young firms	Matured firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0491***	0.0550***	0.0243***	0.0193***
	(0.0046)	(0.0063)	(0.0030)	(0.0037)
avgsale	0.0135	0.0831**	0.0053	0.0031
	(0.0136)	(0.0366)	(0.0057)	(0.0038)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	27,155	34,880	27,155	34,880
Adj R-squared	0.0351	0.0476	0.0836	0.0682
Implied elasticities	0.123	0.092	0.171	0.275
	(5)	(6)	(7)	(8)
	Young firms	Matured firms	Young firms	Matured firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0545***	0.0358***	0.0267***	0.0033
	(0.0083)	(0.0129)	(0.0057)	(0.0053)
avgsale	0.0398*	0.1258***	–0.0051	0.0107**
	(0.0215)	(0.0281)	(0.0069)	(0.0045)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	27,155	34,880	27,155	34,880
R-squared	0.0107	0.0083	0.0356	0.0012
Implied elasticities	0.136	0.060	0.187	–

Notes: Cluster-robust standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

The analysis in this paper suggests that the government should consider investment tax credits and financial support for intangible investments to prevent underinvestment. In particular, such policies are necessary for young and small firms that are likely to be financially constrained. However, actual policies to promote investments have been concentrated on tangible assets, with the exception of R&D.[15] Among potential policy measures, investment tax credits are effective only for firms with positive profits, but more than 70 % of Japanese firms have deficits: according to the statistics from the National Tax Agency, 72.3 % of Japanese corporations had deficits in the 2011 fiscal year. Financial support programs and direct subsidies may be more effective policy tools for firms in deficit.

[15] The effectiveness of investment tax credits or special depreciation on tangible investment itself is a controversial issue because Hall and Jorgenson (1967), Goulder and Summers (1989), for example, present positive results, whereas Pereira (1994) and Goolsbee (1998) are not supportive of the effectiveness of tax measures.

Table 6.9 Estimation results by firm size and age

	(1)	(2)	(3)	(4)
	Young SMEs	Mature large firms	Young SMEs	Mature large firms
OLS	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0522***	0.0345***	0.0234***	0.0197***
	(0.0054)	(0.0069)	(0.0033)	(0.0051)
avgsale	0.0847***	0.0444**	0.0055	–0.0004
	(0.0279)	(0.0215)	(0.0079)	(0.0015)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	13,895	16,865	13,895	16,865
AdjR-squared	0.0428	0.0428	0.0904	0.0662
Implied elasticities	0.137	0.057	0.206	0.229
	(5)	(6)	(7)	(8)
	Young SMEs	Mature large firms	Young SMEs	Mature large firms
FE	tinv_k	tinv_k	iinv_k	iinv_k
cflow_k	0.0564***	0.0042	0.0244***	0.0047
	(0.0096)	(0.0148)	(0.0065)	(0.0061)
avgsale	0.0146*	0.0994***	–0.0005	0.0101
	(0.0411)	(0.0219)	(0.0116)	(0.0064)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of obs	13,895	16,865	13,895	16,865
R-squared	0.0173	0.0025	0.0417	0.0004
Implied elasticities	0.148	–	0.215	–

Notes: Cluster-robust standard errors in parentheses, $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. The last row shows the effects of one unit change of cash flow on the percentage change of tangible/intangible investments. The sample period is 2006–2010

In practice, intangibility itself may be an obstacle to establishing concrete policy measures. Therefore, one possible policy option is to reduce the corporate tax rate on the one hand and to downsize the existing tax expenditures for tangible investments on the other. In addition, direct policy measures to correct market failure are desirable. The improvement of financial intermediaries' capability to evaluate intangibles and the expansion of transaction markets for intellectual property rights are examples of these policies.

This study is subject to some limitations. The data on intangible investments in this paper were confined to the acquisition of intangible assets defined by the current accounting standard. As a result, the analysis in this paper does not cover some intangible investments, such as intellectual property developed inside a firm, and organizational innovations. We used simple OLS and FE to estimate investment functions because the sample period was limited to the 5 years between 2006 and 2010. Employing dynamic panel models to control for the possible endogeneity could be a subject of future research.

References

Aghion, P., Askennazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit constraints and the cyclicality of R&D investment: Evidence from France. *Journal of the European Economic Association, 10*(5), 1001–1024.

Becker, J., & Riedel, N. (2012). Cross-border tax effects on affiliate investment: Evidence from European multinationals. *European Economic Review, 56*(3), 436–450.

Belhocine, N. (2009). *Treating intangible inputs as investment goods: The impact on Canadian GDP* (IMF Working Paper No. 09/240).

Bhagat, S., & Welch, I. (1995). Corporate research and development investments: International comparisons. *Journal of Accounting and Economics, 19*(2–3), 443–470.

Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., & Roberts, J. (2013). Does management matter? Evidence from India. *Quarterly Journal of Economics, 128*(1), 1–51.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*(4), 1351–1408.

Bond, S., & Van Reenen, J. (2007). Microeconometric models of investment and employment. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6A, pp. 4419–4498). Amsterdam: Elsevier B. V.

Borisova, G., & Brown, J. R. (2013). R&D sensitivity to asset sale proceeds: New evidence on financing constraints and intangible investment. *Journal of Banking and Finance, 37*(1), 159–173.

Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *Journal of Finance, 64*(1), 151–185.

Brown, J. R., Martinsson, G., & Petersen, B. C. (2012). Do financing constraints matter for R&D? *European Economic Review, 56*(8), 1512–1529.

Brown, J. R., & Petersen, B. C. (2009). Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments. *Journal of Banking and Finance, 33* (5), 971–984.

Chen, H., & Chen, S. (2012). Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the time series. *Journal of Financial Economics, 103*(2), 393–410.

Chun, H., Fukao, K., Hisa, S., & Miyagawa, T. (2012). *The measurement of intangible investment by industry and its role in productivity improvements: Comparative studies between Japan and Korea* (RIETI Discussion Paper No. 12-E-037).

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *Review of Income and Wealth, 55*(3), 661–685.

Cummins, J. G., Hassett, K. A., & Oliner, S. D. (2006). Investment behavior, observable expectations, and internal funds. *American Economic Review, 96*(3), 796–810.

Czarnitzki, D., & Hottenrott, H. (2011). R&D investment and financing constraints of small and medium-sized firms. *Small Business Economics, 36*(1), 65–83.

Dischinger, M., & Riedel, N. (2011). Corporate taxes and the location of intangible assets within multinational firms. *Journal of Public Economics, 95*(7–8), 691–707.

Driver, C., & Guedes, M. J. C. (2012). Research and development, cash flow, agency and governance: UK large companies. *Research Policy, 41*(9), 1565–1577.

Edquist, H. (2011). Can investment in intangibles explain the Swedish productivity boom in the 1990s? *Review of Income and Wealth, 57*(4), 658–682.

Erickson, T., & Whited, T. M. (2000). Measurement error and the relationship between investment and q. *Journal of Political Economy, 108*(5), 1027–1057.

Falato, A., Kadyrzhanova, D., & Sim, J. W. (2013). *Rising intangible capital, shrinking debt capacity, and the US corporate savings glut* (FRB Finance and Economics Discussion Paper No. 2013-67).

Fazzari, S. M., Hubbard, R. G., & Petersen, B. C. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity, 1*, 141–195.

Fee, C. E., Hadlock, C. J., & Pierce, J. R. (2009). Investment, financing constraints, and internal capital markets: Evidence from the advertising expenditures of multinational firms. *Review of Financial Studies, 22*(6), 2361–2392.

Fukao, K., Miyagawa, T., Mukai, K., Shinoda, Y., & Tonogi, K. (2009). Intangible investment in Japan: Measurement and contribution to economic growth. *Review of Income and Wealth, 55* (3), 717–736.

Goolsbee, A. (1998). Investment tax incentives, prices, and the supply of capital goods. *Quarterly Journal of Economics, 113*(1), 121–148.

Goulder, L. H., & Summers, L. H. (1989). Tax policy, asset prices, and growth: A general equilibrium analysis. *Journal of Public Economics, 38*(3), 265–296.

Griliches, Z. (1998). The search for R&D spillovers. In Z. Griliches (Ed.), *R&D and productivity: The econometric evidence* (pp. 251–268). Chicago: University of Chicago Press.

Gilchrist, S., & Himmelberg, C. (1998). Investment: Fundamentals and finance. *NBER Macroeconomics Annual, 13*, 223–262.

Hall, B. H. (2002). The financing of research and development. *Oxford Review of Economic Policy, 18*, 35–51.

Hall, R. E., & Jorgenson, D. W. (1967). Tax policy and investment behavior. *American Economic Review, 57*, 391–414.

Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the economics of innovation* (Vol. 1, pp. 609–639). Amsterdam: Elsevier B.V.

Hao, K. Y., & Jaffe, A. B. (1993). Effect of liquidity on firms' R&D spending. *Economics of Innovation and New Technology, 2*(4), 275–282.

Himmelberg, C. P., & Petersen, B. C. (1994). R & D and internal finance: A panel study of small firms in high-tech industries. *Review of Economics and Statistics, 76*(1), 38–51.

Hubbard, R. G. (1998). Capital-market imperfections and investment. *Journal of Economic Literature, 36*(1), 193–225.

Kaplan, S. N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics, 112*(1), 167–215.

Kaplan, S. N., & Zingales, L. (2000). Investment-cash flow sensitivities are not valid measures of financing constraints. *Quarterly Journal of Economics, 115*(2), 707–712.

Marrano, M. G., Haskel, J., & Wallis, G. (2009). What happened to the knowledge economy? ICT, intangible investment, and Britain's productivity record revisited. *Review of Income and Wealth, 55*(3), 686–716.

Marrocu, E., Paci, R., & Pontis, M. (2012). Intangible capital and firms' productivity. *Industrial and Corporate Change, 21*(2), 377–402.

Miyagawa, T., & Hisa, S. (2013). Estimates of intangible investment by industry and productivity growth in Japan. *Japanese Economic Review, 64*(1), 42–72.

Miyagawa, T., Lee, K., Kabe, S., Lee, J., Kim, H., Kim, Y. G., et al. (2010). *Management practices and firm performance in Japanese and Korean firms: An empirical study using interview surveys* (RIETI Discussion Paper No. 10-E-013).

Miyagawa, T., Lee, K., Kim, Y. G., Jung, H., & Edamura, K. (2014). Has the management quality in Korean firms caught up with that in Japanese firms? An empirical study using interview surveys. In A. Bounfour & T. Miyagawa (Eds.), *Intangibles, market failure and innovation performance*. Cham: Springer.

Pereira, A. M. (1994). On the effects of investment tax credits on economic efficiency and growth. *Journal of Public Economics, 54*(3), 437–461.

Roth, F., & Thum, A.-E. (2013). Intangible capital and labor productivity growth: Panel evidence for the EU from 1998-2005. *Review of Income and Wealth, 59*(3), 486–508.

Chapter 7
Has the Management Quality in Korean Firms Caught Up with That in Japanese Firms? An Empirical Study Using Interview Surveys

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Abstract Bloom and Van Reenen (Quarterly Journal of Economics 122:1351–1408, 2007) show that differences in management practices are related to productivity differences at the firm level. In this paper we conducted a similar interview surveys on management practices in Japanese and Korean firms in 2008 and 2012. We find that overall management scores as an average of organizational and human resource management scores in Japan are higher than those in Korea. However, the second survey shows that the gap in management scores between two countries has shrunken over time. In addition, average management quality in Korean large firms has surpassed that in Japanese large firms, which are consistent with the literature comparing big businesses in Korea and Japan. This study also compares additional aspects of the management style, such as speed in decision-making and the role of various communication channels, which are not done in the previous literatures.

Keywords Management practices • Organizational management • Human resource management • Korean firms • Japanese firms • Kolmogorov-Smirnov Test • Productivity differences

7.1 Introduction

The classical growth model developed by Solow (1956) predicts that GDP per capita would converge in the long run. As Hall and Jones (1999) pointed out, however, the income gap between rich and poor countries remains wide. Jones and Romer (2009) in their paper titled “New Kaldor Facts: Ideas, Population and Human Capital” state that the income gap can be attributed to differences in productivity as one of the stylized facts. Productivity differences can be considered not only at the country, but also at the firm level. Empirical studies since the 1990s also found that the productivity gap continues to exist at the firm and establishment levels. Bartelsman et al. (2009, 2013), in constructing the productivity database at the firm level across countries, investigate the determinants of these productivity gaps and find that activating entry and exit of firms and more efficient resource reallocation would improve the economy-wide productivity.

The economic performances in Japan and Korea, which both suffered from the financial crises in 1997 and successive deep recessions are also different. While the Japanese economy has stagnated for two decades due to large non-performing loans, the Korean economy recovered rapidly. As a result, firm performance in Korea caught up with those of Japan in some competing industries such as electric machineries and electric devices as shown in Fukao et al. (2008). In growth accounting using the framework of McGrattan and Prescott (2005, 2010), Miyagawa and Takizawa (2011) showed that the labor productivity gap between Japan and Korea after the financial crises was explained by the difference in TFP growth.

Many studies at the firm level found that Korean firms are rapidly catching up with Japanese firms in terms of productivity and market shares in several sectors. Jung et al. (2008) noted that while the productivity of Korean firms were as low as half of that of Japanese firms in the mid 1980s, and there had been substantial catch-up in productivity by the listed Korean firms which were now on average within the 10 % range in the late 1990s. Jung and Lee (2010) find both sectoral-level and firm-level factors responsible for the productivity convergence. While explicit knowledge oriented sectors, like IT, tend to show faster catch-up, firm-level factors, such as innovation capability and export-orientation, were also significant. Joo and Lee (2010) compare Samsung and Sony in terms of the various indicators created using patent data including citations, and conclude that while Samsung caught up with Sony in the mid 2000s in terms of market capitalization and sales volume, technological catch-up, in terms of patent count, quality and mutual citations, etc, occurred as early as the mid 1990s.

While the reasons behind Korea catching up to Japan should involve many diverse factors, the existing studies tend to consider mostly tangible aspects of the firms which are often reflected in standard financial statements or patent application data. In the survey of research on micro-level productivity, Syverson (2010) divides factors that affect changes in productivity into intra-firm factors and environmental factors external to the firm. He argues that one of the main intra-firm factors is in management practices. Aoki (2010) also emphasizes that the organizational architecture within a firm is a major driver of the corporation system in each country. These arguments are in line with the seminal paper by Bloom and Van Reenen (2007) in which they conducted their own survey on management practices of four advanced countries (France, Germany, the UK, and the US) and examined the relationship between the management score and firm level productivity. In their paper, management practices were converted to scores based on interview results, and these scores were included as independent variables when they estimated the production function. The key finding in their paper is that there is a significant difference in management score among countries surveyed. US firms got the highest score of the four countries. They believed that the low score in continental European firms was partly explained by weak competition and the prevalence of many family-owned firms. The estimation results showed that the productivity differences corresponded to the differences in average management scores.[1] In Japan, Kurokawa and Minetaki (2006), Kanamori and Motohashi (2006), and Shinozaki (2007) examined the effects of organizational reform

[1] Bloom et al. (2012) expanded the sample of countries to 12 countries and examined the relationship between the *trust* measure based on World Value Survey on cross-country cultural characteristics and the level of the firms' *decentralization* of managers' decision making authority related to investment, hiring, introduction of new products, product sales, and marketing at the establishment level.

resulting from IT investment on firm performance by using the *Basic Survey on Business Enterprise Activities* and the *IT Workplace Survey*. Their studies suggested that organizational reform resulting from IT investment was partially responsible for improving firm performance. This study extend the previous studies by focusing on comparison of management practices in Korean and Japanese firms in a same framework.

The purpose of this paper is to compare the management quality between Korea and Japan that is considered as a cause for productivity differences in the two countries. We conduct a similar interview survey with respect to Korean and Japanese firms to Bloom and Van Reenen's survey, and compare the organizational and human resource management practices in firms of the two countries. In the next section, we describe an outline of our interview survey. In the third section, we construct a management score by quantifying the two interview results of Japanese and Korean firms, and compare the management practices. Although our interview survey basically follows Bloom and Van Reenen (2007), we incorporate some questions that were not included in their surveys to capture some unique features of Japanese and Korean firms such as the role of informal meetings within the firm and the speed of decision-making. Hence, we compare not only management scores that represent organizational and human resource management practices but also other management styles between Korea and Japan. In the last section, we summarize our studies and discuss the future studies on management practices and firm performances.

7.2 Outline of Interview Surveys in Japan and Korea

The surveys on management practices in Japan and Korea were conducted twice: Once in 2008 and the second time in 2011–2012. The description of each survey is summarized in Table 7.1. The two Japanese surveys were conducted by Research Institute of Economy, Trade & Industry (RIETI) The first Korean survey was conducted by Japan Center for Economic Research (JCER), and the second Korean survey was conducted by Samsung Economic Research Institute. The second Japanese survey was originally scheduled to be conducted in 2011, but was postponed to 2012 due to the Great East Japan Earthquake in March 2011. The number of responses in the second survey was drastically lower than the first, because of the earthquake and the fact that the interviewees were limited to publically traded firms.

In our study, we followed the interview survey conducted by Bloom and Van Reenen (2007). However, we conducted the survey by meeting the managers of the planning departments of firms face-to-face, while Bloom and Van Reenen (2007) conducted their survey by telephone. The reason that we conducted face-to-face interviews is that we were afraid of low response rates. In Japan and Korea, when we want to ascertain qualitative features in firms, face-to-face communication is a more useful tool than telephone interviews.

Table 7.1 Outline of surveys

	Japan		Korea	
	First	Second	First	Second
Survey period	Feb.–Sep., 2008	Jan.–March, 2011 July–Sep., 2011	May–Sep, 2008	Oct. 2011–May, 2012
Firms surveyed	Machinery industries (Electric, Information and communication, Transportation, Precision, Information service, Media Service, and Retail industries) (includes privately owned firms)	All industries, Publicly Traded Firms	Machinery industries (Electric, Information and communication, Transportation, Precision, Information service, Media Service, and Retail industries) (includes privately owned firms)	All industries, Publicly Traded Firms
Number of surveyed firms that responded	573	402	350	505
Response rate	52.8 %	22.2 %	59.2 %	28.9 %

Bloom and Van Reenen (2007) classified their 18 interview questions into four categories: product management, monitoring, the firm's target, and incentives for workers. While their survey was extended to only manufacturing plants, our survey was also extended to firms in the service sector. Thus, we excluded questions about product management in the service sector. As a result, we can classify our questions into two categories: organizational management and human resource management. In the first category, we wanted to examine the organizational goals, communication within the firm, and organizational reform. The second category about human resource management covers questions on promotion and training programs.

The interview also includes questions that are not directly related to management practice and human resource management. Since the IT revolution, changing a pyramid-type decision-making process into a more flat process became more popular. We ask questions targeted to help our understanding of whether firms underwent such organizational restructuring that includes the decision-making process. In the first round, we also ask about the vision of the firm. In the second round of interviews, considering the globalization that was taking place, we include questions regarding firms' primary market and competitiveness (the number of competitors), and the time it takes to enter and exit businesses. The detailed interview questions are shown in Appendixes 1 and 2.

For each question, we have three sub questions. The structure of the point system is that the more sub-questions answered positively in each large question, the more points you score, for instance, in human resource management. In each question with three sub-questions, you score 4 points if you answer positively to all of the three sub-questions. Similarly, with positive answers to the first two sub-questions only, you would score 2 points. In other words, we quantify the responses to the above questions as follows: If the firm manager responds negatively to the first sub-question, we give the response 1 out of a possible total of 4 points for the entire question and move to the next question. If he responds positively to the first sub-question, we move to the second sub-question. If the manager responds negatively to the second sub-question, we mark a 2 and move to the next question. If he responds positively to the second sub-question, we move to the last and third sub-question. In the last sub-question, if the manager responds with a positive answer, he is given 4 points for the positive responses for all three sub-questions while a negative response is given a point of 3 for the two previous sub-questions he answered positively.

7.3 Comparison of Results in Interview Surveys Between Korea and Japan

7.3.1 Distribution of Sample Firms by Sector and by Size

We first show the distribution of the firms interviewed. Table 7.2 provides the share of firms in the manufacturing sector and the service sector for both surveys. In the first survey, we interviewed machinery industries for the manufacturing sector and information service, media-related industry, and retail industry for the service sector. In the second survey, since the sample was limited to public traded firms, we did not limit the interview to specific industries. As the first Japanese survey focused on specific industries in the manufacturing sector, the share of firms in the manufacturing sector is relatively small with the ratio of the manufacturing to service sector being 1–2. In the second survey, the ratio is reversed. In both of the Korean surveys, on the other hand, the manufacturing sector constitutes approximately 80 % of the interviewees.

Table 7.3 shows the distribution of firms by size. In the Japanese surveys, small and medium sized firms with less than 250 employees constituted a slightly greater than one-third share of the sample. On the other hand, in the first Korean survey, the share of small and medium-sized firms dominated the survey and accounted for 65 % of the sample. In the second Korean survey, however, this share fell to 46.3 %.

7.3.2 Comparison of Management Scores

We now compare management scores. In the first survey, we take the average of these scores in Q2, Q4, Q5, and Q7-13 to obtain an overall management score. In the second survey, we take the average of the scores assigned to Q3, Q4, Q5, Q6-1, Q10-2, Q10-3, and Q10-4 to obtain the overall management score.

Table 7.2 Distribution of industries surveyed

	Japan (%)		Korea (%)	
	First	Second	First	Second
Manufacturing	33.9	67.7	84.9	79.0
Services	66.1	32.3	15.1	21.0

Table 7.3 Size distribution of surveyed firms

	Japan (%)		Korea (%)	
Number of employees	First	Second	First	Second
Less than 250	37.6	34.6	64.9	46.3
250–499	27.3	22.6	18.4	25.0
Above 500	35.2	42.8	16.7	28.7

The organizational management scores are the average scores in Q2 in the first survey and by the average score in Q3 and Q10-1 in the second survey. Lastly, the human resource management score is the average score in the questions that are not related to organizational management. A high management score implies that management targets within a firm are set and are widely recognized by the employees. On the other hand, the human resource management score is high when employees with high performance receive rewards and promotion swiftly, and when firms invest in human capital accumulation.

Table 7.4 shows the management scores in Japan and Korea. In both surveys, management scores in Japanese firms are higher than those in Korean firms except for the case of management scores in large firms in the second survey. However, the Japanese management score falls slightly between the first and second survey while the Korean management score increases greatly between the first and second survey, catching up with Japan. In particular, the management score in Korean large firms surpasses that in Japanese large firms in Japan.

Figures 7.1, 7.2, 7.3, and 7.4 show the distribution of scores in all firms and all interview questions in Japan and Korea by using Kernel density. We find that the distributions of management scores in Korean firms are more dispersed than those in Japanese firms. This implies that there are many high score firms and low score firms in Korea while management scores in Japanese firms are more concentrate around their mean values. When we compare the distributions in the two surveys in both countries, the distributions in the second survey in Japan shift slightly to the left. On the other hand, the distributions in the second survey in Japan shift drastically to the right.

We check similar distributions by type of management and by firm size (see Figs. 7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, and 7.12). The distributions of organizational management scores and human resource management scores show similar patterns to Figs. 7.3 and 7.4. When we compare the two surveys, the distributions of two types of management scores in the second survey in Japan do not change much. However, the two distributions of the management scores in the second survey in Korea shifts greatly to the right. In the case of small and medium sized firms, we also see similar patterns for other cases.

Table 7.4 Management scores based on the interview surveys

	Total			Japan			Korea		
The 1st survey	N	Mean	Variance	N	Mean	Variance	N	Mean	Variance
MS (all questions)									
All samples	923	2.458	0.321	573	2.609	0.243	350	2.211	0.351
Manufacturing firms	491	2.343	0.336	194	2.606	0.245	297	2.171	0.321
Service firms	432	2.588	0.273	379	2.610	0.243	53	2.433	0.468
Large firms	459	2.625	0.256	339	2.687	0.213	120	2.450	0.340
Small and Medium-sized firms	426	2.290	0.324	204	2.502	0.256	222	2.094	0.308
MS (Organizational management)									
All samples	923	2.593	0.463	573	2.749	0.398	350	2.339	0.466
Manufacturing firms	491	2.493	0.459	194	2.782	0.367	297	2.305	0.430
Service firms	432	2.707	0.444	379	2.732	0.414	53	2.528	0.634
Large firms	459	2.744	0.418	339	2.830	0.368	120	2.501	0.483
Small and Medium-sized firms	426	2.446	0.448	204	2.645	0.388	222	2.264	0.435
MS (Human resource Management)									
All samples	923	2.356	0.398	573	2.504	0.305	350	2.115	0.458
Manufacturing firms	491	2.231	0.424	194	2.475	0.322	297	2.071	0.428
Service firms	432	2.499	0.330	379	2.518	0.296	53	2.361	0.562
Large firms	459	2.536	0.312	339	2.580	0.271	120	2.411	0.410
Small and Medium-sized firms	426	2.172	0.421	204	2.395	0.338	222	1.967	0.412
	Total			Japan		Korea			
The 2nd survey	N	Mean	Variance	N	Mean	Variance	N	Mean	Variance
MS (all questions)									
All samples	907	2.541	0.311	402	2.568	0.226	505	2.518	0.379
Manufacturing firms	671	2.530	0.336	272	2.552	0.242	399	2.515	0.401
Service firms	236	2.570	0.240	130	2.603	0.191	106	2.530	0.300
Large firms	534	2.644	0.288	263	2.616	0.211	271	2.671	0.362
Small and Medium-sized firms	373	2.393	0.309	139	2.478	0.243	234	2.342	0.342
MS (Organizational management)									
All samples	907	2.669	0.413	402	2.694	0.322	505	2.649	0.485
Manufacturing firms	671	2.662	0.442	272	2.668	0.343	399	2.657	0.511
Service firms	236	2.691	0.330	130	2.750	0.276	106	2.618	0.391
Large firms	534	2.736	0.405	263	2.727	0.328	271	2.745	0.481
Small and Medium-sized firms	373	2.573	0.410	139	2.632	0.308	234	2.538	0.469
MS (Human resource Management)									
All samples	907	2.444	0.414	402	2.474	0.313	505	2.420	0.495
Manufacturing firms	671	2.432	0.443	272	2.465	0.320	399	2.409	0.526
Service firms	236	2.479	0.334	130	2.492	0.300	106	2.463	0.379
Large firms	534	2.574	0.385	263	2.533	0.303	271	2.615	0.463
Small and Medium-sized firms	373	2.257	0.398	139	2.362	0.315	234	2.195	0.439

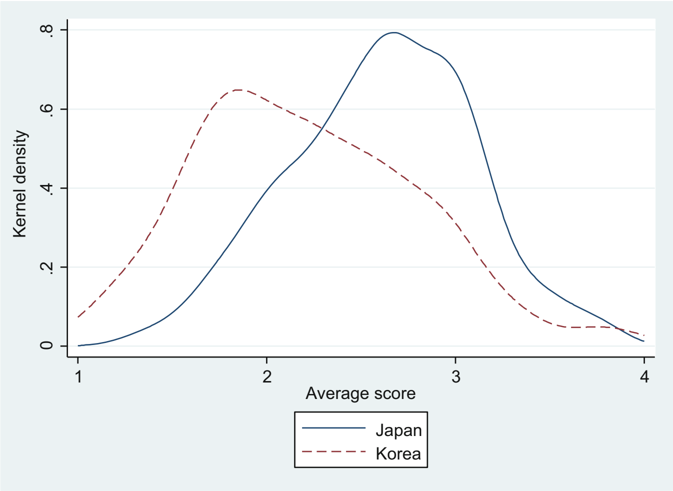

Fig. 7.1 Distribution of management scores (all firms in the 1st survey)

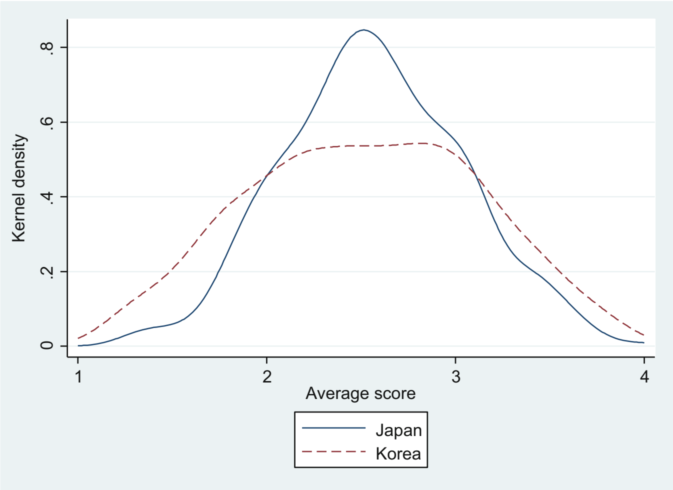

Fig. 7.2 Distribution of management scores (all firms in the 2nd survey)

The distributions of management scores by firm size show similar patterns to those by type of management. In large firms, the distribution of management score in the second survey in Korea showed a great shift to the right, while that in Japan shifted slightly to the left. These shifts suggest that the means of the management scores in Korean large firms is greater than that in Japanese large firms. In addition, these results support the notion that the performances in the listed Korean firms surpassed those in the Japanese listed firms, as Jung et al. (2008) and Joo and Lee (2010) showed. Similarly, the distribution of management scores of the Korean

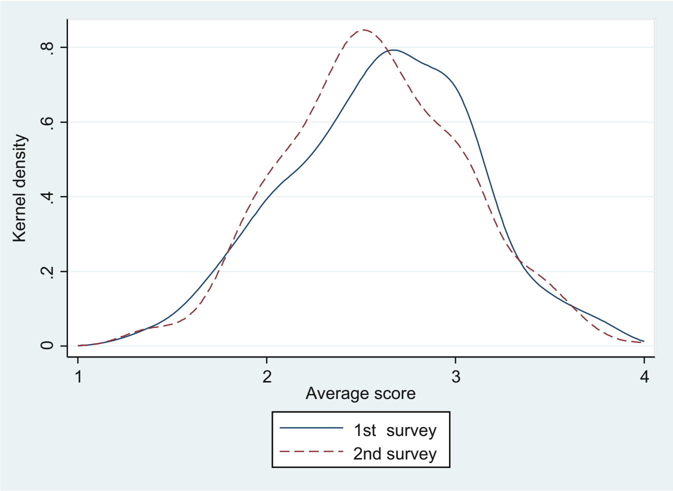

Fig. 7.3 Distribution of management scores (1st vs. 2nd in Japan)

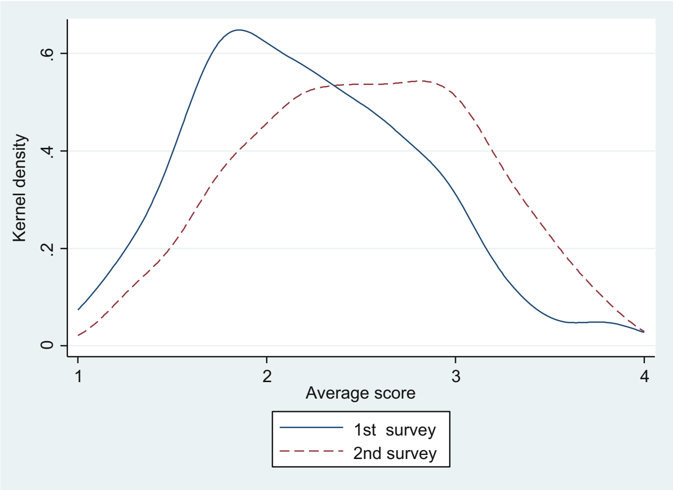

Fig. 7.4 Distribution of management scores (1st vs. 2nd in Korea)

SMEs shifts to the right, although the distribution of management scores in the Japanese SME in the second survey does not move much.

We check the two distributions between the first and second surveys of Japan and Korea by using the Kolmogorov-Smirnov test. Suppose the two cumulative distribution functions ($F(x)$ and $G(x)$) and take the maximum differences between two distributions (D_{mn}) defined from the sample distribution functions of $F(x)$ and $G(x)$.

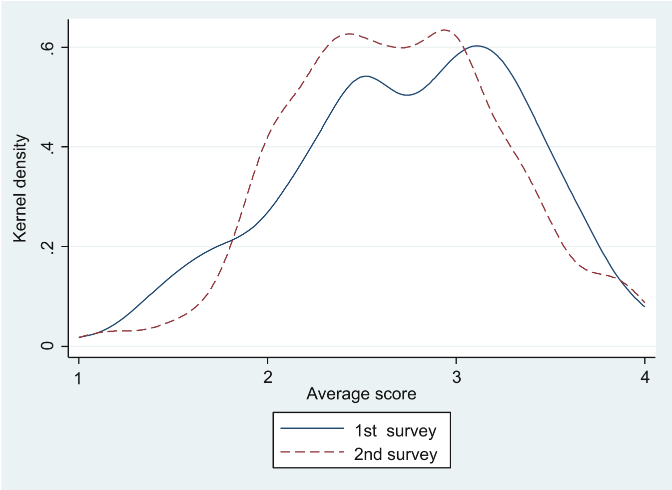

Fig. 7.5 Distribution of organizational management scores (1st vs. 2nd in Japan)

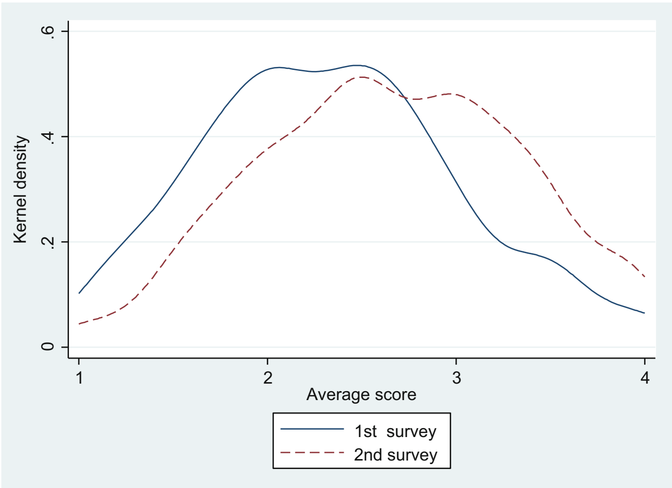

Fig. 7.6 Distribution of organizational management scores (1st vs. 2nd in Korea)

$$D_{mn} = \sup_{-\infty<x<\infty}|F_m(x) - G_n(x)|$$

In the Kolmogorov-Smirnov test, the null hypothesis is that the two distributions are the same ($F(x) = G(x)$). If the test statistics $\left(\frac{mn}{m+n}\right)^{1/2} D_{mn} > c$ and c is an appropriate constant, the null hypothesis is rejected.

The test results are shown in Table 7.5. The Kolmogorov-Smirnov test is conducted in four cases: the comparison of two distributions in Japan and Korea

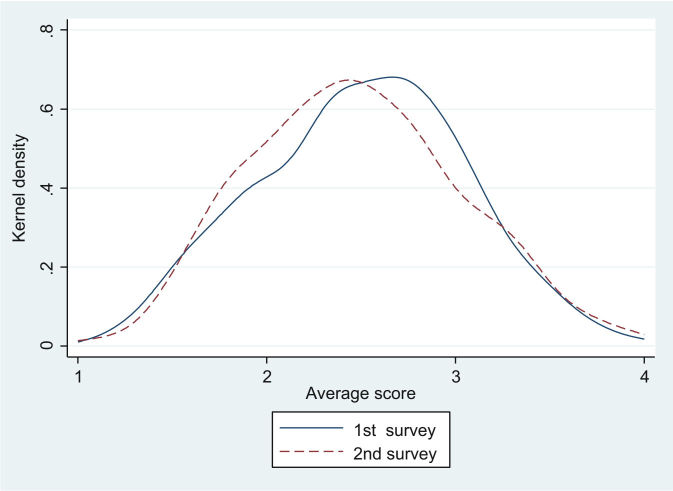

Fig. 7.7 Distribution of human resource management scores (1st vs. 2nd in Japan)

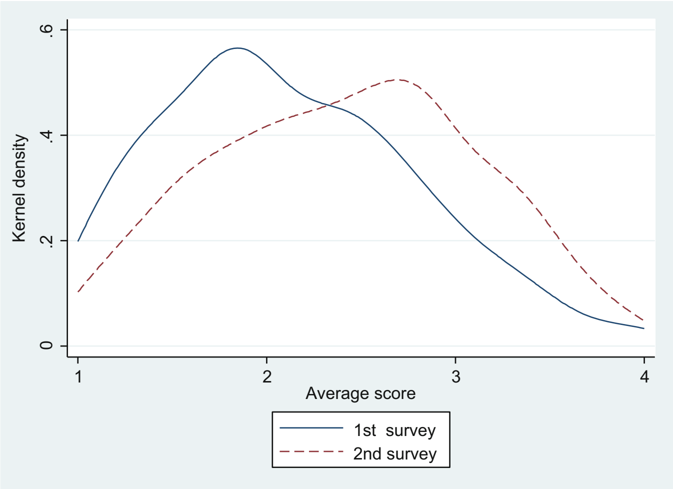

Fig. 7.8 Distribution of human resource management scores (1st vs. 2nd in Korea)

in the first survey, the comparison of two distributions in Japan and Korea in the second survey, the comparison of two distributions in the first and second surveys in Japan, and the comparison of two distributions in the first and second surveys in Korea. In the first row of the table, we test the hypothesis of whether the sample values in Japan are significantly smaller than those in Korea. 'Distance' in the second column shows the maximum distance in the case where the sample value in Japan is less than that in Korea. P values in the first and second surveys show that sample values in Japan are not significantly smaller than those in Korea. However,

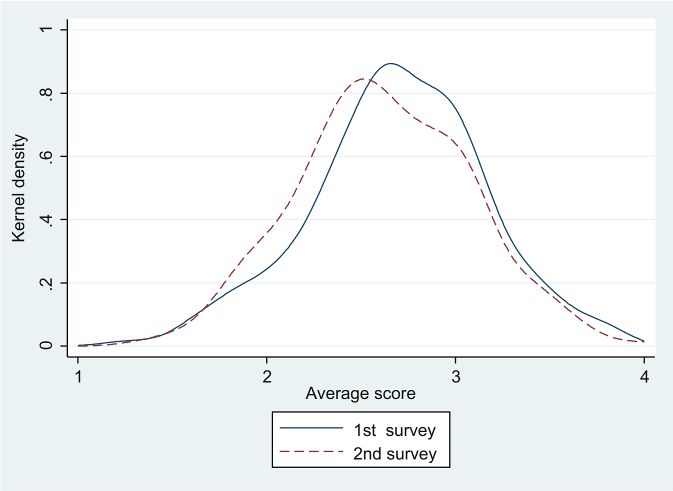

Fig. 7.9 Distribution of management scores in large firms (1st vs. 2nd in Japan)

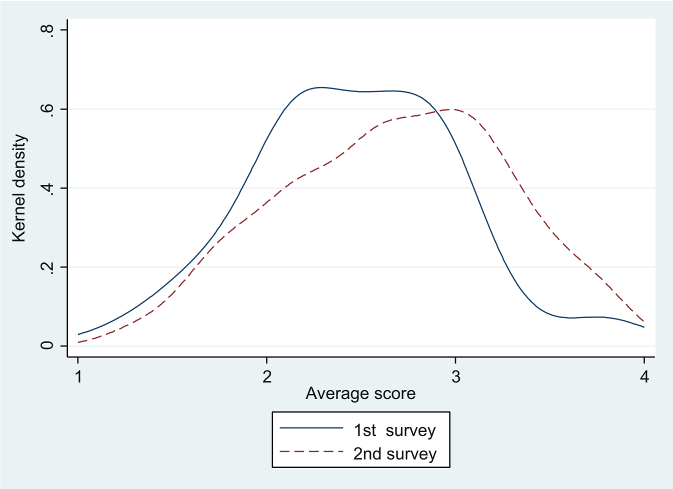

Fig. 7.10 Distribution of management scores in large firms (1st vs. 2nd in Korea)

the P value in the third table shows that the sample values in the first survey are significantly smaller than those in the second survey in Japan. In the case of Korea as well, the sample values in the first survey are significantly smaller than those in the second survey. The second row of the table tests the opposite case. The Kolmogorov-Smirnov test shows that sample values in Japan are significantly larger than those in Korea in both surveys. In the case of the first and second surveys in Japan, the sample values in the first survey are significantly larger than

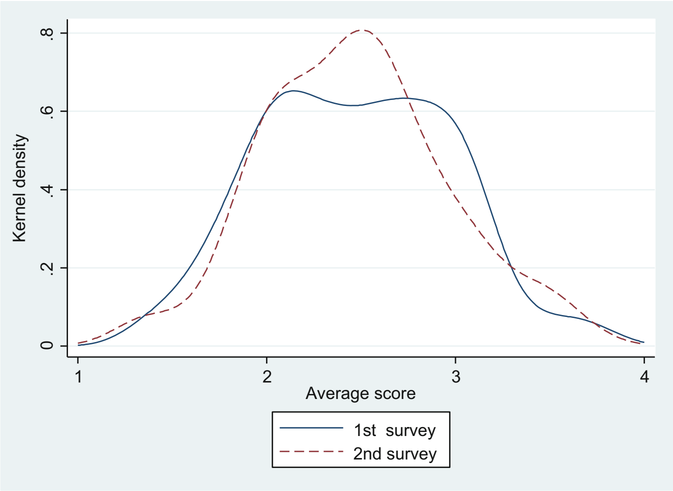

Fig. 7.11 Distribution of management scores in SME (1st vs. 2nd in Japan)

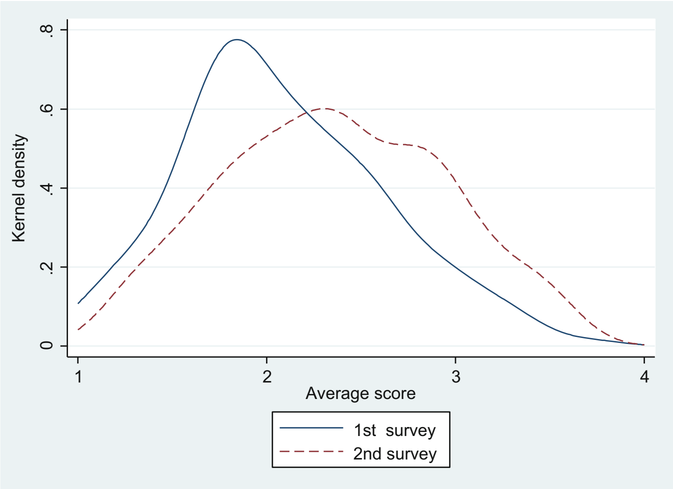

Fig. 7.12 Distribution of management scores in SME (1st vs. 2nd in Korea)

those in the second survey in Japan. The last row shows the combined results of the previous two tests.

These tests imply that the distributions of management scores in Japan have shifted significantly to the right more than those in Korea in both interview surveys. Overall, the organizational targets are clear to all employees in Japan in more cases than in Korea, or Japanese firms improve their organizational structures more

Table 7.5 Kolmogorov-Smirnov test

	All questions		Organizational management		Human resource management	
First survey	Distance	p-value	Distance	p-value	Distance	p-value
Japan < Korea	0.007	0.981	0.005	0.987	0.009	0.965
Japan > Korea	−0.326***	0.000	−0.273***	0.000	−0.294***	0.000
Combined test	0.326***	0.000	0.273***	0.000	0.294***	0.000
Second survey	All questions		Organizational management		Human resource management	
	Distance	p-value	Distance	p-value	Distance	p-value
Japan < Korea	0.060	0.195	0.048	0.354	0.047	0.369
Japan > Korea	−0.110***	0.004	−0.100**	0.011	−0.109***	0.005
Combined test	0.110***	0.009	0.100**	0.022	0.109**	0.010
Japan	All questions		Organizational management		Human resource management	
	Distance	p-value	Distance	p-value	Distance	p-value
Japan 1st < Japan 2nd	0.017	0.869	0.053	0.265	0.017	0.866
Japan 1st > Japan 2nd	−0.081**	0.047	−0.103***	0.006	−0.065	0.140
Combined test	0.081*	0.093	0.103**	0.013	0.065	0.279
Korea	All questions		Organizational management		Human resource management	
	Distance	p-value	Distance	p-value	Distance	p-value
Korea 1st < Korea 2nd	0.215***	0.000	0 199***	0.000	0.203***	0.000
Korea 1st > Korea 2nd	−0.003	0.996	0.000	1.000	−0.003	0.997
Combined test	0.215***	0.000	0 199***	0.000	0.203***	0.000

Note:
'Japan < Korea' means that sample values in Japan are smaller than those in Korea, and vice versa
*$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$

aggressively than Korean firms, because high scores in organizational management indicate a greater degree of transparency of organizational goals or aggressive organizational reform. As for human resource management, Japanese firms are more flexible in their human resource management than Korean firms. However, the flexibility of human resource management improves in Korea, while it declines in Japan.

However, the difference in management scores partially reflects the difference in samples between the first and the second survey. When we limit the sample to be the same and consistent between two surveys for Japan, the management scores in consistent samples show similar patterns to those in the entire sample in the second survey (see Table 7.6). This implies that the shrinking gap of management scores between Japan and Korea cannot be entirely attributed to changes in the samples.

Table 7.6 Comparison of management scores in corresponding industries in the first and second surveys in Japan

	First survey			Second survey (corresponding industries)			Second survey (entire sample)		
	N	Mean	Variance	N	Mean	Variance	N	Mean	Variance
MS (all questions)									
All samples	573	2.609	0.243	105	2.545	0.266	402	2.568	0.226
Manufacturing firms	194	2.606	0.245	67	2.516	0.269	272	2.552	0.242
Service firms	379	2.610	0.243	38	2.596	0.265	130	2.603	0.191
Large firms	339	2.687	0.213	72	2.626	0.248	231	2.642	0.213
Small and Medium-sized firms	204	2.502	0.256	33	2.368	0.268	171	2.469	0.226
MS (Organizational management)									
All samples	573	2.749	0.398	105	2.656	0.370	402	2.694	0.322
Manufacturing firms	194	2.782	0.367	67	2.642	0.419	272	2.668	0.343
Service firms	379	2.732	0.414	38	2.680	0.293	130	2.750	0.276
Large firms	339	2.830	0.368	72	2.708	0.389	231	2.755	0.336
Small and Medium-sized firms	204	2.645	0.388	33	2.540	0.321	171	2.612	0.293
MS (Human resource Management)									
All samples	573	2.504	0.305	105	2.462	0.356	402	2.474	0.313
Manufacturing firms	194	2.475	0.322	67	2.422	0.323	272	2.465	0.320
Service firms	379	2.518	0.296	38	2.533	0.416	130	2.492	0.300
Large firms	339	2.580	0.271	72	2.565	0.335	231	2.557	0.314
Small and Medium-sized firms	204	2.395	0.338	33	2.239	0.338	171	2.361	0.291

7.3.3 Features of the Results in the Second Survey

In the second survey, we asked additional questions to shed some light on management styles in Japanese and Korean firms and the market conditions that they face. Table 7.7 summarizes the responses to the supplementary questions. Question 1 in the second survey asks outline of business and several economic environments which Korean and Japanese firms face. As for the first question in Question 1 which asks the main market for a firm, almost two thirds (2/3) of the Japanese firms answered that they sell more than 75 % of their products in their domestic market. On the other hand, less than half of the Korean firms are selling more than 75 % of their products in their domestic market (see Table 7.7a). The competitive environment asked in the fourth question in Question 1 also differs greatly between Japan and Korea. While more than half of the Japanese firms have more than six competitors, approximately half of the Korean firms have fewer than five competitors (see Table 7.7b).

It is often argued that the major difference between Japanese and Korean firms is the speed of the decision-making process. In the second survey, we ask questions related to this issue. Table 7.7c illustrates that time it takes much less time to change

Table 7.7 Summary of responses to additional questions in the second interview survey

(a) Share in Domestic Market (based on the Question 1a in the second interview survey)		
	Japan (%)	Korea (%)
Above 75 %	66.4	43.6
50–75 %	16.7	18.2
25–50 %	9.7	18.8
Less than 25 %	6.7	19.4
(b) Number of Competitive Firms (based on the Question 1d in the second interview survey)		
	Japan (%)	Korea (%)
One firm	1.5	2.2
From 2 to 5 firms	40.8	52.9
From 6 to 9 firms	20.0	19.8
Above 10 firms	36.5	25.1
(c) Months Required to Revise Organizational Goals and Executing Measures to Attain Them (based on the second question in Question 3-3-4 in the second interview survey)		
	Japan (%)	Korea (%)
Less than 1 month	5.8	25.6
From 1 to 3 months	16.0	40.1
From 3 to 6 months	4.6	17.5
From 6 months to 1 year	63.2	10.4
Above 1 year	10.4	6.3
(d) The Share of 'nemawashi' Hours Required for Organizational Decision for Starting New Business (based on the Question 9-1 in the second interview survey)		
	Japan (%)	Korea (%)
Above 60 %	10.1	17.4
40–59 %	18.3	29.6
20–39 %	27.5	29.8
Less than 20 %	44.2	23.0
(e) Period from the Initial Consideration of New Business till It Begins (based on the supplementary question in Question 9-1 in the second interview survey)		
	Japan (%)	Korea (%)
Less than 1 month	26.3	2.0
From 1 to 3 months	17.9	11.6
From 3 to 6 months	8.9	21.6
From 6 months to 1 year	21.3	37.5
One year and above	24.3	27.3
(f) Period from the Initial Consideration of Exit till It Exits (based on the auxiliary question in Question 9-2 in the second interview survey)		
	Japan (%)	Korea (%)
Less than 1 month	26.6	4.9
From 1 to 3 months	17.1	16.3
From 3 to 6 months	13.5	20.4
From 6 months to 1 year	23.5	29.5
One year and above	18.0	28.9
(g) Share of Amount of Information Held by Managers in the Total Information within a Firm (based on the Question 9-3 in the second interview survey)		
	Japan (%)	Korea (%)
Above 80 %	12.7	29.9

(continued)

Table 7.7 (continued)

60–79 %	17.3	34.5
40–59 %	29.4	24.0
Less than 40 %	40.8	11.7
(h) Share of Informal Information to the Total Information Held by Managers (based on the Question 9-4 in the second interview survey)		
	Japan (%)	Korea (%)
Above 60 %	3.2	4.0
40–59 %	7.1	12.3
20–39 %	25.7	34.1
Less than 20 %	64.0	49.5

the existing targets of the firm for Korean firms than for Japanese firms based on the second question in Question 3-3-4. While 65 % of the Korean firms revise organizational goals and other production processes within 3 months, it takes more than 6 months for approximately three fourths (3/4) of the Japanese firms to reach similar decisions.

However, in Table 7.7d constructed from Question 9-1, over 40 % of the Japanese firms responded that less than 20 % of the time before the project begins is spent on the "nemawashi" informal consensus building. On the other hand, approximately 60 % of the Korean firms spend 20–60 % of their time on this consensus building. Yet, considering the time it takes for the Japanese firms to change its targets, we cannot conclude that the time for these preparations is shorter for Japanese firms than Korean firms. Based on the information in Table 7.7c, suppose that the time it takes for the organizational decisions to take place is 10 months for Japanese firms. The time spent on the informal consulting building constitutes 20 % of that time, which is 2 months. On the other hand, the Korean firms spend on average 3 months to reach organizational decision. Then, 40 % of the 3 months would be spent on this consensus building, which would be 1.2 months.

However, Table 7.7e constructed from the results of the supplementary question in Question 9-1 shows that the time it takes to decide on new projects is not necessarily shorter for the Korean firms. In Japan, the cases can be extreme: cases in which decisions would be made very quickly and those in which decisions would take more than 6 months. On the other hand, almost 60 % of Korean firms take more than 6 months to make a decision on new projects. A similar trend is observed when it comes to the termination of existing projects in Table 7.7f constructed from the results of the supplementary question in Question 9-2. Contrary to common perceptions, a large fraction of Japanese firms take less time to make decisions than their Korean counterparts.

Lastly, we compare the amount of information shared with the manager at establishment level by using the results in Questions 9-3 and 9-4. Table 7.7g indicates that only 12 % of the Korean firms share less than 40 % of pertinent information to project managers while 40 % of Japanese firms do. This indicates that overall, Korean firms tend to give more decision-making authority to project managers than Japanese firms and that decentralization is more common in Korea. Table 7.7h also shows that the share of information obtained by a project manager is via informal route and is not necessarily higher in Japan than in Korea.

7.4 Conclusions and Discussions

In the last 20 years, Korean firms have been catching-up with Japanese firms and some firms have already surpassed the Japanese firms in productivity or market shares. According to growth accounting in Japan and Korea, the accumulation of intangible assets has played a key role in explaining the difference in economic performance in the two countries. Among several types of intangibles, management skills and human capital are crucial to the improvement of a firm's performance. Bloom and Van Reenen (2007) examined the effects of organizational and human resource management on firm performance using interview surveys conducted in France, Germany, the UK, and the US. Following their study, we conducted interview surveys on organizational and human resource management in Japan and Korea.

In this paper, we constructed scores on management practices in each firm based on the two interview surveys. For the scores in organizational management, firms that have clear organizational targets, better communication amongst employees, and conduct organizational reforms would have a higher score. For the scores in human resource management, firms that evaluate human resources flexibly and strive to keep employees motivated would mark higher scores.

When we compared the distributions in average management scores between Japanese and Korean firms, the mean value in Japan was higher than that in Korea except in the case of large firms in the second survey. However, the gap in management scores between Korea and Japan shrunk significantly in the second survey, because management practices in Korean firms improved compared to their scores in the first survey to the second survey. In particular, the higher mean value of management scores seen in large firms in Korea than those in Japan in the second survey is consistent with recent studies comparing firm performances in large firms in Korea and Japan.

Kolmogorov-Smirnov statistics comparing the distributions between Korea and Japan show that the distributions in the average score in Japan are significantly different from that in Korea. The results show that the overall management quality in Japanese firms is higher than that in Korean firms. However, the distribution of management scores in Korean firms has shifted to the right, while that in the Japanese firms moved slightly to the left. In particular, the distribution of the human resource management score of Korean firms shifted to the right in the second survey, which suggests that there was the improvement in human resource management in Korean firms.

Our next task is to examine whether the improvement in firm performance is associated with better management practices. Lee et al. (2012) have already examined the relationship between management practices and productivity at the firm level by conducting production function regressions using the results in the first interview surveys. They show that management scores are positively associated with productivity. In particular, better human resource management is positively correlated to the productivity. From these results, we expect that improvement in human resource management in Korean firms in the second survey is associated with productivity improvement in those firms and the slight decline in management scores in the second survey in the Japanese firms is related to stagnating productivity in those firms. After constructing a database for the management scores in the second survey and corresponding financial statements in the sample firms, we will be able to conduct more rigorous and comprehensive verification of the relationship between the management practices and productivity performance.

Appendix 1: Questionnaire (The First Interview Survey)

1. **Dissemination of management principles (vision)**

- Does your company have management principles that it has upheld for many years?
- What efforts are in place to have those management principles shared by all employees? (For example, announcing them at morning assemblies, or making them portable by writing them on business cards etc.)
- Are management principles also supported by parties such as external partners (customers, suppliers) or the shareholders?

2. **Implementation of organizational goals**

- Are there specific quantifiable goals on multiple levels that go beyond being just a vision or a slogan, regardless of the level of the goals (such as company-wide, divisional or sectional goals)?
- Do you ensure that the goals amongst divisions are consistent?
- Is consistency maintained between these goals and the goals of management principles or long-term company-wide goals?

2-1. Implementation of organizational goals (setting target levels)

- For example, are the parameters for divisional or sectional target levels simply given to you in a top-down fashion? Or is the input of your division or section considered in the setting of these goals?
- Are the target levels appropriately set as non-binding challenges?
- Are target levels checked to ensure they are equitable between divisions or sections? Please provide an example of how they are checked. (   )

2-2. Implementation of organizational goals (penetration of goals)

- Are all employees aware of these goals?
- If goals exist on various levels (such as company-wide, divisional and sectional goals), do all employees understand the level of priority of the goals?
- Do all employees accept these target levels? Please provide an example if possible. (   )

2-3. Implementation of organizational goals (degree to which goals are met, checks on performance)

- Are checks conducted to see how far goals have been achieved? Please give an example of how such checks are conducted. (   )
- Are such checks conducted on a periodic rather than on an as-needed basis? And how frequently are such checks conducted? (   )
- Are additional checks conducted that are decided by the section or department involved itself, rather than just being mandated checks?

2-3-1. Implementation of organizational goals (permeation of degree to which goals are met, and results of performance checks)

- Are the results of such checks made openly available within your division?
- Are the results of such checks made openly available within not only your division but also between relevant divisions?
- Are adjustments made to ensure that the comparison of the attainment of goals between divisions is fair? (for example, by utilizing common measures such as overtime hours?)

2-3-2. Implementation of organizational goals (results of checks - response when goals have not been achieved)

- Is a meeting of managerial staff and employees held as soon as it is determined that the goals were not achieved?
- After investigations, are action items to improve shared throughout the division, and are measures for handling the failure to achieve the goals promptly implemented?
- Are problematic issues and countermeasures made thoroughly known throughout the relevant division, and if necessary, other divisions? Please provide an example if possible. (   )

2-3-3. Implementation of organizational goals (results of checks - response when goals have been achieved)

- When goals are achieved, are investigations conducted so that those goals are renewed on a continuous basis or so that higher goals are set?
- How long does it take for the operation/implementation of those goals after the higher goals have been set?
- Are these measures institutionalized at a company-wide level?

3. **Informal communication within the organization**

- Are measures and activities other than formal meetings used to enhance informal communication? (for example, informal meetings consisting only of key personnel)? Please provide an example. ( )
- Are informal meetings held between divisions?
- Are informal meetings held between persons of various ranks?

4. **Implementation of organizational reform**

- Has your company undergone any organizational reforms in the last ten years? When did these occur? ( )
- Did your company use a consulting company at that time? What was the cost? ( )
- Did you determine the results of the reform in a quantifiable manner? By what percentage did profits increase or by what percentage were costs reduced? ( )

4-1. Period of organizational reform or strategic change

- Did the implementation of the organizational reform take more than one year? How many years were spent including the preparation period? ( )
- Why was organizational reform necessary? Did this have to do with the leadership of senior management?
- During the organizational reform, did mid-level management also strive to achieve the reform, thereby giving the sense of unity in the company?

4-2. Scope of the effects of organizational reform

- Were the effects of the reform evident in the divisions or sections? If they were, please provide an example of the effects. ( )
- Were the effects of the reform evident between divisions, and not just within one division? If they were seen between divisions, please provide an example of the effects. ( )
- Were the effects of the reform evident between the company and the business partners, and not just within the company? If they were, please provide an example of the effects. ( )

4-3. Details of the organizational reform (delegation of authority)

- Was decision-making authority delegated to those in a lower position as a result of the organizational reform?
- Were posts simplified in conjunction with decision-making authority being delegated to those in a lower position?
- As a result, was there a change in the description of the job or the way of doing the job? Please provide an example. ( )

4-4. Details of the organizational reform (IT activities)

- Did the IT system make your company more streamlined, for example by reducing the amount of paper-based documentation?

- In the last decade, did your company launch organizational reform, rather than raise business efficiency, by utilizing the IT system?
- Did an opportunity to earn new profits arise as a result of the organizational reform based on the IT system? Please provide an example. (   )

5. **Promotion system**

- Does your company have a mainly performance-based promotion system?
- If the promotion system is mainly performance-based, does your company have a management-by-objectives system? If so, when did that system begin?
- Did the performance of the employees improve as a result of using the management-by-objectives system and introducing a performance-based promotion system?

6. **Programs to improve motivation**

- Are there any programs other than promotion or pay-related schemes to increase the motivation of the employees? Please provide an example. (   )
- Is that scheme used on an institutional basis throughout the company?
- Do you monitor when the employees' motivation, retention rate or job performance increases as a result of such a program?

7. **Handling employees that perform poorly**

- Are poor performers handled in some formalized way other than by verbal warnings?
- Does the response to poor performers include their movements to another positions?
- Are the measures implemented as soon as a problem is confirmed (before a routine rotation)?

8. **Handling employees that perform well**

- Is it an employee's good performance shared within the division, for example by management praising employees at meetings?
- Do you have a system that ensures that good performance is linked to financial rewards or promotions?
- Was the motivation of the employees raised through introducing such a system?

9. **Retaining talent**

- How do you identify the high performance and core employees, mentioned in question 9, in your company? Please provide an example. (   )
- Are excellent employees treated well compared with ordinary employees? If so, how they are treated? (   )
- Do you have measures to prevent the loss of your excellent employees ?

10. **Evaluating the interpersonal skills of managers**

- Do the managers give clear criteria such as the degree to which persons of a lower position could be developed?

- Is there an incentive system, such as a pay-related or promotion-related system, to reward managers that have developed excellent staff of a lower position?
- Did the managers' motivation increase as a result of introducing such a system?

11. **Training for development of human resources**

- Is there training on an occupational ability basis or an assignment basis, aiming to improve the work skills of the employees? Over the course of one year, on average how long is spent on training? (   )

(Training on an occupational ability basis refers to training in specialist capabilities that are required in each field, such as management, business, research and development, and manufacturing.

Assignment-based training refers to training in areas such as languages, OA, computing, and acquisition of official certifications.)

- Do business results improve as a result of these training activities? Please provide an example. (   )
- Are the effects of those training activities adaptable to other companies?

12. **Developing human resources through OJT**

- Is OJT performed on a daily basis?
  What percentage of the supervisor's working time is spent on providing instructions to those in a lower position? (   )
- Does OJT contribute to business results? Please provide an example. (   )
- Are the effects of OJT monitored? Please provide an example of the methods used. (   )

13. **Employees' expertise**

- Are employees rotated to different positions under a fixed schedule, such as once every two or three years?
- To improve the expertise of the employees, are they assigned to a position for a significant amount of time?
- Is there a systematic program in place to ensure the employees acquire some expertise?

Appendix 2: Questionnaire (Second Interview Survey)

1. **Business environment and responses to changes**

a. With regard to the market your company is operating in, what are the percentages of revenue from your domestic and overseas markets?

- Domestic market accounts for 75 % or higher.
- Domestic market accounts for 50–75 %.
- Domestic market accounts for 25–50 %.
- Overseas market accounts for 75 % or higher.

b. How do you see the competitive environment surrounding the market for your company's major product or service (i.e., the product or the service that has the largest share in your company's revenue)?

- Mild
- Medium
- Intense
- Highly intense

c. What is your market share of the major product or service which relates previous question?

- About 0–5 %
- About 5–10 %
- About 10–25 %
- 25 % or higher

d. How many rival firms are competing for a larger market share?

- None or one firm
- Two to five firms
- Six to ten firms
- Eleven or more firms

e. What actions are typically taken when the market for your main product is favorable and prevailing prices are rising? (Please choose one or two that best describe the situation.)

- Expand investment
- Increase operating time to expand production capacity
- No changes
- Increase employees (transfer, or newly recruit employees)
- Reduce advertising and marketing expenses

f. What actions are typically taken when the market for your main product remains stagnant?

- Cut down operations (reduction in sales and production including restructuring)
- Reduce prices
- Develop production methods to save production costs
- Explore new marketing methods
- Improve product quality and design as well as develop new products

g. We would like to offer our deepest condolences to your employees who greatly suffered from the East Japan Earthquake that hit Japan on March 11, 2011. Please provide any examples of significant changes in corporate strategy caused by this unprecedented disaster, such as the relocation of production bases, or changes in product line-up.

Thank you for sharing your business environment with us so far.

We would appreciate it if we could obtain a brochure that explains your major product or service when we leave your office after completing today's interview. We would like to study it to have a better understanding of your company. (Yes/No)

Then, let us move on to topics concerning corporate visions, followed by goals/targets on a more operational level. Questions can be answered 'Yes' or 'No'.

2. **Production management system**

2-1. Production system

- Please describe your company's production system? Has your company introduced a system aimed at minimizing inventory on the production line?
- Please let us know if your plant has a unique system of inventory management.
- How does your company manage inventory? How do you maintain the proper balance between inventory management and smooth operation of the production line?

2-2. Reason that your company introduced the production system

- What factors led to the introduction of your production system?
- Is your inventory management system mainly designed to reduce costs?
- Or do you believe that your system is more than just a cost-reduction method and that the system has far-reaching positive impacts on logistics, innovation and other systems?

2-3. Improvement of production process

- How has your company improved the production process in the last five years?
- How are problems regarding production processes typically identified and fixed? Please provide an example in which your workers recently identified and fixed a problem with regard to the production line.
- Do factory workers take the initiative to suggest ideas for improving production process?

3. **Organizational goals/targets**

3-1. Questions about goal or target setting

- Is each operating division responsible for setting its own goals/targets, rather than their being set at higher departmental levels?
- In terms of the difficulty of achieving the goals/targets, does the company consider ways to maintain appropriate levels of the division's goals/targets (i.e., ensure they are not too difficult, not too easy)?
- Does the company ensure that all the divisions are treated fairly in terms of difficulty of division's goals/targets? If any, can you provide an example of specific ways to manage these goals/targets? (   )

3-2. Questions about how goals/targets are shared by employees

- Do all employees understand the goals/targets of their divisions?
- If different goals/targets are established on various levels such as section, department, company etc., do employees understand how they relate to each other and what these priorities are?
- Have most employees fully bought into the goals/targets and are motivated into action by them, rather than just "being aware of" the goals/targets?

3-3. Questions about monitoring the degree of achievement

- Does your company monitor the achievement of the goals/targets? If so, can you provide an example of the monitoring method used? (   )
- Is such monitoring conducted periodically? If so, what is the frequency that it is conducted? (   )
- In addition to a system of institutional monitoring, do employees take the initiative to monitor their own achievements?

3-3-2. Questions about how monitored results are utilized

- Do employees share the monitored results of achievement, regardless of whether the results are good or bad?
- Do employees have easy access to the monitored results of achievement of the other departments with whom they work closely?
- Are there specific ways to make a fair evaluation of achievement across divisions such as the measurement of overtime etc.? If so, can you provide an example of such evaluation method? (   )

3-3-3. Questions about cases in which goals/targets are not achieved

- In case set goals/targets are not achieved, do managers and staff have a meeting in a timely manner?
- When the mangers and staff come up with ideas for improving performance in such meetings, are these ideas shared by staff in the division and put into action in a timely manner?
- Does the company ensure that such ideas for improvement are also shared by the other divisions? Please provide an example of specific ideas for improvement that are shared by the other division (   )

3-3-4. Questions about cases in which goals/targets are achieved

- When the goals/targets are met, does your company consider revising them to higher goals/targets?
- Is the time frame required to revise the goals/targets and to implement actions toward such new goals/targets within three months? How long is the time frame? (   )
- When revising the goals to higher level after earlier goals are achieved, are such actions institutionalized as part of a formal corporate process?

4. **Human resource management**

4-1. We understand that various measures are taken to improve employee motivation.

- Do managers evaluate employees mainly on the basis of performance (performance-based system)?

  When was such performance-based evaluation system introduced? (Year)

- Do you use incentives other than promotion and compensation to help improve the motivation of employees? If so, can you provide an example? ( )
- Do you monitor how these incentives lead to better outcome, such as greater motivation, higher retention rate or better financial results?

4-2. When we discussed organizational issues previously, we touched on the management and achievement of goals. Here, we would like to ask similar questions in terms of human resource management.

- Do managers take any specific measures other than verbal advice to employees when their achievements do not reach targets?
- Do such measures include transferring the employee to another position even if he or she has been in their current position for less than the average rotation period?
- Do such internal transfers take place promptly, and no later than the timing of regular rotation?

4-3. Questions regarding high-achieving employees

- When an employee achieves a high performance, do managers announce this within the division by praising the employee at meetings, for example?
- Does your company adopt a compensation and promotion system that is aligned with performance targets and achievements?
- Have you seen improvements in motivation by adopting such performance-based systems of compensation and promotion?

4-4. Questions about managers

- Does the company provide managers with clear guideline as to how they should cultivate the talent of their subordinates?
- Does your company adopt a promotion or compensation system in which managers are incentivized to foster high-achieving employees?
- Have you seen an improvement in the motivation of managers by adopting such an incentive scheme?

5. **Human resource development**

5-1. Questions about human resource development

- Does your company conduct employee training on a regular basis to develop their business skills?

a. How many days a year, on average, does an employee spend on training? (days)

b. There are two types of corporate training programs: 1) functional training designed to obtain technical knowledge and 2) theme-based training designed primarily to obtain a certificate. Which do you focus on?

– Focus on functional training
– Focus on theme-based training
– Both training are conducted roughly equally.

• Do these training programs contribute to improving financial results? If so, please provide an example. ( )
• Do employees obtain a high level of transferable skills that could be utilized soon after she or he moves to another company?

5-2. Questions about OJT (on-the-job training), which is also an important training program

• Does on-the-job training (OJT) take place during daily operations? Roughly what percentage of a manager's time is allocated to such OJT?

If it is difficult to specify the corporate-wide percentage, please base your answers on one of the divisions.

a. On average (throughout the company) (%)

b. Front office/factory (%)

c. Back office (%)

d. Other specialist divisions (%)

• Does this OJT contribute to improving financial results? If so, please provide an example. ( )
• Do you monitor the results of OJT? If so, please provide an example of how you monitor them. ( )

5-3. We understand that job rotation leads to the development of a company's human resources.

• Ia your company's job rotation program flexible? Do you think, for example, that the majority of employees are transferred within the base rotation period of two to three years?
• Do some employees stay in one division for a long period to cultivate a high level of specialized skill and expertise?
• Do you have a human resource development program that integrates various aspects such as training, OJT and job rotation that will help acquire a high level of skill and expertise?

6. **Acquisition of human resources**

6-1. Questions about your workforce, human resources itself

- Is your company able to identify core skilled workforce (star performers) in each division? What quality is typically shared by such star performers? (   )
- Are these star performers treated differently from other employees? If so, in what regard are they treated differently? (   )
- Has your company been successful in retaining your top talent?

6-2. An increasing number of Japanese companies are interested in utilizing non-Japanese employees or management.

- Does your company have non-Japanese employees or management? What is the percentage of non-Japanese to total number of management and employees? (%)
- Do overseas subsidiaries have non-Japanese management?
- Do your board members (head office) include any non-Japanese persons?

7. **Lifetime employment system**

Last topic is lifetime employment.
How does your company view the lifetime employment system?

- Important
- Somewhat important
- Somewhat unimportant
- Unimportant

8. **Relationships between employees (mainly full-time) and management**

Which of the followings best describe your company situation regarding how corporate strategy is formulated?

- Top down decision making
- There are regular meetings between management and employees regarding compensation and human resource management, but corporate strategy is determined only by the management.
- In addition to 2, informal communication is common, where management tries to reflect the opinions of employees when it comes to issues related to compensation and human resource management, though corporate strategy is decided only by the management.
- Communication between management and employees plays a key role in reflecting employees' opinions not only in human resource issues but also in corporate strategy.

9. **Decision making and information flow**

9-1. Let us suppose that multiple divisions are involved to discuss a new business project. If we say the total time spent from starting the feasibility study to launch the project is 100 %, what is the percentage of the time spent on nemawashi (i.e., the consensus-building process outside of formal meetings)?

- 60 % or above
- 40–59 %
- 20–39 %
- 19 % or below

9-2. Let us assume the case in which you must close or exit an existing business. Let us also say that the total time spent from the formation of the project team for winding down the business to start implementing the plan is 100 %, what is the percentage of the time spent on nemawashi (i.e., consensus-building process outside of formal meetings)?

- 60 % or above
- 40–59 %
- 20–39 %
- 19 % or below

Next, let us cover topics on information flow within the company.

9-3. Let us suppose that the total amount of strategic information within the company is 100 %, what percentage of information does the person who is in charge of one business unit have?

- 40 % or below
- 40–60 %
- 60–80 %
- 80 % or above

9-4. Let us suppose that the total amount of strategic information that one employee has is 100 %, what percentage of information does the person obtain informally (e.g., unofficial dinner with colleagues or bosses) rather than through formal ways such as conversation with the boss during business hours or corporate meetings?

- 20 % or below
- 20–40 %
- 40–60 %
- 60 % or above

10. **Organizational reform**

10-1. Please let us know whether your company underwent organizational reform in the past and how great the reform was.

- Has the company undergone an organizational reform in the last 10 years? If yes, we will continue questions. If no, we will move to question 5.
- Did the organizational reform entail changes to the existing organizational framework (e.g., was there restructuring of existing departments and/or sections)?
- Did the organizational reform go beyond the creation of a new business groups or the consolidation of existing business groups?

- Was the organizational reform conducted on a far greater scale that involved company-wide reform? The examples include transformation from a functional organization to a divisional organization or to a matrix organization, transition to a divisional organization or creation of a pure holding company.

Please allow us to continue asking about organizational reform.

a. In which year did the organizational reform start? (   )
b. How many employees were involved in planning and/or implementing the reform as a percentage of total employees? How long did the reform take?

(%) (   )

c. What was the major reason that your company decided to implement organizational reform? (   )

(If the answer is not apparent, we ask you to consider the following possibilities).

– It was clear that the existing organizational structure was not effective to save the company from further deteriorating business performance.
– Though business performance was not deteriorating, we felt it necessary to transform the organization as a countermeasure to competitors who had made similar reforms.
– Though business performance was not deteriorating, our external stakeholders such as major customers advised us to do so.
– Though business performance was not deteriorating, we felt it necessary to better meet the changing needs of the future.

d. What was the major focus of the objective of such organizational reform?

(If the answer is not apparent, we ask you to consider the following possibilities).

– The major objective was to meet customer demand in a more timely manner.
– The major objective was to increase capacity to develop new products, services or new production processes
– Instead of volume or quantity, the major objective was to enhance the ability to offer better quality of new products or services.
– The major objective was to reduce costs, such as labor cost.

We imagine that much internal coordination was required to reform the organization. Such a reform must have resulted in a number of changes. Please answer Yes or No to following questions.

10-2. Questions about the organizational reform process.

- Was the time required for the proposed organizational reform to be accepted by a majority of employees less than one year?
- Did a majority of employees work with middle management in line with the proposed reform after the plan was accepted?

- Did employees suggest other constructive alternatives regarding organizational reform?

10-3. Questions about changes due to organizational reform

- Was some of the decision-making authority delegated to lower-level managers/ employees as a result of organizational reform?
- Did such delegation of decision-making authority help simplify the organizational structure?
- Did the organizational reform lead to changes in terms of what employees do and how they view their jobs? If any, please provide an example. (   )

10-4. Questions about the relationship between IT investment and organizational reform, which are generally considered to be correlated.

- Did your company step up investment in IT after the organizational reform compared with the same period prior to the reform?
- Did your company make company-wide efforts to improve the utilization of information technology, rather than each section or division making IT-related plans individually?
- Did your company strengthen IT management to include not only the internal network but also external business partners such as customers and/or suppliers?

Please provide an example where an effective use of IT helped generate a new business opportunity, if any. (   )

10-5. We understand that a large budget is generally required for organizational reform. Please let us know about funding the reform, which is usually one of the challenges.

What do you estimate is spent on organizational reform as a percentage to your company's annual revenue? (%)

a. How does your company raise these funds required for reorganization?

b. Please provide a ballpark figure of the percentage of each source of funds to the budget?

Internally-generated cash flow	(%)
Borrowings	(%)
Issuance of bonds	(%)
Issuance of stocks	(%)
Other	(%)
Please specify if you choose "other".	( )

Next question is asked only to those who answered "borrowings" in the question b.

c. How did lenders such as banks evaluate the proposed organizational reform?

Please choose the response closest to lenders' attitude.

- The reorganization plan was incorporated into their evaluation and reflected in borrowing conditions (loan amount, interest rate, maturity, security etc.).
- The reorganization plan was evaluated but was not reflected in borrowing conditions.
- The reorganization plan was not evaluated.

Next question is asked only to those who did not choose "borrowings" to the above question b.

c′. Did your company discuss with the banks the possibility of borrowing to fund your reorganization? How did banks evaluate the proposed plan of organizational reform?

Next question is asked only to those who answered yes to the above question c′. Please choose the response closest to the lenders' stance.

- The banks analyzed the reorganization plan and tried to reflect it in borrowing conditions (loan amount, interest rate, maturity, security etc.).
- The banks analyzed the reorganization plan but it did not seem to be reflected in borrowing conditions.
- The banks did not analyze the reorganization plan.

d. If reorganization costs can be recorded as assets, over how many years do you think they should be amortized/depreciated?

Please choose the one closest to your opinion.

- Over 7 years
- 5–6 years
- 3–4 years
- 2 years
- 1 year

References

Aoki, M. (2010). *Corporations in evolving diversity, cognition, governance, and institutions*. Oxford: Oxford University Press.

Bartelsman, E., Haltiwanger, J., & Scarpetta, S. (2009). Measuring and analyzing cross-country differences in firm dynamics. In T. Dunne, J. Bradford Jensen, & M. Roberts (Eds.), *Producer dynamics new evidence from micro data* (pp. 15–79). Chicago: University of Chicago Press.

Bartelsman, E., Haltiwanger, J., & Scarpetta, S. (2013). Cross-country differences in productivity: The role of allocation and selection. *American Economic Review, 103*, 303–334.

Bloom, N., Sadun, R., & Van Reenen, J. (2012). The organization of firms across countries. *Quarterly Journal of Economics, 127*, 1663–1705.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*, 1351–1408.

Fukao, K., Inui, T., Kabe, S., & Liu, D. (2008). An international comparison of the TFP levels of Japanese, South Korean, and Chinese listed firms. *Seoul Journal of Economics, 21*(1), 5–33.

Hall, R., & Jones, C. (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics, 114*, 83–116.
Jones, C., & Romer, P. M. (2009). *The new Kaldor facts: Ideas, institutions, population, and human capital* (NBER Working Paper No. 15094).
Joo, S. H., & Lee, K. (2010). Samsung's catch-up with Sony: An analysis using U.S patent data. *Journal of the Asia-Pacific Economy, 15*(3), 271–287.
Jung, M., & Lee, K. (2010). Sectoral systems of innovations and productivity catch-up by the Korean firms with the Japanese firms. *Industrial and Corporate Change*, *19*, 1037–1069.
Jung, M., Lee, K., & Fukao, K. (2008). Total factor productivity of Korean firms and catching up with the Japanese firms. *Seoul Journal of Economics, 21*(1), 93–137.
Kanamori, T., & Motohashi, K. (2006). *Centralization or decentralization of decision rights? Impact on IT performance of firms* (RIETI Discussion Paper Series 06-E-032).
Kurokawa, F., & Minetaki, K. (2006). How can IT raise productivity linked with workplace re-organization and human capital in Japan? *The Economic Analysis, 178*, 54–95 (in Japanese).
Lee, K., Miyagawa, T., Kabe, S., Lee, J., Kim, Y., & Edamura, K. (2012). *Comparing the management practices and firm performance in Korean and Japanese firms – An empirical study using interview surveys*. Presented at the workshop on "Intangibles, Innovation Policy, and Economic Growth" at Gakushuin University on December 17 and 18, 2012.
McGrattan, E., & Prescott, E. (2005). *Expensed and sweat equity* (Federal Reserve Bank of Minneapolis, Working Paper no. 636).
McGrattan, E., & Prescott, E. (2010). Unmeasured investment and the puzzling U.S. boom in the 1990s. *American Economic Journal: Macroeconomics, 2*, 88–123.
Miyagawa, T., & Takizawa, M. (2011). Productivity differences between Japan and Korea and the role of intangible assets. In K. Asako, N. Iiduka, & T. Miyagawa (Eds.), *Great recessions in the global economy and business cycle analysis*. Tokyo: University of Tokyo Press (in Japanese).
Shinozaki, A. (2007). Effective reforms with information technology: Logit model analysis on business process reengineering, business unit restructuring, and human resource management. *The Economic Analysis, 179*, 36–54.
Solow, R. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70*, 65–94.
Syverson, C. (2010). What determines productivity? *Journal of Economic Literature, 49*, 326–365.

Chapter 8
How Does the Market Value Management Practices of Japanese Firms? Using Management Practice Survey Data

Atsushi Kawakami and Shigeru Asaba

Abstract This paper examines the extent to which firm's management practices are valued in the marketplace using the data of interview survey. First, we divide a firm's market value into its tangible and intangible assets, and further decompose the intangible asset value into the components attributable to advertising, to R&D, and to management practices. We find that the component attributable to management practices is much smaller than the components attributable to R&D or to advertising. We also find that among various management practices, human resource management has a significantly positive impact on Tobin's q. Some of organizational management variables, however, have significantly negative impacts on Tobin's q, contrary to the findings of Bloom and Van Reenen (Quarterly Journal of Economics 122:1341–1408, 2007; Journal of Economic Perspectives 24:203–224, 2010) and Bloom et al. (Academy of Management Perspectives 26:12–33, 2012), to which we referred when we conducted interview survey. Then, we further explore the organizational management practice variables to understand why they do not have significantly positive impacts on Tobin's q. The finer analysis finds that many characteristics of management practices, which are supposed to increase market value of the firms, actually have no significant impact or a negative impact on Tobin's q. The results suggest that information sharing and

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coordination within a unit or a team increase the value, while disclosing information and coordinating across units decrease the value. The results also suggest that quick decision making has different impacts on firm's market value depending upon the contexts. Speedy decision making increases the value in case of new business development, while consultation with the people concerned increases firm's market value in case of closing the existing business. The different results of this study from the existing ones may suggest that good management practices are different among countries.

Keywords Management practices • Intangible assets • Decomposition

8.1 Introduction

It has been argued that various kinds of intangible assets influence firm performance. Corrado et al. (2005, 2009) classified intangible assets into three categories: computerized information, innovative property, and economic competencies. Many studies have examined the impacts of computerized information and innovative property on firm performance.[1] Regarding economic competencies, brand equity as well has been studied by marketing scholars (Aaker 1991; Ito 2000; Simon and Sullivan 1993), but the economic study on management practices, the other component of economic competencies related to human and organizational capital, has just started recently (Bloom and Van Reenen 2007, 2010).[2]

It is recognized that such intangible assets are valuable to firms, but they are not publicly revealed enough. According to *Yuka Shoken Hokoku-sho* (Japanese 10k report) of Canon issued in December 2011, for example, the tangible fixed assets are 750 billion yen, while the intangible fixed assets are 35 billion yen. The latter includes patents, land leaseholds, trademarks, designs, software and so on, which are only some parts of the intangible assets. Most of the intangible assets discussed above, however, are not reported in firm's balance sheet.

Since firms spend much resource to acquire and accumulate intangible assets, it is important to know how the market values them. While several researchers have attempted to evaluate technological capability and brand equity by using the investment in R&D and advertising, few studies have evaluated human and organizational capital. Especially, market value of management practices has not been examined, because the investment in improvement of management practices is not usually available.[3]

[1] As to computerized information, Brynjolfsson and Hitt (1995), for example, examined the relationship between IT investment and productivity. Many management scholars have examined the impact of innovative property or technological capability on firm performance (Argyres 1996; Helfat 1994, 1997; Henderson and Cockburn 1994).

[2] Human and organizational capital has been studied not in economics but in the field of management.

[3] Miyagawa et al. (2012) is an exception. They evaluate economic competence using the data on labor costs and expense of organizational reform.

Therefore, this study tries to know how the market values management practices using the score of the interview survey on management practices for Japanese firms. First, we divide a firm's market value into its tangible and intangible assets, and further decompose the intangible asset value into the components attributable to advertising, to R&D, and to management practices. The results indicate that the component attributable to management practices is much smaller than the components attributable to R&D or to advertising, because some of organizational management variables have significantly negative impacts on Tobin's q, contrary to the findings of Bloom and Van Reenen (2007, 2010) and Bloom et al. (2012). Then, we further explore the organizational management practice variables to understand why they do not have significantly positive impacts on Tobin's q.

The structure of this study is as follows: In the next section, we explain about our management practice survey and propose our analysis. In Sect. 8.3, we describe data and variables. In Sect. 8.4, we report the results of estimation, and with the results, decompose estimated value of intangible assets into the components attributable to management practices and others. In Sect. 8.5, we do a finer analysis on the impact of each organizational management practice on Tobin's q to understand why organizational management practices are valued low in Japan. In the final section, we discuss about the results and the future research agenda.

8.2 Market Value of Management Practices

8.2.1 Management Practice Survey

Following Bloom and Van Reenen (2007), we conducted the interview surveys, "Intangible assets Interview Survey in Japan" (hereinafter referred to as IAISJ). We interviewed the managers of the planning departments of the listed firms in Japan. We conducted the interview twice.[4] The first interview was done between November, 2011 and February, 2012. The second interview was done between July and September, 2012. Consequently, we could accomplish interviews with 402 firms.[5] The composition of the industries of the respondents is described in Table 8.1.

We asked the questions in ten categories: business environment, production management system, organizational goal/target, human resource management, human resource development, acquisition of human resource, lifetime employment system, industrial relations, decision making and information flow, and

[4] We asked the research firms to conduct the interviews. Examining the results of the pilot interviews, we discuss with them on how to interview and score the answers.

[5] The number of the firms we interviewed is 277 for the first interview and 130 for the second interview. Among them, we found two duplicates and three unavailable firm observations, and consequently, we use 402 firm observations.

Table 8.1 Industry composition of the responding firms

Industry	# of Respondents (firms)
Foods	26
Chemical	19
Pharmaceutical	10
Metal	37
Machinery	42
Electric Machinery	45
Automotive	17
Other Manufacturing	76
Sub Total (Manufacturing)	272
Construction	21
Wholesale and Retail	27
Restaurant	19
Real Estate	10
Transportation	5
Information Service	25
Other Service	23
Sub Total (Non-manufacturing)	130
Total	402

organizational reform. We suppose that organizational goal/target, industrial relations, and decision making and information flow are about organizational capital, while human resource management, human resource development, acquisition of human resource are about human capital.

We asked a few questions in each category except for the categories of lifetime employment system and industrial relations, which have only one question. In each question, we have three sub questions, and the more sub questions you answer positively, the more point you get. For example, there are several questions in the category of human resource development. One of the questions, Employee's expertise, is composed of three sub-questions:

1. "Are employees rotated in a fixed schedule (e.g., once every 2 or 3 years)?"
2. "To improve the expertise of the employees, are they assigned to a set position for a long time?"
3. "Is there a systematic program in place for employees to acquire some expertise?"

If you answer "No" to the first sub-question, you get the score, 1. If you answer "Yes", you move to the second sub-question. If you answer "No" to the second sub-question, you get the score, 2. If you answer "Yes", you move to the third sub-question. If you answer "No" to the third sub-question, you get the score, 3. If you answer "Yes", you get the score, 4.

Consequently, we assign the score from 1 to 4 for each question, depending upon the answers to the three sub questions.[6]

[6] Miyagawa et al. (2010) describe the scoring system of this interview survey in more detail.

8.2.2 *Market Value of Management Practices*

While there have been various ways to measure the value of the intangible assets, we adopt financial-market based estimation.[7] Following Lindenberg and Ross (1981), the market value of the firm (*MV*) can be divided into the portions of firm value attributable to the tangible (V_t) and the intangible assets of the firm (V_i).

$$MV = V_t + V_i \tag{8.1}$$

Dividing the both sides of Eq. (8.1) by the tangible asset value gives us

$$(MV/V_t) = 1 + (V_i/V_t). \tag{8.2}$$

The tangible asset value of the firm, V_t, is measured as the replacement cost (*RC*) of the tangible assets of the firm. The left side of Eq. (8.2) may then be written as (*MV*/*RC*) which is by definition Tobin's q. Thus, we obtain

$$q = (MV/V_t) = 1 + (V_i/V_t). \tag{8.3}$$

To estimate the impact of various factors on the intangible asset value of the firm, the following regression equation is estimated:

$$q - 1 = (V_i/V_t) = a + \sum bX + \sum cZ + \varepsilon \tag{8.4}$$

Among *X*, we include the factors which affect such components of intangible assets as innovative property and economic competencies. As the factor related to innovative property, we include R&D expenditures. We also include advertising expenditure as the factor related to brand equity, one component of economic competencies. Moreover, as Konar and Cohen (2001) include environmental performance of the firm as the other factor affecting intangible asset value, we include management practices as the other factor related to economic competencies.

Moreover, market valuation is based on expected profitability. Thus, among control variables, *Z*, we include industry concentration ratio. We also control firm size and age.

The management score multiplied by estimated regression coefficient is the contribution of management practices to *Vi*/*Vt*. Similarly, we calculate the portion of *Vi*/*Vt* attributable to R&D activity and that attributable to advertising.[8]

[7] Other than financial-market based estimation, Simon and Sullivan (1993) pointed out five techniques to measure brand equity: estimation based on the conditions of acquisition and divestment, based on the price premium commanded by a product, based on the brand name's influence on customer evaluation, based on brand replacement cost, and based on a brand-earnings multiplier.

[8] In general, the market value of the firm can be considered a function of the tangible and intangible asset value, and can be represented as $MV = G(V_t, V_i)$. If any interaction between the

8.3 Data and Variables

8.3.1 Variables of Management Practices

We construct the variables of management practices using the score of the interview survey (IAISJ) described above. In the interview, the respondents were required to answer questions on the situation in the latter half of 2000s. To construct the other variables described below, therefore, we collect the financial data of each year from 2005 to 2010. Thus, it is supposed that we have 2,412 observations (402 firms * 6 years). However, some of financial data for many years in the past necessary to construct several variables described below are missing for many firms. Consequently, the number of observations is 373 for the whole sample, 261 for manufacturing industry sub-sample, and 112 for non-manufacturing industry sub-sample.

As for a management practice variable, we use the first principal component calculated by principal component analysis instead of the raw interview score. We asked various questions to measure the degree of good management practices. Thus, the first principal component is considered a general indicator of good management practices. The equation of component c_j is

$$c_j = \gamma_j(X - \mu) \tag{8.5}$$

γ_j is orthonormal eigenvector of component j, X is the vector of scores calculated from each question and μ is mean vector of X. We aggregate all the scores into one variable, *pcaq_all*. To compare the components attributable to management practices and to others in decomposition of estimated value of intangible assets, we standardize the variables of management practices, R&D activities, and advertising. Therefore, we use z score of each variable, which is denoted as *variable name_z* (*pcaq_all_z*, for example). Moreover, we divide the questions into two categories: organizational capital and human resource management. We aggregate the scores in the category of organizational capital into one variable, *pcaq_org*, and aggregate the scores in the category of human resource management into the other variable, *pcaq_human*.

tangible assets and the intangible assets is expressed by the interaction term between V_t and V_i, the market value can be represented as $MV = V_t + V_i + V_t * V_i$. Then, we obtain $q = (MV/V_t) = 1 + ((1 + V_t)/V_t) * V_i$. While the coefficient of V_i is different from that in the model without considering the interaction effect into account, we can estimate the impact of various factors on the intangible asset value of the firm in the same regression. Moreover, when we decompose the three kinds of the intangible asset values using the coefficient estimated by the model with the interaction, the calculated intangible assets value is not V_i/V_t, but $((1 + V_t)/V_t) * V_i$.

8.3.2 Other Variables

To decompose the intangible asset into components stemming from management practices, advertisement, and R&D activities, we estimate Tobin's q − 1. Following Hori et al. (2004), we calculate Tobin's q defined as follows.

$$q = \frac{Average\,stock\,price * Number\ of\ authorized\ shares + Interest\text{-}bearing\ liabilities}{Total\,Assets - K\,at\,previous\,year + Replacement\ value\,of\,real\,capital\,stock\,at\,previous\,year} \tag{8.6}$$

K is tangible assets which are calculated by perpetual inventory method following $K_t = (1-\delta)K_{t-1} + I_t$ except for land. Land price is maintained booked value. δ is depreciation rate.[9]

For R&D activities, we use the natural logarithm of R&D expenditures (*lnrd*), and for advertisement, we use the natural logarithm of advertising expenditures (*lnadv*). As control variables, we include the natural logarithm of number of employees (*lnL*), the natural logarithm of firm age (*lnage*), and four-firm cumulative concentration ratio (*CR4*). Year dummy and industry dummy are also included. Such financial data is collected from securities report by Development Bank of Japan. Definition and summary statistics of the variables are indicated in Tables 8.2 and 8.3.

8.3.3 Estimation Method

For estimating the attribution of each intangible asset to firm value, we use IAISJ and financial data between 2005 and 2010. These data are not panel, but pooled data because the same values of the management practice score of each firm is applied over the observation period. As Wooldridge (2001) pointed out, however, using pooled data may cause a problem of serial correlation. Wooldridge (2001) also suggested that feasible GLS (FGLS) is a way to deal with the problem of serial correlation. Thus, we adopt FGLS as the estimation method.

Process of FGLS is as follows: First of all, we estimate regression of $q-1$ on independent variables, obtain the residuals $\hat{u}$, and take the logarithm of squared $\hat{u}$, $\log(\hat{u}^2)$. Using $\log(\hat{u}^2)$, we estimate regression of $\log(\hat{u}^2)$ on the same independent variables as the first step and obtain the fitted value $\hat{g}$ and exponentiation form of it, $\hat{h} = \exp(\hat{g})$. Finally, we estimate weighted least squares of $q-1$ on the independent variables using weight $1/\hat{h}$.

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[9] The depreciation rate of building is 0.047, structure is 0.0564, machinery is 0.09489, ship is 0.1470, vehicle is 0.1470 and tool is 0.08838.

Table 8.2 Definition of variables

Variables	Definition
V	Tobin's q minus 1
pcaq_all	First component of principle component analysis using questions 4, 5, 6
pcaq_human	First component of principle component analysis using all questions
pcaq_org	First component of principle component analysis using questions 3, 8, 9
lnrd	Logarithm of R&D expenditure
lnadv	Logarithm of advertising expenditure
lnage	Logarithm of firm age
CR4	4 firms concentration ratio
lnL	Logarithm of number of employees

Table 8.3 Summary statistics

	All industries			Manufacturing		
	Observations	Mean	Std. error	Observations	Mean	Std. error
V	269	0.02	1.00	241	−0.08	0.58
lnrd	269	13.37	1.95	241	13.64	1.80
lnadv	269	12.64	1.91	241	12.76	1.87
lnage	269	3.98	0.49	241	4.01	0.45
CR4	269	0.09	0.23	241	0.10	0.24
pcaq_human	269	0.09	1.39	241	0.04	1.39
pcaq_org	269	−0.04	1.20	241	−0.07	1.15
pcaqall	269	0.06	1.51	241	−0.01	1.47
year2	269	2,006.93	1.47	241	2,006.95	1.47
	Non-manufacturing (concluding lnrd)			Non-manufacturing		
	Observations	Mean	Std. error	Observations	Mean	Std. error
V	28	0.91	2.46	112	0.29	1.49
lnrd	28	11.07	1.66	28	11.07	1.66
lnadv	28	11.63	1.96	112	12.56	2.01
lnage	28	3.72	0.74	112	3.61	0.54
CR4	28	0.01	0.01	112	0.01	0.05
pcaq_human	28	0.56	1.24	112	0.23	1.41
pcaq_org	28	0.21	1.55	112	−0.04	1.30
pcaqall	28	0.61	1.78	112	0.25	1.62
year2	28	2,006.79	1.47	112	2,007.06	1.49

Table 8.4 Determinants of Tobin's q (1)

	(1)	(2)	(3)	(4)
pcaq_all_z	0.056**	0.078***		
	(2.09)	(2.96)		
pcaq_hum_z			0.103***	0.099***
			(3.34)	(3.17)
pcaq_org_z			−0.082**	−0.049
			(−2.44)	(−0.91)
lnrd_z	0.166***	0.201***	0.197***	0.220***
	(3.09)	(4.55)	(4.07)	(2.80)
lnadv_z	0.127**	0.145***	0.112**	0.095**
	(2.41)	(3.53)	(2.41)	(2.40)
lnL	−0.142***	−0.190***	−0.148***	−0.176*
	(−2.72)	(−3.76)	(−3.00)	(−1.92)
CR4	0.020	0.038	−0.028	−0.109*
	(0.34)	(0.68)	(−0.53)	(−1.74)
lnage	−0.121	0.089**	−0.188*	0.039
	(−1.49)	(2.30)	(−1.86)	(0.72)
_cons	1.280**	0.587	1.440**	0.698
	(2.36)	(1.44)	(2.33)	(0.91)
Observations	269	241	269	241
F-Statistics	27.048	11.474	23.604	13.466
Prob > F	0.000	0.000	0.000	0.000
R-sq	0.364	0.228	0.415	0.195
Adjusted R-sq	0.326	0.190	0.378	0.153

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parentheses

8.4 Empirical Results

8.4.1 Estimation of q − 1

The results from the estimation of Eq. (8.4) are indicated in Tables 8.4 and 8.5. Model (1) and (2) in Table 8.4 show the results using the first principal component of all the items (*pcaq_all_z*) as a management practice variable, while Model (3) and (4) show the results using the first principal component related to human resource management (*pcaq_human_z*) and that related to organizational capital (*pcaq_org_z*). Model (1) and (3) are for the whole sample, while Model (2) and (4) are for the manufacturing industry sample.

As indicated in Model (1) and (2), *pcaq_all_z* is significant and positive. Thus, these results suggest that management practices have a significantly positive impact on Tobin's q. As shown in Model (3) and (4), on the other hand, *pcaq_org_z* is negative and it is significant in Model (3), while *pcaq_human_z* is positive and significant. Therefore, these results suggest that among management practices,

Table 8.5 Determinants of Tobin's q (2)

	(5)	(6)	(7)	(8)	(9)	(10)
pcaq_all_z	0.017	0.055**	0.122*			
	(0.80)	(2.14)	(1.87)			
pcaq_hum_z				0.080***	0.089***	0.176**
				(2.99)	(3.45)	(2.43)
pcaq_org_z				−0.082***	−0.080**	0.010
				(−2.62)	(−2.04)	(0.11)
lnadv_z	0.092**	0.172***	−0.135*	0.069**	0.171***	−0.135
	(2.31)	(5.00)	(−1.70)	(2.03)	(5.66)	(−1.53)
lnL	−0.012	−0.049*	0.055	0.004	−0.018	0.071
	(−0.49)	(−1.79)	(0.59)	(0.17)	(−0.68)	(0.79)
CR4	0.050	0.015	0.759	−0.001	−0.057	0.752
	(0.78)	(0.28)	(1.08)	(−0.01)	(−1.23)	(1.03)
lnage	−0.394***	−0.116	−1.112***	−0.492***	−0.137	−1.252***
	(−4.32)	(−1.49)	(−4.13)	(−5.32)	(−1.49)	(−5.07)
_cons	1.330***	0.475	4.096***	1.662***	0.395	4.366***
	(2.96)	(1.14)	(4.19)	(3.80)	(0.84)	(4.31)
Observations	373	261	112	373	261	112
F-Statistics	14.535	7.431	8.142	11.868	9.889	9.042
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
R-sq	0.285	0.148	0.584	0.236	0.167	0.641
Adjusted R-sq	0.253	0.113	0.519	0.200	0.131	0.580

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parentheses

human resource management and organizational capital have different effects. Management practices associated with human resource management has a positive impact on Tobin's q, while management practices associated with organizational capital has a negative impact on Tobin's q.

Regarding the other variables related to intangible assets, *lnrd_z* and *lnadv_z* are positive and significant in any models of Table 8.4. Therefore, R&D and advertising expenditures have a positive impact on q and the market value of intangible assets. As to control variables, *lnL* is negative and significant in any models, suggesting that large size in terms of number of employees has a negative impact on q. *CR4* is positive in Model (1) and (2), while negative in Model (3) and (4), but it is significant only in Model (4). *Lnage* is negative for the whole sample and significant in Model (3), while it is positive for the manufacturing industry sample and significant in Model (2).

Table 8.5 shows the results of the estimation for the whole sample (Model (5) and (8)), manufacturing industry sample (Model (6) and (9)), and non-manufacturing sample (Model (7) and (10)). Since R&D data is not available in many firms in non-manufacturing industries, *lnrd* is not included in each model. As indicated in Model (5), *pcaq_all_z* is positive and significant for manufacturing and for non-manufacturing samples as the results shown in Table 8.4, while it is positive but not significant for the whole sample. Advertising expenditures, however, are significantly positive for the whole sample and for manufacturing industry sample, but they are significantly negative for non-manufacturing industry sample.

As shown in Model (8), (9), and (10), *pcaq_human_z* is positive and significant for any samples. However, *pcaq_org_z* is negative and significant for the whole sample and for manufacturing industry sample, while it is positive (but not significant) for non-manufacturing industry sample. Therefore, it is a very robust result that management practices associated with human resource management have a positive impact on Tobin's q.

8.4.2 Decomposition of Intangible Assets

While management practices are not easily observed, the results described above suggest that the market values some of them. In this paper, we suppose that intangible assets are composed of management practices, brand equity (advertising and marketing activities), and technological capability (R&D activities). Thus, we can decompose intangible asset value into the components attributable to management practices, to brand equity, and to technological capability using the results of estimations.

Table 8.6 indicates the decompositions of intangible asset value (ratio to tangible asset value) into *VImp*, *VIrd*, and *VIad*, the components attributable to management practices, R&D, and advertising, respectively. There are 15 different ways of decompositions, each of which is calculated using the estimation of each model in Tables 8.4 and 8.5. When we calculate each component, we use the estimated regression coefficients of the explanatory variables in each model.

As indicated in Table 8.6, when we use the results of estimation using the first principal component, *VIrd* is positive. *VIad* is positive for the whole sample and for the manufacturing industry sample, while it is negative for the non-manufacturing sample (the models used are (7) and (10)). *VImp* is negative when the model with *pcaq_all_z* for the manufacturing sample (the models used are (2) and (6)), while it is positive when the other eight models are used. As far as the value of each intangible asset is positive, the value of *VImp* is much smaller than that of *VIrd* and *VIad*, and *VIrd* is larger than *VIad*. Regarding *VImp*, non-manufacturing firms have larger value than firms in manufacturing firms. Regarding *VIad*, firms in the manufacturing industries have the largest value.

8.5 Further Exploration of Management Practices

The results above indicate that the value of *VImp* is much smaller than that of *VIrd* and *VIad*. It is partly because some variables of management practices, especially those related to organizational capital, have negative impacts on $q - 1$. Therefore,

Table 8.6 Decomposition of intangible assets

Decomposition of V	Used model	Obs	Mean	Std. dev.	Min	Max
VIad	(1)	269	0.010	0.108	−0.247	0.229
VIrd	(1)	269	0.014	0.150	−0.474	0.362
VImp	(1)	269	0.001	0.050	−0.091	0.124
VIad	(2)	241	0.019	0.120	−0.270	0.262
VIrd	(2)	241	0.041	0.167	−0.572	0.437
VImp	(2)	241	−0.001	0.068	−0.127	0.173
VIad	(3)	269	0.009	0.095	−0.218	0.202
VIrd	(3)	269	0.016	0.178	−0.562	0.430
VImp	(3)	269	0.003	0.096	−0.263	0.189
VIad	(4)	241	0.012	0.078	−0.176	0.171
VIrd	(4)	241	0.045	0.183	−0.626	0.479
VImp	(4)	241	0.000	0.089	−0.236	0.160
VIad	(5)	373	0.012	0.078	−0.206	0.165
VImp	(5)	373	0.000	0.016	−0.028	0.038
VIad	(6)	261	0.025	0.141	−0.319	0.309
VImp	(6)	261	−0.005	0.049	−0.089	0.122
VIad	(7)	112	−0.012	0.124	−0.208	0.303
VImp	(7)	112	0.016	0.117	−0.186	0.245
VIad	(8)	373	0.009	0.059	−0.155	0.125
VImp	(8)	373	0.003	0.080	−0.217	0.184
VIad	(9)	261	0.025	0.140	−0.319	0.309
VImp	(9)	261	0.000	0.085	−0.235	0.177
VIad	(10)	112	−0.012	0.125	−0.209	0.303
VImp	(10)	112	0.022	0.175	−0.311	0.356
VIad	(11)	269	0.009	0.093	−0.212	0.197
VIrd	(11)	269	0.015	0.165	−0.519	0.397
VImp	(11)	269	−0.030	0.160	−0.367	0.461
VIad	(12)	241	0.011	0.070	−0.158	0.153
VIrd	(12)	241	0.035	0.141	−0.483	0.369
VImp	(12)	241	−0.032	0.160	−0.398	0.394
VIad	(13)	371	0.007	0.050	−0.132	0.106
VImp	(13)	371	−0.006	0.153	−0.304	0.548
VIad	(14)	261	0.016	0.091	−0.207	0.201
VImp	(14)	261	−0.044	0.158	−0.392	0.329
VIad	(15)	110	0.024	0.310	−0.754	0.518
VImp	(15)	110	−0.121	0.646	−1.111	1.826

we explore further the variables of organizational management practices to understand why they do not have significantly positive impacts on Tobin's q in the following way.

Instead of *pcaq_org_z*, we include dummy variables for each score of each question in the category of organizational capital. As explained above, each question has three sub-questions, and the more sub-questions you answer positively, the more score you get. We assign the score from 1 to 4 for each question, depending upon the answers to the three sub-questions.[10] Therefore, we make the three dummy variables for each question: *Score2_D*, *Score3_D*, and *Score4_D*. *Score2_D* is 1 if the score is 2, and 0 otherwise. *Score3_D* is 1 if the score is 3, and 0 otherwise. *Score4_D* is 1 if the score is 4, and 0 otherwise. We suppose that the larger score you get, the better management practices you have. Thus, we predict that all the three dummy variables have a significantly positive coefficient and that the value of the coefficient is increasing from *Score2_D* through *Score3_D* to *Score4_D*.

The results of the analysis are indicated in the first model of each of Table 8.7 through Table 8.12 and model (17) and (18) in Table 8.13. Each model includes the dummy variables (*Score2_D*, *Score3_D*, and *Score4_D*) to each of the eight different questions. In any models, the results of the dummy variables are different from our expectation. We expect that all the three dummy variables have a significantly positive coefficient and the coefficient of *Score2_D* is the lowest and that of *Score4_D* is the highest. However, in model (11-1) for example, *Score2_D* and *Score4_D* are negative, while *Score3_D* is significantly positive.

Thus, we examine the content of the question, and modify the way to assign scores or drop the observations in the following ways: (1) if there are very few respondents for a certain score, we drop the observations for the score, (2) if the respondents who answer "No" to the first sub-question (score 1) but their answers are suspected to include different meanings, we drop the observations with score 1, (3) we change the dummy variables: in the second model of each table (from Table 8.7 to 8.12) includes *Score3_D* and *Score4_D* (the base is the observations with score 1 and 2), and the third model includes only *Score4_D* (the base is the observations with score 1, 2, and 3).

Table 8.7 shows the results of the exploration of the question on setting target levels. As indicated Model (11-1), the result is different from our expectation. Therefore, following the modification rule (3), we estimate model (11-2) and (11-3). The results indicate that *Score3_D* in model (11-2) is significantly positive, while *Score4_D* in model (11-3) is significantly negative. The second sub-question is "Are the target levels appropriately set as non-binding challenges?" Therefore, setting appropriate levels of targets increases firm value. The third sub-question, on the other hand, is "Are target levels checked to ensure there is fairness between divisions or sections?" Thus, this result may suggest that keeping fairness between divisions needs coordination costs to decreases firm value.

Table 8.8 shows the results on the question of permeation of goals. Following the modification rule (3), we estimate model (12-2) and (12-3). The result suggests that *Score4_D* in model (12-3) is significantly positive. The third sub-question is "Do all the employees accept the target levels and are they motivated to reach the levels?" Thus, the result suggests that whether employees know and understand the goal or not does not matter, but permeation of the goal, which motivates the employees, increases firm value.

[10] As to the questions and sub-questions of organizational capital, see Appendix.

Table 8.7 Determinants of Tobin's q—effect of organizational score (setting target levels)

Variable	Description of scores	(11-1) Coefficient/t	(11-2) Coefficient/t	(11-3) Coefficient/t
Score2_D	Goals on multiple levels	−0.055		
[Score1_D]	[Not Goals on multiple levels]	(−0.71)		
Score3_D	Goals adjusted in each division	0.244**		
		(2.34)		
Score4_D	Consistency maintained	−0.042		
		(−0.66)		
Score3_D			0.235**	
[Score1_D/Score2_D]			(2.27)	
Score4_D			−0.040	
			(−0.58)	
Score4_D				−0.109**
[Score1_D/Score2_D/Score3_D]				(−2.34)
lnrd_z		0.292***	0.281***	0.208***
		(4.55)	(3.84)	(4.43)
lnadv_z		0.106*	0.118**	0.110**
		(1.84)	(2.02)	(2.51)
Observations		298	298	298
R-sq		0.418	0.423	0.357
Adjusted R-sq		0.387	0.395	0.328
F Statistics		32.070	34.340	39.682
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

Table 8.9 shows the results on the question of checking the degree to which goals are achieved. Following the modification rules (3), we estimate model (13-2) and (13-3). In addition, there are very few respondents who get score 1 for this question. Therefore, following the rule (1), the observations with score 1 are dropped.[11] The results, however, indicate that *Score4_D* is not significant. Thus, we understand that insignificant results of any dummy variables suggest that this management practice (checking on performance) is not relevant in Japanese firms.

In Table 8.10, the results on the question of permeation of degree to which goals are achieved are shown. Following the modification rule (3), we estimate model (14-2) and (14-3). The result indicates that any dummy variables are not significant,

[11] For this question, there are no negative responses to the first sub-question (score is 2). As a result, the dummy variables in model (13-1) are *Score3_D* and *Score4_D*, and that in either model of (13-2) or (13-3) is *Score4_D* only, but in model (13-3), the observations with score 1 are dropped, while in model (13-2), they are not dropped.

Table 8.8 Determinants of Tobin's q—effect of organizational score (permeation of goals)

Variable	Description of variable	(12-1) Coefficient/t	(12-2) Coefficient/t	(12-3) Coefficient/t
Score2_D	Employees know the goals	−0.244***		
[Score1_D]	[Employees don't know goals]	(−5.98)		
Score3_D	Employees understand the priority	−0.033		
		(−0.58)		
Score4_D	Employees accept the target levels	0.070		
		(1.53)		
Score3_D			0.062	
[Score1_D/Score2_D]			(1.07)	
Score4_D			0.144***	
			(3.12)	
Score4_D				0.127***
[Score1_D/Score2_D/ Score3_D]				(3.02)
lnrd_z		0.190***	0.198***	0.194***
		(3.90)	(3.43)	(5.28)
lnadv_z		0.155***	0.136***	0.128***
		(4.44)	(3.52)	(3.58)
Observations		298	298	298
R-sq		0.441	0.387	0.419
Adjusted R-sq		0.412	0.357	0.393
F Statistics		30.300	32.956	41.417
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisk *** indicates the coefficient is significant with significance level of 1 %. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

suggesting that any scores do not have any significant impact on firm value. Thus, we understand that this management practice (permeation of degree to which goals are achieved) is not relevant in Japanese firms.

Table 8.11 shows the results on the question of handling when goals have not been achieved. Following the modification rule (3), we estimate model (15-2) and (15-3). Moreover, the first sub-question is "Is a meeting consisting of managerial staff and employees promptly held as soon as it is known that the goals were not achieved?" To this sub-question, not only those who do not have an immediate meeting but also those who achieved all the goals can answer "No." Since it is suspected that the different kinds of respondents can be mixed in those with score 1 (answer "No" to the first sub-question), we drop the observation with score 1, following the modification rule (2). The result in Model (15-2) indicates that *Score3_D* and *Score4_D* are significantly negative, suggesting that either documentation of the measures for handling the failure to achieve the goal or disclosing them to the other division decreases firm value.

Table 8.9 Determinants of Tobin's q—effect of organizational score (checking the degree to which goals are achieved)

Variable	Description of variable	(13-1) Coefficient/t	(13-2) Coefficient/t	(13-3) Coefficient/t
Score3_D	Checking periodically	−1.472***		
[Score1_D]	[Not checking achieved]	(−5.18)		
Score4_D	Checking by employments	−1.470***		
		(−5.15)		
Score4_D			−0.048	(0.00)
[Score1_D/Score3_D]			(−0.92)	(−0.01)
lnrd_z		0.254***	0.219***	(0.26)***
		(5.08)	(3.94)	(5.19)
lnadv_z		0.062	0.107**	(0.07)*
		(1.65)	(2.47)	(1.81)
Observations		298	298	291
R-sq		0.391	0.337	0.363
Adjusted R-sq		0.361	0.306	0.335
F Statistics		32.839	32.398	35.828
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

Table 8.12 indicates the results on the question of handling when goals have been achieved. Following the modification rule (3), we estimate model (16-2) and (16-3). The result indicates that any dummy variables are not significant, suggesting that any scores do not have any significant impact on firm value. Thus, we understand that this management practice (handling when goals have been achieved) is not relevant in Japanese firms.

Table 8.13 shows the results on the question of decision making speed. While in models (17) and (18), the results of the dummy variables are not as we expected, we do not modify the specification of the model. But the results can be interpreted in the reasonable way. The question corresponding to model (17) is "When you start a new business with other departments, how long do you spend ground work?" The result indicates that all the three dummy variables are positive and only *Score4_D* is significant. This result suggests that making a quick decision on starting a new business increases firm value and especially limiting ground work within less than 20 % of the total time significantly increase firm value.

On the other hand, the result in model (18), the question corresponding to which is "When you close an existing business, how long do you spend ground work?" indicates that *Score 2_D* and *Score3_D* are significantly negative. Since score 1 (base) means that the longest consultation with the people concerned, the result suggest that making a quick decision on closing an existing business decreases firm value. We discuss such contrasting results in the next section.

Table 8.10 Determinants of Tobin's q—effect of organizational score (results of checks on performance)

Variable	Description of variable	(14-1) Coefficient/t	(14-2) Coefficient/t	(14-3) Coefficient/t
Score2_D	Results are openly available within division	−0.026		
[Score1_D]	[Not openly available within division]	(−0.18)		
Score3_D	Openly available between relevant division	−0.139		
		(−1.36)		
Score4_D	Adjustments for different divisions	−0.082		
		(−0.68)		
Score3_D			−0.129	
[Score1_D/Score2_D]			(−1.59)	
Score4_D			−0.085	
			(−0.81)	
Score4_D				−0.011
[Score1_D/Score2_D/ Score3_D]				(−0.17)
lnrd_z		0.254***	0.219***	0.256***
		(5.08)	(3.94)	(5.19)
lnadv_z		0.062	0.107**	0.065*
		(1.65)	(2.47)	(1.81)
Observations		298	298	298
R-sq		0.371	0.365	0.355
Adjusted R-sq		0.338	0.334	0.325
F Statistics		31.344	31.181	35.964
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

8.6 Discussion and Conclusion

This paper examined how the market values management practices affecting intangible assets of the firm using the interview survey data, and decomposed intangible asset value into the components attributable to management practices, to brand equity, and to technological capability. We found that the component attributable to management practices is much smaller than the other two components. It is because management practices associated with organizational capital have either an insignificant or a negative impact on intangible asset value. Therefore, we further explored the variables of organizational management practices to know why they do not have a significantly positive impact on Tobin's q contrary to our expectation.

Table 8.11 Determinants of Tobin's q—effect of organizational score (handling when goals have not been achieved)

Variable	Description of variable	(15-1) Coefficient/t	(15-2) Coefficient/t	(15-3) Coefficient/t
Score2_D	Meeting consisting of manager	0.150		
[Score1_D]	[Not have meeting consisting of managers]	(1.12)		
Score3_D	To revise spread throughout the division	−0.055		
		(−0.62)		
Score4_D	Known throughout relevant and other division	−0.063		
		(−0.75)		
Score3_D			−0.187*	
[Score1_D/Score2_D]			(−1.67)	
Score4_D			−0.200*	
			(−1.83)	
Score4_D				−0.108
[Score1_D/Score2_D/ Score3_D]				(−1.65)
lnrd_z		0.223***	0.220***	0.198***
		(3.97)	(4.12)	(4.04)
lnadv_z		0.087*	0.065	0.073
		(1.73)	(1.23)	(1.47)
Observations		298	275	275
R-sq		0.376	0.376	0.346
Adjusted R-sq		0.342	0.345	0.316
F Statistics		37.867	34.514	35.670
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisks *, *** indicate the coefficient is significant with significance level of 10 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

We found that in any organizational management practices, the order of the scores is different from our expectation. We can divide the items of management practices which give unexpected results into two groups. In one group of the items of management practices, there is no significant difference in the influence on firm value among the detailed practices (sub-questions). It means that the items of management practices are not relevant to affect intangible asset value of Japanese firms. In the other group of the items, however, detailed practices we supposed the best ones actually have a negative impact on firm value.

Among the latter group, the item of ground work, for example, has an interesting implication. In case of closing an existing business, much consultation with the people increases firm value. When starting a new business, on the other hand, quick decision making without long ground work is favorable. Therefore, quick decision making have different impacts on firm value between in starting and in closing

Table 8.12 Determinants of Tobin's q—effect of organizational score (handling when goals have been achieved)

Variable	Description of variable	(16-1) Coefficient/t	(16-2) Coefficient/t	(16-3) Coefficient/t
Score2_D	Higher goals set	0.022		
[Score1_D]	[Not set higher goal]	(0.26)		
Score3_D	Period for setting higher goal	−0.089		
		(−1.58)		
Score4_D	Measures institutionalized	0.003		
		(0.03)		
Score3_D			−0.072	
[Score1_D/Score2_D]			(−1.42)	
Score4_D			0.004	
			(0.05)	
Score4_D				0.031
[Score1_D/Score2_D/Score3_D]				(0.40)
lnrd_z		0.241***	0.224***	0.206***
		(5.48)	(5.27)	(4.20)
lnadv_z		0.110**	0.104**	0.106**
		(2.50)	(2.45)	(2.26)
Observations		298	298	298
R-sq		0.392	0.376	0.348
Adjusted R-sq		0.360	0.346	0.318
F Statistics		24.319	31.120	33.417
Prob > F		0.000	0.000	0.000

Note: Estimation method is GLS. Asterisks **, *** indicate the coefficient is significant with significance level of 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

businesses. When you start a new business, quick decision making increase firm value as usually expected. But when you close the existing business, there are many people concerned with the closing business in the firm. Closing the business without consultation with the people increases conflicts and complaints within the firm, which may decrease firm value. Therefore, it is reasonable that quick decision making have different impacts on firm value.

The items of setting target levels and of handling when goals have not been achieved also have an interesting implication. The analysis on the detailed practices for both items found that interaction with other divisions either to keep fairness or to share the measures to the unachieved goals has a negative impact on firm value. It may suggest that coordination costs decrease firm value. Moreover, the analysis on the item of handling unachieved goals found that immediate meeting within the division increases firm value, while documentation of the measures to the unachieved goals and disclosing them to the other divisions decrease firm value.

Table 8.13 Determinants of Tobin's q—effect of organizational score (consultation with the people concerned)

Variable	Description of variable	(17) Coefficient/t	(18) Coefficient/t
Score2_D	40–59 %	0.090	−0.181**
[Score1_D]	[Over 60 %]	(1.04)	(−2.42)
Score3_D	20–39 %	0.006	−0.268***
		(0.07)	(−3.07)
Score4_D	Under 19 %	0.110*	−0.127
		(1.69)	(−1.44)
lnrd_z		0.195***	0.160***
		(3.03)	(2.99)
lnadv_z		0.143***	0.114**
		(3.57)	(2.41)
Observations		287	287
R-sq		0.369	0.352
Adjusted R-sq		0.335	0.316
F Statistics		25.977	24.760
Prob > F		0.000	0.000

Note: Estimation method is GLS. Asterisks *, **, *** indicate that the coefficient is significant with significance level of 10 %, 5 %, 1 %, respectively. Industry dummy and year dummy are included but not reported. t-statistics is in parenthesis

The two detailed practices are corresponding to the different process in knowledge creation.

In the SECI model of knowledge creation, there are the four processes: Socialization, Externalization, Combination, and Internalization (Nonaka and Takeuchi 1995). Immediate meeting within the division is corresponding to socialization, sharing tacit knowledge through face-to-face communication or shared experience, while documentation and disclosing the measures are corresponding to externalization, converting tacit knowledge to explicit knowledge by developing concepts and models. Thus, Japanese firms, which are good at socialization, can increase firm value, while those which have a problem in externalization cannot increase firm value. Moreover, conversion of tacit knowledge to explicit one by documentation and distribution explicit knowledge through the organization may break down tacit knowledge creation among the people with shared experience in the division.

Such results of the further exploration of organizational management practices explain some of the small impact of management practices on firm value. But it is, in some sense, reasonable that management practices have smaller impacts on firm value than R&D activities and brand equity, because management practices as firms' routines are difficult for outsiders to observe. It is consistent that causal ambiguity is one of the intangible barriers to imitation. When a firm's distinctive capabilities involve tacit knowledge, they are difficult to articulate as an algorithm, formula, or set of rules, and therefore, it is not observable or imitable (Rumelt 1984; Reed and DeFillipi 1990). Because of this, it is argued that intangible assets can be the sources of sustainable competitive advantages (Villalonga 2004).

Some researchers develop similar argument on the uniqueness of strategy. Uniqueness in strategy is a necessary condition for creating economic rents and should be positively associated with firm value. However, uniqueness in strategy heightens the cost of collecting and analyzing information to evaluate a firm's future values, and therefore, capital markets systematically discount uniqueness in the strategy choices of firms (Litov et al. 2012). Among intangible assets, technological capability and brand equity, on the other hand, are relatively easy for outsiders to observe, because R&D and advertising expenditures are publicly revealed.

Contrary to our findings, Bloom and Van Reenen (2007, 2010) and Bloom et al. (2012) find that high score of management practices leads to high firm performance, and therefore, is considered good management practices. We consider two possible reasons for such a contradiction: a difference in the ways of the survey and a difference in good management practices across the countries. While Bloom and Van Reenen (2007) conducted the survey to the plant manager of manufacturing, we did so to the managers of the planning departments. That is, while they asked on management practices of manufacturing plants, we asked on management practices of firms as a whole. Some management practices distinctively good for manufacturing plants, however, may not be so for non-plant establishments or organization as a whole. Therefore, this difference in the way of the interview may be the reason for the different results.

Suppose the item on training, for example. It is asked if training on an occupational ability (manufacturing, sales, etc.) is regularly executed in the interview. High score of this item may result in high performance at the plant level, but may not do so at the company level. Instead of such training, training on leadership, strategy formulation, and finance, or education in MBA program may be relevant.

The other reason may be related to the difference in management style among the countries (Aoki 1988, 2010), as our further exploration of organizational management practices suggests. For example, speedy decision making is usually considered a good management practice, while ground work, which slows down decision making, is regarded a bad management practice. In the U.S. firms with hierarchical coordination mechanism, people only have to report to their boss, and do not need prior consultations with many people. Therefore, speedy decision making without long ground work may increase productivity and firm performance. In Japanese firms with horizontal coordination mechanism, on the other hand, people need to consult with many people ex ante to reach a consensus. Decisions without a consensus may not be implemented smoothly, and therefore decrease firm performance.

That is, good management practices which lead to high firm performance are different between in Japan and in other countries. The further exploration of detailed practices in this paper suggests that some of the practices decrease firm value in the Japanese firms. Therefore, it is a promising future direction of international comparative research to refine the survey to capture good management practices for high performance of Japanese firms and to collect the data from Japanese firms as well as their counterparts in foreign countries using the refined survey.

Appendix: Questions Related to Organizational Management Practices

Implementation of organizational goals (setting target levels)

2. Are the settings for the individual or sectional target levels simply given to you from the division or section above you? Or are they given to you while considering the opinions of your division or section?
3. Are the target levels appropriately set as non-binding challenges?
4. Are target levels checked to ensure there is fairness between divisions or sections?

Implementation of organizational goals (permeation of goals)

2. Do all employees know the goals?
3. If goals exist on various levels (such as company-wide, divisional, and sectional goals), do all employees understand the level of priority of the goals?
4. Do all the employees accept the target levels and are they motivated to reach the levels?

Implementation of organizational goals (degree to which goals are achieved, checks on performance)

2. Are checks made to see how far goals have been achieved?
3. Are the checks made regularly?
4. In addition to the checks as a formal system, do employees make the checks voluntarily?

Implementation of organizational goals (permeation of degree to which goals are achieved, and results of checks on performance)

2. Are the results of such checks made openly available within your division?
3. Are the results of such checks made openly within not only your division but also between relevant divisions?
4. Are adjustments made to ensure that the degree to which goals have been achieved at different divisions is fairly compared?

Implementation of organizational goals (results of checks—handling when goals have not been achieved)

2. Is a meeting consisting of managerial staff and employees promptly held as soon as it is known that the goals were not achieved?
3. After investigation, are points to revise spread throughout the division, and are measures for handling the failure to achieve the goals promptly implemented?
4. Are problematic issues and countermeasures made throughout the relevant divisions, and if necessary, other divisions?

Implementation of organizational goals (results of checks—handling when goals have been achieved)

2. When goals are achieved are investigations made so that those goals renewed on a continuous basis or so that higher goals are set?
3. How long is it between the setting of higher goals and the operation/implementation of those goals?
4. Are these measures institutionalized on a company-wide level?

Decision making speed (ground work in case of starting a new business)

When you start a new business with other departments, how long do you spend ground work? Answer the ratio of the time for ground work within 100 % (from the beginning of the project to the start of the business).

1. Over 60 %
2. 40–59 %
3. 20–39 %
4. Under 19 %

Decision making speed (ground work in case of closing an existing business)

When you close an existing business, how long do you spend ground work? Answer the ratio of the time for ground work within 100 % (from the beginning of the project to the closing of the business).

1. Over 60 %
2. 40–59 %
3. 20–39 %
4. Under 19 %

*The number of each sub-question is the score you get when you answer "Yes" to the sub-question.

References

Aaker, D. A. (1991). *Managing brand equity*. New York: Free Press.

Aoki, M. (1988). *Information, incentives, and bargaining in the Japanese economy*. New York: Cambridge University Press.

Aoki, M. (2010). *Corporations in evolving diversity: Cognition, governance, and institutions*. New York: Oxford University Press.

Argyres, N. (1996). Capabilities, technological diversification and divisionalization. *Strategic Management Journal, 17*, 295–410.

Bloom, N., Genakos, C., Sadun, R., & Van Reenen, J. (2012). Management practices across firms and countries. *Academy of Management Perspectives, 26*, 12–33.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*, 1341–1408.

Bloom, N., & Van Reenen, J. (2010). Why do management practices differ across firms and countries? *Journal of Economic Perspectives, 24*, 203–224.

Brynjolfsson, E., & Hitt, L. (1995). Information technology as a factor of production: The role of differences among firms. *Economics of Innovation and New Technology, 3*, 183–200.
Corrado, C., Hulten, C., & Sichel, D. (2005). Measuring capital and technology: An extended framework. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy*. Chicago: University of Chicago Press.
Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *The Review of Income and Wealth, 55*, 661–685.
Helfat, C. E. (1994). Evolutionary trajectories in petroleum firm R&D. *Management Science, 40*, 1720–1747.
Helfat, C. E. (1997). Know-how and asset complementarity and dynamic capability-accumulation: The case of R&D. *Strategic Management Journal, 18*, 339–360.
Henderson, R. M., & Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal, 15*(Summer Special Issue), 63–84.
Hori, K., Saito, M., & Ando, K. (2004). 1990 Nendai no Setsubi Toshi Teimei no Haikei nitsuite: Zaimu Data wo Mochiita Panel Bunseki (On the cause of fixed investment stagnation during the 1990s in Japan: Evidence from panel data of the financial statements). *Economics Today, 25*(4), 1–70 (in Japanese).
Ito, K. (2000). *Corporate Brand Keiei (Corporate brand management)*. Tokyo: Nihon Keizai Shimbunsha (in Japanese).
Kawakami, A., & Asaba, A. (2013). *How does the market value management practices? Decomposition of intangible assets* (RIETI Discussion Paper Series 13-E-044)
Konar, S., & Cohen, M. A. (2001). Does the market value environmental performance? *The Review of Economics and Statistics, 83*, 281–289.
Lindenberg, E. B., & Ross, S. A. (1981). Tobin's q ratio and industrial organization. *Journal of Business, 54*, 1–32.
Litov, L., Moreton, P., & Zenger, T. R. (2012). Corporate strategy, analyst converge, and the uniqueness paradox. *Management Science, 58*, 1797–1815.
Miyagawa, T., Lee, K., Kabe, S., Lee, J., Kim, H., Kim, Y., et al. (2010). *Management practice and firm performance in Japanese and Korean firms – An empirical study using interview survey* (RIETI Discussion Paper 10-e-013).
Miyagawa, T., Takizawa, M., & Edamura, K. (2012). Does the stock market evaluate intangible assets? – An empirical analysis using listed firm data in Japan. *Mimeo*.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.
Reed, R., & DeFillipi, R. J. (1990). Causal ambiguity, barriers to imitation and sustainable competitive advantage. *Academy of Management Review, 15*, 88–102.
Rumelt, R. P. (1984). Toward a strategic theory of the firm. In R. Lamb (Ed.), *Competitive strategic management*. Englewood Cliffs, NJ: Prentice-Hall.
Simon, C. J., & Sullivan, M. W. (1993). The measurement and determinants of brand equity: A financial approach. *Marketing Science, 12*, 28–52.
Villalonga, B. (2004). Intangible resources, Tobin's q, and sustainability of performance differences. *Journal of Economic Behavior & Organization, 54*, 205–230.
Wooldridge, J. M. (2001). *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.

Chapter 9
Intangible Assets and a Theory of Heterogeneous Firms

David J. Teece

Abstract This article outlines a capabilities-enriched economic theory of the firm and its sources of competitive advantage. The nature and key categories of intangibles are discussed, with an emphasis on their suitability for providing differentiation in an era when so many services and tangible goods are readily available on a global basis. The linkages in the conversion of intangibles into profits are analyzed, including the frequent need for co-specialized complements. Among the key categories of intangibles are organizational capabilities, which can be either ordinary or dynamic. Ordinary capabilities are, generally, those that can be measured against best practice and with some effort, imitated by rivals. Dynamic capabilities, which reside in both signature processes and management skills, allow the enterprise and its top management to develop conjectures about the evolution of consumer preferences, business problems, markets, and technology; validate them; and realign assets and competences to enable continuous innovation for the creation of competitive advantage. The key concepts of complementarity, entrepreneurial management, and dynamic capabilities are then applied to deepening the economic theory of the firm, combining with the dominant transaction cost approach to provide a richer understanding of why firms are needed in the economic system.

Keywords Asset orchestration • Competitive advantage • Complements • Dynamic capabilities • Entrepreneurial management • Intellectual property • Know-how • Resources • Transaction cost economics • Theory of the firm

In the nineteenth and twentieth centuries, the assets that economists saw as sources of value were the traditional factors of production—land, labor, and capital—which were scarce and/or stayed within national boundaries. While these factors remain

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important for national economies, their mere ownership by firms does not guarantee that the firm will generate profits, because labor and capital have become highly mobile.

In fact, in today's global economy, most intermediate goods and a great deal of the world's information are so widely available that some say the world is "flat" (Friedman 2005), i.e., uniformly globalized. It is well recognized that a consequence of efficient factor markets is that it will be hard for any firm to earn better than a competitive return (Barney 1986).

The notion of "flatness" is, however, an extreme simplification. In reality, the integration of markets for products, people, and ideas is far from complete and the world remains "semiglobalized" (Ghemawat 2003). In particular, the (dynamic) capabilities required for business enterprises to learn and orchestrate (coordinate and control) resources globally remain scarce, and many types of intangibles do not "travel" easily.

The nexus of reduced barriers to global trade and investment and continued limits to the transfer of capabilities and know-how shapes competitive advantage. As a result, the development and astute management of intangible resources are central to sustained enterprise competitiveness. There are obvious implications for national economic growth and development, too.

The new global reality necessitates the development of new conceptual frameworks for business and economic analysis. As former U.S. Federal Reserve Chairman Alan Greenspan remarked a decade ago, "we must begin the important work of developing a framework capable of analyzing the growth of an economy increasingly dominated by conceptual products" (Greenspan 2004).

Perhaps surprisingly, mainstream economic theory has almost completely failed to come to grips with the role of intangibles, including the intuition and skills of top management, in creating value. Economists, from Adam Smith on, have never had much to say about the role of managers in coordinating the tangible and intangible assets of business enterprises in ways that both create and capture value. Perhaps the reason is that the task of understanding these issues is daunting. Indeed, figuring out the foundations, at a deep level, of enterprise-generated cash flow continues to be one of the greatest conundrums in economic and financial theory. Even management scholars struggle to arrive at an answer with any generality.

To lay out a capabilities-enriched economic theory of the competitive advantage of the firm, this paper proceeds as follows. It begins with a discussion of the nature and key categories of intangibles, emphasizing their importance for the generation of competitive advantage. The links between intangibles and profits are laid out, with an emphasis on the role of co-specialized complements. Special attention is then given to delineating a category of intangibles known as organizational capabilities and to analyzing the critical role of dynamic capabilities in the creation and maintenance of competitive advantage. The key concepts of complementarity, entrepreneurial management, and dynamic capabilities are then applied to the enrichment of the economic theory of the firm, combining with the dominant transaction cost approach to provide a deeper understanding of why firms are needed in the economic system.

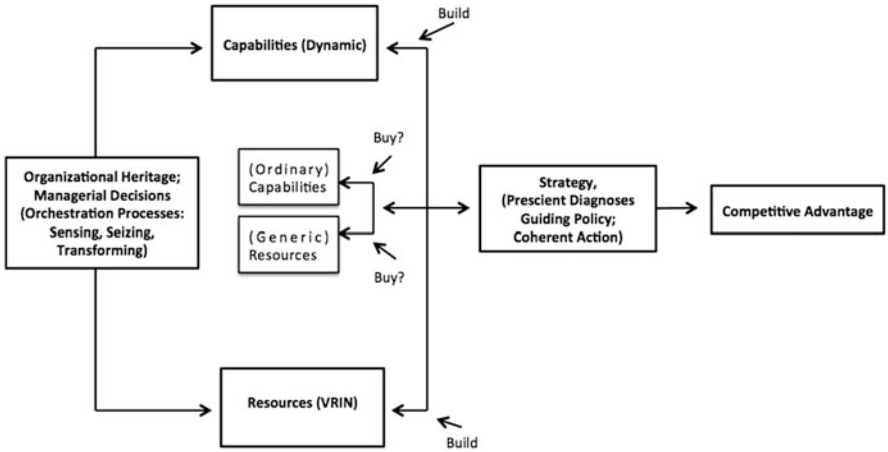

Fig. 9.1 Logical structure of the dynamic capabilities paradigm. Source: Teece (2014)

9.1 Intangible Assets and the VRIN Criteria

In the field of strategic management, the "resource-based" theory of the firm puts great emphasis on the importance of VRIN assets, those that are valuable, rare, inimitable, and non-substitutable (Barney 1991). The resource approach sees competitive advantage as flowing from a firm's VRIN resources. As explained later in this paper, the resource-based approach is not an adequate theory of the sources of competitive advantage. One also needs (dynamic) capabilities and strategy (see Fig. 9.1).

That said, VRIN resources are important building blocks for any theory of firm-level competitive advantage. Furthermore, the most important class of VRIN assets is that of intangibles, or what might be referred to as intellectual capital (Teece 2000).

Ownership (or control) of intangibles and their complements allows innovating firms to differentiate and establish some degree of competitive advantage. The augmentation and orchestration of these assets helps (along with strategy) to generate longer-run enterprise competitive advantage.

This is true across virtually all industries. Consider petroleum extraction. At least as important as the ownership of oil and gas reserves are a company's unique exploration and extraction technologies, the ability to deploy them effectively and safely, and relationships established over time with contract suppliers, regional authorities, and nation states.

In short, intangible assets are a very economically significant asset class, with powerful implications for building and maintaining competitive advantage for the enterprise (and for a nation). Yet most intangible assets are not even recorded on corporate balance sheets.

Table 9.1 Intangible assets compared with physical assets

	Intangible assets	Physical assets
Rival in use?	No	Yes
Property rights	Narrow and often fuzzy	Broad and relatively clear
Measurement and valuation	Relatively difficult	Relatively straightforward
Tradability	Low	High
Recognized on balance sheets	Only in limited ways	Yes (at book value)
Potential strategic (VRIN) importance	High	Low

9.1.1 Characteristics

Table 9.1 summarizes the differences between intangible and physical assets along selected dimensions.

First, intangibles differ from physical assets because they are not what economists call "rival in use," i.e., consumption by one individual does not reduce the amount left for another. One engineer's use of Newton's laws of motion does not subtract from the ability of others to use the same laws. However, while the use of particular industrial knowledge by multiple users will not reduce the availability of that knowledge, and, in some cases, will enhance it, the economic value of the knowledge may well decline, unless no users are direct competitors in the market.

Another important difference between intangible and physical assets is the availability and enforceability of property rights. Physical assets, such as plant, equipment, and land, are generally well protected, at least in developed countries.[1] Ownership is relatively easy to define, and the "boundaries" of the property are usually obvious. Whether theft has occurred is relatively easy to ascertain, and enforcement of the property right is generally available. Intangible assets and intellectual capital, on the other hand, have relatively poor protection. Although there are some exceptions, intellectual property rights are narrowly delineated.

Whereas most physical assets can be bought and sold in "thick" (i.e., liquid) markets with relative ease (apart from equipment that has been highly customized), markets for most intangibles, if they exist at all, will be "thin." This is in part because of the limited nature of property rights surrounding intangible assets. It's also because the value of a knowledge asset often derives from the presence of complementary assets in a way that is context-dependent. Certain knowledge assets (such as technological capabilities) cannot be meaningfully secured without acquiring a company or business unit, then finding a way to retain key personnel. Furthermore, some knowledge assets can be costly to transfer following a purchase (Teece 1981). The number of buyers who will be willing and able to pay for a knowledge asset's full potential strategic value (i.e., its value in use to the present owner) is generally limited.

[1] Needless to say, through land use and other controls, national governments and local authorities can dramatically impair the value of real estate by limiting its use.

This nontradability is central to the (strategic) importance of intangibles. In a world where most assets and services are available for hire, the ownership of unique, non-tradable assets like intangibles offers a potential source of advantage.

Whereas tangible assets are generally included on balance sheets, intangible assets are less readily measured, and their valuation remains too controversial for financial accounting standards boards to agree upon a methodology. As a result, intangibles are mostly absent from a firm's financial statements. Under international accounting standards (IFRS 2012), only non-physical, non-financial assets that are technically separable from the physical and human resources of the firm can be reported as assets. Examples include patents, copyrights, trademarks, customer lists, franchises, marketing rights, software, and digital content.

Intangibles for internal use, such as improved business processes and better-trained staff, are excluded from financial statements. Investments in the creation of new intangibles, including major categories such as marketing and R&D, continue to be mostly expensed rather than capitalized. The chief exception arises from mergers and acquisitions, where accounting rules treat any purchase premium over book value as "goodwill," a non-separable intangible asset recognized by accountants.

Corporate balance sheets are thus poor proxies for the economic value of the assets of an enterprise. Moreover, management is often unaware of some of the firm's knowledge assets and of the deeper sources of its competitive advantage. As the saying goes, you cannot manage what you cannot measure. Yet the effective management of intangibles is one of the most likely foundations for profitability.

The creation of intangibles can be very challenging, depending on the characteristics of the technology involved (Teece 2005). The most common way of adding to the enterprise's stock of intangibles is investment in learning activities, including formal R&D. One reward for this effort is that imitation and replication of intangibles by rivals is often hard, which provides some insulation against the dissipation of profits.

One common feature of both physical and intangible assets is depreciation, or obsolescence. While knowledge does not "wear out" as most physical assets do, knowledge is frequently subject to rapid depreciation because of the creation of new inventions and innovations. If a firm's own renewal process does not make its existing knowledge obsolete, then a competitor's knowledge activities are likely to do so.

9.1.2 Types

There are many types of intangibles. The patent, a form of intellectual property, is perhaps the best known.

A valid patent theoretically provides rights for exclusive use of an invention by the patent owner, but reality is seldom so simple. The validity of a patent may need to be proved in court at considerable expense before it is accepted by rivals.

Ascertaining whether infringement has occurred can be difficult. There can also be "holes" and "gaps" in intellectual property coverage. Moreover, patents (and copyrights) eventually expire.

Trade secrets, another class of intangible, can augment the value of a patent position. They do not provide rights of exclusion over a knowledge domain, but they protect covered secrets in perpetuity. Trade secret protection is possible, however, only if a firm can put its product before the public and still keep the underlying technology secret. This is most likely to be true of industrial processes.

Trade secrets are part of a broad and critical class of intangible called know-how. Know-how is often embedded in the organization as a whole, which can make it the most difficult element of a product's value chain for rivals to imitate. Thus Dell's direct sales and build-to-order business model was embodied in manufacturing, distribution, and IT systems that competitors found hard to imitate, at least for many years (Kraemer et al. 2000). Capabilities, about which more will be said later, are related to know-how.

Another intangible asset of central importance is the firm's business model,[2] i.e., the logic of how a business creates and delivers value to customers while earning a profit for itself (Chesbrough and Rosenbloom 2002; Teece 2010). Business model innovations are critical to success in unsettled markets where traditional revenue and pricing models are no longer applicable. The growth of the Internet is both allowing and requiring business model innovation in many industries ranging from music to insurance. In particular, the Internet requires new pricing structures for many products because users are now accustomed to getting information for free. In other industries, middlemen serving as information brokers are being disintermediated.

Other interesting classes of intangible assets include brands, customer and business relationships, and organizational culture.

9.2 Profiting from Intangibles

Markets are a great leveler. If assets or their services are traded in a market, they can be accessed by all who can pay. The range of domains in which competitive advantage can be built narrows as more and more activities become outsourceable. The Internet and other recent innovations have vastly expanded the number and type of goods and services that are readily accessed externally.

Intangible assets, perhaps the most important category of non-tradables, have the potential to form a basis for long-term profitability if the assets are astutely managed. However, intangible assets by themselves will not generally yield value; they must almost always be combined with other intangible and physical

[2] Business models in their entirety are generally not protected by intellectual property rights. Certain elements of a model might qualify for patent or copyright protection.

complements in a way that yields value for a customer.[3] Then the assets and complements must be managed in a way that maximizes appropriability.

9.2.1 Co-specialized Complements and Ecosystems

The aggregate economic value achieved by combining two or more complementary assets exceeds the value that would be achieved by using these factors in different activities. When complements are worth far more together than in any other separate uses, the complements are said to be co-specialized, and managerial "control" of the complements becomes critical. Whether that control is achieved through ownership or simply through setting the rules for a supporting ecosystem depends on the facts and circumstances. Complements that are not available from competitively-priced suppliers must generally be owned by the focal firm to avoid dissipating profits (Teece 1986, 2006).

Complementarity is not a new phenomenon. Rosenberg (1979: 26) notes: "Time and again in the history of American technology it has happened that the productivity of a given invention has turned on the availability of complementary technologies." Furthermore, "the growing productivity of industrial economies is the complex outcome of large numbers of interlocking, mutually reinforcing technologies, the individual components of which are of very limited economic consequences by themselves. The smallest relevant unit of observation, therefore, is seldom a single innovation but, more typically, an interrelated clustering of innovations" (Rosenberg 1979: 28–29).

The ability to assemble interdependent configurations of co-specialized assets, as in the case of systemic innovation (Teece 1984), can provide a unique value proposition. Common ownership of intangibles and certain complements will enable them to co-evolve in a coordinated way.

Co-specialization is becoming ubiquitous for devices and services that span multiple industries, such as smartphones that combine functions of computing, communication, and consumer entertainment products. As former Nokia CEO Stephen Elop said in his February 2011 (internal) "burning platform" memo, "The battle of devices has now become a war of ecosystems, where ecosystems include not only the hardware and software of the device, but developers, applications, e-commerce, advertising, search, social applications, location-based services, unified communications and many other things. Our competitors aren't taking our market share with devices; they are taking our market share with an entire ecosystem."[4]

[3] The VRIN criteria discussed earlier tend to overlook this point, i.e., the V of VRIN is likely to be highly context dependent.

[4] The leaked Nokia memo was widely reproduced online. See, for example, http://www.engadget.com/2011/02/08/nokia-ceo-stephen-elop-rallies-troops-in-brutally-honest-burnin/ (accessed December 26, 2013).

The smartphone is an example of a multi-invention context (Somaya et al. 2011). It is one manifestation of the increase in technological complementarities that has generated a growing need for taking account of external intellectual property rights. Complicated products—particularly those with many components, parts or functions—may "read on" hundreds, if not thousands, of patents. Innovation in one product or service often increases the value of their complement(s) and may require the in-licensing of patent portfolios to facilitate design and operating freedom.

9.2.2 Appropriability

The appropriability of the income generated by (or with) a knowledge asset is a function of its (inherent) value, its nature (i.e., the type of knowledge), and its ease of imitation (particularly, the effectiveness of intellectual property rights as a barrier to imitation). Appropriability regimes can be "weak" (innovations are difficult to protect because they can be easily codified and legal protection of intellectual property is ineffective) or "strong" (innovations are easy to protect because knowledge about them is tacit and/or they are well protected legally). Table 9.2 shows this interaction of imitability and intellectual property rights.

Factors that make imitation difficult enhance appropriability. Thus, the more tacit the firm's productive knowledge, the harder is imitation by its competitors. When the tacit component is high, imitation may well be impossible, absent the hiring away of key individuals and the (possibly illegal) transfer of key organizational processes.

The tacitness of knowledge varies to some extent over the product cycle. New products and processes are often highly nuanced. Thus in the pre-paradigmatic phase of technological innovation (Abernathy and Utterback 1978; Teece 1986), the tacit component is likely to be high. Once a dominant design emerges, the rate of change of product design slows, and there is then the opportunity, if not the need, to codify technology. However, more rapid rates of innovation mean that there may be no time to codify (make explicit) new knowledge even when it is technically feasible to do so.

The observability of a technology also affects imitability. While insight into product technology can be obtained thorough strategies such as reverse engineering, this is generally not the case for process technology. Secrets are thus more protectable if there is no need to expose them in contexts where competitors can learn about them.

A technology becomes covered by intellectual property once it is legally recognized. In the case of patents, the conversion occurs when a particular country's patent office recognizes the inventor's application and grants a patent. That's not the end of it, however. Patents can be (and often are) challenged by users/

Table 9.2 Appropriability regimes

		Inherent Potential for Imitation	
		High	Low
Intellectual Property Rights	Loose	Weak	Moderate
	Tight	Moderate	Strong

Note: Imitation potential depends on the difficulty and complexity of the relevant know-how
Source: Teece (2005)

implementers. Hence, the value of a patent may evolve over time (Sherry and Teece 2004).

Intellectual property rights vary across jurisdictions in terms of the types of inventions to which they apply, how long they last, and how well they are enforced. But the value of intellectual property also differs across fields of endeavor, not just across industries or countries.

Patents rarely, if ever, confer strong appropriability, outside of special cases such as new drugs, chemical products, and rather simple mechanical inventions (Levin et al. 1987). Many patents can be "invented around" at modest costs (Mansfield et al. 1981; Mansfield 1985).[5] They are especially ineffective at protecting process innovation. Often patents provide little protection because the legal and financial requirements for upholding their validity or for proving their infringement are high, or because, in many countries, law enforcement for intellectual property is weak or nonexistent.

The more fundamental the invention, the better the chances that a broad patent will be granted, and granted in multiple jurisdictions around the world. The inventor of a core technology can further strengthen appropriability by seeking complementary patents on new features and/or manufacturing processes, and possibly on designs. The way the claims in the patent are written also matters.

While a patent is presumed to be valid in many jurisdictions, validity is never firmly established until a patent has been upheld in court. The most valuable patents are those that are broad in scope, have already been upheld in court, and cover a technology essential to the manufacture and sale of products in high demand.

The character of the appropriability regime (strong, weak, or in between) should shape strategy. Weak appropriability dictates reliance on other value capture mechanisms, such as developing complementary assets (e.g., an attractive brand image) that would earn a premium even if the intangible itself did not (Pisano and Teece 2007).

[5] Mansfield et al. (1981) found that about 60% of the patented innovations in their sample were imitated within four years. In a later study, Mansfield (1985) found that information concerning product and process development decisions was generally in the hands of at least several rivals within 12–18 months, on average, after the decision was made. Process development decisions tend to leak out more than product development decisions in practically all industries, but the average difference was found to be less than 6 months.

9.3 Intangible Assets, Resources and Capabilities

For long-term profitability, management must make decisions and take actions to build, modify, and renew intangibles and other resources. A good understanding of how this works is missing from most economic and financial models. The dynamic capabilities framework, which has emerged over the past 20 years in the field of strategic management, provides a theoretical infrastructure in which intangible assets can be seen as jewels. The crown, the frame in which they are assembled, is composed of dynamic capabilities, as explained below. In practice, the crown as well as the jewels need to be constantly revamped in order to support durable value to the realm.

To put this in its larger context, resources are potentially valuable assets (tangible and intangible) and people that are semi-permanently attached to a firm. As discussed above, some of these resources will meet the VRIN criteria. In order to keep their VRIN status, these resources must be constantly renewed. The need for renewal is amplified in fast-moving environments such as those characteristic of high-tech sectors. However, the need to renew resources also occurs in "low-tech" industries (e.g., life insurance).

How resources are used, and hence the value they generate, depends on the firm's capabilities, the subject to which this paper now turns. In this regard, it is useful to distinguish between ordinary and dynamic capabilities.

9.3.1 Ordinary Capabilities

Ordinary capabilities can best be thought of as achieving technical efficiency and "doing things right" in basic business functions: operations, administration, and governance. If done to a very high level of performance, an ordinary capability can become known as a best practice. Such capabilities often have a high public domain component, and, even if not, they are readily imitable and can therefore generally be acquired. I don't mean to denigrate their importance; they are often fundamental. But, on their own, they won't bring long-run success.

Ordinary capabilities involve the performance of those administrative-, operational-, or governance-related functions that are (technically) necessary to complete currently-planned tasks. They are embedded in some combination of (1) skilled personnel, including, under certain circumstances, independent contractors; (2) facilities and equipment; and (3) processes and routines, including the administrative coordination needed to get the job done.

Ordinary capabilities are mostly technical in nature. Much of the knowledge behind them can be borrowed, or "bought," through consultants or through a modest investment in training (Bloom et al. 2013). These capabilities can be measured against the requirements of specific tasks (such as good preventive maintenance, or proper supply chain management) and thus benchmarked to best practice. Strong ordinary capabilities are an indication that the firm has achieved best practices and owns or has access to skilled people and advanced equipment. Exercising them keeps people employed. But on their own they do not generate more than a competitive return—and possibly less—except when the competitive environment is very weak.

A recent demonstration of this was provided by a controlled study by Bloom et al. (2013), in which 14 Indian textile plants were taught a set of 38 well-known (in developed countries) management practices, resulting in a 17 % increase in productivity in the first year. The apparent reason for the firms' initial (avoidable) inefficiency was that the Indian managers had either not known about the superior practices or had been skeptical of what they had heard.

However, in an environment open to global competition where firms can look to similar benchmarks and have access to competitive off-the-shelf technologies and training, good and even "best" practices will diffuse rather quickly among at least some firms. The management consulting industry works hard to introduce clients to new and better—and usually non-proprietary—"best" practices, which contributes to making best practices nearly universal.

But best practices can become a trap, as the relentless and single-minded pursuit of efficiency can drive out the capacity to effectuate change, and the organization becomes sclerotic. Efficiency is easiest to achieve if the set of tasks the organization is to perform remain fixed. Hence, there is often inertia imposed by efforts to achieve best practice.

9.3.2 Dynamic Capabilities

Whereas ordinary capabilities are about doing things right, dynamic capabilities are about doing the right things, at the right time, based on unique managerial orchestration processes, a strong and change-oriented organizational culture, and a prescient assessment of the business environment and technological opportunities. Ordinary capabilities contribute to a firm's *technical* fitness in specific areas, but strong dynamic capabilities assist firms in achieving overall *evolutionary* fitness.

Strong dynamic capabilities help enable an enterprise to profitably build and orchestrate its competences and other assets that lie both within and beyond its boundaries, reconfiguring them as needed to innovate and respond to (or bring about) changes in the market and in the business environment more generally (Teece et al. 1997; Pisano and Teece 2007). They allow the enterprise and its top management to develop conjectures about the evolution of consumer preferences, business problems, markets, and technology; validate them; and realign assets and competences to enable continuous innovation and change.

Learning is central to such developments. The enterprise must learn (1) what customers want, (2) what new technologies might allow, (3) what aspects of the business model are working, and (4) whether the current strategy is effective and the company is on the path toward building a valuable business.

Dynamic capabilities reside, in part, with individual managers and the top management team. At certain key junctures, the ability of a CEO and the top management team to recognize a key development or trend, then delineate a response and guide the firm in its co-creation activities, may be the most important element of the firm's dynamic capabilities. But the organization's values, culture, and its collective ability to quickly implement a new business model or other changes are also integral to the strength or weakness of the firm's dynamic capabilities.

To the extent that dynamic capabilities are routinized, particularly at upper management levels, these practices are likely to rely on "signature processes" (Gratton and Ghoshal 2005). Signature processes, characterized in part by the methods and frequency with which top managers interact, arise from a company's heritage, including its prior management actions, certain irreversible investments, and context-specific learning.

Because of their deep, enterprise-specific roots, signature processes are not so easily imitated by other firms that did not and cannot share this history and that may have a different, incompatible corporate culture as well. Moreover, the replicability of a process or business model is often confounded, particularly externally, by what Lippman and Rumelt (1982) call "uncertain imitability." This, along with a high tacit component to the underlying knowledge, may keep a signature process effectively proprietary for considerable periods. As a result, signature processes themselves could satisfy the VRIN criteria. Hence, signature processes (and signature business models) are likely to be an important source of inter-firm heterogeneity, at least for a while (Jacobides and Winter 2012).

Over longer periods of time, however, even signature processes may become imitable by others. This transformation occurred with Toyota's lean production model, which is a tightly integrated set of processes that encompasses the entire value chain, from product design to customer relations (Womack et al. 1990). The "Toyota Production System" provided the automaker a source of competitive advantage for decades despite numerous and sustained attempts at imitation by rivals. However, it eventually diffused to other firms and even other industries. The multidivisional form (M-form) of business organization is another such example. Armour and Teece (1978) showed how early adopters of the M-form in the petroleum industry reaped significant profits from the new organizational structure, but the M-form-specific profits were competed away after about a dozen years.

Dynamic capabilities encompass how an enterprise obtains strengths, extends these strengths, innovates, synchronizes business processes and models with the business environment, and/or shapes the business environment in its favor. For applied purposes, they can usefully be broken down into three primary clusters: (1) identification, development, co-development, and assessment of technological opportunities in relationship to customer needs (*sensing*); (2) mobilization of resources to address needs and opportunities, and to capture value from doing so (*seizing*); and (3) continued renewal (*transforming*). Sensing, seizing and transforming are essential if the firm is to sustain itself as customers, competitors, and technologies change (Teece 2007). Asset orchestration is a meta-process that envelops and engages all three clusters.

In firms with strong dynamic capabilities, many actions and activities will take place simultaneously: servicing existing customers, acquiring new ones, developing new products and services, hiring top talent, retaining talent, raising capital, introducing new processes, improving operations, transforming as circumstances change, and so on. This requires what O'Reilly and Tushman (2004) call "ambidexterity," the ability to simultaneously keep an existing business in tune while actively exploring new opportunities. Ambidexterity is an example of a dynamic capability (O'Reilly and Tushman 2008). It is especially critical when industries are in rapid transition.

In the modern parlance of Silicon Valley, firms must (and do) "pivot" (Ries 2011) when inflection points occur in the ecosystem or when they discover that their strategy and/or business model is no longer working. While path dependence poses a constraint on the future actions of all enterprises, for some firms the legacy of the past, in the form of the dynamic capabilities they have built, can also provide the foundation and fulcrum of future growth.

9.4 Toward a Capabilities-Based Theory of the Firm

This framework of organizational capabilities, and of intangible resources more generally, can shed light on a fundamental question in economics, namely why the enterprise form of organization exists at all when price-based allocation via contracting is generally considered by economists to be efficient. A large literature has grown up addressing the issue of what types of assets and activities will be internal to the firm rather than allocated by the price system. The leading school of thought in this area concerns transaction costs, but transaction cost economics omits consideration of a number of variables that co-determine not only firm boundaries but also firm success or failure.

The dynamic capabilities framework, which posits that knowledge assets and their entrepreneurial management have become central to profit maximization in an era of globalized commerce and information, suggests a new theory of the firm. It combines the transaction-level understanding of the transaction cost framework with the enterprise-level understanding of management studies. In other words, transaction costs and capabilities are complementary, not competing, lenses for analyzing the business enterprise.

9.4.1 Transaction Costs and the Boundaries of the Firm

The primary contribution of transaction cost economics (Williamson 1975, 1985) to the theory of the firm is in the area of firm boundaries, i.e., the governance modes that the firm will use to conduct its business. To accomplish this, the transaction cost economics framework holds "production" activity constant even though it may depend endogenously on governance modes, as well as on the managerial actions, strategy, and structures chosen. An activity is most likely to be internalized when the assets involved are highly specific to that activity alone. Market modes of governance are seen as likely to "fail" in such cases because contracts between legally separate entities would likely lead to opportunistic renegotiation.

In other words, the appropriability problem of the firm is couched entirely in terms of the risk from opportunistic behavior by potential partners. From such a diagnosis, internalization of the partner's activity is the single and obvious solution. Co-creation activities, conducted within a strategic alliance, for example, are not considered.

The transaction cost conception of market failure is simply too narrow for some purposes. Williamson (1971), in his best-known statement on market failure, which he endorsed 28 years later (Williamson 1999), restricted his attention to market failures that were "failures only in the limited sense that they involve transaction costs that can be attenuated by substituting internal organization for market exchange" (Williamson 1971: 114). In the transaction cost view, entrepreneurial and managerial functions such as opportunity discovery, learning, and knowledge creation play almost no role.

Transaction cost economics, while helpful in many ways, nevertheless deflected attention away from more important issues around the very existence of markets. Market creation and co-creation functions are not merely a response to a market that has somehow failed to perform (relative to an ideal standard). Rather, it is often the case that the market has quite simply failed to emerge and/or needs to be created or co-created by entrepreneurially managed business enterprises (Pitelis and Teece 2010).

In other words, the rationale for the business enterprise is not just to achieve efficiencies relative to a theoretical market-based benchmark, but also to create and manage co-specialization. This necessitates a deeper understanding of complementarity.

9.4.2 Complementarities and Co-specialization

The theory of the firm has benefited, and can benefit further, from a more rigorous exploration of the concepts of complementarities and co-specialization. Early applications in the innovation literature can be found in Rosenberg (1979, 1982) and Teece (1986). Work on complementarities in a strategic context includes Teece (1980), Miller (1988), and Milgrom and Roberts (1990a, 1990b).[6]

[6] For a review of the literature on complementarity and the related mathematical concept of supermodularity, see Ennen and Richter (2010).

Teece (1980) pointed out that the complementarity of two assets or activities in and of itself has no direct implication for the boundaries of the firm because contractual arrangements exist that, in theory, can enable joint activities to take place without common ownership of the parts. Assets that are co-specialized to each other, however, need to be employed jointly, usually inside the firm. In the case of innovation, Teece (1980, 1986, 2006) defined contexts in which directly owning complementary assets is important for capturing value.

A robust theory of complementarities that provides economic insight has yet to emerge. While there is little doubt that complementary relationships exist among heterogeneous factors inside the firm (and that these can impact firm performance), the contexts in which such interactions occur have not been adequately specified. However, some evidence has been assembled. Monteverde and Teece (1982), while testing for the importance of asset specificity in predicting outsourcing decisions by GM and Ford, also found that a "systems effect"—defined as "the degree to which any given component's design affects the performance or [system-level integration] of other components" (p. 210)—was statistically significant in explaining GM and Ford's outsourcing decisions.

It should be noted that the notion of complementarity can be applied at a high level of aggregation, as with the Toyota Production System. It can also be applied at a very fine level of specificity, such as the complementarity between the (integrated) design and manufacture of automobile components. Parmigiani and Mitchell (2009) use the example of automobile dashboards, which they note typically consist of multiple, interdependent, complementary components. Both levels of aggregation seem to provide insights, suggesting the power and generality of insights from the concept of complementarity.

Complementarities expressed through their mathematical corollary (supermodularity) represent a rupture with mainstream models of production in economics. With production functions of the standard kind, decision makers need only equate marginal revenues to marginal cost, and they will deliver the (global) maximum in output. Complementarity, modeled as supermodularity, enables some departures from this extreme caricature by recognizing the existence of local maxima, reducing the deterministic nature of the model. A complements-based model of production also implies that design choices are discrete rather than continuous.

There are many circumstances where internal organization is clearly a superior way to organize and orchestrate the innovative activity essential to the renewal of firm resources. The most important (and also the most under-researched) domain within which organization inside the firm is likely to be necessary is the creation, transfer, protection, and orchestration of know-how and other intangibles of multiple, complementary types and/or from multiple disciplines.

Building and assembling co-specialized intangibles inside the firm (rather than accessing them through a skein of contracts) is not done primarily to guard against opportunism and recontracting hazards. While those considerations matter, effective coordination and alignment of the assets is the critical point, and would be virtually impossible to achieve through the price system. The market failure in this type of case is more fundamental than the mere presence of "transaction costs that can be attenuated" by unitary ownership.

In a dynamic capabilities perspective, the entrepreneurial manager must be free to orchestrate highly co-specialized assets. When performed astutely and proactively, such orchestration can: (1) keep the assets in value-creating alignment, (2) identify new co-specialized assets to be developed through the investment process, (3) pursue new market opportunities to which the assets, combined or separated, are suited, and (4) divest assets that no longer yield special value. These goals cannot be readily achieved through contracting mechanisms in part because of dynamic transaction costs[7] but also because there may not be a competent entity to build the assets that are needed. There is limited utility in labeling these business issues as a transactions cost problem.

Although opportunism surely exists and must be guarded against, the emphasis in dynamic capabilities is on creating the assets that in transaction cost economics become the object of rent appropriation. And effective asset creation depends as much on the talent and skill of entrepreneurial managers as on the capabilities embedded in the enterprise itself.

9.4.3 Managers

Transaction cost economics, and economic theory more generally, leaves us without an understanding of the distinctive role of the manager. Managers must not only choose among market arrangements, alliances, and internal organization; they must also understand how to design and implement different governance structures, to coordinate investment activities, to design and implement business models, and to craft appropriability strategies.

As both a theoretical and practical matter, it is important to ask how firms allocate resources so that they are in their first best use. How firms build, augment, and modify their resource base over time is also of critical importance. In other words, there are important resource allocation functions that (neoclassical) economic theory ignores: namely, how does the non-market coordination inside, between, and amongst firms actually take place? Who performs that role when the price mechanism is not available? Economic theory yields poor answers.

An economic theory of markets needs to somehow recognize that a good deal of resource allocation takes place inside firms and between and amongst firms as a result of entrepreneurial and managerial decisions, activated by managerially designed systems. When managers do take the stage in modern economics and finance, the focus is usually on the distribution, not the creation, of the spoils

[7] Langlois (1992) defines dynamic transaction costs as "the costs of persuading, negotiating, coordinating and teaching outside suppliers" (1992: 113).

between managers and shareholders (Jensen 2000).[8] This begs the question of where the wealth of firms comes from in the first place.

Although management skills have long been recognized in practice as a source of value, the proposition is finding new empirical support. Google, for example set up a project to test the impact of various management practices and found that "even 'the smallest incremental increases in manager quality were quite powerful'" (Garvin 2013: 77, citing Neal Patel, co-leader of Google's study).

Yet managers are scarce even in some versions of the resource-based view of the firm (e.g., Wernerfelt 1984). An idea first advanced by Penrose (1959) is that every firm has resources, including managerial skills, that can potentially be deployed into multiple product arenas. However, the resource-based view gives scant attention to the processes and skills needed for renewing the firm's resources. Moreover, Penrose and those who followed never provided any granularity with respect to the skills that undergird the growth and diversification of the firm, particularly the critical entrepreneurial skills of sensing, seizing, and transforming.

Managers are integral to harnessing the hard-to-imitate practices that undergird the generation, ownership, and management of know-how and other intangible assets. The capabilities to build and astutely manage these intangibles and their related complements have come to overshadow production-related economies of scale and scope as determinants of competitive outcomes in many contexts.

Perhaps more importantly, entrepreneurial managers are needed to design organizations that can discover and create new knowledge and then commercialize market-relevant new technologies. Entrepreneurial managers learn about new opportunities and sometimes help create them, transferring technology as needed. The topic of entrepreneurship, in both new ventures and existing firms, is sufficiently important that it merits separate attention.

9.4.4 Entrepreneurship and Market Creation[9]

Entrepreneurship is too often left out of theories about how economies function and how enterprises evolve. Most economic theories of the firm, apart from a few based directly on entrepreneurship (e.g., Sautet 2000), include an implicit assumption that all opportunities are known. And if they are not known, information costs are all that stand in the way of discovery.

But opportunity discovery is often far from straightforward. In globally competitive environments, consumer needs, technology, and competitor activity are constantly in flux. While the path ahead for some emerging marketplace trajectories is easily recognized, most emerging trajectories are hard to discern. Sensing new

[8] See Bloom and Van Reenen (2007) for a notable exception to the virtual exclusion of firm-specific managerial practices from the economics literature.

[9] This section draws on material in Al-Aali and Teece (2014).

opportunities amid the noise is very much a learning, creative, and interpretive activity at which, by definition, entrepreneurs excel. Necessary complements to individual insight are research and related activities that draw on expert talent and organizational strengths.

A useful tripartite conception of entrepreneurship was proposed by Sarasvathy et al. (2003): (1) the recognition and arbitrage of pre-existing but as-yet-unmatched supply and demand; (2) the process of discovering and exploiting new uses for existing products, such as recognizing a latent demand for gourmet coffee, or of finding a new way to supply an existing demand, such as a better cure for a disease; and (3) the creation and exploitation of new opportunities by conceiving of possible future demands and supplies that do not yet exist. The third, market creation form of entrepreneurship requires what Kirzner called "alertness," which includes "awareness of the ways the human agent can, by imaginative, bold leaps of faith, and determination, in fact create the future for which his present acts are designed" (Kirzner 1985: 56).

The notion that entrepreneurs must create each market before there are prices and consumer preferences that can lead to economic efficiency dates back to the work of Frank Knight (1921). However, this insight was largely eclipsed, particularly in the economics literature, by the contractual approaches to the firm put forward by Coase (1937), Williamson (1975), and others in which markets, technologies, and prices are simply assumed to exist (Boudreaux and Holcombe 1989).

Entrepreneurship and contractual (transaction cost) approaches are not incompatible. Foss et al. (2007) combined them in a theory of the firm by positing that a significant reason for the formation of firms in a world of uncertainty is to allow entrepreneurs to experiment with different combinations of heterogeneous capital. Teece (2014) outlined an entrepreneurial theory of the multinational enterprise.

Over time, the coordination and further development of capital assets will render them more and more specific to their use and to each other. Common ownership within the firm is thus the efficient means of preventing the possibility of a future hold-up by an external owner of one of the assets. It's also a way to best exploit the complementarities, especially when time and place matter.

Thus entrepreneurial sensing and asset orchestration provide a more complete explanation for the existence of the firm than does transaction cost reasoning alone. Entrepreneurial managers aren't simply responding to market failure. They are mobilizing organizational and other resources to stimulate new economic activity. Entrepreneurs are vital to this process because of their ability to form judgments in the face of uncertainty about the conditions in markets that don't yet exist.

Entrepreneurial activity demands a flexible, iterative approach to decision making (Alvarez and Barney 2007). Performing the required tasks takes adaptive leadership, deep knowledge of markets, and a clear understanding of the technical, physical, and human constraints of the resources at hand.

Market creation, including co-creation that involves networks and alliances, is a categorically different process from a make-or-buy decision that can be explained by arguing that markets "fail" under certain conditions, such as where complex know-how transfers are involved. The market in this case has yet to emerge, and might never do so in the absence of the entrepreneur.

The view of the firm as fundamentally entrepreneurial and market-creating is markedly different from contractual and market failure approaches. However, while entrepreneurship deepens an analysis of the existence of firms, it cannot, by itself, account for inter-firm heterogeneity and firm-level competitive advantage because it omits essential elements of environmental fit, strategy, and the need to respond to challenges as well as opportunities. Moreover, entrepreneurship, even in new ventures, is a social process, for the top management team and, ideally, for the whole organization (Foss et al. 2008). In short, dynamic capabilities, which include entrepreneurial management but also much more, must be included in the theory of the firm.

9.4.5 Capabilities

Dynamic capabilities, and organizational capabilities more generally, are all but absent from economic theories of the firm and of markets. The (neoclassical) economic model of market exchange takes for granted that somehow, somewhere new goods and services are being designed, developed, and produced by some method that will be technically efficient, conditional on factor costs. Moreover, it is often assumed that everyone knows all relevant information.

Transaction cost economics implicitly assumes what might be referred to as capabilities neutrality. In transaction cost economics, so called "production costs"—which might be thought of as a proxy for the firm's level of operational capability—are assumed to be the same across organizational types so that the choice between market and non-market arrangements swings entirely on transaction/governance costs.

The introduction of capabilities to the theory not only helps inform the choice of transaction governance, but also brings the possibility of explaining differences between firms in productive efficiency and profitability as a function of managerial activity. The field of strategic management is built on the recognition that firms are different in ways that drive performance differences (Rumelt et al. 1991).

As noted earlier, the production theory of neoclassical economics (implicitly) assumes away numerous organizational problems, rendering firms more or less interchangeable. A production function (or production sets) assumes specified relationships between inputs and outputs and the existence of a global maximum in most states of the world. Inside the black box that is the firm, best practices are implicitly being followed by all.

An exception to the simplification of economics that all firms operate efficiently is Leibenstein's (1966) concept of x-inefficiency, which refers to particular firms operating above their cost curves. This allows for firm-level heterogeneity. Leibenstein and others attributed x-inefficiency to a lack of competition; but the more fundamental reason is likely to be poor management and limited information. In any event, Leibenstein's theory, despite being cited occasionally, has not really been embraced by economists.

The dynamic capabilities framework suggests a theory of the firm that not only accommodates firms with x-inefficiency (i.e., firms with costs above the technically efficient level); they can also suffer from what might be called "d-ineffectiveness" (i.e., weak dynamic capabilities). In other words, (1) not all firms are at the best practice frontier and (2) even those that have adopted best practice may be producing the "wrong" products relative to current market requirements and technological opportunities.

Thus, a theory of "capability economics" allows for (and helps explain) heterogeneity amongst firms. The so-called Austrian School of economics allows for entrepreneurs and for differences between firms related to differential access to information, but it doesn't have much room for the manager. There is a place for both the entrepreneur and the manager in capability economics—and in the dynamic capabilities framework more generally.

Firm-level heterogeneity can be, and has been, assessed empirically. Ordinary capabilities are generally measurable and therefore relatively straightforward to compare across firms. Although dynamic capabilities are complex and not always directly observable, researchers have had success assessing them through the use of surveys (e.g., Morgan et al. 2009), secondary sources of data about corporate decisions (e.g., Adner and Helfat 2003), and the provision of advisory services (Feiler and Teece forthcoming).

9.5 Conclusion

This paper has analyzed the central importance of intangibles for the generation of firm-level profits. It then showed how a specific category of intangibles called dynamic capabilities is able to account for persistent firm-level differences in business and financial performance that mainstream economists often assume away. The proposed capabilities-based theory opens up the black box of the firm and injects into economic theory new considerations that are ignored in most microeconomic and transaction cost models.

A rich understanding of the existence and role of the firm must encompass what successful firms actually do. Concepts such as heterogeneity, complementarity, entrepreneurial management, and dynamic capabilities need to be integrated more fully into mainstream models.

In the theory advanced here, management's task is not just to overcome "failures" in the market for intangibles when structuring the firm; it must also build and leverage distinctive intangible resources, especially signature processes and signature business models, and then combine and orchestrate assets internally and externally, guided by a prescient strategy. Organizations must be designed for the flexibility to undertake periodic renewal and transformation.

In other words, the growth and survival of the enterprise is not just about working around market failures; it's also about creating and implementing VRIN resources and managing complementarities to enable excellence in meeting (and sometimes even modifying) market demand in ways that are hard for competitors to imitate.

In the semi-globalized world economy, intangible assets are more apt than most physical assets to be VRIN. An organization that can bring good strategy and strong dynamic capabilities to intangible assets is likely to have durable competitive advantage.

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References

Abernathy, W. J., & Utterback, J. M. (1978). Patterns of industrial innovation. *Technology Review, 80*(7), 40–47.

Adner, R., & Helfat, C. E. (2003). Corporate effects and dynamic managerial capabilities. *Strategic Management Journal, 24*(10), 1011–1025.

Al-Aali, A., & Teece, D. J. (2014). International entrepreneurship and the theory of the (long-lived) international firm: A capabilities perspective. *Entrepreneurship Theory and Practice, 38* (1), 95–116.

Alvarez, S. A., & Barney, J. B. (2007). Discovery and creation: Alternative theories of entrepreneurial action. *Strategic Entrepreneurship Journal, 1*(1–2), 11–26.

Armour, H. O., & Teece, D. J. (1978). Organizational structure and economic performance: A test of the multidivisional hypothesis. *Bell Journal of Economics, 9*(18), 106–122.

Barney, J. B. (1986). Organizational culture: Can it be a source of sustained competitive advantage? *Academy of Management Review, 11*(3), 656–665.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120.

Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., & Roberts, J. (2013). Does management matter? Evidence from India. *Quarterly Journal of Economics, 128*(1), 1–51.

Bloom, N., & Van Reenen, J. (2007). Measuring and explaining management practices across firms and countries. *Quarterly Journal of Economics, 122*(4), 1351–1408.

Boudreaux, D. J., & Holcombe, R. G. (1989). The Coasian and Knightian theories of the firm. *Managerial and Decision Economics, 10*(2), 147–154.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change, 11*(3), 529–555.

Coase, R. (1937). The nature of the firm. *Economica, 4*(16), 386–405.

Ennen, E., & Richter, A. (2010). The whole is more than the sum of its parts—or is it? A review of the empirical literature on complementarities in organizations. *Journal of Management, 36*(1), 207–233.

Feiler, P., & Teece, D. (forthcoming). Case study: Dynamic capabilities and upstream strategy: Supermajor EXP. *Energy Strategy Reviews*.

Foss, K., Foss, N. J., Klein, P. G., & Klein, S. K. (2007). The entrepreneurial organization of heterogeneous capital. *Journal of Management Studies, 44*(7), 1165–1186.

Foss, N. J., Klein, P. G., Kor, Y. Y., & Mahoney, J. T. (2008). Entrepreneurship, subjectivism, and the resource-based view: Toward a new synthesis. *Strategic Entrepreneurship Journal, 2*(1), 73–94.

Friedman, T. L. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar, Straus and Giroux.

Garvin, D. A. (2013). How Google sold its engineers on management. *Harvard Business Review, 91*(12), 74–82.

Ghemawat, P. (2003). Semiglobalization and international business strategy. *Journal of International Business Studies, 34*(2), 138–152.

Gratton, L., & Ghoshal, S. (2005). Beyond best practice. *MIT Sloan Management Review, 46*(3), 49–57.

Greenspan, A. (2004, February 27). *Remarks on intellectual property rights*. Paper presented at the Stanford Institute for Economic Policy Research Economic Summit, Stanford, CA. Available at Federal Reserve Board. Accessed April 28, 2010, from http://www.federalreserve.gov/boarddocs/speeches/2004/200402272/default.htm

IFRS. (2012). *IAS 38 intangible assets*. International Financial Reporting Standards Foundation. Retrieved December 10, 2013, from http://www.ifrs.org/IFRSs/IFRS-technical-summaries/Documents/IAS38-English.pdf

Jacobides, M. G., & Winter, S. G. (2012). Capabilities: Structure, agency, and evolution. *Organization Science, 23*(5), 1365–1381.

Jensen, M. C. (2000). *A theory of the firm: Governance, residual claims, and organizational forms*. Cambridge, MA: Harvard University Press.

Kirzner, I. M. (1985). *Discovery and the capitalist process*. Chicago: University of Chicago Press.

Knight, F. (1921). *Risk, uncertainty and profit*. New York: Augustus Kelley.

Kraemer, K. L., Dedrick, J., & Yamashiro, S. (2000). Refining and extending the business model with information technology: Dell Computer Corporation. *Information Society, 16*(1), 5–21.

Langlois, R. N. (1992). Transaction-cost economics in real time. *Industrial and Corporate Change, 1*(1), 99–127.

Leibenstein, H. (1966). Allocative efficiency vs. "X-inefficiency". *American Economic Review, 56* (3), 392–419.

Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., & Griliches, Z. (1987). Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity, 1987*(3), 783–831.

Lippman, S. A., & Rumelt, R. P. (1982). Uncertain imitability: An analysis of inter-firm differences in efficiency under competition. *Bell Journal of Economics, 13*(2), 418–438.

Mansfield, E. (1985). How rapidly does new industrial technology leak out? *Journal of Industrial Economics, 34*(2), 217–223.

Mansfield, E., Schwartz, M., & Wagner, S. (1981). Imitation costs and patents: An empirical study. *Economic Journal, 91*(364), 907–918.

Milgrom, P., & Roberts, J. (1990a). The economics of modern manufacturing: Technology, strategy, and organization. *American Economic Review, 80*(3), 511–528.

Milgrom, P., & Roberts, J. (1990b). Rationalizability, learning and equilibrium in games with strategic complementarities. *Econometrics, 58*(6), 1255–1277.

Miller, D. (1988). Relating Porter's business strategies to environment and structure: Analysis and performance implications. *Academy of Management Journal, 31*(2), 280–308.

Monteverde, K., & Teece, D. J. (1982). Supplier switching costs and vertical integration in the automobile industry. *Bell Journal of Economics, 13*(1), 206–213.

Morgan, N. A., Vorhies, D. W., & Mason, C. H. (2009). Market orientation, marketing capabilities, and firm performance. *Strategic Management Journal, 30*(8), 909–920.

O'Reilly, C. A., & Tushman, M. L. (2004). The ambidextrous organization. *Harvard Business Review, 82*(4), 74–81.

O'Reilly, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in Organizational Behavior, 28*, 185–206.

Parmigiani, A., & Mitchell, W. (2009). Complementarity, capabilities, and the boundaries of the firm: The impact of within-firm and interfirm expertise on concurrent sourcing of complementary components. *Strategic Management Journal, 30*(10), 1065–1091.

Penrose, E. T. (1959). *The theory of the growth of the firm*. New York: Wiley.

Pisano, G., & Teece, D. J. (2007). How to capture value from innovation: Shaping intellectual property and industry architecture. *California Management Review, 50*(1), 278–296.

Pitelis, C. N., & Teece, D. J. (2010). Cross-border market co-creation, dynamic capabilities and the entrepreneurial theory of the multinational enterprise. *Industrial and Corporate Change, 19*(4), 1247–1270.

Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. New York: Crown Business.

Rosenberg, N. (1979). Technological interdependence in the American economy. *Technology and Culture, 20*(1), 25–50.
Rosenberg, N. (1982). *Inside the black box: Technology and economics*. New York: Cambridge University Press.
Rumelt, R. P., Schendel, D., & Teece, D. J. (1991). Strategic management and economics. *Strategic Management Journal, 12*(Winter Special Issue), 5–29.
Sarasvathy, S. D., Dew, N., Velamuri, S. R., & Venkataraman, S. (2003). Three views of entrepreneurial opportunity. In Z. J. Acs & D. B. Audretsch (Eds.), *Handbook of entrepreneurship research: An interdisciplinary survey and introduction* (pp. 141–160). Dordrecht, The Netherlands: Kluwer.
Sautet, F. E. (2000). *An entrepreneurial theory of the firm*. London: Routledge.
Sherry, E. F., & Teece, D. J. (2004). Royalties, evolving patent rights, and the value of innovation. *Research Policy, 33*(2), 179–191.
Somaya, D., Teece, D., & Wakeman, S. (2011). Innovation in multi-invention contexts: Mapping solutions to technological and intellectual property complexity. *California Management Review, 53*(4), 47–79.
Teece, D. J. (1980). Economies of scope and the scope of the enterprise. *Journal of Economic Behavior and Organization, 1*(3), 223–247.
Teece, D. J. (1981). The market for know-how and the efficient international transfer of technology. *Annals of the Academy of Political and Social Science, 458*(1), 81–96.
Teece, D. J. (1984). Economic analysis and strategic management. *California Management Review, 26*(3), 87–110.
Teece, D. J. (1986). Profiting from technological innovation. *Research Policy, 15*(6), 285–305.
Teece, D. J. (2000). *Managing intellectual capital: Organizational, strategic, and policy dimensions*. Oxford: Oxford University Press.
Teece, D. J. (2005). Technology and technology transfer: Mansfieldian inspirations and subsequent developments. *Journal of Technology Transfer, 30*(1–2), 17–33.
Teece, D. J. (2006). Reflections on profiting from innovation. *Research Policy, 35*(8), 1131–1146.
Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350.
Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning, 43* (2–3), 172–194.
Teece, D. J. (2014). A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. *Journal of International Business Studies, 45*(1), 8–37.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.
Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171–180.
Williamson, O. E. (1971). The vertical integration of production: Market failure considerations. *American Economic Review, 61*(2), 112–123.
Williamson, O. E. (1975). *Markets and hierarchies: Analysis and antitrust implications*. New York: Free Press.
Williamson, O. E. (1985). *The economic institutions of capitalism*. New York: Free Press.
Williamson, O. E. (1999). Some reflections. In G. R. Carroll & D. J. Teece (Eds.), *Firms, markets, and hierarchies: The transaction cost economics perspective* (pp. 32–36). New York: Oxford University Press.
Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world: Based on the Massachusetts Institute of Technology 5-million dollar 5-year study on the future of the automobile*. New York: Rawson.

Chapter 10
Resource Reallocation and Innovation: Converting Enterprise Risks into Opportunities

Mark A. Dutz

Abstract The paper argues that the increased flow and management of knowledge permitted by Knowledge-Based Capital (KBC), supported by appropriate policies, can be an important factor in reducing the decision risk facing enterprises due to uncertainty and imperfect information, helping improve the resilience of development outcomes. Enterprises are conceptualized as information platforms that manage risk through investments in KBC and complementary assets, providing them with the knowledge, protection/enabling, insurance and coping/leveraging abilities to make better decisions in response to shocks. Investments in KBC allow enterprises to better convert voluntary but risky reallocation and innovation decisions into productivity and wealth-enhancing opportunities. They can help the enterprise sector as a whole and most people to self-protect and realize better jobs, earnings and consumption outcomes by adapting to shocks. However, absent appropriate policies, KBC can have adverse distributional effects—including a skewed industrial concentration of productivity gains and more unequal consumption and income-earning outcomes between rich and poor people. The paper discusses the role of policy in facilitating risk management by enterprises, ultimately to reduce poverty and boost shared prosperity. Insufficient enterprise risk-taking is costly for the enterprise sector and the economy as it results in too little experimentation and learning. Governments should create business environments that stimulate entrepreneurial risk-taking to invest in market and social opportunities that combine new technologies with appropriately-skilled workers. Policies allowing people to better confront and manage their risks include: (1) spurring entrepreneurial experimentation; (2) supporting skills upgrading; and (3) promoting mechanisms for joint learning through global collaboration.

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10.1 Introduction

Measurement of business spending on non-tangible knowledge assets or KBC (Knowledge-Based Capital) is relatively recent, with the seminal work applying direct expenditure methods initially done for the U.S. economy (OECD 1998; Nakamura 2001, Corrado, Hulten and Sichel or CHS 2005 and 2009).[1] In contrast to the conventional approach of treating spending on knowledge assets as intermediate expenditures and thereby assuming that all their benefits are reflected in the current year's output of tangible goods and services, the KBC approach correctly capitalizes outlays that contribute to production and value beyond the taxable year and treats them as longer-lived knowledge investments—using the same cost-based accounting that is used for physical capital. The KBC approach opens up the black box of conventional Total Factor Productivity by explicitly measuring key knowledge-related elements rather than estimating them as a residual. The CHS classification divides KBC into three categories:

1. ***Digital assets*** *(labeled "computerized information")*—what firms spend on databases and software to better measure, manage and reorganize what they are doing in light of changing external demand and supply conditions
2. ***Intellectual assets*** *("innovative property")*—spending on R&D, creative assets, copyright and licensing costs, architectural, engineering and other designs, new products/systems in the financial industry, and mineral exploration and evaluation
3. ***Human-organizational assets*** *("economic competencies")*—outlays on market research, advertising and brand equity, firm-specific human capital, and business process/organizational improvements.

The acceleration of globalization, technological progress, and increased trade and competition have resulted in rents from new ideas becoming more important for sustained firm-level competitiveness and aggregate growth across countries, but also in higher risks in the commercial exploitation of these ideas. As knowledge inputs are becoming a bigger share of value added and all countries are seeking ways to take advantage of information communication and related technologies in their transition to more knowledge-intensive economies, investments in the full range of activities needed to commercialize new ideas and create competitive advantage are becoming more important over time. The increasing importance of KBC over time is shown by the steady increase in the KBC investment rate in the US as a share of expanded nonfarm business output, from 8 % in 1977 to 14 % in

[1] See Corrado et al. (2012) for an application to advanced economies, Dutz et al. (2012b) to Brazil, Hulten and Hao (2012) to China, and Hulten et al. (2012) to India.

2010, in contrast with a secular decline in the tangible investment rate (Corrado and Hulten 2010; Hulten 2013).[2] This is not unique to the developed high-income countries: Hulten and Hao (2012) estimate increases in KBC investments over time for China from 3.8 % in 1990 to 7.5 % as a fraction of GDP for the total economy, and Dutz et al. (2012b) estimate increases for Brazil from 3.5 % in 2000 to 4.8 % in 2008 as a fraction of GDP.

The KBC approach has expanded the conventional proximate measured sources of growth beyond human and physical capital to include knowledge investments in the resource reallocation/innovation and risk management capabilities of the enterprise. Importantly, these investments go significantly beyond traditionally-measured R&D expenditures to include a range of co-investments required for enterprises to decide what to produce and how, to develop new ideas, and to execute and translate these ideas into products, processes and markets—outlays such as market research and databases, design and marketing, skills, management systems including how to get the right people into the right jobs, and joint learning through collaborative networks. Estimates of KBC at the aggregate level across countries, to-date available mainly for high-income OECD countries but also for Brazil, China and India, highlight that KBC is an important element of aggregate economic growth, with a significant positive correlation between investments in "core" KBC (excluding software and architectural and engineering designs to control for the links with IT equipment investment and real estate bubbles) and PPP-adjusted output per capita (Hulten 2013; OECD 2013).[3]

This paper explores the implications of explicitly expanding the range of applicability of the concept of KBC to the risk management challenges that enterprises face—including both exogenous risks arising from unexpected shocks and changing demand and supply trends as well as the endogenous risks arising from voluntary resource reallocation and innovation investments that firms take in the pursuit of opportunities for better expected rates of return. Investments in different types of KBC are consequently conceptualized as investments in both resource reallocation/innovation and risk management capabilities, including investments to manage the risks associated with reallocation and innovation such as outlays on knowledge about emerging new technologies and changes in consumer preferences, on software and databases to build capabilities for more flexible adjustment, and on

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[2] In the UK, business investment in KBC is estimated to have more than doubled as a share of market sector gross value added between 1970 and 2004. For similar data on other developed high-income countries, see OECD (2013).

[3] One particular type of economic competencies-related KBC that has recently benefited from empirical studies in developing countries is "managerial capital". See Bruhn et al. (2010) for an overview, and the complementary findings of Bloom et al. (2013a) on the impact of intensive consulting services from an international firm on the business practices of 20 large Indian textile experimental plants, and Bruhn et al. (2013) on the impact of a heterogeneous set of local consulting firms on 80 small and medium-sized Mexican firms across industries taking the support, with both studies finding that access to management consulting leads to better enterprise performance.

internal organizational routines to learn from failures: KBC investments allow enterprises to better convert voluntary but risky reallocation and innovation decisions into productivity and wealth-enhancing opportunities, and to better cope if the associated investments don't turn out as anticipated.[4] In addition, the types of measured KBC are expanded in this paper to include an additional-to-CHS sub-category likely most important for developing country industries behind the global technological frontier, namely spending on collaboration-related assets to diffuse, capture, adapt to local context and use existing but new-to-the-firm knowledge, such as outlays on networking and peer-to-peer learning from global value chains and from foreign buyers and sellers, from consultants and study tours, and from other forms of global knowledge. The paper maps the main types of KBC investments into the four pillars of risk managed initially proposed by Ehrlich and Becker (1972), namely: investments in ***knowledge*** of supply and demand trends and the likelihood of shocks; investments in ***protection/enabling*** to reduce the probability of losses and increase the probability of successful reallocation and innovation; investments in ***insurance*** to reduce the size of losses by transferring resources from good to bad times; investments in ***coping/leveraging*** for *ex post* loss recovery or benefit enlargement if the investments in reallocation and innovation are successful in the marketplace. As an illustration, the paper applies this framework to investments in KBC that have supported enterprise risk management in the Chilean wine industry.

In its analysis, the paper explores the role of resource reallocation and innovation decisions in adjusting to and leveraging risks and the supportive role of KBC—rather than other complementary mechanisms of enterprise risk management. Section 10.2 discusses how the enterprise sector manages risk, with a focus on KBC as investments in resource reallocation/innovation and risk management capabilities. Section 10.3 then explores how enterprise risk management through reallocation and innovation can help people better manage risks, both indirectly through its impact on the enterprise sector, and directly through its impact on people as consumers and as income earners. Section 10.4 explores the role of public policy, focusing on three possible intervention areas: (1) spurring entrepreneurial experimentation—by setting the rules of the game in the business environment for the allocation of entrepreneurial talent towards innovation including reducing distortionary "costs of success" and "costs of failure", and ensuring sufficiently flexible and competitive product and factor markets with as much policy certainty as possible; (2) supporting skills upgrading—by investing in human capital and facilitating people to invest in themselves through enterprise-driven on-the-job and vocational training, and reinforcing urban agglomerations of enterprises and people for enhanced knowledge spillovers; and (3) promoting mechanisms for joint learning through global collaboration—by facilitating firms' connecting to and learning from global value chains, universities and their extended communities, and the

[4] A number of recent papers, such as Andrews and Criscuolo (2013), Hulten (2013) and OECD (2013) examine key linkages between KBC, resource reallocation and innovation, but do not explicitly consider the role of KBC in facilitating enterprise risk management.

relevant national diaspora, supported by open data platforms. A final concluding section suggests some outstanding issues that could benefit from further measurement, analysis, policy experimentation and learning.

10.2 How Does the Enterprise Sector Manage Risk?

This section explores how efficient risk management by firms involves both reallocation and innovation decisions, and how investments in KBC (together with investments in complementary assets) enable firms to make appropriate decisions in the face of exogenous shocks, and to pursue voluntary but risky reallocation and innovation decisions that can be turned into opportunities for profitable growth.

10.2.1 Resource Reallocation and Innovation as Risk Management

As a desired societal outcome, efficient resource reallocation within each enterprise (and by implication across firms within industries and across industries) and innovation should jointly reflect efficient risk management by enterprises—allowing risks to be confronted and wherever possible turned into opportunities:
"efficient risk management by firms → efficient reallocation & innovation → shared prosperity"
= more resilient development outcomes for most people.
A variety of market and government failures, including a range of frictions and adjustment costs, typically prevent the full extent of these outcomes from being realized.

All enterprises, both formal and informal production units and their direct stakeholders (financiers, owners, managers and workers) are exposed to a range of risks, including risks imposed from outside the firm (exogenous risks) and risks that firms choose to take in pursuit of higher profit (endogenous risks).[5] Exposure to risk

[5] Exogenous risks include *imposed* productivity and/or demand shocks (both first-moment changes in levels and second-moment increases in volatility or "uncertainty shocks") arising from unanticipated external-to-the-firm changes in input and output prices (and other non-price effects) due to natural/weather disasters, pandemic risks/illness of the workforce, resource risks, geopolitical risk and social unrest/strikes, infrastructure risks, other economic, financial, and regulatory risks, and changing trends over time in technology and tastes. Bloom (2009) highlights the importance to policymakers of distinguishing between the more persistent first-moment effects and the more

matters to firms and to the economy, and matters even more for developing countries.

To explore whether exogenous risks reduce growth, or whether the direction of causality runs the other way with recessions increasing uncertainty, Baker and Bloom (2012) examine the impact on GDP growth of over 1,000 unanticipated exogenous shocks for 60 countries, both developed and developing, since 1970. Their identifying assumption is that some shocks, like natural disasters, lead primarily to a change in stock-market levels so are more first-moment shocks, while other shocks like political coups lead more to changes in stock-market volatility, implying they are more second-moment shocks. They find a significant causal impact of both first and second moment shocks on growth: in the quarter following a shock, they estimate that a one standard deviation reduction in stock-market levels and a one standard deviation increase in stock-market volatility each lead to a 1.9 % reduction in GDP; and in the year following the shock, they estimate larger effects, with the same changes leading to falls in annual GDP growth of 2.8 % and 6.3 %, respectively. So both first and second moment shocks have a significant negative impact on growth, with second moment effects having equal or higher impact. To explore the extent to which these results differ across countries, they first include interactions with being a "rich" country, defined as being above the sample-average GDP per capita of $25,000, and find no significant effect—suggesting that shocks have the same impact on rich and poor countries alike. However, the higher frequency of disaster shocks in developing countries implies that the greater uncertainty there has more negative effects on growth and other variables. In addition, they find that less financially developed countries and those with stricter labor regulations[6] have a significantly larger negative impact of uncertainty shocks (with no difference in response to first-moment shocks)—suggesting that incompleteness of financial markets and rigidities in labor markets are two important channels for the impact of risk on firms.

An important part of the plant-specific risks faced by firms, at least in the US, appears to be due to the greater degree of innovations and creative destruction in some industries relative to others. To develop a better understanding of the cross-

temporary second-moment effects of major shocks (with the increased volatility of "uncertainty shocks" typically generating a rapid and costly slowdown followed by a bounce-back in enterprise investment, hiring and productivity growth). Endogenous risks are *voluntary* resource reallocation and innovation investments firms take in the pursuit of opportunities for better expected rates of return.

[6] Their measure of financial development is generated by the World Economic Forum (ranking countries according to the strength of their financial markets and the depth and breadth of access to capital and financial services), while the labor regulation measure is the World Bank's Doing Business indicator of the strictness of hiring, firing and contract change regulations.

industry variation of plant-level idiosyncratic shocks, Castro et al. (2011) examine annual US manufacturing data over the 25 year period 1972–97.[7] They find considerable variation in idiosyncratic risk across industries: plants in the most volatile industries are subject to at least three times as much risk as plants in the least volatile.[8] To explore why certain industries have so much greater variation in the growth of productivity, they propose that the heterogeneity in idiosyncratic risk is driven by the differential extent to which creative destruction shapes competition across industries. They find that their measure of idiosyncratic risk is significantly positively associated with industry measures of product turnover, R&D, and investment-specific technological change.[9]

Enterprises respond to these and other exogenous risks by undertaking accommodating endogenous risky investments through two types of investment decisions, ***reallocating resources and/or innovating***[10]—in addition to mechanisms such as limiting the down-side risk of capital owners through limited liability, and limiting excessive fluctuations in employment and income of their workers through

[7] Their data are comprised of 50–70,000 plants per year distributed over 140 three-digit industries.

[8] Their proxy for risk is the volatility of the portion of Total Factor Productivity (TFP) growth which cannot be forecast by means of factors, either known or unknown to the econometrician, that are systematically related to plant dynamics (which is not explained by either industry- or economy-wide factors, or by plants' characteristics systematically associated with changes in TFP itself): the volatility of TFP growth due to idiosyncratic shocks ranges from 4 % for producers of fur goods to 12.4 % for manufacturers of computer equipment.

[9] Their industry-level proxies for product turnover, R&D and investment-specific technological change (ISTC) are, respectively: the monthly item substitution rate as collected by the US Bureau of Labor Statistics from sales outlets on more than 300 consumer good categories; the industry's average ratio of R&D expenditures to sales in COMPUSTAT; and a time series of quality improvements collected by Cummins and Violante (2002). On average, 1 % increase higher product substitution rate implies 0.25 % higher volatility of TFP growth, 1 % increase in R&D intensity implies 30 % volatility increase, and 1 % increase in ISTC is associated with 0.93 % volatility increase.

[10] Enterprise resource reallocation involves expansion or contraction of factors of production while doing more or less of the same things, namely shifting resources across existing goods and services that the enterprise produces, including exiting some or all product lines. Enterprise innovation, on the other hand, is broadly defined as the commercialization through markets by entrepreneurs of improvements in technology, where technology captures transformations of inputs into outputs including improvements in products, processes, business processes/organization, and marketing—namely doing any productive activity in better ways by making progress over and above the duplication of physical capital and labor. In the context of development, innovations should be recognized as applying to a broader range of non-replicative entrepreneurial accomplishments than just new-to-the-world frontier products, and include value and productivity-enhancing activities that commercialize ideas that are new-to-the-firm—thereby including the adoption, adaptation to local context and use of technologies already used elsewhere but not yet used in the local economy (see Dutz et al. 2012a). Innovation can be measured as the within-firm component of TFP growth (see Dutz 2013). In addition to being a source of endogenous risk, innovation helps firms manage exogenous shocks that require more adaptation than just reallocation of resources. There are of course important interactions between the two: ease of reallocation affects the expected profitability of innovation, while innovation typically requires complementary reallocation of resources.

employment contracts. Reallocation and innovation, in turn, are typically facilitated by a more flexible and formal enterprise sector. Flexibility in the enterprise sector, namely a greater extent of "creative destruction" driven by both more reallocation and innovation (enterprise expansion, contraction, exit and re-entry with better ways of producing), is important for enterprise risk management as it facilitates experimentation and learning in response to shocks. Insufficient entrepreneurial experimentation and enterprise risk-taking is costly for the enterprise sector as a whole because it results in too little investment in knowledge and knowledge spillovers, and prevents the efficient reallocation of resources towards more productive activities and the introduction of better ways of producing in response to supply and demand shocks and changing trends over time. The main risk management problem facing informal enterprises, on the other hand, is that they typically have only limited access to financial markets, professional management, foreign partners, and other essential channels to access, adopt and better use global knowledge—which limits their ability to adjust to shocks and changing trends.[11] As enterprises are able to take advantage of these benefits of formality and grow, they concurrently invest more in the types of intangible assets that allow them to better manage risks and growth in productivity, output and employment terms.[12]

Regarding the effect of risk on resource reallocation, Bloom et al. (2012a) show that the dynamics in enterprise output following exogenous uncertainty shocks arise from three complementary enterprise decision channels: labor, capital, and the misallocation of factors of production. An increase in uncertainty provides an option value from waiting, increasing the returns to inaction and leading to

[11] The informal sector typically exhibits more flexible reallocation only when government policies overly constrain the formal sector's flexibility. In Turkey, for instance, the share of informality increased in growing non-agricultural employment between 2004 and 2010 in the Anatolian East due to rigid and costly labor market rules facing formal enterprises, including a very expensive severance payment regime leading to one of OECD's most rigid employment protection rules for permanent workers, and the most restrictive rules for temporary contracts among OECD countries (Gonenc et al. 2012). Taymaz (2009) suggests that the significant productivity gap between informal and formal firms, and wage gap between informal and formal workers, can be traced back to differences in professional and technical skills of owners and managers, with more educated entrepreneurs and workers moving to the formal sector. This process of self-selection contributes to widen the productivity gap between informal and formal enterprises.

[12] Hsieh and Klenow (2014) examine the importance of resource misallocations that prevent young efficient firms from growing and that punish larger firms over the enterprises' life cycle. Comparing the life cycle of manufacturing enterprises in India and Mexico to the US, they conclude that differences in "within-firm TFP" (that part of aggregate TFP growth that does not come from cross-industry or within-industry cross-enterprise resource reallocation)—as successful US firms grow and accumulate intangible capital and complementary assets while Indian and Mexican firms exhibit little growth in terms of TFP, output and employment, and concurrently also exhibit lower post-entry investment in intangible capital—account for an important part of the gap in aggregate TFP between poor and rich countries. Bollard et al. (2013) similarly report the importance of "within-firm TFP", namely the productivity growth within existing large plants rather than reallocation across plants, in accounting for the rapid productivity growth in Indian manufacturing from 1993 to 2007.

significant falls in hiring, investment and output.[13] When uncertainty increases, most firms pause hiring, as labor cost adjustments make hiring or firing mistakes more costly. The labor force drops as worker attrition continues without replacement hires. Investment similarly falls, with a drop in the capital stock as existing capital depreciates without being replaced. Finally, increased uncertainty also reduces TFP (Total Factor Productivity) growth by reducing the degree of resource reallocation in the economy. As firms reduce expansion and contraction with the uncertainty shock, any desirable productivity-enhancing reallocation across firms (with unproductive firms contracting and productive firms expanding) is also slowed down.

Regarding the effect of risk on innovation across firms, Bloom et al. (2013b) show how a downside shock or unanticipated adversity, such as an increase in import competition from lower-cost countries, can cause enterprises to innovate relatively more if factors of production are trapped inside the enterprise, leading to a natural friction or adjustment cost constraining reallocation of factors of production between firms. The case study examples given all relate to the presence of different types of KBC, such as skilled engineers and R&D and design capabilities, skilled employees whose human capital is specific to the firm and will be lost if they move to other firms, brand capital, and organizational resources. When the shock reduces the price of one or more of the products that the firm produces, the opportunity cost goes down for the trapped inputs within the firm. This behavior has been confirmed across countries that faced a large increase in import competition: individual firms that faced more import competition exhibited a bigger increase in innovation, increasing their R&D expenditure, patenting and adoption of IT (Bloom et al. 2012b).

Caggese (2012) finds that an increase in exogenous uncertainty has a large negative effect on innovation of entrepreneurial firms, with the negative effect being stronger for less diversified entrepreneurial firms—and with no effect of exogenous uncertainty on innovation of more diversified publicly-owned firms.[14] The difference in innovation response across firms appears to be importantly driven by market imperfections, namely the inability of entrepreneurial firms to diversify their risk.[15] Because of these capital market imperfections, entrepreneurial house-

[13] They find that reasonably calibrated uncertainty shocks can explain drops and rebounds in GDP of around 3 %.

[14] Based on a panel of 11,417 Italian manufacturing firms over 1992–2001, a 1 % increase in uncertainty lagged one period leads to a 0.69 % fall in the frequency of innovations of all entrepreneurial firms, and a 0.92 % fall for the group of less diversified/smaller entrepreneurial firms.

[15] It appears not to be driven by risk-loving preferences of entrepreneurs, as experimental studies generally find entrepreneurs to be as risk averse as, and some studies find them to be even more risk averse than non-entrepreneurs. See Sarasvathy et al. (1998), Miner and Raju (2004) and Hongwei and Ruef (2004).

holds typically have most of their wealth invested in their own businesses.[16] In response to an increase in exogenous uncertainty, the main instrument to rebalance the risk-return profile of their assets is the choice of the riskiness of their investment projects. The same effect does not operate in publicly-owned firms, in which the firm's manager is exposed only to a fraction of the firm's risk and can more easily diversify it. One implication of this line of findings, given that developing countries experience more shocks than developed countries, is for enterprises to invest more, wherever appropriate, in lower-risk "new-to-the-firm" adaptive-type innovation rather than riskier "new-to-the-world" frontier-type innovation.

10.2.2 KBC as Investments in Enterprise Risk Management

Investments by firms in KBC and complementary physical assets are largely investments in enterprises' pillars of risk management, and thereby (by providing firms with the knowledge, enabling and leveraging abilities to more effectively develop and commercialize new-to-the-firm technologies, and better self-protect and cope if the innovation investments don't turn out) are also investments in innovation capacity and in the resilience of development outcomes.

The four traditional pillars of risk management include acquiring ***knowledge*** of shocks, exposure and potential outcomes, building ***protection*** to reduce the probability of losses and increase that of benefits, obtaining ***insurance*** to reduce the size of losses by transferring and hedging resources from good to bad times, and ***coping*** to recover from losses and make the most of benefits; the first three represent *ex ante* preparation for risk while the fourth represents *ex post* risk management (Ehrlich and Becker 1972). Investments by firms in KBC for reallocation and innovation activities, coupled with complementary investments in physical assets, can be interpreted largely as investments in these pillars of risk management, to help reduce the downside risks of negative returns and also to increase the positive returns associated with successful innovation (some industries are characterized by very asymmetrically skewed variance of returns from innovation-related investments, with large positive returns for the successful innovator and negative returns for unsuccessful firms).

Figure 10.1 presents available data on KBC accumulation in Brazil, China and India relative to the U.S. The data highlight that investments in a broad range of

[16] Herranz et al. (2009) find that, even in the US, 2 % of the primary owners of small businesses invested more than 80 % of their personal net worth in their firms, 8 % invested more than 60 %, and about 20 % invested more than 40 %.

	US		China		Brazil		India	
1. COMPUTERIZED INFORMATION	**1.24**	**12%**	**1.88**	**27%**	**1.10**	**26%**	**0.22**	**8%**
2. INNOVATIVE PROPERTY	**4.07**	**39%**	**3.40**	**48%**	**2.01**	**47%**	**1.48**	**56%**
Research and Development (R&D)	1.69	16%	1.02	14%	0.56	13%	0.80	30%
Mineral exploration & evaluation	0.78	8%	0.21	3%	0.03	1%	0.00	0%
Copyright & license costs	0.55	5%	0.08	1%	0.11	3%	0.05	2%
Development costs in financial ind.	0.55	5%	0.47	7%	1.10	26%	0.38	14%
Designs, incl. architectural & engineering	0.50	5%	1.62	23%	0.21	5%	0.25	9%
3. ECONOMIC COMPETENCIES	**5.04**	**49%**	**1.80**	**25%**	**1.17**	**27%**	**0.95**	**36%**
Reputation & Branding	1.35	13%	0.38	5%	0.56	13%	0.11	4%
Advertising expenditure	*1.24*	*12%*	*0.38*	*5%*	*0.51*	*12%*	-	-
Market research/Branding	*0.11*	*1%*	-	-	*0.05*	*1%*	-	-
Training & Development	1.05	10%	0.29	4%	0.34	8%	0.01	0%
Continuing vocational training	-	-	*0.29*	*4%*	-	-	-	-
Apprentice training	-	-	-	-	-	-	-	-
Business process improvements	2.64	26%	1.13	16%	0.27	6%	0.83	31%
Purchased	-	-	-	-	*0.03*	*1%*	-	-
Own-account	-	-	*1.13*	*16%*	*0.24*	*6%*	-	-
TOTAL INVESTMENT IN KBC	**10.35**	**100%**	**7.08**	**100%**	**4.28**	**100%**	**2.65**	**100%**

Fig. 10.1 KBC investments as % of expanded GDP, 2006. Source: Dutz et al. (2012b), Hulten and Hao (2012), Hulten et al. (2012)

KBC types, going significantly beyond R&D expenditures, are taking place.[17] R&D has typically been easiest to measure, and therefore the focus of much previous analysis, even though R&D spending is typically less than a quarter of spending on KBC; and there is a presumption that most econometric studies showing large returns to R&D suffer from misspecification due to non-included complementary KBC variables, with returns to other types of KBC incorrectly attributed to R&D. Spending on existing types of economic competencies is the most important broad category in the US, but less important in emerging economies, with reported spending on training particularly low.[18] Importantly, there is recent evidence that

[17] Corrado et al. (2012) show why investments in KBC matter for total factor productivity growth (TFPG), by comparing the correlation of investment in physical capital to TFPG versus the correlation of investment in KBC to TFPG across a range of developed and emerging market countries. There is a much stronger positive correlation between KBC and TFPG, consistent with strong spillover effects; for instance, when one firm invests in software, design, business process improvements or R&D, not only does that firm become more productive but other firms also benefit over time, which is good for overall productivity and provides a rationale for policy intervention.

[18] This aligns with related findings from Bloom and Van Reenen (2010) on measuring management practices of medium and large manufacturing firms covering monitoring (collection and processing of production data), target setting (whether coherent and binding on operations, inventory and quality control), and worker incentives (merit-based pay, promotion, hiring & firing), where Brazil, China and India are at the bottom of the table relative to industrialized countries. It should be mentioned, however, that there is no presumption that US spending levels on KBC are optimal, either for the US or for other countries, and emerging market spending may be appropriate given local returns to different types of KBC (and are no doubt linked to other drivers of investment patterns such as endowments, industrial structure, technological capabilities, and the broader business environment).

the measurement of global collaboration-related economic competencies as an additional type of KBC is important for developing countries, namely investments in joint learning through collaborating with global value chains to facilitate the capture and use of existing global knowledge that is new-to-the-firm (see Box 10.1).[19]

In addition to being an important source of total investment and growth, different types of enterprise investments in KBC play a critical role as investments in enterprises' pillars of risk management, providing enterprises with essential capabilities to anticipate, absorb and adapt to exogenous risks, and undertake endogenous risks in pursuit of larger expected profits with higher probabilities of success—empowering firms to learn and execute in their risky environments as enabled information platforms.[20] The main types of traditionally-measured KBC investments can be relatively easily mapped into the four pillars of risk managed initially proposed by Ehrlich and Becker (1972), namely[21]:

- Investments in ***knowledge*** of supply and demand trends and the likelihood of shocks, including changes in existing and emerging new global technologies and changes in consumer preferences—based on investments in R&D, and in global connectivity (including investments in knowledge diffusion networks and various search and match mechanisms to learn from and co-create with other local firms, global corporate partners, suppliers and buyers, universities and their extended communities, and the diaspora, and investments in local knowledge networks by informal enterprises)
- Investments in ***protection/enabling*** to reduce the probability of losses and increase the probability of successful reallocation and innovation—based on investments in market research, branding and advertising to expand product varieties and market reach and thereby diversify location-specific product risks both on production and demand sides—as the optimal reallocation of resources

[19] The original KBC measurement agenda was launched by a request from then-US Fed Chairman Greenspan, and the types of KBC selected were driven by their perceived importance to the US economy, where a number of firms are relatively close to the technological frontier. Economic competencies related to the capture and learning from existing global knowledge is arguably less important for the US than for countries where most firms are relatively more distant from the prevailing global technological frontier.

[20] See Hulten (2013) on some policy implications of conceptualizing the firm as an information platform.

[21] Sheffi (2005) surveys a wide range of largely intangible investments spanning the four pillars that firms have made to increase knowledge, self-protect, insure against and cope with low-probability high-impact disruptions, broken down into "reducing vulnerability" (early detection and security investments in databases and software to reduce the likelihood of intentional disruptions from industrial actions, sabotage or terrorism), "building resilience through redundancy" (investments in slack, non-used inventory, capacity and IT systems, and increased holdings of retained earnings) and "building resilience through flexibility" (investments in new business models to allow interchangeability of plants, parts and people, realign supplier relations in supply chains, and modify internal culture towards greater safety, quality, continuous communications, and conditioning for disruptions).

under uncertainty may not be to invest all into a high-risk new technology, but to invest some resources in the existing technology and benefit from the option value of waiting until some additional uncertainties are resolved.[22] D'Erasmo and Moscoso Boedo (2012) show that firm-level volatility is negatively correlated with such intangible expenditures: firms that incur higher intangible expenses are able to serve more markets and thereby diversify and reduce market-specific demand risk.[23]

- Investments in ***insurance*** to reduce the size of losses by transferring resources from good to bad times—based on including investments in private or public-private partnerships to pool and share risks such as an agreement with an OEM or with a large distribution chain that provides a resource cushion in temporary downturns and signals lower risk to investors, or investments by start-ups in patents to raise their salvage value if they go bust. Another example is the *ex ante* investment by formal firms in database rosters of specialized experts which can be tapped on-call when the need arises and by informal enterprises in local contacts, rather than *ex post* after the realization of a shock having to search and set up new contractual or non-contractual arrangements. According to Bartelsman (2012), it may be that firms operating in industries that are more prone to high idiosyncratic shocks invest more heavily in ICT (and associated KBC) to lower adjustment costs and smooth profit flows. Insurance-related investments also include efforts by enterprises, households and cities to obtain insurance from the government either directly (anti-dumping, temporary import

[22] Bloom et al. (2007) show that higher uncertainty reduces the responsiveness of investment to demand shocks, with uncertainty increasing real option values and making firms more cautious when investing or disinvesting (firms only hire and invest when business conditions are sufficiently good, and only fire and disinvest when they are sufficiently bad; when uncertainty is higher, this region of inaction expands, as firms become more cautious in responding to business conditions). Investment is also shown to have a convex response to positive demand shocks, magnifying the response, and a concave response to negative demand shocks. Empirically, these 'cautionary' and 'convexity' effects of uncertainty are large and play an economically important role in shaping firm-level investment decisions, with a one-standard deviation increase in their measure of uncertainty (like that which occurred after September 11, 2001 and the 1973 oil crisis can halve the impact effect of demand shocks on enterprise investment. This implies that the responsiveness of firms to any given policy stimulus may be much weaker in periods of high uncertainty, suggesting that countries where firms face systematically higher uncertainty may require significantly higher levels of stimulus to achieve a comparable impact.

[23] The authors find a significant negative relationship between firm-level idiosyncratic volatility and intangible expenses, based on US data from the Kauffman Firm Survey and Compustat both for a general measure of intangibles (selling, general and administrative expenses) and for advertising expenditures, and controlling for industry-time fixed effects and a time trend: their results imply that if the top quartile firm of the intangible expenses distribution in the Compustat sample (a firm with $84 million in intangible expenses) reduces expenditures to that of the median firm, its volatility would increase by roughly 23 %. Their proxy for risk is the volatility of the portion of growth in sales which is not explained by either industry or economy-wide time effects, or firm characteristics associated with growth such as the firm's age or size; all results are robust to a measure of idiosyncratic risk derived from TFP at the firm level.

tariff protection, flood insurance subsidies) or through investment in physical infrastructure.

- Investments in ***coping/leveraging*** for *ex post* loss recovery or benefit enlargement if the investments in reallocation and innovation are successful in the marketplace, including investments in worker and management continuous learning, business process improvements, and software and databases to build up enterprise capabilities for more flexible adjustment, facilitating either scaling up or down, depending on the realization of the shock.

Box 10.1 documents investments in the main traditional types of KBC plus spending on collaboration-related assets linked to global connectivity and their association with export performance in the Chilean wine industry over the period 1990–2010. It provides illustrative examples of how specific KBC investments can be re-interpreted as risk management tools according to the four pillars of knowledge, protection/enabling, insurance, and coping/leveraging.

Box 10.1. KBC and risk management in the Chilean wine industry

The main risks facing the Chilean vine-growing and wine-making industry over the past years were shifts in local inputs and in global demand and supply, exchange rate volatility, and natural disaster risks including viticultural pests and disease hazards, water and temperature variability, and earthquakes. Investments in different types of KBC and complementary physical capital by Chile's wine-producing enterprises have enabled the industry to absorb shocks, innovate and grow exports at stunning rates of 25 % per annum in the 1990s and 10 % per annum in the 2000s while avoiding excessive volatility—leading Chile to be in the global five in terms of value and volume of wine export national shares by the late 2000s (ahead of the US, Germany, New Zealand, Argentina and South Africa, among others). Figure 10.2 shows the association top between investments in KBC relative to investments in tangible assets and changing export levels over the past two decades. In particular, it suggests that total measured investments in KBC, as the sum expenditures on of innovative property (investments in R&D), traditionally-measured economic competencies (outlays on market research, marketing, training and business process improvements) and global connectivity, are more closely correlated with bottled wine exports than available proxies for investments in physical capital (area planted or number of wineries).

Examples of investments in KBC that support enterprise risk management include:

(i) Investments in **knowledge**. An example of adjusting to the risks of losing market share when foreign competitors innovate is Miguel Torres' (a Spanish-owned FDI firm) first introduction in Chile of

(continued)

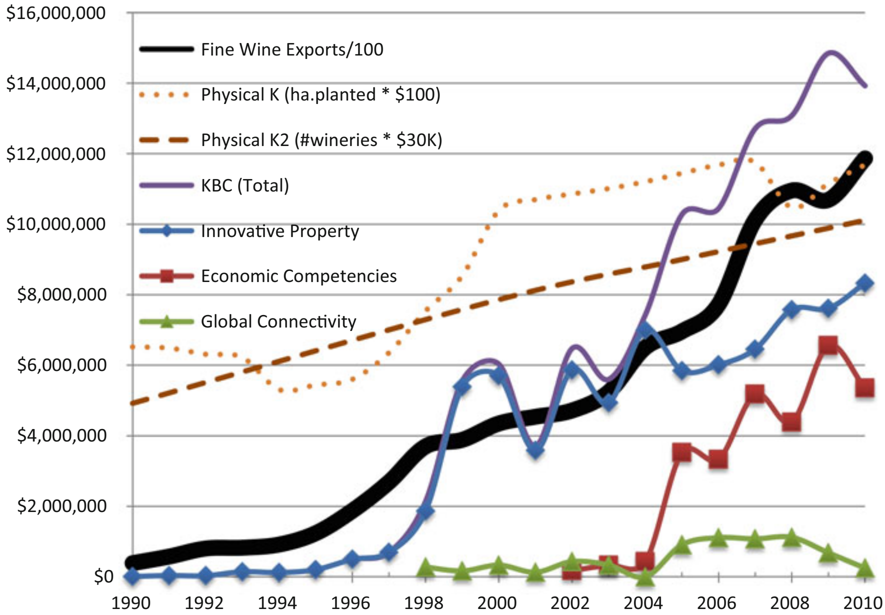

Fig. 10.2 KBC and Chilean wine exports (real 2012 USD). Source: Dutz et al. (2014)

Box 10.1 (continued)

temperature-controlled stainless steel vats instead of the traditional concrete fermenting vats that did not allow temperature control and retained residues adversely affecting taste and smell, widespread in use in high-income countries. This led Chilean-owned vineyards to introduce them—and required additional investments in technical support and local learning, as no one in Chile knew how to assemble them.[24] To further lower the risk of falling behind the evolving technological frontier, Chile's Production Development Corporation (CORFO, a governmental organization to promote investment and innovation) and participating enterprises co-invested $5.1 million between 2005 and

(continued)

[24] The investment in local assembly of stainless steel vats, and the complementary physical capital investments, "an apparently minor innovation", allowed enterprises to export wines sanitarily safely and with reduced variability and higher quality and taste to international standards across vintages (Agosin and Bravo-Ortega 2009).

Box 10.1 (continued)

2010 in 38 foreign technological study tours ('misiones tecnologicas') and in 15 foreign consultancies by oenologists, viticulturalists and other global experts ('consultorias especializadas').[25] And to lower the risk of volatile exports for smaller producers with less widespread distribution networks as well as to increase export levels, CORFO's Associative Development Projects (PROFOS, a program to strengthen the technology absorption and joint marketing capabilities of associations of independent small and medium-scale enterprises) and participating enterprises co-invested $11.5 million between 2005 and 2010 in a range of initiatives to learn how to best promote local wine regions, thereby developing a ready buyers' market and strengthening customer loyalty, reducing the volatility of demand by making demand more price-inelastic.[26]

(ii) Investments in **protection/enabling**. Chile's ideal geographical isolation (desert in the North, mountains to the East, Antarctic to the South, and Pacific to the West) has historically protected it from viticultural hazards such as the phylloxera louse.[27] Chile's government, through its Agriculture and Livestock Service (SAG), invested in rigorous zoo- and phyto-sanitary border control, to protect this natural low-risk factor underpinning its agricultural competitiveness. An example of KBC to protect vine production against disaster risks such as pests and diseases as well as climate change-induced drought and temperature variability is the co-investment of $1.2 million between 2004 and 2012 by the Fund for fostering Scientific and Technological Research (FONDEF, a program of Chile's National Commission for Scientific and Technological Research CONICYT).[28] The co-investment resulted in a major study on

(continued)

[25] The average private contribution to these global connectivity projects was 40 %. The use of global oenologists as foreign consultants also allowed Chilean enterprises to lower the risk of changing global tastes, as they acquired knowledge of the characteristics of changing international demand and began making Chilean wines to those specifications (Agosin and Bravo-Ortega 2009).

[26] In addition to 21 PROFOs, these collaborative investments in marketing also included 18 additional local wine tourism regional development initiatives, and four regional export development initiatives (e.g. "for Asia"). The average private contribution to these collaborative marketing projects was 47 %.

[27] Phylloxera devastated European wine production in the 1860s and led to widespread unemployment. Over time, it even affected Argentina just across the Andes. Chile is the only winemaking country in the world free of phylloxera, and has not been affected to-date.

[28] FONDEF does not fund research if there is not a substantial provision of resources by the private sector: in this case, FONDEF provided 29 % of funding, with 12 wineries and 4 nurseries providing 38 %, and the University of Talca providing the remaining 33 %.

Box 10.1 (continued)

adapting root stock and cultivar grafting to local conditions, generating the know-how to graft local vines on North American grapevine root-stocks and thereby providing resistance to parasites, ensuring local adaptation to changing water and temperature conditions, helping regulate the vigor of vine foliage to changing external conditions, and allowing lower-cost adaptation to other changing conditions such as soil salinity. Other protection against increasing drought as melt-water from the Andes diminishes was provided by investments in drip irrigation, which also enables more precise computer control of both watering and fertilizer, but required complementary investment in worker training.

(iii) Investments in **insurance**. An example of insurance-related KBC is an investment in 2003 in a detailed census of all winemaking enterprises to document and benchmark their existing storage capacity, in order to stimulate investment in storage capacity as a shock absorber of volatile world market wine prices together with exchange rate risk—allowing smoothing of export supply to markets depending on varying earnings potential from year to year. Investment in additional storage capacity also serves as insurance against risk of loss of product from leaking vats as a result of unpredictable earthquakes, minimizing the marketing risks associated with foreign customers not being assured of continuous delivery of product and possibly switching to other countries' product. Finally, an example of investing in KBC to insure against the risk of future continued appreciation of the exchange rate by lowering local costs is the co-investment of $725,000 between 2008 and 2011 by the Foundation for Agrarian Innovation (FIA, a developmental agency of the Ministry of Agriculture) and participating enterprises in R&D and an economic evaluation of sparkling wine based on a traditional low-value grape variety (Pais, or Mission in California)—which dramatically lowered the cost of producing a good-quality sparkling export wine.

(iv) Investments in **coping/leveraging**. An example of coping/leveraging-related KBC is the $15.3 million joint public-private investment in training between 2005 and 2010 to upgrade worker skills to increasingly sophisticated vineyard farming and winemaking techniques.

Box 10.2 provides an illustration of how an assessment of different types of KBC is motivated by banks' desire to better understand companies' strengths and weaknesses during their rating measurement and financial support decisions.

Box 10.2. The use of KBC in BNDES's credit analysis approach

BNDES, the Brazilian Federal Development Bank, has broadened its approach to credit analysis beyond its traditional focus on financial features associated with collateral to reduce the likelihood of default. It is now explicitly considering companies' investments in intangible assets, as they constitute investments in "dynamic capabilities. . . related to the firm's ability to identify opportunities and risks in its external and internal environment, and rearrange its tangible and intangible assets, if necessary" (Tenorio et al. (2013), p. 6; Mendes and Braga (2010), p. 156).

In 2007, a Working Group was set up by BNDES to develop intangible assets measurement, in partnership with COPPE/UFRJ (Coimbra Institute for Graduate Studies and Research in Engineering, part of the Federal University of Rio de Janeiro). In 2010, the BNDES Board approved start of implementation of a "Methodology to Assess Intangible Assets and Competitiveness", to analyze the non-financial features of companies that BNDES supports. The Methodology is intended to allow BNDES bankers to better understand clients' strengths and weaknesses during the financial support decision: "it decreases BNDES' risk and improves support as loans can be applied to finance not only an investment project but the development and improvement of intangible assets" (pp. 11 and 159).

The developed questionnaire allows a rating of companies according to 28 questions on intangible assets, broken down into 7 types of KBC: (1) production and innovation, including innovation management; (2) corporate strategy, including strategies enabling the company to compete on price, sales effort and product differentiation in accordance with the prevailing competition in the company's external environment; (3) external relations, including relations with suppliers and clients; (4) financial policies; (5) corporate governance; (6) environmental and social issues, including reputation and sustainability; and (7) human resources. For each type of KBC, the guiding questions point toward the main aspects which must be considered by the evaluating bankers according to a 5-point scale, with level 5 representing the benchmark for each question. The assessment is based on the company's skills and capabilities, as well as on its investments to reach higher levels. The BNDES Human Resources Division is implementing a training program for 450 of its employees, and the IT staff already developed software to support application of the Methodology. 98 companies have been evaluated using the Methodology to-date.

10.3 How Does Enterprise Risk Management Through Reallocation and Innovation Impact People?

This section discusses how resource reallocation and innovation supported by investments in KBC can help most people better manage risks, both indirectly through their impact on the enterprise sector's risk management, and directly through their impact on people as consumers and as owners of physical capital, ideas/technologies and labor.

10.3.1 Impact on the Enterprise Sector

Efficient resource reallocation and innovation by enterprises can positively affect the risk management of the enterprise sector as a whole, by helping all enterprises to self-protect and capture opportunities from better adapting to changes. In particular, the decisions by firms to scale up existing activities or invest in new activities, even when these decisions result in failure, are helpful, as they allow evolutionary learning both for the failing firms (provided the business environment allows them to re-enter with renewed access to financing following efficient bankruptcy proceedings) and for the enterprise sector as a whole (provided that the business environment has mechanisms in place to facilitate such positive learning and spillovers).[29] However, absent appropriate policies, enterprise reallocation and innovation can lead to a concentration of productivity gains in a small number of formal firms in only one or a few industries, and insufficient spillovers and economy-wide learning—with negative broader impacts including an insufficiently resilient enterprise sector with not enough creative destruction across industries (see Box 10.3).

Box 10.3. Israel's software development: Insufficient spillovers leading to a less resilient "dual economy"[30]

As documented by Trajtenberg (2009), Israel's pre-2000 innovation policies largely benefited its ICT (Information and Communications Technology) and especially software industry. It provides a compelling illustration of how innovation-driven growth is not necessarily resilient and inclusive. It also provides valuable lessons in the design of more diversified (across industries and hence less risky from an economy-wide perspective) and more inclusive innovation policies. By the late 1960s, Israel had reached what may now be

(continued)

[29] See Taleb (2012).

[30] In addition to Trajtenberg (2009), on which this box draws heavily, see also Teubal and Kuznetsov (2012).

Box 10.3 (continued)

termed a middle-income trap: the big waves of immigration had subsided, and though Israel had few natural resources, it had highly skilled manpower and scientific and technological prowess. The question facing policymakers was how to mobilize these assets for faster growth. Public support policies, together with other contributing factors, resulted in growth of 16 % per year in the ICT industries during the 1990s, with ICT exports growing over the 1990s by a factor of 6 and accounting for one third of total exports. However, in many other industries, TFP actually declined on an annual basis between 1996 and 2004, including transportation (−0.4 % per annum), construction (−2.0 %) and retailing and business services (−3.3 %), leading to a dual economy with a large share of the benefits flowing to firms and consumers abroad. Trajtenberg argues that this was in large part due to inappropriate policies that focused on: (1) product innovations rather than also on other types of process, design and organizational innovations; (2) exports rather than benefits for the rest of the economy; and (3) local MNC labs only serving the global needs of the parent companies located outside the country. A key conclusion is the desirability of avoiding narrowly-targeted policies, and instead for policies to be directed at fostering spillovers to the rest of the local economy, ensuring wherever possible that the generation of knowledge, its destination and its ultimate economic impact are inclusive, responsive to the broad needs of the local economy—across households, geography, and industries.

10.3.2 Impact on People

Efficient reallocation and innovation by enterprises can also, supported by appropriate policies, positively affect the risk management of all people, including: lowering the volatility to firms of returns from production and to people of consumption expenditures by providing a diversified mix of products; helping people absorb shocks and provide a steadier stream of income and employment; alleviating the resource constraints that limit people's own risk management possibilities through higher incomes afforded by enhanced productivity; and directly addressing health and safety risks.

10.3.2.1 Impact on People as Consumers

To what extent do reallocation and innovation decisions by enterprises in response to short-term shocks and longer-term changes in demand and supply trends allow the enterprise sector to make the best use of available resources to meet consumer needs, both in aggregate terms and across different income groups? Bartelsman et al. (2013) examine this question in aggregate terms through a model calibrated to developed and developing country enterprise-level data with permanent and transitory enterprise-specific productivity and distortion shocks.[31] Their analytical framework allows for two different channels through which distortions affect aggregate output and consumption, namely both resource reallocation within industries across enterprises of different productivity levels as well differing paces of firm selection (entry and exit of enterprises of differing levels of productivity). In the presence of distortions, the enterprises with the highest productivity no longer have the highest market shares, outputs and inputs, and some highly productive enterprises with a "bad distortion draw" will exit while some low productivity enterprises will be able to operate, leading to a further misallocation of inputs. A higher dispersion in distortions worsens selection based on productivity and lowers the overall efficiency of resource allocation across operating enterprises, reducing enterprise sector output and consumption by households. They show how the improved selection and size-productivity relationship in Central and Eastern European economies as their transition to a less distorted market economy progressed in the 1990s is associated with a substantial increase in consumption.[32]

Acemoglu et al. (2013) examine the impact of enterprise reallocation and innovation decisions on aggregate consumption through a complementary general equilibrium model that allows enterprises to differ in their degree of innovativeness and allows exit to be driven by creative destruction (innovation by other firms replaces the leading-edge status of a firm in a particular product line), an exogenous disaster shock, and obsolescence (firms with sufficiently low productivity endogenously exit from product lines). Their model highlights that the decentralized allocation calibrated to US enterprise-level data does not maximize growth or aggregate welfare in consumption equivalents. Indeed, their striking finding is that the allocation that a welfare-maximizing social planner would choose results in a 70 % increase in the growth rate (growth increases from roughly 2.2–3.8 %) with welfare in consumption equivalents increasing by 6.5 % relative to the market-based decentralized outcome. A first reason for the divergence between

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[31] The inclusion of idiosyncratic, enterprise-specific distortion shocks—interpreted broadly to include any distortion that impacts the scale of a business—is consistent with evidence that certain regulations apply *de jure* differently to enterprises of different sizes (such as rules affecting the hiring and firing of workers applying only to enterprises above a certain size threshold in a number of countries), whereas other regulations are *de facto* enforced unevenly across enterprises of different sizes, industries, and rent-seeking propensities.

[32] Holding the distribution of plant productivity fixed, Hsieh and Klenow (2009) provide suggestive evidence that resource misallocation between existing plants can account for about one-third of the gaps in aggregate manufacturing TFP between the US and countries such as China and India. In Hsieh and Klenow (2014), they show that another type of misallocation that punishes large plants lowers the productivity of the average plant in India and Mexico. Both types of distortions are important in reducing aggregate output and consumption by households. Based on a panel of enterprises in Ghana, Kenya and Tanzania, Soderblom et al. (2006) find that TFP does not impact on survival of small firms, suggesting that there is no process of sorting or selection by which the more efficient firms survive and grow, again reducing aggregate output and consumption (see also Teal 2013).

decentralized and efficient equilibria is the traditional knowledge externality and under-investment in R&D (and some other types of KBC) associated with enterprises not being able to appropriate the full value of new innovations, including the productivity increases to other firms from the increased stock of knowledge. But a more important second reason is a substantial inefficiency in the decentralized equilibrium arising from selection effects: low productivity, low innovation-capacity firms remain active too long because they do not take into account that by freeing resources from the fixed cost of operations for these firms, skilled labor can be reallocated and combined with R&D (and other KBC-related) inputs—which is not fully internalized by the market because the skilled wage is depressed relative to its social value. So even when their model is calibrated to a relatively well-functioning economy like the US, there are substantial growth and consumption gains from even faster exit of low-innovation capacity firms and faster entry of high-innovation capacity firms than in a market-based outcome. This suggests significant untapped benefits for consumers from business environments that facilitate more enterprise innovation-related risk-taking, experimentation and learning.

Absent appropriate policies, market incentives for reallocation and innovation can also result in the product and quality mix remaining tilted toward higher-income consumers with the ability to pay, with innovative products that enable improved risk management by the poorest people not being developed or marketed.[33] Illustrative examples of inclusive innovation that enable improved risk management by poor people and may not take place absent some appropriate policy intervention include:

- The novel use of rice husks in India for rural electrification or solar lighting—reducing the fire hazard and health risks from the fine particles in the fumes associated with kerosene-fuelled lanterns, and broadening the risk-absorption capabilities of household members by facilitating home study and other productive activities at night)[34]
- The use of solar panels to power an electrochemical toilet that turns human sanitation waste into useful things such as chlorine (a disinfecting solution used to flush the toilet), hydrogen (suitable for cooking or powering a fuel cell to produce electricity) and residue (used as fertilizer)—this toilet, winner of the Gates Foundation "Reinventing the Toilet" $100,000 first prize, will if widely deployed, help prevent the risk of the 1.5 million childhood deaths from diarrhea

[33] See Dahlman and Kuznetsov (2014) for a categorization of different types of base-of-the-pyramid (BOP) innovation and relevant policy issues. Their working definition of BOP innovation is any organizational and or technical novelty that is likely to be broadly diffused and have an impact on the welfare and living standards of low-income households through the consumption channel. They do not discuss how innovation helps the BOP population through its impact on income earners through jobs and increasing earnings, or as owners of even small amounts of capital.

[34] See "Energy technology: Cheaper and better solar-powered electric lights promise to do away with kerosene-fuelled lanterns", *The Economist*, September 1, 2012.

that now occur each year, in addition to reducing the risk of other diseases associated with untreated and exposed human waste[35]

- Other products that allow consumers to mitigate the risks they face, such as shifting from entire families precariously clinging to motor bikes and exposing themselves to severe accidents to "frugally engineered" low-cost small cars with seatbelts,[36] and shifting to healthier fruit and vegetable diets from high-sodium, high-fat, high-sugar diets exposing consumers to obesity, diabetes and chronic heart disease.[37]

Absent appropriate policies, market incentives for reallocation and innovation also can result in negative safety and environmental impacts of the production and consumption of goods and services not being sufficiently addressed. Illustrative examples of adverse safety and environmental impacts that may take place absent some appropriate policy intervention include:

- Non-earthquake-proof houses and schools absent appropriate construction standards and their effective enforcement, as highlighted by China's earthquake in Sichuan province in May 2008 that killed approximately 70,000 people (including thousands of children crushed to death by collapsing school buildings) and by Turkey's north-western earthquake in August 1999 that killed approximately 25,000 people (with older buildings remaining standing but newer buildings built on shallow foundations with cement mixed with too much sand literally pulverized by the impact of the tremor)[38]
- The explosion on the Deepwater Horizon oil rig in the Gulf of Mexico in April 2010 due to inadequate preventive measures triggered one of the largest oil spills in history, while there have been approximately 2,400 fresh oil spills involving foreign energy companies in the 2006–2010 period alone in the Niger Delta that contains Nigeria's vast oil and gas reserves. The impact of the Gulf of Mexico spill on oyster fishermen alone has been significant, with oysters possibly taking as long as 10 years to recover, fishing boat captains no longer having customers, and associated enterprises laying off almost all their staff. Pollution from oil spills has also devastated the fishing industry in the Niger Delta, though the

[35] See "Technology and development: Each year 1.5 m children die from diarrhea. Better toilets could reduce the death toll", *The Economist*, September 1, 2012; and Ramani et al. (2012).

[36] See "A brilliant, cheap little car has been a marketing disaster", *The Economist*, August 20, 2011.

[37] Years of healthy life lost from being overweight as a percentage of years lost to all chronic disease, at over 30 %, was already significantly higher in Oceania and Middle East & North Africa in 2010 than in North America and Western Europe. The Vitality Group, part of a health insurance company in South Africa, finds ways to pay people to eat more fruit and vegetables and exercise, getting its money back because it pays fewer medical bills. See "The big picture: Obesity special report", *The Economist*, December 15, 2012.

[38] See "The Sichuan earthquake: Bereaved parents treated like criminals", *The Economist*, May 14, 2009, and "Lessons from Turkey: After the horror, there could be changes for the better", *The Economist*, August 26, 1999.

perception is that “one bad spill in the West is getting more attention than half a century of irresponsible oil production in the Delta”—linked to the problem that Nigeria has plenty of environmental laws but few are enforced[39]
- Overuse of antibiotics is leading to loss of potency and furthering the spread of antibiotic-resistant bacteria, with the number of infections that are resistant to treatment by antibiotics on the rise, a problem that is compounded by falling incentives for global drug companies to develop more resistant antibiotics especially for diseases affecting the poorest.[40]

10.3.2.2 Impact on People as Income Earners

One of the most important ways that the enterprise sector helps people manage risk is through the steadier and rising incomes provided by the employment of their human capital and other assets, which in turn allows them to consume a range of better risk management products. Reallocation and innovation can deepen and widen product and factor markets, creating more resilient and productive development outcomes. Productivity levels have important implications for the ability of enterprises to manage risk and offer stable and steadily increasing employment. Bartelsman et al. (2013) show, in their empirically-calibrated model with productivity and distortion shocks, that the enterprise sector in countries with fewer distortions and higher productivity also employs more workers, and uses more capital.

Efficient reallocation and innovation can benefit people as stakeholders in enterprises (investors, entrepreneurs, workers), with different types of enterprises playing different roles in creating jobs and other asset employment opportunities depending on the prevailing business environment. Acemoglu et al. (2013) show, in their empirical examination of the forces jointly determining resource allocation, innovation and productivity in the relatively low-distortion US business environment, that young firms are both more R&D intensive, grow more and create more

[39] See “Deepwater Horizon: Mopping up the legal spill”, *The Economist*, March 3, 2012, “Nigeria’s oil: A desperate need for reform”, *The Economist*, October 20, 2012, and “Oil in the Niger Delta”, *The Economist*, June 25, 2010.

[40] See “The Dangers of Hubris on Human Health” in World Economic Forum (2013), where one cited study found that 98 % of children with the common cold at a Beijing hospital were given antibiotics (useless for treating viral infections), since drug prescriptions is their main income generator (Yezli and Li 2012), with strong antibiotics sold over-the-counter in pharmacies or in local marketplaces in India without a prescription, leading to significant inappropriate self-medication—while strong antibiotics should be a last line of defense, pharmacy sales in India increased nearly six-fold in India from 2005 to 2010 (Westly 2012). The slowdown in the development of new antibiotics is linked, among others, to the greater potential return on drugs to treat chronic illnesses such as diabetes and hypertension, diversion of attention to new life science technologies such as nano-scale engineering and synthetic biology, and the high cost of regulatory burdens for clinical trials.

jobs.[41] These growth rate differences across enterprise size types, and in particular the higher growth rates for young start-up enterprises conditional on survival, conform to more general patterns for economies with low distortions (Haltiwanger et al. 2013).[42]

However, these patterns do not appear to persist in countries with significant market and policy distortions, and with a significant number of informal enterprises. Hsieh and Klenow (2014), based on time series data that capture the large informal sector (as well as the formal plants) in Mexico and India as well as in the US, show that while the average young plant that enters in the US increases employment more or less smoothly over time to a tenfold increase by age 35, in Mexico employment only witnesses a twofold increase by age 25 and then remains unchanged after that, while in India average employment actually falls to one-fourth of its level at entry by age 35.[43] The steady growth of surviving enterprises in the US results in the bulk of employment being concentrated in larger, older (and more productive) plants, in contrast to Mexico and India, where employment is concentrated in smaller, young (and less productive) plants; since average wages are higher in larger plants (not only in the US but also in Mexico and India), this leads to fewer workers in Mexico and India benefiting from higher wages.[44] They show that low average employment growth in Mexico and India can largely be attributed to low TFP growth with age. They then show that resource misallocations that punish large plants can discourage investments that raise plant productivity (and job creation and wage growth).

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[41] This matches the empirical findings from a large literature on firm age and innovation, where younger and smaller enterprises tend to produce more innovations per unit of research resources (Akcigit 2010).

[42] The main finding of Haltiwanger et al. (2013), based on comprehensive data tracking all enterprises and plants in the US non-farm business sector for the period 1976–2005, is that there is no systematic relationship between enterprise size and growth, once enterprise age is controlled for. They document an "up or out" dynamic for young enterprises in the US. Young firms are more volatile and exhibit higher rates of both gross job creation from entry and expansion and gross job destruction from exit. But conditional on survival, young firms grow more rapidly than their mature counterparts. Their findings show that small, mature businesses have negative net job creation.

[43] These patterns hold across many industries and for formal and informal plants alike. Growth in average employment of a cohort is driven by survivor growth and/or by the exit of smaller plants. Hsieh and Klenow show that what appears to differ between US and India is the growth of incumbents: in the US, surviving plants experience substantial growth while in India incumbent plants become smaller with age.

[44] Older plants in the US (more than 40 years old) account for almost 30 % of total employment in the US, while they account for less than 10 % of employment in Mexico and India; in contrast, less productive plants less than 10 years old account for 50 % of employment in Mexico and India, while they account for roughly 20 % of total employment in the US. Plants (informal and/or family-owned) that only employ unpaid workers account for 72 % of employment in India in 1989–90, while the employment share of family plants has increased in Mexico from 10 % in 1998 to almost 30 % by 2008.

It has long been recognized that innovation impacts employment through multiple channels of varying time scales and complexity, and that the overall effect is sensitive to the character of the innovation (process versus product, radical versus incremental, etc.) and its setting. Process innovation can lead to productivity gains which enable firms to produce the same level of output with fewer inputs, including direct labor-saving impacts or "displacement effects". However, these direct negative effects of process innovation on employment can be counterbalanced by indirect expansion impacts or "compensation effects" when the cost reductions from the innovation spur price reductions to drive higher demand and greater output. Product innovation, on the other hand, generally leads to "market-expansion effects" when it stimulates domestic and foreign demand for the firm's outputs, thereby enhancing labor demand for the innovating firm. However, both product and process innovation can cause demand diversion from substitute products of other firms or "business-stealing effects" and thereby have an uncertain impact on aggregate employment (depending on the relative strengths of market-expansion and business-stealing effects). How these countervailing impacts of innovation on employment balance in practice is an empirical question, depending on the nature of the technology employed, the substitutability of input factors, the own- and cross-price elasticities of demand, the degree of competition in the relevant product market, the nature of the business environment, the type of process innovation, the degree of novelty of the new product, and a host of other factors.[45]

In a recent paper, Dutz et al. (2012a) debunk a conventional view that innovation is not inclusive in the sense that the benefits are presumed to flow only to skilled workers and shareholders of technically sophisticated companies. They provide support for a contrasting view that innovation should be interpreted as applying to a broader range of entrepreneurial activities, including the introduction of products and processes that are new-to-the-firm. Based on firm-level data of over 26,000 manufacturing enterprises across 71 countries, they show that enterprises that innovate in this broader sense employ a higher share of unskilled workers, a higher share of female workers, and attain higher TFP and more rapid employment growth

[45] Using data on German manufacturing and service-sector firms from the third Community Innovation Surveys (CIS3) for the period 1998–2000, Peters (2005) finds that product innovations have a net positive impact on employment while process innovations are associated with employment reduction for manufacturing but not service firms. These findings are largely confirmed by Harrison et al. (2008) in a study that is also based on CIS3. Using comparable firm-level data across four European countries—France, Germany, Spain, UK—they find that process innovation has significant displacement effects that are partially counteracted by compensation mechanisms. The displacement effects of process innovation are most pronounced in manufacturing. On the other hand, product innovation is associated with employment growth and these results are similar across countries. Based on a firm-level comparison across provinces and cities in China, Mairesse et al. (2009) find that the compensation effects of product innovation more than counterbalance the displacement effects of process innovation, the net result being that innovation makes a strong positive contribution to total employment growth. Alvarez et al. (2011) find that in the case of Chile, process innovation is generally not a relevant determinant of employment growth, and that product innovation is positively associated with employment growth.

than firms that do not innovate. In particular, when enterprises experience the positive spur that comes from the ability to expand by accessing competitive markets, product and process innovation and increased TFP make expansion profitable: the ensuing output expansion creates job growth that is not biased away, but rather is generally tilted towards inclusion of the unskilled. Across all countries, unskilled workers constitute 34 % of the share of the employees of the combined group of product and process innovative firms, versus 30 % for non-innovative firms. A 10 % increase in the share of unskilled workers is associated with an employment annual growth rate that is almost 1 % higher for innovative firms than for non-innovating firms, and the difference is quantitatively important over time. Also, across all countries, innovative firms' employment of female workers is 29 % versus 22 % for non-innovative firms, and again the employment growth rate of innovative firms is greater than for non-innovating firms where the share of female workers is greater. Importantly, our finding that innovating firms employ a higher share of unskilled and female workers than non-innovating firms does not imply that their income is higher, or their income growth is faster, than the skilled—as even though innovating firms hire a larger share of unskilled workers than non-innovating firms, their share is still significantly lower than skilled workers. And they may be receiving significantly lower pay and lower income growth, questions that our data unfortunately did not allow us to address. However these findings, coupled with the increasing empirical support in the literature for the view that low-wage jobs are a stepping stone for the integration of the jobless into employment and better-paid work in the future, do provide a key underpinning to innovation-driven inclusive growth.[46]

No matter how efficient the reallocation and innovation patterns in any given country's enterprise sector, employment and wages will fluctuate especially for workers in those firms that contract or go out of business and in new businesses that are launched and expand. And the introduction of new skill-biased and labor-saving technologies can lead to widening employment opportunities and earnings differentials between skilled and non-skilled workers, and to technological (structural) unemployment—creating three overlapping sets of losers (Brynjolfsson and McAfee 2011): (1) low-skilled workers (technologies often displace routinized tasks and increase the value of more abstract and data-driven tasks, enhanced by complementary changes in work organization technologies); (2) "non-superstar" workers (in some winner-take-all or winner-take-most industries, a few highly-talented people get the lion's share of rewards); and (3) owners only of own-labor (to the extent that technology reduces the relative importance of labor, owners of capital will capture a bigger share of income from production). The level and

[46] A number of recent papers have sought to ascertain empirically whether low-wage employment is a stepping stone that enhances future occupational advancement prospects, or whether it results in a low-pay-no-pay poverty trap cycle. Although the evidence is somewhat mixed and subject to debate, there seems to be greater support for the stepping-stone effect. For analysis of the pathways of upward mobility for low-wage workers, see among others Booth et al. (2002), Knabe and Plum (2013) and Mosthaf (2011).

fluctuation of employment and wages, in particular affecting these groups of workers, can be reduced when the enterprise sector is more flexible and labor contracts are more enforceable, and appropriate support policies are in place to address inevitable adjustment frictions affecting displaced workers.

10.4 What Is the Role of Public Policy?

This section discusses interventions addressing the double externalities of knowledge- and risk-related market failures compounded by traditional externalities in areas such as more inclusive and greener development where market prices do not reflect societal values.

Appropriate types of government support will depend, among others, on the prevailing technological capabilities and adjustment costs in the enterprise sector's locality and industry.

Governments should help create business environments that stimulate entrepreneurial risk-taking to invest in market and social opportunities that combine new technologies with appropriately-skilled workers. To help address the mismatch between accelerating (exponentially-growing and global) technologies versus relatively stagnant (linearly-advancing and local) skills, labor market institutions, organizational know-how and regulatory frameworks, there is a strong role for policies that promote entrepreneurship and organizational innovation and foster skill development—with entrepreneurs having the lead role in inventing new business models that can leverage evolving technologies and make the most productive and remunerative use of available pools of labor (Brynjolfsson and McAfee 2011).

Policies should reflect a better understanding of the relative importance of different types of KBC in affecting the four pillars of risk management (knowledge, protection/enabling, insurance and coping/leveraging), and in turn the relative importance of the four pillars in managing different types of risks across different types of industries and countries. Importantly, the case for policy intervention should demonstrate that costs associated with implementation and with any government failure from policy action are outweighed by the benefits from addressing the market failures. In the case of KBC, key market failures that create a possible rationale for policy actions include knowledge spillovers, increasing returns to scale in production, path dependencies, and efficiency-cum-distributional effects. A well-understood market failure is the non-rivalrous nature of knowledge, namely that most types of KBC involve development costs that are not re-incurred when that knowledge is used again, leading to its desirable spillovers and re-use by as many as possible on efficiency grounds—but also to possible under-investment in new knowledge generation to the extent that the initial enterprise may not be able to fully appropriate the returns to the investment. The increasing returns nature of costs can foster enterprise growth but may also raise specific competition policy concerns. And to the extent that shared prosperity is an explicit national goal, markets will typically not on their own, absent appropriate policy intervention, result in the most able entrepreneurs investing in the types of KBC that are most likely to achieve efficient growth and shared prosperity. A simple illustration, adapted from Banerjee and Duflo (2005), is the reality that less able high-income entrepreneurs will be able to self-invest in lower-efficiency skills upgrading, networking/global collaboration and project outcomes, while more able low-income entrepreneurs may not be able to similarly invest in higher-efficiency skills upgrading, networking/global collaboration and project outcomes.

10.4.1 Spurring Entrepreneurial Experimentation

Policymakers have an important role to play in creating an enabling environment for entrepreneurs to take risks, experiment and learn. Possibly the highest risk to the enterprise sector in any country is maintaining a business environment with high exit costs and low levels of risk-taking, as there is then no impetus for rapid reallocation and innovation. Key policy imperatives are to set the appropriate rules of the game for the allocation of entrepreneurial talent towards innovation, including reducing distortionary "costs of success" and "costs of failure", and ensuring sufficiently flexible and competitive product and factor markets with as much policy certainty and as little policy arbitrariness as possible.

Policy can influence the allocation of entrepreneurship more effectively than it can influence its total supply. By establishing or altering the prevailing "rules of the game", policy plays a key role in specifying the relative payoffs to different entrepreneurial activities that determine whether these people develop and use these talents and most critically how they allocate their entrepreneurial talent and effort: whether entrepreneurship will be directed to destructive activities (e.g. war lords or drug barons), to unproductive activities (e.g. public sector rent-seeking by creating and taking advantage of protection from competition and monopoly rents, and private sector rent-seeking including through insider dealing, unproductive tax evasion, litigation and societally-inefficient corporate takeovers), or to socially productive activities, namely efficiency-enhancing reallocation and innovation (Baumol 2010).

Distortionary "costs of success" inhibiting risk-taking and growth include a high likelihood of expropriation of the rewards of innovation and a range of related policy barriers. One of the most important sets of rules to stimulate the allocation of entrepreneurial talent toward innovation activities is to ensure, through contract enforcement and rule of law, that successful innovators are allowed to reap generous rewards commensurate with the risk undertaken, that entrepreneurs are permitted to grow and accumulate wealth without a high risk of expropriation by other firms or by the state (including through excessive taxation, various forms of corruption, or dominant firms denying expansion opportunities through illegal means if the young growing firms are too successful), and that the respect for such rules is widely followed and trusted throughout society. Based on evidence from India and Mexico, Hsieh and Klenow (2014) suggest that the return on investments in plant-specific intangible capital (KBC) to boost within-firm TFP may be lower in Mexico and India than in the US due a range of market and government distortions punishing enterprise expansion — such as higher tax enforcement and/or corruption,[47] difficulties in obtaining skilled managers and/or bigger contractual frictions in hiring non-family labor, [48] difficulties in buying land to expand,[49] higher costs of shipping to distant markets,[50] and finance frictions.[51] Such barriers encourage firms to stay informal/small and not invest sufficiently in innovation-enhancing and risk-mitigating types of KBC, so policy has an important role to play in addressing these barriers.

Distortionary "costs of failure" that increase the costs required for entrepreneurs to try out commercializable ideas also inhibit risk-taking experimentation and growth, with higher exit costs acting as entry barriers. Distortionary costs include excessively strict bankruptcy regulations and the inability to borrow again in formal financial markets after bankruptcy, high labor hiring/firing costs, the inability to share high-fixed cost facilities or the absence of sufficiently deep lease, rental or resale markets (including for essential business services such as power and IT-serviced business premises),[52] and the negative social stigma associated with

[47] In Mexico, Levy (2008) argues that payroll taxes (roughly 32 % of the wage bill) are more stringently enforced on large plants, as are other taxes (Anton et al. 2012). Indian labor regulations, applying more strictly to larger firms (or that small formal and informal firms find easier to evade), are emphasized by Besley and Burgess (2004). La Porta and Shleifer (2008) document that larger formal plants spend more on bribes (as a share of revenue) than do smaller formal and informal plants.

[48] Bloom et al. (2013a) argue that delegation costs raise the costs of managers in India, supported by models where managerial inputs are important for large plants but less important for smaller formal or informal plants (see the appendix in Hsieh and Klenow 2014). The fact that the gap in average wages between large and small plants in Mexico and India is almost twice that observed in the US also suggests that larger plants in Mexico and India may pay higher efficiency wages due to monitoring costs or that the cost of skilled managers is higher there.

[49] Hsieh and Klenow (2014) provide evidence that the average product of land is rising with plant size in India: this could be evidence of technological differences (if larger plants use less land-intensive techniques) but it can also be evidence that frictions to land reallocation raise the marginal cost of land faced by high-productivity plants.

[50] Holmes and Stevens (2012) show that larger plants sell to more distant domestic markets. Hsieh and Klenow (2014) provide a model in their appendix where higher shipping costs per unit of distance lower the number of markets a firm with a given productivity serves, which lowers the returns from investing in higher productivity.

[51] Cole et al. (2012) also construct a quantitative model to fit the same facts for the US, Mexico and India, where financing frictions inhibit incumbent technology adoption in Mexico and India.

[52] Cooper and Haltiwanger (2006) highlight that "the irreversibility of many projects caused by a lack of secondary markets for capital goods acts as an important form of adjustment cost."

failure (not viewing failure as a critical learning mechanism and as a likely by-product of high-risk activities). Policy should address these barriers, as well support information dissemination such as the documentation and widespread diffusion of role models of successful high-risk taking local entrepreneurs.

The welfare effects of lowering barriers to entrepreneurship depend on more than the impact on the level of entrepreneurship and should take into account how individuals select into entrepreneurship and how these firms behave *ex post*. If individuals self-select into entrepreneurship only if the return they perceive overcomes the cost of entry (the "self-selection view"), reducing entry costs leads to a worsening in the pool of entrepreneurs since the marginal entrepreneurs have worse characteristics than incumbents. If, on the other hand, individuals only learn their abilities by trying to start a business (the "experimentation view"), reducing entry barriers will draw in constrained individuals who may have even better entrepreneurial abilities than incumbent unconstrained entrepreneurs. Hombert et al. (2013) evaluate a large-scale French policy action implemented in 2002 that lowered entry costs by reducing potential entrepreneurs' "costs of exit", namely providing "downside protection" by allowing unemployed individuals to retain their rights to unemployment benefits in case their venture fails. The reform also provided insurance against cash flow shortfalls by mandating the insurance fund to pay out any gap between their entrepreneurial revenues and their unemployment benefits. Their findings confirm that this form of lowering the "costs of exit" did indeed spur entrepreneurial experimentation, and is consistent with the "experimentation view": they find a very large effect of the reform on business creation across industries, with a 25 % increase in monthly creation rates after the reform was implemented, and with wages and productivity larger in the newly-created firms when compared with "shrinking" incumbents. And even though the crowding-out effects in terms of jobs destroyed in existing small incumbents offset most of the direct job creation effects of lowering entry barriers, the labor reallocation process had a positive net impact on aggregate productivity since the newly-created firms were on average more productive.

Box 10.4 reviews recent empirical findings on the importance of policies ensuring sufficiently flexible and competitive product and factor markets. Recent findings by Acemoglu et al. (2013) on the special importance of selection effects when taking into account both reallocation and innovation —namely that faster exit and entry rates than in market-based outcomes are desirable to allow resources to flow to high innovation-capacity firms— would suggest the desirability of a policy of actively encouraging the exit of low innovation-capacity incumbent enterprises by taxing their operating costs or subsidizing their exit, or more realistically taxing all incumbents' operating costs and thereby leading the least cost-efficient ones to exit.

Box 10.4. Flexible product, labor, financial and R&D markets and bankruptcy laws that do not overly penalize failure raise the expected returns of investing in KBC

There are stark differences in business growth dynamics across countries as reflected in enterprises' heterogeneous reallocation and innovation responses to exogenous shocks—driven by underlying differences in the enabling environment.[53] Data covering the whole distribution of firm employment growth across both manufacturing and non-manufacturing industries show clear differences in the process of reallocation and innovation across countries, with the US displaying a higher level of business dynamism (with both faster growing and shrinking firms) than most continental European countries (Fig. 10.3). Across countries, high-growth firms (HGFs) make a disproportionate contribution to employment growth: HGFs account only for between 3.6 and 6.4 % of all surviving firms, yet they account for between 25.5 % (Austria) and 64 % (UK) of all jobs created by surviving firms. However, non-HGFs still account for between 1/3 and ¾ of job creation (and the underlying reallocation and innovation), highlighting the need to consider the full growth distribution when designing policies to foster desirable reallocation and innovation.

This and related studies highlight the importance for reallocation and innovation of:

1. Flexible product market (entry and competition) regulations, with less stringent regulations in manufacturing industries associated with higher allocative efficiency, and reforms in services markets regulations having stronger effects on resource allocation when labor and credit markets are more responsive (Andrews and Cingano 2012)
2. Flexible labor market regulations, lowering the costs of downward adjustment, spurring greater risk taking, faster job reallocation and increasing productivity growth in R&D intensive and labor-intensive sectors, with firms less willing to expand their workforce or enter into new markets if they cannot reduce their workforce later if their reallocation and

(continued)

[53] High-income countries for which these data are available include the US, Canada and eight European countries (Austria, Denmark, Finland, Italy, Netherlands, Norway, Spain, and the UK). The data provide measures for the percentiles of the growth distribution for surviving enterprises with ten or more employees during 2002–05, as well as the share of enterprises growing or shrinking at a particular rate. The data only include surviving firms (defined as those that have survived with positive employment throughout the 3-year period), so do not allow analyses of entry and exit patterns or of the contribution of entry and exit to aggregate employment growth. However, the data do capture the reallocation and innovation processes that enterprises undertake, including jobs lost by firms that dismiss employees in response to external shocks or if innovations don't turn out as anticipated, as well as spinouts that reduce the headcount, and on the upside organic growth and acquisitions. See Bravo-Biosca et al. (2012).

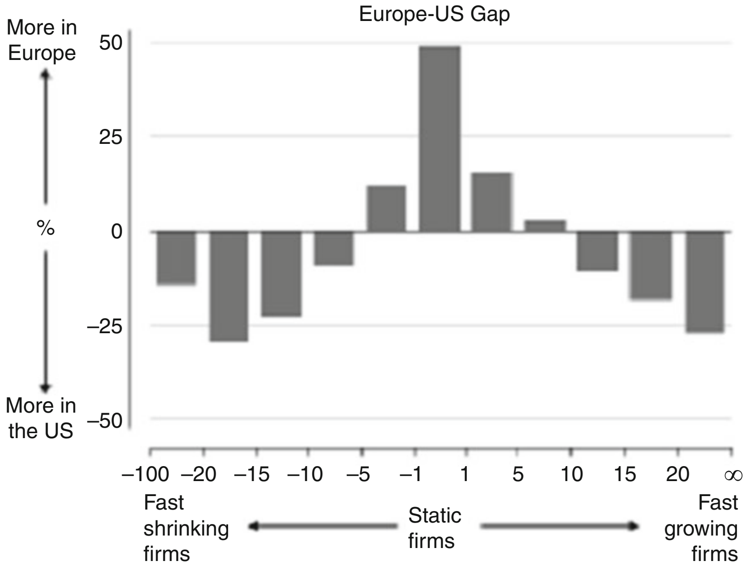

Fig. 10.3 Distribution of enterprise employment growth, 2002–05. Source: Bravo-Biosca et al. (2012)

Box 10.4 (continued)

innovation decisions prove unsuccessful (Andrews and Criscuolo 2013; Bartelsman et al. 2010, 2013)[54]

3. More developed financial markets, regulations that encourage banking competition and an efficient judicial system that enforces contracts on the growth distribution of firms, boosting the growth of the best performing firms and speeding up the contraction of underperforming firms in industries highly dependent on external finance (Dutz et al. 2012a)[55]

(continued)

[54] Bartelsman et al. (2010) describe how firing costs reduce the incentive for firms to attempt adopting risky technology, impeding flexibility to be able to reorganize operations to best fit the technology (firms that turn out to be unsuccessful in adopting new risky technologies need to be able to avoid deep losses, otherwise the incentive for adoption is lost). More generally, any regulation that becomes more burdensome at some size threshold is shown by Bartelsman et al. (2013) to generate significant welfare losses from misallocation.

[55] Based on an econometric analysis of over 26,000 manufacturing enterprises across 71 countries, Dutz et al. (2012a) find that countries with a more competitive business environment (measured by Doing Business variables interpreted as reflecting access to key essential business services, especially access to credit and to registering property) are associated with more innovation and more inclusive-type job creation. Access to information (Internet use) and formal job training are much more important to the employment growth of young enterprises than they are to other categories of enterprises.

Box 10.4 (continued)

4. Bankruptcy laws that are not excessively stringent, as they impose high exit costs in the event of business failure and therefore may make entrepreneurs less willing to experiment with risky technologies; with more debtor-friendly bankruptcy codes being associated with more rapid technological diffusion, enabling countries to catch-up with the technological frontier (Westmore 2013).[56]

Importantly, R&D fiscal incentives may have the unintended consequence of protecting incumbents and slowing down the reallocation of resources towards more innovative entrants. Fiscal incentives for R&D, a market-based tool intended to support R&D activities that otherwise would not have taken place by reducing the marginal cost to firms of R&D activities, are increasingly being used in developing countries (including Brazil, Chile, China, India, Poland, Russia, and Turkey), in addition to being widely used in developed countries (Estonia, Finland, Germany, Mexico, New Zealand and Sweden do not employ R&D tax incentives). Based on a general equilibrium model calibrated to US data, Acemoglu et al. (2013) caution against subsidization of all R&D activities based on the one market failure of underinvestment in R&D. In comparison to a relatively non-distorted business environment, they show that subsidies to incumbent enterprises (or equivalently higher exit costs) reduce growth, consumption and welfare: a subsidy to incumbent R&D equivalent to 5 % of GDP reduces aggregate welfare by 1.5 % in consumption equivalent terms because it deters entry of new high innovation-capacity firms. The policy has a negative selection effect, with an adverse impact on both incumbents and potential entrants, reallocating resources from more- to less-efficient enterprises since it directly helps only those firms that are near the lower end of the product quality/innovation distribution and at the exit margin, namely disproportionately low-productivity enterprises—further depressing innovation. Due to the importance of selection effects in their model, it turns out to be much better to support entry and incumbent R&D by freeing resources such as skilled labor from inefficient low innovation-capacity incumbents by taxing their operating costs or subsidizing their exit (or more realistically taxing all incumbents' operating costs, leading the least cost-efficient ones to exit) than to subsidize entry or incumbent R&D directly. In addition, R&D

(continued)

[56] The direction of the link between bankruptcy regimes and innovation is less clear-cut and varies according to the capital intensity and the dependence on external finance of the industry, as loose bankruptcy regulation with weaker creditor rights also attenuates the creditors' insurance effect and thereby increases the cost of raising external finance. For a review of recent empirical evidence, see Andrews and Criscuolo (2013).

Box 10.4 (continued)

subsidies may mainly increase the wages of inelastic inputs rather than innovation (Romer 2001; Wilson 2009), and may be ineffective when other complementary investments such as basic science are not also in place and subsidized (Akcigit et al. 2012). In support of these views, recent OECD studies find no correlation between R&D tax incentives and TFP growth at the aggregate level (Westmore 2013) and a negative correlation in more R&D intensive sectors, with more generous R&D tax credits being associated with a higher share of stagnant firms and a lower share of shrinking firms, slowing down an otherwise more efficient reallocation process (Bravo-Biosca et al. 2012).

10.4.2 Supporting Skills Upgrading

Inappropriate reallocation and innovation decisions can have dire short and long-term impact on people. Enterprises worldwide together with education systems have not performed adequate investment and reallocation decisions given the persistence of the twin crises of a shortage of jobs and a shortage of skills: 75 million youth are unemployed worldwide, with young people three times more likely than their parents to be out of work, representing not only a huge pool of untapped talent but a long-term underinvestment in human capital and a source of potential social unrest and individual despair. In addition, half of youth are not sure that their post-secondary education has improved their chances of finding a job, and almost 40 % of employers say a lack of skills is the main reason for entry-level vacancies (Mourshed et al. 2012).

As a second area of policy action, policymakers should support more knowledgeable and skilled risk-taking by people within individual enterprises and as part of urban agglomerations. While a KBC focus invites a re-examination of the priorities of all types of government policies, perhaps the most important area concerns the importance of appropriate human capital policies, given that human capital underpins KBC. Appropriate policies that balance skills supply and demand become even more essential, as do the need for such policies to be even more demand-driven by the current and anticipated future needs of employers, with education/training curricula and apprenticeships that produce workers that enterprises want to hire supported by PPPs (Hulten 2013; OECD 2013). Key policy imperatives are to support investments in human capital and facilitate people to invest in themselves through enterprise-driven on-the-job and vocational training, and to support agglomeration of enterprises and people for enhanced knowledge spillovers, in particular urban agglomerations that attract, retain and spur interaction of talent.

Based on an analysis of more than 100 education-to-employment initiatives from 25 countries (selected on the basis of their creativity and effectiveness), and a survey of youth, education providers, and employers in nine countries that are diverse in geography and socioeconomic context (Brazil, Germany, India, Mexico, Morocco, Saudi Arabia, Turkey, the UK and the US), Mourshed et al. (2012) argue that a big part of the skills policy solution is to oblige educators to step into employers' shoes and employers' to step into educators', and students to move between the two—by reinventing vocational and on-the-job training, with two promising trends. First, technology is greatly reducing the cost of vocational education with a range of replicable models including:

- "Serious games" facilitated by computer technology advances provide young people with a chance to gain virtual hands-on experience at minimum cost
- Colombia's Labor Observatory provides details on the graduation and employment rates of every educational institution in the country, disseminating information about education and employment demand, and thereby empowering students to select programs leading to good pay, and incentivizing schools to become more relevant to the workplace (and improving flow of information to manage risk via more rigorous and continuous monitoring and evaluation).

And second, private and public sector institutions are coming up with ideas to improve vocational training, with agreements between private sector employers and community colleges pulling the educational curriculum towards market needs. Recent examples include:

- Korea has created a network of vocational schools, labeling students as "young meisters" in order to counteract the country's obsession with academic laurels (from the German for 'master craftsmen'
- China Vocational Training Holdings specializes in matching students with jobs in the Chinese car industry by keeping masses of data on both students and companies
- Mozilla (creator of the Firefox web browser) has created "open badges initiative" that allows people to get recognition for programming skills (importance of certification to signal quality of training)
- IL&FS Skills gives Indian students a job guarantee if they finish its courses, with training contracts helping to deal with poaching externality (Almeida et al. 2012).

Another policy area ripe for joint federal and local reforms in coordination with the private sector is the urban dimension of entrepreneurship and absorptive capacity development, namely the enhancement of the livability and "stickiness" of cities, to attract and retain talent. Recent evidence shows that local agglomerations of firms in specific technology areas, which likely increase technology and supply-chain spillovers, also reduce income uncertainty of skilled workers (Ellison et al. 2010)—which puts a premium on appropriate urban policies as part of desirable skills upgrading policies.

International experience suggests that much of the absorption of existing frontier technologies and the nurturing of technological advances are likely to be concentrated in a few metropolitan regions. Half of the productivity growth recorded by the US between 2000 and 2008 was by 20 metropolitan areas, with these cities accounting for 40 % of GDP (McKinsey 2011). The shift in population as workers move from rural agriculture to urban areas that facilitate face-to-face learning and creative interactions between young entrepreneurs, skilled people, and institutions connected to global knowledge should help unleash innovation (Glaeser 2011). Dense urban-industrial cluster agglomerations have been vital for technological upgrading and productivity growth by opening opportunities and stimulating supplies of capital and skills. China's establishment of special economic zones, followed by a range of support by national and local governments for further industrial deepening in its three major urban/industrial agglomerations (the Pearl River Delta centered on Shenzhen, Dongguan and Foshan, the Yangtze River region around the Shanghai-Suzhou axis, and the Bohai region in the vicinity of Beijing and Tianjin) and in a number of the inland cities (including the footwear cluster in Chengdu and the Wuhan opto-electronics cluster) highlights how a mix of instruments can be employed together, including science parks and extension services, encouragement of local universities to establish industrial linkages, attracting a major local or foreign anchor firm that can trigger the in-migration of suppliers and imitators, and above all dense transport and communication connectivity infrastructure (Yusuf et al. 2008).

10.4.3 Promoting Joint Learning Through Global Collaboration

As a third area of policy action, policymakers should ease enterprises' investments in lower-risk new-to-the-firm adaptive innovations (versus typically longer gestation and higher risk new-to-the-world frontier innovations) by creating a business environment that facilitates the local diffusion, capture and adoption of existing global knowledge, enables local firms to collaboratively improve on existing technologies, and supports collaborative risk sharing. Key policy imperatives include facilitating firms' joint learning through global collaboration by connecting to and learning from global value chains, universities and their extended communities, the relevant national diaspora, supported by open data platforms to pull global knowledge towards meeting the neglected needs of poorer segments of populations, allowing them to better confront and manage their risks.

Based on recent analyses of processes of technology diffusion across countries and over time, Comin and Mestieri (2013) highlight that over 70 % of the variation in per capita income today across countries can be accounted for by differences in how quickly technology diffuses both across and within countries, with the intensive margin or within-country component responsible for most of the difference. Differences in the extensive margin of technology adoption (differences across countries in the timing of the adoption of new technologies after their invention, that is, whether or not a technology is adopted at all by a country) account for roughly 25 % of the cross-country variation in TFP. Importantly, newer technologies such as cell phones, Internet usage, and MRIs have been adopted faster than old ones such as electricity and telephones, reflecting benefits of globalization. An additional 45 % of the cross-country variation in TFP can be attributed to differences in the intensive margin, namely how quickly and how many units of the technology are adopted within-country for a given size economy, given that it is adopted. While the cross-country dispersion in adoption lags had declined significantly over the last two centuries, Comin and Mestieri (2010) find no such convergence pattern in the intensive margin. Comin et al. (2012) report evidence that geography plays a significant role, with technology diffusing slower to locations that are further away from the adoption leaders. However, this effect is stronger across high-income countries. This suggests that better understanding of why within-country diffusion has been so slow in lower-income countries could be critical in helping reduce differences in cross-country income per capita, including a better understanding of the relative importance of different drivers of the intensive margin such as absorptive capacity and adoption costs (including historical endowments such as the quality of the education system and familiarity with related technologies), institutional constraints that affect the overall efficiency of the economy (e.g. expropriation risk), and distortions that affect the price and incentives to invest in physical capital and KBC.[57]

In a suggestive study, Fogli and Veldkamp (2012) explore how different social structures might affect a country's rate of technology diffusion and progress. Based on the idea that communicable diseases and technologies spread in similar ways, through inter-personal contact, they explore an evolutionary model where limited connectivity reduces the risk of an infection entering the social group, allowing people to live longer, but also restricting the group's exposure to new ideas, slowing technology diffusion and inhibiting growth.[58] The network model, which explicitly addresses the intensive margin of adoption, explains why societies with a high prevalence of contagious disease might evolve toward low-connectivity, growth-inhibiting social institutions, and how small initial differences can produce large divergence in incomes. A main finding is that a 1-standard deviation increase in connectivity between people increases TFP by an amount equal to 23 % of US productivity: these numbers imply, for example, that the difference between high-connectivity Finland and low-connectivity Ghana explains just under half of the difference in their technology diffusion rates, and just over one-third of their per capita output gap.[59] An explicit promotion of global collaboration via global

[57] Both Comin and Hobijn (2010) and Comin and Mestieri (2010) rely on data on the diffusion of 15 important technologies in 166 countries over the last two centuries.

[58] In his 1969 AEA presidential address, Kenneth Arrow observed: "While mass media play a major role in alerting people to the possibility of an innovation, it seems to be personal contact that is most relevant in leading to its adoption. Thus, the diffusion of innovation becomes a process formally akin to the spread of an infectious disease".

[59] Fogli and Veldkamp (2012), pp. 31–2. Results are based on data on the prevalence of 34 diseases in 78 geopolitical regions (the countries with the highest pathogen prevalence are Brazil, China, Ghana, India and Nigeria, with the lowest include Canada, Hungary, Switzerland and Sweden),

consortia and other mechanisms to facilitate within- and cross-country connectivity and collaboration between people and enterprises that otherwise would not have interacted may be called for. It could be interpreted as tilting prevailing social structures towards global collaboration growth-enhancing social networks that speed the diffusion of new ideas and technologies, and that help better manage risks. This is especially important in environments where the risk of germ infection is now less than the risk of foregone ideas that otherwise would impede more efficient risk management (see Boxes 10.5 and 10.6).

Box 10.5. Policies to spur collaborative risk-sharing for innovation: Combining technology-push with market-pull support, underpinned by open data policies

Traditional technology-push public R&D grants to researchers at US NIH-type national research councils, universities and public labs face a number of challenges, such as allocating resources to the best researchers,[60] the need to reduce systematic error in published research and ensure the transparent dissemination of all research results (including "negative results" that fail to support the hoped-for hypothesis),[61] and ensuring that the research

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and a survey by Hofstede (2001) on national differences in cultural values reflecting degrees of collectivism (where low-connectivity societies where people from birth onwards are integrated into strong, cohesive in-groups, often extended families, with people averse to breaking those ties, and with weak or non-existent global ties are labeled collectivist, and high-connectivity societies with strong global ties are labeled individualistic; the most collectivist countries are Ecuador, Guatemala, Indonesia, Pakistan and Venezuela, while the most individualist are Australia, Canada, the Netherlands, the UK and the US).

[60] Nicholson and Ioannidis (2012) ask whether the US National Institutes of Health award its grants to those most likely to make fundamental breakthroughs in their fields (based on biomedical researchers who studies received more than 1,000 citations), and find that only 40 % of such high-impact primary authors who are not part of study sections (experts in the fields in question who hand out the grants) currently receive NIH grants. This finding that too many US researchers of the most innovative and influential papers in the life sciences do not receive NIH funding is supported by a second finding that study sections appear to favor work similar to that done by their existing members or that they recruit members with similar interests to themselves, and whose citation impacts typically were classed as 'good' or 'very good' but not 'exceptional'.

[61] It is well-known that errors are part of science. However, examining what fraction of published biomedical research findings turn out not to be true in the light of further research, Ioannides (2005) shows that for most study designs and settings, it is more likely for a research claim to be false than true. In particular, the greater the financial and other interests and prejudices in a scientific field, the less likely the research findings are to be true. As an illustration, researchers at a US-based human therapeutics company were able to confirm the results of only six of 53 'landmark studies' in preclinical cancer research (Begley and Ellis 2012). As another illustration regarding the higher risk of heart attacks from the use of a top diabetes drug (in September 2010, the FDA announced major restrictions on the use of the drug with European regulators ordering it off the market on the same day; a US FDA scientist later estimated that the drug had been associated with 83,000 heart attacks and deaths), each of the 11 authors of the drug's clinical trial had received money from the company (four were employees and held company stock). Interviews, FDA

Box 10.5 (continued)

itself is responsive to some relevant societal need. In an effort to push researchers towards entrepreneurship, programs such as Singapore's National Research Foundation NFIE (National Framework for Innovation and Enterprise) have provided funds to develop academic entrepreneurship in institutes of higher learning, including proof-of-concept grants and a technology incubation scheme. These efforts on their own have not been as successful as anticipated, no doubt due to the difference in temperament and skills of most academics versus entrepreneurs. Building on the recent successes of university entrepreneur-in-residence programs in the US, an interesting policy direction would be to provide seed funding for entrepreneurs interested and able to partner with researchers in technologies that they perceive have the highest potential for commercialization. Such policies would be a natural complement to university TTOs (technology transfer offices), but instead of pushing researcher-developed technologies out to the market, they would help by bringing the imperative of market needs to bear on which research projects get additional funding, by facilitating market-savvy entrepreneurs to partner with the developers of technologies at a sufficiently early stage so that their R&D trajectory could still be modified at relatively low cost to better meet market needs. In addition, to help researchers, entrepreneurs, users and civil society at large better assess the promise of new technologies, global public policy should support an open data platform for all emerging research results (ideally even including "negative results" from corporate-funded clinical trials), curated to highlight what has been learned including how perspectives or hypotheses should be modified in light of all available data.[62]

documents and emails released by a US Senate investigation indicated "that the company withheld key information from the academic researchers it had selected to do the work; decided against conducting a proposed trial because it might have shown unflattering side effects; and published the results of an unfinished trial even though they were inconclusive and served to do little but obscure the signs of danger that had arisen" (Whoriskey 2012). In July 2012, the company pleaded guilty to criminal charges and agreed to a $3 billion settlement of the largest health-care fraud case in the U.S. and the largest payment by a drug company in the US. The settlement is related to the company's illegal promotion of best-selling anti-depressants and its failure to report safety data about this diabetes drug.

[62] Transparency about all research, including industry-sponsored trials, would allow independent researchers and potential entrepreneurs to analyze the data and come to their own conclusions. As stated by Yale Professor of medicine Harlan Krumholz, a leading advocate of open data access, "If you have the privilege of selling a drug [or any other product], in return should come the responsibility to share everything you know about the product" (quoted in Whoriskey 2012).

Box 10.6. Policies to support affordable innovations: Learning from global collaboration and local experience

There appear to be significant benefits from global collaboration supported by "contracting for innovation" based on "diagnostic monitoring" (systematic error detection and error correction for continuous improvement of processes pioneered by the Toyota production system), especially in high-risk rapidly changing industries such as biotech, ICT, and contract manufacturing (where the ability to respond quickly to demand fluctuations —to bear the risk of either over or under-capacity—is central to the package offered to customers). Non-state-contingent contracts or governance mechanisms for long-term collaborative innovation appear particularly desirable in situations where the parties cannot specify *ex ante* what innovations would become necessary or feasible, or could be produced at a cost-effective price; they typically include agreed milestones to measure and monitor performance, mechanisms for deterring on-going opportunism and build trust among collaborators, and processes for dispute resolution.[63]

Since its creation in 1986 by India's Ministry of Science and Technology, the Department of Biotechnology (DBT) has been actively initiating and supporting global product development consortia between local and foreign closer-to-the-frontier firms, universities and public research organizations, including an Indo-Swiss Collaboration in biotech applied to agriculture (with over USD 33 million in public investment since 1974), the Indo-US Vaccine Action Program (with over USD 20 million in public investment since 1987), a partnership with Wellcome Trust for affordable healthcare (with over UK£ 45 million in public investment committed since 2010), and bilateral consortia with Australia, Canada, Denmark, Finland, Germany, Japan, Norway, Sweden and others. These consortia have been vehicles for investment in KBC and learning by Indian firms, not only about intellectual property but about "how-to" tacit knowledge regarding structured research protocols that help mitigate risk. Suggestive evidence of the positive spillovers of such learning are provided by a recent survey of Indian biotech enterprises recipients of public support. Interestingly, 55 % of respondents reported that they directly address the needs of Base of Pyramid people in the lowest income groups. Based on survey results, Indian biotech firms may have been learning over time not only about international product knowledge but about the

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[63] As described by Gilson et al. (2008), transactions involving collaborative innovation across organizational boundaries are characterized by product characteristics design and specification not being able to be contracted ex ante. A desirable contracting structure should (1) induce efficient investment by both parties, (2) establish a framework for iterative collaboration and adjustment of obligations under continuing uncertainty, and (3) limit the risk of opportunism that otherwise could undermine relation-specific investments.

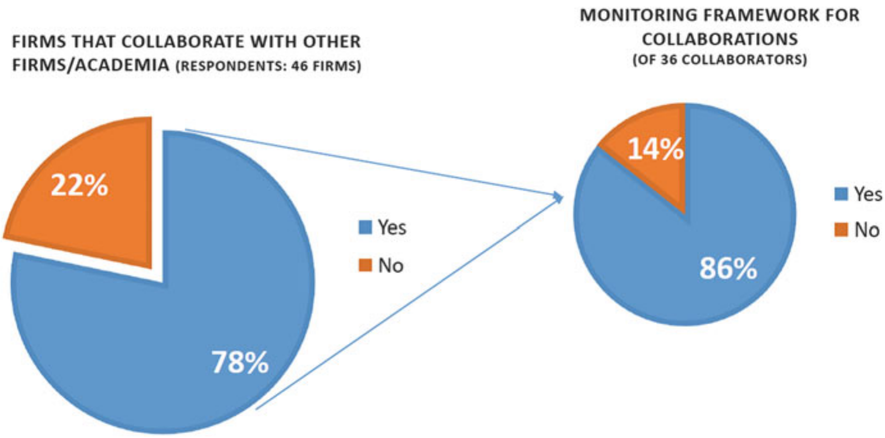

Fig. 10.4 India biotech firms—Collaboration supported by research protocols, 2012. Source: Dutz and Vijayaraghavan (2014)

Box 10.6 (continued)

benefits of co-creation through partnerships and structured research protocols: 36 of 46 surveyed biotech firms (78 %) indicated that they collaborate with other firms or academia for co-development (Fig. 10.4). More tellingly, 31 of these 36 firms (86 %) reported jointly monitoring progress and results via structured research protocols, including in their contracts or informal agreements governing their partnerships one or more of: (1) common data sharing processes, (2) commercialization-driven milestone-based incentives, (3) monitoring via joint review processes, and (4) well-defined escalation mechanisms for dispute resolution.

DBT's support of global consortia is part of a broader systematic approach to learn and build on existing global knowledge and thereby avoid the higher risks of frontier innovation. Policy support also included (1) a focus on translational research, namely where interdisciplinary teams focus on translating existing basic science findings to practical commercializable solutions through adaptation and verification to meet local needs, supported by the set-up of dedicated facilities configured to promote cross-disciplinary collaboration with more interaction than usual between academic research and industry practice[64]; (2) support of domestic PPPs for early-stage funding of

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[64] The setting up in early 2009 of the Translational Health Science and Technology Institute, south of Delhi, modeled on the interdisciplinary Harvard-MIT Health Science and Technology Program, was specifically designed to foster collaboration among research institutes, hospitals and

Box 10.6 (continued)

SMEs and viability gap funding for larger higher-risk projects; (3) skills development; (4) strengthening of the regulatory framework; and (5) institutional governance, including the set-up of Special Purpose Vehicles (SPVs) to govern the global consortia.

A notable outcome to-date is India's first indigenously-developed oral vaccine to prevent high infant mortality from rotavirus-caused diarrhea.[65] The project was supported by India's product development consortia with the US (Indo-US Vaccine Action Program), received support from India's two domestic PPP programs for early-stage funding and for viability gap funding, as well as being supported by other Product Development Partnership (PDP) members.[66] It is the first time that an Indian company is bringing a vaccine successfully through phase III trials, India's first community clinical trial conducted directly through doctors and clinics, with the licensed vaccine to be sold to governments worldwide including UN procurement agencies at a price of $1—and once widely distributed, dramatically reducing the risk of further deaths from this disease.[67]

Finally, a new and as-yet-insufficiently-tried innovation policy that may hold promise in a range of areas addressing global public goods which impose higher risks on developing countries such as climate change and neglected diseases involves fostering genuinely global consortia by building on existing bilateral consortia. As an illustration, Canada created in 2011, as a new element of its Networks of Centers of Excellence program, a bilateral Canada-India Research Center of Excellence (CIRCE) initiative. CIRCE recently announced the award of CAD 13.8 million in funding over 5 years

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companies by encouraging practicing doctors to work with basic researchers and engineers to solve local health problems.

[65] An estimated 130,000 infants still die annually in India from sever rotavirus gastroenteritis.

[66] Other PDP members, in addition to Bharat Biotech, the Indian company headquartered in Hyderabad, include: AIIMS (all India Institute of Medical Science, Delhi), IISc (India Institute of Science, Bangalore), PATH (Program for Appropriate Technologies in Health), the Atlanta Center for Disease Control, Stanford University, and the Bill and Melinda Gates Foundation. While the PDP model arose to address the mismatch between the need for health technologies to address developing country needs and the private sector's inability to meet that need profitably due to the costs and risks of such R&D being too high relative to ability to pay, it could in principle be applied to a range of BoP needs ranging from agriculture and education to climate change.

[67] On the most recent status of the "Phase III Clinical Trial to Evaluate the Protective Efficacy of Three Doses of Oral Rotavirus Vaccine (ORV) 116E (ROTAVAC)", see http://clinicaltrials.gov/show/NCT01305109

Box 10.6 (continued)

to a consortium of Canadian and Indian universities, public sector research agencies, private-sector partners, and not-for-profit and non-governmental organizations.[68] The objective is to meet research objectives and create substantial impact in strategic areas such as alternative cleaner energy, water quality and resource management, advanced materials and sustainable urbanization, and other aspects of environmental sustainability. Once the fixed costs of setting up initiatives like this are incurred, it would require relatively little additional cost to enrich and globalize such bilateral consortia by including to existing platforms other appropriate participants, such as a relevant university researchers, private sector corporate researchers and entrepreneurs from other countries. CIRCE has indicated interest in complementing their bilateral consortium with relevant multilateral additions. The policy challenge is how best to fund such add-on initiatives, how best to identify and bring in the most appropriate complementary global talent, and how best to support the global dissemination and commercialization of the research findings.

10.5 Conclusion

This paper has presented an initial exploration of the role of different types of KBC and the role of appropriate policies in supporting enterprise risk management, in particular reallocation and innovation decisions in response to changing demand and supply trends and unexpected shocks. It has argued that the increased flow and management of knowledge permitted by investments in KBC can be an important factor in reducing the decision risk facing enterprises due to uncertainty and imperfect information. It has highlighted that, absent appropriate policies, KBC investments can have adverse distributional effects on the enterprise sector and on people—including a skewed industrial concentration of productivity gains, and more unequal consumption and income-earning outcomes between rich and poor people. A key message is that insufficient enterprise risk-taking can be costly for the enterprise sector and the economy, as it results in too little experimentation and learning. And that policy has an important role to play in creating business environments that stimulate entrepreneurial experimentation, support skills upgrading, and promote mechanisms for joint learning through global collaboration.

Looking forward, there remains an important policy research agenda across countries with different levels of technological and institutional capacities and

[68] See http://www.nce-rce.gc.ca/Media-Medias/news-communiques/News-Communique_eng.asp?ID=120

industrial structures to better understand the magnitude of investments in different types of KBC, their importance for enterprise risk management and impact on the enterprise sector and on people as consumers and income earners, and policy implications.

Regarding measurement, efforts are needed to collect better comparable data across developing countries by national governments supported by capacity building of national statistical agencies, at the level of both national accounts and individual firms (including farms and informal and formal non-farm enterprises). This work should be accompanied by testing and eventual systematic inclusion of additional national enterprise census and survey questions related to investments in different types of KBC and enterprise risk management. Regarding analysis and experimentation, it would be helpful to better understand the linkages between investments in different types of KBC by both formal and informal enterprises, the channels through which capabilities in enterprise-level risk management are improved, and their impact on productivity and jobs dynamics as well as shared prosperity, including the extent to which productivity increases are shared through more and better-paid jobs over time. Do for example increases in investments in particular types of KBC by enterprises in a given industry result in lower volatility in earnings of these enterprises over time relative to that same industry in other countries, and are there important spillovers across enterprises within and across related industries? And how does it differ across different types of industries? Regarding policy actions, it would be helpful to develop more tailored recommendations for countries with different endowments and at different stages of development. What is the impact of increased enterprise exit and entry and experimentation on displaced workers, and what policies are best at both spurring entrepreneurial experimentation while easing adjustment costs associated with failure of enterprises and displacement of people? Further work is also required to determine the extent to which different constraints to investment and use of different types of KBC are binding at different times, including under what circumstances more productive enterprises are more likely to expand and create more jobs. This could provide more useful recommendations regarding the pace and sequencing of policy actions. And finally, it will be important also to include in the design and implementation of policies specific approaches to measure how effective the policies actually are, so that no only the enterprises are learning, but policymakers and policy advisors are learning as well.

References

Acemoglu, D., Akcigit, U., Bloom, N., & Kerr, W. (2013, April). Innovation, reallocation and growth (NBER Working Paper 18993). Mimeo.

Agosin, M., & Bravo-Ortega, C. (2009, February). *The emergence of new successful export activities in Latin America: The case of Chile* (Inter-American Development Bank Research Network Working Paper R-552).

Akcigit, U. (2010). *Firm size, innovation dynamics and growth* (University of Pennsylvania Working Paper).
Akcigit, U., Hanley, D., & Serrano-Velarde, N. (2012). *Back to basics: Basic research spillovers, innovation policy and growth* (University of Pennsylvania Working Paper).
Almeida, R., Behrman, J., & Robalino, D. (2012). *The right skills for the job? Rethinking training policies for workers* (Human development perspectives). Washington, DC: World Bank.
Alvarez, R., Benavente, J. M., Campusano, R., & Cuevas, C. (2011). *Employment generation, firm size and innovation in Chile: The microeconometric evidence*. Centro INTELIS, Universidad de Chile.
Andrews, D., & Cingano, F. (2012). *Public policy and resource allocation: Evidence from firms in OECD countries* (OECD Economics Department Working Paper No. 996). OECD.
Andrews, D., & Criscuolo, C. (2013, May). *Knowledge-based capital, innovation and resource allocation* (OECD Economic Policy Papers No 04). OECD.
Anton, A., Hernandez, F., & Levy, S. (2012). *The end of informality in Mexico? Fiscal reform for universal social insurance*. Inter-American Development Bank.
Baker, S. R., & Bloom, N. (2012, November 5). Does uncertainty reduce growth? Using disasters as natural experiments. Mimeo, Stanford University.
Banerjee, A., & Duflo, E. (2005). Growth theory through the lens of development economics. In P. Aghion & S. Durlauf (Eds.), *Handbook of economic growth* (Vol. 1A, pp. 473–552). Amsterdam: Elsevier Academic.
Bartelsman, E. J. (2012, August). Social and labor market policy in a world of affluence and abundance. Mimeo.
Bartelsman, E. J., Gautier, P., & De Wind, J. (2010). *Employment protection, technology choice and worker allocation* (IZA Discussion Paper). Institute for the Study of Labor (IZA).
Bartelsman, E. J., Haltiwanger, J. C., & Scarpetta, S. (2013). Cross-country differences in productivity: The role of allocation and selection. *American Economic Review, 103*(1), 305–334.
Baumol, W. J. (2010). *The microtheory of innovative entrepreneurship*. Princeton, NJ: Princeton University Press.
Begley, C. G., & Ellis, L. M. (2012). Drug development: Raise standards for preclinical cancer research. *Nature, 483*, 531–533.
Besley, T., & Burgess, R. (2004). Can labor regulations hinder economic performance? Evidence from India. *Quarterly Journal of Economics, 119*, 91–134.
Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica, 77*(3), 623–685.
Bloom, N., Bond, S., & Van Reenen, J. (2007). Uncertainty and investment dynamics. *Review of Economic Studies, 74*, 391–415.
Bloom, N., Draca, M., & Van Reenen, J. (2012b). Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. Mimeo.
Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., & Roberts, J. (2013a). Does management matter? Evidence from India. *Quarterly Journal of Economics, 128*(1), 1–51.
Bloom, N., Floetotto, M., Jaimovich, N., Saporta-Eksten, I., & Terry, S. (2012a, July). *Really uncertain business cycles* (NBER Working Paper No. 18245).
Bloom, N., Romer, P. M., Terry, S. J., & Van Reenen, J. (2013b). A trapped-factors model of innovation. *American Economic Review: Papers & Proceedings, 103*(3), 208–213.
Bloom, N., & Van Reenen, J. (2010). Why do management practices differ across firms and countries? *Journal of Economic Perspectives, 24*(1), 203–224.
Bollard, A., Klenow, P., & Sharma, G. (2013). India's mysterious manufacturing miracle. *Review of Economic Dynamics, 16*, 59–85.
Booth, A., Francesconi, M., & Frank, J. (2002). Temporary jobs: Stepping stones or dead ends? *The Economic Journal, 112*(480), F189–F213.
Bravo-Biosca, N., Criscuolo, C., & Menon, C. (2012). *What drives the dynamics of business growth* (STI Working Paper 2012/6). DSTI, OECD.

Bruhn, M., Karlan, D., & Schoar, A. (2010). What capital is missing in developing countries? *American Economic Review: Papers & Proceedings, 100*(2), 629–633.

Bruhn, M., Karlan, D., & Schoar, A. (2013). The impact of consulting services on small and medium enterprises: Evidence from a randomized trial in Mexico. Mimeo.

Brynjolfsson, E., & McAfee, A. (2011). *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*. Lexington, MA: Digital Frontier.

Caggese, A. (2012). Entrepreneurial risk, investment, and innovation. *Journal of Financial Economics, 106*, 287–307.

Castro, R., Clementi, G. L., & Lee, Y. (2011). *Cross-sectoral variation in the volatility of plant-level idiosyncratic shocks* (NBER Working Paper 17659).

Cole, H. L., Greenwood, J., & Sanchez, J. M. (2012). *Why doesn't technology flow from rich to poor countries?* (Working Paper 2012-040A). Federal Reserve Bank of St Louis.

Comin, D., Dmitriev, M., & Rossi-Hansberg, E. (2012, November). *The spatial diffusion of technology* (NBER Working Paper 18534).

Comin, D., & Hobijn, B. (2010). An exploration of technology diffusion. *American Economic Review, 100*, 2031–2059.

Comin, D., & Mestieri, M. (2010). *The intensive margin of technology adoption* (Harvard Business School Working Paper 11-026). Cambridge, MA: HBS.

Comin, D., & Mestieri, M. (2013, May). *Technology diffusion: Measurement, causes and consequences* (NBER Working Paper 19052).

Cooper, R. W., & Haltiwanger, J. C. (2006). On the nature of capital adjustment costs. *Review of Economic Studies, 73*, 611–633.

Corrado, C., Haskel, J., Jona-Lasinio, C., & Iommi, M. (2012, July). *Intangible capital and growth in advanced economies: Measurement methods and comparative results* (IZA Discussion Paper No. 6733).

Corrado, C., & Hulten, C. (2010). How do you measure a 'Technological Revolution'? *American Economic Review, 100*(5), 99–104.

Corrado, C., Hulten, C., & Sichel, D. (2005). Measuring capital and technology: An expanded framework. In C. Corrado, J. Haltiwanger, & D. Sichel (Eds.), *Measuring capital in the new economy, studies in income and wealth* (Vol. 65, pp. 11–45). Chicago: The University of Chicago Press.

Corrado, C., Hulten, C., & Sichel, D. (2009). Intangible capital and U.S. economic growth. *Review of Income and Wealth, 55*(3), 661–685.

Cummins, J. G., & Violante, G. L. (2002). Investment-specific technical change in the United States (1947-2000): Measurement and macroeconomic consequences. *Review of Economic Dynamics, 5*(2), 243–284.

D'Erasmo, P. N., & Moscoso Boedo, H. J. (2012). Intangibles and endogenous firm volatility over the business cycle. Mimeo, University of Maryland.

Dahlman, C., & Kuznetsov, Y. (2014). Innovation for the 'base of the pyramid': Developing a framework for policy experimentation. In M. A. Dutz, Y. Kuznetsov, E. Lasagabster, & D. Pilat (Eds.), *Making innovation policy work: Learning from experimentation*. Paris: OECD.

Dutz, M.A. (2013). Investments in productivity: KBC as a driver of growth and structural change. *PRMED Growth FAQ Note*, The World Bank.

Dutz, M.A., Kannebley, S., Jr., Scarpelli, M. & Sharma, S. (2012b). *Measuring intangible capital in an emerging economy: An application to Brazil* (Policy Research Working Paper 6142). The World Bank.

Dutz, M.A., Kessides, I., O'Connell, S., & Willig, R. (2012a). Competition and innovation-driven inclusive growth, Chapter 7. In L. de Mello & M. A. Dutz (Eds.), *Promoting inclusive growth: Challenges and policies*. Paris: OECD (and Policy Research Working Paper 5852).

Dutz, M.A., O'Connell, S.D., & Troncoso, J.L. (2014). *Public and private investments in innovation capabilities: Structural transformation in the Chilean Wine Industry* (Policy Research Working Paper 6983). The World Bank

Dutz, M. A., & Vijayaraghavan, K. (2014). Supporting affordable biotechnology innovations: Learning from global collaboration and local experience. In M. A. Dutz, Y. Kuznetsov, E. Lasagabster, & D. Pilat (Eds.), *Making innovation policy work: Learning from experimentation*. Paris: OECD.

Ehrlich, I., & Becker, G. S. (1972). Market insurance, self-insurance, and self-protection. *Journal of Political Economy, 80*(4), 623–648.

Ellison, G., Glaeser, E. L., & Kerr, W. R. (2010). What causes industry agglomeration? Evidence from coagglomeration patterns. *American Economic Review, 100*(3), 1195–1213.

Fogli, A., & Veldkamp, L. (2012). Germs, social networks and growth (NBER Working Paper 18470). Mimeo, University of Minnesota.

Gilson, R. J., Sabel, C. F., & Scott, R. E. (2008, December). *Contracting for innovation: Vertical disintegration and interfirm collaboration* (ECGI Law Working Paper 118).

Glaeser, E. (2011). *Triumph of the city: How our greatest invention makes us richer, smarter, greener, healthier and happier*. New York: Penguin.

Gonenc, R., Rohn, O., Koen, V., & Saygili, S. (2012). *Structural reforms to boost Turkey's long-term growth* (OECD Economics Department Working Papers No 987). Paris: OECD.

Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2013). Who creates jobs? Small versus large versus young. *Review of Economics and Statistics, 95*(2), 347–361.

Harrison, R., Jaumandreou, J., Mairesse, J., & Peters, B. (2008). *Does innovation stimulate employment? A firm-level analysis using comparable micro-data from four European countries* (NBER Working Paper 14216).

Herranz, N., Krasa, S., & Villamil, A. P. (2009). Small firms in the SSBF. *Ann Finance, 5*, 341–359.

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Thousand Oaks, CA: Sage.

Holmes, T. J., & Stevens, J. J. (2012). Exports, borders, distance, and plant size. *Journal of International Economics, 88*(1), 91–103.

Hombert, J., Schoar, A., Sraer, D., & Thesmar, D. (2013). Should the government make it safe to start a business? Evidence from a French reform. Mimeo.

Hongwei, X., & Ruef, M. (2004). The myth of the risk-tolerant entrepreneur. *Strategic Organization, 2*, 331–355.

Hsieh, C.-T., & Klenow, P. J. (2009). Misallocation and manufacturing TFP in China and India. *Quarterly Journal of Economics, 124*(4), 1403–1448.

Hsieh, C. -T., & Klenow, P. J. (2014). The life cycle of plants in India and Mexico. *Quarterly Journal of Economics,* forthcoming.

Hulten, C. (2013). *Stimulating economic growth through knowledge-based investment* (STI Working Paper 2013/2, DSTI/DOC (2013)2). Paris: OECD.

Hulten, C., & Hao, J. (2012, September). *The role of intangible capital in the transformation and growth of the Chinese economy* (NBER Working Paper 18405).

Hulten, C., Hao, J., & Jaeger, K. (2012). *The measurement of India's intangible capital*. Paper prepared for the World Input-Output Data project, The Conference Board.

Ioannides, J. P. A. (2005). Why most published research findings are false. *PLoS Medicine, 2*(8), 696–701.

Knabe, A., & Plum, A. (2013). Low-wage Jobs — Springboard to high-paid ones? *Labour, 27*(3), 310–330.

La Porta, R., & Shleifer, A. (2008). The unofficial economy and economic development. *Brookings Papers in Economic Activity,* 275–352.

Levy, S. (2008). *Good intentions, bad outcomes*. Washington, DC: Brookings Institution.

Mairesse, J., Zhao, Y., & Zhen, F. (2009). Employment growth and innovation in China: A firm level comparison across provinces and city districts. http://www.merit.unu.edu/MEIDE/papers/2009/1235915501_FZ.pdf

McKinsey Global Institute. (2011, February). *Growth and renewal in the United States: Retooling America's economic engine*. Washington, DC: McKinsey.

Mendes, A., & Braga, J. P. (2010). A Metodologia de Avaliação de Empresas: uma sistemática para avaliar ativos intangíveis e competitividade com base no padrõa de concorrência. In A. C. Além & F. O. Giambiagi, *BNDES em um Brasil em Transição*. Rio de Janeiro: BNDES.
Miner, J. B., & Raju, N. S. (2004). Risk propensity differences between managers and entrepreneurs and between low- and high-growth entrepreneurs: A reply in a more conservative vein. *Journal of Applied Psychology, 89*, 3–13.
Mosthaf, A. (2011). *Low-wage jobs: Stepping stones or just bad signals?* (Institute for Employment Research Discussion Paper No. 11).
Mourshed, M., Farrell, D., & Barton, D. (2012). *Education to employment: Designing a system that works*. Washington, DC: McKinsey Center for Government, McKinsey and Company.
Nakamura, L. (2001). *What is the U.S. gross investment in intangibles? (At least) one trillion dollars a year!* (Federal Reserve Bank of Philadelphia Working Paper 01-15).
Nicholson, J. M., & Ioannidis, J. P. A. (2012). Research grants: Conform and be funded. *Nature, 492*, 34–36.
OECD. (1998). *Measuring intangible investment: National efforts to measure intangible investment*. OECD Secretariat.
OECD. (2013). *Supporting investment in knowledge capital, growth and innovation*. Paris: OECD.
Peters, B. (2005). *Employment effects of different innovation activities: New microeconometric evidence* (Discussion paper No. 04-73). ZEW—Centre for European Economic Research.
Ramani, S.V, Frühauf, T., Dutta, A., & Meijers, H. (2012). *Determinants of the prevalence of diarrhoea in adolescents attending school: A case study of an Indian village school* (MERIT Working Papers 059). United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT)
Romer, P. M. (2001). Should the government subsidize supply or demand in the market for scientists and engineers? In A. B. Jaffe, J. Lerner, & S. Stern (Eds.), *Innovation policy and the economy* (Vol. 1, pp. 221–252). Cambridge, MA: MIT Press.
Sarasvathy, D., Simon, H., & Lave, L. (1998). Perceiving and managing business risks: Differences between entrepreneurs and bankers. *Journal of Economic Behavior and Organization, 33*, 207–225.
Sheffi, Y. (2005). *The resilient enterprise: Overcoming vulnerability for competitive advantage*. Cambridge, MA: MIT Press.
Soderblom, M., Teal, F., & Harding, A. (2006). The determinants of survival among African manufacturing firms. *Journal of Development Economics, 73*, 369–394.
Taleb, N. N. (2012). *Antifragile: How to live in a world we don't understand*. New York: Random House.
Taymaz, E. (2009). *Informality and productivity: Productivity differentials between formal and informal firms in Turkey* (ERC Working Papers in Economics 09/01). Ankara: Middle East Technical University.
Teal, F. (2013). The enterprise sector: Providing employment and sharing risk. *Background Note for World Development Report 2014*, mimeo, The World Bank.
Tenorio, H., Braga, J. P., & Barboza, R. (2013). Assessing intangible assets and competitiveness in Brazilian firms: The BNDES' approach to credit analysis. Mimeo, BNDES, Rio de Janeiro.
Teubal, M., & Kuznetsov, Y. (2012). Sequencing public interventions to support techno-entrepreneurship, Chapter 6. In L. de Mello & M. A. Dutz (Eds.), *Promoting inclusive growth: Challenges and policies*. Paris: OECD.
Trajtenberg, M. (2009). Innovation policy for development. In D. Foray (Ed.), *The new economics of technology policy*. Cheltenham: Edward Elgar (http://econ.tau.ac.il/papers/foerder/6-2006.pdf).
Westly, E. (2012). India moves to tackle antibiotic resistance. *Nature, 489*, 192.
Westmore, B. (2013). *R&D, patenting and productivity: The role of public policy* (OECD Economics Department Working Paper No 1047). Paris: OECD.

Whoriskey, P. (2012, November 25). Can drug research still be trusted? Even in the most respected of medical journals, firms' influence over studies opens door to bias. *The Washington Post,* Sunday, pp. A1, A10-11.

Wilson, D. (2009). Beggar thy neighbor? The in-state, out-of-state and aggregate effects of R&D tax credits. *Review of Economics and Statistics, 91*, 431–436.

World Economic Forum. (2013). *Global risks 2013* (8th ed.). Geneva: WEF.

Yezli, S., & Li, H. (2012). Antibiotic resistance amongst healthcare-associated pathogens in China. *International Journal of Antimicrobial Agents, 40*, 389–397.

Yusuf, S., Nabeshima, K., & Yamashita, S. (2008). *Growing industrial clusters in Asia: Serendipity and science*. Washington, DC: World Bank.

Chapter 11
Innovation in Information Systems and Valuation of Intangibles

Feng Gu and John Q. Li

Abstract Innovations in information systems, including the adoption of new information technologies and the creation of new flows of knowledge and information beyond traditional boundaries, represent an emerging form of intangibles relevant for firms from a wide range of industries. We examine firms' incentives to invest in the production of this intangible and provide evidence on the role of this innovation in the value creation of firms' intangibles. Our research setting involves firms using internet to create a continuous stream of new knowledge about the firm's performance and share it with external stakeholders. We find that firms with more investment in other intangibles, such as R&D and advertising, are more likely to undertake this type of information systems innovation. We also find that this innovation enhances the value of firms' other intangibles, including investor trust in the firm and firms' investment in R&D and advertising. Thus, our study demonstrates that innovation in information systems creates a distinct and valuable intangible asset and complements firms' other intangibles.

Keywords Innovation • Information systems • Intangible assets • Valuation

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11.1 Introduction

It is long recognized that information systems play a fundamental and strategic role for ensuring firms' long-term competitiveness (e.g., Clemons 1986). Innovation in information systems, including the deployment of cutting-edge information technologies (e.g., hardware and software) and the creation of new flows of knowledge beyond traditional boundaries, is important in the success of information systems investment. In this study, we examine firms' incentive to undertake information systems innovation and provide evidence on the specific benefits of the innovation. We focus on the setting of firms utilizing internet to communicate internal knowledge about firms' activity and performance to external stakeholders (e.g., investors). This setting highlights how firms adopt other concurrent innovations (i.e., internet) in information systems innovation. The adoption reflects the evolving nature of innovation in information systems, a fundamental attribute of information systems innovation identified by prior research (Swanson 1994).

Internet-based sharing of firms' internal knowledge with external stakeholders features several innovations in firms' information systems. First, it substantially expands the usage of existing information goods without incurring additional information production cost. Because the value of information goods increases with the number of users (Shapiro and Varian 1999), this expansion can create new net value for firms' information systems investment. Second, the expansion also validates the robustness of a firm's information systems (e.g., the firm's internal control strength) and its ability to meet the stringent standard of external scrutiny. High quality information systems enhance firms' ability to capture new business opportunities and outperform competitors (e.g. Bharadwaj 2000). Third, unlike information systems innovations that bring only internal changes at organizations, an externalization of internal knowledge redefines the dynamics of firms' interactions with external stakeholders by creating a new channel of information sharing. Prior research suggests that firms benefit from sharing information with external stakeholders (e.g., Cachon and Fisher 2000; Ha and Tong 2008).

The setting of our study involves firms that use internet to report monthly information originally designed and compiled for internal purposes. This type of information systems innovation has not been examined in the literature that investigates the role of innovation and intangible assets in corporate value creation.[1] This innovation leads to new knowledge flows that deliver previously unavailable content (i.e., the new knowledge flow is distinct from firms' traditional information flows, such as quarterly and annual financial reports) and may generate large impact on intended information users by facilitating new transactions outside the firm.

[1] Prior studies focus on the value-relevance and risk-relevance of investment in information systems and technologies (e.g., Brynjolfsson and Hitt 1996; Brynjolfsson et al. 2002; Dewan et al. 2007). Investment in information systems, however, is different from information systems innovation in that firms' decision to invest in information systems can be driven by industry-wide adoption of information technologies rather than the strategy to differentiate from others (Porter 1985).

Existing research confirms these enhancements signify the success of firms' information systems and in turn contribute to the creation of valuable information-based intangible assets (e.g., DeLone and McLean 1992, 2003).

To shed light on firms' incentive to undertake information systems innovation, we compare our sample firms with other firms using a matched-sample research design. We predict that firms making larger investments in intangible assets, such as R&D and advertising, are more likely to be engaged in information systems innovation. Prior research shows that the output from firms' conventional information systems, such as financial accounting data, is inadequate for the purpose of valuing intangible assets, leading to undervaluation of firms' intangible investment (e.g., Chan et al. 2001; Eberhart et al. 2004). Thus, firms investing more in intangibles have stronger incentives to increase information flows by undertaking information systems innovation to create new knowledge streams with richer content and wider reach.

We also examine the economic benefits associated with information systems innovation. We predict that externalization of internal knowledge about firm activity and performance cultivates investor trust in the firm by aligning the perspectives of investors with those of management and facilitating investors' task of assessing firm performance. Prior research shows that investor trust is a valuable intangible that confers considerable advantages to firms accessing the capital market, such as lower costs of capital (e.g., Healy et al. 1999). There is, however, a dearth of research on the effect of information systems innovation on investors as an important group of stakeholders (Petter et al. 2012). Our study specifically fills this gap by providing evidence on investor response to firms' information systems innovation. We also consider the implications of information systems innovation for firms' other intangible assets. Early research of innovation finds that innovative efforts are more successful when firms invest in diverse and complementary areas of innovation (Teece 1986). Because sophisticated investors, such as analysts and institutional investors, are likely more knowledgeable about the intricacies of innovation, including the complementary nature of innovation success and the benefits of knowledge spillover in innovation, we predict that information systems innovation would increase sophisticated investors' recognition of the value of firms' other intangible assets.

Consistent with our predictions, we find that firms investing more in R&D, advertising, and other intangibles are more likely to provide new streams of information to share internal knowledge with external stakeholders. Our results indicate that firms undertaking this type of information systems innovation experience a significant increase in investor following and trust after the initiation of the innovation. We also find that this innovation effort complements firms' other innovative activities by increasing sophisticated investors' recognition of firms' intangible value. Taken together, the results of our study demonstrate that innovation in information systems not only creates a distinct and valuable intangible asset but also complements firms' other intangibles. To our best knowledge, our study is the first to document the unique dual roles of information systems innovation in the value creation of intangible asset.[2]

The remainder of this paper proceeds as follows. We develop our research hypotheses in Sect. 11.2. In Sect. 11.3, we describe our sample and report descriptive statistics of sample firms. We report the empirical results in Sect. 11.4. Section 11.5 concludes our study.

11.2 Hypothesis Development

We predict that firms making larger investments in intangible assets have stronger incentives to undertake information systems innovation. Existing research finds that investments in intangibles, such as R&D and advertising, are *undervalued* by investors, due to the inability of firms' existing information systems, such as financial accounting, in informing investors of the value and prospects of the investment (Chan et al. 2001; Eberhart et al. 2004; Faurel 2008).[3] A logical response to the problem is for firms to innovate their information systems to create new knowledge streams beyond traditional boundaries. Innovations leading to enhanced knowledge streams, such as monthly reporting, are particularly appealing for this purpose because they can keep investors better informed. Fishman and Hagerty (1989) show that investing firms have incentives to attract investor attention with more information production and wider information dissemination when the investment is complex for investors to assess and when the intrinsic value of the investment is not adequately reflected in stock prices. Thus, we hypothesize that firms with larger investments in intangible assets are more likely to be engaged in information systems innovation to enhance knowledge flows.

H1 Firms' incentive to innovate information systems is positively associated with the amount of the firm's investment in intangible assets.

Existing research also indicates that firms moving to provide new streams of information enjoy a boost in investor trust as reflected in increases in the following by analysts and institutional investors (e.g., Healy et al. 1999). More information attracts greater analyst following because it reduces the cost of knowledge acquisition for analysts. Institutional investors also prefer investing in firms with more information because more information reduces the cost of monitoring managerial action and ensures compliance with their fiduciary duties. Innovations in

[2] For a review of prior research on the role of various intangible assets in value creation, see Lev (2001), Ashton (2005), and Lev (2008).

[3] Prior research suggests that this information deficiency exacerbates the information asymmetry problem for intangibles—investors know less about firms' innovation activities than management (Aboody and Lev 2000).

information systems, such as monthly reporting, confer these benefits to analysts and institutional investors by providing new knowledge not available from other sources. The new knowledge has considerable value to analysts and institutional investors because it facilitates the monitoring of managerial action and reduces undesirable managerial behavior. Thus, we predict increases in investor trust after the initiation of information systems innovation.

H2 Firms that are engaged in information systems innovations experience increases in investor trust.

We also consider the effect of information systems innovation on investors' recognition concerning the value of firms' investment in intangible assets. The strategic role of information systems and technologies as an enabler of other value-creating activities is well recognized by academics and practitioners. Prior research finds that firms' intangible assets perform better when they are backed by information systems innovations linked to the deployment of cutting-edge information technologies (e.g., Powell and Dent-Micallef 1997).[4] The complementary relationship between information systems innovations and other intangible assets is consistent with the finding of Teece (1986) and others (e.g., Gòmez and Vargas 2012) that investing in diverse but related innovations is crucial for the success of innovating firms. Because sophisticated investors, such as analysts and institutional investors, focus more on the importance of investment that increase firms' long-term value but may not immediately improve short-term results (Porter 1992), we predict an increase in sophisticated investors' valuation of intangible assets after firms initiate information systems innovation.

H3 Firms that are engaged in information systems innovation experience increases in sophisticated investors' recognition concerning the value of intangible assets.

11.3 Sample and Data

We seek to examine firms that innovate information systems to create new flows of knowledge and information beyond traditional boundaries. Our research setting involves firms using internet to share monthly information with external

[4] A high quality internal information reporting system, such as timely and reliable monthly reporting procedure, is particularly valuable for capturing total innovation value because it can directly facilitate the assessment of externalities and knowledge spillover in innovation, which are the key to value creation in innovation (IMA 2005).

stakeholders. Our sample includes 52 firms that innovate their information systems by providing monthly reporting on their websites during the period of 1998–2007 ("innovating firms" hereafter). We identified these firms by searching relevant information on firms' websites during the sample period. To ensure data availability, we require sample firms to be covered in COMPUSTAT. To obtain insights into factors associated with firms' innovation in information systems, we match each innovating firm with a non-innovating firm by three-digit SIC industry membership and firm size measured by sales and total assets. We perform this matching procedure in the year when the sample firm started the innovation and obtain an industry-, size-, and year-matched sample of 52 firms ("non-innovating firms" hereafter).

Table 11.1 reports descriptive statistics of our sample firms. It shows that besides similar size, the innovating firms and non-innovating firms have similar financial leverage and sales growth. The innovating firms, however, have larger amounts of capital expenditure, spend more on R&D, advertising, and acquired intangibles, and have more employees relative to sales than the non-innovating firms. Table 11.1 also provides statistics on analysts following, institutional holding, and managerial ownership for the sample firms. Information on analyst following is from I/B/E/S. Data on institutional ownership is obtained from 13f filings, and the statistics on managerial stock ownership are based on COMPUSTAT Execucomp. Compared to the non-innovating firms, the innovating firms are covered by more analysts (e.g., 9.346 vs. 5.885 for the mean) and have more institutional investors (e.g., 195 vs. 144 for the mean). The level of managerial stock ownership, however, is similar for both samples.

11.4 Empirical Results

11.4.1 The Incentive of Information Systems Innovation

We examine firms' incentive to innovate information systems by estimating the following logistic regression for the year of the innovation initiation:

$$INNOVATE_{it} = \alpha_0 + \alpha_1 R\&DE_{it} + \alpha_2 ADVT_{it} + \alpha_3 INTG_{it} + \alpha_4 CAPE_{it} + \alpha_5 NEMP_{it} + \alpha_6 AFLW_{it} + \alpha_7 PIH_{it} + \alpha_8 PMH_{it} + \alpha_9 FIN_{it} + \alpha_{10} ROA_{it} + \alpha_{11} M/B_{it} + \alpha_{12} BVOLT_{it} + \varepsilon_{it}, \quad (11.1)$$

where i and t are firm and year subscripts, respectively. *INNOVATE* is a binary variable that takes the value of one for innovating firms and zero otherwise. *R&DE* is the firm's R&D expenditure. *ADVT* is advertising expense. *INTG* is the firm's reported intangible assets other than goodwill. *NEMP* is the number of employees (our proxy for investment in human capital). *CAPE* is capital expenditure.[5] *R&DE*,

[5] We include capital expenditure as a control in this test because increases in investment in intangibles may require firms to invest in new capital projects as well.

Table 11.1 Mean (median) value of key financial characteristics of sample firms

Variable	Innovating firms	Non-innovating firms	*p*-value for mean (median) difference
Total assets (*TAST*)	7,286	8,586	$p = 0.456$
	(1,899)	(1,899)	$(p = 0.442)$
Sales revenue (*SALES*)	3,246	3,421	$p = 0.434$
	(1,490)	(1,582)	$(p = 0.478)$
Financial leverage (*LEVG*)	0.282	0.287	$p = 0.452$
	(0.275)	(0.272)	$(p = 0.516)$
Sales growth rate (*ΔSALES*)	0.186	0.171	$p = 0.423$
	(0.098)	(0.094)	$(p = 0.551)$
Return on assets (*ROA*)	0.0529	0.0174	$p = 0.074$*
	(0.0556)	(0.0433)	$(p = 0.062)$*
Market-to-book ratio (*MTB*)	2.776	1.933	$p = 0.072$*
	(2.427)	(1.876)	$(p = 0.010)$***
Capital expenditure (*CAPE*)	0.066	0.039	$p = 0.037$**
	(0.047)	(0.027)	$(p = 0.052)$*
R&D expenditure (*R&DE*)	0.025	0.012	$p = 0.082$***
	(0.006)	(0.000)	$(p = 0.025)$**
Advertising expenditure (*ADVT*)	0.006	0.002	$p = 0.043$**
	(0.0002)	(0.000)	$(p = 0.001)$***
Acquired intangible assets (*INTG*)	0.070	0.036	$p = 0.063$***
	(0.002)	(0.000)	$(p = 0.047)$**
Number of employees relative to sales (*NEMP*)	0.013	0.008	$p = 0.081$***
	(0.007)	(0.003)	$(p = 0.079)$***
Number of analysts following (*NAFL*)	9.346	5.885	$p = 0.004$***
	(8.000)	(4.000)	$(p = 0.002)$***
Number of institutional investors (*NIH*)	195	144	$p = 0.024$**
	(179)	(105)	$(p = 0.018)$**
Percentage of institutional ownership (*PIH*)	0.584	0.521	$p = 0.074$*
	(0.624)	(0.547)	$(p = 0.066)$*
Managerial ownership (*PMH*)	0.012	0.021	$p = 0.200$
	(0.0000)	(0.0000)	$(p = 0.286)$
Financing activity (*FIN*)	0.308	0.250	$p = 0.259$
	(0.000)	(0.000)	$(p = 0.259)$

Variable definitions are as follows. *TAST* is the amount of the firm's total assets. *SALES* is the firm's sales revenue. *LEVG* is the firm's financial leverage, defined as the ratio of the sum of long-term debt and current liabilities to total assets. *ΔSALES* is the percentage rate of sales change from the prior year to the current year. *ROA* is the return on assets, defined as the ratio of the firm's income before extraordinary items to average total assets. *MTB* is the ratio of the firm's market value to book value measured at the fiscal year-end. *CAPE* is the firm's capital expenditure deflated by sales. *R&DE* is the firm's R&D expenditure deflated by sales. *ADVT* is the firm's advertising expense deflated by sales. *INTG* is the firm's recorded intangible assets other than goodwill (deflated by total assets). *NEMP* is the number of employees deflated by sales. *NAFL* is the number of analysts issuing earnings forecasts for the firm. *NIH* is the number of institutional investors holding the firm's share. *PIH* is the percentage of shares held by institutional investors. *PMH* is the percentage of shares held by management. *FIN* is a dummy variable that takes the value of 1 for firms issuing equity or debt during the period of year t to year $t+1$ and 0 otherwise
*, **, and *** indicate one-tailed statistical significance at the 0.1, 0.05, and 0.01 level, respectively

ADVT, *NEMP*, and *CAPE* (*INTG*) are deflated by the firm's sales (total assets). The control variables of Eq. (11.1) include *AFLW*, *PIH*, *PMH*, *FIN*, *ROA*, *M*/*B*, and *BVOLT*. *AFLW* is the measure of analyst following defined as the logarithm of the number of analysts issuing earnings forecasts for the firm. *PIH* is the percentage of shares held by institutional investors. *PMH* is the percentage of shares held by management. *FIN* is a dummy variable that takes the value of 1 for firms issuing equity or debt during the period of year t to year t+1. *ROA* is the firm's return on assets. *M*/*B* is the firm's market-to-book ratio at fiscal year-end. *BVOLT* is the measure for the firm's business volatility, defined as the absolute change in the firm's decile rank of book value from year $t-1$ to year t (Lev and Zarowin 1999) Prior research suggests that firms' incentive to increase information flow is associated with these control variables (Lang and Lundholm 1993).

We report the results of the logistic regression of Eq. (11.1) in Table 11.2. The model is statistically significant in explaining firms' decision of information systems innovation. Consistent with prior evidence, the coefficients on analyst following (*AFLW*), institutional ownership (*PIH*), financing activity (*FIN*), and business volatility (*BVOLT*) are significantly positive. The coefficients on R&D expenditure (*R&DE*), advertising expense (*ADVT*), intangible assets (*INTG*), capital expenditure (*CAPE*), and the number of employees (*NEMP*) are all positive and statistically significant at the 0.05 level or higher. These results are consistent with our predictions on the positive relation between firms' investment in intangibles and the incentive of information systems innovation (H1).

11.4.2 Information Systems Innovation and Investor Trust

We next turn to examine the effect of firms' information systems innovation on investor trust. Prior research finds that investor trust is a valuable intangible asset that confers future benefits to firms, such as better access to capital market and lower costs of capital. We use two benchmarks to assess the effect of information systems innovation on the level of investor trust. First, we examine the change in the proxies for investor trust for innovating firms after the initiation of the innovation. This test of time-series changes uses the innovating firms as their own controls. Second, we compare the time-series changes for the innovating firms with those for the matched non-innovating firms. This test of cross-sectional differences controls for the effect of contemporaneous and common factors that affect both the innovating firms and non-innovating firms. The use of both cross-sectional and time-series benchmarks enhances the robustness of our conclusion. We report the results of these tests in Table 11.3. The first (middle) three columns of Table 11.3 give the mean statistics for the year before the innovation, year $t-1$, the year after the innovation, year $t+1$, and the time-series from year $t-1$ to year $t+1$ for the innovating firms (non-innovating firms). The last three columns, titled "Innovating firms vs. non-innovating firms," report the statistical differences between

Table 11.2 Results from the logistic regression of information systems innovation

Variable	Predicted sign	Coefficient	*p*-value
Intercept	+/–	4.211	0.001
R&DE	+	4.945**	0.003
ADVT	+	3.732**	0.003
INTG	+	3.723**	0.006
CAPE	+	5.894*	0.017
NEMP	+	4.011*	0.033
BVOLT	+	1.147**	0.005
ROA	+	1.738	0.131
AFLW	+	0.858**	0.003
PIH	+	2.375	0.072
PMH	+	−0.558	0.143
M/B	+	0.034	0.362
FIN	+	1.424*	0.021
N		104	
Model χ^2		47.29	
(*p*-value)		(0.0005)	
Pseudo R^2		31.34 %	

Variable definitions are as follows. *R&DE* is the firm's R&D expenditure deflated by sales. *ADVT* is the firm's advertising expense deflated by sales. *INTG* is the firm's recorded intangible assets other than goodwill (deflated by total assets). *CAPE* is the firm's capital expenditure deflated by sales. *NEMP* is the number of employees deflated by sales. *BVOLT* is the measure for the firm's business volatility, defined as the absolute change in the firm's decile rank of book value from year $t-1$ to year t. *ROA* is the return on assets, defined as the ratio of the firm's income before extraordinary items to average total assets. *AFLW* is the logarithm of the number of analysts issuing earnings forecasts for the firm. *PIH* is the percentage of shares held by institutional investors. *PMH* is the percentage of shares held by management. *MTB* is the ratio of the firm's market value to book value measured at the fiscal year-end. *FIN* is a dummy variable that takes the value of 1 for firms issuing equity or debt during the period of year t to year $t+1$ and 0 otherwise. The logistic regression is based on 104 observations (52 innovating firms and 52 matched non-innovating firms). The dependent variable of the logistic regression, *INNOVATE*, is an indicator variable that takes the value of 1 for firms undertaking information systems innovation ("innovating firms") and 0 otherwise

*, **, and *** indicate one-tailed statistical significance at the 0.05, 0.01, and 0.001 level, respectively

innovating firms and non-innovating firms in year $t-1$, year $t+1$, and for the changes from year $t-1$ to year $t+1$, respectively.

The first row of Table 11.3 provides statistics on the extent of analysts following (*NAFL*), measured as the number of financial analysts who provide earnings forecasts for the firm. Consistent with our prediction in H2, we find a significant increase in the number of analysts following the innovating firms from year $t-1$

Table 11.3 Mean value of key variables reflecting investor trust before and after initiation of information systems innovation

	Innovating firms			Non-innovating firms			Innovating firms vs. non-innovating firms		
Variable	Year $t-1$	Year $t+1$	Change (t-stat.)	Year $t-1$	Year $t+1$	Change (t-stat.)	Year $t-1$ (t-stat.)	Year $t+1$ (t-stat.)	Change (t-stat.)
NAFL	8.308	9.865	1.557** (2.63)	5.615	6.112	0.497 (0.58)	2.693** (2.57)	3.753*** (3.45)	1.060** (2.49)
PIH	0.571	0.653	0.082*** (3.21)	0.514	0.535	0.021 (0.41)	0.057** (2.52)	0.118*** (3.14)	0.061** (2.43)
NIH	182.2	220.1	37.9** (2.82)	142.3	145.6	3.300 (0.24)	39.9 (3.58)	74.5*** (4.56)	34.6** (2.75)

Variable definitions are as follows. *NAFL* is the number of analysts following the firm. *PIH* is the firm's percentage of shares held by institutional investors. *NIH* is the number of institutional investors holding the firm's shares. Year $t-1$ ($t+1$) is the year before (after) the initiation of information systems innovation

*, **, and *** indicate one-tailed statistical significance at the 0.05, 0.01, and 0.001 level, respectively

to year $t+1$ (8.308 vs. 9.865). The non-innovating firms, however, experience no significant increase in the number of analyst following from year $t-1$ to year $t+1$ (5.615 vs. 6.112). Consistent with these patterns of intertemporal changes, we find that the innovating firms experience a significantly larger increase in analyst following over time than the non-innovating firms (1.557 vs. 0.497).[6] A comparison between the innovating firms and non-innovating firms with respect to changes in investor trust over time, reported under the last column titled "Innovating firms vs. non-innovating firms" (Change), shows that the innovating firms experienced significantly greater increases in analyst following over time than the non-innovating firms. This evidence is consistent the prediction of H2 and indicates the effect of information systems innovation on improving firms' visibility and credibility with analysts.

The second and third rows of Table 11.3 report statistics on the percentage of institutional holding (*PIH*) and the number of institutional investors (*NIH*), respectively. We find that the innovating firms have statistically significant increases in institutional ownership after the initiation of information systems innovation. From year $t-1$ to year $t+1$, the mean percentage of institutional holding increases from 57.1 to 65.3 %. The change is statistically significant at the 0.001 level. The mean number of institutional investors increases from 182.2 to 220.1, with the change statistically significant at the 0.001 level. Table 11.3 also shows that the innovating firms have significantly larger increases in the percentage of institutional holding and the number of institutional investors over time than the non-innovating firms.

[6] In un-tabulated tests, we find that the increases in analyst following for the innovating firms continue in future years. For year $t+2$, the mean number of analysts following the innovating firms further increases to 11.077, whereas the mean number of analysts following the non-innovating firms is 6.365 in year $t+2$ vs. 6.112 in year $t+1$.

These results are consistent with the prediction of H2 and indicate that innovations in information systems attract more institutional investors. Thus, our tests reported in Table 11.3 indicate that information systems innovation is associated with increases in investor trust. Given the prominence of investors among all stakeholders, an increase in investor trust may likely have a spillover effect on other stakeholders, such as suppliers and customers.

11.4.3 Information Systems Innovation and Valuation of Intangibles

We now turn to examine whether the innovation in information systems also leads to changes in investors' recognition of the value of firms' investment in intangibles. We focus on analysts and institutional investors as representative types of investors and examine the relation between the recognition of analysts and institutional investors and changes in firms' investment in intangible assets, including R&D, advertising, human capital, and others. Our measure of analysts' recognition is their forecasts of firms' long-term earnings growth (*AFLTG*), a direct indicator of analysts' assessment of long-term firm performance. Our regression for the examination of analysts' recognition is as follows:

$$AFLTG_{it} = \gamma_0 + \gamma_1 \Delta R\&DE_{it} + \gamma_2 \Delta ADVT_{it} + \gamma_3 \Delta INTG_{it} + \gamma_4 \Delta CAPE_{it} + \gamma_5 \Delta NEMP_{it} + \gamma_6 SIZE_{it} + \gamma_7 AGE_{it} + \gamma_8 M/B_{it} + \gamma_9 \Delta EARN_{it} + \varphi_{it}, \quad (11.2)$$

where i and t are firm and year subscripts, respectively. *AFLTG* is the median analyst forecast of the firm's long-term earnings growth rate. $\Delta R\&DE$ is the yearly change in R&D expenditure. $\Delta ADVT$ is the yearly change in advertising expense. $\Delta INTG$ is the change in intangible assets. $\Delta CAPE$ is the change in capital expenditure. $\Delta NEMP$ is the change in the number of employees. $\Delta R\&DE$, $\Delta ADVT$, $\Delta CAPE$, and $\Delta NEMP$ are deflated by the firm's sales. $\Delta INTG$ is deflated by total assets. *SIZE* is the logarithm of total assets. *AGE* is the firm's age as a publicly traded firm. *M*/*B* is the market-to-book ratio. $\Delta EARN$ is the change in earnings relative to the prior year. *SIZE*, *AGE*, *M*/*B*, and $\Delta EARN$ are control variables for analyst forecast of long-term earnings growth. Analysts' expectations of earnings growth over long run are likely greater for smaller firms, younger firms, firms with higher investor expectations of growth as reflected in higher market-to-book ratios, and firms recently reporting better news of earnings change.

We report the regression estimates of Eq. (11.2) in Table 11.4, Panel A. To provide more robust evidence, we estimate Eq. (11.2) for both the innovating firms and non-innovating firms in the year before the innovation initiation (year $t-1$) and the year after the innovation initiation (year $t+1$), respectively. The results for the innovating firms indicate that in year $t-1$, analyst forecast of long-term earnings

Table 11.4 Relation between information systems innovation and sophisticated investors' recognition for the value of firms' intangible assets

	Innovating firms		Non-innovating firms	
Variable	Year $t-1$	Year $t+1$	Year $t-1$	Year $t+1$
Panel A. Analyst forecast of long-term earnings growth (AFLTG)				
Intercept	−0.104	−0.037	0.041	0.021
	(−0.59)	(−0.57)	(0.52)	(0.27)
ΔR&DE	−4.842	10.219**	−2.124	−3.778
	(−1.27)	(2.72)	(−0.42)	(−0.75)
ΔADVT	3.702	4.315*	2.781	2.029
	(1.45)	(1.71)	(0.83)	(0.61)
ΔINTG	−0.052	−0.359	−0.803*	−0.847*
	(−0.15)	(−1.02)	(−1.73)	(−1.85)
ΔCAPE	0.376	0.709*	0.072	0.087
	(1.14)	(2.19)	(1.23)	(1.51)
ΔEMP	3.366	16.630*	−10.451*	−6.089
	(0.80)	(2.02)	(−2.08)	(−1.23)
SIZE	−0.026**	−0.024**	−0.010	−0.009
	(−2.85)	(−2.62)	(−1.04)	(−0.89)
AGE	−0.006**	−0.002*	−0.003*	−0.003*
	(−2.80)	(−2.20)	(−2.14)	(−2.03)
MTB	0.001	0.006	−0.001	−0.003
	(0.15)	(1.25)	(−0.12)	(−0.35)
ΔEARN	−0.009	0.007	0.081*	0.108**
	(−0.26)	(0.19)	(2.05)	(2.81)
N	52	52	52	52
F-stat.	2.72	2.96	1.77	1.83
Adj. R^2	23.3 %	27.8 %	12.0 %	12.7 %
Panel B. Change of institutional ownership (ΔPIH)				
Intercept	0.001	0.004	0.002	0.002
	(1.24)	(1.87)	(2.75)	(0.10)
ΔR&DE	−0.015	0.118***	−0.041	−0.371***
	(−0.71)	(3.27)	(−0.57)	(−4.43)
ΔADVT	−0.025	0.051**	−0.074*	0.151
	(−1.28)	(2.87)	(−1.69)	(1.46)
ΔINTG	−0.002	0.001	−0.002	−0.004
	(−0.89)	(0.59)	(−0.12)	(−0.42)
ΔCAPE	−0.001	0.010***	0.001	−0.009
	(−0.52)	(4.55)	(0.70)	(−0.69)
ΔEMP	0.014	0.059*	−0.171**	−0.096
	(0.29)	(1.86)	(−2.55)	(−0.41)
ΔNAFL	0.001**	0.001	0.001	0.001
	(2.89)	(0.82)	(0.90)	(0.34)
ΔEARN	0.005***	0.002*	0.008**	0.017***
	(5.87)	(1.68)	(2.76)	(4.56)
SIZE	−0.001	−0.001	0.002	0.001
	(−1.44)	(−1.58)	(0.67)	(0.55)

(continued)

Table 11.4 (continued)

	Innovating firms		Non-innovating firms	
Variable	Year $t-1$	Year $t+1$	Year $t-1$	Year $t+1$
MTB	0.001*	−0.000	−0.001	−0.001*
	(2.11)	(−0.36)	(−1.52)	(−1.86)
N	52	52	52	52
F-stat.	2.89	3.32	2.10	2.94
Adj. R^2	25.45 %	31.01 %	21.06 %	26.88 %

Variable definitions are as follows. *AFLTG* is the median analysts' forecast of the firm's long-term earnings growth rate. *ΔPIH* is the change in the percentage of firms' shares held by institutional investors. *ΔR&DE* is the change in the firm's R&D expenditure deflated by sales. *ΔADVT* is the change in the firm's advertising expense deflated by sales. *ΔINTG* is the change in the firm's recorded intangible assets other than goodwill (deflated by total assets). *ΔCAPE* is the change in the firm's capital expenditure deflated by sales. *ΔEMP* is the change in the number of employees deflated by sales. *ΔEARN* is the change in the firm's income before extraordinary items deflated by average total assets. *ΔNAFL* is the change in the number of analysts issuing earnings forecasts for the firm. *SIZE* is the logarithm of the firm's total assets. *AGE* is the number of years for which the firm is a publicly traded firm. *MTB* is the ratio of the firm's market value to book value measured at the fiscal year-end

*, **, and *** indicate one-tailed statistical significance at the 0.05, 0.01, and 0.001 level, respectively

growth is not significantly associated with increases in firm's investment in R&D, advertising, human capital, other intangibles, and capital expenditure. In year $t+1$, however, we find significantly positive coefficients on *ΔR&DE*, *ΔADVT*, *ΔCAPE*, and *ΔNEMP*. Thus, our evidence indicates an increase in analysts' recognition concerning the effect of investment in intangibles on firms' long-term performance. The results from estimating Eq. (11.2) for the non-innovating firms, however, show no consistent relation between analysts' forecast of long-term earnings growth and firms' investment in intangibles.

We examine the relation between changes in the percentage of institutional holding (*ΔPIH*) and changes in firms' intangible investment with the following regression:

$$\Delta PIH_{it} = \delta_0 + \delta_1 \Delta R\&DE_{it} + \delta_2 \Delta ADVT_{it} + \delta_3 \Delta INTG_{it} + \delta_4 \Delta CAPE_{it} + \delta_5 \Delta NEMP_{it} + \delta_6 \Delta NAFL_{it} + \delta_7 \Delta EARN_{it} + \delta_8 SIZE_{it} + \delta_9 M/B_{it} + \xi_{it}, \quad (11.3)$$

where i and t are firm and year subscripts, respectively. *ΔPIH* is the yearly change of the percentage of institutional holding. All other regression variables have the same definitions as in Eq. (11.2), except for *ΔNAFL*, which is the change in the number of analysts following the firm. We include *ΔNAFL* as a control variable because prior research suggests a positive association between analysts' and institutions' decision to follow a firm (e.g., O'Brien and Bhushan 1990). Table 11.4, Panel B, presents the regression estimates of Eq. (11.3). For the innovating firms in year $t-1$, the year before the innovation initiation, none of the coefficients on the changes of intangible investment. In year $t+1$, however, the coefficients on

ΔR&DE, *ΔADVT*, *ΔCAPE*, and *ΔNEMP* for the innovating firms are positive and statistically significant at the 0.05 level or better. These results indicate that after the initiation of the innovation, institutional investors recognize the value-enhancing effect of the innovating firm's investment in intangibles. This, however, is not the case for the non-innovating firms as none of the coefficients on the investment variables is positive for these firms.[7]

11.5 Summary and Conclusions

This study examines firms' information systems innovation that generates new flows of knowledge and information beyond traditional boundaries. We focus on firms that use internet to share knowledge created for internal purposes with external stakeholders. Our evidence shows that firms with greater investment in intangible assets (e.g., R&D, advertising, and human capital) have stronger incentives to undertake this type of innovation in information systems. The innovation complements firms' existing intangible assets by enhancing external stakeholders' trust in the firm and improving sophisticated investors' valuation of firms' investment in R&D, advertising, and human capital. Taken together, our study demonstrates that information systems innovation not only creates a distinct and valuable intangible asset but also enhances the value of firms' other intangibles.

The ongoing evolution in information technologies and business practices provide firms with new opportunities to innovate their information systems. For example, the XBRL-based reporting approach has significantly increased the scope and depth of information sharing between firms and their stakeholders (e.g., Wagenhofer 2007), whereas new forms of communication, such as social media, can further enhance the speed and reach of new information production and dissemination. The adoption of these emerging technologies in information systems innovation can lead to new and improved forms of information-based intangible assets. Future research can increase our knowledge about information systems innovation by examining newer forms of innovation in information systems and their impact on a broader range of intangible assets (e.g., customer loyalty, employee productivity, and technological creativity).

References

Aboody, D., & Lev, B. (2000). Information asymmetry, R&D, and insider gains. *Journal of Finance, 55*, 2747–2766.

[7] We also examined changes in the number of institutional investors (*ΔNIH*) as an alternative measure and obtained similar results.

Ashton, R. (2005). Intellectual capital and value creation: A review. *Journal of Accounting Literature, 24*, 53–134.
Bharadwaj, A. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly, 24*(1), 169–196.
Brynjolfsson, E., & Hitt, L. M. (1996). Paradox lost? Firm-level evidence on the returns to information systems. *Management Science, 42*(4), 541–558.
Brynjolfsson, E., Hitt, L. M., & Yang, S. (2002). Intangible assets: Computers and organizational capital. *Brookings Papers on Economic Activity, 1*, 137–198.
Cachon, G., & Fisher, M. (2000). Supply chain inventory management and the value of shared information. *Management Science, 46*(8), 1032–1048.
Chan, K., Lakonishok, J., & Sougiannis, T. (2001). The stock market valuation of research and development expenditures. *Journal of Finance, 56*, 2431–2456.
Clemons, E. (1986). Information systems for sustainable competitive advantage. *Information and Management, 11*(3), 131–137.
DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60–95.
DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9–30.
Dewan, S., Shi, C., & Gurbaxani, V. (2007). Investigating the risk-return relationship of information technology investment: Firm-level empirical analysis. *Management Science, 53*(12), 1829–1842.
Eberhart, A., Maxwell, W., & Siddique, A. (2004). An examination of long-term abnormal stock returns and operating performance following R&D increases. *Journal of Finance, 59*, 623–650.
Faurel, L. (2008). *Market valuation of corporate investments: Acquisitions versus R&D and capital expenditures* (Working Paper). New York University.
Fishman, M., & Hagerty, K. (1989). Disclosure decisions by firms and the competition for price efficiency. *Journal of Finance, 44*(3), 633–646.
Gòmez, J., & Vargas, P. (2012). Intangible resources and technology adoption in manufacturing firms. *Research Policy, 41*, 1607–1619.
Ha, A., & Tong, S. (2008). Contracting and information sharing under supply chain competition. *Management Science, 54*(4), 701–715.
Healy, P., Hutton, A., & Palepu, K. (1999). Stock performance and intermediation changes surrounding sustained increases in disclosure. *Contemporary Accounting Research, 16*, 485–520.
Institute of Management and Administration (IMA). (2005). *Internal reporting is best way to boost corporate value*. Newark, NJ
Lang, M., & Lundholm, R. (1993). Cross-sectional determinants of analysts ratings of corporate disclosures. *Journal of Accounting Research, 31*, 246–271.
Lev, B. (2001). *Intangibles: Management, measurement, and reporting*. Washington, DC: Brookings Institution Press.
Lev, B. (2008). A rejoinder to Douglas Skinner's 'accounting for intangibles—a critical review of policy recommendations'. *Accounting and Business Research, 38*(3), 209–213.
Lev, B., & Zarowin, P. (1999). The boundaries of financial reporting and how to extend them. *Journal of Accounting Research, 37*, 353–385.
O'Brien, P., & Bhushan, R. (1990). Analyst following and institutional ownership. *Journal of Accounting Research, 28*, 55–76.
Petter, S., Delone, W., & McLean, E. (2012). The past, present, and future of "IS success". *Journal of the Association of Information Systems, 13*, 341–362.
Porter, M. (1985). *Competitive advantage: Creating and sustaining superior performance*. New York, NY: Free Press.
Porter, M. (1992). *Capital choices: Changing the way America invests in industry*. Washington, DC: Council on Competitiveness.

Powell, T., & Dent-Micallef, A. (1997). Information technology as competitive advantage: The role of human, business, and technology resources. *Strategic Management Journal, 18*(5), 375–405.

Shapiro, C., & Varian, H. (1999). *Information rules*. Boston, MA: Harvard Business School Press.

Swanson, E. (1994). Information systems innovation among organizations. *Management Science, 40*(9), 1069–1092.

Teece, D. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*, 285–305.

Wagenhofer, A. (2007). Economic consequences of internet financial reporting. In R. Debreceny, C. Felden, & M. Piechocki (Eds.), *New dimensions of business reporting and XBRL*. Heidelberg: Springer.

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