Regulation, competition and banking markets

Professor Stephen P King
Faculty of Business and Economics
Monash University

Professor Rodney Maddock
Department of Economics
Monash University

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Stephen P. King and Rodney Maddock
Monash University
Melbourne, Australia

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Abstract

Banks use a mix of wholesale and deposit funds to finance lending. If a country is a net importer of wholesale funds, then a financial crisis in a foreign country can ‘infect’ the banking system by raising the cost of wholesale funds. Indeed, countries such as Australia imported a crisis through the wholesale funding market in the recent global financial crisis.

We present a model to show how a rise in the costs of wholesale funding can trigger a crisis in an otherwise healthy banking sector. We also consider a range of government policies, such as ‘bailouts’, minimum equity requirements, entry restrictions and limits on wholesale funding, that may be deployed to prevent such a crisis. In particular, we focus on the implications of such policies for the structure and level of competition in banking and the rates paid by borrowers and received by depositors, in ‘normal times’. We show that some policies, such as minimum equity requirements, can stabilise the banking sector, while ad hoc policies, such as debt guarantees or bailouts, destabilise the banking sector. Other policies, such as licensing, can limit competition but have ambiguous implications for bank stability.
1 Introduction

A financial crisis in a one country’s banking system can ‘infect’ the banking system in other countries through a variety of mechanisms. This paper focuses on contagion which operates through international wholesale funding markets.

Banks often use a mix of wholesale and deposit funding to finance lending. The rationale for banks using a mix of funding sources — for example deposits, short-term borrowings, long-term borrowings, securitization and covered bonds — has been extensively discussed in the literature.\(^1\)

Short-term and long-term wholesale funds are a key funding source for banks in a variety of countries. This is illustrated in figure one. The wholesale funding market is international. Thus, changes in the international price for wholesale funds will have consequences for the financial sector in countries across the world.

In this paper, we consider the impact of a sudden, significant rise in the international price of wholesale funds for a country whose banking system is a net importer of those funds. In the short term, the price rise will lead banks to switch towards other sources of funding, such as domestic deposits, and to reduce lending. This, in turn, may lead to bank insolvency as banks are unable to meet existing obligations.

In the longer term, the potential for a funding shock will be taken into account by banks when establishing their operations. Variability in the international price of wholesale funds will change the expected pool of profits for competing banks. This will determine the number of banks that are viable and the degree of competition in the domestic banking sector. Over the longer term, the number of banks operating in a country is endogenous and will depend on both the likelihood of any shock to the cost of wholesale funds and domestic government policies to deal with the potential volatility in the international price of funds.

The aim of this paper is two-fold:

\(^{1}\)See for example, Gorton, G. and Metrick, A. (forthcoming); Affinitio, M. and E. Tagliaferri (2010); and Ambrose, B, M. LaCour-Little, and A. Sanders (2005).
• To develop a model to consider the longer term effects of potential volatility in the international price of wholesale funds on the level of competition and, consequently, the ‘normal’ prices paid by domestic borrowers and received by domestic depositors, for a country that is a net importer of wholesale funds; and

• To analyse the consequences of alternative government policies that are designed to deal with a potential ‘imported crisis’. In particular, how will these policies impact on the operations of the country’s banking system when there is not a crisis and who will ‘win’ and ‘lose’ due to the government policies?

To illustrate the potential for a country to ‘import’ a banking crisis through the international market for wholesale funds, and the interplay with government policy, consider Australia. The Australian banking system overall was highly profitable throughout the 2008 ‘banking crisis’ despite being heavily dependent on world capital markets for its funding, having a housing sector which was among the most over-valued in the world by many measures, and having a bank-centric financial system. The return on equity for the major banks never fell below 10 per cent during the crisis despite the fact that they sourced some 34 per cent of their funding from wholesale markets, one of the highest levels in the world, and the cost of these funds was subject to a very sharp upward movement during the crisis. Funding costs rose sharply with the spread of wholesale borrowing costs over the inter-bank rate increasing by about 40 basis points at short tenor and by about 150 points at longer tenor between June 2007 and June 2010.²

The Australian government responded to the rise in the cost of wholesale funds and the potential to import a crisis in a variety of ways. In October 2008, it both introduced explicit deposit insurance, which had not been part

²For example, in Australia, short-term wholesale debt funding accounted for “more than 30 per cent of total [bank] funding in the middle of 2007” (B. Robertson and A. Rush, 2013). An important feature of the Australian system, however, is its heavy reliance on variable rate mortgages: the banks are more dependent on mortgage lending than most other countries but can raise rates at their discretion.
of the Australian banking system, and guaranteed banks’ wholesale borrow-
ing. This followed similar actions by a number of other countries, beginning
with Ireland.\textsuperscript{3} In the post-crisis period, the Australian authorities have raised
capital requirements, announced an intention to fund its deposit insurance
by a tax on deposits, and imposed D-Sifi rules.

Despite the relative stability of the Australian banking system, such ad
hoc policies, introduced piecemeal in the face of a funding crisis and in re-
response to global issues are unlikely to be optimal. Further, such policies have
long-term implications for the structure of the banking system. The model
developed in this paper is able to analyse the long term consequences of these
types of policies.

In our framework, a bank is established using equity and/or ‘founda-
tion’ debt. The on-going operation of a bank is funded through domestic
retail deposits and the international wholesale market for funds.\textsuperscript{4} The coun-
try takes the wholesale funds rate as given, reflecting its ‘small’ volume of
transactions relative to the world market as a whole.\textsuperscript{5} We will also treat any
offshore borrowing as fully hedged as is substantially the case with Australian
bank borrowings.

In the absence of a crisis, access to international wholesale funds provides
an important addition to domestic deposit savings. As such it lowers the

\textsuperscript{3}When introducing the measures, the government noted that “Recent developments in
the international wholesale funding markets have created acute funding pressures that now
pose potential risks to the total supply of finance to the Australian economy”. See Prime
Minister of Australia (2008). The government also intervened to find a buyer for Bankwest,
a small regional bank owned by a large British bank that was facing financial difficulties.
For background see Australian Competition and Consumer Commission (2008).

\textsuperscript{4}Dividing debt funding into deposits, wholesale funding and ‘foundation’ debt reflects the
different sources, availability and seniority of alternative debt funding.

\textsuperscript{5}We concentrate on the situation where the country, like Australia, is a net ‘borrower’
so wholesale funds fill a gap between domestic deposit funding and domestic lending. If the
country’s banking system had excessive deposits that were lent through the international
wholesale funds market then it could face similar issues to European banks due to holding
assets in crisis hit banks overseas.
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interest rate paid by borrowers and also lowers the interest rate paid to depositors as wholesale funds ‘compete’ with domestic deposits. Overall, accessing wholesale funding will increase bank-funded investment activity (i.e. the quantity rises).

However, a major offshore banking crisis can lead to a significant contraction in the international wholesale funds market. This can occur because of a reduction in supply as potential lenders either hoard liquidity or insist on a much higher risk premium than previously. From the small country’s perspective, the wholesale funds market can even completely cease to be a source of loanable funds. In this case domestic banks will be forced to rely on (relatively expensive and limited) domestic deposit funding, and may not be able to meet their commitments (as happened to Bankwest, HBOS’s subsidiary in the Australian market). In other words, the domestic banks ‘import’ the crisis and risk insolvency through the funding market. This would impose significant costs on depositors, equity and foundation bond holders in banks, and on the broader domestic economy.

Using our framework, we analyse a range of policies that can be implemented by the government to help avoid importing a banking crisis. The policies that we analyse include explicit regulation of the number of banks and other ‘competitive controls’ on the banking system such as minimum equity regulations for banks; limiting a bank’s access to wholesale funds; and ‘bailout policies’ for insolvent banks such as government debt guarantees, cash injections or nationalisation. Importantly, we analyse the impacts of these policies for the domestic banking sector in ‘normal times’ when there is no crisis.

The types of policies we consider have been discussed widely in the literature. For example, competition restrictions have recently been examined by Anginer, D., A. Deirguc-Kunt and M. Zhu (forthcoming) while Carletti, E. and P. Hartmann (2002) provide a survey of the literature on competition and stability of the banking sector. Dermine, J. (1986), uses a framework similar to the one developed here to examine non-performing loans and deposit insurance. Hellman, T., K. Murdock and J. Stiglitz (2000) is one of the many papers that consider deposit insurance in a moral hazard frame-
work. Downing, C., D. Jafee and N. Wallace (2009) consider the effect of
government guaranteed mortgages using an adverse selection framework.

Our contribution is two-fold. First, we explicitly focus on wholesale fund-
ing rates rather than non-performing loans. As such, our model analyses the
import of an overseas banking crisis through the cost of funding rather than
concerns about bad debts. The potential lack of wholesale market liquid-
ity, which drove recent concerns about the banking sector in much of the
Asia-Pacific region and in Canada, differs significantly from standard crisis
transmission mechanisms.\footnote{Indeed, in our model there is no issue of bad debt, moral hazard or adverse selection in banking operations. Interestingly, a range of our results are ‘in line’ with the results of the literature on imperfect information in banking, but arise simply through the operations of an imperfectly competitive banking market.}

Second, our model allows for the explicit feedback from government policy
to the structure of the banking industry. Different government policies change
the structure of the banking market by altering expected profits and raising
or lowering entry barriers. While the importance of endogenous structure is
well understood in the literature,\footnote{For example, Keeley, M. (1990) explicitly recognises the feedback between regulation and competition in his empirical analysis of US banking.} some theoretical models take structure as exogenous. In our model, structure and levels of competition are endogenous so we can analyse the implications of different crisis-management policies for the banking sector in situations when there is no crisis.

Our paper builds on the classic Monti-Klein model of a ‘monopoly bank’.\footnote{See Klein M. (1971) and Monti, M. (1972). Freixas, X. and J-C Rochet (2008) provide a useful summary of the basic monopoly model and its extension to Cournot competition. Baltensperger, E. (1980) and Santomero, A. (1984) provide early critical evaluations of the Monti-Klein framework and its extensions.} We extend the model to allow for a generalised model of competition.\footnote{In particular we do not rely on specific competitive assumptions or approaches such as Cournot competition. See Freixas and Rochet (2008) for an extension of the Monti-Klein model to Cournot competition. Our model incorporates Cournot competition but can also allow for any level of competition from a perfect cartel through to homogeneous goods}
crisis is imported when the wholesale funds rate becomes so high that banks cannot effectively access that market to fund their activities. A bank may become insolvent in this situation depending on its capital structure.

By changing the initial government policy settings, we are able to compare the effectiveness of different responses to the potential for a crisis. These policies alter the nature of competitive interactions between banks, affecting market outcomes in the absence of a crisis. We compare and contrast different policies noting their economic consequences in ‘good times’, not just in the crisis.

We show, for example, that minimum equity requirements can be an effective policy tool to reduce the potential for an ‘imported’ banking crisis. However, as with all policies, this intervention comes at a cost. It may reduce competition in the absence of a crisis if the change in a bank’s debt/equity mix is costly for the bank.

Similarly, restricting the number of banks through a licensing regime will limit competition and harm borrowers and depositors in the absence of a crisis. Restricting the number of competing banks can be effective to prevent an imported crisis, but only when banks do not pay for the relevant license. In this case, the ‘free license’ is like an ex ante tax payer bailout. In contrast, if banks pay the government for a banking license, the effects of this policy on the likelihood of a banking crisis are ambiguous.

Restricting the ability of banks to access wholesale funds, in the extreme, will clearly prevent an imported banking crisis. If banks have no wholesale funding, a change in the price of those funds cannot alter their behavior. But such a blanket restriction would come at a significant cost through decreased bank competition. Further, a more modest limit on wholesale funding has ambiguous implications. It is possible that such a restriction could raise banks’ profitability by enhancing banks’ monopsony power over depositors, encouraging entry and raising the risk of insolvency if there is a crisis.

Bertrand competition. Further, our model can allow for different intensity of competition depending on whether we consider the deposit or loans side of the market and depending on whether there is or is not a banking crisis.
Finally, an (implicit or explicit) government debt guarantee will lower banks’ costs and encourage competition. It will also raise the likelihood of a banking crisis. Given the ad hoc bailouts following the 2008 crisis, this suggests that the ‘do nothing’ policy for governments, with an implicit debt guarantee if a crisis occurs, may itself promote a future banking crisis.

2 The model

Consider the market for ‘loanable funds’. Loans are mediated by banks through a ‘retail’ market.\textsuperscript{10} Various parties demand loanable funds through the retail market, such as home buyers who demand these funds as mortgages, small businesses who seek loans to start or continue operations, consumers who seek short term funding to smooth any mismatch between the flow of income and debt, and so on. We refer to these parties as ‘borrowers’.

In general the borrowers are relatively ‘small’ and we assume that they act as price takers. There will be a demand function for loanable funds $q^d(r^d)$ where $r^d$ is the interest rate paid by borrowers and $q^d$ is the amount of loanable funds demanded by borrowers. There is a finite highest interest rate $\tilde{r}^d$ such that $q^d(r^d) = 0$ for all $r^d \geq \tilde{r}^d$ and $q^d(0)$ is finite. We assume that $q^d$ is continuous and decreasing in $r^d$ (i.e. $(\partial q^d/\partial r^d) \leq 0$) and $(\partial^2 q^d/\partial (r^d)^2) \leq 0$ for $r^d \in [0, \tilde{r}^d]$.

There are two sources of supply of loanable funds. First, there are parties who supply loanable funds to banks in the retail market through a variety of financial products such as ‘at call deposits’ and ‘fixed term deposits’. These suppliers include households and small businesses seeking to place their funds in a relatively secure retail financial product. These suppliers, who we will refer to as ‘depositors’, are price takers.\textsuperscript{11} They do not monitor banks and their supply of funds does not depend on government policy that

\textsuperscript{10}This contrasts with large corporate loans that may be directly sourced through the issuance of bonds or other financial instruments.

\textsuperscript{11}Borrowers and depositors are unable to directly interact with each other but must interact through a bank.
relates to a potential future bank failure.\textsuperscript{12} Thus there will be a supply curve of loanable funds from retail depositors denoted by \( q^s(r^r) \), where \( q^s \) is the amount of loanable funds supplied by depositors and \( r^r \) is the ‘retail’ interest rate received by depositors. We assume that there is a smallest interest rate \( \bar{r}^r \geq 0 \) such that \( q^s(r^r) = 0 \) for all \( r^r \leq \bar{r}^r \). Further we assume that \( q^s \) is continuous and strictly increasing in \( r^r \) (i.e. \( (\partial q^s / \partial r^r) > 0 \)) with \( (\partial^2 q^s / \partial (r^r)^2) \geq 0 \) for \( r^r \in [\bar{r}^r, \infty) \). Further, \( \bar{r}^d > \bar{r}^r \). Note that by our assumptions, there will be a unique, finite value of \( r \in [\bar{r}^r, \bar{r}^d] \) such that \( q^d(r) = q^s(r) \).

Second, there is a source of loanable funds that banks can access through wholesale markets. These funds may be either domestically or internationally sourced. We make a ‘small country’ assumption and assume that these funds are available at any desired quantity at a specific interest rate \( r^w \) that is invariant to the quantity of loanable funds transacted in the domestic market. The price of these ‘wholesale funds’, however, is random and depends on a variety of factors outside the influence of the domestic market. We assume that \( r^w \in \{\underline{r}^w, \bar{r}^w\} \) where \( \underline{r}^w < \bar{r}^w \). The \textit{ex ante} probability that \( r^w = \underline{r}^w \) is given by \( (1 - \rho) \) with the \textit{ex ante} probability that \( r^w = \bar{r}^w \) given by \( \rho \). We can think of \( \underline{r}^w \) as being the ‘normal’ wholesale funds rate while \( \bar{r}^w \) is the ‘crisis’ rate that emerges when there is an overseas banking crisis. In this sense, \( \rho \) is the probability of the domestic banking system ‘importing’ an international financial crisis through the wholesale funds market. We assume that \( \bar{r}^w \) is sufficiently high so that banks will never draw on wholesale funds in equilibrium to fund loans at the interest rate \( \bar{r}^w \) and \( \underline{r}^w \) is sufficiently low so that banks will always draw on wholesale funds in equilibrium to fund loans at the interest rate \( \underline{r}^w \). We formalize these assumptions below.

\textsuperscript{12}As Freixas and Rochet (2008, p.309) note, “[t]he distinguishing characteristic of banks (and more generally of financial intermediaries) is that their creditors are also their customers. In contrast to non financial firms, whose debt is mostly held by professional investors . . . the debt of banks (and insurance companies) is held in large part by uniformed, dispersed, small agents (mostly households) who are not in a position to monitor the banks’ activities” (emphasis in original).
To operate and access funds from depositors, a bank must first invest an amount of capital $K$. We can think of $K$ as the up front cost of a bank accessing depositors, such as the cost of opening a physical and/or virtual network of ‘branches’ to receive funds from depositors, and the cost of designing appropriate retail products for depositors. The size of $K$ may also depend on the policy chosen by the government. For example, government policy may require a bank to gain a license and the cost of obtaining a banking license will be included in $K$. $K$ must be paid by a bank before it commences operations and, once paid, is sunk and unrecoverable.

The ‘founders’ of a bank will issue debt and equity to cover the fixed cost $K$ of establishing the bank with minimum financing costs. In the absence of government policy that impinges on the funding mix used to underwrite a bank’s operations, we denote this optimal mix of funding by $K^0_e$ of equity and $K^0_d$ of foundation debt where $K = K^0_e + K^0_d$.\(^{13}\)

A bank will face marginal costs $c^r$ to write loans using funds sourced from depositors (i.e. retail funds). This is the marginal cost of receiving deposits and organising for these funds to be provided to appropriate borrowers. $c^r$ may also depend on government policy and it includes any marginal regulatory costs, such as compulsory deposit insurance or the per unit costs of meeting regulatory capital requirements.

The bank may also want the ability to source funds from the wholesale market. For convenience, we assume that once a bank is established, there are no additional fixed costs of the bank accessing wholesale funds. However the bank’s marginal cost of creating retail loans from wholesale funds may differ from the marginal cost of loans created from deposits, and we denote this ‘wholesale funding’ marginal cost by $c^w$. Again $c^w$ includes any costs relating to government policy and $c^w$ will differ from $c^r$ when regulators impose different requirements on banks depending on where the banks source their funds. We define the difference in marginal costs as $\Delta = c^r - c^w$. $\Delta$ may be positive, negative or zero.

In the absence of any government policy explicitly restricting the number

\(^{13}\)We discuss the funding decision of a bank in detail in section 3.3 below.
of banks, we assume that there is free entry of banks, in the sense that any
party who meets the fixed costs associated with a bank can establish a bank
and commence operations.\footnote{Of course, government policy may still influence the number of banks through fees
and license requirements that impinge on $K$.} We denote the number of banks that compete
in equilibrium by $N$.

Finally, we assume that the government has access to a finite set of policies
$\mathcal{P}$. We denote a specific government policy by $P$ and assume that $\mathcal{P}$ includes
the option of ‘no specific banking policy’, which we denote by $P = \emptyset$. This
will be our base-case policy. $\mathcal{P}$ will also include other specific policies that
we consider below.

The timing of interaction between banks is as follows:

$t=0$: The government chooses a banking policy $P \in \mathcal{P}$.

$t=1$: Banks enter the market by paying the fixed cost $K$. Each bank de-
determines its source of funding for $K$, $K_e$ and $K_d$. The mix of funding
used by a bank may depend on the government’s policy choice $P$.

$t=2$: The cost of wholesale funds, $r^w$ is determined exogenously as either $r^w$
with probability $(1 - \rho)$ or $\tau^w$ with probability $\rho$.

$t=3$: Banks compete in the provision of loans to borrowers.

$t=4$: Banks realise their profits and pay back $K_d$ to foundation debtors (if
possible) with any remaining profit used to remunerate equity holders.
If a bank’s profit is less than $K_d$ the bank is insolvent and (unless
otherwise dealt with through the government policy $P$) deposits at the
bank are (temporarily) frozen.

Bank failure leads to a loss in liquidity as depositors’ funds are temporar-
ily frozen and this may have macroeconomic consequences for the govern-
ment.\footnote{Note that because there is no risk of default by borrowers in our model the risk of
bank failure is derived through the variable supply of wholesale funds. There will be}
likelihood or consequences of a bank failure and we analyze these policies below.\textsuperscript{16}

Because there is free entry by banks, (unless otherwise prevented by government policy) in equilibrium banks will enter until expected profits are zero. Note, however, that banks are required to enter prior to the determination of the cost of wholesale funds. This timing reflects that banks are ‘long lived’ institutions that face significant long-term investments in branches, technology and reputation with retail depositors.

Bank competition is ‘imperfect’. In equilibrium, banks will make a margin on the provision of loans that not only covers the marginal costs of providing the loans but also contributes to covering their fixed costs. The equilibrium margin will depend on both the source of funds and the number of competing banks. The equilibrium bank margins are denoted by $M^i_N$ where $N$ is the number of banks and $i = r$ refers to the margin on retail deposits while $i = w$ refers to the margin on wholesale funds. Thus, if $r^r_N$ is the rate set for retail depositors when there are $N$ banks and the wholesale funds rate is $r^w$, the rate of interest that banks charge borrowers is $r^d = r^r_N + c^r + M^r_N = r^w + c^w + M^w_N$. We denote the difference between the ‘retail’ and ‘wholesale’ fund margins for a bank by $m_N = M^r_N - M^w_N$.

\textbf{3 The base case with bank failure}

We start by considering the base case where the government sets no specific banking policy at $t = 0$, so $P = \emptyset$. In order to consider the nature of bank competition at $t = 3$ we first consider the behaviour of a monopoly bank sufficient funds to payback all depositors in the case of a banking crisis but not to also pay back foundation debt holders. Thus, so long as depositors have higher standing than debt holders as creditors of an insolvent bank, the cost to depositors of a crisis is inconvenience and a loss of liquidity rather than uncertainty about eventual return of their funds.\textsuperscript{16}In our framework, bank failure is caused by the rise in the wholesale funds rate. A bank failure may be preceded by a ‘run’ by depositors on a bank. But this is a consequence of depositors’ concerns about the liquidity of their funds and does not cause bank failure.
at $t = 3$ as in Klein (1971) and Monti (1972). This will provide us with ‘benchmark’ margins to analyse the outcomes when there are two or more banks.

### 3.1 Monopoly bank

Assume that $N = 1$ and the government has set $P = \emptyset$. A monopoly bank’s profit maximizing pricing will depend on the wholesale funds rate that is determined at $t = 2$.

First, suppose that the wholesale fund rate is high, $\bar{w}$ and that this rate is sufficiently high so that the monopoly bank maximizes profits by financing all loans through retail deposits.$^{17}$ Denote the profit maximizing interest rate paid to depositors in this situation by $\bar{r}_1$. As the bank only uses retail deposits to fund loans we only have to consider the profit maximizing margin on retail deposits, $\bar{M}_1$. The bank will loan all funds that it receives from depositors so that $q^d(\bar{r}_1) = q^d(\bar{r}_1 + c + \bar{M}_1)$. The profit of the bank is given by $\pi_1 = \bar{M}_1 q^d(\bar{r}_1 + c + \bar{M}_1)$. The bank will set $\bar{M}_1$ to maximize its profit subject to $q^s(\bar{r}_1) = q^d(\bar{r}_1 + c + \bar{M}_1)$. Our assumptions on $q^d$ and $q^s$ mean that this is a (strictly) concave optimization problem with a unique solution.

Solving: $^{19}$

$$\bar{M}_1 = \frac{q^s(\bar{r}_1)}{(\partial q^s/\partial r)} - \frac{q^d(\bar{r}_1)}{(\partial q^d/\partial r)} \quad \text{with} \quad q^s(\bar{r}_1) = q^d(\bar{r}_1 + c + \bar{M}_1) \quad (1)$$

To interpret (1), we can break the margin $\bar{M}_1$ into two parts. First suppose that the monopoly bank can set the rate that it pays depositors but that it has no control over the rate it charges borrowers (i.e. $(\partial q^d/\partial r) = \ldots$)

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$^{17}$We confirm that this is the case through our assumption on $\bar{w}$ below.

$^{18}$This implicitly assumes that the marginal cost of retail funding, $c'$, includes the cost of any reserve requirements for the bank. Thus an increase in the reserve requirements will raise $c'$. This is isomorphic to the approach used, for example, by Klein (1971) where reserve requirements are explicitly subtracted from available deposit funds.

$^{19}$Note that this is essentially the same problem as that faced by a government that seeks to set a revenue maximizing transactions tax on the relevant market.
−∞). Then the margin charged by the bank would be \( \frac{q_s}{(\partial q_s/\partial r)} \) which would reflect its monopsony power over retail depositors.

Alternatively, suppose that the monopoly bank can set the rate that it charges retail lenders but that it has no discretion over the rate it pays to retail depositors (i.e. \( (\partial q_s/\partial r) = ∞ \)). Then the margin charged by the bank would be \( \frac{q_d}{(\partial q_d/\partial r)} \) which would reflect its market power over retail borrowers.

The actual profit maximizing margin for a monopoly bank that does not use wholesale funds is simply the sum of its ‘borrowing’ margin and its ‘lending’ margin.

We are now able to formalize the assumptions on \( \tau^w \) and \( \tau^r \). To make sure that banks will never find it profitable to use wholesale funds when the rate on these funds is high, we assume that:

**Assumption 1:** \( \tau^w > \tau^r_1 + \Delta + M^r_1 \)

If the realised interest rate for wholesale funds is \( \tau^w \) then banks will always access the wholesale fund market to finance at least some of their loans. However, we want to constrain the wholesale funds rate so that it is not so low as to drive out funding from retail deposits. A sufficient condition for this is given by the following:

**Assumption 2:** \( \tilde{\tau}^r < \tau^w < \tau^r_1 + \Delta \) where \( \tau^r_1 \) is the profit maximizing interest rate that a monopoly bank would set for depositors when not accessing any wholesale funds, \( \tilde{\tau}^r \) is the minimum rate above which the supply of deposits will be strictly positive and \( \Delta = c^r - c^w \).

If the actual wholesale fund rate at \( t = 2 \) is given by \( \tau^w \) then the monopoly bank will set both the retail funds margin \( M^r_1 \) and the wholesale funds margin \( M^w_1 \) to maximize its profits. Borrowers will pay \( \tau^d = \tau_1^r + c^r + M^r_1 = \tau^w + c^w + M^w_1 \).

It follows that \( \tau_1^r = \tau^w - \Delta + M^w_1 - M^r_1 \). Thus, we can write the monopoly bank’s profit as:

\[
\pi_1 = M^r_1 q_s (\tau^w - \Delta + M^w_1 - M^r_1) + M^w_1 (q_d (\tau^w + c^w + M^w_1) - q_s (\tau^w - \Delta + M^w_1 - M^r_1))
\]
Remembering that \( m_N = M_r^r - M_r^w \), we can rewrite the monopoly bank’s profit as:

\[
\pi_1 = M^w_1 q^d (r^w + c^w + M^w_1) + m_1 q^s (r^w - \Delta - m_1)
\]

Maximizing \( \pi_1 \) with regards to \( M^w_1 \) and \( m_1 \) gives first order conditions:

\[
\frac{M^w_1}{M^r_1} = -\frac{q^d}{(\partial q^d/\partial r)} \quad \text{and} \quad m_1 = \frac{q^s}{(\partial q^s/\partial r)}
\] (2)

Note that \( m_1 > 0 \) implying that \( M^r_1 > M^w_1 \). This reflects the monopsony power of the bank, so that it makes a greater margin on loans funded by retail deposits than on loans funded by wholesale funds. It also means that loans are not funded in the lowest cost way from a social perspective. The social cost of funding loans is minimised if \( r^r_1 + c^r = r^w + c^w \). However, in equilibrium, \( r^r_1 + c^r + m_1 = r^w + c^w \). As \( m_1 > 0 \) this means that, given the quantity of loans, too few are funded by deposits from a social perspective and too many are funded using wholesale funds.\(^20\)

Substituting in for \( m_1 \):

\[
M^w_1 = -\frac{q^d}{(\partial q^d/\partial r)} \quad \text{and} \quad M^r_1 = \frac{q^s}{(\partial q^s/\partial r)} - \frac{q^d}{(\partial q^d/\partial r)}
\] (3)

Bank profits will be higher when there is a low wholesale funds rate, \( r^w \) than when there is a high wholesale funds rate \( r^w \). This follows as the monopoly bank could choose to mimic its strategy under a high wholesale funds rate and fund all retail loans through deposits. The result that the bank does not do this, but relies on some wholesale funds, implies that the bank must find it profitable to change its funding mix, and that its profits must be higher. What, however, of depositors and borrowers?

The ‘competition’ provided by wholesale funds lowers the return to depositors when the wholesale fund rate is low. This is formally shown by lemma 3.1. (All proofs are provided in the appendix).

\(^{20}\)Note that, as in the standard Monti-Klein model, there is a separation between the ‘lending’ and ‘borrowing’ margins for the monopoly bank. The wholesale funds rate plays the same role here as the interbank rate plays in the Monti-Klein model.
Lemma 3.1 $\tau_1^r < \tau_1^w$

While depositors are worse off when wholesale funds have a low rate, borrowers are better off, as shown by lemma 3.2.

Lemma 3.2 $\tau_1^r + c^r + M_1^r > \tau_1^w + c^w + M_1^w = \tau_1^w + c^w + M_1^w$

In summary, if the wholesale funds rate is $r_1^w$, the monopoly bank will finance retail loans using both retail deposits and wholesale loans. The margin that the bank makes on loans financed by retail funds, $M_1^r$ is strictly greater than the margin the bank makes on loans financed through wholesale funds $M_1^w$. Compared to the situation with a high wholesale funds rate $r_1^w$, the bank will make more profit, will provide more loans in total at a lower interest rate, but will use fewer deposit funds and will pay depositors a lower interest rate when the wholesale funds rate is low.

3.2 Competition between banks

We now consider the situation where there are competing banks. In particular, we allow free entry of banks, subject to the fixed cost $K$. Banks will enter and establish at $t = 1$ until expected profits equal zero.

Given the government policy setting, at $t = 3$ competition between banks will depend on the number of banks and the realised wholesale funds rate $r_1^w$. We take a simple but parsimonious approach to modelling competition through the changes in the relevant profit margins. Thus, suppose that the wholesale funds rate is high, $\tau_1^w$. In this situation a monopoly bank would not utilise wholesale funds and would set a profit maximizing margin on retail funds of $M_1^r$. If there are $N > 1$ banks then:

Assumption 3: If the wholesale funds rate is $\tau_1^w$ and there are $N$ banks, then the banks will only use retail (deposit) funds to finance loans. The retail margin set by each of the $N$ banks in equilibrium is $\overline{M}_N^r = \alpha(N)M_1^r$ where $\alpha(N) \in [0, 1]$ and is continuous and non-increasing in $N$.

Alternatively, suppose that the wholesale funds rate is low, $\tau_1^w$. In this situation, a monopoly bank would always use both wholesale and retail deposit funds to finance retail loans. The monopoly bank would set a profit
maximizing margin for wholesale funded loans, $M^w_1$ and a profit maximizing margin for deposit funded loans $M^r_1$ where $M^r_1 > M^w_1$. If there are $N > 1$ banks then:

**Assumption 4:** If the wholesale funds rate is low, $r^w$ and there are $N$ banks, then the banks will fund loans using both retail and wholesale funds. The wholesale margin set by each of the $N$ banks in equilibrium is $M^w_N = \omega^w(N)M^w_1$ where $\omega^w(N) \in [0,1]$ and is continuous and non-increasing in $N$. The difference between the retail and the wholesale margins set by each of the $N$ banks in equilibrium will be $m_N = \gamma(N)m_1$ where $\gamma(N) \in [0,1]$ and is continuous and non-increasing in $N$.

These competitive assumptions are intuitive. First, competing banks will use the same mix of funding sources as a monopoly bank. This reflects our assumptions (1) and (2) on wholesale funding rates. As $r^w$ lies above the rate that a monopoly bank would set for borrowers, and this rate will decrease with bank competition, no bank would ever find it profitable to deviate in equilibrium and source some wholesale funds at $r^w$. Such a deviation would involve using funds that cost more than the bank could charge borrowers for those funds. In contrast, $r^w$ is low enough so that a monopoly bank will always find it profitable to use wholesale funds. However, $r^w$ is not so low that a monopoly bank will only rely on wholesale funds but will also finance loans using retail deposits. For competitive banks, given our assumptions on margins, the same must hold.

Second, for any number of competing banks, competition will never lead to either retail or wholesale margins that are above those charged by a monopoly bank. Such margins would be inconsistent with profit maximization as all banks would make more profit by lowering their margins. Competition may, however, drive the rate set by banks to marginal cost.

Third, increasing levels of competition (i.e. $N$ increasing) tends to reduce the margins charged by banks. Further, as these margins are always below the relevant monopoly margins and the monopolist’s profit maximisation

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21 This implies that the retail margin $M^r_N = \omega^w(N)M^w_1 + \gamma(N)m_1$. It will be non-negative and non-increasing in $N$. 
problem is strictly concave, a rise in \( N \) cannot raise total industry profits, and may lower total industry profits, whether the wholesale funds rate is high or low.

At the same time, the model is flexible. It can allow for perfect collusion on some margin (e.g. \( \overline{M}_N = \overline{M}_1 \) for all \( N \)) or for intense competition (e.g. \( \overline{M}_N = 0 \) for all \( N \geq 2 \)). Further the degree of competition can differ between the ‘demand’ margin and the ‘supply’ margin when the rate on wholesale funds is low. Competing banks may compete vigorously for deposits but ‘collude’ on the rate charged to borrowers (i.e. \( m_N \approx 0 \) and \( M^w_N = M^w_1 \)) or compete vigorously for loans but have little if any competition when sourcing deposit funds (i.e \( M^w_N \approx 0 \) but \( m_N = m_1 \)). For example, the latter could arise if banks compete in a national market for the provision of loans, but have regional branches and networks for depositors.

To analyse the competitive behaviour of banks, consider \( t = 3 \) when there are \( N \) banks and government policy is set at \( P = \emptyset \). If the wholesale funds rate is high, \( r^w \), then the banking industry will only use retail deposits to fund retail loans. Total banking profits will be \( \pi_N \) where:

\[
\pi_N = \overline{M}_N q^d (r^r_N + c^r + \overline{M}_N^r) \quad \text{where} \quad q^s(\overline{r}_N^r) = q^d(\overline{r}_N^r + c^r + \overline{M}_N^r)
\]

By assumption 3 and concavity of the monopoly banks profit function, \( \pi_N \leq \pi_1 \) and non-increasing in \( N \). An increase in the number of competing banks cannot raise the level of total bank profits and, if bank margins fall with increased competition, will lower total bank profits.

Note that this means that the profit per bank (\( \pi_N/N \)) is strictly decreasing in \( N \). Even if competing banks perfectly collude, increased entry spreads the (fixed) industry profits over more banks.

As \( \overline{M}_N \) is decreasing in \( N \), and given our assumptions on \( q^d \) and \( q^s \), the constraint that \( q^s = q^d \) means that \( \overline{r}_N^r \) is increasing in \( N \) but the rise in \( \overline{r}_N^r \) as \( N \) increases can be no greater than the fall in \( \overline{M}_N \) as \( N \) increases. Thus, when the cost of wholesale funds is high, the interest rate paid by borrowers is decreasing in the number of competing banks, \( N \), while the interest rate received by depositors is increasing in \( N \).

If the wholesale funds rate is low, \( \underline{r}^w \), then banks will use both wholesale
funds and retail deposits to fund loans to borrowers. Total banking profits will be $\pi_N$ where:

$$\pi_N = M^w_N q^d (r^w + c^w + M^w_N) + m_N q^s (r^w - \Delta - m^w_N)$$

By assumption 4 and concavity of the monopoly banks profit function, $\pi_N \leq \pi_1$ and non-increasing in $N$. Again, this implies that the profit per bank, $(\pi_N/N)$ is strictly decreasing in $N$.

The rate charged to borrowers is $r^w + c^w + M^w_N$. As $M^w_N$ is decreasing in $N$ this implies that the rate paid by borrowers is decreasing in $N$.

The rate paid to depositors is $r^r_N = r^w - \Delta - m^r_N$. As $m^r_N$ is decreasing in $N$ this implies that the rate paid to depositors is increasing in $N$. However, because $m^r_N$ is non-negative, the rate paid to depositors is never greater than $r^w + c^w - c^r$.

Comparing interest rates between the situation with a high wholesale fund rate and a low wholesale fund rate, note that for any $N$, depositors always receive a lower rate when the wholesale funds rate is low. To see this note that $r^r_N \geq r^r_1$ but that $r^w < r^r_1 + \Delta$ by assumption 2. As $r^r_N \leq r^w - \Delta$ this means that $r^r_N < r^r_1 \leq r^r_N$. In this sense, lemma 3.1 generalizes to any number of competing banks.

However, under the general approach to competition taken here, and despite lemma 3.2 which shows that borrowers pay a lower rate when the wholesale funds rate is low for a monopoly bank, we cannot say whether borrowers pay a higher or lower rate when the wholesale funds rate is low and there is competition. This is because of our parsimonious assumption on bank margins. For example, suppose that competition has little effect on the wholesale margin when the wholesale funds rate is low so that $M^w_N = M^w_1$ but there is a strong effect on retail margins when the wholesale funds rate is high so that $M^r_N = 0$ for all $N > 1$. Then, if both $c^w$ and $c^r$ are low, the supply of deposits is elastic but the demand for loans is inelastic it is easy to show that it is possible to have $r^w + c^w + M^w_N > r^r_N + c^r + M^r_N$ even though $r^w < r^r_1 + \Delta$. Thus, depending on the effect of competition, borrowers may or may not pay a higher interest rate when the cost of wholesale funds is high compared to when it is low.
Nevertheless, such a result depends on significant asymmetries in competition and in many situations it may be reasonable to expect the borrowers will pay a lower rate when the wholesale funds rate is low.

Similarly, while the profits of a monopoly bank are higher when there is a low wholesale funds rate than when there is a high wholesale funds rate, it is not possible to make a general statement about banks’ profits when there is competition. Depending on the degree of competition, banks’ profits may be higher or lower with a high wholesale funds rate than with a low wholesale funds rate, when \( N > 1 \). To see this, assume that \( M^r_N = M^r_1 \) but \( M^w_N = m_N \approx 0 \) for \( N > 1 \). Again, however, this ordering of profits depends on significant competitive asymmetries and in many situations it will be reasonable to assume that \( \pi_N < \bar{\pi}_N \). We formalise this assumption below:

**Assumption 5:** For all \( N \geq 2 \), if \( P = \emptyset \) then \( \pi_N < \bar{\pi}_N \).

Given banks’ profits at \( t = 3 \), we can now consider the entry decision faced by banks at \( t = 1 \). Bank profits will depend on the (uncertain) level of the wholesale funds rate. Thus, at \( t = 1 \) each bank has an expected profit if it enters of:

\[
E\pi_N = (1 - \rho) \frac{1}{N} \pi_N + \rho \frac{1}{N} \bar{\pi}_N - K
\]

Because \( \bar{\pi}_N \) and \( \pi_N \) are both finite and decreasing in \( N \) it immediately follows that \( E\pi_N \) is strictly decreasing in \( N \) and there exists a finite number of banks, \( \tilde{N} \) such that \( E\pi_{\tilde{N}} = 0 \). This will be the equilibrium number of banks. As our aim is to analyse the effects of competition in banking, we restrict \( K \) so that \( E\pi_2 \geq 0 \) so at least two banks will exist in equilibrium.

### 3.3 Bank funding and bank stability in the absence of explicit government policy

Given that the government has chosen at \( t = 0 \) not to have an explicit banking policy (\( P = \emptyset \)) it follows from assumption 5 and free entry that \( \frac{1}{N} \pi_{\tilde{N}} > K \) and \( \frac{1}{N} \bar{\pi}_{\tilde{N}} < K \). This means that banks may face issues of solvency when the wholesale funds rate is high.
A bank is declared insolvent at $t = 4$ if it is unable to make ‘variable’ profits (i.e. profits after paying out deposit liabilities) that are at least able to pay back the outstanding foundation debt $K_d$. This will never arise when the wholesale funding rate is low because $\frac{1}{N}\pi_N > K \geq K_d$. However, it could arise when the cost of wholesale funds is high and a bank is highly leveraged so that $\frac{1}{N}\pi_N < K_d$.

The risk of insolvency will depend on the funding choices made by banks at $t = 1$. So far, however, we have taken the level of equity and foundation debt of a bank as fixed with $K = K_e + K_d$ given $P = \emptyset$. However, the capital structure of a bank is endogenous and chosen at $t = 1$. In order to analyse bank stability we need to consider the funding choices made by banks.

The fixed cost of establishing a bank is given by $K$. However, the funding cost will be at least $K$. The funding cost will involve any opportunity cost of funds that the bank needs to pay investors (in expectation) and any costs that arise as the funding mix changes.

To avoid excessive notation, assume the opportunity cost of the funds needed to establish a bank is the risk free rate of return and this is normalised to zero.

For risk neutral investors, the cost of funding will be the same for any mix of debt and equity. If, given their expectations about the number of banks that will be competing, a bank’s founders choose a level of debt $K_d \leq \frac{1}{N}\pi_N$ then the bank will always be able to pay its foundation debt holders $K_d$ at $t = 4$. The bank will never be insolvent, so debt holders will require compensation at the risk free rate (normalised to zero).

In contrast, if $K_d > \frac{1}{N}\pi_N$ then the bank will be insolvent if the wholesale fund rate is high. We assume that deposit holders are senior creditors of the bank, with foundation debt holders next most senior, and equity holders the lowest in order of payout. Thus, if a bank risks insolvency, bond holders will need to be compensated for this possibility in terms of their expected return.

Bond holders will receive all of the (variable) profits that are available when the wholesale fund rate is high so that interest rate on foundation debt is
given by \( r_d \) where \( K_d = (1 - \rho)(1 + r_d)K_d + \rho \pi \tilde{N} \). Thus:

\[
r_d = \frac{\rho}{(1 - \rho)K_d} \left( K_d - \frac{\pi}{\tilde{N}} \right)
\]

As expected, \( r_d \) is increasing in both the level of foundation debt and in the level of expected bank competition \( \tilde{N} \).

If \( K_d \leq \frac{1}{\tilde{N}} \pi \tilde{N} \) then the return on equity will be the expected profits less the level of foundation debt. But free entry ensures that in equilibrium, this return is just equal to the risk free rate (normalised to zero).

If \( K_d > \frac{1}{\tilde{N}} \pi \tilde{N} \) then equity holders only receive a return in the situation where the rate on wholesale funds is low. If the rate of return on equity is \( r_e \) then:

\[
(1 + r_e)K_e = (1 - \rho) \left( \frac{\pi}{\tilde{N}} - (1 + r_d)K_d \right) - K_e
\]

Substituting in for \( r_d \) and noting that free-entry of banks means that \( E\pi \tilde{N} - K = 0 \), the equilibrium return on equity is just the risk free rate. Thus, if the only cost of funding is to compensate investors for the opportunity cost of funds then the cost of funding does not depend on the structure of debt and equity and any mix of \( K_e \) and \( K_d \) such that \( K_e + K_d = K \) will be equally profitable for a bank.\(^{22}\)

There are a variety of reasons why neutrality of the funding mix will not actually hold for banks. For example, tax laws may bias costs towards a specific mix of debt and equity. These reasons are peripheral to our analysis here, but will be important when we allow for government policy that constrains the mix of funding for a bank. We introduce these costs of the ‘mix’ of funding in a simple manner. Let the cost of establishing a bank be given by \( K + \Gamma(K_e) \) where \( \Gamma(K_e) \) is a continuous, non-negative, convex function with a minimum of \( \Gamma(K_e^0) = 0 \). Thus, in order to minimise the costs of funding, each bank will set its equity at \( K_e^0 \) and its level of foundation debt at \( K_d^0 = K - K_e^0 \). This will occur if there is no government intervention, \( P = \emptyset \), as assumed in the analysis above. However, government policy may force banks to adopt different mixes of funding and this may have a cost through \( \Gamma \).

\(^{22}\)Of course, this is just a specific application of the Modigliani-Miller theorem.
It follows from the discussion above that bank insolvency is only a concern if the wholesale funds rate is high and if $\frac{1}{N} \pi_N < K_d^0$. We can think of the situation where the wholesale funds rate is high as a situation where the relevant country ‘imports’ a banking crisis. With probability $\rho$ the ability of domestic banks to fund their activities using overseas wholesale funds is restricted, leading banks to make low profits. If these profits are insufficient to fund a bank’s debt obligations then the bank is insolvent. Assumption 6 ensures that a banking crisis is possible.

**Assumption 6:** If $P = \emptyset$, $\frac{1}{N} \pi_N < K_d^0$.

We are interested in how *ex ante* changes to government policy effect the likelihood of bank failure and the consequences of such policies for the banking system even in the absence of failure. We consider this in section 4.

4 The consequences of government banking policy

If the government does not set explicit banking policy then, under assumption 6, bank insolvency will occur with probability $\rho$. The government may choose active banking policies to deal with the possibility of bank insolvency. In this section we consider a range of such policies. The aim of our analysis is to consider the consequences of alternative policies on the outcomes of the banking market. In particular, we are interested in the outcome when there is not a crisis and to compare the outcomes between different policies.

4.1 Policies that guarantee ‘foundation’ debt

First, consider the situation where the government acts to protect debt holders in the event of a crisis. This may occur through an explicit policy. Or, as we observed in 2008, it may occur through *ad hoc* government support for failing banks (a ‘bail out’) or through nationalization.

These policies protect the holders of bank debt from loss of funds when bank profit is insufficient to cover the debt. Thus, if $K_d > \frac{1}{N} \pi_N$, the gov-
ernment ‘makes up the difference’. However, equity holders are not fully protected so they continue to face the possibility of a loss of funds in the event of bank failure.

Formally, a ‘debt guarantee’ is a government policy where the government covers the difference between $\frac{1}{N}\pi_N$ and $K_d$ with taxpayer funds if $K_d > \frac{1}{N}\pi_N$. A debt guarantee is equivalent to a ‘bail out’ policy for a bank’s debt holders but not its equity holders.

Given the number of banks, a debt guarantee does not change bank behaviour. However a debt guarantee effectively reduces the loss suffered by the parties that fund the bank if the wholesale funds rate is high. This will have two effects. First, holding the level of bank foundation debt and equity constant, the policy will reduce the loss suffered by bank investors when the wholesale funds rate is high. This will lead to an increase in the number of banks in equilibrium. Second, the debt guarantee will change the optimal funding for a bank. A debt guarantee will lower the cost of debt to the bank relative to equity, so at $t = 1$, when a bank chooses its source of funding, it will choose a higher level of debt and a lower level of equity.

To see the first of these effects, fix $K_e = K^0_e$ and $K_d = K^0_d$. If the wholesale fund rate is high then the government will transfer an amount $K^0_d - \frac{1}{N}\pi_N$ to each bank, so that all banks are able to cover their cost of foundation debt. Holding the number of banks fixed at $\tilde{N}$, expected profits for each bank is:

$$E\pi_N = (1 - \rho)\frac{1}{N}\pi_N + \rho K^0_d - K > (1 - \rho)\frac{1}{N}\pi_N + \rho \frac{1}{N}\pi_{\tilde{N}} - K = 0$$

Because the debt guarantee increases expected profits it will lead to more banks entering in equilibrium.

Second, the founders of the bank will set the capital structure to maximise expected profits. As $K = K_e + K_d$,

$$E\pi_N = (1 - \rho)\frac{1}{N}\pi_N + \rho(1 - K_e) - K - \Gamma(K_e)$$

Maximizing with regards to $K_e$ we obtain the first order condition $-K_e[\rho + \Gamma'(K_e)] = 0$ with $-\rho - \Gamma'(K_e) < 0$ if $K_e = 0$.

Note that if $\Gamma(K_e) = 0$ for all $K_e$ (i.e. the Modigliani-Miller theorem holds) then the profit maximizing level of equity is $K_e = 0$. 
More generally, if $\Gamma(K_e) > 0$ then, so long as $\lim_{K_e \to K_0^e} \Gamma'(K_e)$ from below is greater than $-\rho$, the optimal capital structure for a bank will involve a level of equity $K_e < K_0^e$ such that either $\Gamma'(K_e) + \rho = 0$ or $K_e = 0$. Each bank will reduce its equity below $K_0^e$ albeit that the bank may not be fully debt funded.

With a debt guarantee, the level of subsidy from the government when the wholesale funds rate is high, is increasing in the level of foundation debt and, thus, decreasing in the level of equity. It is profit maximising to increase the level of debt in order to maximise the government subsidy when the bank is in crisis.

The rebalancing of capital towards debt raises expected profits and encourages entry. Thus while the number of banks increases with a debt guarantee holding $K_e = K_0^e$, the number of banks increases still further when banks set the optimal capital structure given the government’s policy. This entry effect, together with the increase in the level of foundation debt raises the gap between the level of foundation debt and the level of (variable) profit when the wholesale funds rate is high (i.e. it raises $K_d - \frac{1}{\hat{N}}\pi_N$). In this sense, rebalancing the capital structure of each bank increases the severity of any crisis.

A debt guarantee will encourage bank entry and to encourage increased bank debt. In terms of margins and interest rates, the overall effect will be the same as it there were a fall in the establishment costs for a bank. Lemma 4.1 summarises these effects.

**Lemma 4.1** A rise (fall) in $K$ will lead to a fall (rise) in the equilibrium number of banks $\hat{N}$, will lead to higher (lower) bank margins $\bar{M}_N^r$, $\bar{M}_N^w$ and $\bar{M}_N^r$, will increase (decrease) the ‘gap’ between the wholesale and retail margins when the wholesale rate is low, $m_N$, will raise (lower) the rate paid by borrowers and will lower (raise) the rate received by depositors, regardless of the wholesale funds rate.

By raising the equilibrium number of competing banks, a debt guarantee will benefit both borrowers and depositors. The increased bank competition
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drives down the rate of interest that borrowers pay while increasing the rate received by depositors.

These changes are unsurprising. The debt guarantee transfers risk from banks to the taxpayer, and the benefits to the bank are shared by the banks various stakeholders.

Importantly, however, the debt guarantee can increase the severity of any banking crisis. it raises the level of debt held by banks so that when the wholesale funds rate is high, these banks face a larger ‘debt overhang’. Again, this is unsurprising. A debt guarantee effectively is a subsidy to banks when they hold foundation debt. The subsidy creates the incentive for banks to hold more foundation debt and less equity.

To the degree that the debt guarantee distorts a bank’s cost-minimising choice of funding, the guarantee raises the costs of each bank. From the bank’s perspective, this extra cost is more than offset by the increased profits through subsidised foundation debt. However, from a social perspective, the cost of inefficient bank funding is a deadweight loss.

The potential costs of a debt guarantee are even more acute if, contrary to assumption 6, we assume that $\frac{1}{N}\pi_N > K^0_d$. Notice that in this situation, if $P = \emptyset$ then there is no banking crisis. Even if the wholesale funds rate is high, banks can all pay their foundation debt. The expected profit for each bank is $E\pi_N = (1 - \rho)\frac{1}{N}\pi_N + \rho\frac{1}{N}\pi_N - K = 0$

However, suppose that the government (either explicitly or implicitly) has a policy of guaranteeing each bank’s foundation debt and consider the debt level $\hat{K}_d \leq K$ such that $\hat{K}_d = \frac{1}{N}\pi_N$. We know that this debt level exist because $K > \frac{1}{N}\pi_N$. Given the number of banks, if a bank set a foundation debt level $K_d > \hat{K}_d$ then its expected profit would be $E\pi^{alt}_N = (1 - \rho)\frac{1}{N}\pi_N + \rho K_d - K - \Gamma(K_e)$ where $K_e = K - K_d$.

$E\pi^{alt}_N - E\pi_N = \rho K_d - \Gamma(K_e) - \rho\frac{1}{N}\pi_N$. But this is greater than zero so long as $\Gamma(K_e)$ is not too large. This means that, so long as the cost to a bank of reducing equity and increasing foundation debt, as represented by $\Gamma$, is not too large, a policy of guaranteeing banks’ debt will lead banks to deliberately choose a level of debt that will lead to insolvency when the wholesale funds rate is high. The ‘bail out’ policy will turn a stable banking system into a
system that needs to be bailed out!

For example, suppose that $\Gamma(K_e) = 0$ for all $K_e$ so the funding costs of a bank are invariant to the mix of funding used to found a bank. Then the profit maximising mix of capital for a bank is to increase the level of debt and set $K_d = K$. Of course, this means that the bank will always have a crisis when the wholesale funding rate is high. In contrast, without the debt guarantee, the bank would have chosen a level of foundation debt $K_d^0$ and would never be insolvent.

More generally, so long as $\Gamma(K_e)$ is not too high as $K_e$ is reduced below $K_e^0$, the government debt guarantee will lead banks to raise their level of debt. In equilibrium, banks will fail when the wholesale funds rate is high, even if such failure would not have occurred in the absence of the debt guarantee.

The increased profits from the debt guarantee mean that more banks will enter in equilibrium. Thus the bank guarantee continues to have a naive pro-competitive effect even if assumption 6 doesn’t hold. But in this situation the debt guarantee is not a response to the potential for bank insolvency. Rather, the government debt guarantee causes banks to restructure to deliberately become insolvent if there is a high wholesale funds rate. Banks receive a government subsidy if they are in crisis. Unsurprisingly, it becomes profitable for banks to have a crisis in order to access the subsidy, even though restructuring may have a real cost, $\Gamma$

The possibility that a debt guarantee could raise the likelihood of a banking crisis has been noted before.\textsuperscript{23} However, most analysts have noted the moral hazard effects of a debt guarantee.\textsuperscript{24} In contrast, the effect of a debt guarantee in our model operates through competition and simple profit maximisation. Banks continue to make ‘good’ loans. However, having a policy that subsidises a bank when it has higher levels of debt creates an incentive for banks to have higher levels of debt. Further, because the debt guarantee raises profits, it increases bank competition. The increased debt levels and increased competition increase both the likelihood and severity of bank

\textsuperscript{23}See Freixas and Rochet (2008) and the references therein.

\textsuperscript{24}If debt is guaranteed, debt holders are less likely to monitor the bank and equity holders have an increased ability to take risks that can lead to bank failure.
failure.

In summary:

**Proposition 4.2** A government debt guarantee benefits both borrowers and depositors in the absence of a banking crisis. It also increases the number of competing banks. However, it leads to higher bank debt. This creates a dead-weight loss to the degree that a bank chooses a more costly mix of equity and foundation debt. Under assumption 6, the debt guarantee will raise the severity of any crisis in the sense that the size of each bank’s loss when the wholesale funds rate is high is greater with a debt guarantee than without such a guarantee. If assumption 6 does not hold, then a debt guarantee will increase the likelihood of bank insolvency.

While proposition 4.2 looks at a government guarantee for debt holders, it extends to any government policy that, either implicitly or explicitly, protects holders of foundation debt (but not equity holders) from the consequences of bank insolvency.

A broader ‘bail out’ policy that protected both holders of foundation debt and equity, also will have similar effects. If assumption 6 holds, then each bank will receive \( \frac{1}{N} \pi - K \) when the wholesale funds rate is high. This will encourage bank entry. However, banks have no incentive to distort their mix of equity and foundation debt as the subsidy from the government does not depend on this mix.

Conversely, if assumption 6 does not hold, banks will restructure to ensure that a crisis occurs (so long as \( \Gamma \) is not too high). Banks increase foundation debt to raise the chance of insolvency, given that they receive a government subsidy when they are insolvent. Like a ‘debt guarantee’, broader bank ‘bail out’ policies can, in fact, create a banking crisis.

### 4.2 Bank licensing and restricted entry of banks

An alternative approach to the potential for a banking crisis, is for the government to limit bank competition by requiring banks to hold a (costly) bank
license or by explicitly restricting the number of banks that are allowed to operate. Both of these policies are equivalent to an increase in $K$, although the benefit in terms of profits depends on whether the government receives the increase in $K$ (the case where the government charges an explicit license fee on banks) or whether the increase in $K$ becomes an implicit rent to ‘allowed’ banks (where government restricts bank entry).

It follows from lemma 4.1, that either policy will reduce the number of competing banks. In the absence of a crisis this will raise the rates charged to borrowers and lower the rates received by depositors. So borrowers and depositors will ‘pay’ for the restriction of competition through the rates that they respectively pay and receive. Further, the quantity of loanable funds transacted will decrease in equilibrium.

The policies will also effect the likelihood of bank failure, but in different ways.

If the number of banks is simply restricted below the unregulated equilibrium level, so that $K$ is unchanged from the perspective of (licensed) banks, then $K_d^0$ will be unchanged but bank profits will rise. The reduction in competition will raise $\pi$ while the reduction in $N$ will increase $\frac{1}{N}\pi_N$. A bank is insolvent if $K_d^0 > \frac{1}{N}\pi_N$ so the increase in the right-hand-side of this inequality, with the left-hand-side unchanged, reduces the likelihood of bank failure.

Similarly, an explicit bank license also reduces the number of competing banks and raises $\frac{1}{N}\pi_N$. However, the license fee increases $K$ so that $K_d$ also rises. So while the license fee has the same effects as restricting the number of banks in the absence of a crisis, it has different consequences when there is a banking crisis. By lowering $N$ the license policy reduces the likelihood of a banking crisis. By raising $K_d$, the license policy raises the likelihood of a banking crisis. So a bank licensing policy may or may not change the possibility of bank failure. We simply cannot say a priori.

Of course, the difference is due to the change in taxpayer revenue. In this sense, a bank license fee raises taxpayer revenue. In contrast, a simple restriction on bank numbers allows the banks to keep this revenue as an economic rent on bank operation. However, if the aim of policy is to prevent
a bank failure, the distribution of these funds is critical.

It might be thought that an explicit bank license fee together with a guarantee of government bailout might provide a compromise to replicate a restriction on bank numbers without allowing banks to make economic rents when there is no crisis. However, as discussed above, a debt guarantee leads to a change in the mix of funding used by banks. Depending on the size of the license fee and the effect of the guarantee on the cost of debt, such a mixed policy could encourage or discourage bank entry. In this sense, it may raise or lower the likelihood of bank failure.

In summary:

**Proposition 4.3** A license policy for banks will reduce the number of competing banks and will harm both borrowers and depositors in the absence of a banking crisis. If the license simply restricts the number of banks but does not involve a charge to the banks then the license will raise banks’ profits and reduce the likelihood of bank insolvency when wholesale fund rates are high. In contrast, if the licenses involve a payment by the banks (e.g. are simply sold to the ‘highest bidder’ by the government) then the effects on bank insolvency are ambiguous.

### 4.3 Minimum equity ratios

Bank insolvency arises when there is a crisis due to high wholesale funding rates and a bank is unable to meet its debt obligations so \( K_d^0 > \frac{1}{N} \pi_N \). One simple policy to deal with this problem is to limit the amount of debt banks can raise and, as a consequence, raise the amount of equity they must hold.

In practice, restrictions on the capital structure of banks are often implemented through a minimum equity requirement, usually expressed as a percentage of the level of a bank’s retail loans under non-crisis situations (i.e. under normal operating conditions). In our framework, when the rate on wholesale funds is low at \( r_w \), the equilibrium level of loans for a bank is given by \( q^d = q_d^d (r_w + c_w + M_w^w) \). Denote the minimum equity ratio by \( k_e \). Thus a minimum equity requirement usually requires that \( (K_e/q^d) \geq k_e \).
To explore the consequences of a minimum equity requirement on the banking system, first, suppose that changing the mix of debt or equity used to initially establish a bank does not alter the establishment costs (i.e. \( \Gamma = 0 \)). In that situation, the fixed cost \( K \) of establishing a bank does not depend on the level of equity \( K_e^0 \) relative to ‘foundation’ debt \( K_d^0 \). Thus the minimum equity requirement does not alter the costs of establishing or operating a bank and so does not change either the equilibrium number of banks or the level of loans when there is no crisis, \( q^d \). Thus, so long as \( k_e \leq (K/q^d) \), so that a bank that is fully equity funded can meet the minimum equity requirement in equilibrium, the imposition of such a requirement simply leads a bank to raise its level of equity and equally reduce its level of foundation debt. There will be no flow-on effects to bank competition or interest rates.

In this situation, the minimum equity requirement can eliminate the risk of bank insolvency. The level of foundation debt for a bank subject to a minimum equity requirement will be no greater than \( K - k_e q^d \). If \( K - k_e q^d < \frac{1}{N} \pi_N \), a minimum equity requirement will eliminate the risk of bank insolvency without distorting the market for loanable funds.

Alternatively, suppose \( \Gamma > 0 \) so the establishment cost of a bank be \( K + \delta(K_e) \).

Suppose that in the absence of any regulation (with equity level \( K_e^0 \)) the equilibrium number of banks is \( N^0 \) and the level of loans in the state with a low wholesale funds rates is \( q_d^0 \). The minimum equity requirement will only bind if \( k_e > (K_e^0/q_d^0) \). Further, assume that there exists a finite level of equity \( K_e \) such that \( K_e = K + \Gamma(K_e) \), so that, in theory, it is possible to have a bank with 100% equity. Let the equilibrium number of banks when all banks are fully equity funded be denoted by \( N \). Note that by lemma 4.1, \( N < N^0 \).

Note that the equilibrium level of loans when the wholesale funds rate is low \( q_d^0 \) is continuous and decreasing in \( r^w + c^w + M_N^w \) and \( M_N^w \) is continuous and decreasing in \( N \). Thus \( q_d^d \) will be a continuous decreasing function of \( K_e \) so that \( (K_e/q_d^d) \) is continuous and increasing in \( K_e \). This means that

\[25\text{There is significant debate about the actual cost of regulating the funding mix used by banks on the cost of banking. See for example REFS.} \]
any minimum equity requirement that is greater than the equity ratio for an unregulated bank but less than the equity ratio for a bank with 100% equity, can be implemented in equilibrium. Further, as banks will individually seek to minimise funding costs, the minimum equity ratio will bind.

In summary, any ratio \( k_e \) that is greater than the equity ratio set by an unregulated bank but less than the equity ratio for a bank with no foundation debt will lead to an equilibrium level of equity for all banks between \( K_e^0 \) and \( K_e \). By continuity, any \( K_e \in [K_e^0, K_e] \) can be implemented. But this means that any level of bank debt \( K_d \in [0, K_d^0] \) can be implemented in equilibrium, albeit with an increase in the cost of founding the bank to \( K + \Gamma(K_e) \).

Thus, it is always possible to impose a minimum equity ratio on the banking system that eliminates the possibility of default, but only by raising the cost of establishing a bank. The increase in cost will reduce the number of banks that enter in equilibrium and will raise the interest rates paid by borrowers, and lower the rates received by depositors, in the absence of a crisis. But it will raise \( \frac{1}{N} \pi_N \) by both lowering \( N \) and raising \( \pi_N \). In this sense, if the government’s aim is to limit bank insolvency, the a minimum equity ratio appears to be an unambiguously successful policy. Even if the policy raises bank funding costs by requiring banks to have an inefficient mix of debt and equity funding, this creates a positive feedback to bank stability.

In summary:

**Proposition 4.4** Imposing an appropriate minimum equity ratio on banks will reduce the likelihood of bank insolvency. If the minimum equity ratio does not raise the overall funding costs for a bank then the reduction in bank insolvency risk will involve no (other) distortion to the loanable funds market. If the minimum equity ratio does raise a bank’s funding costs, then the policy will reduce bank competition and harm borrowers and depositors in the absence of a crisis. It will also create a deadweight loss to the economy as banks are forced to adopt an inefficient mix of equity and foundation debt. However, the feedback through a reduction in bank competition will further stabilise the banking system.

It should be noted that the stabilising effect of minimum equity require-
ments have on the banking system is not the result of a reduction in moral hazard. Rather, it reflects a direct effect: reducing debt levels reduces the probability of insolvency. It also reflects a feedback from higher equity levels raising banks funding costs, and so reducing the number of banks that compete. This raises individual bank’s profits in the event of a wholesale funding crisis, reducing the likelihood of insolvency.\footnote{Clearly the overall desirability of a minimum equity requirement will depend on the cost of changing bank funding $\Gamma$. However, if $\Gamma$ is not too high, this policy appears to be a useful way for a government to prevent banking crisis.}

4.4 Limiting banks’ access to the market for wholesale funds

Our analysis focusses on the risk of a country importing a crisis through the market for wholesale funds. A potential government policy to deal with this would be to limit banks’ access to wholesale funds. In other words, if banks cannot rely on wholesale funding then a banking crisis cannot be triggered by a rise in the rate on wholesale funds.

In our framework, this is trivially true in the extreme. If banks were barred from using wholesale funds to finance loans then bank’s expected profits would be constant and equal to $\pi_N$. Banks would enter and establish until $\frac{1}{N}\pi_N - K = 0$. No bank would ever become insolvent as $\frac{1}{N}\pi_N = K \geq K_b^0$.

While such an extreme policy would stabilise the banking system, it comes at a cost. By assumption 5, $\pi_N < \bar{\pi}_N$. Being unable to access wholesale funds reduces banks’ profits and limits entry. This will reduce competition and will raise interest rates to borrowers and reduce the equilibrium quantity of loanable funds transacted. At the same time, the interest rate for depositors will rise as competition in the supply of loanable funds from the wholesale market is eliminated.

More generally, suppose that the government places a tax on wholesale funds to discourage banks from using these funds when the rate on wholesale
funds is low. This is equivalent to a rise in either $r^w$ or in $c^w$. However, the effect of an intermediate level of tax on wholesale funds (i.e. one that does not eliminate the use of wholesale funding entirely) is ambiguous.

To see this, denote the tax by $t$ so that the effective cost of wholesale funds to banks is $r^w + t$. Naively, it might be considered that a rise in $r^w + t$ would lower banks’ profits given that this rate is a cost from the perspective of the banks. And, indeed, this holds true for a monopoly bank. But it need not hold true for competitive banks.

A rise in $r^w + t$ has two effects on competing banks. First, it raises the cost of using wholesale funds to finance loans. Second, it shifts the balance of funding for loans to (relatively cheap) retail deposits. Depending on the competitive margins earned by banks on different loans, the rise in $r^w$ may enable banks to rebalance their portfolios from ‘low margin’ loans funded by wholesale funds to ‘high margin’ deposit-funded loans. This would occur, for example, if there were strong competition between banks in writing loans but (perhaps due to local branch networks) weak competition in terms of attracting deposit funds.

For example, suppose that $\alpha^r(N) \approx 0$ and $\alpha^w(N) \approx 0$ but $\gamma(N) \approx 1$. Competition between banks is intense except for deposits when wholesale funding is available. This will result in $\pi^r < \pi^w$ as required. However, a tax on the wholesale fund rate will enable banks to shift their competitive activity from the highly competitive areas to the situation where they have strong monopsony power.

While this example depends on a strong degree of asymmetry in competition, it highlights that complex changes can occur due to a tax on wholesale funds. To appropriately analyse the direction of changes in rates and margins with a change in $t$, a careful analysis of the nature of competition is required. Using an intermediate level of wholesale funding tax could, in theory, encourage entry by banks and make banks more vulnerable to a crisis.

\footnote{Note that a change in either of these variables will have identical effects in our model as these terms always enter together as $r^w + c^w$ when determining banks’ profits, banks’ profits or rates paid by customers.}
A crisis occurs when the wholesale funds rate is high but to determine the
direction of the effects on the market when the wholesale funds rate is high,
analysis of the nature of competition when the wholesale funds rate is low is
required.

The government could also reduce banks’ reliance on wholesale funds by
limiting the amount of wholesale funds that banks, in total, are allowed to
borrow. From banks’ perspective, a ‘quota’ on allowable wholesale funds will
be similar to a tax, except that the individual banks will retain any implicit
tax revenue. Relative to an equivalent wholesale funding tax, a wholesale
funding quota will raise banks’ expected profits. Thus, the situation where
the limit on wholesale funds actually destabilises the banking sector, rather
than stabilizes it, is more likely under a quota relative to a tax.

**Proposition 4.5** *Except in the extreme, where access to wholesale funding
is banned, limiting access to wholesale funding has ambiguous implications
for both bank competition and the likelihood of a banking crisis.*

## 5 Discussion and conclusions

In this paper, we have extended the classic Monti-Klein model of a monopoly
bank to allow for dual sources of bank funding, uncertainty over the price of
wholesale funds, and imperfect competition with free entry. We have used
this model to illustrate the potential for a country whose banking system
relies on ‘imported’ wholesale funds to face a crisis due to a change in the
price of wholesale funds. Such a crisis could be precipitated by events in
overseas banks, as occurred in 2008. We have also used the model to explore
a variety of policy options for governments that are aimed at dealing with
a potential ‘imported’ crisis. In particular we have considered the effects of
such policies on the behaviour of the banking system in ‘normal times’.

Our model is complementary to much of the existing literature on banking
crises. There is no moral hazard or adverse selection in our model. Indeed,
there are no bad loans in our framework that may create banking problems.
Also a crisis is not precipitated by a run on a bank by depositors. While a
bank run may arise in our model, the underlying cause of a bank crisis is the change in the cost of imported wholesale funds and the effect of a cost shock on banks’ cash-flows and profitability. In this sense, we approach bank crises from a different direction to much of the literature, albeit reflecting actual events during the 2008 crisis.

Because the structure and level of competition is endogenous in our model, the key to analysing a banking crisis is bank profitability. A crisis occurs when bank profitability falls relative to debt when the cost of wholesale funds is high. Thus, effective government policy must address either the level of debt or manipulate banks’ profits over different states-of-the-world.

Minimum equity requirements (or equivalently, maximum levels of debt) address the problem directly. We show how such policies are robust to prevent a crisis. That said, depending on bank’s capital costs, minimum equity requirements may reduce normal levels of bank competition.

Alternatively, to raise banks’ profitability when there is a crisis, governments can limit the number of banks. However, the effects of such a policy depend on whether banks pay upfront for the license. If they do — so that the cost of a license is simply an additional capital cost to banks — a license may simply raise banks’ levels of both debt and equity. In such a case, competition in banking will be limited with ambiguous consequences for a crisis.

In contrast, if banks do not pay for a license, restricting entry will raise banks’ profits in all situations. Competition falls but banks may be more stable.

Restrictions on banks’ access to wholesale funds can also lead to ambiguous effects. While appearing to directly address the issue of potentially importing a crisis through the price of wholesale funds, such policies also effect the monopsony power of banks over depositors. It is possible that such restrictions act as a collusive device for banks when dealing with coroners, raising profits, encouraging entry and destabilising the banking sector.

Finally, we show that ad hoc policies such as bank bailouts, increase competition in normal times by encouraging bank entry. This encouragement reflects the governments guarantee to protect the bank in a crisis. Of course,
in equilibrium, this can raise the risk of such a crisis, making ad hoc policies self defeating.

Proofs:

Proof of lemma 3.1: Note that \( r_1^r = r^w - \Delta - m_1 \). But by assumption 2, \( r^w < \tau_1^r + \Delta \). By substitution, \( r_1^r < \tau_1^r - m_1 \). But \( m_1 > 0 \) so \( r_1^r < \tau_1^r \). □

Proof of lemma 3.2: Consider the margin \( \hat{M} \) such that \( \hat{M} = -\frac{q^d}{\partial q^d/\partial r} \) at \( q^d(\tau_1^r + c^r + M_1^r) \) and define the wholesale rate \( \hat{r}^w \) by \( \hat{r}^w + c^w + \hat{M} = \tau_1^r + c^r + M_1^r \).

Note that by construction:

\[
\hat{M} = -\frac{q^d}{\partial q^d/\partial r} < -\frac{q^d}{\partial q^d/\partial r} + -\frac{q^s}{\partial q^s/\partial r} = M_1^r
\]

Thus, \( \hat{r}^w + c^w > \tau_1^r + c^r \). Equivalently, \( \hat{r}^w > \tau_1^r + \Delta \). But by assumption, \( \underline{r}^w < \tau_1^r + \Delta \). So \( \hat{r}^w > \underline{r}^w \).

Note that for any wholesale rate \( r^w \) the optimal margin \( M_1^w \) solves \( M_1^w \frac{\partial q^d}{\partial r} + q^d(\tau_1^r + c^r + M_1^r) = 0 \). As this holds for all \( r^w \) it can be totally differentiated to give:

\[
\frac{dM_1^w}{dr^w} = -\frac{M_1^w \frac{\partial q^d}{\partial r}}{M_1^w \frac{\partial q^d}{\partial r} + 2 \frac{\partial q^d}{\partial r}}
\]

By our assumptions on demand, the left-hand-side of this equation is an element of \((-1, 0]\). Thus, a decrease in \( r^w \) will lead to an increase in \( M_1^w \) but a fall in \( r^w + M_1^w \). Remembering that \( \hat{r}^w > \underline{r}^w \), this means that \( \hat{r}^w + c^w + \hat{M} > \underline{r}^w + c^w + M_1^r \). But, by construction, this means that \( \tau_1^r + c^r + M_1^r > \underline{r}^w + c^w + M_1^w \) as required. □

Proof of lemma 4.1: In equilibrium, \( E\pi_N = \rho^\frac{1}{N} \pi_N + (1 - \rho)^{\frac{1}{N}} \pi_N - K = 0 \).

Rearranging and taking the total derivative with regards to \( N \) and \( K \),

\[
\frac{dN}{dK} = -\frac{N}{\rho \frac{\partial \pi_N}{\partial N} + (1 - \rho) \frac{\partial \pi_N}{\partial N} - K}
\]

But as \( \frac{\partial \pi_N}{\partial N} < 0 \) and \( \frac{\partial \pi_N}{\partial N} < 0 \) this means that \( \frac{dN}{dK} < 0 \). Thus a rise (fall) in \( K \) will lead to a fall (rise) in the equilibrium number of banks \( \bar{N} \).
By assumption $\overline{M}_N^r$, $M^w_N$, $M^r_N$ and $m_N$ are all decreasing in $N$ so that a rise (fall) in $K$ will increase (reduce) each of $\overline{M}_N^r$, $M^w_N$, $M^r_N$ and $m_N$.

The rate charged to borrowers is increasing, and the rate paid to depositors is decreasing, in $\overline{M}_N^r$ when the wholesale funds rate is high.

If the wholesale funds rate is low, then the rate paid by borrowers is $\overline{r}^w + c^w + M^w_N$, which is increasing in $M^w_N$. The rate paid to depositors is $\overline{r}^w + c^w + M^w_N - c' - M^r_N$, which is equal to $\overline{r}^w - \Delta - m_N$ and is decreasing in $m_N$. Thus, due to the change in margins an increase (decrease) in $K$ will lead borrowers to pay higher (lower) interest rates and depositors to receive lower (higher) interest rates regardless of the level of the wholesale funds rate.

References


Figure One: Banks’ wholesale debt. Share of total funding, 2011.

Excludes net repo financing
Source: Stewart, Robertson and Heath (2013) figure 10