Economic Theory **12**, 451–460 (1998)

Economic Theory

Informational asymmetries in macroeconomics and finance: An introduction

Bruce D. Smith
Department of Economics, University of Texas at Austin, Austin, TX 78712, USA
(email: bsmith@eco.utexas.edu)

Received: May 20, 1998; revised version: May 20, 1998

One of the major developments of modern macroeconomics has been the use of dynamic competitive general equilibrium models to analyze both short and long-run macroeconomic phenomena. However, it was recognized quite early – as is clear from Lucas' (1972) work – that to understand many macroeconomic issues it is necessary to depart from several of the assumptions of Arrow and Debreu that allow the abstraction from various frictions. And, indeed, it is now standard in analyses of unemployment or asset pricing to impose various kinds of nonconvexities or to impose a structure of markets that is, exogenously, incomplete.

Of course, simply imposing a structure where markets are incomplete is uncomfortable along several dimensions. Most obviously, it is ad hoc. The very spirit of the original introduction of general equilibrium theory into macroeconomics was to avoid arbitrariness in the specification of an economic environment by a modeller. And, in addition, it now seems well-established that institutional structures "matter" in the determination of both short and long-run macroeconomic performance. Why institutions differ across economies, or within a given economy over time, cannot be understood by exogenously imposing a structure of incomplete markets.

Let me give two examples of institutional structures that seem to matter very much from a macroeconomic perspective, and that are not readily understood either within the context of the basic Arrow-Debreu paradigm, or within the structure of exogenous market incompleteness. The first is an example drawn from long-run growth experience. Gurley and Shaw (1955, 1960, 1967) observed some time ago that there is a typical co-evolution of the real and the financial sectors of an economy during the growth process. In particular, in very primitive economies investment in either human or physical capital is typically financed either by the individual investor, or within a small group of individuals who borrow and lend among themselves. Intermediation is not observed. As economies become somewhat more developed banks emerge and intermediate borrowing and lending. However, at

first the claims created in this process are rarely traded. Only at relatively advanced stages of development do debt, equity, and other markets in financial claims become important.

In the Gurley-Shaw account, real development promotes financial development and the financial development that occurs is a further stimulus to real development. No direction of causation is attributed. Moreover, it appears to be empirically well-documented that financial development is important in the growth process. For example, King and Levine (1993 a, b) and Levine and Zervos (1995) establish that measures of banking and equity market activity are essentially the only robustly significant predictors of future growth performance.

The second example is drawn from historical experience with business cycles. Friedman and Schwartz (1963) found that every U.S. recession between the Civil War and World War II but one was associated with a large scale withdrawal of resources from the banking system. Particularly severe recessions were associated with banking panics. And, since World War II, several recessions have involved similar phenomena termed "disintermediation" or "credit crunches". While it is logically possible to construct business cycle models where these events in the financial sector are purely passive responses to events elsewhere in the economy, such models are greatly at odds with the interpretation of events given by astute observers such as Friedman and Schwartz. And, worlds where monetary policy "worked" by affecting credit market conditions and, through that channel, real activity, were central to the thinking of Keynes and many others in works like "A Tract on Monetary Reform."

In the basic framework of Arrow and Debreu intermediaries or financial market institutions play no real role; there are no frictions for intermediaries to address. Thus the significance of financial market institutions for either growth performance or business cycle phenomena cannot be understood in that context. And, the evolution of financial market institutions in the growth process cannot be understood by exogenously imposing market structures on economies.

In economies with informational asymmetries, however, the structure of contracts and institutions will generally matter for allocations. Moreover, as authors like Diamond (1984), Boyd and Prescott (1986), and Williamson (1986) have shown, banks and other financial market institutions can emerge in such economies as an optimal mechanism for allocating resources in the presence of private information. Thus, models of private information hold out the hope of understanding the structure of markets and institutions as an endogenous economic outcome, of understanding how this structure might respond to other changes in the economic environment, and of understanding what role these institutions play in the growth process, or in generating or propagating business cycles. And, in fact, earlier work by Williamson (1987b), Bernanke and Gertler (1989), and Smith (1989) has already demonstrated that the presence of private information can provide propagation mechanisms for shocks that would be irrelevant in Arrow-

Debreu economies. In addition, Azariadis and Smith (1998) have shown how financial markets that operate under informational asymmetries can be a *source* of shocks that could not occur in Arrow-Debreu economies.

The articles in this symposium constitute an attempt to further understand the role of informational frictions – and of the institutions and contractual arrangements that arise in response to them – in the growth process, and in the mechanics of business cycles. And, at least some of the papers treat these as integrated issues.

Growth and development

As Gurley and Shaw noted, economic development in market economies is typically accompanied by an increasing "sophistication" of the financial system. A particularly oft-noted fact is that equity markets typically are larger (in trading volume) and more active in developed than in developing economies. And, for firms, equity issues become a more significant source of funds as the development process becomes more advanced. Moreover, as Levine and Zervos (1995) demonstrate, this financial market evolution represents a further stimulus to growth.

The article by Boyd and Smith employs a costly state verification (CSV) model to try to understand these observations. The most obvious reason to do so is that – under well-known circumstances (Gale and Hellwig, 1985) – the fact that it is costly for external investors to observe investment returns implies that it is optimal for external finance to be obtained by issuing debt. And, under other well-known circumstances (Diamond, 1984; Williamson, 1986) it is optimal for debt issues to be intermediated.

Boyd and Smith utilize these facts in a model where there are two technologies for creating capital. One of these is subject to a CSV problem, and one is not. Investments employing the technology with the CSV problem attached should optimally be financed with debt, whereas investments with observable returns can be financed with equity. Under certain assumptions that they describe, state verification becomes more costly with development – in practice perhaps because production processes become more complex. Thus, as an economy grows, firms optimally reduce their reliance on investment technologies subject to the CSV problem – and on debt – and increase their use of equity.

As is central to the Gurley – Shaw account of finance and development, often equity markets become active only once an economy reaches a crucial stage. After this stage is reached, equity markets might evolve slowly. Or, as in Korea – where the ratio of stock market trading to GDP increased by a factor of 12 from 1986 to 1989 – equity market development might be extremely rapid. The Boyd-Smith article indicates how either outcome can occur.

The paper by Antinofi and Huybens pursues another aspect of economic development – one particularly relevant to small open economies. In such economies, development agencies and policy-makers often argue that the real

exchange rate (typically taken to be a relative price between traded and nontraded goods) can and should be manipulated as a means of stimulating economic development. However, despite the existence of strong priors, formal theories of the relationship between real exchange rates and real activity are largely lacking. Antinofi and Huybens take a step towards rectifying this. In their model capital investment is again subject to a CSV problem. In addition, investors can provide some internal finance for their projects. As noted by Bernanke and Gertler (1989) and many others, in the presence of a CSV problem internal finance acts to mitigate the severity of the informational asymmetry. Antinofi and Huybens show that the level of the real exchange rate will typically affect the incomes of domestic investors and, consequently, their ability to contribute internal finance to their projects.

In this context Antinofi and Huybens demonstrate the potential for multiple steady states to be observed: there is one steady state with a relatively high real exchange rate in which borrowers provide little internal finance, and a second with a lower real exchange rate in which investors contribute more internal finance for their projects. Antinofi and Huybens also show that there is no necessary connection between movements in the real exchange rate and real activity; a declining real exchange rate can be associated either with a rising or a falling capital stock. This paper thus provides a theoretical foundation for the notion that real exchange rates and economic activity are linked. At the same time it provides a caution to policymakers that the nature of comovements in production and the real exchange rate may differ dramatically across economies, or over time within a given economy.

Betts and Bhattacharya also consider an economy in which capital investment is subject to a CSV problem. However, the focus of their article is on how this credit market friction interacts with an adverse selection problem in labor markets. The latter friction creates scope for labor to be unemployed, just as the presence of a CSV problem in capital markets creates scope for credit to be rationed.

When adverse selection problems lead to the existence of unemployment, several things happen. As capital is accumulated the real wage paid to more skilled labor rises relative to that of less skilled labor. When skill levels are privately observed, this exacerbates the adverse selection problem in labor markets. Since unemployment is used as a sorting device, the consequence is that the equilibrium level of unemployment rises. In addition, since capital-labor ratios depend on the quantity of unemployed labor, next period's capital-labor ratio may be nonmonotonically related to today's capital-labor ratio. This makes it possible to observe multiple asymptotically stable steady state equilibria, oscillatory equilibria en route to a steady state and, potentially, equilibrium trajectories that converge to limit cycles. Thus frictions that arise due to informational asymmetries in labor markets have implications both for long-run outcomes, and for the possibility of shorter-run fluctuations.

Betts and Bhattacharya also establish that the potential for development traps and for oscillation – damped or otherwise – depends on the severity of the CSV problem in capital markets. The more severe the CSV problem, the greater the likelihood that these phenomena can be observed. This is the sense in which credit and labor market frictions interact.

Business cycles

Three of the papers in the symposium are further explorations of the notion that informational asymmetries can amplify the effects of exogenous shocks, thereby increasing the severity of business cycles. Cooley and Nam do this taking as their starting point a conventional monetary real business cycle model. Money is introduced via a cash-in-advance constraint and, to generate a liquidity effect, there is limited participation as in Lucas (1990), Fuerst (1992), and Christiano and Eichenbaum (1992a, b). The implication of limited participation is that firms and financial intermediaries – the latter stand between firms and households – adjust their portfolios more often than the agents who supply funds (households) can. This is what permits a liquidity effect to occur.

The innovation of the Cooley-Nam paper is that firms require "credit in advance" in order to finance their current operating expenses, and that this credit extension is subject to a CSV problem.[1] The intermediaries who provide this credit operate subject to a reserve requirement. And, the firms they lend to are subject to individual specific – as well as aggregate – shocks. These idiosyncratic shocks can be observed by outsiders only at a cost, introducing a conventional CSV problem.

In this context, Cooley and Nam find that the response of the economy to a technology shock is quite similar to what one would observe in an economy where all idiosyncratic shocks are freely observed.[2] However, the presence of the CSV problem magnifies the effects on the capital stock of a shock to the money growth rate, although most other variables respond in essentially the same way to a monetary shock whether or not the CSV problem is present.

Cooley and Nam also consider the possibility that monetary policy shocks take the form of innovations to reserve requirements (and, indeed, effective reserve requirements on banks have varied substantially over time). They find that such shocks have very strong real effects on the economy in the presence of a CSV problem: in effect, the existence of a CSV problem seems to provide a strong propagation mechanism for shocks to bank regulation.

[1] In contrast to several other papers in the symposium, intermediaries finance firms' current operating expenditures. But, they do not finance capital investment. And, Cooley and Nam abstract from any internal financing of activities by firms. This was the source of propagation in Bernanke and Gertler (1989), and of endogenously arising volatility in Boyd and Smith (1997, 1998).

[2] This is somewhat different from the finding of Carlstrom and Fuerst, as discussed below.

Carlstrom and Fuerst also take as their starting point a conventional real business cycle model.[3] As was already noted, if one wants to introduce credit market considerations into such a model, there is an issue about (a) what activities require credit, and (b) what activities involve a CSV problem. In the Antinofi-Huybens, Betts-Bhattacharya, or Boyd-Smith contributions to this volume, the CSV problem is attached to the activity of physical capital investment. In Cooley-Nam, it attaches to the production of final goods and services. Carlstrom and Fuerst investigate, in a business cycle context, the extent to which it "matters" where the CSV problem lies.

In earlier work (Carlstrom and Fuerst, 1997) the same authors developed a real business cycle model where physical capital investment required credit extension, and where the CSV problem applied to this investment. Here they allow the CSV problem to attach to the production of final goods and services (as do Cooley and Nam). By comparing the results, Carlstrom and Fuerst conclude that having the CSV problem associated with physical capital investment allows greater scope for the informational asymmetry to amplify the effects of a technology shock.

As is implicit in some other work where capital investment is credit-financed – and subject to a CSV problem – Carlstrom and Fuerst note that the presence of the CSV problem has some consequences similar to the introduction of adjustment costs. Moreover, existing capital cannot be a perfect substitute for newly-created capital, introducing considerations analogous to "Tobin's Q." In the specification of their economy where the CSV problem is associated with capital investment, these adjustment-cost style aspects actually dampen the initial impact of a technology shock.[4]

In contrast, when there is a CSV problem that attaches to final goods production, the implied "agency costs" lead to a mark-up in goods prices. This mark-up distorts allocations in factor markets, and it is this mechanism by which informational frictions affect the propagation of shocks.

Carlstrom and Fuerst conclude that the "output model" generates less amplification and propagation of shocks than the "investment model." This is due to the fact that distortions of investment decisions have a larger economic impact than output and factor market distortions in their economy. This is an important conclusion from the standpoint of "optimal" strategies for introducing informational asymmetries into real business cycle models.

As do Cooley and Nam or Carlstrom and Fuerst, the contribution by Labadie incorporates a CSV problem into a dynamic general equilibrium

[3] Unlike Cooley and Nam, Carlstrom and Fuerst do not consider any issues related to money or monetary policy.

[4] This observation is quite different from the illustrations by Williamson (1987b), Bernanke and Gertler (1989) and Labadie that the presence of a CSV problem can create real consequences from shocks that would be irrelevant under perfect information. It is also distinct from the point made by Azariadis and Smith (1996, 1998) or Boyd and Smith (1997, 1998) that informational asymmetries can create a role for fluctuations due to self-fulfilling prophecies that would be absent under perfect information.

model that is subject to random shocks. Unlike the other articles, however, her paper considers an overlapping generations economy, and it focuses on shocks that would be economically irrelevant under full information.

Specifically, Labadie examines an economy where symmetrically informed agents can shed risk completely, and where this complete risk sharing precludes aggregate fluctuations from "mattering." However, the presence of the CSV problem attenuates (but does not eliminate, as in many models of exogenous market incompleteness) opportunities for risk sharing. When risk sharing is incomplete a propagation mechanism for shocks appears and shocks that would be irrelevant under full information can become causes of business cycles. They also have distributional effects that may be of concern from an aggregate perspective.

The papers by Cooley and Nam or Carlstrom and Fuerst take on the issue of how to incorporate informational asymmetries into one kind of dynamic stochastic general equilibrium model – the real business cycle model – and to analyze their consequences. Labadie tackles the same issue in the context of another dynamic stochastic general equilibrium model: the overlapping generations model with production. All three of these papers consider models with aggregate shocks, and they take no key variables as exogenous.[5] These contributions represent important methodological advances along this dimension.

Finance

Azariadis and Chakraborty attack the issue of asset price volatility in a model that also has relevance to business cycle phenomenon. Indeed, the volatility of asset prices in their economy is a reflection of volatility in real activity and inflation as well.

The fluctuations that can arise in the Azariadis-Chakraborty economy are the consequence of the economy transiting between two regimes: a regime of high real activity, substantial lending by the financial system, and relatively efficient intermediation (due here to a low cost of state verification incurred by lenders), and a regime of low real activity, limited credit extension, and relatively inefficient intermediation (high costs of state verification). These transitions between regimes are driven purely by beliefs; beliefs that are confirmed in equilibrium.

The two regimes arise because of the Azariadis-Chakraborty assumption that there are increasing returns to scale in financial intermediation.[6] When aggregate lending activity is low (high), intermediation (state verification) is relatively costly (cheap). The result is that, for a given current state of the economy, there is more than one possible value for next period's capital

[5] Bernanke and Gertler (1989) and the Boyd-Smith contribution to this issue construct their models so that the real rate of interest on savings is exogenously determined.

[6] The same assumption underlies recent Federal Reserve System support for consolidation in banking, although here the increasing returns are of a somewhat different nature.

stock (and everything else). If lenders are "optimistic," there is extensive lending and a large volume of investment. Moreover, the implied decreasing costs of intermediation imply that this optimism will be justified, in equilibrium. Similarly, "pessimism" by lenders leads to a small volume of credit extension, and a low level of investment. The pessimistic attitude of lenders is validated, in equilibrium, by high costs of intermediation.

This mechanism – whereby there are many possible regimes that can be entered from any given current state – was originally developed by Azariadis and Smith (1998). There, it was made possible by an endogenously severe adverse selection problem in credit markets. In Azariadis and Chakraborty, multiple regimes arise due to the specification that the more lending there is, in the aggregate, the cheaper state verification is for any lender. And the costs of state verification must decrease sufficiently rapidly with aggregate lending over some range.

Other authors (for example Boyd and Smith; 1997, 1998) have shown how endogenous volatility – but not multiple regimes – may arise in related models where the cost of state verification is fixed. However, those models, as do many in the CSV literature (Williamson, 1986, 1987a; Bernanke and Gertler, 1989) introduce another kind of (microeconomic) nonconvexity: an upper bound on the amount that can be invested by any single borrower. In practice it is possible that both kinds of nonconvexities have some relevance, suggesting the possibility that not only might multiple equilibrium regimes exist, but that endogenous volatility can be observed within some or all of these regimes.

All of the papers discussed thus far are about the aggregate consequences of private information. But, in order for informational asymmetries to have significant macroeconomic consequences, they must have microeconomic consequences as well. And it is perhaps easier to verify (or to falsify) the importance of private information at the microeconomic level.

One testing ground that has emerged concerning the empirical significance of agency problems is in the realm of executive compensation. Haubrich and Popova reexamine this topic. Using data on CEO compensation, Jensen and Murphy (1990) found what they interpreted as quite a weak empirical relationship between CEO compensation and firm performance. They further argued that models of principle-agent relationships were inconsistent with these apparently small performance incentives. If taken at face value, this conclusion would cast considerable doubt on the empirical significance of one likely source of agency problems.

In subsequent work, Haubrich (1994) wrote down a simple parameterization of the principal-agent model developed by Grossman and Hart (1983), and showed that it was not necessarily inconsistent with the Jensen-Murphy findings. Wang (1997) reached a similar conclusion using a model of repeated interactions between a principal and an agent (Green, 1987; Spear and Srivastava, 1987).

Haubrich and Popova take the next logical step, and "calibrate" a model of a principal-agent relationship between shareholders and a CEO. They

allow for a relatively large number of potential actions by a firm manager, and they also allow for nonlinear incentive schemes. Indeed, Haubrich and Popova find that the optimal managerial incentive scheme involves significant nonlinearites; managers should receive greater rewards for increasing production in bad states than they do in good states.

The Haubrich-Popova model is calibrated using information about shareholder values for 350 firms from the Jensen-Murphy data set. They find that the calibrated model matches quite closely the average performance/pay ratio found in the data. The Haubrich-Popova results suggest that observed CEO compensation is, in fact, very much in line with the predictions of a basic principal-agent model. Their findings allow increased confidence that informational asymmetries are important at a microeconomic level.

To conclude, the 1980s saw major contributions to the theory of financial markets and financial intermediation. Many of these were based on the existence of informational asymmetries. In the 1990s these insights have been applied to growth theory and to the theory of business cycles – two areas in which financial factors have long been held to be of central importance. Moreover, we know that there are major evolutionary changes in the financial system as an economy develops, and that the financial system experiences strong changes over the business cycles. Models of private information hold out the potential of explaining these changes in a fully endogenous way.

References

Azariadis, C., Smith, B. D.: Private information, money, and growth: indeterminacy, fluctuations, and the Mundell-Tobin Effect. Journal of Economic Growth **1**, 309–332 (1996)

Azariadis, C., Smith, B. D.: Financial intermediation and regime switching in business cycles. American Economic Review (forthcoming) (1998)

Bernanke, B. S., Gertler, M.: Agency costs, net worth, and business fluctuations. American Economic Review **79**, 14–31 (1989)

Boyd, J. H., Prescott, E. C.: Financial intermediary coalitions. Journal of Economic Theory **38**, 211–232 (1986)

Boyd, J. H., Smith, B. D.: Capital market imperfections, international credit markets, and nonconvergence. Journal of Economic Theory **73**, 335–364 (1997)

Boyd, J. H., Smith, B. D.: Capital market imperfections in a monetary growth model. Economic Theory **11**, 241–173 (1998)

Carlstrom, C. T., Fuerst, T. S.: Agency costs, net worth, and business fluctuations: a computable general equilibrium analysis. American Economic Review **87**, 898–910 (1997)

Christiano, L. J., Eichenbaum, M.: Liquidity effects and the monetary transmission mechanism. American Economic Review **82**, 346–353 (1992a)

Christiano, L. J., Eichenbaum, M.: Liquidity effects, monetary policy, and the business cycle. Institute for Empirical Macroeconomics Discussion Paper 70, Federal Reserve Bank of Minneapolis (1992b)

Friedman, M., Schwartz, A. J.: A monetary history of the United States, 1867–1960. Princeton: Princeton University Press 1963

Fuerst, T. S.: Liquidity, loanable funds, and real activity. Journal of Monetary Economics **29**, 3–24 (1992)

Gale, D., Hellwig, M.: Incentive-compatible debt contracts: the one-period problem. Review of Economic Studies **52**, 647–663

Green, E. J.: Lending and the smoothing of uninsurable income. In: Wallace, N., Prescott, E. C. (eds.) Contractual arrangements for intertemporal trade. Minneapolis: University of Minnesota Press 1987

Gurley, J. G., Shaw, E. S.: Financial aspects of economic development. American Economic Review **45**, 515–538 (1955)

Gurley, J. G., Shaw, E. S.: Money in a theory of finance. Washington, DC: Brookings Institute 1960

Gurley, J. G., Shaw, E. S.: Financial structure and economic development. Economic Development and Cultural Change **15**, 257–268 (1967)

Jensen, M. C., Murphy, K. J.: Performance pay and top-management incentives. Journal of Political Economy **98**, 225–264 (1990)

King, R. G., Levine, R.: Finance and growth: Schumpeter might be right. Quarterly Journal of Economics **108**, 717–738 (1993a)

King, R. G., Levine, R.: Finance entrepreneurship, and growth: theory and evidence. Journal of Monetary Economics **32**, 513–542 (1993b)

Levine, R., Zervos, S.: Stock markets, banks, and economic growth. Manuscript, The World Bank (1995)

Lucas, R. E. Jr.: Expectations and the neutrality of money. Journal of Economic Theory **4**, 103–124 (1972)

Lucas, R. E. Jr.: Liquidity and interest rates. Journal of Economic Theory **50**, 237–264 (1990)

Smith, B. D.: Unemployment, the variability of hours, and the persistence of disturbances: a private information approach. International Economic Review **30**, 921–928 (1989)

Spear, S., Srivastava, S.: On repeated moral hazard with discounting. Review of Economic Studies **54**, 599–617 (1987)

Wang, C.: Incentives, CEO compensation, and shareholder wealth in a dynamic agency model. Journal of Economic Theory **76**, 72–105 (1997)

Williamson, S. D.: Costly monitoring, financial intermediation, and equilibrium credit rationing. Journal of Monetary Economic **18**, 159–179 (1986)

Williamson, S. D.: Costly monitoring, loan contracts, and equilibrium credit rationing. Quarterly Journal of Economics **102**, 135–145 (1987a)

Williamson, S. D.: Financial intermediation, business failures, and real business cycles. Journal of Political Economy **95**, 1196–1216 (1987b)