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How important is the credit channel? An empirical study of the US banking crisis ☆

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ABSTRACT

We examine whether by adding a credit channel to the standard New Keynesian model we can account better for the behaviour of US macroeconomic data up to and including the banking crisis. We use the method of indirect inference which evaluates statistically how far a model's simulated behaviour mimics the behaviour of the data. We find that the model with credit dominates the standard model by a substantial margin. Credit shocks are the main contributor to the variation in the output gap during the crisis.

1. Introduction

The banking crisis that erupted in 2007 and triggered the Great Recession of 2009 has led many economists and policy-makers to question the standard New Keynesian model of the economy on the grounds that it can neither account for the crisis nor shed any light on banking behaviour since it has no banking sector. In its defence it can be said that it has been shown to give a good account of the US economy's business cycle behaviour in recent years, including the crisis period – Liu and Minford (2012); furthermore if shifts in the trend of potential output are added to the model, it can give a good account of the overall behaviour since the crisis, including the permanent effects of such shifts in trend – Le et al. (2012b). However, the absence of a banking sector remains a serious gap since clearly banking shocks contributed to the recent crisis in a material way. Accordingly, in this paper we explore how far adding a banking sector, based on recent work of De Fiore and Tristani, 2013, can improve the standard model's fit to the US data and also how this extended model accounts for the recent behaviour of the US economy. Our approach, which uses small aggregated DSGE models, parallels recent work on the US that uses large-scale DSGE models with an added banking sector to account for the crisis – Christiano et al. (2010), Gilchrist et al. (2009), Jermann and Quadrini (2012) and Le et al. (2012b).

To anticipate, we find that the model with the banking extension improves on the standard model substantially and also attributes the bulk of the output recession to banking. This result, as we have already said, applies to the business cycle part of the data – to give an overall account of the crisis one must also add in the effects of trend output shifts which we do not deal with here.

In the rest of this paper, we first set out the standard and extended models; in the third section we explain our testing procedures which are based on indirect inference, whereby a model is judged by its ability in simulation to replicate behaviour found in the data; in the fourth we set out our results for the usual calibrated versions of these models; in the fifth section we reestimate the models to get them as close as possible to the data and test these reestimated versions. In the sixth section we interpret the model results for the crisis episode and compare them with other recent work on the crisis origins. The last section concludes.

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2. The models

The standard New Keynesian model includes a standard aggregate demand equation, an aggregate supply function, and a policy rule equation, as follows:

$$\widetilde{Y}_t = E_t\widetilde{Y}_{t+1} - a_1(R_t - E_t\pi_{t+1}) + \varepsilon_{1t} \quad (1)$$

$$\pi_t = b_1\widetilde{Y}_t + \beta E_t\pi_{t+1} + k\varepsilon_{2t} \quad (2)$$

$$R_t = (1 - c_1)(c_2\pi_t + c_3\widetilde{Y}_t) + c_1R_{t-1} + u_t \quad (3)$$

where $\widetilde{Y}_t$ is the output gap, π_t is the rate of inflation, R_t is the nominal interest rate, and $\varepsilon_{1t}, \varepsilon_{2t}$, and u_t are respectively the demand, supply and policy errors. These errors are assumed to be autoregressive processes with the coefficients calculated from the sample estimates. Eq. (1) is the aggregate demand equation, determined by the expectation of output gap in the next period and real interest rate. Eq. (2) is the New Keynesian Phillips Curve. Eq. (3) is the Taylor Rule (1993) but with the lagged interest rate added to allow for smoothing of interest rate reactions over time. This rational expectations model is solved by Dynare (Juillard, 2001).

2.1. A model with credit: adding a banking sector

We follow De Fiore and Tristani (2013) in their adaptation of this model to include a credit channel. They assume that firms producing homogeneous goods for the wholesale market consist of risk-neutral entrepreneurs who produce with inputs of labour and idiosyncratic productivity shocks. They have to pay workers in advance of production by raising external finance from banks. It is assumed that the financial market is imperfect, with asymmetric information and costly state verification (see Townsend, 1979; Gale and Hellwig, 1985); there is a risk of default on their debts because of their idiosyncratic shocks. Perfectly competitive banks lend to them on debt contracts that are optimal under this set-up.

The timing of the economy is as follows. At the beginning of the period, the financial market opens with the aggregate shocks. Households then make their portfolio decisions by allocating their wealth (including existing assets, bond and deposits). The banks keep these deposits, which are used to finance the production of firms. Each wholesale firm stipulates a contract with a bank in order to pay its labour costs. In the second period, the goods market opens. Wholesale firms produce homogeneous goods, which are then sold to the retail sector. If profits are adequate to repay the debt, then the firms will place the remaining revenues into the financing of entrepreneurial consumption. If the revenues are not sufficient to repay the debt, then they will default and their production is seized by the banks. Firms in the retail sector buy the homogeneous goods from wholesale entrepreneurs in a competitive market and they use them to produce differentiated goods at no cost. Retail firms have some market power due to the differentiation of their goods. However, they are not free to change their price because prices are subject to Calvo contracts. The retail goods are then purchased both by households and wholesale entrepreneurs for their own consumption.

Everything in this model is standard to the New Keynesian model apart from the banking contract. In the wholesale sector, the firms (indexed by i) are owned by entrepreneurs, who face a linear technology production function that is specified as:

$$y_{i,t} = A_t\omega_{i,t}l_{i,t} \quad (4)$$

where A_t is an aggregate productivity shock and $\omega_{i,t}$ is an idiosyncratic productivity shock with log-normal distribution function Φ and density function ϕ. This production function can be seen as an abstraction from capital accumulation which forms the basis of the credit need in the Bernanke et al. (1999) model. In De Fiore and Tristani's model, it is assumed that each firm receives a constant endowment of internal funds τ at the beginning of each period; but these funds are insufficient to finance their desired level of production so that they must borrow from the banks. These charge an interest rate spread over the risk-free rate, reflecting the resulting default risk.

Firms pay wages by raising external finance before profiting from the sale of retail goods. The financial contract is stipulated with the banks before observing the idiosyncratic productivity shock but after observing aggregate shocks. The amount of external finance is $P_t(x_{i,t} - \tau)$, which means that the total funds at hand are $P_tx_{i,t} = P_tx_t$ since all firms are identical. Since these wholesale firms are perfectly competitive and operate under constant returns to scale, they make zero profits in equilibrium and borrow the full amount of their wage bill as dictated by aggregate demand.

The terms on which they can do this are dictated by the bank contract. The banks, also perfectly competitive, will lend at a spread that gives them an expected return equal to their cost of deposits, R_t. This must compensate for the risk of default which rises with the size of the loan (=the wage bill) and the risk-free rate. As the wage bill (i.e. the value of employment) rises, the size of possible bankruptcy rises and with it the credit spread. As the risk-free rate rises, the banks' cost of funds rises and this is passed onto firms; because this higher cost makes it harder for the firms to pay back the funds, default probabilities rise. Unlike the credit contract of Bernanke et al. (1999), which is for investment, the contract here is for working capital, i.e. for production itself. Bank funding is therefore a cost of production that affects inflation.

The logic of the bank contract works as follows. The firm needs enough funds to pay for its wage bill, i.e. its direct production costs, for producing the goods required for equilibrium aggregate demand. Since it has limited funds, the total funds it needs defines its required leverage. For the bank to supply this leverage it requires, for a given profit rate of the firm, a certain bankruptcy threshold, which rises with rising leverage; this threshold is given by the incentive compatibility constraint on the firm – namely that at this threshold it must be just in the interest of the firm not to default, so that the loan service it has to pay is just equal to its expected return on its assets. The combination of this leverage and the threshold define for this rate of profit what the bank must charge as a risk-spread on top of the risk-free interest rate, so that it (as a perfectly competitive bank) earns an expected return on its loans just equal to the risk-free deposit rate it pays on its deposits.

The full derivation of the optimal contract is complex – see De Fiore and Tristani (2013). The key details are as follows: the threshold $\bar{\omega}$ is given by the equation for the bank's zero profit conditions as $g(\bar{\omega}, \mu)$ [the bank's expected share of firm profits net of bankruptcy monitoring costs] $= \left(\frac{x-\tau}{x}\right)\frac{R}{q}$ where the threshold rises with required funds, x, the risk-free rate, R, and it falls with the profit rate the firm makes, q. The interest rate the firm will pay on its loan, z, relative to its profit rate, q, is in turn given by $\frac{z}{q} = \bar{\omega}\left(\frac{x}{x-\tau}\right)$, which can be thought of as measuring the burden of funding costs on the firm. For the firm to be willing to pay these costs the burden must be lowered sufficiently by a rise in the profit rate, which lowers $\bar{\omega}$. The optimal contract is set where q is large enough to optimise the firm's expected profits after paying the funding costs – as firms have free entry under perfect competition this will in the long run (i.e. steady state) also be the zero net profit point where the firm's costs including funding just equal its revenues.

After successive substitutions to reduce it to a small compact form, the credit model can be written in loglinearised form as:

$$\widetilde{Y}_t = E_t\widetilde{Y}_{t+1} - a_1(R_t - E_t\pi_{t+1}) - a_2(\widehat{\Delta}_t - E_t\widehat{\Delta}_{t+1}) + a_3(R_t - E_tR_{t+1}) + \epsilon_{1t} \quad (5)$$