Journal of Banking & Finance 37 (2013) 3623–3638

Contents lists available at SciVerse ScienceDirect

Journal of Banking & Finance

journal homepage: www.elsevier.com/locate/jbf

How do banks respond to shocks? A dynamic model of deposit-taking institutions

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ARTICLE INFO

Article history:
Received 8 November 2012
Accepted 14 May 2013
Available online 6 June 2013

JEL classification:
G21
E51

Keywords:
Banks
Credit
Interest rate smoothing
Credit crunch
Liquidity creation

ABSTRACT

This paper proposes a dynamic model of the optimal choices of a bank that benefits from market power and takes into account the impact of the deposit generation process. Interbank lending/borrowing emerges as a buffer that assists the bank in smoothing intertemporal adjustments in interdependent loan and deposit choices. The bank smooths the impact of interest-rates shocks on its customers to minimize the adjustments over time of the stocks of deposits and loans. It does not, however, provide insurance against negative shocks of real origin that increase its expected default costs. The predictions of the model help to shed light on the available empirical evidence and to analyze some recent developments of the banking industry.

1. Introduction

This paper proposes an imperfectly competitive version of a dynamic model of a representative bank, building on the framework initially developed by Cosimano (1987, 1988) and Elsasyani et al. (1995).[1] The model provides a simple micro-foundation of the process of deposit generation that helps understanding how banks react to either a monetary shock or a contraction of economic activity. The analysis of the interactions between the dynamics of loans and deposits provides an explanation of the empirical finding that the issuance of commercial and industrial loans rises following a monetary tightening, and suggests that credit crunches are produced by voluntary risk-retrenchment when bankers expect loan impairments to rise and a sharp reduction of the demand for loans. These dynamics can also shed some light on some recent developments of the banking industry, as the explosive growth of the shadow banking system that has followed the introduction of money market mutual funds, or the sharp contraction of deposits that has followed the deleveraging process in several countries in the aftermath of the financial crisis. Finally, the results of the model allow analyzing some of the policy and regulatory responses that currently are being undertaken to restructure the banking industry.

The structure of the model is based on the empirical evidence that the transaction component of the demand for money is persistent, and therefore the supply of deposits displays a similar degree of persistence.[2] I further introduce a link between deposits and loans, by assuming that the supply of deposit funds is affected by the equilibrium quantity of loans. In this framework, loans become an “investment” that generates deposits.

Liquidity creation is a fundamental function of the banking system, as banks create liquidity by issuing liquid deposits backed by illiquid loans. This process is at the heart of the models by Diamond and Rajan (2001a,b), and Song and Thakor (2007), whose common theme is the idea that banks can finance the very illiquid and opaque investment projects at the heart of relationship banking exclusively by issuing demand deposits, or core deposits.[3] The process of deposit creation has a very long tradition in monetary theory, and it has been explicitly formalized in monetarist models of the money multiplier, such as Brunner (1961) or Brunner and Meltzer

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[1] Chami and Cosimano (2001) have introduced monopolistic power in this class of models, and Kopecky and VanHoose (2012) and Dia and Giuliodori (2012) have developed a monopolistic version of the general framework by Elsasyani et al. (1995).

[2] Contrary to the standard practice in dynamic models of banking, I adopt the convention that banks demand deposit funds and supply loan funds, to be consistent with the recent empirical literature studying the determinants of credit crunches and the impact of monetary policy on loans issuance.

[3] As in this model deposits are the only liquid liability of banks, liquidity creation amounts to deposit generation.

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http://dx.doi.org/10.1016/j.jbankfin.2013.05.023

(1966), and it is implicitly assumed in monetary models whenever a concept such as *inside money* or *endogenous money creation* is considered in the analysis.[4] The same process, however, is usually not formalized in microeconomic models of banking, which normally adopt either the simplifying assumption of portfolio separation, or that of perfect competition, and in both cases the process of liquidity creation depends exclusively on the choices of the central bank. In an imperfectly competitive framework, however, the process also depends on the structure of the banking industry, and it affects the transmission of monetary policy impulses. The only exception is Aftalion and White (1977), which compares the responsiveness of the monetary system to external shocks under both perfect competition and monopoly when the central bank conducts monetary policy by pegging the discount rate and allowing unlimited allowances to the banking system at that rate. This paper is very similar in spirit, but it develops a dynamic model. The dynamics of the process, in fact, matters because information costs generate large frictions, so that the impact of changes over time in the stock of loans or deposits is not simply captured by the flows discussed in a static framework.[5]

The dynamic properties of the model depend on a single nonlinearity: a convex default cost function that captures a fundamental aspect of banking activity, the ability of banks to finance opaque investment projects whose risk other agents cannot price. Default costs represent the main constraint on the size of the portfolio of the bank, but they also implicitly generate adjustment costs on the stock of deposits. The equilibrium composition of the portfolio and the size of the portfolio are thus jointly determined, but despite this joint determination of the two, I obtain a simple mathematical solution for the equilibrium quantities and interest rates.

The design of the model is similar to that of previous studies that have made use of a static framework to analyze the impact of the banking industry in the transmission of monetary impulses, as for example in Hancock (1993). The dynamic framework, however, generates predictions that are somehow different from those of the static models, and sheds some light on the different behavior of large and small banks. In particular, in line with Saving (1977, 1979), I study the bank as a multi-product firm, underlying the relevance of the provision of payment and transaction services for the equilibrium solutions; as VanHoose (1983, 1985), I introduce the hypothesis that banks benefit from market power; finally, following Aftalion and White (1977), I introduce a liquidity generation process in the framework. The present model, however, has some relevant limitations with respect to the previous studies. First, the model's focus is on deposits only, leaving aside currency, so that it does not represent a general monetary framework.[6] Secondly, this simplified framework does not consider monetary policy under different regimes, and in particular does not describe a market for reserves where the central bank operates. It thus describes a regime where banks are not constrained by lack of reserves, as in the case of Aftalion and White (1977).[7] Lastly, the market for securities is exogenous, so that this partial equilibrium framework cannot consider the impact of the banking industry on the market for securities, and the feedback from the prices of securities on the public's demand for loans and supply of deposits as VanHoose (1983, 1985) does.

Notwithstanding its limitations, the model provides a simple framework to analyze the role played by banks in the transmission of monetary and real shocks, and it generates predictions that help to understand some puzzling empirical results. A large class of macroeconomic models, in fact, suggests that banks provide a specific channel for the transmission of monetary policy and real shocks, influencing the business cycle by generating a financial accelerator (Bernanke et al., 1996, 1999). These models predict that banks should reduce the issuance of loans following a monetary tightening, or when other negative, non-monetary shocks reduce the value of bank capital, eventually generating a credit crunch. The empirical analysis of these issues is particularly challenging, since endogeneity problems are ubiquitous. We now have, however, a substantial amount of empirical evidence that, while broadly supporting the theory, casts some doubts on some relevant features of the same theory. There is strong evidence supporting the basic assumption of the models, namely that portfolio separation does not hold, so that bank lending is influenced by the behavior of deposits (Elsasyani et al., 1995; Driscoll, 2004; Dia and Giuliodori, 2012). However, while there is substantial evidence that bank lending affects small firms in the United States (Gertler and Gilchrist, 1993a), the evidence for a broad credit channel is more mixed: Driscoll (2004), in particular, has found very poor support for the hypothesis that bank lending affects output, at least for the case of the United States. Furthermore, we have evidence that the issuance of commercial and industrial loans behave as predicted, falling after a monetary tightening, only in the case of small banks (Kashyap and Stein, 2000). On the contrary, and quite at odds with the theory (Gertler and Gilchrist, 1993b,a, and, more recently, Den Haan et al., 2007) suggest that, in the case of large banks, commercial and industrial loans issuance rises following a monetary tightening. Finally, the empirical evidence on the credit crunches of the 1990s in the USA and Japan does not univocally support the idea of a supply-side lead credit crunch (Bernanke and Lown, 1991; Berger and Udell, 1994; Brinkmann and Horwitz, 1995 for the United States, Woo (2003) and Watanabe (2007) for Japan). These studies highlight that demand-side factors, and voluntary risk retrenchment, are at least as important as changes in capital regulation in explaining the credit crunch.

The main results of the model developed in this work have a straightforward intuition. When shocks of real nature permanently increase expected default costs, a bank reacts with a credit crunch. The bank, in fact, chooses the optimal amount of loans partially in a backward-looking way, partially forward-looking. The size of the forward looking part depends on expected marginal default costs, so that if these last double, new lending halves.[8] Moreover, in presence of expectations of rising interest rates, commercial and industrial loans issuance rises, because lending becomes more profitable. This effect is due to the deposit creation process: by issuing more loans the bank expands proportionally its deposit liabilities, so that this feedback effect offsets the standard substitution effect, particularly in the case of large banks. This result is peculiar to the model, as it does not emerge in the static framework of Aftalion and White (1977), and it provides a rationale for the very strong findings of Den Haan et al. (2007). The alternative explanation that is normally provided is that commercial and industrial loans issuance rises following tighter monetary policy because most

[4] The empirical relevance of this phenomenon has been recently analyzed by Berger and Bowman (2009), and their findings strongly support the basic assumption of the paper.

[5] The structure of the results differ from the basic, static, model of Klein (1971) and Monti (1972) in two important respects. First, the portfolio separation property does not hold, as the optimal amount of loans and deposits are not set independently of each other. Second, changes in marginal costs and revenues, including crucially those of market interest rates, do not affect the level of the quantities, as in the static case, but a nonlinear transformation of the first difference of the level. A dynamic formulation is thus much more realistic, since loans and deposits, and their respective interest rates, display a high degree of persistence, as the empirical results of Akella and Greenbaum (1992) suggest.

[6] The results concerning deposits could be extended to larger money aggregate only under some restrictive assumptions regarding the public's demand for currency, as for example that of a limited interest rate elasticity.

[7] A similar regime has recently been adopted by the ECB by means of its Long-term refinancing operations (LTRO).

[8] The empirical results of Den Haan et al. (2007) suggest that commercial and industrial loans decrease sharply following a non-monetary negative shocks.