

Macroeconomic Implications of U.S. Banking Liberalisation*

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Abstract

I develop a Dynamic Stochastic General Equilibrium (DSGE) model featuring imperfect competition in banking to shed light on the macroeconomic repercussions of U.S. banking deregulation during the 1980s and 1990s. Banks function as traditional financial intermediaries, transferring funds from private households to entrepreneurs in the economy. Prior to deregulation, banks exploit their market power and charge high interest rates on loans to entrepreneurs. Financial liberalisation leads to more vigorous competition among banks, which effectively ameliorates credit market access of investors. I construct model generated panel data and reproduce various regression exercises implemented in related studies. In doing so, I contribute to bridging the gap between my theoretical framework and the vast empirical literature on U.S. banking deregulation. The model succeeds in both qualitatively and quantitatively replicating several empirical findings. In particular, bank market integration is associated with (i) an increase in investment in new firms, (ii) a decline in average firm size, (iii) an erosion of the bank capital ratio, (iv) a reduction of state business cycle volatility, and (v) improved consumption risk sharing of entrepreneurs.

Keywords: Banking Deregulation, Financial Intermediation, Firm Entry, Macroeconomic Volatility, Consumption Risk Sharing.

JEL Classification: E32, E44, G21.

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1 Introduction

Is financial liberalisation a bane or boon for the real economy? As so often in economic questions, it depends. For more than a century, much research has been conducted on the relationship between finance and economic development. In a pioneer contribution, Schumpeter (1912) highlights the essential role of financial intermediaries in promoting innovations and economic prosperity. Well-performing banking systems mobilise funds and allow an allocation of resources to places where they yield highest returns. In this sense, free banking is beneficial as it enhances efficiency and thereby fosters economic growth. On the other hand, the recent financial crisis taught us how bad real economic activity can suffer if liberal financial systems tend to malfunction. This experience has reignited the still on-going debate on how to reform regulation of banks in order to address financial stability.

This paper investigates an episode of financial liberalisation in the United States that provides support in favour of the Schumpeterian view. I develop a Dynamic Stochastic General Equilibrium (DSGE) model incorporating credit market frictions that helps to understand the macroeconomic repercussions of the relaxation of intra- and interstate banking limitations through the 1980s and 1990s. Prior to the 1980s, a multitude of different state and federal laws restricted financial institutions in the geographical range of their activities. The Douglas Amendment to the federal Bank Holding Company Act of 1956 virtually prohibited banking organisations from acquiring out-of-state banks or branches. In addition, most state legislatures designed laws that prevented banks from establishing branches in different counties within state borders. These barriers to bank entry and expansion effectively curbed competition in local markets and allowed banks to operate in a quasi-monopolistic fashion. Regulatory change began only in the late 1970s, when states gradually lifted these legal impediments. Eventually, the transition to full intra- and interstate banking was completed by the mid 1990s. The regime switch triggered a consolidation in the U.S. banking industry, followed by improved access to financial services for customers and more vigorous competition among banks.

Several empirical studies have shown that the annulment of geographical bank entry restrictions had considerable ramifications on the financial and non-financial economy in the United States. In an influential paper, Jayaratne and Strahan (1996) argue that branching deregulation accelerated economic growth. The regulatory change also led to an increase in firm creation (see Black and Strahan (2002), Cetorelli and Strahan (2006), and Kerr and Nanda (2009)) and a reduction of the average size of non-financial firms (see Cetorelli and Strahan (2006)). What is more, banking deregulation was associated with a decrease in state business cycle volatility (see Morgan, Rime, and Strahan (2004)), a tightening of the income distribution (see Beck, Levine,

and Levkov (2010)), an improvement of risk sharing (see Demyanyk, Ostergaard, and Sørensen (2007)), as well as a decline in the pro-cyclicality of risk sharing (see Hoffmann and Shcherbakova-Stewen (2009)). Regarding the impact on the financial industry, Jayaratne and Strahan (1998) find that bank market integration lowered the interest rate on loans, whereas there was no significant change in bank profitability or deposit interest rates. Also, a recent study by Hanson, Kashyap, and Stein (2010) provides evidence that bank capital ratios fell after the reform.

Despite the vast empirical literature on the real effects of U.S. banking deregulation, this issue has been clearly under-studied from a theoretical viewpoint. To this end, I set up a dynamic macro model featuring endogenous firm entry and imperfect competition in banking to shed light on several empirical observations in a coherent framework. Banks play a central role in the model. They act as traditional financial intermediaries, transferring funds from savers to investors in the economy. To be more precise, banks finance the provision of loans to entrepreneurs through sight deposits collected from private households and bank equity accumulated through retained earnings. Entrepreneurs can be interpreted as venture capitalists. They hold a portfolio of profitable capital good producing firms and invest in the establishment of new firm start-ups. I build on Kiyotaki and Moore (1997) assuming that investors face a borrowing limit. That is, entrepreneurs can only pledge part of their expected future income for collateral purposes. Importantly, I assume that the potential loan capacity depends positively on the size of the firm portfolio, i.e. a larger firm portfolio expands the credit line of investors.

The model embeds financial frictions in form of monopolistic competition in the credit market. Prior to deregulation, financial intermediaries exploit their market power and charge a high premium on their loan interest rates. These credit market imperfections effectively create substantial barriers to external finance for entrepreneurs. Since I focus on a closed economy setup, there is no distinction between banking deregulation on the intra- or interstate level in the model. Accordingly, financial liberalisation is straightforwardly simulated as a one-time permanent increase in competition among banks. This decline in the market power of banks directly translates into lower loan interest rates, which improves investors' access to credit.

A major challenge of my analysis is to link the theoretical model to the related empirical literature. Researchers have exploited the fact that states relaxed their geographical restrictions on bank entry at different points in time to study the effects of deregulation through panel regressions. To assess the empirical performance of the model, I reproduce various regression exercises of previous studies based on model generated panel data. Thus, this approach represents an appropriate way to merge economic theory with empiricism.

Indeed, my model succeeds in quantitatively replicating several empirical findings. First, I pin down the size of the deregulation shock in the simulation to match a 0.7 percentage point drop in the bank capital ratio. This figure is in line with empirical evidence reported by Hanson, Kashyap, and Stein (2010). Second, consistent with Black and Strahan (2002) and Kerr and Nanda (2009) deregulation leads to an increase in firm creation. After the reform, investors can borrow on softer terms, which induces them to finance new firm start-ups. Furthermore, the rise in the number of producers in the economy reduces the relative size of a single firm as is documented in Cetorelli and Strahan (2006). Third, concurrent with the findings in Morgan, Rime, and Strahan (2004), bank market integration is also associated with a decline in the state-level volatility of output and personal income of private households and entrepreneurs. In fact, featuring three stochastic exogenous shocks, i.e. a standard technology shock, a shock to the collateral value pledged by entrepreneurs, and a bank competition shock, the model generally predicts ambiguous effects of deregulation on macroeconomic variability. Deregulation mitigates the responses following disturbances to productivity and bank competition, but exaggerates the outcome of a shock to the collateral value. Overall, the model suggests a stabilisation of the business cycle after the reform, because the dampening effects of productivity and competition shocks outweigh the amplified impact of changes in the collateral value. Fourth, the regime switch improves consumption risk sharing of entrepreneurs, but does not affect insurance of private households. This result is to some extent supported by Demyanyk, Ostergaard, and Sørensen (2007), who show that income insurance increased markedly after the transition to interstate banking. In particular, they point out that the effect is more pronounced in states where small businesses are more important. This finding emphasises the crucial role of bank finance especially for small firms. As a matter of fact, we can interpret entrepreneurs in the model as the owners of a number of small firms. Prior to deregulation, credit is expensive so that investors have difficulties in buffering consumption against fluctuations in their portfolio income. Financial liberalisation improves their access to banking services, which allows them to better hedge consumption against idiosyncratic business cycle shocks.

My work is closely related to Ghironi and Stebunovs (2010), who analyse the domestic and international effects of interstate banking deregulation using a two-economy DSGE framework. They show that bank market integration may account for several macroeconomic phenomena in the U.S. during the 1980s and 1990s, such as increased firm entry, lower aggregate macroeconomic volatility, as well as a persistent real appreciation and external imbalances. I follow their approach in formalising product market entry and exit in my model. That is, the creation of new firms is subject to sunk setup costs and existing producers face an exogenous business closure shock. In Ghironi and

Stebunovs (2010) banks can basically be interpreted as investors, who own the stock of firms in the economy. In contrast, my paper explicitly distinguishes between financial intermediaries and entrepreneurs. This separation allows to disentangle market power of banks from competition in the product market. Thus, credit market frictions affect the dynamics of firm entry through its impact on the borrowing opportunities of entrepreneurs.

The remainder of the paper is organised as follows. The next section introduces the theoretical framework. In Section 3, I calibrate the parameters of the model. Section 4 simulates deregulation of the banking sector in the theoretical economy, while Section 5 assesses the empirical performance of the model. A few concluding remarks appear in Section 6.¹

2 Model Environment

This section develops a dynamic general equilibrium model, which will be used later for an empirical investigation of the macroeconomic repercussions of U.S. banking liberalisation. The theoretical economy comprises five types of agents. There is a unit mass of identical, infinitely lived private households, who work, consume and save. The producing economy consists of a representative final good producer and a continuum of profitable intermediate good firms. These intermediate good firms are owned by a discrete number of entrepreneurs, who receive additional funds through loans supplied by a continuum of banks.

The banking sector is rather stylised. Banks operate as financial intermediaries, supplying two different types of financial securities: sight deposits and loans. Private households and entrepreneurs are assumed to be heterogeneous with respect to their degree of patience. This is the reason why patient households are the savers in the economy and hold deposits at banks, while impatient entrepreneurs are the investors, who partly finance their investment activities through bank loans.

The financial system is characterised by substantial credit market frictions. Prior to deregulation, competition among financial institutions is heavily curtailed, which enables banks to charge high interest rates on their loans. This form of financial imperfection impedes entrepreneurs' access to external finance, which prevents them from borrowing to fund profitable investment in new firms. Once the financial system liberalises, market power of banks permanently declines. As a result, a more competitive loan market mobilises more funds and thereby ameliorates investors' borrowing opportunities.

¹The Appendix to this paper is available upon request. It presents a detailed derivation of the model solution as well as an overview of deregulation dates across federal states.

For the sake of parsimony, I describe a closed economy setup and abstract from long-run economic growth. Also, there is no money in the model such that all variables are expressed in real terms, i.e. in units of the homogeneous final good.

2.1 Private Households

There is a representative private household with a unit mass of identical, atomistic, infinitely lived members. The expected lifetime utility of the representative household is

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^H, 1 - l_t),$$

where E_0 denotes the expectation operator conditional on the information set available at date zero, $\beta \in (0, 1)$ is the subjective discount factor, and c_t^H is the household's consumption at time t . For convenience, total time endowment in each period is normalised to one, and the agent devotes a fraction of l_t to work, and $1 - l_t$ to leisure activities.

Household's preferences are characterised by a standard Cobb–Douglas period utility function of the form

$$u(c_t^H, 1 - l_t) = \frac{[(c_t^H)^\xi (1 - l_t)^{1-\xi}]^{1-\gamma}}{1 - \gamma},$$

where $\xi \in (0, 1)$ measures the importance of consumption relative to leisure in determining the agent's instantaneous utility, and $\gamma \geq 1$ is a parameter governing the risk attitude of private agents.

Akin to Ghironi and Stebunovs (2010), the representative agent has access to two different types of financial securities. On the one hand, it can hold risk-less bank deposits, while on the other hand, it can buy stocks in a risky mutual fund of banks. Each period t , the household enters with d_t deposit holdings and purchases d_{t+1} new deposits. Deposits have a maturity of one period. To keep matters simple, there is no default risk of banks. That is, at time t , the household always receives back the full amount of its deposits d_t plus a risk-free interest rate r_t , where r_t denotes the return between time $t - 1$ and t , known with certainty at date $t - 1$. Furthermore, the agent holds x_t shares in the mutual fund and buys x_{t+1} new shares. This investment trust consists of a continuum of all banks in the economy. At time t , each individual bank ι disburses part of its profits as dividends $a_t(\iota)$ to the fund's shareholders. Accordingly, total dividend payments amount to $\int_{\iota} a_t(\iota) d\iota$. Since shareholders of the investment trust are entitled to receive dividend payments in the future, the price of one stock in the fund must be equal to the price of claims to all banks' future dividends. Let $v_t(\iota)$ denote the price of such a claim to bank ι . This implies that the price of a share in

the trust has to be $\int_{\iota} v_t(\iota) d\iota$. As a result, the overall payoff of a stock in the mutual fund comprises the share price and dividends, equal to $\int_{\iota} (a_t(\iota) + v_t(\iota)) d\iota$. Finally, the household supplies l_t units of labour, earning labour income of $w_t l_t$, where w_t denotes the real wage rate.

In sum, the representative household generates income from supplying labour, the redemption of bank deposit plus accrued interest, as well as dividend income and revenue from selling the current stock portfolio. The household's flow of expenses includes consumption, and purchases of new deposits and shares. The period budget constraint of the representative agent can therefore be written as

$$d_{t+1} + x_{t+1} \int_{\iota} v_t(\iota) d\iota + c_t^H \leq (1 + r_t) d_t + x_t \int_{\iota} (a_t(\iota) + v_t(\iota)) d\iota + w_t l_t. \quad (1)$$

The household takes prices as given and seeks to maximise expected lifetime utility by choosing c_t^H , l_t , d_{t+1} , and x_{t+1} , subject to the period budget constraint (1), given d_0 and x_0 . Optimisation renders:

$$\frac{\left((c_t^H)^{\xi} (1 - l_t)^{1-\xi} \right)^{1-\gamma}}{c_t^H} = \beta (1 + r_{t+1}) E_t \left[\frac{\left((c_{t+1}^H)^{\xi} (1 - l_{t+1})^{1-\xi} \right)^{1-\gamma}}{c_{t+1}^H} \right], \quad (2)$$

$$v_t = \beta E_t \left[\left(\frac{(c_{t+1}^H)^{\xi} (1 - l_{t+1})^{1-\xi}}{(c_t^H)^{\xi} (1 - l_t)^{1-\xi}} \right)^{1-\gamma} \frac{c_t^H}{c_{t+1}^H} (a_{t+1} + v_{t+1}) \right], \quad (3)$$

where $v_t \equiv \int_{\iota} v_t(\iota) d\iota$ and $a_t \equiv \int_{\iota} a_t(\iota) d\iota$. Moreover,

$$w_t = \frac{1 - \xi}{\xi} \frac{c_t^H}{1 - l_t}. \quad (4)$$

Equation (2) is the standard intertemporal Euler Equation with respect to bank deposits. Condition (3) is the usual Lucas (1978) consumption-based asset pricing formula. The share price of the mutual fund must be equal to its expected discounted future payoff, where $\beta \left(\frac{(c_{t+1}^H)^{\xi} (1 - l_{t+1})^{1-\xi}}{(c_t^H)^{\xi} (1 - l_t)^{1-\xi}} \right)^{1-\gamma} \frac{c_t^H}{c_{t+1}^H}$ determines the stochastic discount factor or the pricing kernel. Finally, equation (4) describes the intratemporal labour-leisure trade-off.

An optimal contingent plan for consumption, work, deposit and share holdings is described by sequences $\{c_t^H\}_{t=0}^{\infty}$, $\{l_t\}_{t=0}^{\infty}$, $\{d_{t+1}\}_{t=0}^{\infty}$, and $\{x_{t+1}\}_{t=0}^{\infty}$, satisfying the first-order conditions (2)–(4), the budget constraint (1), as well as the transversality conditions for deposits and shares given by $\lim_{T \rightarrow \infty} E_t \left[\left(\prod_{k=1}^T \frac{1}{1 + r_{t+k}} \right) d_{t+T} \right] = 0$ and $\lim_{T \rightarrow \infty} E_t \left[\left(\prod_{k=1}^T \frac{1}{1 + r_{t+k}} \right) v_{t+T} \right] = 0$, respectively.

2.2 Firms

2.2.1 Final Good Producers

The final good is manufactured in a perfect competitive industry. A final good producer employs differentiated intermediate, or capital good varieties to produce the homogeneous final good. At time $t = 0, 1, 2, \dots$, there is a continuum of capital good inputs of measure n_t available. Technology is described by a standard Dixit and Stiglitz (1977) Constant Elasticity of Substitution (CES) production function of the form

$$y_t = \left(\int_0^{n_t} k_t(\omega)^{\frac{\phi-1}{\phi}} d\omega \right)^{\frac{\phi}{\phi-1}},$$

where y_t is the output amount of the final good, $k_t(\omega)$ denotes the input quantity of capital good component $\omega \in [0, n_t]$, and $\phi > 1$ represents the constant elasticity of substitution between different input varieties.

Perfect competition and constant returns to scale imply that the market size is indeterminate, which allows to consider a representative firm. Since the producer has to purchase intermediate goods in each period, the representative firm's objective can be described by solving a series of static, one-period profit maximisation problems. Accordingly, the representative producer chooses differentiated intermediate good inputs to maximise profits:

$$\max_{k_t(\omega)} \left(\int_0^{n_t} k_t(\omega)^{\frac{\phi-1}{\phi}} d\omega \right)^{\frac{\phi}{\phi-1}} - \int_0^{n_t} p_t(\omega) k_t(\omega) d\omega, \quad \forall t = 0, 1, 2, \dots,$$

where $p_t(\omega)$ is the price for variety ω .

First-order conditions with respect to each specific capital good input ω are given by

$$p_t(\omega) = \left(\frac{y_t}{k_t(\omega)} \right)^{\frac{1}{\phi}}, \quad \forall \omega \in [0, n_t]. \quad (5)$$

Equation (5) states the usual condition for optimality under perfect competition. The marginal product of each intermediate good input must be equal to its price.

2.2.2 Intermediate Good Producers

At date t , each capital good producer $\omega \in [0, n_t]$ hires labour $l_t(\omega)$ to manufacture a differentiated variety. The production function is identical for all firms and takes the simple form of

$$k_t(\omega) = z_t l_t(\omega),$$

where z_t is an exogenous stochastic labour-augmenting technology shock. Specifically, z_t follows a univariate AR(1) process in logs

$$\log(z_{t+1}) = (1 - \rho_z)\log(z) + \rho_z \log(z_t) + u_{z,t+1}, \quad \text{with } |\rho_z| < 1, \quad (6)$$

where z is the mean of the process, and $u_{z,t+1}$ measures independently and identically distributed draws from a normal distribution with mean zero and standard deviation σ_z .

Because intermediate goods are imperfect substitutes in the production technology of the final good sector, capital good firms act in a monopolistic competitive fashion. The objective of an individual capital good firm ω is to set the price $p_t(\omega)$, subject to the demand for its variety by the representative final good producer determined by equation (5), in order to maximise profits:

$$\max_{p_t(\omega)} \pi_t^F(\omega) = p_t(\omega)k_t(\omega) - \frac{w_t}{z_t}k_t(\omega), \quad \forall t = 0, 1, 2, \dots, \\ \text{subject to (5).}$$

The first-order condition for this problem is given by

$$p_t(\omega) = p_t = \frac{\phi}{(\phi - 1)} \frac{w_t}{z_t}. \quad (7)$$

Condition (7) indicates that the price of an intermediate good is simply determined by a constant mark-up of $\frac{\phi}{\phi-1}$ over marginal costs $\frac{w_t}{z_t}$. This premium as well as marginal costs are common to all capital good producers, such that all firms choose the same price-quantity combination, i.e. $p_t(\omega) = p_t$ and $k_t(\omega) = k_t$. As a consequence, the production function in the final good sector simplifies to

$$y_t = n_t^{\frac{\phi}{\phi-1}} k_t, \quad (8)$$

and condition (5) can be re-written as

$$p_t = \left(\frac{y_t}{k_t} \right)^{\frac{1}{\phi}}. \quad (9)$$

Finally, period profit of a capital good firm is

$$\pi_t^F = \frac{1}{\phi} \frac{y_t}{n_t}. \quad (10)$$

2.3 Entrepreneurs

The economy is inhabited by a discrete number $\mu_E > 1$ of risk-averse entrepreneurs. Entrepreneurs can be interpreted as venture capitalists. They own the stock of intermediate good producers in the economy and absorb all profits generated by firms. In addition to the returns on their firm portfolio, entrepreneurs can obtain funds through bank loans in order to finance consumption of the final good and investment in new firm start-ups.

The expected lifetime utility of entrepreneur j is

$$E_0 \sum_{t=0}^{\infty} \beta_E^t u_E(c_t^E(j)),$$

where $\beta_E \in (0, 1)$ is the subjective discount factor, and $c_t^E(j)$ denotes entrepreneur j 's consumption at date t . Preferences are identical among all investors and given by a standard power utility function

$$u_E(c_t^E(j)) = \frac{(c_t^E(j))^{1-\gamma_E}}{1-\gamma_E},$$

where $\gamma_E \geq 1$ represents the Arrow-Pratt coefficient of relative risk aversion.

At each time t , entrepreneur j holds a portfolio of $n_t(j)$ capital good firms and funds the foundation of $n_{e,t}(j)$ new firms. Firm entry and exit is analogue to Bilbiie, Ghironi, and Melitz (2009) and Ghironi and Stebunovs (2010). The establishment of new enterprises is costly. Before a firm enters the market and starts to produce, the investor has to finance an exogenous sunk setup cost. For the sake of simplicity, this entry cost is assumed to be fix and amounts to one unit of the homogeneous final good.²

A firm entrant in period t is only able to start production in period $t + 1$. This induces a one period time-to-build lag in the economy. As shown in section 2.2.2, production in the intermediate good sector does not incur fixed costs. This implies that an operating firm produces in every period until it is forced to shut down and exit the market. In particular, I assume that firm exit occurs exogenously. With independent probability $\delta \in (0, 1)$, an incumbent producer will be hit by the closedown shock and vanishes at the end of every period.³ The fact that only existing producers face the exit

²As Ghironi and Melitz (2005) point out, we can think of an individual firm as a production line for the distinct variety it manufactures. In this respect, the theoretical model does not distinguish between product innovations that are introduced by new or existing producers.

³The reason why I assume an exogenous exit shock, independent of the state of the economy or firm specifics, is twofold. First, endogenous business closure would complicate the model enormously. Second, empirical evidence suggests that the product and business destruction rate in the U.S. has been invariant over the business cycle. For instance, Broda and Weinstein (2010) find that product creation is strongly pro-cyclical, whereas the destruction of good varieties does not respond heavily to cyclical

shock implies that a firm established during period t will operate at least in period $t + 1$ before it is subject to potential closure. As a result, the number of firms in entrepreneur j 's portfolio evolves according to

$$n_{t+1}(j) = n_{e,t}(j) + (1 - \delta)n_t(j). \quad (11)$$

Hence, the dynamic equation for the overall number of capital good producers in the economy can then be written as

$$n_{t+1} = n_{e,t} + (1 - \delta)n_t, \quad (12)$$

where $n_t = \sum_{j=1}^{\mu_E} n_t(j)$ and $n_{e,t} = \sum_{j=1}^{\mu_E} n_{e,t}(j)$.⁴

Changes in the firm portfolio are costly. In particular, variations in the number of enterprises involve a quadratic adjustment cost of $\frac{\chi}{2} \left(\frac{n_{e,t}(j)}{n_t(j)} \right)^2 n_t(j)$, where $\chi > 0$ is a constant parameter determining the importance of these costs.⁵ The underlying cost function exhibits an increasing marginal cost of portfolio expansion or, symmetrically, shrinking. This specification captures the idea that a more rapid change in the stock of firms results in a more than proportional rise in adjustment costs. Moreover, costs are declining in the portfolio size. Since I can interpret firms as differentiated production lines, an entrepreneur can also be regarded as the owner of a holding company. In this sense, an investor that possesses a large stock of single enterprises might have more expertise and is therefore more efficient in managing its fund.

Entrepreneurs have access to external finance through the credit market. They can agree on one-period loan contracts with banks. At each date t , an investor is able borrow $b_{t+1}(j)$ from banks and must reimburse its past obligations $b_t(j)$ plus interest r_t^b . The borrowing rate r_t^b determines the price of a loan between period $t - 1$ and t and is known at date $t - 1$. As in Kiyotaki and Moore (1997), entrepreneurs face a borrowing limit. The loan capacity of an investor today depends on both the expectations about returns of its firm portfolio tomorrow and on the current portfolio size. In particular, the gross loan repayment in period $t + 1$ cannot exceed a certain time-varying fraction of expected future income:

$$(1 + r_{t+1}^b)b_{t+1}(j) \leq \kappa_t n_t(j) E_t \left[n_{t+1}(j) \pi_{t+1}^F \right]. \quad (13)$$

movements. In addition, Lee and Mukoyama (2008) show that although entry of manufacturing plants in the U.S. is pro-cyclical, exit rates do not differ between boom and recession phases.

⁴As Bilbiie, Ghironi, and Melitz (2009) highlight, equation (12) reminds of the basic capital accumulation equation in canonical real business cycle (RBC) models. The stock of firms in period t represents an endogenous state variable and is the counterpart to physical capital in the standard RBC model.

⁵The idea of investment being subject to quadratic adjustment costs builds on the traditional Tobin's q model of investment (see Tobin (1969)).

Expression $\kappa_t n_t(j)$ defines the debt-to-income (DTI) ratio and determines how much future income an investor can pledge as collateral. Thus, the DTI ratio can be interpreted as a measure for financial market development as it affects banks' willingness to accept firm profits as loan securities. I assume that the borrowing limit is increasing in today's size of the portfolio $n_t(j)$, such that a larger stock of firms improves an investor's access to credit.⁶ Besides, the DTI ratio is a function of an exogenous random variable κ_t , capturing the quality of future earnings for collateral purposes. This collateral shock variable follows an exogenous first-order autoregressive process in logs

$$\log(\kappa_{t+1}) = (1 - \rho_\kappa) \log(\kappa) + \rho_\kappa \log(\kappa_t) + u_{\kappa,t+1}, \quad \text{with } |\rho_\kappa| < 1, \quad (14)$$

where κ denotes the mean of the shock variable, and $u_{\kappa,t+1}$ follows an i.i.d. Gaussian White Noise process with standard deviation σ_κ .

I follow Iacoviello (2005) and assume that entrepreneurs are less patient than private households, meaning that $\beta > \beta_E$. This assumption is crucial as it avoids a pure self-financing behaviour of investors and ascertains that there is financial intermediation in equilibrium. Since entrepreneurs are impatient, they do not accumulate enough resources through postponing consumption and investment into the future but demand loans from banks, while private households hold sight deposits.

The objective of entrepreneur j is to choose $c_t^E(j)$, $b_{t+1}(j)$, $n_{t+1}(j)$ and $n_{e,t}(j)$ in order to maximise lifetime utility, subject to the period budget constraint

$$c_t^E(j) + n_{e,t}(j) + (1 + r_t^b)b_t(j) + \frac{\chi}{2} \left(\frac{n_{e,t}(j)}{n_t(j)} \right)^2 n_t(j) \leq n_t(j)\pi_t^F + b_{t+1}(j), \quad (15)$$

the evolution of firm number (11), and the borrowing constraint (13), taking b_0 and n_0 as given.

Two first-order conditions of this optimisation problem are non-standard and deserve special attention. First, let us consider the optimality condition with respect to

⁶Imagine that there is an informal credit rating mechanism at work. Banks know the current number of firms owned by a potential creditor. They consider entrepreneurs with large firm portfolios to be notably safe. For this reason, these investors receive better credit ratings and find it easier to obtain loans from banks.

$n_{t+1}(j)$ representing the intertemporal investment Euler Equation:

$$\begin{aligned}
q_t(j) = & \beta_E E_t \left[(c_{t+1}^E)^{-\gamma_E} \left(\underbrace{\pi_{t+1}^F + n_{t+1}(j) \frac{\partial \pi_{t+1}^F}{\partial n_{t+1}} \frac{\partial n_{t+1}}{\partial n_{t+1}(j)}}_{\text{Profit Destruction Externality}} + \frac{\chi}{2} \left(\frac{n_{e,t+1}(j)}{n_{t+1}(j)} \right)^2 \right) + (1 - \delta) q_{t+1}(j) \right] \\
& + \underbrace{\mu_t(j) E_t \left[\kappa_t n_t(j) \left(\underbrace{\pi_{t+1}^F + n_{t+1}(j) \frac{\partial \pi_{t+1}^F}{\partial n_{t+1}} \frac{\partial n_{t+1}}{\partial n_{t+1}(j)}}_{\text{Profit Destruction Externality}} \right) \right]}_{\text{Borrowing Constraint Externality}} + \beta_E E_t \left[\mu_{t+1}(j) \kappa_{t+1} n_{t+2}(j) \pi_{t+2}^F \right],
\end{aligned}$$

where $\mu_t(j)$ denotes the Lagrange multiplier for the borrowing constraint and $q_t(j)$ is the shadow price of a firm. This condition states that value of an additional firm $q_t(j)$ has to be equal to the discounted sum of the increase in total profits received from the portfolio, the contribution to lower adjustment costs, and the future shadow price given that the firm still exists plus the value of the improvement of today's and tomorrow's borrowing conditions. The assumption of a discrete number of entrepreneurs implies that a single investor is not small. Thus, firm portfolio decisions of entrepreneur j have an impact on total number of enterprises in the economy and thereby affect individual firm profits. An increase in the number of producers in the intermediate good sector *ceteris paribus* reduces the market share of a single firm and consequently diminishes its profits. Ghironi and Stebunovs (2010) call this effect the profit destruction externality (PDE) of portfolio expansion. Also, the investment Euler Equation incorporates the internalisation of a positive borrowing constraint externality (BCE). Investors take into account that a higher $n_{t+1}(j)$ lifts the borrowing limit today and in the next period.

The first-order condition with respect to new firm start-ups $n_{e,t}(j)$ forms an entry condition

$$q_t(j) = (c_t^E)^{-\gamma_E} \left[1 + \chi \frac{n_{e,t}(j)}{n_t(j)} \right].$$

Optimality requires that the value of an additional firm $q_t(j)$ is equal to the present value of the marginal cost of firm creation.⁷

I impose symmetry across entrepreneurs, such that optimality conditions simplify

⁷Proceeding as in Ghironi and Stebunovs (2010), the number of entrants $n_{e,t}(j)$ is strictly positive in every period, implying that the entry condition always holds with equality. I keep the magnitude of exogenous shocks in the economy small enough in order to ensure positive investment at all points in time.

to⁸

$$(c_t^E)^{-\gamma_E} = \beta_E(1 + r_{t+1}^b)E_t[(c_{t+1}^E)^{-\gamma_E}] + \mu_t(1 + r_{t+1}^b), \quad (16)$$

$$q_t = \beta_E E_t \left[(c_{t+1}^E)^{-\gamma_E} \left(\left(1 - \frac{1}{\mu_E} \right) \pi_{t+1}^F + \frac{\chi}{2} \left(\frac{n_{e,t+1}}{n_{t+1}} \right)^2 \right) + (1 - \delta)q_{t+1} \right] \\ + \mu_t \kappa_t n_t \left(1 - \frac{1}{\mu_E} \right) E_t[\pi_{t+1}^F] + \beta_E E_t \left[\mu_{t+1} \kappa_{t+1} n_{t+2} \pi_{t+2}^F \right], \quad (17)$$

$$q_t = (c_t^E)^{-\gamma_E} \left(1 + \chi \frac{n_{e,t}}{n_t} \right), \quad (18)$$

and

$$\mu_t \left(\kappa_t n_t E_t[n_{t+1} \pi_{t+1}^F] - (1 + r_{t+1}^b)b_{t+1} \right) = 0. \quad (19)$$

Conditions (16) and (17) are the intertemporal consumption and investment Euler Equations, respectively. Equation (18) is the firm entry condition and equation (19) represents a complementary slackness condition for the borrowing limit.

Entrepreneurs choose contingent optimal plans $\{c_t^E\}_{t=0}^\infty$, $\{b_{t+1}\}_{t=0}^\infty$, $\{n_{t+1}\}_{t=0}^\infty$, and $\{n_{e,t}\}_{t=0}^\infty$, conform to the optimality conditions (16)–(19), the resource constraint (15), and the transversality condition $\lim_{T \rightarrow \infty} E_t \left[\left(\prod_{k=1}^T \frac{1}{1+r_{t+k}^b} \right) b_{t+T} \right] = 0$.

2.4 Banks

Financial intermediation in the economy is conducted by a continuum of banks of measure one. Banks have two sources to finance lending to entrepreneurs. On the one hand, they raise funds through collecting deposits from private households. On the other hand, they accumulate bank capital through retained earnings in every period.

The market for deposits is perfectly competitive and banks take the deposit interest rate r_{t+1} as given. In contrast, financial frictions in the loan market allow banks to benefit from market power in performing their lending activities. Akin to Gerali, Neri, Sessa, and Signoretti (2010), financial intermediaries act under monopolistic competition in the credit market. They supply differentiated varieties of loans to investors, which are aggregated according to the standard Dixit and Stiglitz (1977) CES aggregator. Thus, total demand of entrepreneurial debt is given by

$$b_{t+1} = \left(\int_{\iota} b_{t+1}(\iota)^{\frac{\epsilon_t-1}{\epsilon_t}} d\iota \right)^{\frac{\epsilon_t}{\epsilon_t-1}},$$

where $b_{t+1}(\iota)$ denotes a specific loan component supplied by bank $\iota \in [0, 1]$, $\epsilon_t > 1$ is an exogenous stochastic variable determining the elasticity of substitution between differentiated loans. This elasticity of substitution is a crucial variable in my analysis. It

⁸In a symmetric equilibrium, all entrepreneurs make identical decisions, such that $c_t^E(j) = c_t^E$, $b_t(j) = \frac{1}{\mu_E} b_t$, $n_t(j) = \frac{1}{\mu_E} n_t$, $n_{e,t}(j) = \frac{1}{\mu_E} n_{e,t}$, and $\mu_t(j) = \mu_t$.

measures the degree of credit market competition and thus determines the extent of financial frictions in the economy. In particular, a higher value of ϵ_t indicates that individual bank loans are more easily substitutable, resulting in more fierce competition among banks. The logarithm of the elasticity of substitution follows an AR(1) process given by

$$\log(\epsilon_{t+1}) = (1 - \rho_\epsilon)\log(\epsilon) + \rho_\epsilon \log(\epsilon_t) + u_{\epsilon,t+1}, \quad \text{with } |\rho_\epsilon| < 1, \quad (20)$$

where ϵ represents the mean elasticity. The disturbance $u_{\epsilon,t+1}$ is i.i.d. normal with zero mean and standard deviation σ_ϵ .

Investors behave optimally and demand a mix of differentiated loans in order to minimise their debt obligations. Let $r_{t+1}^b(\iota)$ denote the interest rate on loans supplied by bank ι . Cost minimisation of creditors implies that bank ι faces a loan demand of

$$b_{t+1}(\iota) = \left(\frac{r_{t+1}^b(\iota)}{r_{t+1}^b} \right)^{-\epsilon_t} b_{t+1}, \quad (21)$$

where $r_{t+1}^b = \left[\int_\iota r_{t+1}^b(\iota)^{1-\epsilon_t} d\iota \right]^{\frac{1}{1-\epsilon_t}}$ determines the average rate charged by banks in the market.

At each date t , banks have to satisfy their balance sheet identity

$$b_t(\iota) = k_t^B(\iota) + d_t(\iota). \quad (22)$$

This accounting identity requires that outstanding bank loans (assets) $b_t(\iota)$ must be equal to the sum of bank capital (equity) $k_t^B(\iota)$ and sight deposits (liabilities) $d_t(\iota)$.

Financial intermediaries cannot raise capital by issuing fresh equity shares. However, they are able to implement dividend policy in order to increase their capital base. During period t , bank ι obtains new equity through retained earnings $\pi_t^B(\iota) - a_t(\iota)$, where $\pi_t^B(\iota)$ denotes bank profits. In addition, it takes into account that the administration or management of equity involves costs equal to a constant fraction $\delta^B \in (0, 1)$ of capital. Consequently, the evolution of bank equity is governed by

$$k_{t+1}^B(\iota) = (1 - \delta^B)k_t^B(\iota) + \pi_t^B(\iota) - a_t(\iota). \quad (23)$$

Financial intermediation is subject to non-interest transaction costs. For instance, we can think of expenses coherent with the acquisition of information about potential creditors or service fees associated with deposit-taking activities. To this end, operating costs are dictated by a function $\Theta_t(\iota)$, which is increasing and concave in both newly issued loans $b_{t+1}(\iota)$ and deposits due in the next period $d_{t+1}(\iota)$.⁹

⁹This assumption implies that the more funds a bank transfers from savers to investors in the economy the more costs it has to bear. However, the marginal increase in intermediation expenses is declining. This is in contrast to Van den Heuvel (2008), who assumes transaction costs that are increasing but

A substantial body of the empirical banking literature suggests that there are non-negligible scale economies in the banking industry.¹⁰ Large financial institutions are able to provide their services in a more efficient way and at lower expenses than their smaller rivals. In general, we can imagine that big banking organisations might benefit from improved diversification of risks (see e.g. Hughes, Mester, and Moon (2001)), an elaborated branch network (see e.g. Berger, Hancock, and Humphrey (1993)), or, at these days, an ultimate bailout insurance because of "too-big-to-fail". Motivated by these insights, I assume that transaction costs $\Theta_t(l)$ are a decreasing function of current bank size, determined by total assets $b_t(l)$.

In light of the above considerations, I specify intermediation costs as

$$\Theta_t(l) = \theta_0 \left(\frac{1}{b_t(l)} \frac{b_{t+1}(l)}{k_{t+1}^B(l)} \right)^{\theta_1}, \quad (24)$$

where $\theta_0 > 0$ defines the weight assigned to operating expenses, and $\theta_1 \in (0, 1)$ is a parameter governing the curvature of the cost function.

Financial intermediaries are owned by the stockholders of the mutual fund, i.e. private households. Therefore, the objective of a typical bank is to maximise the shareholder value. In particular, at each date t , bank l sets the interest rate on its loans $r_{t+1}^b(l)$ and chooses bank capital $k_{t+1}^B(l)$ in order to maximise the net present value of expected future dividend payments. More concisely, the optimisation problem can be stated as

$$\begin{aligned} \max_{r_{t+1}^b(l), k_{t+1}^B(l)} \quad & E_0 \sum_{t=0}^{\infty} \prod_{s=1}^t \frac{1}{(1+r_s)} a_t(l), \\ \text{subject to} \quad & \pi_t^B(l) = (1+r_t^b(l)) b_t(l) + d_{t+1}(l) - (1+r_t) d_t(l) - b_{t+1}(l) - \Theta_t(l), \\ & (2), (21), (22), (23), \text{ and } (24). \end{aligned}$$

Again, I focus on a symmetric equilibrium.¹¹ The optimality condition for the loan interest rate is given by

$$r_{t+1}^b = \frac{\epsilon_t}{\epsilon_t - 1} \left[\underbrace{r_{t+1} + \frac{\theta_0 \theta_1}{b_{t+1}} \left(\left(\frac{b_{t+1}}{b_t k_{t+1}^B} \right)^{\theta_1} (1+r_{t+1}) - \left(\frac{b_{t+2}}{b_{t+1} k_{t+2}^B} \right)^{\theta_1} \right)}_{\text{Marginal Cost of Lending}} \right]. \quad (25)$$

Imperfect competition in the credit market facilitates banks to charge a mark-up of convex in loans and deposits.

¹⁰Evidence on scale and scope economies in financial institutions is fairly mixed. For a review on efficiency in financial firms see for instance Berger and Humphrey (1997) and more recently Fethi and Pasiouras (2010).

¹¹Symmetry among banks and normalisation of the measure of banks to one imply that $r_{t+1}^b(l) = r_{t+1}^b$, $b_{t+1}(l) = b_{t+1}$, $d_{t+1}(l) = d_{t+1}$, $k_{t+1}^B(l) = k_{t+1}^B$, and $\pi_{t+1}^B(l) = \pi_{t+1}^B$.

$\frac{\epsilon_t}{\epsilon_t - 1}$ over marginal cost of lending. Banks take into account that an expansion of loan supply has two converse impacts on their operating expenses. Additional loan supply directly lifts intermediation costs today. This effect is represented by the first term in parentheses on the right-hand side of equation (25). Moreover, an increase in assets *ceteris paribus* dampens transaction costs in the next period, because of scale economies. This effect is captured by the second expression in parentheses on the right-hand side of equation (25).

The first-order condition with respect to bank capital is

$$\underbrace{2}_{\text{Marginal Cost of Bank Capital}} = \underbrace{\frac{\theta_0 \theta_1}{k_{t+1}^B} \left(\frac{b_{t+1}}{b_t k_{t+1}^B} \right)^{\theta_1}}_{\text{Marginal Benefit of Bank Capital}} + \frac{2 + r_{t+1} - \delta^B}{1 + r_{t+1}}. \quad (26)$$

Financial intermediaries increase their capital position until the value of additional equity is offset by its marginal cost. Funding loans through capital is costly as it reduces today's cash flow to shareholders. However, banks internalise that an expansion of the capital base allows to cut sight deposits and thereby operating expenses (first expression on the right-hand side of equation (26)). Furthermore, an increase in bank equity leads to higher capital in the next period and consequently raises future dividend payments (second term on the right-hand side of equation (26)).¹²

Owing to the fact that banks are identical, equations (22) and (23) as well as bank profits become

$$b_t = k_t^B + d_t, \quad (27)$$

$$k_{t+1}^B = (1 - \delta^B) k_t^B + \pi_t^B - a_t, \quad (28)$$

and

$$\pi_t^B = (1 + r_t^b) b_t + d_{t+1} - (1 + r_t) d_t - b_{t+1} - \Theta_t, \quad (29)$$

respectively.

2.5 General Equilibrium

To close the model, all markets have to be cleared at every date t . Equilibrium in the market of shares in the mutual fund implies that $x_t = x_{t+1} = 1$. As a result, the budget constraint of the representative private household (1) simplifies to

$$c_t^H + d_{t+1} = (1 + r_t) d_t + a_t + w_t l_t. \quad (30)$$

¹²Condition (26) illustrates that the introduction of intermediation costs is also sensible from an analytical point of view. The properties of the underlying cost function $\Theta_t(\iota)$ ensure that banks are willing to keep a positive amount of bank capital at every point in time. Higher bank capital reduces dividend payments. Intuitively, banks would never have an incentive to finance loans through equity, if collecting sight deposits was free of charge.

The budget constraints of entrepreneurs can be aggregated to

$$\mu_E c_t^E + n_{e,t} + (1 + r_t^b) b_t + \frac{\chi}{2} \left(\frac{n_{e,t}}{n_t} \right)^2 n_t = n_t \pi_t^F + b_{t+1}. \quad (31)$$

Consequently, aggregate resource constraint in the economy can be derived as

$$c_t^H + \mu_E c_t^E + n_{e,t} + \frac{\chi}{2} \left(\frac{n_{e,t}}{n_t} \right)^2 n_t + \Theta_t + k_{t+1}^B - (1 - \delta^B) k_t^B = w_t l_t + n_t \pi_t^F. \quad (32)$$

The interpretation of the aggregate resource constraint is similar to any standard general equilibrium model. Consumption plus investment in both new firms and bank capital (left-hand side of equation (30)) must be funded by wage income and dividend income from the firm portfolio (right-hand side of equation (30)). Finally, final good market clearing requires that

$$y_t = w_t l_t + n_t \pi_t^F. \quad (33)$$

According to Walras' Law, once all markets for goods and assets are in equilibrium, the labour market will be cleared implicitly:

$$l_t = \frac{1}{z_t} n_t k_t. \quad (34)$$

2.6 Model Solution

The structural model forms a system of 23 non-linear expectational difference equations in 23 variables. This system is featured by conditions (2), (3), (4), (6), (7), (8), (9), (10), (12), (14), (16), (17), (18), (19), (20), (25), (26), (27), (28), (29), (31), (32), and (33). The model includes three exogenous state variables (z_t , ϵ_t , and κ_t), and five endogenous state variables (r_t , b_t , n_t , k_t^B , and r_t^b). The remaining 15 variables (c_t^H , c_t^E , w_t , π_t^F , π_t^B , v_t , y_t , q_t , k_t , p_t , l_t , $n_{e,t}$, μ_t , d_t , and a_t) are controls.

Since there is no closed-form solution to this problem available, the solution has to be approximated. To this end, I log-linearise the system around its deterministic steady state and solve the resulting log-linear approximation using the modified Blanchard and Kahn (1980) methodology suggested by Klein (2000). This renders a state space representation of the structural model, where the variables are expressed in terms of log deviations from steady state.

3 Calibration

To make the model amenable for empirical analysis, I next assign parameter values. The twelve structural parameters (β , β_E , γ , γ_E , ξ , μ_E , δ , ϕ , χ , δ^B , θ_0 , θ_1) as well as

the parameters governing the three stochastic processes ($\rho_z, \sigma_z, \rho_\kappa, \sigma_\kappa, \rho_\epsilon, \sigma_\epsilon, z, \epsilon, \kappa$) are calibrated so as to make the setup consistent with empirical macro and micro regularities in the U.S.

Calibrated values are reported in Table 1. For the standard preference parameters, I choose conventional values. I count the time unit t as years and set β equal to 0.96 in order to match an annual real risk-free deposit rate of about 4 percent. The subjective discount factor of investors β_E is fixed at 0.90, which lies between the annualised values selected by Carlstrom and Fuerst (1997) and Iacoviello (2005). Furthermore, I assume that private agents and entrepreneurs do not distinguish in their risk attitude and set both γ and γ_E equal to one.

Without loss of generality, the mean value of labour productivity z is normalised to one. In addition, consistent with evidence from empirical micro studies (see e.g. Juster and Stafford (1991)), I pin down l at 0.3, implying that private households spend roughly two thirds of their time as leisure. The elasticity of substitution in the intermediate good sector ϕ is set equal to 5 in order to obtain a price mark-up over marginal cost of 25 percent.¹³ According to an empirical study by Bernard, Redding, and Schott (2010), the annual product destruction in the U.S. amounts to 8.8 percent. Therefore, I choose an exogenous business closure rate δ of 0.088. Regarding the degree of investment adjustment costs, I follow Schmitt-Grohé and Uribe (2003) and set $\chi = 0.028$.

The model constrains the choice of ξ , the consumption weight in the utility of private households. This parameter does not only play a role for the model dynamics but also features important scale effects with respect to the long-run equilibrium. Therefore, I choose $\xi = 0.3022$ to approximate an entrepreneurial debt to income ratio of 53 percent, which is close to the corporate leverage ratio in the data observed by Bernanke, Gertler, and Gilchrist (1999). Furthermore, I calibrate the mean value of the collateral shock variable κ at 10 to deliver a reasonable capital to output ratio of about 2. Based on this parametrisation, the number of entrepreneurs μ_E can then be derived from the steady state versions of the investment Euler Equation (17) and the firm entry condition (18).

The parameters characterising the banking sector are harder to define since there are no applicable values in previous studies. I set the parameter determining the curvature of the intermediation cost function θ_1 equal to 0.5.¹⁴ Moreover, I fix the *pre-deregulation* elasticity ϵ , the weight of intermediation cost θ_0 and the depreciation rate of bank capital δ^B to hit four steady state targets: (i) a bank equity-to-asset ratio of 6 percent, which corresponds to the mean capital ratio of U.S. banks between 1970 and

¹³There is no customary value for ϕ in the macro literature. Ghironi and Melitz (2005) argue that a mark-up as high as 35 percent is reasonable in models without any fixed cost, whereas Rotemberg and Woodford (1992) suggest a premium of only 20 percent.

¹⁴Admittedly, the selection of this parameter value is somewhat ad hoc. Nonetheless, robustness checks have shown that the model's performance is rather insensitive to the choice of θ_1 .

Table 1: CALIBRATED VALUES

β	discount factor households	0.96	θ_1	curvature of intermediation costs	0.5
β_E	discount factor entrepreneurs	0.90	z	mean value of labour productivity	1
γ	curvature of household utility	1	ϵ	mean elasticity of loan demand	1.6441
γ_E	risk aversion of entrepreneurs	1	κ	mean of collateral shock variable	10
ξ	consumption weight in utility	0.3022	ρ_z	productivity shock persistence	0.7
μ_E	number of entrepreneurs	1.5708	ρ_ϵ	bank competition shock persistence	0.2
δ	business closure rate	0.088	ρ_κ	collateral shock persistence	0.6
ϕ	subst. elasticity capital goods	5	σ_z^2	variance of productivity shocks	0.0001
χ	adjustment costs	0.028	σ_ϵ^2	variance of bank competition shocks	0.5
δ_B	depreciation bank capital	0.08	σ_κ^2	variance of collateral shocks	0.01
θ_0	weight for intermediation costs	5.4989e-06			

1981 reported by Tarullo (2008); (ii) an annualised lending rate of 10.71 percent, the average real bank prime loan interest rate between 1975 and 1985 in the U.S.;¹⁵ (iii) a bank profit to capital ratio of 10 percent; as well as (iv) a dividend payout ratio of 20 percent.

Calibration of the parameters describing the exogenous processes is not self-evident. I therefore assign values to ensure that both real and financial shocks play a non-negligible role in driving the dynamics in the model. My parametrisation implies that shocks to labour augmenting technology account for more than 50 percent in the variation of output and consumption in the pre-deregulation era. Conversely, investment in new firms and demand for bank loans are mainly driven by collateral shocks and disturbances in bank competition. My prior is that in 'normal' times, i.e. when no banking reforms occur, shocks to the elasticity of substitution between differentiated loans are not very long-lasting. Productivity and collateral disturbances, however, ought to be more persistent. Accordingly, I set $\rho_z = 0.7$, $\rho_\epsilon = 0.2$, and $\rho_\kappa = 0.6$. The variances of the innovations are fixed at $\sigma_z^2 = 0.0001$, $\sigma_\epsilon^2 = 0.5$, and $\sigma_\kappa^2 = 0.01$.

4 Banking Deregulation

I now turn to the banking deregulation exercise. Prior to deregulation, geographical barriers on bank entry and expansion allowed banks to benefit from quasi-monopoly power in their local markets. The removal of these restrictions triggered a consolidation in the U.S. banking industry. Although the overall number of institutions declined, the number of branches has increased remarkably. As a consequence, these regulatory changes have been followed by greater availability of financial services and enhanced competition among banks (see Berger, Kashyap, and Scalise (1995)).

In the following, the aforementioned regime switch is simulated as a one-time per-

¹⁵The calculation of the real prime lending rate is based on data from the International Financial Statistics (IFS).

manent increase in the elasticity of substitution between differentiated loans ϵ , implying a permanent reduction of the market power of banks. Since I focus on a closed economy setup, I do not distinguish between intra- and interstate deregulation in the model. I pin down the magnitude of the liberalisation shock to impose a long-run erosion of the bank capital ratio by 70 basis points. This choice is consistent with recent empirical evidence by Hanson, Kashyap, and Stein (2010). They use bank data from Call Reports over the period from 1976 to 1994 to analyse how the relaxation of entry restrictions influenced bank capitalisation. They show that the transition to inter- and intrastate branching induced a drop in the average capital ratio of about 0.2 and 0.3 percentage points, respectively. Furthermore, their results suggest that the impact of financial integration varies considerably across the distribution of bank equity. The total decline in the 25th and 75th percentile of the capital ratio is, respectively, 0.28 and 0.92 percentage points. Thus, my calibration of the deregulation shock appears to constitute a sensible numerical experiment.

4.1 Steady State Effects

Let us first discuss the long-run implications of banking liberalisation. Table 2 summarises the steady state effects of selected variables. An increase in the elasticity of substitution reduces the mark-up in the loan market, such that the lending interest rate falls. Lower borrowing costs permanently alleviate investors' access to external finance. They have an incentive to demand more credit from banks in order to fund a greater number of firm start-ups. This additional investment in entrants is accompanied with an increase in the total number of firms in the economy. As there are more competitors in the intermediate good sector, market share and thereby profits of each producer shrink. In principle, larger portfolio size and lower firm profits have opposite repercussions on total dividend income of entrepreneurs. Nevertheless, portfolio expansion outweighs the decline in firm profits, such that overall earnings of investors go up, which induces them to raise consumption.

Banks have to fund their increased loan position. Long-run equilibrium levels of bank equity and deposit interest rate are solely determined by constant parameters and do not alter.¹⁶ As a result, the expansion of the bank balance sheet is captured by a one-to-one increase in sight deposits. Moreover, augmented competition in the credit market makes bank lending less profitable, because banks are no longer able to charge high loan premia. Eventually, their unique source of revenue dries up to a large extent and profits plunge.

¹⁶Steady state bank capital and deposit interest rate can be derived as $k^B = \left(\frac{\theta_0 \theta_1}{1 - \beta(1 - \delta^B)} \right)^{\frac{1}{1 + \theta_1}}$, and $r = \frac{1}{\beta} - 1$.

Table 2: LONG-RUN EFFECTS OF BANKING DEREGULATION

ϵ	mean elasticity of loan demand	35.12	q	shadow price of investment	-2.18
r^b	loan interest rate	-28.81	c^E	entrepreneurial consumption	2.23
r	deposit interest rate	0.00	π^F	firm profits	-5.39
b	loans	13.21	k	intermediate good input	-7.17
d	deposits	14.05	p	intermediate good price	1.91
k^B	bank capital	0.00	w	wages	1.91
π^B	bank profits	-48.76	l	labour supply	0.13
n_e	firm entrants	7.86	c^H	household consumption	1.74
n	firm number	7.86	y	output	2.04

Notes: Percentage changes compared to initial steady state levels.

Steady state changes of the remaining variables can be simply explained by our knowledge from basic economic theory. The representative final good producer employs less of each capital good, because there is a larger measure of differentiated inputs available. Lower demand for each variety lifts their corresponding marginal product, such that prices go up. Since the price of capital goods is determined through a constant mark-up over marginal cost, the relative increase in prices and wages must be equal. In turn, the rise in wages boosts both labour supply and consumption of the representative household. Finally, market clearing requires that the increase in consumption and investment is met by higher output.

4.2 Dynamic Analysis

Figures 1 and 2 present selected impulse responses to the deregulation shock. The vertical axis shows the percentage deviations from the initial steady state. The horizontal axis indicates the number of quarters after the shock.

Transition dynamics of investment in new enterprises exhibit a hump-shaped pattern. Entrepreneurs realise that greater firm portfolio and cheaper credit will lead to permanently higher income. Accordingly, the portfolio expansion effect outweighs the profit destruction externality in the short-run. This induces a rise in the shadow value of an additional producer and investors have an incentive to fund new entrants. Since firm creation today is more attractive relative to the post-deregulation equilibrium, investment overshoots on impact.

The rise in firm start-ups leads to an increase in the number of enterprises over time. Similar to the model in Ghironi and Melitz (2005), the number of firms plays a central role for the dynamics in the economy. The existence of sunk entry costs, time-to-build lag as well as adjustment costs implies that the number of producers constitutes an endogenous state variable. That is the reason why we do not observe an immediate jump, but a smooth transition to its post-deregulation equilibrium level.

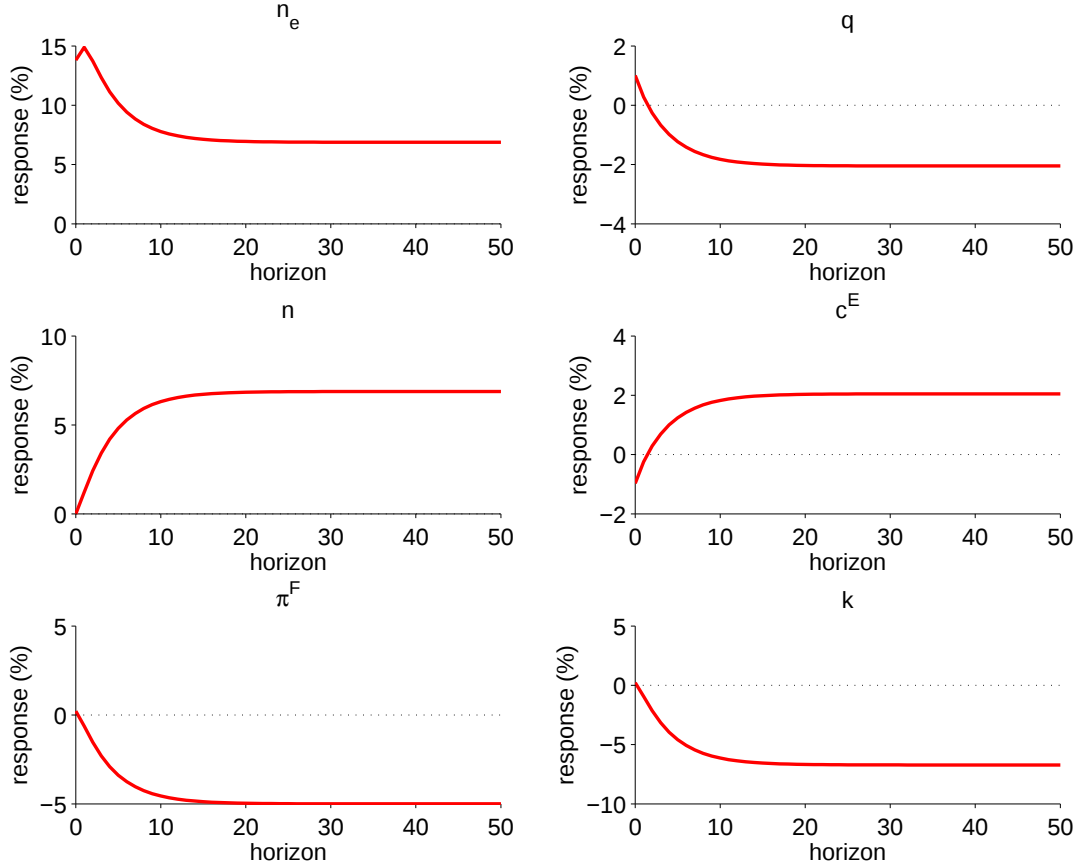


Figure 1: SELECTED IMPULSE RESPONSES TO BANKING DEREGULATION I

As more and more competitors enter the market for intermediate goods, firm profits decline. Consequently, the dominance of the portfolio expansion effect over the profit destruction externality fades away, and firm value and hence investment in entrants converge to their new steady states.

Reduced monopoly power of banks pushes down the loan interest rate on impact.¹⁷ In contrast, entrepreneurs cannot immediately adjust their demand for credit to the post-deregulation steady state level, although external finance has become more attractive. Interestingly, the impulse response of bank loans resembles the smooth transition path of the number of producers. This comovement of loan demand and portfolio size can be attributed to the borrowing limit faced by investors. The expansion of the firm portfolio gradually loosens the borrowing constraint, because (i) the debt-to-income ratio increases, such that more future income can be pledged as collateral; and (ii) total dividend earnings go up, as the rise in the number of firms exceeds the decline in individual profits.¹⁸ Furthermore, since the borrowing limit prevents entrepreneurs from obtaining their desired loan volume in the short-run, they are willing to cut con-

¹⁷Remember that the lending rate as well as bank capital and deposit interest rate are endogenous state variables. Due to the timing convention, these variables do not react at time zero in Figure 2, but with a one-period lag.

¹⁸Consider the log-linearisation of the complementary slackness condition (19) for the borrowing

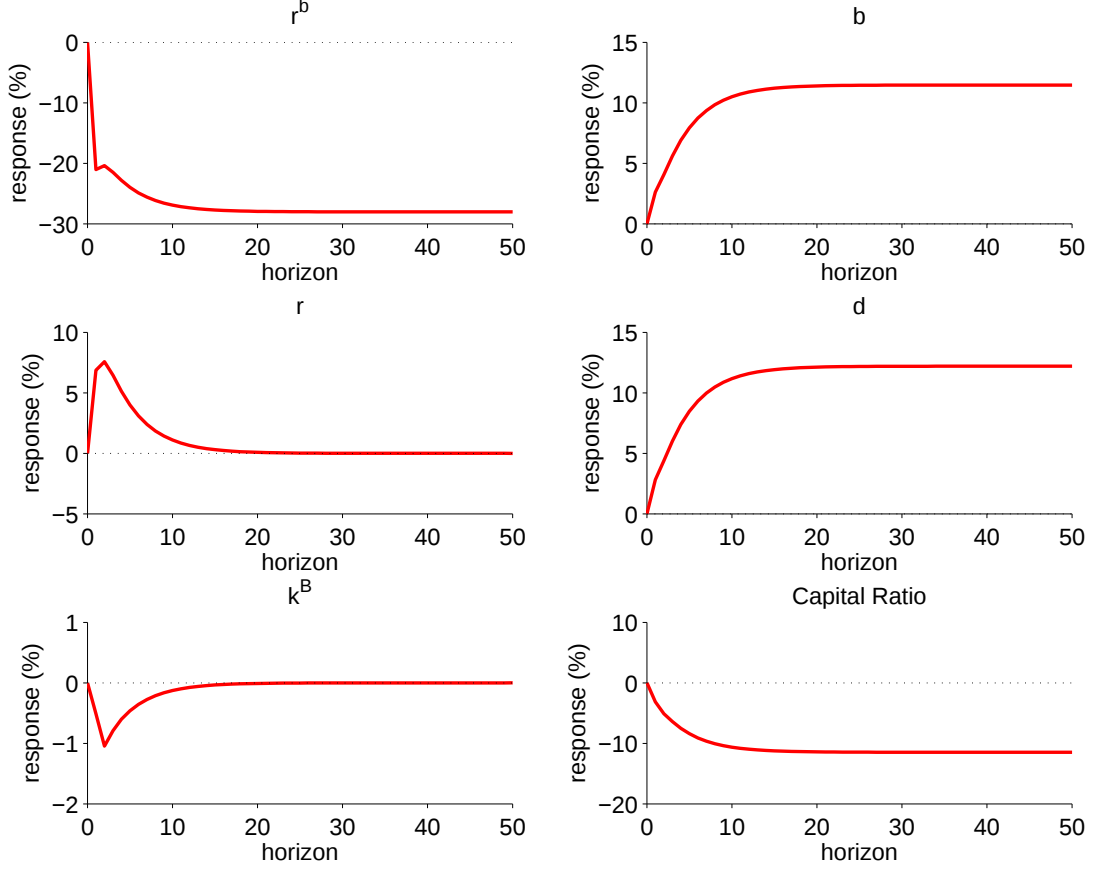


Figure 2: SELECTED IMPULSE RESPONSES TO BANKING DEREGULATION II

sumption initially in order to mobilise additional funds for firm creation.

Private households expect bank profits and dividends to be permanently lower in the future. As a result, the share price of the mutual fund decreases dramatically, which drives up its return in the short-run. No arbitrage requires that a higher return on risky stocks is associated with a lift in the interest rate on safe bank deposits. The jump in the deposit interest rate dominates the sluggish rise in bank loans, such that marginal benefit of bank capital diminishes on impact. Since marginal costs remain unchanged, bank equity must fall.¹⁹ During the transition to the new equilibrium, bank assets in-

constraint:

$$\underbrace{\widehat{\kappa}_t + \widehat{n}_t}_{\text{Increase in DTI ratio}} + \underbrace{\widehat{n}_{t+1} + E_t[\widehat{\pi}_{t+1}^F]}_{\text{Increase in total dividends}} = \frac{r^b}{1+r^b} \widehat{r}_{t+1}^b + \widehat{b}_{t+1},$$

where hatted variables denote log-deviations from steady state. The loan interest rate falls immediately and remains at low levels during the transition. Hence, the upgrade of the DTI ratio and the rise in dividend earnings translate into an increase in bank loans.

¹⁹Recall the first-order condition with respect to bank capital in equation (26). The log-linearised version of this condition is

$$\frac{1+\theta_1}{k^B} \widehat{k}_{t+1}^B = \theta_0 \theta_1^2 (\widehat{b}_{t+1} - \widehat{b}_t) - \beta(1-\beta)(k^B)^{\theta_1} (1-\delta^B) \widehat{r}_{t+1}.$$

Based on the calibration described above, the factor in front of $(\widehat{b}_{t+1} - \widehat{b}_t)$ is smaller than the term in

crease gradually, whereas the return on deposits declines. As a consequence, the initial drop in the marginal benefit of bank capital vanishes over time and bank equity converges back to its old steady state. Eventually, the capital ratio falls due to an expansion of the bank balance sheet.

On a first glance, the predictions of the model are qualitatively concurrent with various empirical observations on the U.S. branching deregulation from the 1970s through the 1980s. Consistent with findings in previous literature, the model suggests (i) an increase in the number of incorporations (see Black and Strahan (2002), Kerr and Nanda (2009)); (ii) a reduction in the size of non-financial firms (see Cetorelli and Strahan (2006)); (iii) a decline in borrowing interest rates, while deposit interest rates remain unchanged (see Jayaratne and Strahan (1998)); as well as (iv) a positive effect on employment, output and personal income (see Beck, Levine, and Levkov (2010), Jayaratne and Strahan (1996)). However, in the theoretical economy, financial liberalisation is also associated with a sharp decline in bank profits. This finding seems to be at odds with what we observe the data. For instance, Jayaratne and Strahan (1998) show that the removal of branching restrictions led to a slight, although insignificant, increase in the profitability of commercial banks.

Having stressed that the model succeeds in *qualitatively* matching the empirical long-run effects of deregulation on certain variables, the next section discusses the *quantitative* implications of the framework in greater detail.

5 Empirical Evaluation of the Model

The comparison of pre- and post-deregulation steady states in the previous section provides an insight on how bank market integration affects various economic variables in the long-run. Nonetheless, this approach represents a fairly ad hoc way to evaluate the empirical performance of the model. It is also natural to ask whether the setup can capture other well-recognised ramifications of U.S. banking deregulation, such as the stabilisation of macroeconomic fluctuations or improved risk sharing.

In this section, I will scrutinise the empirical validity of the model in a more elaborate manner. Specifically, to gauge the model's potential in explaining certain empirical facts, I construct artificial panel data and reproduce miscellaneous regression exercises implemented in previous studies. In doing so, I try to bridge the gap between the present theoretical framework on the one hand, and a pure empirical approach followed by the existing literature on the other.

front of $\widehat{r_{t+1}}$. Accordingly, the initial increase in the deposit interest rate outweighs the effect of higher bank loans, such that bank equity declines.

5.1 Data Generation

The prohibition of intra- and interstate banking in the U.S. was imposed by a multitude of different state and federal laws. As a consequence, the relaxation of geographical barriers to bank expansion across states occurred at different points in time. This cross-sectional and time variation in liberalisation made it convenient for researchers to examine the effects of the banking reform through panel regressions. On this account, I simulate the theoretical economy 500 times for 50 U.S. states and the District of Colombia. I therefore obtain 500 panel data sets covering 51 states in the cross-section over 130 years. For each state, I use the model of the pre-deregulation era to generate data until the year in which statewide branching via mergers and acquisitions was allowed. From that year onwards, I switch to the post-deregulation economy setup. Deregulation dates are taken from Demyanyk, Ostergaard, and Sørensen (2007) and can be found in the Appendix.²⁰

5.2 Firm Entry and Size

I first consider to what degree the regime switch affects investment in new firms and the size of a producer. To facilitate comparison, I follow Kerr and Nanda (2009) and implement the simple reduced-form panel regression

$$Y_{s,t} = \alpha_s + \alpha_t + \beta \cdot D_{s,t} + \epsilon_{s,t}, \quad \text{for } s = 1, \dots, 51, \quad (35)$$

where $Y_{s,t}$ is the dependent variable of interest in state s and year t , and stands for the logs of the number of firm entrants n_e , total number of firms n , or size of an individual firm, measured by its production volume k , respectively. α_s and α_t denote dummy variables that control for state and time fixed effects, $D_{s,t}$ is an indicator variable which takes the value 1 from the year in which the state deregulates and 0 otherwise, and $\epsilon_{s,t}$ is the error term. Thus, the coefficient β determines by how much the respective dependent variable changes, once a state lifts its branching restrictions.

Since, I estimate equation (35) using model generated panel data I end up with 500 different estimation results for each specification in (35). Table 3 documents the regression output associated with the median estimate for the β coefficient in front of the deregulation dummy. To get an idea of how disperse the estimation results are, I also report the 10th and 90th percentile of the estimates in brackets.

From the discussion in Section 4 we expect increased firm creation and smaller firm size in the aftermath of financial liberalisation. This is indeed what Table 3 reveals. The

²⁰Of course, it does not matter at all whether I use the year of intra- or interstate deregulation to date the regime switch in the simulation. Here, I have chosen the year of *intrastate* deregulation. Note that a few states permitted intrastate branching already before the 1970s. For these states I fix the year of deregulation at 1970.

Table 3: FIXED EFFECTS REGRESSIONS: IMPACT OF BANKING DEREGULATION ON NON-FINANCIAL FIRMS ENTRY AND SIZE

	Dependent Variables		
	(I) Firm Startups	(II) Total Firm Number	(III) Firm Size
Deregulation	7.48*** (2.77) [4.64* / 10.54***]	7.55*** (18.30) [6.29*** / 8.92***]	-7.42*** (17.01) [-8.67*** / -6.25***]
R^2	0.03	0.33	0.31
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	6,630	6,630	6,630
Simulations	500	500	500

Notes: Table reports the results of the fixed effects panel regressions $Y_{s,t} = \alpha_s + \alpha_t + \beta \cdot D_{s,t} + \epsilon_{s,t}$, for $Y = \{\log(n_e), \log(n), \log(k)\}$. The dependent variables in model (I), (II), and (III) are the logs of new firm start-ups, total number of firms, and firm size, respectively. Regression output in each specification, presents the median results for the estimate of the β coefficient in front of the deregulation dummy. The values in brackets correspond to the 10th and 90th percentile of the estimates for the β coefficient. Slope coefficients are multiplied by 100. Absolute values of t-statistics are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

estimate of the median slope coefficient on the deregulation dummy is significant at the 1% level in all regressions. In the model for firm entrants, the lower and upper percentiles of the β coefficient range from 4.64 percent to 10.54 percent. Results are similar if we look at the total number of firms as dependent variable. In this specification, the 10th and 90th percentile of the estimate are 6.29 percent and 8.92 percent. As a matter of fact, these findings mirror the results reported by Black and Strahan (2002) and Kerr and Nanda (2009). Examining data from Dun and Bradstreet (D&B), Black and Strahan (2002) show that the removal of intra- and interstate branching restrictions led to an increase in the number of new incorporations of 3.8 percent and 7.9 percent, respectively. As a comparison, Kerr and Nanda (2009) propose that the relationship between banking liberalisation and the creation of non-financial enterprises is weaker. They use data from the Longitudinal Business Database (LBD) and find that total firm entries increased by only 6 percent after interstate banking was permitted, whereas intrastate deregulation had virtually no effect. Lastly, column (III) in Table 3 indicates that the simulated model somewhat understates the effect on firm size. Output volume of an individual producer, which serves as a proxy for the size of a typical firm, decreases by about 6 to 8 percent after deregulation. In a recent paper, Cetorelli and Strahan (2006) use the number of employees in manufacturing establishments to analyse the impact on the size of production sites. Overall, the average establishment has shrunk by as much as 12.3 percent after the relaxation of state- and nationwide

branching restrictions.

By and large, estimation results in Table 3 illustrate that the theoretical model indeed manages to not only qualitatively but also quantitatively replicate the effects of deregulation on firm entry and firm size.

5.3 Business Cycle Volatility

Next, I want to explore in how far my model helps to understand the relationship between financial liberalisation and macroeconomic volatility. To measure the impact of bank market integration on state business cycle volatility, I build on the approach adopted by Morgan, Rime, and Strahan (2004). That is, I perform fixed effects panel regressions of the simple form:

$$Y_{s,t} = \alpha_s + \alpha_t + \beta \cdot D_{s,t} + \epsilon_{s,t}, \quad \text{for } s = 1, \dots, 51. \quad (36)$$

The dependent variable $Y_{s,t}$ is the fluctuation in the growth rate of output, income of private households or income of entrepreneurs, respectively. Fluctuations are determined by the absolute deviation from the conditional mean growth of the corresponding variable. To estimate conditional mean growth rates, I run the auxiliary regression

$$\Delta \log(X_{s,t}) = \gamma_s + \gamma_t + \delta \cdot D_{s,t} + \eta_{s,t}, \quad \text{for } s = 1, \dots, 51, \quad (37)$$

where $X_{s,t}$ equals output, household labour income and entrepreneurial portfolio income, respectively, in state s at time t . That is, the conditional mean growth rates are fitted by regressing first differences in logs of each variable on state fixed effects γ_s , time fixed effects γ_t , and the deregulation dummy $D_{s,t}$. Thus, growth fluctuations in equation (36) can be calculated by the absolute value of the residuals in auxiliary regression (37), i.e.

$$Y_{s,t} = |\eta_{s,t}|. \quad (38)$$

Results are displayed in Table 4. My findings support the notion that banking deregulation leads to a stabilisation of variations in output and income growth. The coefficient on the deregulation dummy enters highly significant in all regressions. The estimated effects are also economically sizeable. Column (I) presents the results for output growth fluctuations. The removal of entry restrictions in the banking industry reduces output growth volatility by about 0.07 to 0.25 percentage points. The effect is even stronger if we look at the volatility in income of households and entrepreneurs in columns (II) and (III). Evidently, capitalists are not only the chief beneficiaries from a liberalisation of the banking sector due to lower borrowing costs, but also in terms of reduced variability in their portfolio income. The median estimate of the β coefficient

is -0.96 in the regression for entrepreneurial income growth variations compared to -0.46 for labour income growth variations.

Table 4: FIXED EFFECTS REGRESSIONS: IMPACT OF BANKING DEREGULATION ON STATE BUSINESS CYCLE FLUCTUATIONS

	Dependent Variables		
	(I) Output Fluctuations	(II) HH Income Fluctuations	(III) Entr. Income Fluctuations
Deregulation	-0.1610^{**} (2.4556) [-0.2495^{***} / -0.0714]	-0.4600^{***} (5.1530) [-0.6016^{***} / -0.3464^{***}]	-0.9637^{***} (5.3411) [-1.2074^{***} / -0.7287^{***}]
R^2	0.0341	0.0495	0.0501
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	6,579	6,579	6,579
Simulations	500	500	500

Notes: Table reports the results of the fixed effects panel regressions $Y_{s,t} = \alpha_s + \alpha_t + \beta \cdot D_{s,t} + \epsilon_{s,t}$. The dependent variables in model (I), (II), and (III) are fluctuation in output, household labour income and entrepreneurial portfolio income. Fluctuations are determined by the absolute deviation from conditional mean growth in the corresponding variable. Regression output in each specification, presents the median results for the estimate of the β coefficient in front of the deregulation dummy. The values in brackets correspond to the 10th and 90th percentile of the estimates for the β coefficient. Slope coefficients are multiplied by 100. Absolute values of t-statistics are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

In a nutshell, estimation results in Table 4 closely reflect the empirical findings in Morgan, Rime, and Strahan (2004). Their analysis shows that the transition to inter- and intrastate branching reduced growth fluctuations in the gross state product by 0.6 and 0.2 percentage points. This effect is a bit stronger than my simulated economy suggests. Regarding the volatility in personal income growth they report a decline by 0.5 (0.1) percentage points after interstate (intrastate) deregulation, which is very close to the estimates I obtain in the regression for labour income fluctuations of private households.

How can we explain the moderation of the business cycle followed by the opening up of the banking market? In principle, the influence of deregulation on economic volatility in the model is ambiguous. Banking deregulation changes the severity of shocks in different ways. For instance, consider a positive transitory shock to bank competition. An increase in the elasticity of substitution between loans temporarily pushes down the borrowing interest rate, inducing entrepreneurs to expand their demand for credit and to increase investment new firms. As we know, enhanced firm entry eventually translates into higher income and consumption for both entrepreneurs and households. However, it is important to note that after the banking

reform, the steady state level of the borrowing interest rate is lower. This implies that the relative drop in r^b is smaller, which curbs the effect on lending, investment, income and consumption. A similar line of reasoning applies if we look at a shock to labour-augmenting technology. As productivity of workers goes up, firm production and profits increase. This creates incentives for investors to finance new firm start-ups. Recall from Section 4 that banking deregulation leads to a permanent fall in the shadow value of an additional producer. Intuitively, an entrepreneur's marginal benefit of funding new firm entrants is lower compared to the pre-deregulation era, attenuating the portfolio expansion effect induced by the positive productivity shock. That means, the relative increase in investment is muted, and so is the respective rise in income and consumption. In contrast, the effects of a collateral disturbance become more pronounced once the banking industry is liberalised. A positive collateral shock lifts the borrowing limit as banks are more willing to accept future portfolio earnings as securities. Consequently, loan demand and investment go up, while the cost of credit decreases. The fact that credit is permanently cheaper after the regime switch actually reinforces the decline in the loan interest rate.²¹ This, in turn, intensifies the boost in bank credit and firm entry relative to the pre-deregulation economy.

In the present calibration exercise, the dampening effects of productivity and bank competition shocks after the reform outweigh the amplifying responses associated with disturbances in the collateral value. This predominance of technology and competition shocks in driving the dynamics in the model accounts for the overall stabilisation of the business cycle.

5.4 Risk Sharing

Lastly, I now examine the impact of banking deregulation on risk sharing. Individuals face substantial income uncertainty over the business cycle. People benefit from higher wealth in booms, but suffer from lower endowment during recessions. The services provided by banks, however, allow agents to buffer their consumption against income shocks. In particular, households and entrepreneurs can transfer cash flows across time through the trade of non-contingent financial assets in form of sight deposits and loans, respectively. Having shown that banking deregulation reduces macroe-

²¹This effect becomes more clear if we re-consider the log-linearised expression for the complementary slackness condition (19) for the borrowing constraint:

$$\widehat{\kappa}_t + \widehat{n}_t + \widehat{n}_{t+1} + E_t[\widehat{\pi}_{t+1}^F] = \frac{r^b}{1+r^b} \widehat{r}_{t+1}^b + \widehat{b}_{t+1}.$$

Note that the term in front of relative change in the loan interest rate $\widehat{r}_{t+1}^b$ is lower after deregulation. Hence, changes in the collateral shock variable κ , ceteris paribus, lead to stronger reactions in the cost of borrowing.

conomic volatility, it is now natural to ask whether financial liberalisation can also help agents to better diversify their consumption risk.

To test how deregulation affects consumption risk sharing, I build on the empirical model described in Hoffmann and Shcherbakova-Stewen (2009):²²

$$\Delta \widetilde{c}_{s,t}^k = \alpha_s + \alpha_t + \beta_1 \cdot \Delta \widetilde{y}_{s,t} + \beta_2 \cdot D_{s,t} + \beta_3 \cdot \Delta \widetilde{y}_{s,t} \cdot D_{s,t} + \epsilon_{s,t}, \quad \text{for } k = \{H, E\}, \quad (39)$$

where variables with a tilde denote log deviations from the average across all states. That is, $\Delta \widetilde{c}_{s,t}^H \equiv \Delta \log \left(\frac{c_{s,t}^H}{c_t^H} \right)$, $\Delta \widetilde{c}_{s,t}^E \equiv \Delta \log \left(\frac{c_{s,t}^E}{c_t^E} \right)$, and $\Delta \widetilde{y}_{s,t} \equiv \Delta \log \left(\frac{y_{s,t}}{y_t} \right)$, where c_t^H , c_t^E , and y_t stand for the national average of per capita household consumption, entrepreneurial consumption, and output, respectively. Again, α_s and α_t control for state and time fixed effects, $D_{s,t}$ is the deregulation dummy variable, and $\epsilon_{s,t}$ is the error term.

In equation (39), I regress $\Delta \widetilde{c}_{s,t}^k$ on state output growth relative to the mean growth in the cross section instead of relative household or entrepreneurial income growth. Since output equals total income in the theoretical economy (see equation (32)), output changes are associated with direct endowment shocks for both groups of agents. Hence, the specification in regression (39) serves as a convenient approach to assess the risk sharing pattern in the model. The fact that output is highly correlated with personal income also explains why I focus on consumption risk sharing rather than income insurance. Per construction, individuals cannot hedge their labour or capital income stream against state-specific business cycle shocks, such that an analysis of income risk sharing would not be very enlightening. Besides, it is changes in consumption and not income that determines how severely people are affected by economic up- and downturns. In this vein, the choice of relative consumption growth as dependent variable appears to be more reasonable.

As Hoffmann and Shcherbakova-Stewen (2009) point out, panel regressions of this structure have become very popular in empirical macroeconomic research on the completeness of financial markets. In this setup, the coefficient β_1 usually takes on a value between 0 and 1 and captures the impact of state income growth on state consumption growth. Therefore, we can easily interpret β_1 as the fraction of state-specific, or idiosyncratic, output risk that is uninsured. With complete markets, all idiosyncratic risk can be diversified away through the trade of state contingent Arrow-Debreu securities. In this case, perfect risk sharing is achieved and consumption growth is independent of state level business cycle risk, i.e. $\beta_1 = 0$. Primary interest of my analysis lies in the magnitude of the coefficient β_3 in front of the interaction between the dereg-

²²Contrary to my analysis here, Hoffmann and Shcherbakova-Stewen (2009) focus on how intrastate deregulation affected the pro-cyclicality of consumption insurance. They find that interstate risk sharing has become less pro-cyclical after the reform.

ulation dummy and state output growth relative to average nationwide output growth. This coefficient measures the (negative) change in consumption insurance once a state lifts its bank entry restrictions. To be more precise, β_1 determines the share of non-diversified idiosyncratic risk *before* deregulation, whereas $(\beta_1 + \beta_3)$ measures the share of uninsured risk *after* deregulation. If deregulation leads to improved risk sharing, the relationship between state level income changes and consumption growth will mitigate, so that $\beta_3 < 0$.

Table 5 shows the estimation results of this exercise. Here, I present the regression output accompanied with the median estimate of the β_3 coefficient on the interaction term. As before, numbers in brackets refer to the 10th and 90th percentile of the respective estimated coefficient.

Let us first consider the pattern of consumption risk sharing of private households summarised in column (I) of Table 5. The median estimate of the coefficient on $\Delta \widehat{y}_{s,t}$ is 0.24 and significant at the 1% level. This means that prior to deregulation, roughly one quarter of idiosyncratic output risk cannot be hedged through financial trading. Interestingly, this figure is pretty close to its empirical counterpart. For instance, based on annual state level data on U.S. per capita consumption and output over the period 1963–2005, Hoffmann and Shcherbakova-Stewen (2009) report an estimate of about 0.2. More importantly, my estimation results suggest that household consumption risk sharing does not change once the banking sector becomes liberalised. Estimates of the β_3 coefficient are virtually zero and statistically insignificant.

Turning to consumption risk of entrepreneurs, the picture is a clearly different one. As can be seen from column (II) in Table 5, consumption insurance of investors is far from perfect. The median estimate of the β_1 coefficient is as high as 0.74 and significant at the 1% level. This implies that entrepreneurs can only hedge around one quarter of state-specific business cycle risk before the regime switch.²³ However, the regulatory change in banking contributes to a considerable improvement in risk sharing of investors. As a matter of fact, deregulation reduces the share of uninsured idiosyncratic shocks by about 9 to 13 percentage points. Also, this effect is economically sizeable and highly significant throughout all regressions.

Estimation results for the simulated economy are to some extent in line with the findings of Demyanyk, Ostergaard, and Sørensen (2007). These authors show that the relaxation of intra- and interstate banking restrictions had a positive impact on personal income insurance. On average, banking deregulation increases the portion of diversified idiosyncratic shocks by around 10 percentage points. The effect is even

²³The model proposes that risk sharing for entrepreneurs is much lower than for private households. In fact, this observation can be supported empirically. For example, Agronin (2003) analyses income risk sharing across U.S. states over the period 1963–1999. He shows that proprietorial income risk is substantially less diversified than non-proprietorial income risk.

Table 5: FIXED EFFECTS REGRESSIONS: IMPACT OF BANKING DEREGULATION ON CONSUMPTION RISK SHARING

	Dependent Variables	
	(I) Household Consumption	(II) Entrepreneurial Consumption
$\Delta \widetilde{y}_{s,t}$	0.2412*** (15.4271) [0.2266*** / 0.2640***]	0.7352*** (83.5828) [0.7253*** / 0.7583***]
$D_{s,t}$	-0.0018 (1.6059) [-0.0020* / -0.0005]	-0.0008 (1.3533) [-0.0013** / -0.0001]
$\Delta \widetilde{y}_{s,t} \cdot D_{s,t}$	0.0037 (0.1693) [-0.0230 / 0.0302]	-0.1102*** (9.3881) [-0.1338*** / -0.0874***]
R^2	0.7262	0.9470
State Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	6,579	6,579
Simulations	500	500

Notes: Table reports the results of the fixed effects panel regressions $\Delta \widetilde{c}_{s,t}^k = \alpha_s + \alpha_t + \beta_1 \cdot \Delta \widetilde{y}_{s,t} + \beta_2 \cdot D_{s,t} + \beta_3 \cdot \Delta \widetilde{y}_{s,t} \cdot D_{s,t} + \epsilon_{s,t}$, for $k = \{H, E\}$. The dependent variables in model (I), (II), and (III) are the log deviations of household, entrepreneurial and total consumption per capita from the national average of the respective variable. Regression output in each specification, presents the median results for the estimate of the β_3 coefficient in front of the interaction term between log deviation of state output from average output and the deregulation dummy. The values in brackets correspond to the 10th and 90th percentile of the estimates for the corresponding coefficient. Absolute values of t-statistics are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

more pronounced in states where small businesses are relatively important. In these states income risk sharing improves by about 20 percentage points. This can be attributed to the importance of bank finance for small enterprises and the close link between personal income of firm owners and firm profits. Furthermore, bank market integration markedly reduces the sensitivity of proprietorial income to state-specific business cycle shocks. As a consequence, it is especially proprietors, or equivalently entrepreneurs in my theoretical economy, who enjoy better diversification following the regime switch.

This leaves us with one question: Why does the model predict an increase in risk sharing of entrepreneurs, whereas private households cannot benefit from enhanced insurance after deregulation? The degree to which agents can spread macroeconomic risks depends on the availability and quality of banking services. Prior to deregulation, high borrowing costs hamper investors' access to external finance. Expensive credit

effectively prevents entrepreneurs from smoothing their consumption through the demand for bank loans. Accordingly, there is limited potential to shift wealth across time, such that income fluctuations directly translate into consumption changes. Financial liberalisation permanently decreases loan interest rates and ameliorates borrowing opportunities. Thus, entrepreneurs can to some extent disentangle their consumption from income and risk sharing increases. In principle, we can think of bank market integration improving insurance, because financial intermediaries now partly absorb the firm portfolio income risk faced by entrepreneurs. Conversely, deregulation does not systematically affect deposit interest rates. Financial trading conditions for private households remain unchanged and hence they cannot improve diversification.

6 Conclusion

Empirical research on the economic effects of the relaxation of intra- and interstate banking limitations has been quite active. Striking, however, is the dearth of theoretical work on this issue. My paper complements this strand of the literature by analysing the macroeconomic implications of banking deregulation from a theoretical perspective. I present a DSGE model with financial frictions and endogenous firm entry that helps to understand the interaction between banking and the rest of the economy. The model emphasises the essential role of financial intermediation for real economic activity. Banks provide plain vanilla financial services: they collect sight deposits from private households, accumulate equity through retained earnings and supply loans to entrepreneurs. The financial system is characterised by monopolistic competition in the credit market. Consequently, banks exploit their market power and charge a high margin on loan interest rates. Financial deregulation spurs competition in the banking sector and thus facilitates credit market access of entrepreneurs.

A key contribution of my analysis is how I connect the theoretical framework to the existing empirical literature. I construct model generated panel data and perform various regression exercises similar to those implemented in related studies. The model accomplishes to explain certain empirical findings. In particular, financial liberalisation is followed by an increase in firm creation, a decline in average firm size, an erosion of the bank capital ratio, lower state business cycle volatility, and an improvement of entrepreneurial risk sharing.

The events of the recent financial crisis have stressed the need for incorporating more sophisticated financial sectors in dynamic macroeconomic models. Banking in my setup is rather stylised. All investors are identical and there is no risk of default. No matter what state of the economy occurs, creditors pay back the full amount of their debt. Financial intermediaries have only one type of assets in their balance sheets

which is totally safe. This is tantamount to saying that banks cannot fail and stability of the financial system is always granted. Naturally, this assumption is a strong simplification of the real economy. It might be interesting to extend the framework along this dimension and study the impact of deregulation on the riskiness of financial institutions.

This paper is a stark reminder of the potential benefits associated with free banking. Today we call for tougher regulation of the financial industry to avoid the recurrence of a global financial meltdown. No doubt, reforming our financial system is inevitable. Nevertheless, policymakers and regulators should not ignore the merits of financial liberalisation when they re-define the regulatory environment for banks.

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