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The interbank market, Keynes's degree of confidence and the link between banks' liquidity and solvency

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Abstract

The link between banks' liquidity and solvency is not adequately addressed in the literature, despite the central role of the interbank market in the spread of the recent crisis. This paper proposes a possible way by which the interbank rate and the required return on equity capital are determined, and are related to each other. Thereby, a link between liquidity and insolvency risk is derived on the grounds of Keynes's concept of 'degree of confidence' on held expectations about economic prospects. High degree of confidence and trust prevailing in the interbank market makes risk sharing possible at prices which render bank capital regulation ineffective in the rising phase of the cycle, and overly restricted in the downswing. Basel's III higher capital, liquidity and leverage ratios might not be enough if measures, in the sense of Minsky's Big Government-Big Bank, targeting overconfidence in booms and redressing the lack of confidence in the downturns are not taken into account.

Keywords: Degree of confidence, Interbank market, Liquidity preference, Insolvency risk, Financial cycles.

JEL Classification: E12, E32, G21

1. Introduction

The crisis of 2007-2009 revealed the interconnections between liquidity and solvency of financial institutions and the crucial role of the interbank market (Adrian 2015). Interbank transactions were an important flow of bank lending before the crisis (Kregel 2010). However, when banks desperately needed liquidity to cover their subprime exposures as the crisis unfolded, the interbank market froze (Gale and Yorulmazer 2013; Ashcraft, McAndrews and Skeie 2011). Basel III recognized that solvent banks were put at risk because the liquidity problems they were facing lasted much longer than expected (BCBR 2010).

Yet, despite the acknowledgement of regulatory shortcomings, the crucial mechanism which links liquidity and insolvency risk is not adequately addressed in the literature (Puhr and Schmitz 2013). Pierret (2015) notes an interaction between solvency and liquidity risk in a sample of US bank holding companies for the period 2000 – 2013. Following the ideas developed by Diamond and Rajan (2005), Allen and Gale (1998) and Shleifer and Vishny (1992), Pierret (2015) maintains the view that the causality runs from perceived insolvency to illiquidity. Investors' distressed expectations about future economic prospects affect the market value of banks' capital and lead to sales of banks' assets in an attempt of the latter to raise their capital adequacy ratios. However, in a systemic crisis, banks sell their assets at fire sale prices thus deteriorating both their solvency position and the solvency position of other banks with similar assets (Hanson, Kashyap and Stein 2011). Eventually, a rise in insolvency risk will exacerbate liquidity risk as depositors might run on their deposits. The policy proposal derived by this line of argument is for a rise in capital buffers that would take account of this solvency-liquidity risk interaction and boost investors' confidence in the banking system. However, Jordà, Richter, Schularick and Taylor (2017) using data from 17 economies for the period 1870-2013, have noticed the superior performance of liquidity indicators, as opposed to solvency indicators, as predictors of financial fragility and crisis. Eventually, the most powerful predictor of financial crises appears to be the level of credit growth which is closely related to banks' liquidity preference.

This paper explores the reverse causality than that of Pierret (2015) and focuses on banks' liquidity and credit growth as suggested by Jordà, Richter, Schularick and Taylor (2017). In addition, building on the link between liquidity and insolvency risk presented by Alves, Dymski and de Paula (2008), it argues that perceptions of illiquidity in the banking system

might lead to a rise in its insolvency. The paper explains how an 'average' degree of confidence on banks' expectations about future economic prospects (Keynes 1936 [1973]; 1937) is formed in the interbank market. This degree of confidence reflects a level of mutual trust which prevails in the banking sector and affects the liquidity premia. The paper also demonstrates how this 'average' degree of confidence might affect the risk premia in the market for banks' share capital thereby establishing a link between liquidity and insolvency risk. Finally, it is shown that fluctuating levels of mutual trust among banking firms make risk sharing possible among the various contracting parties and render capital regulation ineffective in the rising phase of the financial cycle and overly restricted in the downswing. If this is the case, the paper concludes that, in the context of Minsky's (1982) Big Government-Big Bank view, the authorities should take measures to curb overconfidence in the boom and redress confidence in the downturn.

2. Liquidity and insolvency risk and the degree of confidence factor

2.1 The interbank market as a barometer of banks' degree of confidence

Since our world is plagued by fundamental ignorance of the future, economic decisions crucially depend on the degree of confidence by which expectations are held given established conventions, rather than on objective knowledge of the probability distributions (Keynes 1921[2004]; 1936[1973]; 1937). This holds true not just for non-financial firms that assume borrowers' risk but also for banking firms that take on lender's risk. Banks extend credit or cut on lending depending on their expectations of future economic prospects and the confidence with which they hold these expectations. They also provide credit *to each other* in order to exploit profit opportunities (Dymski 1988). Fisher (1933) has argued that overconfidence cannot explain cyclical events unless coupled with overindebtedness. However, to reverse the conditionality, overindebtedness of firms might itself be explained by overconfidence prevailing in the banking system, which, in turn, makes possible a credit expansion capable of sustaining a boom. In addition, Minsky (1972) has pointed out, the significance of changing beliefs and confidence in both the demand and the supply side of the credit market, the moment that euphoric expectations overcome the effect of rising interest rates.

The link between liquidity preference in the form of precautionary demand for money and the confidence with which expectations are held is given in Keynes (1930[1971]; 1936[1973]; 1937) and is commented in Cardim de Carvalho (1999, 2010), Dequech (1999,

2005) and Runde (2003). Specifically, Keynes (1936[1973], p. 240 and 1937) establishes the relationship between liquidity preference and the degree of confidence since 'The possession of actual money lulls our disquietude; and the premium which we require to make us part with money is the measure of the degree of our disquietude'. In this context, banks' liquidity preference might be a portfolio decision which relates both to banks' ability to pay off debts (deposits) on demand and to their perception of future economic prospects. The first is a Minskian interpretation but the latter comes directly from Keynes (1930[1971]). Keynes describes the attempt of banks to establish a trade-off in their balance sheets between profitability and liquidity (Cardim de Carvalho 1999; Bibow 2009, pp. 107-8) as they '… feel that a speculative movement or a trade boom may be reaching a dangerous phase…' and '… try to move, so far as they can, into a more liquid position' (Keynes 1930[1971], pp. 59-60). Moreover, liability management has turned the spotlight on the interbank market since the recourse of banks to wholesale markets for liquidity risk transformation have increased the fragility of the banking system itself (Moore 1988, pp. 36, 38).

Building on the above ideas and following Kam and Smithin (2012), Alves, Dymski and de Paula (2008), Moore (1988) and Dymski (1988) a stylized commercial bank's j balance sheet takes the form $\mathcal{L}_j + R_j + T_{jA} + B_j = D_j + T_{jL} + E_j$. The Assets' side is comprised of loans[1] $\mathcal{L}_j$, required reserves R_j, excess reserves[2] in the form of holdings of interbank securities T_{jA} and Treasury bills B_j. The Liabilities' side is comprised of deposits D_j , the market value of equity capital E_j and bank's own securities issued on the interbank market, T_{jL}. The difference $T_j = T_{jA} - T_{jL}$ indicates the net position of bank j in the interbank market. A typical balance sheet is shown in Table 1.

Table 1: Representative bank j balance sheet

Assets	Liabilities
Loans ($\mathcal{L}_j$)	Equity (E_j)
Required Reserves (R_j)	Deposits (D_j)
Interbank Loans (T_{jA})	Interbank Borrowing (T_{jL})
Treasury bills (B_j)	

[1]Since the focus of the model is on the interbank market, I assume for simplicity that 'loans' is a portmanteau term which includes both non-marketable and marketable assets subject to both credit and market risk.
[2] Even if there were no *required* and consequently, no *excess* reserves, banks might still have held liquid assets as *desired* reserves. In any case, Basel III's provision for liquidity ratios, especially the Liquidity Coverage Ratio, justifies the inclusion in this model of a measure of required reserves, no matter how these are calculated.

Given the above, the following ratios can be defined: the required reserves ratio $k_t = \frac{R_{jt}}{D_{jt}}$, the bank's j net position in the interbank market over its deposits $\tau_{jt} = \frac{T_{jt}}{D_{jt}} = \frac{T_{jAt} - T_{jLt}}{D_{jt}} = \tau_{jAt} - \tau_{jLt}$, the ratio of Treasury bills possessed by the bank over its deposits $b_{jt} = \frac{B_{jt}}{D_{jt}}$, and the *target* solvency ratio $e_{jt} = \frac{E_{jt}}{\mathcal{L}_{jt}}$, which is *constant* for bank j during a given time period. The ratios k_t, τ_{jt} and b_{jt} are the liquid assets' ratios. The ratio k_t pertains to required reserves whilst the sum $\tau_{jt} + b_{jt}$ refers to excess reserves. The required reserves ratio k_t and the solvency ratio e_{jt} are directly influenced by the existing regulatory framework of the financial system.

In the following model, the liquid assets ratios τ_{jt} and b_{jt} are related to behavioral relationships that give rise to a liquidity preference function for banks. The novelty of this model for the interbank market lies in the inclusion of a variable $conf_{jt}$ which represents the *degree of confidence* with which bank j holds its expectations of economic prospects. Alternatively, $conf_{jt}$ can be interpreted as the inverse of a *subjective* perception and aversion of uncertainty factor λ_{jt} on behalf of each bank j at time t namely, $conf_{jt} = \frac{1}{\lambda_{jt}} > 0$. Following Dequech (2005), a lower level of subjective perception/aversion of uncertainty λ_{jt} represents higher confidence in future economic prospects. Subjective perception/aversion of uncertainty or the degree of confidence are psychological factors concerning the subjective way a bank perceives and assess its financial performance, the conditions and costs of its funding and the conditions and prospects in the banking industry. Having the above relationship in mind, henceforth the subjective perception/aversion of uncertainty factor λ_{jt}will be referred to as a measure of the degree of confidence of bank j.

Following the money endogeneity tradition "loans make deposits" (Moore 1988, p. 46) in the sense that bank j extends loans on demand in the credit market and then covers any resulting funding (unexpected) deficit on the interbank market.[3] Hence, bank's j issue of short-term securities as liabilities T_{jLt} at the end of day t should equal the realized deficit in funding deposits $w_{jt}D_{jt}$.

$$T_{Ljt} = w_{jt}D_{jt} \tag{1}$$

[3] In order to focus on the effect of the interbank market I ignore any other sources of wholesale funds such as those from non-financial firms and households.

However, according to Dow (2006, p. 36) banks' liquidity preference is an additional factor that determines the volume of loans offered. Hence, at the end of each day, a bank has to decide how much liquidity to hold for the next day and in what form. For both decisions, the degree of confidence formed by bank's experience in the current day t is of crucial importance. A high degree of confidence would be correlated with lower liquid assets' ratios and higher lending. The contrary would be the case when the degree of confidence of bank j falls (Dow 2006, pp.41-2). Hence, at the end of day t bank j has to decide its holdings in liquid assets for the next day in the form of interbank $T_{jAt} = \tau_{jAt} D_{jt}$ and government $B_{jt}(.) = b_{jt}(.) D_{jt}$ securities. These holdings should satisfy expected demand for excess reserves for the next day as this is estimated at the end of day t, namely, ${x_{jt}}^e(w_{jt}, \lambda_{jt}, k_t)$, times the amount of end-of-the-day deposits D_{jt}. Expected demand for liquidity ${x_{jt}}^e(.)$ would depend negatively on the required reserves ratio k_t, and positively on bank's realized, at the end of day t, deficit in funding deposits w_{jt}, and on bank's subjective perception/aversion of uncertainty λ_{jt} (the inverse of the degree of confidence of bank j).[4] A rising uncertainty perception/aversion or a lower level of confidence urges banks to hold more liquid assets in the form of excess reserves for the next period at the expense of illiquid loans.

$$B_{jt}(r_B, \lambda_{jt}) + T_{jAt} = {x_{jt}}^e(w_{jt}, \lambda_{jt}, k_t) D_{jt} \qquad (2a)$$

In addition to the fact that it affects the amount of liquidity demand, a rising subjective perception/aversion of uncertainty λ_{jt} also affects the composition of liquid assets because it determines bank's preference *between* interbank securities and Treasury bills as alternative forms of holding excess reserves. Hence, demand for Treasury bills $B_{jt}(r_B, \lambda_{jt})$ depends positively on both the *daily* rate of return on these securities[5] r_B *and* the subjective perception/aversion of uncertainty factor λ_{jt}. It is straightforward that a rise in the riskless rate r_B boosts demand for Treasury bills. On the other hand, the higher λ_{jt}, the higher the riskiness of interbank transactions as perceived by bank j (the lower its degree of confidence concerning

[4] A mathematical expression for expected demand for excess reserves could be ${x_{jt}}^e(.) D_{jt} = \int_{k_t}^{1} [z_{t+1}(w_{jt}, \lambda_{jt}) D_{jt} - k_t D_{jt}] f(z) dz$ where required reserves $k_t D_{jt}$ are subtracted from any possible amount of total liquidity needs for the next day $z_{t+1}(.) D_{jt}$ and the calculated expected value depends on the perception/aversion of uncertainty λ_{jt} of bank j.

[5] This is the effective rate of return for one day of 3-month Treasury bills.

future economic prospects) and the higher the incentive for this bank to hold a greater proportion of short-term funds in the form of Treasury bills rather than in the form of interbank securities. Different degrees of confidence correspond to different 'degrees of liquidity' which are related to different types of assets in the sense of Cardim de Carvalho (1999, pp.11, 13).

Therefore, the part of bank's j liquidity preference which takes the form of interbank securities is expressed as:

$$T_{jAt} = x_{jt}{}^{e}(w_{jt}, \lambda_{jt}, k_t)D_{jt} - B_{jt}(r_B, \lambda_{jt}) \qquad (2b)$$

Expression (2b) is a behavioral relationship which hinges on the realized funding gap, the required reserves ratio, the Treasury bill rate and banks' j subjective perception/aversion of uncertainty.

Depending on the net outcome of their demand for and supply of liquidity some banks end up as net lenders on the interbank market (when $\tau_{jAt} > \tau_{jLt}$) and others as net borrowers (when $\tau_{jAt} < \tau_{jLt}$) of liquidity. A bank's position can change from a net borrower to a net lender and vice versa as subjective perception/aversion of uncertainty λ_{jt} (or the degree of confidence) and funding gaps w_{jt} change along the cycle.[6] At the end of day t net borrowers resort to the interbank market to cover their funding gaps with funds supplied by net lenders. In other words, aggregate borrowing/demand for liquidity $\sum_{j=1}^{m} T_{Ljt}$ is satisfied by aggregate liquidity supply $\sum_{j=1}^{m} T_{Ajt}$ and the level of the interbank rate that clears the interbank market is determined:

$$\sum_{j=1}^{m} T_{Ajt} = \sum_{j=1}^{m} T_{Ljt}$$

$$\therefore \quad \sum_{j=1}^{m} x_{jt}{}^{e}(w_{jt}, \lambda_{jt}, k_t)D_{jt} - \sum_{j=1}^{m} B_{jt}(r_B, \lambda_{jt})\, D_{jt} = \sum_{j=1}^{m} w_{jt}D_{jt} \qquad (3)$$

[6] The psychological nature of the degree of confidence (or the subjective nature of uncertainty perception/aversion) does not admit any direct relationship with current funding gap w_{jt}. There might be a rise in funding gap even as bank's degree of confidence is high or vice versa. This observation adds realism to this model and underlines the unpredictable character of the degree of confidence factor.

A rise in aggregate liquidity demand as indicated by a rising funding gap for a significant number of banks $\sum_{j=1}^{m} w_{jt} D_{jt}$ can only be met if aggregate supply of liquidity in the interbank market given by the left-hand side of (3) rises accordingly. This is possible if the subjective perception/aversion of uncertainty of a sufficient number of banks λ_{jt} rises (or their degree of confidence falls) causing the rise of total demand for liquid securities $\sum_{j=1}^{m} x_{jt}{}^{e}(w_{jt}, \lambda_{jt}, k_t) D_{jt}$. However, a rising λ_{jt} increases at the same time the demand for Treasury bills $\sum_{j=1}^{m} B_{jt}(r_B, \lambda_{jt})$ as a safer choice as opposed to interbank securities. Hence, sellers of interbank securities need to offer a higher interbank rate to attract buyers for their securities. Consequently, equilibrium in the interbank market implies that higher λ_{jt}'s go hand in hand with a higher interbank rate. Furthermore, as buyers and sellers meet each other in the interbank market, each one of them bringing along its own λ_{jt} as a measure of its degree of confidence, an 'average opinion' (Keynes 1936 [1973], p. 156) or 'average' perception/aversion of uncertainty of the banking sector $\bar{\lambda}_t = g(\lambda_{1t}, \dots, \lambda_{jt}, \dots, \lambda_{mt})$ takes shape and this is in fact the one which determines the level of the interbank rate. Then, we can define the interbank rate as:

$$r_T = r_B(1 + \bar{\lambda}_t)$$
$$\therefore \quad r_T - r_B = r_B \bar{\lambda}_t \qquad (4)^{7}$$

In (4) r_B is the riskless rate on Treasury bills and $\bar{\lambda}_t = \frac{1}{\overline{conf}_t}$, with $0 < \bar{\lambda}_t \leq \bar{\lambda}_{up}$ is the *'average'*, across banks, subjective perception/aversion of uncertainty factor, a measure of the *degree of confidence* and mutual *trust* prevailing in the banking sector. Thus, if the level of the interbank rate reflects the *liquidity premium of money in the interbank market* expressed by $\bar{\lambda}_t$, then fluctuations in the latter correspond to fluctuations in the degree of confidence with which probabilistic estimates are made, in the sense of Keynes (1936[1973], p. 240). In fact, the liquidity premium in the interbank market is inversely related to the average degree of confidence which is reflected in the degree that banks hold interbank securities instead of Treasury bills, in the sense of Dequech (2005; 1999). In other words, the interbank rate is the

[7] Although r_B is the daily effective return in this model, Sarno and Thornton (2003) have confirmed the existence of a positive difference, on average, between the US effective overnight federal funds rate and the US 3-month Treasury bill rate for the period 1/1/1974-31/12/1999.

rate of return on interbank securities that is just enough to compensate investors for their 'degree of illiquidity' (Cardim de Carvalho 1999, p. 13).[8]

An extremely low value of the average subjective perception/aversion of uncertainty $\bar{\lambda}_t$ close to zero indicates a high degree of confidence on expectations held by the majority of individual banks, and for the banking sector as a whole, a high level of *trust* prevailing in the interbank market, such that the interbank rate becomes almost equal to (yet higher than) the riskless interest rate. On the contrary, a rising value of $\bar{\lambda}_t$ is an indication of decreasing confidence and increasing *distrust* in the interbank market, which raises the interbank rate well above the riskless rate.

As noted above, a rising perception/aversion of uncertainty $\bar{\lambda}_t$ increases the incentive for shifting from interbank securities to Treasury bills but, the interbank market will attract buyers for interbank securities to the degree that the higher risk is 'adequately' compensated by a higher interbank rate. Although the interbank rate depends on an 'average' measure of degree of confidence, each bank maintains its own subjective perception/aversion of uncertainty which might differ by this 'average'. In this sense, the higher the liquidity premium embodied in the interbank rate and expressed by the 'average' $\bar{\lambda}_t$ the lower the proportion of banks willing to assume this risk according to their individual uncertainty perceptions/aversions λ_{jt}. In fact, there will be a level of uncertainty perception/aversion for each bank λ_{jup} where the need for security outperforms any monetary gain in the form of liquidity premium. This is the case in which a bank values its liquidity higher than its profitability (Moore 1988, p. 50) when buying insurance against future liquidity shocks. In addition, as the 'average' $\bar{\lambda}_t$ rises, an extremely high $\bar{\lambda}_t = \bar{\lambda}_{up} > 0$ indicates that confidence has plummeted for a significant majority of banks or distrust predominates in the interbank market. In such circumstances, it is doubtful whether liquidity demands can be serviced in the interbank market since most lenders of liquidity prefer to hold Treasury bills instead of interbank securities.

2.2 Banks' degree of confidence and the link between liquidity and solvency

[8] Obviously, the loan rate is also a measure of the 'degree of illiquidity' of banks' loans as opposed to the more liquid interbank securities and Treasury bills. However, this paper asserts that the liquidity premium in the interbank market is a measure of the average degree of confidence in the banking sector as a whole. Moreover, the interbank rate, representing the money market rate or the wholesale rate, enters in the mark-up pricing that determines the loan rate (Palley 2013, pp.11, 16; Dow 2006, p.46).

This section provides a justification for Alves, Dymski and de Paula (2008) emphasis on the interconnection between liquidity and insolvency risk. However, it does that by highlighting the particular importance for the stability of the banking system that banks' degree of confidence acquires, as this is formed in the interbank market.

Insolvency risk usually takes the form of default on loans and/or devaluation of marketable assets. The losses from defaulted loans (write-offs) and from devaluation of tradable assets should be covered by equity capital. This could take the form of retained earnings or equity capital raised from the capital market. It is also common among banks to aim at maintaining a constant target solvency ratio e_j. Besides, raising capital by issuing shares on the capital market implies a cost of equity capital equal to r_{Ejt}. If α_{jt} (with $0 \leq \alpha_{jt} \leq 1$ for every bank j) is the current period's default/devaluation rate [9] then the *market* value of equity at the end of day t is equal to $E_{jt} = E_{jt-1} + \Pi_{jt-1} - \alpha_{jt}\mathcal{L}_{jt} + \Delta E_{jt}(r_{Ejt})$. In this expression, $\alpha_{jt}\mathcal{L}_{jt}$ is the realized level of write-offs in loans and/or the realized devaluation of assets at the end of day t. The term Π_{jt-1} stands for retained earnings from the previous period. The last variable $\Delta E_{jt}(r_{Ejt})$ indicates the capital raised from the capital market by bank j at a cost r_{Ejt} so as for this bank to be able to maintain its target solvency ratio e_j. Hence, the market value of equity capital at the end of the current period equals its value at the end of the previous period, plus retained earnings carried forward from the previous period, minus losses from write-offs and assets' devaluation, plus newly issued equity capital on the stock market. Of particular interest is the last term $\Delta E_{jt}(r_{Ejt})$ since through this variable, the cost of write-offs and devaluation of assets is transformed into a cost for raising equity capital from the market. Hence, it is important to define the factors that affect this cost of equity capital.

A bank is solvent if the market value of all of its assets that are liquidated at the end of day t is just enough to cover its debt liabilities. Hence, the difference $a_{jt} - e_j = 0$ indicates the cut-off point for a bank's solvency at time t.[10] Having that in mind, every investor i forms

[9] If 'loans' include both marketable and non-marketable assets then $\alpha_{jt} > 0$ expresses both the current period default rate and the current period rate of depreciation of marketable assets. Possible asset appreciation would have the opposite sign and might counterbalance the effect of the default rate. I ignore this case in order to keep the model simple and focus on the less favorable situation for banks. I also assume for simplicity, as in Heid (2007), that borrowers default on the principal amount of their loan rather than on interest payments.

[10] Indeed, if $(1 - \alpha_{jt})\mathcal{L}_{jt}$ is the proportion of healthy loans, solving the expression $(1 - \alpha_{jt})\mathcal{L}_{jt} + R_{jt} + T_{jt} + B_{jt} = D_{jt}$ for α_{jt} and noting that $\mathcal{L}_{jt} + R_{jt} + T_{jt} + B_{jt} - D_{jt} = E_{jt}$ and $e_j = \frac{E_{jt}}{\mathcal{L}_{jt}}$ we end up with or $a_{jt} = e_j$.

expectations at the end of day t about bank's j possible bankruptcy in the next day $t+1$.[11] In particular, the expected for day $t+1$ default/devaluation rate $a_{ijt+1}\left(a_{jt}, \mu_i(\bar{\lambda}_t)\right)$, depends on the currently published rate a_{jt} and it is conditioned by some subjective perception/aversion of uncertainty factor $\mu_i(\bar{\lambda}_t)$ which is the measure of degree of confidence that characterizes investor i. It is the argument made by this paper that this measure of investors' degree of confidence with respect to bank's j financial condition, should have been a function of the average subjective uncertainty perception/aversion factor in the banking industry $\bar{\lambda}_t$, since it is the one which reflects the *systemic* risk which is present in the interbank market (Iori, Jafarey and Padilla 2006). A knowledgeable investor takes into consideration this systemic risk, along with their bank's individual risk as this is reflected in its current default/devaluations rate a_{jt}, when gauging a bank's insolvency risk. Moreover, equity market participants can infer $\bar{\lambda}_t$ at the end of day t by the level of the interbank rate.

Given the above, the cost of equity capital is determined in the market for bank's j stocks where demand meets supply.

$$S_{jt}^{S}(\alpha_{jt}, \lambda_{jt}) = \sum_{i=1}^{m} S_{ijt}^{D}(a_{jt}, \bar{\lambda}_t) \qquad (5)$$

Demand for bank's j stocks would be the sum of individual investors' demands $\sum_{i=1}^{m} S_{ijt}^{D}(a_{jt}, \bar{\lambda}_t)$. The higher is the level of current defaults/devaluations a_{jt} the higher will be the expectation of a significant number of investors that bank j will go bankrupt and the lower will be their demand for its stock. Moreover, the lower is the degree of confidence within the banking sector (the higher is $\bar{\lambda}_t$) the lower will be the demand for bank's j stocks, as investors fear of a systemic crisis that might affect the solvency of this bank. On the supply side, the higher is the current default/devaluation rate α_{jt}, the higher will be the chance that bank j will resort to the capital market for equity funding. Hence, bank's j supply of own securities in the capital market will depend positively on its current default rate α_{jt} and on its management's perception/aversion of uncertainty λ_{jt} namely, $S_{jt}^{S}(\alpha_{jt}, \lambda_{jt})$. The higher is λ_{jt} (the lower the degree of bank's confidence) and/or the higher is the current default rate α_{jt}, the higher should be the return on capital that the bank should offer to attract buyers for its securities.

[11] Mathematically, investor's i expectation about bank's j future bankruptcy can be expressed as ${\psi_{ijt}}^{e} = \int_{e_j}^{1}(a_{ijt+1}(a_{jt}, \mu_i) - e_j) f(a) da$. The psychological nature of the degree of confidence (or the subjective nature of uncertainty perception/aversion) μ_i does not admit any direct relationship with current default rate a_{jt}.

Hence, the cost of equity capital of bank j that is formed in this market is given by:

$$r_{Ejt} = d_{jt} + c_{jB}\sigma_{jt}(\alpha_{jt}, \bar{\lambda}_t) \quad (6)^{12}$$

In this expression, the cost of equity capital is a mark-up over the cost of debt d_{jt} by the amount $\sigma_{jt}(\alpha_{jt}, \bar{\lambda}_t)$ which is derived by the *market* estimate, at the end of period t of the possibility of bankruptcy in the next period given current default rate α_{jt} and the average confidence factor in the banking industry $\bar{\lambda}_t$. The product of $\sigma_{jt}(.)$ times c_{jB} (which stands for a fixed cost in case of bankruptcy)[13] gives the estimated bankruptcy cost.

A rising opportunity cost of capital, as implied by d_{jt}, or a rising expected bankruptcy cost $c_{jB}\sigma_{jt}(\alpha_{jt}, \bar{\lambda}_t)$ would raise the cost of equity capital for bank j. The expected bankruptcy cost might increase either due to higher current default/devaluations rate α_{jt} that affects investors' expectation of future bankruptcy or because of a rising $\bar{\lambda}_t$ (lower degree of confidence in the banking industry) that affects investors' measure of degree of confidence on their expectations $\mu_i(\bar{\lambda}_t)$. In addition, a rise in the fixed cost parameter c_{jB} would raise the cost of equity capital ceteris paribus.

The important point here is that the degree of confidence establishes a direct link between banks' liquidity and solvency position. Insofar as the average measure of degree of confidence factor in the banking sector $\bar{\lambda}_t$ is an indicator of the level of trust in the interbank market, the way banks handle their liquidity risk has a direct impact on the way they cope with their insolvency risk. This is because, holders of banks' shares acknowledge that a bank's solvency position depends both on its individual default/devaluation characteristics and on the fact that it functions as part of a nexus of interconnected institutions that make up the banking sector. The latter point, which has a direct systemic effect, is captured by the degree of confidence measure $\bar{\lambda}_t$ in the expression for the cost of equity capital. Then, the level of trust in the interbank market, which is the market that manifests this interconnection among banks in the most comprehensive way, is bound to be a crucial variable in the calculation of the cost of equity capital. In this sense, equity holders, when they calculate their required rate of

[12] The specification of the cost of equity capital follows Estrella (2004) whilst expression $\sigma_{jt}(\alpha_{jt}, \bar{\lambda}_t)$ is derived directly from the market process described in (5).

[13] Following Estrella (2004), the parameter c_{jB} might refer to pecuniary and non pecuniary costs such as loss of charter value, reputational loss and legal costs.

return, take into account the effect that a possible liquidity asphyxia in the banking system might have on asset prices (Allen and Carletti 2008) and hence, the effect of liquidity risk on the solvency position of banks. The fact that this systemic effect becomes apparent in a financial crisis such that of 2007-2008 does not mean that it is not there in the form of low average perception/aversion of uncertainty in the banking sector $\bar{\lambda}_t$ or high average degree of confidence that renders it undetected during the boom. However, if it is indeed there and fluctuates with the financial cycle, new challenges emerge for the regulatory authorities that follow the Basel's rules.

3. Interbank market and regulation evasion along the financial cycle

The link between liquidity markets and capital markets provides a way for banks to evade Basel's capital regulations. Such a possibility is explained below, having in the background a Minsky (1972)-Kindleberger (1978) financial cycles model with an emphasis on its psychological standpoint (Toporowski 2005, p. 138).

Suppose that the economy is placed at the rising phase of the cycle where optimism prevails. If banks' subjective perception/aversion of uncertainty $\bar{\lambda}_t$ is close to zero, then the interbank rate is close to the riskless rate. At this considerably low level of average perception/aversion of uncertainty $\bar{\lambda}_t$, the return on interbank securities r_T is slightly higher than the riskless rate r_B. This should satisfy the majority of banks with individual perceptions/aversions of uncertainty $\lambda_{jt} \leq \bar{\lambda}_t$ as the *minimum* return required by them to hold interbank securities is lower than the market interbank rate r_T. In other words, the market return on interbank securities outweighs their infinitesimal risk and an overwhelmingly high proportion of banks, which are net lenders of liquidity, would hold interbank securities instead of Treasury bills. At this low interbank rate, demand for interbank securities at the end of period t would be met by their supply and would validate the increasing lending activity which was spurred by banks' increased confidence on economic prospects. These banks are now the net borrowers of liquidity on the interbank market.

Hence, a high degree of confidence and trust in the banking sector at the rising phase of the cycle provides the impetus both for credit growth on behalf of net borrowing banks and its funding support by net lender banks. In addition, high average degree of confidence and enhanced trust in the banking sector affects investors' confidence on their expectations about

banks' solvency and hence, its measure $\mu_i(\bar{\lambda}_t)$. Furthermore, increased investors' confidence and low levels of default/devaluation rates α_{jt} in the upswing entail a low cost of restoring target equity capital ratios after absorbing realized write-offs and asset devaluations. This implies a relaxation of the solvency constraint on banks' credit growth imposed by Basel's rules. It also highlights a channel through which banks' liquidity position affects their capital adequacy position.

If low liquidity premia in the interbank market continue to be validated by euphoria, credit growth in the economy will continue and the leverage of non-financial firms will increase. As long as the degree of confidence of banks is high, an increase in current default rates in the portfolio of loans for some of them or a possible devaluation of some of their assets will not change things dramatically. Nevertheless, as the boom in investment demand goes on, demand for credit will grow faster than its supply thus exerting an upward pressure in loan rates (Minsky 1980B). Higher loan rates could lead to present value reversals for those non-financial firms which have the weaker financial structures (Minsky 1980A) ending up to a proliferation of bankruptcies among them. After some point in time, spreading of present value reversals among firms-borrowers of banks will lead to a reassessment of risk premia in the interbank market. This means that there will be an increasing number of banks for whom their individual perceptions/aversions of uncertainty far exceed average perception/aversion of uncertainty or $\lambda_{jt} > \bar{\lambda}_t$. For these banks the level of the interbank rate no longer compensates for the increased risk of interbank securities. Consequently, higher uncertainty perceptions/aversions and decreased confidence will increase the demand for Treasury bills and will exert an upward pressure *on both* the interbank rate and the cost of equity capital. As the economy is heading into recession, the average perception/aversion of uncertainty factor reaches its maximum[14] $\bar{\lambda}_t = \bar{\lambda}_{up}$ (or the degree of confidence plummets). At this phase of the cycle, the high level of the liquidity premium on interbank funds and the high cost of equity capital express the prevailing pessimism in the banking sector and the economy.

Beyond this point the interbank market might freeze because demands for liquidity are difficult to be serviced in the interbank market since most lenders of liquidity prefer to hold Treasury bills instead of interbank securities. The level of trust is very low as the liquidity premium expressed by the level of $\bar{\lambda}_t$ is very high and confidence is at its lowest. In such

[14] Of course, there is not a fixed maximum level $\bar{\lambda}_t = \bar{\lambda}_{up}$ which is applicable to every time or place. The level of $\bar{\lambda}_{up}$ will depend on psychological factors and especially on how market participants perceive the prevailing condition of the economy in each historical period.

conditions, hoarding of liquidity and precautionary reserves will dry up the interbank market as they did in 2007-2008 (Gale and Yorulmazer 2013; Acharya and Merrouche 2012; Ashcraft, McAndrews and Skeie 2011).

However, as this model has explained, such freezing of the interbank market might have adverse consequences for banks' solvency as well. The measure of confidence factor of those participating in the capital market μ_i might be affected by the non-properly functioning of the interbank market since the latter is reflected in the measure of confidence factor in the banking sector $\bar{\lambda}_t$. In this way, this factor $\bar{\lambda}_t$ reveals its *systemic* character since it signals concerns about the stability of the whole banking system. Hence, if the interbank market is unable to operate properly because of the extreme value of $\bar{\lambda}_t$ then, raising capital from the stock market at a reasonable cost in order to maintain a target solvency ratio e_j will become more difficult.

Eventually, in such extreme conditions, the compound effect of widening funding gaps w_{jt} on the one hand, and of write-offs and losses from asset devaluations α_{jt} eating into equity capital on the other, would lead to both liquidity asphyxia and capital inadequacy for banks which are net demanders of both liquidity and capital. The direct link between liquidity and insolvency risk expressed by the average measure of degree of confidence factor $\bar{\lambda}_t$ manifests itself through its devastating effects for banks' balance sheets. Equity capital is difficult to be replenished whilst other alternative sources of borrowed funds would require a rise in the relevant borrowing rates and, hence, a further rise in the loan rate leading to a vicious circle of firms' and banks' bankruptcies. On the other hand, it is doubtful whether depositors would increase their bank deposits in the first place and not run on them, plagued by what Kindleberger called 'panic'. Deposit insurance will only be a partial solution, if it is not followed by policies that will revive confidence on expectations held by banks for future economic prospects. Restoring lending activity is at the heart of the problem as it is argued in the next section.

4. Policy Implications: Towards a 'regulation of confidence'

The argument presented in this paper points to a 'regulation of confidence' perspective in the spirit of Minsky's (1982) Big Government-Big Bank approach, which would target the fluctuations in the degree of confidence either at the boom or at the trough. In stressed conditions there is both unsatisfied demand for liquidity by net borrowers *and* shortening of investment horizons by both net borrowers and net lenders (Ashcraft, McAndrews and Skeie

2011). The Central Bank, as a lender of last resort, could have eased the strain in the interbank market by discounting net borrowers' short term securities at a rate r_P lower than the highest level of the interbank rate $r_T = r_B(1 + \bar{\lambda}_{up})$. Such an operation would restore the liquidity position of net borrowers and permit them to revitalize gradually their loan activity. More importantly, it would have stopped the eventual plummeting in *confidence* reflected in the rising $\bar{\lambda}_t$ and would have partly restrained the flight of net lenders to Treasury bills. On the other hand, the government could sell newly issued Treasury bills to net lender banks at the riskless rate r_B to cover their unsatisfied demand for liquid assets, given the limited supply of Treasury bills on the secondary market. In this way, the government satisfies the need of net lender banks to shorten the maturity of their portfolio and at the same time it collects funds that could be partly channeled to net borrower banks through the Central Bank and partly used for public spending in order to sustain economic activity.

Note that the government borrows from net lender banks at the riskless rate but lends net borrower banks, via the Central Bank, at a higher rate close to $r_T = r_B(1 + \bar{\lambda}_{up})$. This might have two consequences: Firstly, the government obtains a premium from net borrower banks which is close to the market premium thus reducing the burden that tax-payers assume when they rescue troubled banks. Secondly, since the government pays out to net lenders just the riskless rate for their holdings of Treasury bills, it provides an incentive for net lenders to enter again the interbank market and seek for a higher rate of return, including a liquidity premium.

However, the crucial point of this kind of Big Government-Big Bank intervention is its ability to regulate confidence. This paper explained how falling perceptions/aversions of uncertainty λ_{jt} for an increased proportion of banks, after government intervention, could drive the average $\bar{\lambda}_t$ down and counterbalance the pressure on the cost of equity capital of individual banks exerted by their default/devaluation rates α_{jt}. Hence, the fall of the *systemic* component of the cost of equity capital $\bar{\lambda}_t$ could initiate a virtuous circle of falling premia in both the liquidity and capital market.

On the other hand, it is of practical importance, in the rising phase of the cycle, to adopt a cash-flow oriented approach to banks' balance sheets (Minsky, 1967) which is able to acknowledge the pervasive link between liquidity and solvency risk as explained in this paper. It is in this context that bank examination by the central bank that is based on financial fragility indices (Tymoigne 2011) may restrain the use of destabilizing bank practices which feed off excessive optimism and over-confidence in financial booms.

Hence, raising capital adequacy ratios through capital buffers or countercyclical capital reserves, or introducing new liquidity and solvency ratios as proposed in Basel III, might not be enough since these proposals target the end-result rather than the root cause of eventual illiquidity and insolvency. This root cause lies in the degree of confidence factor that determines banks' credit growth and dictates their net liquidity position. The latter impacts on banks' solvency position, through the liquidity-solvency link. Hence, Basel III provisions might not be enough if this link is not explicitly recognized and measures targeting the degree of confidence in the banking sector are not taken on board.

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