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Abstract Until recently, financial services regulation remained largely segmented along national lines. The integration of financial markets, however, calls for a systematic and coherent approach to regulation. This paper studies the effect of *market based* regulation on the proper functioning of the interbank market. Specifically, we argue that restrictions on the payout of dividends by banks can reduce their expected default on (interbank) loans, stimulate trade in this market and improve the welfare of consumers.

Keywords Dividend Restriction · Interbank Market · Default · Liquidity · Regulation

JEL Classification D52 · E4 · E5 · G11 · G21

1 Introduction

Since August 2007 banks have accumulated losses of $1.11 trillion in the current crisis. However what is striking is that banks have continued to pay out dividends even though the value of common equity has suffered immensely. Acharya *et al.* (2009) argue that dividend payments represent a transfer to equity holders from creditors (and taxpayers) in violation of the priority of

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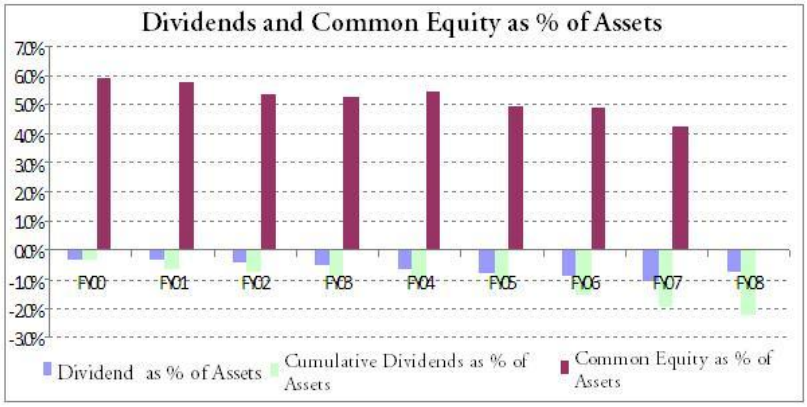

Fig. 1 Please write your figure caption here

debt over equity and that the dwindling pool of common equity may be an important reason for the continued reluctance of banks to extend credit in spite of the large-scale injection of bailout capital.

The figure above[1] shows that bank dividend payouts increased from 0.4% of assets in 2000 to 1.1% of assets in 2007 and were still at 0.7% of assets through the first three quarters of 2008 - i.e. banks barely reduced their dividends in the first fifteen months of the crisis. This data is also consistent with anecdotal evidence that banks were reluctant to cut or even reduce dividends[2].

We study this problem not from the point of view of the transfer between debt holders and equity holders but from the point of view of the collapse of the interbank market. At the end of 2008 the volume of interbank lending in the British currency fell to 205 billion pounds down from 635 billion pounds in July 2007 and down 24 percent from the average since the credit crunch started in August 2007, and 38 percent for the five years ending December 2006. We argue that market based regulation, which affects all participants in a particular market (in this case the interbank market), curtailing the payout of dividends increases the liquidity of borrowers in the interbank market, stimulates trade in the market and ultimately improves the welfare of consumers.

Liquidity and default have frequently been regarded as two separable concepts. Our view, instead, is that these two concepts are inherently intertwined;

[1] From Acharya *et al.* (2009).

[2] Lehman Brothers Holdings announced a 13% increase in its dividend and a $100 million share repurchase in January 2008, Citigroup cut its dividend close to zero only in November 2008. JPMorgan and Wells Fargo, while recipients of the TARP capital in Fall 2008, cut dividends as late as February and March 2009, respectively, and even as the Federal Reserve was urging banks receiving bailout funds to cut dividends. This is to be compared to the fact that 61 members of the Standard & Poor's 500-stock index cut their dividends during 2008 (c.f. Acharya *et al.* (2009)).

you cannot have one without the other. For example, if no one ever defaulted, and was without any credit risk, then everyone's IOU would be perfectly acceptable in payment. The concept of gradations of liquidity in such circumstances would be invalid. There would be no need for money, nor for financial intermediaries. And such an assumption of zero default unfortunately lies at the heart of most of the macro-economic models currently in mainstream use, which explains why they have been so spectacularly useless during the recent crisis.

Inevitably, concerns about liquidity and default interact. The original idea that the start of the financial crisis in August 2007 was just a liquidity problem, though a widely shared view at the time, was always ludicrous. Instead, the economic shock arising from the US housing market and its effect on mortgage-based securities raised the prospect of a higher probability of default amongst an increasing range of banks and their associated conduits. In turn, this concern about enhanced default risk led to a reduction in market liquidity and hence to a fall in asset prices. But this fall in asset prices then reinforced concerns about banks' and other financial intermediaries' solvency, and this further reduced liquidity in a range of asset markets, with a variety of self-amplifying spirals then bringing the whole financial system to its knees. Lack of liquidity dries up key financial markets, thus preventing institutions from restructuring their portfolios, adapting their strategies, and steering away from potential dangers caused by exogenous economic shocks. In turn, defaults start accumulating and the domino effect leads to further reductions in liquidity, and ultimately leads financial institutions, corporates and other non-financial bodies to start failing to meet their contractual obligations.

In this paper we concentrate on the collapse of the interbank market under counterparty risk and show that trade can be restored with the appropriate liquidity requirement. In Peiris and Vardoulakis (2009) trade in risky securities such as loans in the interbank market (and subsequently delivery rates in them) improve when agents hold greater amounts of liquid savings. However, in their model welfare improves only if originally there is some minimal trade. If initially there is no trade in the risky security then welfare will fall in spite of a more favourable final allocation, due to the dead-weight loss of default. In this paper, the distinction between traders in such securities (banks) and the final consumers of goods (households) means that a restriction on the payout of dividends allows households to enjoy the benefits of an improved allocation and hence higher welfare. In light of recent events in the financial markets, such a policy would, we believe, be greatly beneficial. Given that the interbank market consists of an international array of banks, an internationally coherent approach to regulation here is needed. Hence we are advocating *market based* regulation, which is tied to participation in particular markets, as opposed to national institution based regulation.

To properly formulate such an argument, and capturing the many interrelated effects and channels, requires a formal general equilibrium analysis incorporating money, banks and default. Importantly, a formal welfare analysis can only be studied in such an environment, as each effect will have direct and indirect implications on the final allocation of consumption.

To date, regulation has focused on the influence of capital on the risk-taking behaviour of banks and their potential systemic effects. With the high mobility of international capital, efforts to harmonize capital standards began in the 1980s with the 1988 Basel Accord on capital standards and focused on the measurement of capital and the definition of capital standards for credit risk. The Basel I Accord sets minimum capital requirements for international banks worldwide and is based on only a limited differentiation of risk using broad categories of exposure-with an 8% charge for all exposures except OECD government, OECD interbank, under one-year non-OECD interbank and residential mortgages. The requirements reflect the type of loan and not the riskiness of the loan (except for the OECD/non-OECD distinction and recognition of some types of financial collateral) and therefore did not change if the creditworthiness of borrowers deteriorated.

The Basel II Accord on the other hand differentiates exposures according to the riskiness of the borrower. Capital requirements will therefore rise if the creditworthiness of borrowers deteriorates. The new Accord offers two approaches (standardized and internal ratings based) for the setting of risk-based capital requirements.

Under a standardized approach, banks will allocate borrowers to bands according to the external rating of the borrower (for example, from a rating agency). Looking at the 1990-92 recession, corporate ratings based on Moody's approach lead to little increase in capital requirements whereas ratings based on a Merton-type model lead to a 40% to 50% increase. Bank ratings are generally not forward looking, and therefore do not take full account of risks taken in booms, and exacerbate the economic cycle by encouraging over-lending in booms.

Under an alternative, internal ratings-based (IRB) approach, banks allocate borrowers to probability of default bands. The Committee has set out a function for calculating the capital requirement for each loan based on the probability of default (PD) of the borrower (set by the bank) and the loss given default (LGD) which would be experienced were the borrower to fail. Under the foundation (IRB) approach the Committee would set the loss given default, and under an advanced approach the bank would set it. The capital requirements were calculated by the Committee, using credit risk models, for losses over a one-year horizon with a 99.5% confidence level. It was assumed that the correlation between the returns on different corporate exposures was 20%. This was based on information on correlations used by the industry and

also research carried out by the Committee on correlations implicit in economic capital allowed by firms.

One weakness of both Basel I and Basel II lies in their dependency on capital rather than liquidity[3]. Defaults across asset classes become highly correlated during an economic downturn, often occurring unexpectedly. In such scenarios what is needed is not only capital or assets, but also *liquid* capital or assets. This is precisely what is argued in this paper: Banks should hold greater amounts of liquid wealth as a precautionary means of meeting claims in times of crisis.

One response of the authorities worldwide to the most recent financial crisis has been to propose a new and separate body to introduce tougher regulation on systemic financial institutions. While we agree with this in general, we would also wish to point to two difficulties. First, the boundary between an institution which is systemic, and one which is not, is not constant and fixed, but depends on economic conditions at the time, and these will vary. Northern Rock was systemic in 2007, but would not have been in 2005. The idea that there is a given set of systemic institutions which can be clearly identified and treated differently, is just wishful thinking. One of the key exercises for the systemic regulator will be to try to observe how the boundary between the more systemic, and the less so, is continually shifting.

Moreover, the current proposal is that the bigger, and more systemic, financial intermediaries should face more onerous regulation. That would cause shifts in competitiveness, whether through regulatory arbitrage or not, between those defined as systemic and those defined as less so. By regulating banks only and not all participants of a key capital market is to ignore the likelihood that business and risk will tend to shift over time to the less regulated. Consider the inter-bank market or exotic derivatives markets with their esoteric financial instruments. The purpose of any regulatory intervention could be neutralised, if not reversed, should only large banks be regulated. In any race track the same rules of the game apply to all cars, and not only to those built by well-established car manufacturers.

Section 2 of this paper outlines the model while section 3 discusses endogenous default. Section 4 presents the results of the simulation exercise and shows why dividend restrictions can be beneficial. Finally, section 5 concludes.

[3] In addition, there is the issue of procyclicality in setting risk-weights thereby exacerbating credit contraction during recessions and, hence, possibly causing a credit crunch. For more on this see Catarineu *et al.* (2005) and Pederzoli *et al.* (2008)

2 Model

Our main objective is to describe a situation where the interbank market collapses and propose regulation that restores trade. Hence, we consider an environment with two heterogeneous banks (γ and δ) that can enter into a contractual agreement to transfer funds between them. Banks are not obliged to honour this contract when the time for repayment comes and thus active default in the interbank market can occur in equilibrium. As stated in the previous section, the presence of a default penalty is necessary to ensure trade in such defaultable contracts. Nevertheless, when default penalties are low, adverse shocks in the anticipated future profits and capital position of banks can induce them to default completely in the interbank market, which collapses. We describe this situation and show how regulation on dividends can alleviate this problem. Banks optimizing behaviour and their attitude towards risk are important elements in our analysis, since the possibility of default may deter banks from participating in the interbank market not only due to low profit expectation, but also due to high risk.

Our second consideration is how fair is such a regulatory policy and what is its effect on welfare. Banks are financial intermediaries that extend credit to consumers and their purpose is to facilitate trade and risk-sharing. Thus, we also consider two households (α and β) that have utility for goods traded in the economy and receive credit from banks to fund their trade. Households cannot write their own contracts-promissory notes and exchange them for goods. They need money to acquire goods in the corresponding markets. In our model we assume limited participation so that Mr. α is affiliated with Bank γ and Mr. β with Bank δ. Households maximize the utility of consumption. Apart from receiving credit from banks they also receive dividends as they own stakes in both of them. The interaction of the real and the nominal sector of the economy allows us to focus on the effect of dividend restrictions on (individual) households welfare in order to evaluate the fairness of such a policy.

We consider a two-period economy where agents know the present (period 0) but are uncertain about the future where one of $s \in \{1, 2\}$ states of nature may occur both with probability $1/2$. In order to motivate trade and risk sharing, we consider two perishable goods in the economy and agents have utility for both in all periods. Trade takes place between two agents $H = \{\alpha, \beta\}$ and money is the stipulated means of payment. There is also an interbank market through which banks can borrow money in the present and repay in the future. Interbank loans are risky, since banks choose how much to repay in the last period. Banks extend short-term credit to households to buy goods. Banking profits at the end of the first period are equal to the short-term credit extension plus interest minus the repayment in the money market.

The reason we utilize a General Equilibrium model is that default and liquidity affect the interest rates and are affected by households and banks through the market system. This in turn has welfare implications and influences the final allocations of goods in the economy. In sum, welfare and distribution of goods can rigorously be studied within a General Equilibrium framework. Uncertainty and heterogeneity are also important elements of our model. Households and Banks transact with each other not only to smooth they consumption-profits between today and tomorrow, but also to hedge their risk due to an uncertain future and thereby smooth their future consumption. If there was no uncertainty default would be strategic and one cannot distinguish between solvency and illiquidity. However, with uncertainty default arises from ill-fortune and/or strategic considerations, thereby differentiating illiquidity from insolvency. Therefore, dividend restrictions can restore the functioning of the interbank market in cases of illiquidity.

Banks can either distribute these profits as dividends or retain them for the next period. We consider a situation in which the interbank market collapses if banks distribute their profits in the initial period as dividends, while trade in the interbank market is restored once they retain their profits. The reason for this is that banks marginal profit from defaulting becomes lower and, therefore, they opt not to default and suffer the default penalty. Consequently, unduly pessimistic expectations of loan repayment cease to exist and confidence is restored. This argument follows from Peiris and Vardoulakis (2009) who argue that liquid savings requirements restore trade in defaultable asset markets.

Banks will not voluntarily hold capital, since they can extend credit in the initial period and earn the (positive) interest rate. Nevertheless, once profits are realized they cannot commit to retain the profits in order to accumulate reserves in the last period. Thus, the need for liquidity (capital) requirements arises. As shown in Peiris and Vardoulakis (2009), this can restore trade in defaultable asset markets, since capital will be held when the contract is traded. However, if banks can commit not to distribute dividends at the end of the period, then the effect will be the same as if they raised capital requirements. The issue of commitment is not simple and depends on corporate governance and regulation. For the purposes of this paper we assume that banks can, indeed, commit not to distribute dividends. Government intervention through regulation can provide incentives for such a commitment.

Formally, we consider a canonical General Equilibrium model with Incomplete Markets, Commercial banks, Fiat Money and Endogenous Default. Banks are modeled as in Goodhart, Sunirand and Tsomocos (2004, 2005, 2006a, 2006b) and Tsomocos (2003). There are two households with utility for goods (Mr. α and Mr. β) and two profit maximizing commercial banks (Bank γ and Bank δ) that extend short-term credit to households. In our model we assume limited participation such that Mr. α is affiliated with Bank γ and Mr. β with

Bank δ.

Each $h \in H$ is endowed with a stake in each of the two banks, which gives him rights to banking profits. These profits are, at some point of time distributed as dividends. Mr. α holds w_γ^α of bank γ and w_δ^α of bank δ. Similarly, Mr. β holds w_γ^β of bank γ and w_δ^β. Obviously, $w_\gamma^\alpha + w_\gamma^\beta = 1$ and $w_\delta^\alpha + w_\delta^\beta = 1$.

2.1 The Economy

The economy E is characterized by the following exogenous parameters:

- $l \in L = \{1, 2\}$ commodities.
- $s \in S = \{1, 2\}$ states of nature.
- $s^* \in S^* = \{0\} \cup S$ set of all states.
- $t \in T = \{0, 1\}$ where $s = 0$ when $t = 0$ and $s \in S = \{1, 2\}$ when $t = 1$.
- $h \in H = \{\alpha, \beta\}$ set of households in the monetary economy.
- $k \in K = \{\gamma, \delta\}$ set of banks in the monetary economy.
- $e_{s^*}^h = (e_{s^*}^h) \in R_+^{S^* L}$ endowment for agent $h \in H$ in state s^* of perishable goods.
- $m_{s^*}^h$ is the private monetary endowment in state s^* belonging to agent h.
- $e_{s^*}^k$ is the capital of bank k in state s^*.
- $I^k \in [0, 1]$ an indicator of the percentage of initial period profits distributed as dividends.
- $u^h : R_+^{S^* \times L} \to R$ utility function of agent $h \in H$.
- π_s^k bank's k profits minus retained earnings in state s^*.
- c^k the coefficient of risk-aversion of bank k.
- w_k^h the stake of household h in bank k.

2.2 Governments and Central Banks

There is a central bank which has the authority to act in markets on behalf of its government through Open Market Operations (OMOs). The actions of the central bank will be taken as exogenous allowing us to analyse the consequences of government activities on the dynamics of the market.

In the short term (intra period) money market the central bank will fix the amount of money lent to banks (M_{s^*}, $s^* \in S^*$) with the interest rate being endogenously determined (r_{s^*}, $s^* \in S^*$).

2.3 The Time Structure of Markets

In each period $t \in T$, four markets meet: first the short-term (intraperiod) money market followed by the interbank market, the consumer lending market

and the commodity markets. Finally, short-term bonds in the money market and consumer loans come due at the end of the period. The interbank market settles in the last period.

The first period thus has four transaction moments: short bonds in the money market and consumer lending, interbank market, commodities, short-bond and consumer loan deliveries, while the second period has the following transaction moments: short bonds in the money market and consumer lending, interbank deliveries, commodities, short-bond and consumer loan deliveries. In the initial period there is no delivery on the interbank market while in the last period there is no market for interbank.

Figure 1 indicates our time line, including the moments at which the various loans and bonds come due. We make the sequence precise when we formally describe the budget set.

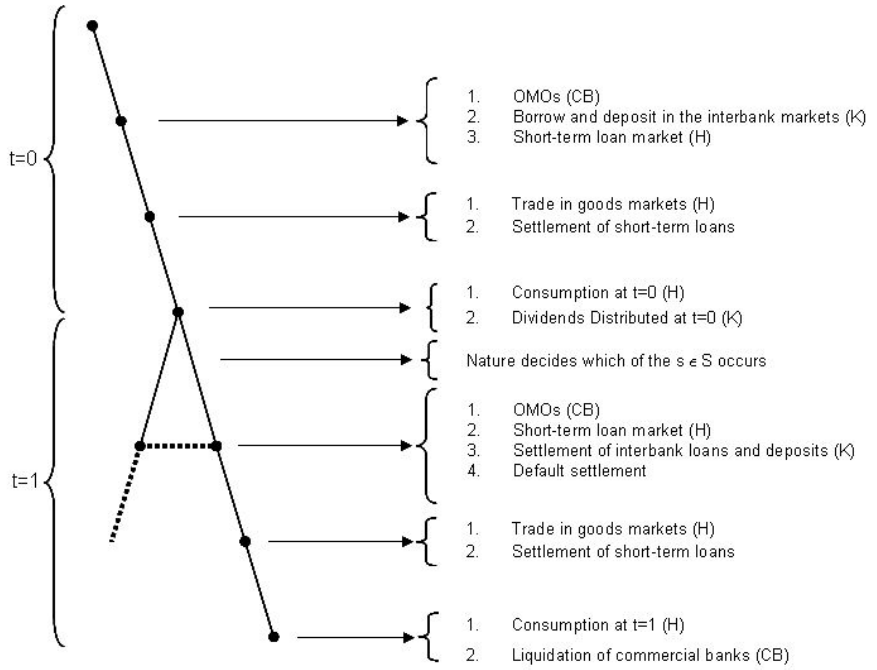

Fig. 2 Time Line of Monetary Economy

2.4 Structure of the Model

Agent $h \in (\alpha, \beta)$ sells good $l \in L$ in each period with quantities given by q_{s^*l}. Agents α is endowed only with the first good, while agent β only with the second.

Prices of goods are determined in equilibrium and are taken as fixed by agents p_{s^*l}. The money traded for a good in state s^* by agent h is $b^h_{s^*l}$.

The short-term money repaid by agent h in state s^* is $\mu^h_{s^*}$.

Banks borrow money from the Central Bank and extend credit to consumers. They can also act in the interbank market to transfer wealth intertemporally and hedge risk. The interbank market is an anonymous market. We denote by $\bar{\mu}^k$ and $\bar{d}^k$ the amounts that bank k chooses to borrow and deposit in the interbank market, respectively, at the ex-ante interest rate ρ. In equilibrium bank k will either deposit or borrow from the interbank market but not both. The amount that a bank which borrows chooses to repay is state-contingent and is denoted by D^k_s, $s \in S$. Each bank that deposits in this market receives the effective delivery rate on each unit of deposit, which is given by K_s, $s \in S$. We assume that bank γ is relatively richer than bank δ today, but poorer tomorrow. Thus, bank γ will be a net lender in the interbank market and bank δ a net borrower.

2.5 Market Clearing Conditions

2.5.1 Money Markets

The intra-period money markets clear when the amount of money which banks offer to repay at the end of the period ($\mu^k_{s^*}$, by bank $k \in K$ and $s^* \in S^*$) is exchanged for the (exogenously determined) amount of money lent by the central bank at the (endogenously determined) interest rate at the beginning of each period. In state $s^* \in S^*$ the central bank lends M_{s^*}. The market clearing condition is:

$$1 + r_{s^*} = \frac{\sum_{k \in K} \mu^k_{s^*}}{M_{s^*}} \quad \mathrm{s}^* \in \mathrm{S}^*$$

2.5.2 Goods Market

The goods market clears when the amount of money offered for goods is exchanged for the quantity of goods offered for sale.

In state $s^* \in S^*$ for good $l \in L$.

$$p_{s^*l} = \frac{b^h_{s^*l}}{q^{h'}_{s^*l}}$$

That is, the price of a good sold by agent h' will be determined by the ratio of the money offered to purchase this good by the other agent divided by the quantity of the good sold.

2.5.3 Consumer Credit Markets

The intra-period consumer credit markets clear when the amount of money which households offer to repay at the end of the period ($\mu^h_{s^*}$, $s^* \in S^*$) by agent $h \in H$ is exchanged for the amount of money lent by the commercial banks ($m^k_{s^*}$, $s^* \in S^*$) at the interest rate at the beginning of each period. In each period and state the interest rate is determined endogenously:

$$1 + r^k_{s^*} = \frac{\mu^h_{s^*}}{m^k_{s^*}}$$

$$\text{where } h = \alpha \text{ for } k = \gamma \text{ and } h = \beta \text{ for } k = \delta$$

We assume no default in the money market to simplify the analysis and concentrate on the default in the interbank market.

2.5.4 Interbank Market

The interbank market clears when the volume of money borrowed $\frac{\bar{\mu}^\delta}{1+\rho}$ equals the amount of deposits $\bar{d^\gamma}$, i.e. $1 + \rho = \frac{\bar{\mu}^\delta}{\bar{d^\gamma}}$.

Banks are promised a nominal repayment of $1+\rho$ for each unit they deposit in the interbank market in state $s \in S$ but receive K_s - the delivery rate- and is given by:

$$K_s = \begin{cases} \frac{D^\delta_s}{\bar{\mu}^\delta} \quad \text{if} \quad \bar{\mu}^\delta > 0 \\ \\ \text{or arbitrary if} \quad \bar{\mu}^\delta = 0 \end{cases}$$

2.5.5 Capital Markets

The capital markets clear when the total profits distributed by banks equal the total dividends received by households. As stated the equity stakes of each households are given at t=1 and are not transferable.

$$\Delta^h_0 = \sum_{k \in K} w^h_k \cdot \pi^k_0$$
$$\& \sum_{h \in H} w^h_k = 1$$
$$\forall \text{ k} \in \text{K}$$

2.6 Budget Sets for Agents

Households maximise inter-temporal consumption and value consumption equally in the present and the future. Therefore, considering their endowments of goods and money, preferences and subjective probabilities, they maximise the utility they get from consuming the two goods by choosing the amount of each good they buy and sell and the amount of money they borrow.

Households are not unconstrained in their choice of the above variables. At each point in time the amount of money that they spend on goods or use to repay loans have to be less or equal to the amount of money that they receive from the sale of goods they are endowed with or the money they borrow. Given the time-structure of the markets households face in the initial period the following two constraints. First, the expenditure for goods that they are not initially endowed with has to be less or equal to amount borrowed short-term from the bank they are associated with plus their initial private monetary endowment. Second, the amount that they repay in the short-term loan market has to be less or equal to monetary value of sales of the good they are initially endowed with.

In the last period and in every possible scenario they face similar constraints. First, the expenditure for goods that they are not endowed with in that state of the world has to be less or equal to the amount borrowed short-term in that state plus the dividends that accrue from banking profits in the initial period. Second, the amount that they repay in the short-term loan market has to be less or equal to monetary value of sales of the good they are endowed with in that state of the world.

Agent α maximises inter-temporal consumption with a discount factor of 1 and subjective belief .5 of each state occurring. Therefore, considering agent α's endowments of goods and money, preferences and subjective probabilities, his optimization problem is (Lagrangian multipliers are in brackets):

$$\max_{q^{\alpha}_{s1}, b^{\alpha}_{s2}, \mu^{\alpha}_{s}} \Pi^{\alpha} = u(e^{\alpha}_{01} - q^{\alpha}_{01}) + u\left(\frac{b^{\alpha}_{02}}{p_{02}}\right) + \sum_{s\in S} \theta_s u(e^{\alpha}_{s1} - q^{\alpha}_{s1}) + \sum_{s\in S} \theta_s u\left(\frac{b^{\alpha}_{s2}}{p_{s2}}\right)$$

$$s.t. \quad \mathrm{b}^{\alpha}_{02} \leq \frac{\mu^{\alpha}_{0}}{1+\mathrm{r}^{\gamma}_{0}} + \mathrm{m}^{\alpha}_{0} \qquad (\psi^{\alpha}_{01})$$

(i.e., expenditure for good 2 at t=0 $\leq$ amount borrowed short-term at t=0 + initial private monetary endowment)

$$\mu^{\alpha}_{0} \leq p_{01} q^{\alpha}_{01} \qquad (\psi^{\alpha}_{02})$$

(i.e., short-term loan repayment $\leq$ good 1 sales at t=0)

$$b^{\alpha}_{s2} \leq \frac{\mu^{\alpha}_{s}}{1+r^{\gamma}_{s}} + \Delta^{\alpha}_{0} + m^{\alpha}_{s} \qquad (\psi^{\alpha}_{s1})$$

(i.e., expenditure for good 2 in state $s \in S \leq$ amount borrowed short-term in state $s \in S$ + dividend at t=0 + private monetary endowment)

$$\mu_s^{\alpha} \leq p_{s1} q_{s1}^{\alpha} \qquad (\psi_{s2}^{\alpha})$$

(i.e., short-term loan repayment $\leq$ good 1 sales in state $s \in S$)

The optimization problem is analogous for agent β as well, but instead of buying good 2 and selling good 1 he is doing the opposite:

$$\max_{q_{s2}^{\beta}, b_{s1}^{\beta}, \mu_s^{\beta}} \Pi^{\beta} = u(e_{02}^{\beta} - q_{02}^{\beta}) + u\left(\frac{b_{01}^{\beta}}{p_{01}}\right) + \sum_{s \in S} \theta_s u(e_{s2}^{\beta} - q_{s2}^{\beta}) + \sum_{s \in S} \theta_s u\left(\frac{b_{s1}^{\beta}}{p_{s1}}\right)$$

$$s.t. \quad \mathrm{b}_{01}^{\beta} \leq \frac{\mu_0^{\beta}}{1 + \mathrm{r}_0^{\delta}} + \mathrm{m}_0^{\beta} \qquad (\psi_{01}^{\beta})$$

(i.e., expenditure for good 1 at t=0 $\leq$ amount borrowed short-term at t=0 + initial private monetary endowment)

$$\mu_0^{\beta} \leq p_{02} q_{02}^{\beta} \qquad (\psi_{02}^{\beta})$$

(i.e., short-term loan repayment $\leq$ good 2 sales at t=0)

$$b_{s1}^{\beta} \leq \frac{\mu_s^{\beta}}{1 + r_s^{\delta}} + \Delta_0^{\beta} + m_s^{\beta} \qquad (\psi_{s1}^{\beta})$$

(i.e., expenditure for good 1 in state $s \in S \leq$ amount borrowed short-term in state $s \in S$ + dividend at t=0 + private monetary endowment)

$$\mu_s^{\beta} \leq p_{s2} q_{s2}^{\beta} \qquad (\psi_{s2}^{\beta})$$

(i.e., short-term loan repayment $\leq$ good 2 sales in state $s \in S$)

For both agents $h \in \{\alpha, \beta\}$, the utility function is CRRA, i.e. $u(c) = \frac{c^{(1-\rho^h)}}{1-\rho^h}$.

2.7 Budget Sets for Banks

Bank γ maximises inter-temporal profits. Therefore, considering γ's endowments of capital, risk-aversion and subjective probabilities, it maximizes profits by choosing the amount it borrows from the central bank, the amount of money it lends in the interbank market, its credit extension to consumers and finally the deliveries in their interbank loans in each possible scenario.

Its initial constraint is that the amount of money it lends short-term plus what it lends in the interbank market has to be less or equal to the amount of money it borrows from the central bank plus its initial capital. In each possible

scenario in the future the amount of money it lends short-term has to be less or equal to the amount it borrows from the central bank plus the repayment of the interbank loan it extended in the initial period, the retained earnings from the initial period and its capital in that state of the world.

The profit it distributes as dividends is the total earnings from the credit extension to consumers minus the repayment to the central banks multiplied by the dividend payout ratio. Its final profits are equal to the earnings from the credit extension to consumers minus the amount of money they repay to the central bank. The above hold for bank δ as well.

Bank γ maximises inter-temporal profits with subjective belief .5 of each state occurring. Therefore, considering agent γ's endowments of capital, risk-aversion and subjective probabilities, its optimization problem is (Lagrangian multipliers are in brackets):

$$\max_{\mu_s^\gamma, m_s^\gamma, \overline{d}^\gamma, I^\gamma} \Pi^\gamma = \pi_0^\gamma - c^\gamma(\pi_0^\gamma)^2 + \sum_{s\in S} \theta_s \left(\pi_s^\gamma - c^\gamma(\pi_s^\gamma)^2\right)$$

$$s.t. \quad \mathrm{m}_0^\gamma + \overline{\mathrm{d}}^\gamma \leq \frac{\mu_0^\gamma}{1+\mathrm{r}_0} + \mathrm{e}_0^\gamma \qquad (\psi_0^\gamma)$$

(i.e., short-term lending + deposits in the interbank market $\leq$ borrowing in the money market + initial capital endowment at t=0)

$$m_s^\gamma \leq \frac{\mu_s^\gamma}{1+r_s} + \overline{d}^\gamma \cdot K_s \cdot (1+\rho) + (1-I^\gamma)\cdot m_0^\gamma(1+r_0^\gamma) + e_s^\gamma \quad \forall \mathrm{s} \in \mathrm{S} \qquad (\psi_\mathrm{s}^\gamma)$$

(i.e., short-term lending $\leq$ borrowing in the money market + bond deposits and interest payment + retained first period earnings + capital endowment in $s \in S$)

where

$$\pi_0^\gamma = I^\gamma \cdot (m_0^\gamma(1+r_0^\gamma) - \mu_0^\gamma)$$

(i.e., profits distributed as dividends = (short-term loans repayment - money market repayment) times payout ratio)

$$\pi_s^\gamma = m_s^\gamma(1+r_s^\gamma) - \mu_s^\gamma \quad \forall \mathrm{s} \in \mathrm{S}$$

(i.e., profits = short-term loans repayment - money market repayment in $s \in S$)

Bank δ maximises inter-temporal profits with subjective belief .5 of each state occurring. Therefore, considering its endowments of capital, risk-aversion and subjective probabilities, it maximizes profits by choosing the amount it borrows from the central bank, the amount of money it borrows from the interbank market, its credit extension to consumers and finally the deliveries in

their interbank loans in each possible scenario.

Its initial constraint is that the amount of money it lends short-term has to be less or equal to the amount of money it borrows from the central bank and the interbank market plus its initial capital. In each possible scenario in the future the amount of money it lends short-term plus the interbank loan repayment has to be less or equal to the amount it borrows from the central bank plus the retained earnings from the initial period and its capital in that state of the world.

The optimization problem is analogous for bank δ:

$$\max_{\mu_s^\delta, m_s^\delta, \overline{\mu}^\delta, D_s^\delta, I^\delta} \Pi^\delta = \pi_0^\delta - c^\delta(\pi_0^\delta)^2 + \sum_{s\in S}\theta_s\left(\pi_s^\delta - c^\delta(\pi_s^\delta)^2\right) - \lambda\sum_{s\in S}\theta_s \max\left(\overline{\mu}^\delta - D_s^\delta, 0\right)$$

$$s.t. \quad \mathrm{m}_0^\delta \leq \frac{\mu_0^\delta}{1+\mathrm{r}_0} + \frac{\overline{\mu}^\delta}{1+\rho} + \mathrm{e}_0^\delta \qquad (\psi_0^\delta)$$

(i.e., short-term lending $\leq$ borrowing in the money market + interbank borrowing + initial capital endowment at t=0)

$$m_s^\delta + D_s^\delta \leq \frac{\mu_s^\delta}{1+r_s} + (1-I^\delta)\cdot m_0^\delta(1+r_0^\delta) + e_s^\delta \quad \forall \mathrm{s} \in \mathrm{S} \qquad (\psi_s^\delta)$$

(i.e., short-term lending + interbank loan repayment $\leq$ borrowing in the money market + retained first period earnings + capital endowment in $s \in S$)

where

$$\pi_0^\delta = I^\delta \cdot (m_0^\delta(1+r_0^\delta) - \mu_0^\delta)$$

(i.e., profits distributed as dividends = (short-term loans repayment - money market repayment) times payout ratio)

$$\pi_s^\delta = m_s^\delta(1+r_s^\delta) - \mu_s^\delta \quad \forall \mathrm{s} \in \mathrm{S}$$

(i.e., profits = short-term loans repayment - money market repayment in $s \in S$)

2.8 Equilibrium

Equilibrium is reached when households and banks optimize given their constraints, all markets clear and expectations are rational. Prices, interest rates and delivery rates are determined endogenously and are taken as fixed by agents. In addition, every potential buyer of an asset (in our case bank γ that lends in the interbank market) is correct in his expectation about the fraction of promises that are delivered. Finally, regulation can affect the set of choices

that are available to agents, which is in our case is the dividend payout ratio.

In the following section we will parameterise our model and show that for default penalties for which the interbank market collapse, i.e. banks default completely in both states, distributing less dividends removes this problem and enables the interbank market to become active again. Moreover, economic welfare improves.

The variables determined in equilibrium and taken by agents as fixed is given by $\eta = \{p, r, \rho, K\}$. The choices by agent $h \in (\alpha, \beta)$ and $k \in \{\gamma, \delta\}$ is given by $\square^h = \{q^h, b^h, \mu^h\}$ and $\square^k = \{m_s^k, \mu_s^k, \overline{\mu}^k, \overline{d}^k, D_s^k, I^k\}$.

We say that $(\eta, (\square^h)_{h\in H}), (\square^k)_{k\in K}$ is an **Monetary Equilibrium with Commercial Banks and Default** and denote it MEBD for the economy $E = \big((u^h, e^h, m^h)_{h\in H}, (c^k, e^k, I^K)_{k\in K}, M\big)$ if and only if:

1. $(\square^h) \in Argmax_{\square^h \in B(\eta)} \;\; U(x^h)$
2. $(\square^k) \in Argmax_{\square^k \in B(\eta)} \;\; \Pi(x^k)$
3. $1 + r_{s^*} = \frac{\sum_{k\in K} \mu^k_{s^*}}{M_{s^*}} \quad \mathrm{s}^* \in \mathrm{S}^*$
4. $p_{s^*l} = \frac{b^h_{s^*l}}{q^{h\prime}_{s^*l}} \quad \mathrm{s}^* \in \mathrm{S}^*, \; \mathrm{l} \in \mathrm{L}$
5. $1 + r^k_{s^*} = \frac{\mu^h_{s^*}}{m^k_{s^*}} \quad \mathrm{s}^* \in \mathrm{S}^*$
   where $h = \alpha$ for $k = \gamma$ and $h = \beta$ for $k = \delta$
6. $\Delta^h_0 = \sum_{k\in K} w^h_k \cdot \pi^k_0$
   & $\sum_{h\in H} w^h_k = 1$
   $\forall$ k $\in$ K
7. $1 + \rho = \frac{\sum_k \bar{\mu}^k}{\sum_k \bar{d}^k}$
8. $K_s = \begin{cases} \frac{D^\delta_s}{\bar{\mu}^\delta} \;\; \text{if} \;\; \bar{\mu}^\delta > 0 \\ \\ \text{or arbitrary if} \;\; \bar{\mu}^\delta = 0 \end{cases}, \forall \; \mathrm{s} \in \mathrm{S}$

Conditions 1 and 2 says that all agents optimise; 3 says that the money markets clear; 4 says that all commodity markets clear, or equivalently that price expectations are correct, 5 and 7 says that all credit markets clear, or equivalently, that predictions of interest rates are correct, 6 says that the capital markets clear while 8, together with the budget set, says that each potential buyer of an asset is correct in his expectation about the fraction of promises that get delivered.

3 A Note on Endogenous Default

When an individual, company or institution seeks credit, he/it enters into a contractual agreement to repay money in the future. Default on the part of the seller of the contract is a possibility that the lender takes into consideration when he sets up the terms of the contract. If the seller of the contract faces no punishment or real loss from defaulting on his obligation, then he would default no matter how rich he would be in the future. This raises the need for the application of some kind of punishment for agents that choose to default on their obligations. Historically bondage, corporal punishment and debtors' prison were used, each being a mechanism to force a debtor to reveal assets assumed to be hidden.

The emphasis on punishment changed in the mid-nineteenth century when bankruptcy started to be seen as an economic rather than moral failure. The introduction of collateral as a way to secure loans was first done in the agricultural sector. The terms of collateralized loans have changed since then, allowing the borrower to extract economic benefits from the collateralized assets and to use a variety of assets as collateral including financial assets. In a collateral equilibrium, agents will default when the value of their collateralized assets is less than the value of the promise they have to keep. This raises concerns at times of crisis when deflationary pressures are apparent and collateral is of low quality due to expected drop in value in the future. If collateral cannot be used to secure defaultable assets, then the markets for these asset will collapse in the presence of low default penalties, which is the case in modern societies.

In this paper we try to resolve the problem of the collapse of the interbank market by imposing restrictions on dividends. The intuition behind this argument comes from conditions under which agents will choose to default. In our model default is endogenous and thus a decision variable for agents. The first treatment of endogenous default in the presence of default penalties is due to Shubik and Wilson (1977) and was analysed in a General Equilibrium framework by Dubey, Geanakoplos and Shubik (2005).

Each additional unit of income will have a marginal value for agents. But, not delivering an additional unit according to one's contractual obligation and choosing to default will incur a marginal penalty. When the marginal value - utility is higher than the marginal penalty then agents will default on that additional unit of income.

In our model the two banks are they only agents that enter into risky contracts. When the time comes to honour their contractual obligation they can either default completely on their promise in the interbank market, default partially or delivery fully. In the case they default they will sustain a disutility equal to the amount they default multiplied by the (marginal) de-

fault penalty. Default in this model can be either strategic or due to ill-fortune.

The following the conditions characterize these three cases:

- Banks default completely when the marginal gain (lagrange multiplier) for zero delivery of the asset they sell is higher than the marginal loss (default penalty) from defaulting, i.e.
  $\psi_s^k > \lambda$
- If at zero delivery the marginal utility gain is less than the marginal disutility from defaulting then then they will default up to the level that the marginal gain is equal to the marginal loss, i.e.
  $\psi_s^k = \lambda$
- Banks will deliver fully when their marginal gain for full delivery is lower than the marginal loss, i.e.
  $\psi_s^k < \lambda$

As shown in Peiris and Vardoulakis (2009) savings requirements reduce the distance between the marginal gain and the marginal loss from defaulting completely. This restores the incentives to trade and risky assets markets start function in an orderly fashion. Dividend restrictions do the exact same trick as banks carry the money that they do not distribute as dividend as cash.

In the following section we will parameterise our model and show that for default penalties for which the interbank market collapse, i.e. banks default completely in both states, distributing less dividends alleviates this problem and enables the interbank market to become active again.

4 Simulation

We study a an economy parameterised to minimise the number of interactions and highlight the effect of dividend restrictions. The data for the economy is shown in table 1. There is no uncertainty with respect to monetary policy or real endowment in the last period. The uncertainty is derived from the different monetary endowments of banks and agents. Bank gamma is relatively wealthier in state 1 while agent beta is wealthier in state 1. The risk aversion of agents is .9, while for the banks it is .02. Agents own equal shares of the two banks.

The table 2 shows what occurs when banks commit to distribute fewer dividends and keep the retained profits as capital. The first column shows the equilibrium without dividend restriction and the second column shows what occurs when banks decrease their dividend payout ration I^γ from 0.15 to 0.10 and I^δ from 0.25 to 0.20. We can see that this stimulates trade in the interbank

Table 1 Data of the Economy

e_0^γ	1.00	M_0	2.50	w_γ^α	0.50	m_0^α	0.75	e_0^α	10.00
e_1^γ	0.50	M_1	2.00	w_δ^α	0.50	m_1^α	0.25	e_1^α	10.00
e_2^γ	0.35	M_2	2.00	w_γ^β	0.50	m_2^α	0.25	e_2^α	10.00
e_0^δ	0.65	I^γ	0.15	w_δ^β	0.50	m_0^β	0.80	e_0^β	10.00
e_1^δ	1.00	I^δ	0.25	$c^\gamma = c^\delta$	0.02	m_1^β	0.30	e_1^β	10.00
e_2^δ	1.00	λ	1.26	$\rho^\alpha = \rho^\beta$	.9	m_2^β	0.25	e_2^β	10.00

Table 2 Endogenous variables

Endogenous variables	Equilibrium **without** dividend restrictions	Equilibrium **with** dividend restrictions	Change
$\bar{\mu}^\delta$	0.00	0.54	0.54
$\bar{d}^\gamma$	0.00	0.40	0.40
D_1^δ	0.00	0.54	0.54
D_2^δ	0.00	0.54	0.54
K_1	-	1.00	1.00
K_2	-	1.00	1.00
ρ	-	0.35	0.35
Π^α	18.00	18.11	0.11
Π^β	18.01	18.12	0.11
Π^γ	2.32	2.13	- 0.19
Π^δ	2.36	2.25	- 0.11

market and improves welfare[4].

We have shown here that by restricting only the percentage of profits distributed as dividends, we can increase liquidity in the second period, reduce the incentive to default and hence establish trade in the interbank market. Note that no ex-ante commitment to repay interbank debt was used here, but rather banks had individual incentives to 1) trade in the market and 2) repay when loans are due as in doing so would avoid a relatively harsher cost of the default penalty.

Table 3 shows the effect of the operational interbank market on consumer credit markets. Interest rates in the second period fall substantially as a result of the ability of banks to better manage their risks. The overall interest rates also fall as banks require less money in the second period, rather relying on the financial markets directly.

Table 4 shows the improved allocation as a result of the interbank market functioning. The lower consumer credit rates in the second period result in more efficient trade and so we see agents sell more of their own good and purchase more of the alternate good thereby improving their welfare. Essentially

[4] Rounding is made after the difference is calculated.

Table 3 Endogenous variables - interest rates

Endogenous variables	Equilibrium **without** dividend restrictions	Equilibrium **with** dividend restrictions	Change
r_0	0.31	0.35	0.04
r_1	0.35	0.26	-0.09
r_2	0.31	0.26	-0.05
r_0^γ	0.36	0.38	0.02
r_1^γ	0.35	0.26	-0.09
r_2^γ	0.40	0.26	-0.14
r_0^δ	0.39	0.37	-0.02
r_1^δ	0.35	0.26	-0.09
r_2^δ	0.31	0.26	-0.05

Table 4 Endogenous variables - consumption

Endogenous variables	Equilibrium **without** dividend restrictions	Equilibrium **with** dividend restrictions	Change
c_{01}^α	9.60	9.60	-0.00
c_{11}^α	9.54	9.10	-0.44
c_{21}^α	9.54	9.09	-0.54
c_{02}^α	0.40	0.40	0.00
c_{12}^α	0.46	0.89	0.43
c_{22}^α	0.46	0.91	0.45
c_{01}^β	0.40	0.40	0.00
c_{11}^β	0.46	0.90	0.44
c_{21}^β	0.46	0.91	0.45
c_{02}^β	9.60	9.60	-0.00
c_{12}^β	9.54	9.11	-0.43
c_{22}^β	9.54	9.09	-0.45

this result reflects the importance to consumers of risk sharing in the financial markets and the need to encourage its proper functioning.

5 Conclusion

The international nature of the modern interbank (loan) market demands a coherent approach to regulation. Here we advocate *market based* regulation, which affects all participants in a particular market, on the proper functioning of the interbank market. Specifically, we argue that restrictions on the payout of dividends by banks can reduce their expected default on (interbank) loans and hence stimulate trade in this market.

The payout of dividends during a crisis is clearly of concern for debt holders. However, it may in fact also be to the detriment of equity holders. In this paper we argue that a reduction in the fraction paid out in dividends to shareholders allows banks greater access to debt markets, especially the interbank

market, because it provides an ex-ante commitment to increase the available capital when liabilities are due. We have shown in this paper that even an extreme situation where the interbank market implodes can be remedied through the introduction of dividend restrictions and results in an improvement in the welfare of shareholders.

We have shown that the presence of a functioning interbank market results in lower consumer credit rates, more efficient trade and a superior final allocation for consumers. The result is surprising in as much as we only restricted the dividend payout policy of the borrowing bank, yet improved welfare of that bank's borrowers, and ultimately its shareholders. This result is encouraging as it is a simple method to re-start financial trade. Furthermore, compared to other policies such as quantitative easing, enforcing dividend restrictions is a relatively inexpensive mechanism for encouraging risk sharing in the financial markets.

The forthcoming regulatory architecture should recognise that there are markets that are 'too important to fail' and not only banks that are 'too big to fail'. So regulation should also be focused on 'systemic markets' as well as 'systemic institutions' and hence should be international, and market based, as opposed to national and individualised (and hence not directly tied to participation in a particular market) restrictions on economic activity.

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