Credit demand, credit supply, and the business cycle

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Introduction: Economists often find it hard to identify demand and supply movements in a market separately. This also applies to the case of the market for credit: When aggregate measures of credit are seen to increase during an economic boom, is it then mainly driven by borrowers' demand for more credit to finance higher levels of consumption and investment, or mainly due to lenders' increased willingness to supply larger amounts of credit to wealthier borrowers with more profitable projects? If policymakers find that, e.g., credit growth is excessive, it is important to identify the source in order to provide the adequate policy response. An obvious example is the credit growth observed in many developed countries up until the financial crisis of 2007-09. Many posit that this was an important impetus to booming housing markets, and to the severity of the ensuing recession. Few, however, have attempted to disentangle, and quantify, the underlying factors behind such a credit-driven boom-bust cycle in a macroeconomic general-equilibrium framework. Was it supply or demand or some combination? The present project aims at shedding light on this issue.

A recent empirical study by Bassett *et al*. (2014) is particularly helpful in this respect, as it combines evidence from lending surveys by the US Federal Reserve with macroeconomic and bank-specific factors to construct an empirical measure of shocks to credit supply in the US during 1991-2012. We intend to adopt this time-series measure, along with other macroeconomic variables, in an estimation of a so-called Dynamic Stochastic General Equilibrium (DSGE) model of the macroeconomy. This will enable us to improve the empirical validity of this class of models by allowing for separate identification of shocks to credit demand and credit supply. Since these shocks have different implications for macroprudential policy, this distinction is a crucial step in developing DSGE models that may be readily used for policy purposes.

Policy Relevance: The policy relevance of the project is twofold: First, shocks to credit demand and credit supply have significantly different implications for macroprudential and regulatory policies. If shocks to credit demand emerge as key drivers of macroeconomic fluctuations, this suggests that macroprudential policies should focus on limiting the ability of (certain types of) households and firms to transform increases in the price of houses or other assets into additional credit availability during a boom. If instead credit supply shocks are more prevalent, regulatory efforts could include countercyclical loan-to-value ratios, which may potentially offset such shocks. Correct identification of credit-market shocks are thus essential for the design of appropriate macroprudential policies.

Second, at a more general level, DSGE models are increasingly used as the standard workhorse macroeconomic model not only in academic journals, but also at policy institutions in many countries. In recent years, Danmarks Nationalbank and the Danish Ministry of Finance have used DSGE models for various policy analyses. Our project helps to ensure that the development of DSGE models takes place also in a Danish context, and that DSGE-based policy implications are disseminated through the Danish economic environment; including policymakers, practitioners, and economics students.

Project description: As described above, the purpose of this project is to use the time-series measure of credit conditions produced by Bassett *et al*. (2014) in the estimation of a macroeconomic DSGE model of the US economy. Such models are usually estimated using Bayesian statistical techniques in order to obtain identification of the parameters *and* the shock processes of the model, despite typically using a relatively low number of macroeconomic data series. Estimated DSGE models have become popular in recent years, as they allow the researcher to investigate which types of economic shocks have played an important role during specific historical episodes. In a nutshell, a high degree of explanatory power is assigned to those shocks that are able to generate the observed comovement between the set of macroeconomic time series included in the estimation during the sample period. This makes the choice of sample period and, especially, of observable macroeconomic time series very important.

A case in point, and an important part of the motivation for the current project, is the estimated model presented by Liu *et al*. (2013). They find that a so-called "housing preference shock" was an important driver of the boom and bust in US GDP during the last decade. A housing preference (or housing demand) shock changes the relative weight attached to housing relative to non-durable consumption and leisure in the utility function of households. Liu *et al*. (2013) find this shock to be quantitatively important, as it is the only shock in their model capable of generating the strong, positive comovement between house prices and output observed in US data. However, a recent study by Pinter (2014) calls this conclusion into doubt on two grounds. First, he questions the empirical identification of the housing preference shock, and argues that this shock is barely distinguishable from a credit supply shock. Second, he shows that the estimation of Liu *et al*. (2013) implies an empirically implausible series of credit supply shocks. For example, this series – which may be interpreted as a measure of credit standards – did not exert any significant, negative contribution to output and investment during the periods 1990-91 and 2008-09, when credit conditions are generally believed to have had a strong, negative impact on the US economy. This is because no measure of credit conditions as such is included in the set of observable macroeconomic variables used for the estimation.

While credit standards are notoriously difficult to measure, Bassett *et al*. (2014) have produced a reliable time-series indicator of changes in bank lending conditions in the US during the period 1991-2012. They use the so-called *Senior Loan Officer Opinion Survey on Bank Lending Practices*

conducted on a quarterly basis by the US Federal Reserve. In this survey, individual banks are asked about the changes in lending conditions applied by each bank over the last three months. The contribution of Bassett *et al*. (2014) is to construct and estimate a model of changes in bank-specific lending standards, and to use this model to "correct" the observed changes in lending standards for macroeconomic and bank-specific factors relevant for a given bank's credit conditions. The remaining variation may then be interpreted as a measure of credit standards. Bassett *et al*. (2014) use a Vector Autoregressive (VAR) model to demonstrate that shocks to their measure of credit standards have effects that accord well with the notion of a shock to credit supply: When credit standards are tightened, real output decreases, while credit spreads increase.

The idea behind this project is to use their measure of credit standards in the estimation of a DSGE model with financial frictions. By including this series in the set of observable variables, we expect to be able to resolve both of the shortcomings in the study of Liu *et al*. (2013) pointed out by Pinter (2014). First, it will enable us to separately identify housing preference shocks and credit supply shocks; since a credit supply shock will directly affect the measure of credit conditions, while a housing preference shock will generally not. Second, since the changes in credit standards observed historically are included among the observable variables, any estimation that relies on counterfactual changes in credit conditions will be rejected by the data. In other words, the empirically implausible series of credit supply shocks implied by the model of Liu *et al*. (2013) will be ruled out in our setup.

A separate identification of housing preference shocks and credit supply shocks is crucial if the model is to be used for policy analyses and recommendations, since the policy implications of these two types of shocks are very different. If shocks to credit conditions are found to be important, this suggests that changes in credit *supply* over the business cycle play a key role for macroeconomic fluctuations. This may call for macroprudential policies aimed at limiting the procyclicality of credit supply, e.g. by imposing countercyclical movements in regulatory loan-to-value ratios. On the other hand, if housing preference shocks dominate, this would suggest that changes in the *demand* for credit are of key importance. In that case, other types of macroprudential measures may be more appropriate, e.g. policies that seek to limit the ability of credit-constrained households to borrow against an increase in the price of their house. Thus, understanding which type of shocks played a prominent role in, e.g., the pre-crisis boom in the US economy, is of key importance for the design of macroprudential policies for the future, and therefore requires a model in which each shock is correctly identified.

We plan to build the project on our own previously developed theoretical model, cf. Jensen *et al*. (2015). In our previous study, we present a DSGE model of the macroeconomy featuring credit constraints on households as well as firms. This is a significant advantage over the model of Liu *et al*. (2013), which considers only credit-constrained firms. Importantly, the empirical measure of credit conditions developed by Bassett *et al*. (2014) covers bank lending to both households and firms, and thus fits naturally into the context of our model. In Jensen *et al*. (2015), we

demonstrated that long-term, *secular* changes in credit conditions (as a result, e.g., of financial liberalization) have important implications for the business cycle. In the current project, we instead focus on *cyclical* changes in credit standards.[1] Also, while our previous study took a theoretical approach based on simulation studies, the main contribution of the current project is empirical. Finally, a key contribution of our previous work is that we, in contrast to most existing studies, take into account that in response to large expansionary shocks to the economy, credit constraints may become temporarily non-binding. In other words, the model in Jensen *et al*. (2015) features "occasionally non-binding credit constraints". We plan to incorporate this feature also in the current project, despite the fact that this complicates the solution and estimation of the model significantly.

Theoretical Background and Related Literature: Since the outbreak of the financial crisis in 2007, macroeconomic models with financial frictions have been a lively research area in business cycle analysis. There are two main approaches on which the literature has relied. One is the "financial accelerator" model developed by Bernanke *et al*. (1999). According to this model, borrowers must pay an "external finance premium" when they access credit to finance investment projects. However, a firm may reduce this premium by putting more of its own funds into the project, as the agency problem between borrower and lender is reduced when borrowers have more "skin in the game". This will be easier for the firm when the economy is in a boom; asset prices are high, and the firm is more wealthy. As a result, firms will have access to cheap credit during good times, adding even more fuel to the boom; hence the term "financial accelerator".

The second main avenue of research follows the "collateral constraint" model of Kiyotaki and Moore (1997), according to which borrowers must pledge collateral (e.g., their house) in order to obtain a loan. Fluctuations in the price of collateral assets therefore lead to changes in the credit availability of borrowers: If house prices increase, homeowners are able to take out a new and larger mortgage loan, and use the additional funds to increase current consumption. An important advantage of this approach is that it applies equally well to households as to firms, while the "financial accelerator" of Bernanke *et al*. (1999) is mainly relevant for firms. Following our own previous work in Jensen *et al*. (2015), we plan to build the current project on this approach.

Recent developments in the literature on financial frictions in macroeconomic models include the introduction of an imperfectly competitive banking sector (e.g., Gerali *et al*., 2010), the presence of asset price bubbles (e.g., Galí, 2014), and maturity transformation in the banking sector (e.g., Gertler and Karadi, 2013). While these are all interesting extensions, we do not plan to incorporate any of these features in the current project. The paper most closely related to our project is probably the recent study by Guerrieri and Iacoviello (2014), who use an estimated DSGE model to study the role of household credit constraints for house-price fluctuations in the US.

[1] In related work, one of us has studied the importance of cyclical changes in credit standards for macroeconomic volatility from a theoretical viewpoint, cf. Ravn (2015).

Publication Strategy: The role of financial frictions in DSGE models is a very "hot" topic on the international research agenda after the financial crisis. Most of the papers related to this project have been published either in top-5 journals or in top field journals. We believe the most realistic outlets for a project of this type are the best field journals in macroeconomics, e.g., *Journal of Monetary Economics*, *American Economic Journal: Macroeconomics*, or similar.

Timeline and Budget: The timeline of the project is as follows: We plan to start working on the project in the fall of 2015, where the necessary refinements of the model developed in Jensen *et al*. (2015) will take place, and where the econometric work on the estimation of the model will be initiated. We hope to have obtained a preliminary estimation by early 2016, after which the model analysis, simulations, and alternative experiments will take place. We plan to start writing up a first draft of the paper in the late spring of 2016, when our teaching obligations ease off. This should enable us to have a first version of our paper around **September 2016**, i.e., approximately a year after the project is initiated.

The macroeconomic time series data to be used for the project are publicly available, so there are no costs of obtaining data. Estimating a DSGE model is, however, time consuming, and involves a lot of econometric and computational challenges. This is especially the case when the model features "non-linearities" such as the presence of occasionally non-binding credit constraints. We therefore apply for funding for research time for the members of the research team, cf. the attached detailed budget.

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