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by

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Evaluation of macroeconomic models for financial stability analysis*

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Abstract

As financial stability has gained focus in economic policymaking, the demand for analyses of financial stability and the consequences of economic policy has increased. Alternative macroeconomic models are available for policy analyses, and this paper evaluates the usefulness of some models from the perspective of financial stability. Financial stability analyses are complicated by the lack of a clear and consensus definition of 'financial stability', and the paper concludes that operational definitions of this term must be expected to vary across alternative models. Furthermore, since assessment of financial stability in general is based on a wide range of risk factors, one can not expect one single model to satisfactorily capture all the risk factors. Rather, a suite of models is needed. This is in particular true for the evaluation of risk factors originating and developing inside and outside the financial system respectively.

Keywords: Financial stability; Banks; Default; Macroeconomic models; Policy
JEL Classification: E1, E4, E5, G1, G2

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I Introduction

In parallel with the strong growth in financial markets and more frequent instances of widespread financial distress during the last decades, financial stability has become an increasingly important objective in economic policymaking. In addition to a role in crisis resolution, many central banks have a clear mandate to promote financial stability. As many non-supervisory central banks, Norges Bank has adopted a macro prudential approach to financial stability, with focus on systemic risks in the financial system.[1] A financial stability targeting role involves analyses of potential threats to financial stability, assessment of the present situation and the outlook ahead, and policy actions based on the risk assessment. Available instruments to financial stability targeting central banks are monetary policy, lender of last resort policy and soft instruments, such as financial stability reports, speeches, meetings with market participants etc. Regulation is of course an important instrument to promote financial stability, and by cooperating with the regulatory authority, the central bank can influence the regulation of the financial system, i.e., the regulation of financial institutions, markets and infrastructure.

Financial stability reports published by central banks show that central banks, in general, base their assessment of financial stability on an extensive amount of information and a wide range of analyses. When analysing potential threats to financial stability, there are two complementary approaches. The first approach focuses on risk factors that originate and develop within the financial system and contagion. Central banks typically monitor systemically important financial institutions, securities markets and payments systems in order to detect trends in credit, liquidity and market risks that may increase financial fragility and weaken the stability of the financial system. Common exposures across financial institutions, either direct counterparty exposures or via third parties, are typically also scrutinised, since common exposures are channels of contagion, which may cause problems at a single financial institution to spread and give rise to systemic problems.

The second approach focuses on risks that originate and develop outside the financial system, reflecting that the fragility of the financial system depends on macroeconomic conditions.

[1] See keynote address by Governor Svein Gjedrem at the conference ”Monetary Policy and Financial Stability”, hosted by the Oesterreichische Nationalbank in Vienna, May 2005, www.norges-bank.no/cgi-bin/pr.cgi.

Strong growth in debt burdens, imbalances in asset prices, and national or international macroeconomic disturbances that cause debt servicing abilities or collateral values to decrease, may negatively affect financial stability. Hence, from a financial stability point of view, it is important to understand the development in macroeconomic conditions such as disposable income of households and firms' profits, or unemployment and bankruptcy rates, and how these developments affect financial stability. And furthermore, from a policy maker's point of view, it is clearly of interest to understand the implication of financial instability or increased fragility to economic growth and welfare, and how policy actions affect financial stability.

In their surveillance of the financial system, financial stability targeting central banks generally apply a wide range of tools. Pure financial soundness indicators are commonly used, but also more structural types of models that explicitly include behaviour of economic agents have been developed by central banks. In this paper we take a closer look at the "model choice" issue, and we evaluate alternative macro models for financial stability analyses. We focus on two classes of models, i.e. macro models within the theory-based general equilibrium framework and structural macroeconometric models. Assessment of financial stability is typically based on the development of a wide range of risk factors, and in general one can not expect a single model to satisfactorily handle all these risk factors. In this evaluation of macroeconomic models, we therefore particularly look at what issues each model can be used to analyse, in addition to the methodological strength and limitations of each model typology.

A discussion of the usefulness of alternative models for financial stability analyses is complicated by the lack of a clear and consensus definition of "financial stability". In the literature, a number of alternative definitions are available, and we start this paper by a discussion of the most common definitions. However, when applying models for financial stability analyses, one needs operational definitions that explicitly can be identified within the models. Hence, although academics and practitioners one day may agree on an overall definition of financial stability, one must expect operational definitions to be model specific.

In Section 2, the issue of how to define financial stability is discussed. In Section 3 we present what properties we ideally would want macroeconomic models for financial stability analysis to possess, while in Section 4 we give a superficial presentation of available models, some models are discussed in more detail. Section 5 summarises and concludes.

2 Financial (In) stability: Definitions

Numerous authors have defined financial stability, and, at one level, the various definitions seem to be familiar both from a theoretical as well as a practical viewpoint. However, few attempts have been made to define and formally characterize this term in an analytically rigorous manner. Another challenge when defining financial stability is that it is useful for policy analysis (i.e. crisis prevention and management) depends on whether the definition is operational and quantifiable.

Academics and policy makers have suggested a *potpourri* of definitions.[2] We categorize them into two broad categories; one is more information-based whereas the other is more institutionally oriented. For example, Mishkin (1994) offers a more information-based characterization of financial instability. ‘Financial instability occurs when shocks to the financial system interfere with information flows so that the financial system can no longer do its job of channelling funds to those with productive investment opportunities’. Crockett (1997), on the other hand, suggests that ‘financial stability (refers) to the stability of key institutions and markets that go to make up the financial system...stability requires (i) that the key *institutions* in the financial system are stable, in that there is a high degree of confidence that they continue to meet their contractual obligations without interruption or outside assistance; and (ii) that the key *markets* are stable, in that participants can confidently transact in them at prices that reflect fundamental forces and changes in fundamentals’.

Regarding information-based definitions, Issing (2003) and Foot (2003)[3] have suggested that financial stability is related to financial market bubbles, or more generally, volatility in financial market proxies. Indeed, bubbles impair financial markets efficiency; however, in and of themselves, they do not constitute a defining characteristic of financial fragility, and more generally financial instability. The same argument can be put forward with respect to financial market imperfections such as missing financial markets. Imperfections increase the likelihood of financial instability occurring but do not necessarily cause it. One can classify Minsky’s

[2] A survey of these definitions and extensive discussion can be found in Bank for International Settlements (1998).

[3] ‘Monetary and Financial Stability: Is there a Trade-off?, paper delivered to Conference on ‘Monetary Stability, Financial Stability and the Business Cycle’, Bank of International Settlements, Basel, March 28-29, 2003 and ‘Protecting Financial Stability-How good are we at it?’ speech given at the University of Birmingham, June 6, 2003.

Financial Instability Hypothesis in this family of definitions[4] since he claims that the inherent financial instability of financial markets is based on the overoptimistic behaviour of economic agents.

Other authors have suggested institutionally oriented definitions. Haldane *et al* (2004), among others, have emphasized deviations from the optimal savings-investment plan as a necessary ingredient of a definition of financial instability. They propose the following definition: '...financial instability could be defined as **any** (emphasis ours) deviation from the optimal saving-investment plan of the economy that is due to financial imperfections in the financial sector.' However, as Otmar Issing has pointed out, '...the efficient allocation of savings to investment, though without a doubt a highly desirable feature of an economy, should not be part of a definition of financial stability. For example, no one would say that savings were allocated efficiently to investment opportunities in the Soviet Union between 1917 and 1991, but the Soviet Union did not suffer from financial instability, except right at the end of its existence.'[5] In addition, no single optimal savings-investment plan is universally accepted so that to be able to quantify deviations from it unambiguously.

Schwartz (1986) suggests that 'a financial crisis is fuelled by fears that means of payment will be unobtainable at any price and, in a fractional reserve banking system, leads to a scramble for high powered money... In a futile attempt to restore reserves, the banks may call in loans, refuse to roll over existing loans, or resort to selling assets.' Allen and Wood (2005) offer a related definition.

Finally, Goodhart *et al* (2004, 2005, 2006 a, b), and Tsomocos (2003 a, b) offer a definition that hinges upon the welfare effects on the economy and distributional consequences arising during periods of financial instability. They argue that a combination of probability of default - variously measured - of both banks as well as economic agents together with bank profitability characterize financially unstable (fragile) regimes of the economy. This has the added advantage that it can be applied, *mutatis mutandis*, at both the individual and aggregate levels. Thus, financial instability is characterized by both high probabilities of default and low profits. Moreover, it is allowed that the authorities (government and/or the Central Bank) determine the level of debt above which (and the profit below which), a financial environment

[4] See Minsky (1978).
[5] Issing (2003).

becomes fragile, given the idiosyncrasies of a particular economy. Also note that this definition treats financial fragility/instability as an equilibrium phenomenon compatible with the orderly function of the markets. This in turn conforms to deviations from the optimal savings and investment plan in equilibrium, as has been suggested by Haldane *et al* (2004). The standard techniques and theorems of equilibrium theory can be readily applied. Equilibrium analysis is also amenable to comparative statics. For example, by varying capital requirement rules and altering monetary policy, one can determine the expected default, bank profitability, and the welfare effects of the regulatory-monetary policy mix during episodes of financial instability. Hence, the interaction of monetary and regulatory policy can be assessed, and financial instability can be studied in the *continuum* rather than as an extreme and discontinuous phenomenon.

This definition is sufficiently flexible to encompass most of the recent episodes of financial instability. The Mexican crisis of the early 1990s is a classic example of such a crisis. The late 1990s East Asian crisis was characterized by a banking crisis and economic recession as well as extensive default. Finally, the Russian crisis, the Texas banking crisis, and the US Stock Market crash of 1987 conformed to the characterization of a financially unstable regime generated by extensive default and declines in bank profitability.

In summary, the information-based definition of Mishkin, Issing and Froot, and Minsky and the institutionally oriented one offered by Crockett, Haldane *et al*., and Schwarz, encompass crucial aspects of financial stability. However, they do not capture the main reason that policy makers focus on instability, namely its welfare and distributional effects. In other words, their definitions highlight the inefficiency and the asset price volatility that a financially unstable regime generates, but they do not link them explicitly and in an analytically tractable manner with welfare. Therefore, they can not be readily applied for welfare analysis. On the other hand, widespread default and pronounced decrease in banks profitability impair financial and capital markets, and eventually trade collapses altogether. Thus, a systemic financial crisis of the economy can be reinterpreted as a case of equilibrium non-existence.

3 Demand for models: Desirable characteristics of models for financial stability analysis

Within the regularly monitoring and assessment of financial stability, as well as within policy evaluation, there are many uses for macroeconomic models. We will now discuss what properties these models ideally should possess. A model that satisfied all needs and wishes would be extremely complicated. In practise, different models satisfy different needs and are able to handle different types of risks to financial stability and policy actions. Macroeconomic models for financial stability analyses can take many forms, from elaborate structural models with microeconomic optimising behaviour to a system of indicators. We will now outline the minimum structural characteristics that such models should ideally possess.

1. *Contagion*

Central banks are charged with responsibility for maintaining the stability of the financial system as a whole. A major potential cause of systemic problems within the financial system is the possibility of contagious interactions between individual participants, notably banks. This interaction can have many channels, for example direct counterparty effects when one of the parties fails, distress sales causing the market value of other agents' assets to decline, cut-backs in lending causing economic depression and leading to failures elsewhere, and so forth. Such interactions may occur directly amongst banks via interbank linkages, or between banks and other participants in the economy via credit and loan markets.

The possibility of contagious failures between banks and their borrowers could be a major threat to financial stability. Central banks and international financial institutions should therefore develop models which enable assessment of the risks of interactive contagion.

2. *Default*

An important element in contagion is the possibility of default, and it is essential that a model exploring contagion should include default. This is intellectually challenging. Models cannot easily handle the discontinuous, non-linear, functions that are involved, and indeed most extant macroeconomic models in effect exclude default. At best, they handle default in an *ad hoc* manner and not as an equilibrium outcome stemming from economic agents' optimal behaviour due to uncertainty. But that is not an option for a model of contagion that attempts to assess systemic risk. After all, if it were certain that everyone would repay all their debts in full, including accumulated interest, everyone could borrow, or lend, without credit risk.

3. *Missing Financial Markets*

Another important aspect of the real world is that markets are incomplete - not every eventuality can be hedged. Unforeseen, and unhedged, events are often a feature of the onset and propagation of crises. When some financial markets are missing, or otherwise imperfect, there can be a role for regulating intermediation and policy intervention.[6] In addition, security design and financial innovations do not necessarily induce welfare improvements as was the case with junk bonds. Even so, it is important to be clear in what particular respects the system of financial markets is incomplete. The aspect of missing markets is of particular importance when analysing the need for and the consequences of regulatory policy.

4. *Roles for Money, Banks, Liquidity and Default Risk*

It is essential for a model exploring systemic risk to include liquidity risk and/or the incompleteness of financial markets. After all, in the absence of these factors, there would be no essential need for money and no need for banks.[7] While there would still be a real interest rate, determined by time preference and expected returns to investment, there would be no essential role for either liquidity or default premia in the determination of the term structure of interest rates. The unit of account should not be treated as the same as all other goods and services as in the standard Arrow-Debreu general equilibrium model. As long as money has a distinct role in the economy and is not substitutable by any other commodity, then liquidity constraints acquire a functional role. Liquidity affects both the real and nominal sectors of the economy.

5. *Heterogeneous Agents*

If all banks were assumed to be identical, then they would never have an incentive to trade with each other. Direct interactions between banks, notably, but not only, in the inter-bank markets, are often viewed as a key channel of financial contagion. An assumption that all banks were identical, or equivalently that the banking system can be modelled as consisting of

[6] Geanakoplos and Polemarchakis (1986) show that, with incomplete asset markets, the economy may even fail to reach the second-best, i.e. constrained Pareto-optimality. In such case, policy intervention may induce welfare improvements.

[7] We do not explicitly consider the industrial organization explanation for the existence of financial intermediaries, i.e. that banks offer differentiated services to their costumers (depositors and lenders) that are costly to produce.

a single representative bank, therefore excludes a main potential channel of contagious interaction. In any case, the assumption that all banks, or bank customers, are identical is hardly realistic; while it can be a useful simplification for some purposes, it cannot be so for a study of contagion. Also, interaction among agents or banks should not be imposed exogenously but should ideally be an outcome of optimal behaviour. Consequently, genuine agent heterogeneity should be an integral ingredient of a model dealing with crisis prevention and management.

5. *Macroeconomic Conditions*

The fragility of the financial system depends on macroeconomic conditions and risk factors that may originate and develop outside the financial system. Macroeconomic disturbances that increase the number of bankruptcies and unemployment, and, as a result, weaken the debt servicing ability of firms and households, may threaten financial stability. In addition, poor macroeconomic prospects are likely to affect the benevolence of banks and other creditors to renegotiate debt servicing conditions of debt holders in financial stress, which may amplify the negative effect of macroeconomic disturbances for financial stability. A macroeconomic model for financial stability analysis should therefore include external risk factors and the inter-linkage between these and financial stability.

6. *Structural Micro-foundations*

There are, of course, in any major field a wide range of potential models. This is also the case in the study of financial stability. Some start by examining the data in order to perceive and to estimate the likelihood of defaults in individual banks, or even systemic financial crises, from other predetermined variables, such as the market value of banks' equity (Merton-type models) or subordinated debt, or the rate of growth of bank loans, or from macroeconomic data more widely. Such models have the advantage of congruence with the data, which is important from a surveillance perspective, but they can be subject to the Lucas critique (and Goodhart's Law)[8] that such regularities may break down as the (policy) regime changes. Indeed, financial stability analysis is intimately connected with regime changes and discontinuous changes of economic and financial variables.

[8] See Lucas (1976) and Goodhart (1975).

At the other end of the spectrum, one can start by trying to establish models based on optimising micro-foundations. The complexity of human behaviour and the wide and diverse scope of the economy imply, however, that not only do such models require simplifying assumptions that are extreme, but also that they may have less congruence with the data (than other, more atheoretical, data-fitting models). Indeed one can position one's research at any point along the efficient frontier between data congruence and theoretical coherence.

7. *Empirically Tractable*

While the above characteristics will be desirable in constructing a satisfactory theoretical model of contagious interaction, such a model will have little lasting practical effect unless it can be used empirically by regulators to assess systemic financial fragility, using real data. That means that it must also be empirically tractable. But the above characteristics do also make for complexity in empirical estimation. As noted already, there is an inevitable trade-off between including desirable theoretical features and complexity. One possibility would be to construct a suite of models at different points on the trade-off. The trade-off may, however, be made less stark by designing a model structure which is flexible enough to switch focus from one practical issue to another, and so only include those elements of the wider model necessary to handle the question at hand. Thus, the introduction of an analytically coherent framework may be more relevant for financial stability analysis rather than specific models that aspire to being canonical models.

9. *Forecasting and Policy Analysis*

A wider role of monitoring financial stability is in the form of forecasting and policy analysis. Forecasting properties of a model are usually related not only to how well it fits the data, but also to how robust it is. These considerations manifest themselves as a trade-off between short-run and long-run properties. For forecasting purposes, the short-run properties are the most important. Both for forecasting and policy analysis, the Lucas critique need to be heeded. Whether a model will be useful for policy analysis, is a question of the model's invariance to shocks, both in the form of external events and policy changes. (For example, could the banking crisis following the liberalization of credit markets be avoided by policy simulations with appropriate models? Perhaps: first, the process was sequential, so the policy makers of Norway, Sweden and Finland had the possibility to observe the outcomes in Denmark and the UK. Second, the answer will of course depend upon whether the parameters of the models were invariant to the big structural changes the deregulation entailed.) A well designed macro model can be used to analyse how monetary policy affects risks to financial stability that originate outside the financial system. In general, however, authorities put much emphasis on regulation as an instrument to promote financial stability and eliminate or reduce undesirable consequences of imperfections in financial markets. Regulatory changes can in principle be analysed within different types of macro models, but the analysis may suffer from the Lucas critique. These issues are probably better understood within models with a more detailed and heterogeneous representation of financial institutions. Independent of policy instrument in focus, the model applied for policy analysis should be able to clarify the transmission mechanisms involved.

10*. Testing device*

Another attractive property of a model can be phrased as its usefulness to act as a statistical testing device of alternative theories of relevance. As economics is an evolving science, competing theories are suggested, and discarded, continuously. When an issue of financial instability occurs, the causes, effects and remedies are rarely readily at hand. One important use of a model is the ability to sift out the best explanations useful for the problem at case. It is essential that the model is as correct as possible, in order for it to act as a reliable reality check in as many situations as possible.

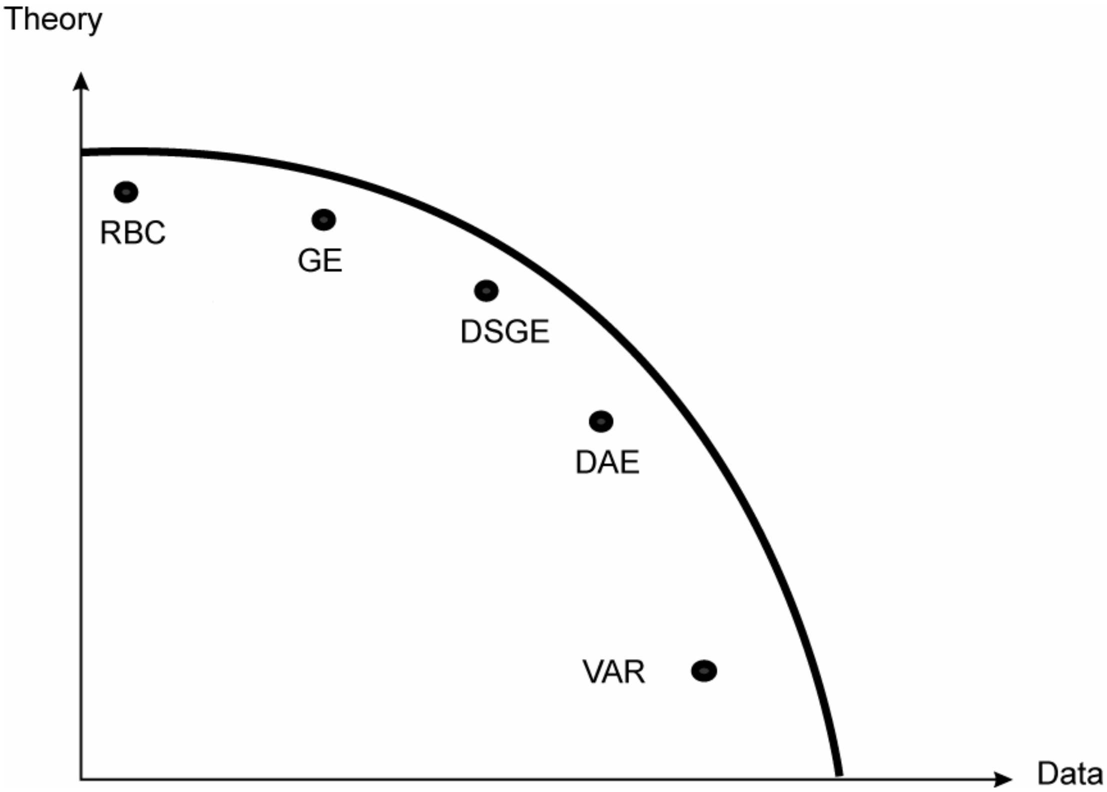
4 Supply of models: State of the art

4.1 Classification of models

Macroeconomic models come in many forms and species. They vary a lot, not only in terms of the complexity of their representation of economies, but also in the way the quantitative measurements of causes and effects are obtained. So, even when the task is to evaluate models for use within a specific area, like financial stability issues, it is not obvious what constitutes the best class of models. Parameters of models are estimated by means of a variety of Classical and Bayesian econometric techniques and by simulation and calibration techniques. The latter two approaches are not only used as alternative methodologies in their own right, but are now employed to compute estimators in situations where standard methods are impractical or fail.

A classification of macroeconomic models can be done along many different dimensions. One classification, that has proved useful in other settings, has been to structure the discussion along the theory versus data coherency. In his review of the modelling at the Bank of England, Pagan (2003) introduced a very helpful diagram, illustrating the trade-off between theory and data for the choice of a macroeconomic model class. We can classify the main model types in use today within a version of this diagram as described below. The trade-off is evident: Direct translation of theoretical relationships to econometric specifications is likely to lead to misspecified models with inefficient estimates and unnecessary bad forecasts. On the other hand, models without due attention to relevant theory is needed to get a clear interpretation of estimation results and of model properties.

Figure 1. A Pagan-diagram for model classification



RBC: Real Business Cycle models; GE: General Equilibrium models; DSGE: Dynamic Stochastic General Equilibrium models; DAE: Dynamic Aggregative Econometric models; VAR: Vector Autoregressive models

In general, the models will also vary with respect to the preferable characteristics outlined in Section 3. For example, the classic Arrow-Debreu general equilibrium model with complete markets rests on three basic principles, namely, agent optimisation, market clearing, and rational expectations. However, there is no role for financial intermediaries or credit and default in this model, since there are no uninsurable risks, neither aggregate nor idiosyncratic, all contracts are perfectly enforceable, and money is not part of the model. Thus, this model is not able to illuminate the various channels of financial instability, even though the main issues of financial instability, such as contagion and systemic risk, are fundamentally general equilibrium phenomena that arise from the interaction among different agents of the economy in various markets. However, there is a growing literature that attempts to model financial intermediaries in a general equilibrium framework with incomplete asset markets and capital markets imperfections.

It is infeasible to summarise all existing models, so, instead, we will focus on representative papers from some categories, in order to illuminate their main features and critically evaluate them. We will discuss the following model classes.

- Real business cycle (RBC) models. Infinite horizon, representative agent, calibrated.
- Dynamic stochastic general equilibrium (DSGE) models. Infinite horizon, representative agent, calibrated or estimated.
- Overlapping generation (OLG) models. Infinite horizon, calibrated.
- Finite horizon general equilibrium (FHGE) models. Heterogeneous agents, calibrated. Endogenous default and liquidity constraints.
- Dynamic aggregative estimated (DAE) models. Large and small scale, reduced form. (Cowles commission type of models.)
- Structural vector autoregressive (SVAR) models. Estimated.

4.2 Evaluation of some macroeconomic models for financial stability analysis[9]

Calibrated theory (CGE and RBC models)

At the theory-heavy end we find calibrated general theory-models, usually so-called computable general equilibrium (CGE) models. These models are theories, given explicit functional forms, and with parameters chosen so the model generates "plausible" time paths in the sense of being able to replicate observable business cycle fluctuations. These models have a long tradition in international trade, but are today mainly associated with the Real Business Cycles (RBC) research program initiated by Kydland and Prescott. More often than not, no parameters are estimated. Their main emphasis is on having very strong microeconomic foundations, usually in the form of forward looking agents engaging in optimal path allocations of resources. Since they are often not tested, nor estimated, their use is primarily in communication and illustration and as a consistency check.

[9] We hasten to add that we do not consider aggregate theoretical models with no microfundations (e.g. Blum and Hellwig (1995)) and partial equilibrium models (e.g. Chami and Cosimano (2001), Rochet, Decamps and Roger (2002)).

Dynamic stochastic general equilibrium (DSGE) models

The main difference between DSGE models on one side and VARs and aggregated models on the other is that DSGE models are explicitly derived from first principles, in the same way as RBC models. DSGE models describe the general equilibrium allocations and prices of the economy in which agents are supposed to dynamically maximize their objective functions subject to their resource constraints. Consequently, the DSGE model parameters have interpretations as invariant parameters of tastes and technology of the consumers and producers.

Two common problems with these models have been that they traditionally have been linearized and use filtered data. The motivation for this practice is of course that linear representations, following from 1. order Taylor expansions around variables with static equilibria, are much easier to handle. The resulting models have only been interpretable in terms of variables measured as deviations from their steady states. The data has therefore been separated into a business cycle part and a long-run growth part, where the latter has not been used in the modelling. In consequence, the models have not been very useful for forecasting, since the variables of interest are cast in levels—not steady-state deviations. Two points can be made at a general level. First, as pointed out by Bårdsen, Hurn and Lindsay (2004), a Taylor expansion around a steady-state implies a linear Equilibrium Correction representation. That means that cointegrated restrictions could be exploited rather than Hodrick-Prescott filtered data, as is the common practise. Second, it is now possible to estimate and solve these models in their original non-linear specifications. It will therefore be interesting to see how well these models can do in forecasting compared to more traditional linear econometric models. Since financial instabilities and bubbles have clearly non-linear features, this is a very interesting and relevant research area for the issues at hand.

We will now discuss one particular model within this model class in more detail.

- Bernanke, Gertler, Gilchrist (1999), The financial accelerator in a quantitative business cycle framework

Summary

This model belongs to the category of representative agent models with asymmetric information. It is a DSGE model. The main contribution of this paper is that a relationship between a financial variable and firms' investments is analysed within a general equilibrium framework. The model determines the incentive compatible contract and firms' investments.

Bernanke, Gertler, Gilchrist (1999), develop a new Keynesian model. The authors need both a real and a nominal rigidity to get a relationship between a financial variable (firms' net worth[10]) and investment. They incorporate a partial equilibrium model of the credit market (similar to the one developed by Bernanke and Gertler (1989)) into a standard dynamic new Keynesian framework with monopolistic competition and price stickiness. The model includes a government sector, whose monetary policy rule sets the current nominal short-term interest rate.

There is a credit market imperfection due to asymmetry of information on the realisation of an idiosyncratic shock to the gross return to capital (privately observable only by entrepreneurs). To avoid moral hazard, the intermediaries monitor borrowers at a cost and write incentive-compatible contracts, i.e. contracts that induce borrowers to reveal the true impact of any shock on the return on capital.

The optimal contract in the credit market resembles a debt contract consisting of a pair of the loan rate and a threshold level for the idiosyncratic shock. If the realisation of the shock for the firm is below the threshold level, the firm goes bankrupt. In this case, the intermediaries monitor the outcome of the random return to firm's capital and get the firm's residual equity. If, on the other hand, the realisation of the shock for the firm is above the threshold level, the firm pays the agreed rate per unit of loan to the lender and keeps the residual return. The equilibrium in the credit market is characterised by a level of capital investment and by a loan contract. Firms' demand for investment is a function of their net worth. The channel through which the financial position of firms affects their investment decision is as follows: the default cost of capital financing is an increasing function of the ratio of firms' borrowing to net worth. In other words, the external finance premium depends inversely on firms' net worth

[10] The net worth is defined as the difference between total assets and total liabilities.

since the more that firms need to borrow (the less their net worth), the higher is the loan rate and thus the likelihood that they will not be able to repay their debt.

To characterise the equilibrium for the economy, the credit market partial equilibrium is embedded in a general equilibrium framework. The variables that were taken as given in finding the optimal loan contract in the credit market are now determined by considering the other sectors of the economy and their optimal choices (with households maximising expected utility and retailers and firms maximising expected profits).

Movements in asset prices are the main source of changes in the return to capital and affect the value of the entrepreneurs' net worth. Movements in asset prices may be a result, *inter alia*, of changes in monetary policy. A decrease in the short-term interest rate raises asset prices and therefore the entrepreneurs' net worth. This, in turn, reduces the external finance premium and boosts investment and output more than through the traditional monetary transmission mechanism.

Comments

1. It is a general equilibrium model with a costly state verification feature *à la* Townsend (1979). The `classical dichotomy' is broken by assuming asymmetric information in the credit market and sticky prices in the goods market.
2. Monetary policy has an impact on the real economy through the balance sheets of the borrowers, i.e., through a financial accelerator mechanism.
3. Banks' only source of funding is deposits and they are risk-free by construction. Therefore, there is no possibility for banks to go bankrupt, and no straightforward way of introducing supervisory policy or market discipline.
4. The entrepreneurs are assumed to be bank-dependent, since they are not allowed to collect external funds in other financial markets.
5. The high degree of aggregation and the associated lack of genuine heterogeneity, prevent this model from being suitable for welfare analysis and for analysing distributional effects of policy changes.
6. Equilibrium outcomes are constrained efficient, i.e., a second best allocation is achieved. Thus, liquidity and capital requirement regulation cannot be assessed in this class of models.

7. The banking sector is rudimentary without a fully active role, e.g., without diverse portfolio management and credit extension, and there is no representation of intermediate default levels.

8. The model can be calibrated fairly easily. However, an extension to incorporate a fully fledged banking sector is analytically demanding due the difficulty of embedding the partial equilibrium solution of the credit market to the general equilibrium framework. Put differently, it is cumbersome to extend it to a fully fledged general equilibrium model.

Overlapping generation (OLG) models

We will base our discussion of this model class on the following contributions:

- Azariadis and Smith (1993), Reichling and Siconolfi (2002), Zicchino (2002)

Summary

These models are overlapping generation models with asymmetric information. Their main contribution is that economies with different initial levels of aggregate wealth may converge to steady states characterised by either a low or high level of capital accumulation and by different financial systems. Assuming that lenders' preferences are represented by a utility function with decreasing relative risk aversion, the economy may experience output fluctuations, with contractions. They may involve a sharp decline in the interest rate on savings deposits, an increase in credit rationing and the inactivity of the stock market.

This class of models analyses the effects of moral hazard arising from asymmetric information in the credit market on both short-run (business cycle) and long-run (growth) macroeconomic phenomena. This is done by embedding the Stiglitz and Weiss (1981) model of credit rationing in an overlapping generations model with production.

Capital investment is externally financed by savers, either directly, through claims on firms' profits, or through banks. Asymmetric information on the firms' investment choices gives rise to a moral hazard problem. As a consequence, the loan contracts offered by banks must be incentive compatible. To keep the analysis simple, it is assumed that two investment technologies are available to firms: a "good" one and a "bad" one. The second technology is characterised by both a lower probability of success and by a lower expected marginal productivity than the first one. The moral hazard problem is due to the possibility that firms may undertake the bad investment project, thus reducing capital formation and therefore the level of real activity relative to what would have occurred under full information.

Individuals live for two periods but consume only in the second one. In order to transfer their wealth across time, individuals can invest directly in one firm and get the return on the shares they buy, or they can deposit their endowment in a bank and receive a risk-free return. Banks use the funds they collect from individuals to finance firms. They can spread the risks of the investment projects in the same way insurance companies spread the risks of individual accidents over a large number of policyholders. Under the hypothesis of a perfectly competitive credit market, banks will make zero profits by offering a return on deposits equal to the return on their loan portfolio.

This economy can be characterised by two different competitive equilibria. In one case, firms adopt the good technology and individuals optimally allocate their savings between a risk-free asset (bank deposit) and a risky asset (firms' shares). The other possible equilibrium entails the disappearance of the stock market. Firms choose the risky investment project and individuals deposit all their savings, since the risk-free return they receive from a bank dominates the return on firms' shares. The key feature of this model is that one of the two equilibria can prevail depending on the level of loanable funds.

To conclude, these papers (e.g. Zicchino (2002)) provide an explanation of the evolution of the financial system along the economy's growth path. The financial system develops from a simple one, where the only intermediaries are banks, to a more complex one, characterised by a market for firms' shares. The paper also provides an explanation of output fluctuations, which are endogenously generated in the presence of asymmetrically distributed information.

Comments

1. This is a dynamic general equilibrium model with asymmetric information between borrowers and lenders which gives rise to moral hazard.
2. As in the Bernanke, Gertler, Gilchrist (1999) (B-G-G) model, banks fund entrepreneurs by collecting deposits. Thus, there is no role for banks' financial structure in the amplification and transmission of macroeconomic shocks.
3. Differently from B-G-G, output cycles are endogenous and not a result of changes in the monetary policy or exogenous shocks to the macroeconomy.

4. The model includes production, which implies that the relationship between credit markets and output growth can be analysed.
5. Households are not only depositors. They can also allocate their savings in the stock market.
6. The banking sector is rudimentary without a fully active role, e.g., without diverse portfolio management and credit extension, and intermediate defaults can not occur.
7. It is difficult to incorporate heterogeneous banks and study their interaction through the interbank market.

Finite horizon general equilibrium (FHGE) models

We will base our discussion of this model class on the following contributions:

- Goodhart, Sunirand and Tsomocos (2004, 2005, 2006 a, b), Tsomocos (2003 a, b)

Summary

The main contribution of this framework is that financial fragility emerges as an equilibrium phenomenon, and therefore there is a role for active policy for crisis prevention and management. In addition, since a monetary sector is incorporated, the interaction of both monetary and regulatory policies can be assessed. In principle, their welfare effects can be measured. It provides a highly flexible framework that can conveniently be adjusted to answer specific policy questions and conduct scenario analysis for various risks in the banking system.

The model is based on the work by Tsomocos (2003 a, b). It incorporates heterogeneous banks and capital requirements in a general equilibrium model with incomplete markets, money and default. The model extends over two periods[11] and all uncertainty is resolved in the second period. Trade takes place in both periods in the goods and equity markets. In the first period agents also borrow from, or deposit money with banks, mainly to achieve a preferred time path for consumption. To smooth out their individual portfolio positions, banks also trade amongst themselves. The central bank intervenes in the interbank market to change the money supply and thereby determines the official interest rate.[12] Capital adequacy requirements (CARs) on banks are set by a regulator, who may, or may not, also be the

[11] Any finite horizon extension follows *mutatis mutandis*.
[12] The official rate and the rate in the interbank market are the same, since our focus is on financial fragility.

central bank. Penalties on violations of CARs, and on the default of any borrower, are in force in both periods. In order to achieve formal completeness for the model, banks are liquidated at the end of the second period and their profits and assets distributed to shareholders.

In the first period, trades by all agents take place against a background of uncertainty about the economic conditions (the state of nature) that will prevail in the second period. Agents are, however, assumed to have rational expectations, and to have subjective probabilities when they make their choices in period one. In period two, the actual economic conjuncture (the state of nature) is revealed and all uncertainty is resolved.

The model incorporates a number of distinct, i.e. heterogeneous, commercial banks, each characterised by a unique risk/return preference and different initial capital. Since each bank is, and is perceived as being, different, it follows that there is not a single market for either bank loans or bank deposits. In addition, in Goodhart, Sunirand and Tsomocos (2004, 2005, 2006 a, b), limited access is introduced to consumer credit markets, with each household assigned (by history and custom) to borrow from a predetermined bank. This feature allows for different interest rates across the commercial banking sector.[13] In sum, multiple credit and deposit markets lead to different loan rates among various banks and to endogenous credit spreads between loan and deposit rates.

Individual non-bank agents are also assumed to differ in their risk attitudes and hence in their preferences for default. We model the incentive for avoiding default by penalising agents and banks proportionately to the size of default. Banks that violate their capital adequacy constraint are also penalised in proportion to the shortfall of capital.[14] Both banks and households are allowed to default on their financial obligations, but not on commodity deliveries.

In the model, financial fragility is taken to include any private sector defaults and reduced bank profitability, and, therefore, it is not limited to episodes of bank runs, panics and other extreme disruptions of the financial system. The presence of a secondary market for bank equity also allows us to investigate how a fall in bank equity values would affect financial fragility. Our definition of financial fragility is connected to welfare losses, liquidity shortages

[13] We assume, however, that there is a single interest rate that clears the interbank market.
[14] This way of dealing with default was first introduced by Shubik and Wilson (1977). For further discussion of approaches to modelling default, see Tsomocos and Zicchino (2005).

and the banking sector's vulnerability to default. Among other consequences, financial fragility may impair the efficient allocation of savings to financial investments and thus the ability of households to smooth consumption.

In this model, both regulatory and monetary policies are non-neutral. This arises essentially from having incomplete financial markets and liquidity constraints. Monetary and regulatory policies influence the distribution of income and wealth among heterogeneous agents and hence have real effects. Some other main results are:

(i) the central bank controls the overall liquidity of the economy, and liquidity in addition to endogenous default risks determine interest rates;

(ii) nominal changes, i.e. changes in monetary aggregates, affect both prices and quantities;

(iii) the nominal interest rate is equal to the real interest rate plus the expected rate of inflation (Fisher effect).

Using the model for a set of comparative statics exercises, a number of implications arise. First, in an economic environment in which capital constraints are binding, more expansionary monetary policy may lead banks in some cases to adopt riskier strategies.[15] Thus expansionary policies causing 'excessive' loan expansion can lead to financial fragility. Second, agents who have more investment opportunities can deal with negative shocks more effectively by restructuring their investment portfolios expeditiously. Thus, banks with asset portfolios that are not well diversified tend to follow a countercyclical credit extension policy in the face of a tightening of regulatory standards in the loan market (e.g. tighter loan risk weights) during an economic downturn. In contrast, banks that can quickly restructure their portfolio tend to reallocate their investments away from the loan market, thus following a procyclical credit extension policy. Third, an improvement such as a positive productivity shock, which is concentrated in one part of the economy, does not necessarily improve the overall welfare and profitability of the economy. The last two insights relate to the innovative feature of the model of incorporating heterogeneous agents; banks and bank borrowers are not all alike. This has some, fairly obvious, implications. The result of a shock depends on the particular sector of the economy which is affected, and it can often shift the distribution of income, and welfare, between agents in a complex way, which is hard to predict in advance.

[15] This does not imply, in our model, that a deflationary bias is optimal. The model does not include inflation targeting, but such a regime could be approximated by maintaining money supply as fixed.

The existence of a competitive monetary equilibrium with commercial banks and default is established under certain regularity assumptions. If an equilibrium exists, then default and financial instability are equilibrium phenomena. The definition provided in this model allows for the analysis of a continuum of possible contingencies, whereas other standard definitions only consider the extreme situations of default of the entire banking sector. This means that, from a policy standpoint, intervention measures can be considered before a financial crisis occurs given that the equilibria are constrained inefficient.

A Diamond-Dybvig type of equilibrium is derived as a special case as well as a version of the liquidity trap in which monetary policy affects prices but not interest rates.

Comments

1. It is a general equilibrium model without production. It has endogenous default, i.e., the behaviour of agents in the economy depends on the level of aggregate default. It includes active and heterogeneous banks that are subject to balance sheet regulatory constraints.
2. The model is dynamic and therefore allows for the study of the effect of capital constraints on the intertemporal decision making of banks.
3. The model provides an explicit definition of financial instability, which allows for a continuum of contingencies. It is therefore possible to analyse the effect of policy measures undertaken before a financial crisis actually occurs.
4. The imperfection in the economy that breaks down the Modigliani-Miller irrelevance theorem is a cash-in-advance constraint. In other words, goods or bonds need to be purchased with cash that agents can obtain from their private endowments, or out of inventories from previous market transactions. If interest rates are positive, the necessity to have cash in order to purchase commodities and assets invalidates the `classical' dichotomy between the real and financial sectors of the economy. A liquidity constraint causes a price wedge between the selling and buying price of each good as long as interest rates and default penalties are positive. Therefore, when interest rates change, the equilibrium allocations have to change. Put differently, a change in monetary policy will change not only prices but also quantities. Thus the classical dichotomy collapses.
5. The model permits comparative statics exercises to analyse the impact of shocks to the economy.

6. It is a model of an exchange economy. We cannot analyse the relationship between financial instability and economic growth.
7. The model may be flexible enough to study other aspects related to the relationship between credit markets and the real economy, e.g., borrowers' collateral or banks' provisioning policy.
8. A limitation of the model is its difficulty to compute and calibrate.

Dynamic aggregative estimated (DAE) models

Traditionally, the prominent models in macroeconomics before the rational expectations revolution, i.e. from the late 1950s to the early 1970s, were large-scale simultaneous equation models. These models have been updated to incorporate rational expectations and are still heavily used for forecasting and policy-making by central banks around the world as well as by commercial forecasters. Recently, a class of small-scale aggregated dynamic econometric models have emerged, see e.g. Garratt et al. (2003) and Bårdsen and Nymoen (2005). These models typically pay close attention to the steady-state properties, estimated as cointegrating relationships, while theory-based cross-equation restrictions of the short-run dynamics are only imposed if they are consistent with the data. The models will then take the form of a simultaneous system in Equilibrium Correction (EqC) form. Compared to VARs, they usually contain much fewer parameters, so the associated parameter and forecasting uncertainty is much smaller. The cost of these models is usually in the interpretation of the underlying economic behaviour, being less transparent than in calibrated models, since there is usually no underlying microeconomic general equilibrium framework.

Within macroeconometric modelling, there seems to be a new synthesis emerging—see Juselius and Johansen (2005). The background is the following. Over the course of the last 10-15 years, the class of dynamic stochastic general equilibrium models (DSGEs) have formed a dominant macroeconomic paradigm—see, for example Azariadis (1993). Over the same period the estimation of stochastic difference equations in EqC form—see, for example, Hendry (1995)—has been equally well established. This is a consequence of the seminal work on cointegration by Engle and Granger (1987), where cointegration between a group of non-stationary time-series implies equilibrium correction. This generalizes the earlier error-correction framework of the stationary case, see e.g., Hendry, Pagan and Sargan (1984). Following King, Plosser and Rebelo (1988), Campell (1994) and Uhlig (1999), a DSGE model is usually solved by the use of log-linear approximations. However, Bårdsen, Hurn and Lindsay (2004) show that *any* dynamic system with a steady-state solution has a linear EqC representation. Linearizations imply EqC representations. Thus, the econometric methodology of cointegrated non-stationary systems, following Johansen (1988), provides a convenient general framework for macroeconometric modelling. From such a common framework of a steady-state stochastic growth model, one can classify the validity of alternative short-run model specifications derived from competing theories. [16]

In the wider setting of the macroeconomic methodological debate, DSGE models, built on representative agent theory, competitive markets and rational expectations theory, represent the view that macroeconometric models should be specified from microeconomic principles. According to this research program, which has won almost universal acclaim among economists, theory represents the correct specification, leaving only parameter estimation or calibration to the empirical investigator. These requirements might prove to be too strict. By that we do not mean any disagreement with the injunction to "pay attention to" the microeconomic foundations of macroeconomics, which is too sensible for anyone to wish to reject. In practice however, as noted by e.g. Hahn and Solow (1997), the convention has ascribed status and legitimacy only to models that are exact aggregation of (in general identical) agents that optimize subject only to intertemporal constraints. Until a few years back, this was true for macroeconomic theory, today the same can be said about empirical macro.

Several alternative reactions are already emerging. One alternative approach is pioneered by Del Negro and Schorfheide (2004), who combine the VARs and DSGEs in a Bayesian framework. The idea is to generate simulated data from the DSGE and add these to the actual data. The VAR is then used to find what parameters of the DSGE most at odds with the data. Recently, Del Negro et al. (2004) have used this framework to evaluate the New Keynesian model of Smets and Wouters (2003). They conclude that "even large scale DSGE models are to some extent misspecified and that relaxing some of their restrictions leads to improved empirical performance".

[16] This approach was pioneered by King et al. (1991).

Another alternative is to use a model constructed from a different, and on the face of it, heterodox set of principles. To take one example, it does seem sensible to us to make full use of game theory in modelling of wages, when it is obvious that wage formation to a large part is determined, not by households in isolation (as generally assumed by DSGEs), but by bargaining between worker's unions and firms. By `full use' we do not mean that the empirical model of wage formation is fully specified from theory, but instead that the resulting theoretical model is valid as an approximation of a steady state situation, and as an attractor that can be used in the specification of the empirical model (in EqC form). In this way, one can make sure that relevant theory is used as a guideline in the specification of a model which also accommodates institutional features, attempts to accommodate heterogeneity among agents, addresses the temporal aspects for the data set (see below), and so on, see e.g., Granger (1999).

One recent attempt along these lines in the field of monitoring financial instability is to allow for asset price effects in the model of Bårdsen and Nymoen (2001)—see also Akram et al. (2006).

The motivation is as follows: A recent view of monetary policy is that a central bank can improve macroeconomic performance by reacting to asset price changes---in addition to inflation deviations and the output gap—see e.g. Cecchetti et al. (2000), Borio and Lowe (2002) and Bordo and Jeanne (2002). The main argument is that an asset price bubble may lead to excessive investment and consumption—with corresponding negative changes when the bubble bursts. In terms of excessive variability in output and inflation, macroeconomic performance could suffer. And, as argued above, credit driven asset price bubbles are particularly disadvantageous, since they may threaten financial stability in particular and macroeconomic stability in general not only through a weakening of the debt servicing ability of debt holders when the bubble burst, but also through the effect on collateral values. A modest tightening or easing of monetary policy when asset prices rise above or below sustainable levels may help to smooth fluctuations in output, inflation and the financial system. It might also reduce the possibility of an asset price bubble forming in the first place. Hence, several authors argue that monetary policy makers should use asset prices not only as a part of their information set to assess future inflation, but also to let interest rates partly offset deviations of asset prices from their sustainable equilibrium levels, see e.g. Chadha et al. (2004).

The main argument for the traditional view---that interest rates should be set in response to inflation and the output gap only---is also straightforward: Not only are asset prices quite volatile, but asset price misalignments are also hard to identify. The end result could therefore be an overactive monetary policy that may prove to be destabilizing rather than stabilizing. The central bank should therefore react indirectly to asset price changes—by responding to their effects on inflation and output, see e.g. Bernanke and Gertler (2001) and Bean (2003). For example, exchange rates may have direct effects on inflation through imported inflation, while housing and equity prices may affect inflation and output through their effects on credit growth, aggregate consumption and investment.

This brings us directly to the role of macroeconometric models. The two positions on the role of asset prices in monetary policy have mostly been framed and analysed within the framework of calibrated or stylized models with strong theoretical foundations, see e.g. Ball (1999), Batini and Haldane (1999), Svensson (2000), Walsh (1999), and Woodford (2000). Such models are not necessarily well-suited for the problem at hand. First, they do not seem readily able to analyse effects of state dependent or large shocks caused by e.g. asset price fluctuations. Second, the impact of asset price volatility on the economy is economy-specific, by its very nature, and is therefore more appropriately investigated within an empirical framework. Furthermore, these models are in general not designed to analyse the explicit role of credit in the economy, since credit effects are implicitly captured by interest rate effects. With imperfections in financial markets, however, additional credit effects may well be present. From a financial stability perspective, it is therefore of interest to explicitly analyse credit effects within a macroeconometric model.

In the following, we will focus on a small macroeconometric model that is under development for financial stability analysis.

- Bårdsen and Nymoen (2001), Akram et al. (2006)

Summary

This is a small macroeconometric model for the Norwegian economy initially set up to represent the key inflation mechanisms. The extended model is designed to evaluate the interplay of financial stability and monetary policy. In the present model, variables that are generally highlighted in financial stability analysis and assessment of financial fragility are fully integrated and linked to macroeconomic conditions. In addition, the model includes a credit channel effect that also represents rigidities in financial markets.

The original model presented a first attempt at a small, yet fully articulate, model of wage and price inflation in the Norwegian economy and was designed to represent the key inflation mechanisms over a monetary policy horizon of to 3-5 years. The starting point of the extended model is that, at a minimum, house prices, household credit and the bankruptcy ratio of domestic firms should be considered jointly with exchange rate movements, foreign and domestic aspects of inflation and the impetus from the labour market---the battle of mark-ups between unions and monopolistic firms, when evaluating the interplay of financial stability and monetary policy. The main properties of the model are shown in Figure **2**. The policy instrument in the model is the money market interest rate, symbolized by i in the figure.[17] Other policy instruments, such as regulation, are not explicitly represented in this model.

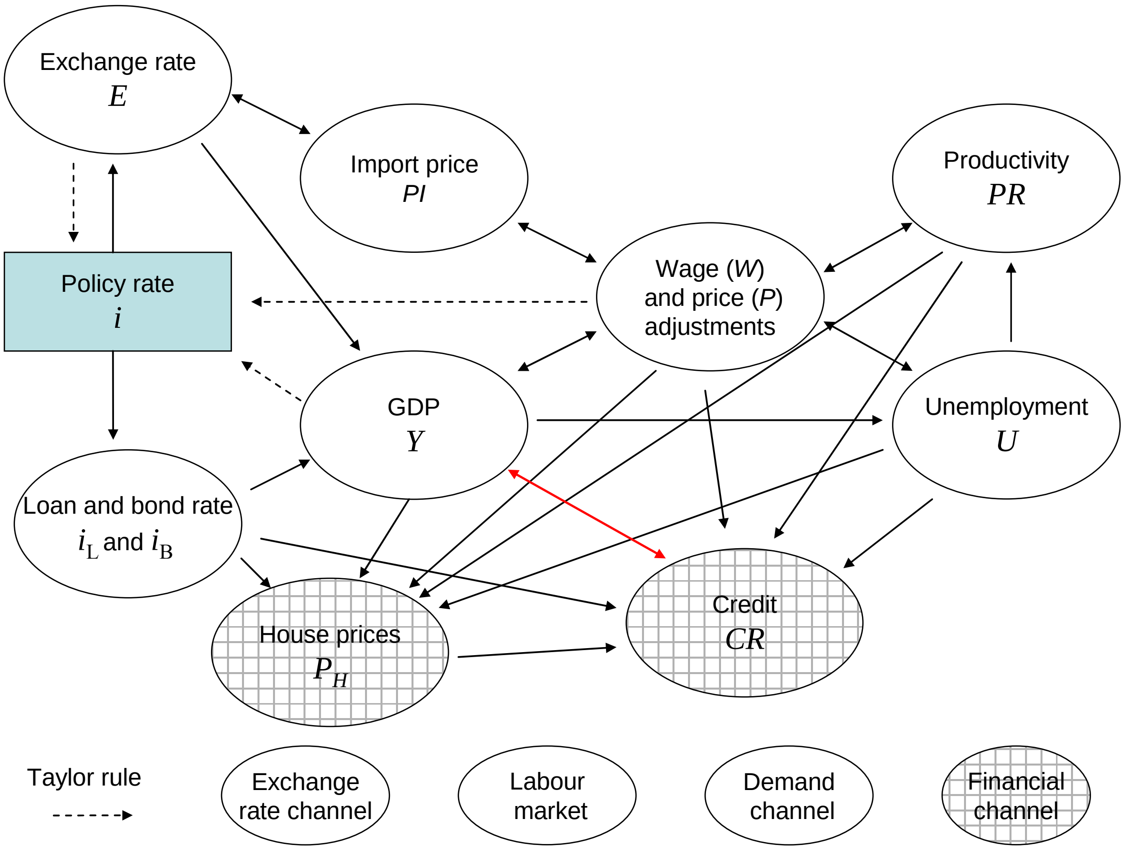
The figure shows the transmission mechanisms that are embedded in the model. Consider for example a decrease in the policy interest rate, i. The immediate and direct effect is a depreciation of the krone, measured as an increase in the exchange rate, V, defined as kroner per unit foreign exchange[18]. The increase in V will affect domestic price and wage setting through increased import prices, P_I. Hence, at least for a period of time after the interest rate cut, the *exchange rate channel* will provide inflation impetus following a cut in the interest rate. However, for the exchange rate channel to fuel inflation over a period of time, the initial jump in V is not enough. Instead, a higher rate of depreciation is required, lasting through several periods after the policy change. If the nominal exchange rate is a simple function of the interest rate, a prolonged period of depreciation must be put down to de-stabilizing expectations. However, in a multi-dimensional model, which also takes into account that a purchasing power parity (PPP) mechanism is at work in the medium run, unstable nominal exchange rate dynamics follows logically.

[17]In practice, the policy instrument is the sight deposit rate set by the Central Bank, but since the sight deposit rate represents (banks') marginal funding cost, changes in the sight rate are transmitted to the money market rate immediately.
[18]The size of the depreciation will depend upon the risk premium, whether expectations counteract or strengthen the initial effect of the interest rate cut, and so forth.

The exchange rate channel also affects wages and prices indirectly, through GDP, Y, and unemployment, U. The mechanism is as follows. Due to sticky prices, also the real exchange rate depreciates when the nominal rate depreciates. This improves domestic firms' competitiveness, and the result is increased output and reduced unemployment, and hence, for a period, increased price and wage inflation. Improved competitiveness reduces the bankruptcy rate of domestic firms, and hence, at the aggregate, increases their debt servicing ability. This is highly relevant for the assessment of financial stability, since banks' credit risk is strongly linked to firms' debt servicing ability.

The interest rate effects on the real economy are first channelled through financial markets, where a cut in the money market rate leads to adjustment of the banks' interest rate, i_L, and the bond yield, i_B. A rise in i_L affects GDP through an increase in the real interest rate. This is the *demand channel* found in mainstream monetary policy models, see e.g., Ball (1999).

Figure 2. Monetary policy channels of the small macroeconometric model



In addition to the monetary policy effect on competitiveness and firms' debt servicing ability, the *credit channel* is of major interest in the present discussion. Through this channel. interest rates affect both house prices, P_H, and households' real credit demand, *CR*, directly and indirectly. The relationships in the model builds directly on Jacobsen and Naug (2004, 2005), whose motivation was the interrelationship between housing prices and household debt as a possible cause of financial instability. To cite Jacobsen and Naug (2004): "If there is a price bubble in the housing market, prices may fall sharply if price expectations change. Prices may show a particularly sharp decline if price expectations change as a result of a change in fundamentals. In this case, banks may experience that the value of the collateral falls below the value of the loan and that households increasingly have difficulty repaying (very high) debt. This can, as described above, lead to an economic downturn."

In addition to the housing stock, Jacobsen and Naug (2004, 2005) identify aggregate income, banks' lending rates and the unemployment rate as fundamentals of the housing price.

Household debt is mainly driven by the same variables, in addition to house prices. All of these variables are in their turn affected by monetary policy in the model, as shown in the flowchart. The model set-up is therefore well suited to investigate whether a central bank can improve macroeconomic performance by reacting to asset price changes---in addition to inflation deviations and the output gap. This is the question investigated by Akram et al. (2006). They use a version of the model with a simpler specification of the credit channel, but the model is richer in the sense that they in addition model financial assets in the form of demand for equities. Their results are that the quality of monetary policy could be enhanced, in the sense of less volatility in inflation and output growth, by including asset prices, but not the exchange rate, in the monetary policy rule. These results reflect the dynamic structure of the economy, and the general lesson to learn is that policy efficiency can be improved if the policy maker reacts to early changes in the drivers of the target variables and not only the target variables themselves when delayed effects are present. Furthermore, although these results are model specific and country specific, it is a clear indication that financial stability considerations could be important—at least in Norway.

A simple indicator for financial stability that resembles the definition in Goodhart et al (2004, 2005, 2006 a,b) and Tsomocos (2003 a,b), as discussed in Section 2, can be included. This model does not explicitly include banks, but the probability of default by economic agents, including banks, and banks' profitability, can be represented by borrowers debt servicing abilities, i.e. the bankruptcy ratio of firms and households' debt burden. Furthermore, one may argue that house prices, reflecting collateral values and hence losses given default, also should be part of a financial stability indicator. In situations with price-misalignments, or more precise an overvaluation, in the housing market, financial fragility increases as house prices increase.

Vector autoregressions (VARs and SVARs)

Where calibrated models emphasize theory replication, VARs emphasize data replication. VARs were introduced by Sims (1980) to overcome "incredible" restrictions, and became very popular, in particular in forecasting, but they are also used for policy analysis. However, the need for structure soon prompted the need for restricted versions, structural VARs (SVARs), where restrictions are put on the distribution of the residuals of the system to identify shocks and their transmission mechanisms in the form of impulse responses. These models still remain at the forefront of empirical modelling, in particular coupled with Bayesian estimation methods. For example, a BVAR model (a VAR with Bayesian priors) is used for forecasting at the Swedish Riksbank. However, since financial instability definitions must rely heavily on identification of structure and imbalances, we find this model class relatively less interesting for analysis of the issues under investigation.

5 Conclusion

As financial stability has gained focus in economic policymaking, the demand for analyses of financial stability and the consequences of economic policy has increased. Alternative macroeconomic models are available for policy analyses, and in this paper we evaluate the usefulness of some models from the perspective of financial stability.

The ideal characteristics of such a model are discussed, but a model that satisfies all needs and wishes would be extremely complicated. Among the ideal characteristics are contagious interaction among financial institutions, default, missing financial markets, banks, liquidity, heterogeneous agents, structural micro-foundations, macroeconomic conditions, the model should be used for forecasting and policy analysis and as a testing device.

It is infeasible to summarise all existing models, so, instead, a superficial presentation of different classes of macroeconomic models is given, and only a few models are discussed in detail. We particularly pay attention to the finite horizon general equilibrium (FHGE) model of Goodhart et al. (2004, 2005, 2006 a, b) and Tsomocos (2003 a, b) and the dynamic aggregative estimated (DAE) model of Bårdsen and Nymoen (2001) and Akram et al. (2006).

Financial stability analysis is complicated by the lack of a clear and consensus definition of ‘financial stability’. The paper therefore discusses alternative definitions of this term. It is argued that, ideally, the definition of financial stability should hinge upon welfare effects on the economy and distributional consequences arising during periods of financial instability. A combination of probability of default – variously measured – of both banks as well as economic agents together with bank profitability, should be used to characterize financially unstable (fragile) regimes of the economy. This has the advantage that it can be applied at both individual and aggregate levels, and, also, that financial stability can be studied in the continuum rather than merely as an extreme and discontinuous phenomenon. However, few macro models have been designed consistently with this definition (see, however, Goodhart et al. (2004, 2005, 2006 a,b) and Tsomocos (2003 a, b)), and the paper concludes that, in general, one must expect operational definitions of financial stability to vary across alternative models.

In sum, since assessment of financial stability in general is based on a wide range of risk factors, one can not expect one single model to satisfactorily capture all the risk factors. Rather, a suite of models is needed. This is in particular true for the evaluation of risk factors originating and developing inside and outside the financial system respectively.

References

Akram, Q.F., G. Bårdsen and Ø. Eitrheim (2006), 'Monetary policy and asset prices: To respond or not?', *International Journal of Finance and Economics*, forthcoming.

Allen, W.A. and G. Wood (2005), 'Defining and Achieving Financial Stability', *Journal of Financial Stability*, forthcoming

Azariadis, C. (1993), *Intertemporal Macroeconomics*, Blackwell Publishers.

Azariadis, C. and B. Smith (1993), 'Adverse Selection in the overlapping generations model: the case of Pure Exchange', *Journal of Economic Theory*, 60, 227-305.

Ball, L. (1999), 'Policy Rules for Open Economies', in Taylor, J. B. (ed.), *Monetary Policy Rules*, A National Bureau of Economic Research Conference Report, 127–144. University of Chicago Press, Chicago.

Bank for International Settlements (1998), 'Implications of structural change for the nature of systemic risk', Basel, Switzerland.

Batini, N. and A. G. Haldane (1999), 'Forward-looking rules for monetary policy', in Taylor, J. B. (ed.), *Monetary Policy Rules*, A National Bureau of Economic Research Conference Report, 157–192. University of Chicago Press, Chicago.

Bean, C. (2003), 'Asset prices, financial imbalances and monetary policy: Are inflation targets enough?', BIS Working Papers No. 140, Basel: BIS.

Bernanke B. and M. Gertler (1989), 'Agency costs, net worth and business fluctuations', American Economic Review, 79, 14-31.

Bernanke, B. S. and M. Gertler (2001), 'Should central banks respond to movements in asset prices?', *American Economic Review*, 91, 253–7.

Bernanke, B, M. Gertler and S. Gilchrist (1999), 'The financial accelerator in a quantitative business cycle framework', in: Taylor, J B and M. Woodford (editors), *Handbook of Macroeconomics*, Amsterdam: Elsevier Science.

Blum, J and M. Hellwig (1995), 'The macroeconomic consequences of capital adequacy requirements for banks', *European Economic Review*, 39, 739–49.

Bordo, M. and O. Jeanne (2002), 'Boom-busts in asset prices, economic instability and monetary policy', Discussion paper 3398, CEPR.

Bårdsen, G., S. Hurn and K. Lindsay (2004), 'Linearizations and equilibrium correction models', *Studies in Nonlinear Dynamics and Econometrics*, **8**(4), article 5.

Bårdsen, G. and R. Nymoen (2001), ‘Rente og inflasjon (Interest Rate and Inflation)’, *Norsk Økonomisk Tidsskrift*, 115, 125-48.

Bårdsen, G. and R. Nymoen (2005), ‘A Norwegian Econometric Model for Medium Term Analyses’, Working paper.

Campbell, J. (1994), ‘Inspecting the mechanism: an analytical approach to the stochastic growth model’, *Journal of Monetary Economics*, 33, 463-506.

Cecchetti, S. G., H. Genberg, J. Lipsky and S. Wadhwani (2000), ‘Asset prices and central bank policy’, *Geneva Reports on the World Economy 2*, International Centre for Monetary and Banking Studies and CEPR.

Chadha, J., L. Sarno and G. Valente (2004). ‘Monetary policy rules, asset prices and exchange rates’, *International Monetary Fund Staff Papers*, 51 , 529–52.

Chami, R. and T. F. Cosimano (2001), ‘Monetary policy with a touch of Basel’, IMF WP/01/151.

Crockett, A (1997), ‘Maintaining financial stability in a global economy’, in *Federal Reserve Bank of Kansas City’s Symposium*, Jackson Hole, Wyoming, 28-30 August.

Del Negro, M. and F. Shorfheide (2004), ‘Priors from General Equilibrium Models for VARs’, *International Economic Review*, 45, 643-673.

Del Negro, M., F. Schorfheide, F. Smets and R. Wouters (2004), ‘On the Fit and Forecasting Performance of New-generation New-Keynesian Models’, Working Paper 2004-37, Federal Reserve Bank of Atlanta.

Engle, R. and C. Granger (1987), ‘Co-integration and Error Correction: Representation, Estimation, and Testing’, *Econometrica,* 55, 251-276.

Foot, M., (2003), ‘Protecting Financial Stability-How good are we at it?’, speech given at University of Birmingham , June 6, 2003.

Garratt, A., K. Lee, M.H. Pesaran and Y. Shin (2003), ‘A Long run structural macroeconometric model of the UK’, *Economic Journal*, 113, 412-55.

Geanakoplos, J.D. and H. M. Polemarchakis (1986), ‘Existence, Regularity and Constrained Suboptimality of Competitive Aloocations whe the Asset Market is Incomplete’, In *Essays in Honor of K. Arrow*, Vol. III, edited by W. Heller, and D. Starret, Cambridge, U.K.: Cambridge University Press.

Goodhart, C.A.E. (1975), ‘Problems in monetary management: the U.K. experience’, in: Courakis, A.S., *Inflation, Depression and Economic Policy in the West*, Totowa, N.J.: Barnes and Nobles, 1981.

Goodhart, C.A.E., ‘Some New Directions for Financial Stability?’ Per Jacobsson Lecture (delivered at Zurich University on 27 June 2004 as part of the

Annual General Meeting weekend of the Bank for International Settlements).

Goodhart, C.A.E., P. Sunirand and D.P. Tsomocos (2004), 'A Model to Analyse Financial Fragility: Applications', *Journal of Financial Stability*, 1, 1-35.

Goodhart, C.A.E., P. Sunirand and D.P. Tsomocos (2005), 'A Risk Assessment Model for Banks', , *Annals of Finance*, 1, 197-224.

Goodhart, C.A.E., P. Sunirand and D.P. Tsomocos (2006 a), 'A Model to Analyse Financial Fragility', *Economic Theory*, 27, 107-142.

Goodhart, C.A.E., P. Sunirand and D.P. Tsomocos (2006 b), 'A Time Series Analysis of Financial Fragility in the UK Banking System', *Annals of Finance*, 2, 1-21.

Granger, C.W.J. (1999), *Empirical Modeling in Economics. Specification and Evaluation*, Cambridge University Press, Cambridge.

Hahn, F., and R. Solow, (1997), *A Critical Essay on Modern Macroeconomic Theory*, MIT Press, Cambridge.

Haldane A., S. Hall, V. Saporta and M. Tanaka (2004), 'Financial stability and macroeconomic models', Bank of England *Financial Stability Review,* June, 80-88.

Hendry, D.F. (1995), *Dynamic Econometrics*, Oxford University Press, Oxford.

Hendry, D., A. Pagan and J. Sargan (1984), 'Dynamic Specification', in Z. Griliches and M.D. Intriligator (eds.), *Handbook of Econometrics*, Elsevier, Amsterdam.

Issing, O. (2003), 'Monetary and Financial Stability: Is there a Trade-off?', paper delivered to Conference on 'Monetary Stability, Financial Stability and the Business Cycle', Bank for International Settlements, Basel, March 28-29, 2003.

Jacobsen, D. H. and B. Naug (2004), 'What influences the growth of household debt?', *Economic Bulletin*, No. 3-04, 103-11, Norges Bank.

Jacobsen, D. H. and B. Naug (2005), 'What drives house prices?', *Economic Bulletin*, No. 1-05, 29-41, Norges Bank.

Johansen, S. (1988), 'Statistical Analysis of Cointegration Vectors', *Journal of Economic Dynamics and Control,* 12, 231-254.

Juselius, K. and S. Johansen (2005), 'Extracting information from the data: A Popperian view on empirical macro', in D. Colander (ed.), *Post Walrasian Macroeconomics: Beyond the Dynamic Stochastic General Equilibrium Model*, Cambridge University Press.

King, R., C. Plosser and S. Rebelo (1988), 'Production, Growth and Business Cycles: The Basic Neoclassical Model', *Journal of Monetary Economics*, 21, 196—232.

King, R., C. Plosser, J. Stock and M. Watson (1991), 'Stochastic Trends and Economic Fluctuations', *American Economic Review*, 81, 819-40.

Lucas, R.E. (1976), 'Econometric policy evaluation: a critique', *Carnegie-Rochester Series on Public Policy*, 1, 19-46.

Mishkin, F.S. (1994), 'Global financial instability: framework, events, issues', *Journal of Economic Perspectives*, 13, 3-25.

Minsky, H. (1978), 'The Financial Instability Hypothesis: A restatement', *Thames Papers on Political Economy*.

Pagan, A. (2003), 'Report on Modelling and Forecasting at the Bank of England'. *Bank of England Quarterly Bulletin*, Spring, 1-29.

Reichlin P. and P. Siconolfi (2002), 'Optimal debt contract and moral hazard along the business cycle', manuscript.

Rochet, J. C., J.P. Decamps and B. Roger (2002), 'The Three Pillars of Basel II: Optimizing the Mix in a Continuous-Time Model', manuscript.

Schwartz, A. (1986), 'Real and Pseudo Financial Crises'. In: Capie, F.H., G.E. Wood (Eds), *Financial Crises and the World Banking System*, 11 – 31. Macmillan, London.

Shubik, M. and C. Wilson (1977), 'The Optimal Bankruptcy Rule in a Trading Economy Using Fiat Money', *Journal of Economics*, 37, 337-354.

Sims, C.A. (1980), 'Macroeconomics and Reality', *Econometrica*, 48, 1-48.

Smets, F. and R. Wouters (2003), 'An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area', *Journal of the European Economic Association*, 1, 1123-75.

Stiglitz, J. and A. Weiss (1981), 'Credit Rationing with Imperfect Information', *American Econommic Review*, 71, 393-410.

Svensson, L.E.O. (2000), 'Open economy inflation targeting'. *Journal of International Economics*, 50, 155–83.

Townsend, R.M., (1979), 'Optimal Contracts and Competitive Markets with Costly State Verification', *Journal of Economic Theory*, 21, 265-293.

Tsomocos, D.P. (2003), 'Equilibrium Analysis, Banking, and Financial Instability', *Journal of Mathematical Economics*, 39, pp. 619-655.

Tsomocos, D.P. (2003), 'Equilibrium Analysis, Banking, Contagion and Financial Fragility', *Bank of England W.P. Series* #175. (Also, *Greek Economic Review*, 23(1), 2004.)

Tsomocos, D.P. and L. Zicchino (2005), 'On modelling endogenous default', *Oxford Financial Research Working Paper #15.*

Uhlig, H. (1999), 'A toolkit for analysing nonlinear dynamic stochastic models easily'. In Marimon, R. and A. Scott (eds.), *Computational Methods for the Study of Dynamic Economies*, Oxford University Press, Oxford, 30-61.

Walsh, C.E. (1999), 'Monetary policy trade-offs in the open economy', mimeo.

Woodford, M. (2000), 'Pitfalls of forward-looking monetary policy', *American Economic Review*, 90, 100–4.

Zicchino, L., (2002), 'Models of Bank Behaviour and the Macroeconomy', manuscript, Bank of England.

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