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Strategy

1.1 Strategy and Value

The objective of all firms is the creation of value. A firm's strategies describe how it intends to create value over an immediate time frame, and the value opportunities it is searching for over the long term. Value, however, has different meanings to different stakeholders. Firms manage resources to create value through their capabilities to deliver products or services that provide customer value, maintain relationships with resource providers and customers, and organize activities through governance, management systems and processes. To do this, a firm has to create an equitable balance between stakeholders such as management, customers, employees, financiers, unions, suppliers, shareholders, government and society in general.

Although value has to be established and maintained by firms in order to offer incentives to various stakeholders, a premium is associated with value creation for customers and shareholders. The creation of value for other stakeholders is dependent on the success of creating value for customers and the incentives offered to shareholders—the residual stakeholders. Offering unsuitable incentives to stakeholders, however, is likely to lead to the destruction of shareholder value.

Strategy as a search for value is the discovery and development of sources of profitability to maximize firm value. To achieve sustainable shareholder value, firms have to simultaneously manage and deliver on operations in the short term, while investing and divesting to maintain long-term continuity. The issue then becomes the durability of a firm's competitive advantage to maintain a rate of return on the firm's assets greater than its cost of capital. A firm's

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external environment presents the value opportunities, while a firm's resources and capabilities determine how to leverage these opportunities.

Analysing how innovation and technology have influenced industries, firms, strategy, business models and investments provides a foundation for identifying what lies ahead. The themes that dominate the external environment today are new technologies and their diffusion, globalization, industry dynamics and climate. The question then becomes how these factors will influence industry transformation, innovation and the firm, strategy and future value.

1.2 The External Environment

1.2.1 Technology and Innovation

Technology is defined as the processes by which an organization transforms labour, capital, materials and information into products and services of greater value. All firms have technologies. Innovation refers to a change in one of these technologies. So spectacular was the wave of innovation in the late nineteenth century that the Commissioner of the United States Office of Patents recommended in 1899 that the office be abolished with the words 'Everything that can be invented has been invented'.

Since the First Industrial Revolution, economic growth has been driven by science and research funded by financial speculation, with financial bubbles being a persistent feature of this process. Periodically, the focus of the financial speculation is an innovation that fundamentally transforms the economy. This relationship has repeatedly created transformative infrastructures such as canals, railroads, electrification, cars, airplanes, computers and the internet, with the fundamental value to the economy realized decades later.

Business cycles are the recurring levels of economic activity over time, and were once described as having long predictable durations. Kondratiev waves are long macroeconomic cycles lasting 50–60 years that the Russian economist Nikolai Kondratiev theorized existed in capitalist economies. The economist Joseph Schumpeter extended Kondratiev's concept with his own theories on long technology waves. In Schumpeter's theory of business cycles and economic development, the circular flow of income, an economic model depicting the circulation of income between consumers and producers, is stationary. Entrepreneurs disturb this equilibrium through innovations, and in doing so, create the economic development that drives the economic cycle.

Schumpeter formed two theories in regards to entrepreneurship. The first (1909) was that individuals and small firms were more innovative, which he expanded in a second theory (1942) in which large firms drive innovation by investing in research and development (R&D) through their access to capital and resources. Schumpeter's 'gale of creative destruction' is the fundamental driver of new industries or industry combinations, the result of entrepreneurs producing innovative new products, processes or business models across markets and industries that either partially or entirely displace previous innovations. Entrepreneurship can, therefore, be framed as recognizing and exploiting value opportunities, and applies to individuals, small firms or large institutions.

Schumpeter also recognized and analysed the dynamic interaction between competition and industry structures. Schumpeter focused on innovation as the central component of competition and the driving force behind industry evolution. In Schumpeter's view, each long wave of economic activity is unique, driven by entirely different clusters of industry. Each upswing stimulates investment and an expansion of the economy, resulting in an economic boom. Each long boom eventually declines as the technologies mature and investors' returns decline, only to be followed by a new wave of innovations that replace the old methods and create the conditions for a new upswing.

The long wave theories of Kondratiev and Schumpeter both focused on economic growth. While Kondratiev does not identify a specific causal factor and Schumpeter tied these waves to technological revolutions, both were attempting to describe long-term deviations in GDP and the economy in general.

Neo-Schumpeterians moved the emphasis to the technological revolutions themselves, the diffusion processes that result with each wave and the resulting transformative effects on the economy. Technological revolutions are viewed as creating clusters, following Schumpeter's long wave theory, where interconnected innovative new products, processes and infrastructure initially lead to new fundamental industries, which are then followed by their diffusion to incumbent industries.

The economic historian Carlota Perez identified a regular pattern of technological revolutions over the past 250 years that materialized every 50–60 years. These cycles have discrete phases, where the emergence of general-purpose technologies signals massive changes in the economy. These general-purpose technologies lay the foundations for generating clusters of products, processes and innovations, initially with the rise of new fundamental industries, followed by the diffusion of the technologies to more mature industries.

Table 1.1 illustrates the waves of general-purpose technologies that laid the foundations for successive technology revolutions, starting with the Industrial

Table 1.1 The general-purpose technology revolutions

1st wave: 1770s	2nd wave: 1830s	3rd wave: 1870s	4th wave: 1900s	5th wave: 1970s
Water power Iron	Steam power Railways	Electricity Steel	Oil Automobiles	Computers Telecommunications

Revolution in the late eighteenth century, the Second Industrial or Technological Revolution, the Third and Fourth Technological Revolutions, and finally, the Information Revolution. The waves refer to a starting period instead of a specific year.

The Industrial Revolution, with its origins in the UK during the 1770s, began with factory automation transforming the English economy, followed by infrastructure such as roads, ports and, in the 1790s, the emergence of canals, all of which stimulated the flow of trade. The Second Industrial Revolution that began in the 1830s in the UK saw the emergence of steam, iron and railway technologies. The Third Industrial Revolution, with its foundation in the mid-1870s, facilitated the first globalization. Steel, heavy engineering and electrification technologies emerged, which led to transcontinental railways, fast steamships and the intercontinental telegraph, which facilitated the flow of information and trade.

In the early 1900s, mass production, oil and the automobile emerged in the US with the Fourth Industrial Revolution, leading to enormous investment until the 1929 financial crash and the 1930s Depression. The 1970s saw the emergence of information and telecommunications technologies that are driving the current technological revolution, which—following the technology cycle theory—is midway through its evolution.

During the course of the Information Revolution over the last quarter of the twentieth century, a number of fundamental changes emerged in the global economy. The burst of innovation in information technology reduced the cost of communications, which in turn facilitated the globalization of production and capital markets. This laid the groundwork for the use of innovative new business models. A new knowledge economy also emerged, driving the transformation from an industrial to a post-industrial economy centred around intangible assets and services. This led to the growing significance of intellectual assets relative to physical assets. Finally, there was a shift from closed to open innovation systems, an important trend that identifies and acquires new technologies from outside the firm. As a result of these factors, stock market indexes are now dominated by service industries such as information technology, financial services, pharmaceuticals, telecommunications and retail industries that leverage technology and science.

1.2.2 Industry Dynamics

Industry dynamics focus on how industries are currently organized, how they differ from earlier periods, what factors brought about the reorganization of the industry and how these factors changed over time.

The successive technology waves over the nineteenth and twentieth centuries are reflected in the transformations of the listed stock market industry sectors. Figures 1.1 and 1.2 illustrate the industry shifts in the US and UK indexes for the years 1899, 1950 and 2000. The industry sectors are weighted in the figures and based on the industry classifications in use in 1900, with a few additional sectors that, although minor in 1900, grew to significance through to 1950.

Railroad companies were the first true industrial giants at the beginning of the twentieth century. As they gradually became regulated and nationalized, however, the industry was marginalized by new industries such as steel, chemicals, rubber, mechanical engineering, machinery and consumer durables. Some sectors that were insignificant in 1900 grew to dominance through to 1950, and had declined by 2000. One example is the chemical industry, with US growth increasing from 0.5% to 13.9% in weighting between 1900 and 1950, and declining to 1.2% by 2000. The UK

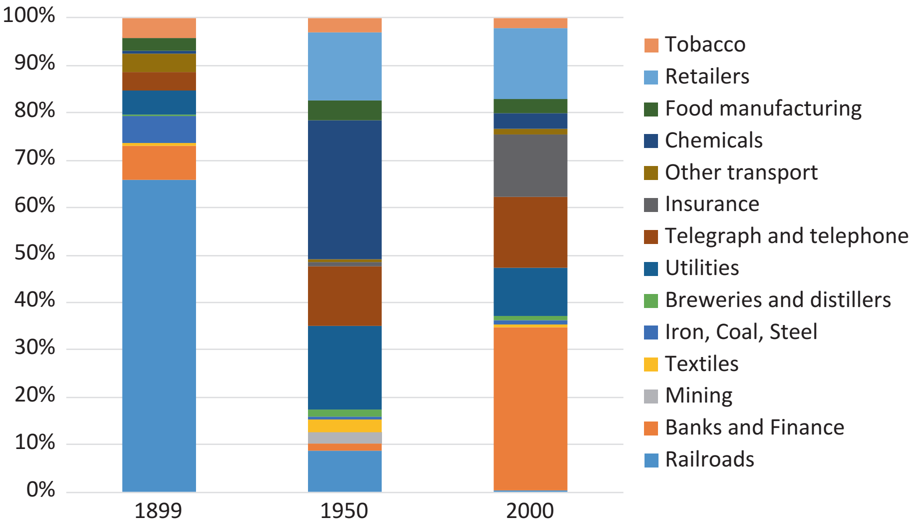

Fig. 1.1 US industry sector weights based on the 1899 classification system. (Source: Dimson et al. 2002). UK 1899 and 1950 sector weights are based on the largest 100 stocks. 2000 sector weights indicate the entire market. US 1899 weights include all NYSE and New York City banks. 1950 and 2000 weights reflect the entire US market

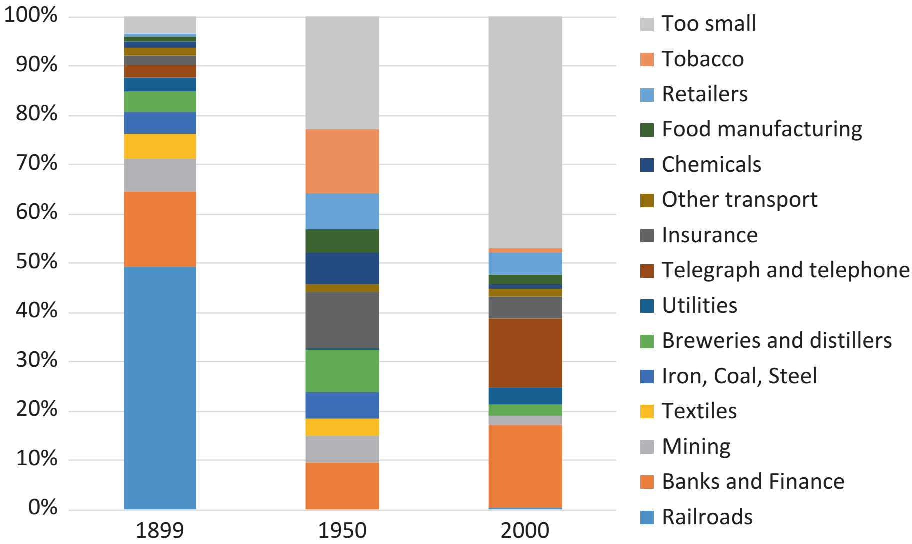

Fig. 1.2 UK industry sector weights based on the 1899 classification system. (Source: Dimson et al. 2002)

chemical sector followed a comparable pattern, with a huge weighting increase from 1900 to 1950, followed by a dramatic decline by 2000. The banks and finance sector in the US and the UK, however, declined and then grew in weightings from 1900 to 1950, and then to 2000—from 6.7% to 0.7% to 12.9%, and 15.4% to 9.7% to 16.8%, respectively. The telegraph and telephone sector saw moderate growth in the US from 3.9% to 6.0% to 5.6%, and significant growth in the UK from 2.5% to 0.0% to 14.0% in weightings over the twentieth century.

Figures 1.3 and 1.4 illustrate firms classified under the industry sector definitions as at 2000 and listed according to their US and UK significance. In 2000, the three largest US sectors were information technology, banks and finance, and pharmaceuticals, which combined, accounted for over a third of US firms. Sectors such as oil and gas and pharmaceuticals in the US and UK were nearly non-existent in 1900, and information technology had a zero weight in the years 1900 and 1950. In 1950, pharmaceuticals were still relatively insignificant, while oil companies in the US had reached dominance, followed by a decline in relative weighting. The telecommunications sector, while relatively small in 1900, grew to approximately 6% of the US market, where it has since remained. The UK telecommunications sector was nationalized up to the 1980s, when it was then privatized, ultimately reaching 14% of the UK 2000 weightings.

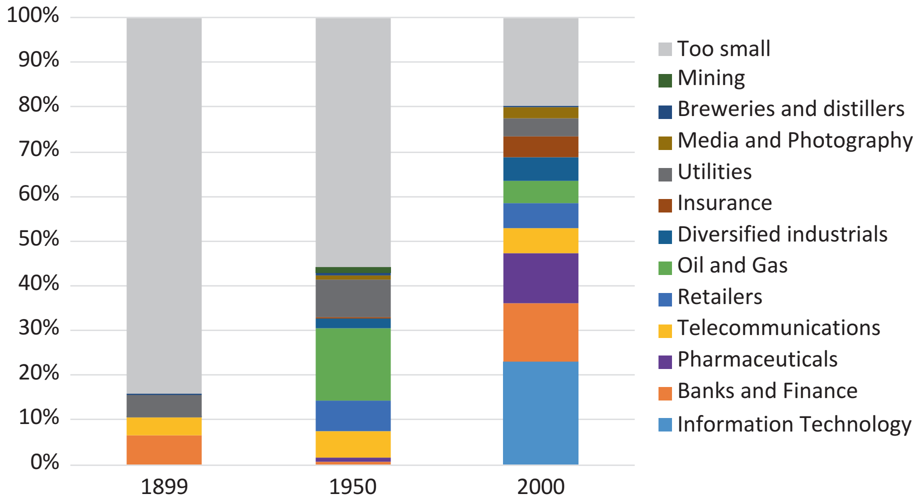

Fig. 1.3 US industry sector weights based on the 2000 classification system. (Source: Dimson et al. 2002)

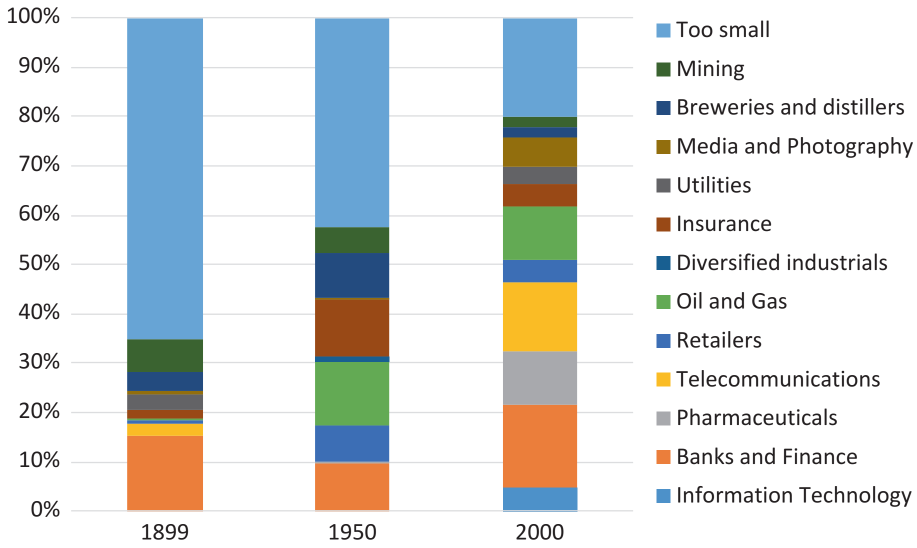

Fig. 1.4 UK industry sector weights based on the 2000 classification system. (Source: Dimson et al. 2002)

The composition of the stock market indexes has always been shifting. Over the first 75 years of the twentieth century, these shifts were gradual, with new industrials replacing older ones and manufacturing dominating. US industrials, however, began a relative decline after the mid-1950s, with the decline accelerating in the 1970s due to soaring energy costs and increased competition domestically and from overseas. On the supply side, US industrials were facing low-cost foreign competitors that were producing products that were increasingly improving in quality. On the demand side, growth in the US domestic market had ceased, with demand for industrial goods diminishing by the end of the 1960s.

The final quarter of the twentieth century saw a significant change in the US economy with the decline in manufacturing and growth in service industries, and a shift to information technology, a revolution that also significantly expanded the extent of services. Figure 1.5 illustrates the transformation of the 100 largest US firms as measured by revenues for the years 1955, 1975 and 2000. The 1955 and 1975 sectors show a relatively small decline in manufacturing sales and market value and the rise of financial services, information technology, and pharmaceuticals and healthcare. Both lists are fundamentally the same, with manufacturing firms dominating. By 2000, however, manufacturing had declined significantly, with financial services, information technology, and telecoms and media dramatically increasing, as measured by revenues.

There were a number of fundamental changes in the US economy over the last quarter of the twentieth century. The first was the appearance and growth in the components of a new knowledge economy. These included computer

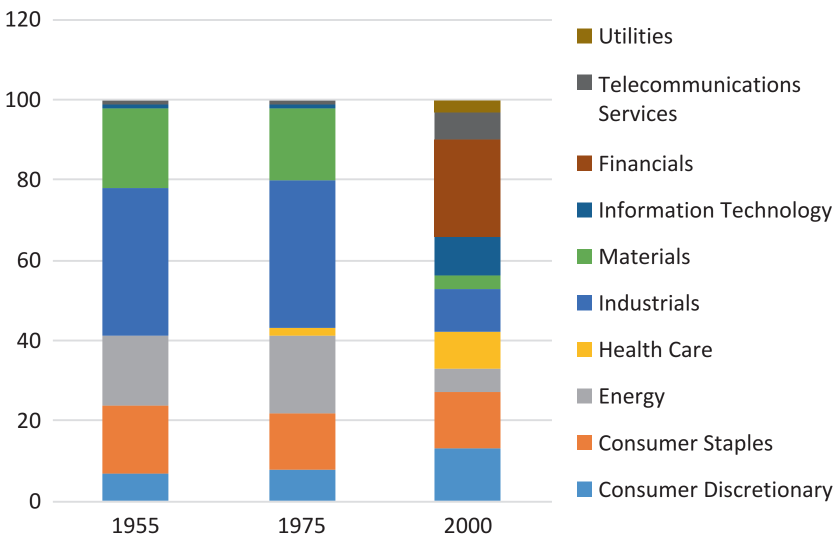

Fig. 1.5 Industry sector weights for the largest 100 firms by revenues—1955, 1975, 2000. (Source: Fortune 100–1955, 1975 and 2000)

hardware, software and services, providers of internet services and content, and the telecoms that develop and manage the infrastructure over which information flows. The combination of these components created an information revolution equivalent to the Industrial Revolution, which generated the expansion of the industrial economy. Analogies can be drawn between firms in the information economy and those from the industrial economy, with chips the equivalent of basic materials such as metals and plastics, software equal to process control and electrical mechanical systems, and telecommunications infrastructure and services the equivalent to transportation and related services. These information economy firms have grown significantly and now have considerable influence, as did their industrial equivalents, as information technology diffused and integrated into the economy.

The second is the growing significance of intellectual assets compared to physical assets. The foundations for value generation in industrial firms are physical assets such as plant and factories. In the knowledge economy, science and technology are increasingly driving business, as firms in all industries use these factors to create a competitive advantage. This is reflected in how firms manage R&D and commercialize innovation, with the shift to the formation of networks, partnerships, and other structures to exploit discoveries and mitigate R&D risks.

The third attribute was the manner in which new entrants were financed compared to their industrial counterparts. Risk capital was provided by venture capital, which financed entrepreneurs and laid the foundation for the rise of new information technology and biotechnology firms with a relatively small amount of initial capital. The fourth was the use of innovative new business models. The fifth was the emergence of a new economic focus. While economies of scale and scope, the primary drivers of industrial growth, continued to be significant, network economies rose to become of equal importance and included the drive for standards and alliances.

The result of all these factors was the shift of large industrial firms from the centre to the fringe of the modern global economy. The forces that created the new knowledge economy will continue to drive the transformation from an industrial economy, with its foundations in physical assets and production, to a post-industrial economy centred around intangible assets and services.

The shift in the economy has also influenced the turnover in the composition of the major stock market indexes. In 1917, Forbes published their first list of the 100 largest American firms ranked by assets, with steel, oil and gas, mining, food and telecoms the dominant sectors. In 1997, only 15 survived, and by 2017, only 2 firms—AT&T and GE—from the original 1917 Forbes list endured under their original trade names.

The same result was found for Standard & Poor's S&P 500. Changes in the S&P 90 index were relatively slow for the first 20 years after its initial start in the 1920s, with an average turnover in companies of 1.5% per year. A firm that was included in the index during this period would remain there for an average of more than 65 years. By 1998, the rate of change in the S&P index had shifted dramatically, with an increase to nearly 10%. The time a firm spent in the index over the last 70 plus years had decreased from an average of 65 years to 10 years. Over the last 40 years, only 74 of the original 500 firms that comprised the S&P 500 in 1957 still remained on the index in 1997.

Turnover in the stock market indexes is often cited in economic analysis as a metric for productivity and innovation. Annual turnover, the number of firms entering and exiting the S&P 500, on average was relatively normal in the late 1950s and decreased in the 1960s and 1970s. Turnover increased on average however to historically high levels from the early 1980s, and in the late 1990s, reached new peaks, with high M&A (mergers and acquisitions) volume reflected in the higher volatility. Turnover since 2000 has however declined to the levels seen towards the end of the 1950s.

While turnover can be represented as the volume of firms entering and exiting the S&P 500, there are a number of underlying factors as to why this single metric cannot be used as an indicator for innovation. The omission of service firms before the mid-1990s, the cycle of many firms re-entering and exiting, and the concentration of turnover at the low end of the S&P 500 all convolute turnover as a single aggregate number.

Turnover is also a reflection of economic dynamics, such as transformations in financial markets, mergers and acquisitions and initial public offerings that are a function of temporal change, new technologies, sector transformations and geopolitical considerations. Other factors include the unbundling of firms as a result of the Information Revolution, the growth in the information and telecommunications sectors in which innovation is especially important, service industries having less barriers to entry than manufacturing, and the persistence of firms that can be attributed to the advantage of scale and innovation.

1.2.3 Industry and Globalization

Information and communications technologies have been a fundamental driver of the integration of the global economy over the last 40 years. The 1980s saw conglomerates broken up, a wave of mergers and acquisitions, widespread industry restructuring and deregulation that resulted in industries such as telecoms being subjected to competition. In the 1990s, US firms focused on overseas expansion through a boom in mergers and acquisitions (M&A). Firms from high-income economies massively expanded their international operations, with industry concentration rising significantly across diverse industries as firms integrated global business systems through M&A.

Almost every industry sector saw the emergence of firms with leading technologies and brands that dominated their global market sector. This process cascaded into global supply chains, with a broad restructuring of value chains around these core firms, which further intensified the concentration of industries. These dynamics stimulated intense competition and unparalleled advances in technology as a result, and created firms that became the foundation of the global economy, with technologies and brands concentrated among a small cluster of firms.

Since 2008, the US has seen a further wave of mergers with a total value of $10 trillion, one of the largest in history. While the previous M&A wave focused on building global dominance, the post-2008 wave saw consolidation and increased market share across US industries. The result of these waves is that 10% of firms now produce 80% of global profits according to a McKinsey estimate, while 60% of revenues and nearly 65% of the total market capitalization are sourced to firms with greater than $1 billion in revenues.

In the US, profits as a ratio of GDP are larger than at any other time since 1929. From 1994 to 2013, the percentage of nominal GDP produced by the Fortune 500's largest US firms increased from 33% to 46%, while the Fortune 100 percentage of revenues increased from 57% to 63%. The number of US listed firms almost halved from 6797 to 3485 from 1997 to 2013, with a fifth of total US corporate profits now sourced abroad. Dominant firms have also built up massive cash reserves equal to 10% of US GDP, with domestic free cash flows of approximately $800 billion per annum.

Today's technology firms have reached enormous scale within a few decades, and dominate in terms of market share, revenues and the information economy's infrastructure. In the industrial economy, firms leveraged economies of scale to achieve size. Today's giant technology firms have adapted this economic law to the digital economy by focusing on demand and network effects over supply side and production efficiencies. Innovations in technologies have moved the industrial economy's cost focus to the leveraging of network effects in the digital economy.

These dominant technology firms also have built huge cash reserves, which are used to further consolidate market dominance through the acquisition of start-ups that have patent portfolios and new technologies while also removing potential competitors. Today's technology firms are also platforms that provide the capabilities to quickly reach scale. These platforms also provide data and software cloud computing services that offer cost advantages and flexibility, and reduce the lead time for start-ups to become cash flow positive. Technology firms can also leverage their platforms by moving into other industries and further scale across other sectors. Therefore, firms that have the balance sheets capable of making considerable investments in the physical and digital assets that are necessary in the digital economy will continue to dominate.

1.2.4 Industry and Climate Change

Industrialization has had a significant influence on economic growth over the last 250 years. A residual effect of the technologies and innovations that drove this growth has been the impact on climate. The same drivers of innovation also have the potential, however, to address the factors that contributed to climate change over the last 200 years.

The factory was an innovation that introduced scale, efficiency and standardization in production, and increased the output of many products. This increase in output intensified pressure on transportation infrastructure. Innovations in the steam engine produced the locomotive and steam-driven ship, which along with the expansion of railways, transformed the transportation of people and freight. The demand generated by railways resulted in the expansion of iron followed by steel production. This created a surge in coal mining to supply the fuel for iron smelting and the developments in steam engines. Nineteenth-century railways also dramatically increased immigration, integrated markets and spurred other industries. This further created an enormous increase in the use of coal, iron, steel and petroleum-based products.

Car manufacturing combined numerous innovations, including the internal combustion engine and new steel manufacturing methods. The mass production that followed in the early twentieth century led to lower prices and product access for the masses. Industry and agriculture also began using gasoline and diesel-powered transportation and machinery.

The advent of electricity saw the development of long-distance power transmission and the expansion of electricity utilities and grids. Electrical power became available for street lighting, residential use, public transport and industrial uses such as heat for the refining and manufacturing of copper and aluminium. Coal became the fuel source for electrical power with the development of coal-fired electrical generating plants towards the end of the nineteenth century.

While industrialization has produced tremendous economic benefits, it has also generated significant burdens. Accompanying the Industrial Revolution was a massive growth in energy consumption, largely through the burning of coal, a fossil fuel. Since the onset of the Industrial Revolution, societies have increased their use and dependence on fossil fuels such as oil, coal and gas, primarily to generate electricity, and power transportation and industrial processes. One of the great challenges of climate change today is that greenhouse gas emissions result from almost every major function in society, including electricity production, transportation, agriculture and industry.

Climate change generates systematic risks throughout the economy, and will have an influence on agriculture, energy, health, national income, regulation and reputations at the industry and firm levels. Sectors such as agriculture, fisheries, forestry, health care, insurance, real estate, tourism and the energy infrastructure will disproportionally feel the effects of climate change. The consequence is that climate change is changing the competitive environment, with particular sectors, industries and organizations more at risk than others.

As there are uncertainties in regards to how climate change will impact future states of the world, any number of risk factors will have an impact on a firm. These include exposures to financial, commodity, legal, operational, strategic, technology, product, political and reputational risks. Climate change could include some or all of these risk factors, depending on the nature of a firm's activities. Two specific risk categories can, however, be defined. Sector-specific risk, the risk exposure to firms within an industry sector, includes regulatory and physical risks—for example, severe weather directly affecting economic sectors such as insurance, agriculture, health care, real estate, water and tourism. Firm-specific risk includes competitive, litigation and reputational risks, where a firm's operations could result in repercussions from consumers, shareholders and stakeholders.

Climate-related events represent risks to all firms at some level. These can occur as events at regular frequencies, and regionally, such as disruptions to agricultural or energy production, supply chains or infrastructure. Most firms have strategies and processes to manage the regular changes in climate. Firms in the future, however, cannot depend on climate conditions being consistent with those over the last century. Climate trends are anticipated to undermine the notion of continuity, with deviations both in general conditions and the number and severity of extreme weather events.

1.3 Transformation and the Firm

1.3.1 Innovation and the Firm

Transformations in technology have been driven by momentum from needs and end users in some cases, and developers and system builders in others. Firms, however, have played a consistent role as participants, and while not always the initiator, have been leading players in innovation as invention and research developed into processes in the nineteenth century. In the early twentieth century, many firms had internalized innovation and focused on efficiency and rationalization as a means to secure their technologies. Other firms had leveraged innovation to pursue new products or processes, which became an important development that, while riskier, was potentially more rewarding.

Over the course of the twentieth century, innovation and research and development (R&D) were institutionalized, which influenced both the trends and speed of change in technology throughout the industrial and industrializing worlds. A principal driver of new technologies over the twentieth century was the exploitation of science by US industry, which is reflected in the shifts in the research environment. The industrialization of research began with the establishment of centralized research laboratories at the turn of the nineteenth century at large US industrial and telecom firms. These new science-based firms were confronting hostile business environments that included new competing technologies for expiring patents and antitrust activities, and these laboratories were established as a defence.

During the period between the First and Second World Wars, US corporate laboratories pushed the limits of innovation strategies. In the 1920s, the focus was on optimizing and rationalizing production, which reflected the final phase of scientific management. The 1930s saw a shift from engineering departments to corporate laboratories as the principal focus for innovation, with new products being given the utmost priority. This trend laid the foundations for the post-World War II recovery.

Corporate interest in technology as a driver of business development appeared after World War II, with the tying of technology investments to strategy. Numerous science-related products emerged from corporate laboratories that were also driven to some extent by huge increases in military spending. This created the linear model of innovation that existed for a number of decades. Motivated by large World War II projects, such as the atom bomb and radar, many US firms in the 1950s and 1960s embraced the concept that R&D investment was all that was required for commercial innovation. The linear innovation model reinforced this perception, with the innovation process starting with a scientifically developed concept, followed by methodical development stages. The perception was that by basing innovation on science, large payoffs could be expected through the opening of new markets.

Cynicism with this approach began in US industry during in the 1970s and followed soon after in Europe. Up to the 1960s, demand from the reconstruction of the industrialized economies and the lack of any major competition resulted in a focus on the optimization and enhancement of system operations as opposed to productivity and innovation. A large component of US R&D was also derived from government funding in the high tech sector, especially the military.

By the 1980s, it became obvious in many sectors that an innovation system based on research had problems executing the later phases of innovation. Another issue was that the expectations of significant new products based on science had been overstated, with final success often elusive. Invention on demand did not fit the process model, with a number of product failures challenging corporate research, and management calling into question R&D expenditure levels.

Open innovation systems then gained traction, with global firms successfully coordinating design and manufacturing communities to deliver their requirements with speed, efficiency and flexibility. Networks led to successes in innovations and have typically included both small and large firms that swapped expertise and information. Innovation prospers on the diversity and flow of information, and having access to knowledge networks proved to be far more valuable than the centralized corporate laboratory with its long project cycles and large overheads.

The business environment today is similar to that at the turn of the twentieth century when large vertical corporations dominated, with today's huge technology firms seen as sources of innovation. Approximately 90% of successful start-ups today are acquired in private markets by incumbent firms. This represents a fundamental change to the venture capital technology model—from the development of successful new firms to the funding of private research and development start-ups that will be acquired by established incumbents, an approach used by biotech venture capital. Dominant technology firms today are valued by investors for their future market share, continuing network effects and amassing of data, and ultimately, monopoly profits.

1.3.2 Industry Boundaries

Industry dynamics focuses on how industries are currently organized, how they differ from earlier periods, what factors brought about the reorganization of the industry, and how these factors changed over time. The factors that drive innovation, entry and exit, growth and decline, and ultimately, an industry's evolution can be framed within its business infrastructure. An industry's business infrastructure includes assets that are used in the production and distribution of goods and services that the firm is unable to provide. These include technologies of production, transportation, communications and financing, while government influences both the firm's regulatory environment and provides infrastructure. Government infrastructure investments are important public goods, as firms are unable to capture the benefits, and therefore, reluctant to bear the costs of these investments.

A firm's boundaries describe its business model, and include scale, scope and in what businesses to conduct operations. A firm's horizontal boundaries are defined by the size of its product markets, while its vertical boundaries are those activities that the firm conducts internally versus those bought from external markets. A firm's corporate boundaries are the portfolio of discrete businesses in which the firm competes.

Horizontal boundaries are defined by scale and scope. Scale defines the range of output for a production process, in which the average cost declines over that range as output increases, and the marginal cost of the last unit of production is less than the average cost. Scope relates to the cost savings a firm can realize as it increases the diversity of goods and services produced.

Vertical boundaries include a firm's make-versus-buy decisions, whether an activity is performed in-house or procured on external markets. Make-versus-buy decisions can include long-term contracts, joint ventures and alliances in which firms can pool resources for strategic purposes. Goods and services in a production process generally flow from upstream to downstream along a vertical chain, initially with materials, then components, manufacturing, and finally, distribution and retailing. A firm's position along this vertical chain defines its vertical boundaries, and therefore, the costs and benefits of make-versus-buy decisions.

The Third Industrial Revolution that began in the 1870s saw huge investments in mechanization initially in the UK then in the US, and, by the late nineteenth century, the rise across many industries of large vertically integrated corporations. The emergence of these organizational structures was facilitated by flow rationalization, a process that addressed internalized bottlenecks within the boundaries of the firm, used organizational hierarchies and provided owners and management direct authority over the supervision of labour and work design. A series of innovations in systematic management that included cost accounting, schedule planning, and production and inventory control also emerged as solutions to management control. These innovations, as opposed to pure fundamental technologies, were an essential condition in the design of industrial step processes and the ultimate source of value.

Big business during the Fourth Industrial Revolution was defined by a number of concepts by the 1920s. The high volume mass production and distribution of goods relied on complex step processes. Systematic management, combined with industrial engineering, increased production volume and lowered costs. Budget planning, financial control and the vertical integration of industries—in itself a comparatively new phenomenon—also provided management with the critical components for control over the entire process and the organizational hierarchies.

While innovations in systematic management enabled the ascent of dominant vertically integrated firms leading into the twentieth century, new technologies led to a transition from vertical to horizontal boundaries in the computer industry a century later. The final two decades of the twentieth century saw dominant vertically integrated firms in the computer industry virtually disappearing, and in their place, the ascent of open platforms, and from 1985, the emergence of ecosystems. The effects of this transformation were enormous in regards to firm turnover and value created and lost.

What separated computers from the industrial era is that they are both complex systems with separate functional components, and platforms that offer multiple options, which facilitated both their exponential growth in functional development and decline in costs. Platform systems also differ from step processes in regards to organizational design. While step processes led to integrated ownership, vertical integration, hierarchical information flows, central planning and direct authority, the component optionality within platform systems removed the need for vertical controls and supply chain logistics, promoted open innovation, and enhanced overall value within the platform system.

Platforms can be closed or open systems. Open platforms can be built intentionally by a sponsor to generate fee revenues, or created as a closed system by a sponsor. In closed or product platforms, components are supplied by one firm, and by definition, are vertically integrated. Open platforms are ecosystems by definition, where components are supplied by multiple firms and communities. Industry structures will ultimately shift from closed to open platforms, as platforms facilitate open innovation, offer network effects, an increase in value through optionality and the ability to generate fee revenues.

1.3.3 Strategy and the Environment

Strategy is defined as the process by which a firm deploys its resources and capabilities within its business environment in order to achieve its goals. Corporate strategy is concerned with where a firm competes, while business strategy is concerned with how a firm competes.

The development of business strategy over the last 60 years was driven more by business pragmatism than theory. The 1950s and 1960s were a period of relative stability, and firms focused on growth through diversification, vertical integration, mass marketing, efficiencies through scale and long-term investments. Corporate planning grew in popularity as a result of the increasing size and complexity of these firms and the problems associated with management and control. Although financial budgeting offered some means for addressing these issues, the main strategic objective was the long-term planning of investments, which required a longer time horizon than that provided by annual budgets.

In the 1970s, analytical concepts such as portfolio planning matrices became popular strategy and resource allocation frameworks. The matrix approach was designed to assess business unit performance and the corporate portfolio's performance and strategies in general. Boston Consulting Group's growth-share matrix was an innovation in corporate strategy, and became a principal framework for resource allocation in diversified firms. A number of economic events during the 1970s, however, ended the post-war period of relative stability. The oil shocks, high interest rates and the increased international competition from Asia and Europe created an unstable business environment in which diversification and planning no longer provided the expected synergies.

Firms moved towards more flexible strategic management methods that focused on competitiveness as a result, with competitive advantage becoming the main objective. This had a significant impact on strategic concepts at the beginning of the 1980s. One development pioneered by Michael Porter was the use of industrial organization economics in the analysis of profitability, which emphasized a firm's competition, market environment and industry structure. Capital market developments and the profit incentives in reviving non-performing corporations also created a fertile environment for the emergence of corporate raiders and leveraged buyout firms. The activities of these players exposed the vulnerability of many large diversified corporations, which led to several takeovers. Management became focused on the stock market valuations of their firms as a result.

In the 1990s, shareholders and the financial markets continued to pressure management to maximize shareholder returns, and as a result, the shareholder value concept was included in all aspects of strategy. Growth strategies such as diversification, vertical integration and corporate planning developed over the previous 30 years were replaced with a focus on profitability. The focus also moved from the external environment to the analysis of a firm's resources and capabilities as the basis for competitive advantage, where those resources and capabilities that are unique to the firm are identified as delivering value.

Since the start of the twenty-first century, information technology has had an increasing influence on strategy analysis. Technology intensive businesses have unique investment requirements. These include markets with strong network effects, the creation of value from intellectual property assets, and leveraging technology to build platforms. The cost structures in technology industries also fundamentally differ from those found in manufacturing and service industries.

Profit is derived as revenue from demand minus costs that are a function of the technical aspects of production. There are two business drivers have unique attributes in technology businesses. The first are network effects, which have a significant impact on product demand. The second are cost structures. Almost all costs are fixed and sunk, which influences the cost per unit associated with a firm's level of output, while marginal costs are almost zero, which implies increasing returns with scale.

A third characteristic of technology businesses is the value found in intellectual property assets. This includes both the creation of intellectual property and business models that can capture the value. The patent litigation seen today is driven, in part, by smartphone developments that are providing a foundation for the next open platform.

Digital platforms share these characteristics with previous transformational innovations, such as railroads and utilities. Marginal costs will move towards zero and below average costs. Price will also be driven to the marginal cost, generating operating losses for competitors and providing a potential source of competitive advantage. The initial cash flow deficits funded by internal cash flow and investors, and the amortization required for the huge investments made in assets, are a function of the expected growth and massive profits that can result when a monopoly emerges. The payoff is that platforms ultimately offer scale and dominance, and the ability to create large ecosystems of consumers and suppliers.

Value is created when a firm earns a return greater than the cost of capital employed to generate that return through the efficient management of resources. The continuing rise of the information economy will therefore require the realignment of a firm's resources and capabilities as technology continues to redefine business models, industry boundaries, strategic alliances and networks, strategies based on IP and platforms, and ultimately, the creation of value.

1.3.4 Future Value

The digital economy is defined in terms of the Internet and related information, communications and technology (ICT). The digital sector are those core activities that include digitalization, ICT, platforms and platform activities, while digitalization includes an array of new applications of information technologies within business models and products that are transforming the economy and industry sectors. While innovation is often defined in terms of new products or processes, it also includes new business models, management systems, organization forms, value chains, processes, contractual relationships and investment approaches.

Platforms have the potential to reach the scale and scope seen with the huge vertical corporations that dominated at the turn of the twentieth century. Since the 1980s, the PC (personal computer) has evolved into a huge open platform system, while in the 1990s, the Internet generated a still greater open platform, which led to open platform exchanges that facilitated the exchange of information, products and other transactions. Open platforms create ecosystems, which transform industries dominated by vertically integrated firms into networks of specialized modular firms.

How value is created in platforms is a function of the economic relationships within the Internet, data, analytics, software, computer capacity, intellectual property and the ecosystem generated by the platform and the terms under which users participate. Platforms in many situations are also disrupting the structure of economic activity through regulatory arbitrage, the rearrangement of the barriers to entry, and ultimately, how value is created.

Platform technologies include cloud computing, data, analytics and software services. Data and analytics are the new innovations in systematic management in the digital economy, and are equivalent to the innovations in systematic management seen in the huge vertical firms at the turn of the twentieth century. These technologies also form a foundation for other technologies such as the Internet of Things, the Industrial Internet, autonomous vehicles and mobile technologies.

Externalities and public goods are economic concepts that have a much larger influence within the digital economy relative to the industrial economy. Two concepts used in digital business models are open source products and patients.

While the open source model is economically efficient—with a zero marginal cost of providing a good and therefore a theoretical zero price—there is, however, an initial cost. Free digital goods in the open source model are therefore cross-subsidized through income sources that typically include advertising.

Patents, by definition, are legal monopolies that provide an exclusive right to leverage an idea, and are central to technology standards. Patents that create industry standards also have leverage, as they provide the ability to disrupt other businesses. Patient litigation is the result of the inevitable disruption that emerges with new expansive markets. The current legal wars over smartphone patents were also seen when the telegraph and radio technologies emerged, as firms attempted to position themselves for these new markets. Also indicative of a fundamental change in the economy is the increased patient litigation seen today in industries not related to the technology industries, such as the automotive, food and mining industries.

Digitization will also drive a fundamental realignment of industry boundaries. While these dynamics may not affect every firm and sector, many industry boundaries will however be redefined. Vertical to horizontal transitions are seen today in industries such as biotech and pharmaceuticals, telecommunications, and media and entertainment. Firms that have a horizontal dominance in technologies will also leverage those resources across other vertical sectors. Those firms with operations within established industry sectors will compete with firms from other sectors as a result, and require the resources and capabilities to manage these cross-sector dynamics. Industries exposed to these dynamics include health care, financial services and energy.

The energy industry is in the process of a fundamental transformation. Global oil demand is forecast to potentially peak as early as 2025. Accelerating the peak is an array of competitive alternatives to fossil fuels that include solar, wind power, batteries and electric vehicles. Government restrictions on greenhouse gas emissions are also having an impact. The intensity of climate trends and events is likely to increase in the future, and also have an impact on global supply chains and other industries to various degrees. Although investments in renewable energy are currently double that of coal, natural gas and nuclear combined for power generation, as of 2017, 85% of the global energy system is still originated from fossil fuels.

To address the impact of global warming and move towards zero carbon clean electricity, the power supply system will need to expand by an estimated factor of four to 2050, with electricity demand expected to reach approximately 100,000 terawatt-hours. The global demand for electricity, currently 20% in the energy mix, will potentially rise to 60% by the 2050s. To meet future electricity demand, the energy mix will likely consist of intermittent renewables and firm low-carbon energy resources such as natural gas, carbon capture technologies, nuclear power and bioenergy.

The storage of energy can be achieved through a number of methods that include thermal, mechanical, which includes hydroelectric, electrical and electrochemical technologies. Electrochemical energy storage, including lithium-ion batteries, has seen the largest growth in scale capacity in energy storage since the start of the twenty-first century. The transformation of electricity grids to an intermittent renewable and firm generation mix requires the ability to smooth out demand spikes, and large-scale battery deployment offers a solution for grid management. Hydrogen fuel-cell vehicles offer a solution to the decarbonization of road transport. There are, however, significant challenges that need to be addressed, which include its manufacture, the price of fuel cells in which hydrogen is used, and its transportation.

Biopharmaceuticals have the potential to become the foundation of the pharmaceutical industry. Replicating large molecules on an industrial scale, however, requires new capabilities in manufacturing. DNA sequencing platforms, or biofoundries, have the potential to become a new industry. Biofoundries offer a solution for the centralization of process work in genetic engineering research, can provide scale by centralizing the cost of biotechnology firms operating their own laboratories, and therefore offer a shift from the biotech vertical business model. This will facilitate a new synthetic lifeform design process that can be scaled up from the current boutique business model to a global industry.

While the digital revolution has its seeds in the information technology sector, it is consistent in scale and scope to that seen in the railroad and electrification technology revolutions. The diffusion of these technologies took approximately 50 years to be realized in the economic transformations that followed. It has taken an equivalent period to deploy the fundamental technologies of the digital economy. As with these prior technologies, it is therefore likely to take another 50 years to see the full economic impact of digitization, and as such, the digital revolution and its diffusion is only half way there.

Appendix: Classifying Industry Sectors Today

Industry classification systems categorize firms into groups using a number of different factors, which can include similar production processes, products or financial market behaviour. In general, industries are identified with relatively broad markets, while markets themselves refer to specific products. The rise of the information and service economies, however, has blurred the boundaries between manufacturing and services, and created an issue in how to define an industry's boundaries.

One distinction is the difference between high technology and mature industries. High technology or technology intensive industries are science-based manufacturing industries that have above average R&D levels. Measures for high technology industries include the level of R&D intensity, derived by dividing industry R&D expenditures with industry sales, and levels of patent activity. Examples of high tech industries include the information technology sector, aerospace, pharmaceuticals and communications.

Mature industries are those that have moved through the emerging and growth phases, and have reached a stage in their life cycle where they grow in line with the economy. Examples include financial services, insurance, food, energy, construction, automotive, tobacco, steel and textiles. R&D expenditure is typically less than 1% of sales, which contrasts to high technology industries, where R&D spending can be up to 65% of sales.

In 1999, Standard & Poor's and Morgan Stanley Capital International (MSCI) together launched the Global Industry Classification Standard (GICS) to establish consistent industry definitions. The GICS system was designed to classify firms into groups that have similar stock market behaviour, and today, consists of 11 sectors aggregated from 24 industry groups, 69 industries and 158 sub-industries. The 11 sectors are:

- Consumer discretionary
- Consumers staples
- Energy
- Financials
- Health care
- Industrials
- Information technology
- Materials
- Communication services
- Utilities
- Real estate

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