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THE BANK LENDING CHANNEL OF MONETARY POLICY: IDENTIFICATION AND ESTIMATION USING PORTUGUESE MICRO BANK DATA

EUROSYSTEM MONETARY TRANSMISSION NETWORK

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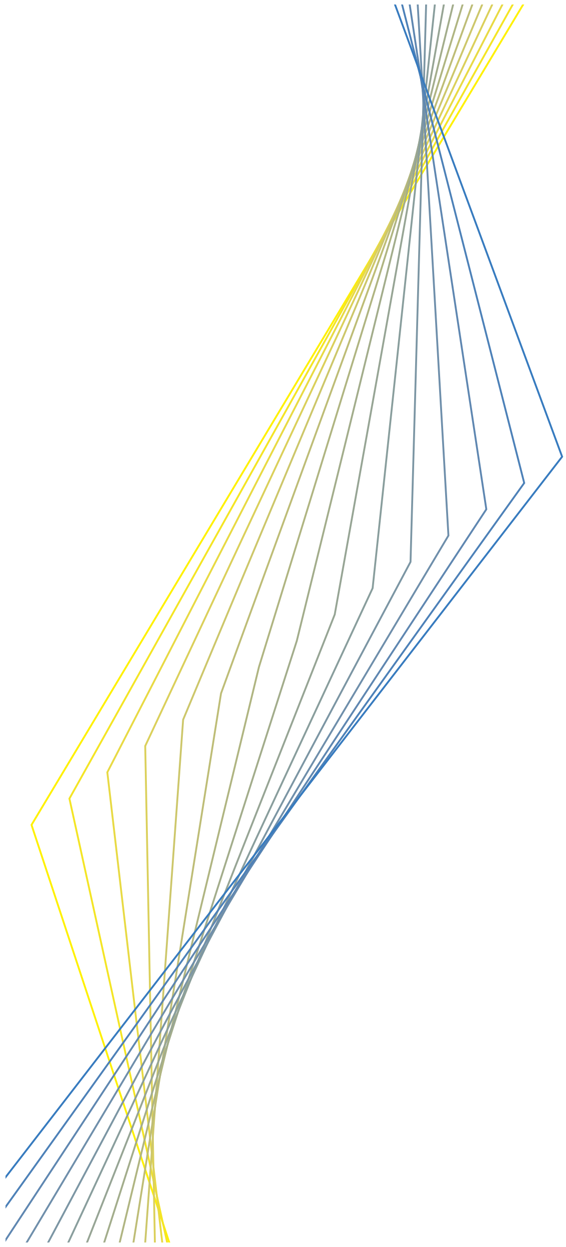

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The Eurosystem Monetary Transmission Network

This issue of the ECB Working Paper Series contains research presented at a conference on "Monetary Policy Transmission in the Euro Area" held at the European Central Bank on 18 and 19 December 2001. This research was conducted within the Monetary Transmission Network, a group of economists affiliated with the ECB and the National Central Banks of the Eurosystem chaired by Ignazio Angeloni. Anil Kashyap (University of Chicago) acted as external consultant and Benoît Mojon as secretary to the Network.

The papers presented at the conference examine the euro area monetary transmission process using different data and methodologies: structural and VAR macro-models for the euro area and the national economies, panel micro data analyses of the investment behaviour of non-financial firms and panel micro data analyses of the behaviour of commercial banks.

Editorial support on all papers was provided by Briony Rose and Susana Sommaggio.

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Abstract

This paper investigates the existence of the bank-lending channel in the transmission of monetary policy using Portuguese micro bank data. In contrast to the conventional approach, which addresses the identification issue by resorting to reduced form equations for bank credit with variables in differences, we directly estimate loan-supply schedules with variables in levels, thereby exploiting recent results on cointegration for panel data.

We conclude that there is evidence of the existence of a bank-lending channel, and that the importance of the bank lending-channel is larger for less capitalised banks.

JEL classification: C33, E44, E52, G21;

Keywords: Monetary policy transmission mechanism; bank lending channel; identification; nonstationary panel data; cointegration;

NON-TECHNICAL SUMMARY

The mechanisms through which the monetary policy of central banks affects real activity are not completely understood. A relatively recent strand of the literature emphasizes the special role of banks in the transmission mechanism through the so-called credit channel of monetary policy. According to this mechanism, monetary policy affects the real economy not only through the impact of interest rate on the aggregate demand but also through shifts in the supply of bank loans. In particular, a bank-lending channel operates if, due to imperfect information between banks and their providers of funds, banks cannot costlessly compensate the reduction of deposits resulting from a monetary policy tightening with alternative sources of funds. In this case the reduction of deposits would also translate into a reduction of loan supply.

Most of the empirical research aiming at testing the existence of a credit channel in the transmission of monetary policy is based on the estimation of a model for credit that may be interpreted as the reduced form equation of the market for bank loans. In this paper we suggest an alternative approach, which amounts to directly estimate the loan supply schedule.

First, we show that with this approach it is possible to identify the effect of monetary policy on credit supply with much more plausible assumptions than those that are necessary under the so-called reduced form approach. Then, we analyse the importance of the credit channel in the Portuguese economy by directly estimating an equation for the supply of bank loans using data for the period 1990-1997. Also, departing from the existing literature, the model is estimated with the variables in levels, resorting to very recent results on cointegration for nonstationary panel data.

The results obtained suggest the existence of a lending channel in the transmission of monetary policy in Portugal. As expected, the incidence of the lending channel seems to be larger for less capitalised banks. On the contrary, size and liquidity do not appear as relevant bank characteristics in determining a differential impact of monetary policy on the supply of bank loans.

1. Introduction

The mechanism by which monetary policy is transmitted to the real economy remains a central topic of debate in macroeconomics. Considerable research has recently examined the role played by banks in the transmission of monetary policy aiming at uncovering a credit channel and assessing the relative importance of the money and credit channels.

As the credit or lending channel operates through shifts in loan-supply schedules, uncovering the credit channel implies distinguishing shifts in loan-supply from shifts in loan demand schedules brought about by monetary policy shocks.

Distinguishing the relative importance of the money and credit channels is useful for various reasons. First, understanding which financial aggregates are impacted by monetary policy would improve our understanding of the link between the financial and the real sectors of the economy. Second, a better understanding of the transmission mechanism would help monetary authorities and analysts to interpret movements in financial aggregates. Finally, more information about the transmission mechanism might lead to a better choice of intermediate targets. In particular, if the credit channel is an important part of the transmission mechanism, then the banks' asset items should be the focus of more attention.

The importance of the credit channel depends on the extent to which banks rely on deposit financing and adjust their loan supply schedules following changes in bank reserves (for a given bank-dependency of the borrowers). The aim of this paper is just to show that bank loan supply depends on bank deposits and thus, monetary policy by affecting bank deposits is also able to shift loan bank supply schedules.

At the empirical level, the bulk of the most relevant literature has tried to uncover the lending channel through the estimation of a reduced form equation for the bank credit market, with variables in first differences (i.e., stationarised variables). This paper adds to this area of research, but departs from previous studies on several aspects. In particular it is argued that the reduced form approach requires strong identifying restrictions and that it does not allow estimating the relevant parameters. As an alternative we suggest a "structural approach" which amounts to directly estimate bank loan-supply schedules, with variables in levels. For that purpose we resort to very recent panel data cointegration techniques.

The main conclusion of the paper is that there is a banking lending channel in the transmission of monetary policy in the Portuguese economy and that the importance of this channel is larger for the less capitalised banks. Size and liquidity do not appear to be relevant bank characteristics in determining the importance of the lending channel.

This paper is organised as follows. Section 2 briefly reviews the money and credit views of the monetary transmission mechanism. Section 3 introduces an IS/LM model of the monetary policy transmission mechanism in order to clarify the restrictions, which underlie the conventional reduced form approach and motivate the alternative approach suggested in this paper. Section 4 discusses the main restrictions underlying the reduced form approach. Section 5 describes the "structural approach" followed in this paper and discusses the identification problem and the econometric approach to be implemented in the empirical section. Section 6 briefly characterises the Portuguese banking sector and the changes it underwent during the nineties. Section 7 reports the empirical results for Portugal and section 8 summarises the main conclusions.

2. The bank lending channel

The classical textbook approach to monetary policy focus on how the central bank's actions affect the households and firms portfolios, by assuming the existence of only two classes of assets: money and other assets (usually simply labelled as "bonds"). Under this approach to the monetary policy transmission mechanism, known as the money view or money channel of monetary policy, the central bank, by manipulating banks' reserves is assumed to be able to control the quantity of money (deposits, with the banks) thereby affecting the nominal interest rate (the relative price of money and bonds). In turn, changes in nominal interest rate are expected to translate into changes of the real interest rate (prices are sticky in the short run) thus affecting the economy either through aggregate demand (IS/LM framework) or/and through aggregate supply (Christiano and Eichenbaum (1995) framework). Thus, according to the money view, the monetary transmission mechanism operates through the liability side of banks' balance sheets.

There are two basic necessary conditions for the money channel to work: (a) banks cannot perfectly shield transaction balances (deposits) from changes in reserves; and (b) there are no close substitutes for money in the conduct of transactions in the economy.

The point of departure of the credit view is the rejection of the notion that all non-monetary assets are perfect substitutes. In particular, it is assumed that internal funds, bank loans and other sources of financing are imperfect substitutes for firms. According to the credit view of the monetary policy transmission mechanism, monetary policy works by affecting bank assets (loans) in addition to banks' liabilities (deposits). The key point is that monetary policy besides shifting the supply of deposits also shifts the supply of bank loans. In this context, the crucial response of banks to monetary policy is their lending response and not their role as deposit creators. The two key necessary conditions that must be satisfied for a lending channel to operate are: (a) banks cannot shield their loan portfolios from changes in monetary policy; and (b) borrowers cannot fully insulate their real spending from changes in the availability of bank credit.

The first of these conditions tells us that banks are not able to completely offset the decrease in deposits brought about by monetary policy shocks, by resorting to alternative sources of funds (at least not without incurring in increasing costs). Because of the extra premium that banks have to pay to bring in alternative external funds, banks will make fewer loans after the fall in reserves brought about by monetary policy. Of course, it is expected that banks hedge against changes in monetary policy, by holding securities as a buffer against a reserve outflow. But such buffer is not expected to fully offset the effects of a contractionary monetary policy, as buffer stocks are costly for banks (in terms of interest foregone).

The second condition tells us that some spending, which is financed with bank loans, will not occur if banks cut the loans, else the real consequences of the credit channel will be null.

In summary, while the traditional theory emphasises the households' preferences between money and other liquid assets (bonds) the credit view argues that the banking behaviour is also very important to the transmission of monetary policy[1].

3. An IS/LM model with the lending channel

In this section we introduce a standard IS/LM model for analysing the monetary transmission mechanism at the bank level. On the one hand, the model will help us to

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[1] Some authors (for instance, Bernanke and Gertler (1995)) distinguish between "credit channel" and "bank-lending channel". The transmission channel which we indistinctly labelled in this section as the "lending or credit channel", is referred to by these authors as the "bank-lending channel" and they use the expression "credit channel" in a broader sense, which includes both the bank-lending channel and the so-called "balance-sheet channel". This latter channel reflects the influence of monetary policy on the net worth and other determinants of the financial position of potential borrowers. In this paper we do not make such a distinction, and in the following sections the strictly speaking bank-lending channel is referred to indistinctly both as the credit channel or the bank-lending channel. Readers interested in a detailed analysis of the theoretical underpinnings of the bank lending channel are referred, for instance, to Kashyap and Stein (1998), Valery Ramey (1993), Bernanke and Gertler (1995) or Trautwein (2000), who present very good discussions of some of the micro-foundations that underlie the bank lending channel theory of monetary policy transmission mechanism.

understand the identifying restrictions underlying the econometric approach, which has been followed in the empirical literature to uncover the lending channel and, on the other hand, will enable us to define an alternative testing strategy. The model draws heavily on Bernanke and Blinder (1988), but it departs from their model in the way money supply is modelled and monetary policy is implemented.

Let us assume that we have an economy with three different agents or sectors and four assets. The agents are the non-banking sector, the banking sector and the central bank. The central bank sets monetary policy either by changing the reserve requirement ratio, setting the discount interest rate or controlling the bond rate by conducting open market operations. In either case banks react by changing the amount of reserves as well as the other items of their balance sheets. In our model we explicitly assume that the central bank sets monetary policy by changing the discount rate or the money market rate, but the model can easily be adapted to deal with other monetary policy instruments.

The four assets are deposits held by the private sector with banks, loans granted by banks to the private sector, reserves held by banks for legal and liquidity reasons and bonds held both by banks for liquidity reasons and by the non-financial sector for liquidity and or portfolio reasons.

For the money market we assume a conventional LM curve. The demand for money (in the form of deposits held with a typical bank) by the non-monetary sector is the conventional money demand function

$$\ln(D/P)_t^d = \beta_0 + \underset{(+)}{\beta_1 \ln y_t} + \underset{(-)}{\beta_2 \pi_t} + \underset{(-)}{\beta_3 i_t} \qquad (3.1)$$

where D_t stands for the nominal deposits held by the private sector at a typical bank, P_t the price level, y_t a scale variable (for instance real GDP), π_t the inflation rate and i_t the interest rate on bonds. Below each coefficient in equation (3.1) is the corresponding expected sign according to the conventional economic theory[2].

We write the (real) money supply as

[2] For ease of presentation we have assumed in equation (3.1) that deposits depend on a single interest rate. Because D_t includes order as well as time deposits, a more realistic money demand function should also include the own rate on time deposits or a weighted average of the interest rates on total deposits. However in this case we would have also to explicitly model the bond market, which would make the solution of the model somewhat cumbersome, without changing the main points we want to make.

$$\ln(D/P)^s_t = \gamma_0 + \gamma_1 \ln(\mathrm{R/P})_t + \gamma_2 l_t + \gamma_3 i_t + \gamma_4 r_t \qquad (3.2)$$
$$\qquad (+) \qquad\qquad (+) \quad (+) \quad (-)$$

where R stands for the bank reserves, l_t for the interest rate on loans, i_t for the interest rate on bonds and r_t for the relevant monetary policy interest rate controlled by the central bank. We note that equation (3.2) should be perceived as a generalisation of the textbook equation, according to which the money supply is equal to bank reserves times the money multiplier, which, in turn is a function of l_t, i_t, r_t and the required reserve ratio (assumed constant for ease of presentation).

In equilibrium equations (3.1) and (3.2) determine the equilibrium interest i_t and the equilibrium quantity of money for given P, y, π, R, l and r.

Let us now focus on the credit market. The loan demand by the non-banking sector may be specified as

$$\ln(C/P)^d_t = \lambda_0 + \lambda_1 \ln \mathrm{y_t} + \lambda_2 \pi_t + \lambda_3 l_t + \lambda_4 i_t \qquad (3.3)$$
$$\qquad (+) \qquad (-) \qquad (-) \quad (+)$$

where y_t captures the transactions demand for credit, π_t the uncertainty in the economy and i_t the possibility of the private sector to have access to sources of funding which are not perfect substitutes of bank loans. The null $\lambda_3 \neq 0$ captures the idea that borrowers cannot fully insulate their real spending from changes in the availability of bank credit.

For the loan supply we have

$$\ln(C/P)^s_t = \alpha_0 + \alpha_1 \ln(\mathrm{D/P})_t + \alpha_2 \pi_t + \alpha_3 l_t + \alpha_4 i_t \qquad (3.4)$$
$$\qquad (+) \qquad\qquad (-) \qquad (+) \quad (-)$$

where it is assumed that the loan supply depends on the level of total deposits held by the private sector with the banks, on the inflation rate as a measure of uncertainty in the economy as well as on the loan and bond interest rates [3]. Assets held by banks in the form of bonds are seen as substitutes for loans, held mainly for liquidity reasons. The null

[3] The specification of the loan supply equation with deposits as an explanatory variable closely follows Bernanke and Blinder (1988). The introduction of such a variable in the supply schedule may be justified in theoretical terms in the context of a profit-maximizing bank, in which the amount of deposits is out of the control of the bank being determined by central bank policy. See, for instance Kashyap and Stein (1995) and Courakis (1988). We shall return to this issue further below in the empirical section, in which we argue for the need of the loan supply equation to also account for the banks' own capital.

$\alpha_1 \neq 0$ in (3.4) captures the idea that banks cannot shield their loan portfolios from changes in monetary policy, i.e., from changes in deposits brought about by monetary policy and plays a central role in our analysis. Also important is the coefficient α_3 as it determines the slope of the supply curve.

Equilibrium in the credit market will determine the equilibrium loan interest rate, l_t, and the equilibrium quantity of real bank credit, $\ln(C/P)_t$, for given y_t, $\ln(D/P)_t$, π_t and i_t. Finally, plugging the equilibrium values for i_t and $\ln(D/P)_t$ obtained from the money market into the equilibrium equations for l_t and $\ln(C/P)_t$ we find the reduced form equations for l_t and $\ln(C/P)_t$ as a function of the exogenous variables of the model: $\ln(R/P)_t$, $\ln y_t$, π_t and r_t.

As we saw in the previous section the lending channel operates through shifts in the loan supply curve in response to changes in monetary policy. To see how it operates in our model, let us assume, for instance, that the central bank increases the discount rate, r_t. This will reduce the equilibrium quantity of money in the economy, i.e., deposits in our model, through the interaction between money supply and money demand schedules (3.1) and (3.2). In turn, the drop in deposits held by the private sector with the banks shifts the loan supply schedule upwards if $\alpha_1 > 0$ in (3.4). It is this additional transmission mechanism – the upward shift in supply of loans – which is known in the literature as the bank-lending channel. As mentioned above, at the micro level the existence of a lending channel rests on the assumption that banks cannot easily replace lost deposits with other sources of funds, such as certificates of deposits or new equity issues, or by selling securities. Otherwise, we would expect α_1 not to be significantly different from zero. Of course for the upward shift to occur the supply curve cannot be horizontal. In other words we need the additional assumption that α_3 in (3.4) is finite.

To test the existence of the credit channel and evaluate its importance we need to estimate α_1 and α_3 in equation (3.4), and test whether α_1 is significantly different from zero and positive and that α_3 is not very large. The credit channel is the more important the larger α_1 and the smaller α_3. In empirical terms, this upward shift in the loan supply needs to be clearly distinguished from the simultaneously expected inward shift in loan demand (the so-called money view). This is the well-known identification problem, which we address in the following section.

4. What are the difficulties with the reduced form approach?

So far, in the literature, the bulk of tests for the existence of a credit channel of monetary policy has been carried out by estimating reduced form equations for bank credit. Most of these tests acknowledge the existence of an identification problem, which amounts to distinguish shifts in banks' loan supply from shifts in banks' loan demand schedules[4]. In this section we address this issue in the context of the model presented in section 3, by explicitly deriving the restrictions that underlie its reduced form equation for credit. To that end we derive the reduced form of the model introducing only two minor changes. First, we introduce an additional variable in the supply function (3.4) to allow for interaction effects that capture bank specific sources of heterogeneity. Thus, equation (3.4) now reads as

$$\ln(C/P)^{s}_{it} = \underset{}{\alpha_0} + \underset{(+)}{\alpha_1}\ln(\mathrm{D/P})_{\mathrm{it}} + \underset{(-)}{\alpha_2}\ln(\mathrm{D/P})_{\mathrm{it}} z_{it} + \underset{(+)}{\alpha_3} l_t + \underset{(-)}{\alpha_4} i_t + \underset{(-)}{\alpha_5}\pi_t \qquad (4.1)$$

where z_{it} measures a bank specific characteristic such as size, liquidity or capitalisation. The term $\alpha_2 \ln(D/P)_{it} z_{it}$ intends to capture the idea that shifts in the supply curve brought about by monetary policy changes depend on some banks' specific characteristics (size, liquidity, capitalisation, etc.), as the lending channel theory predicts. In principle we expect that $\alpha_2 < 0$ so that loan-supply shifts are larger for small, less liquid or less capitalised banks.

The second change in the model of section 3 is that, for ease of presentation, we assume that in equation (3.2) we have $\gamma_2 = 0$, so that money supply does not directly depend on the credit interest rate. This simplifying assumption does not change the conclusions *vis-à-vis* the general model, but makes the solution of the model much easier to derive and analyse. Solving the model with equations (3.1), (3.2), (3.3) and (4.1), the reduced form equation for real credit reads as[5]

$$\begin{aligned}\ln(C/P)_t = {} & \theta_0 + \underset{(?)}{\theta_1} \ln y_t + \underset{(-)}{\theta_2} \ln y_t z_t + \underset{(?)}{\theta_3} r_t + \underset{(+)}{\theta_4} r_t z_t + \underset{(?)}{\theta_5} \pi_t + \underset{(+)}{\theta_6} \pi_t z_t \\ & + \underset{(?)}{\theta_7} \ln(R/P)_t + \underset{(-)}{\theta_8} \ln(R/P)_t z_t + \underset{(?)}{\theta_9} z_t\end{aligned} \qquad (4.2)$$

in which

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[4] Some important references in this area of research are: Romer and Romer (1990), Bernanke and Blinder (1992), Kashyap *et al*. (1993), Kashyap and Stein (1995 and 2000), Favero *et al*. (1999), Kishan and Opiela (2000) and Jayaratne and Morgan (2000).

[5] The full solution of the model is derived in the Appendix 1.

$$\theta_3 = \frac{\alpha_1\lambda_3\beta_3\gamma_4 + (\alpha_4\lambda_3 - \lambda_4\alpha_3)\gamma_4}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{4.3}$$

$$\theta_4 = \frac{\alpha_2\lambda_3\beta_3\gamma_4}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{4.4}$$

First of all we note that equation (4.2) is similar to the ones estimated in the literature with the possible exception of the terms concerning the banks' reserves, which are usually not included. However the banks' reserves would drop from equation (4.2) had we assumed $\gamma_1 = 0$ in (3.2), so that money supply would not depend directly on the amount of reserves[6].

There are some important points to note about equation (4.2). The first important point to note is that we may have $\alpha_1 = 0$ in (4.3), but $\theta_3 \neq 0$ or $\theta_3 = 0$ in (4.2) with $\alpha_1 > 0$. Thus, as recognised in the literature, the fact that the coefficient of r_t in the estimated reduced form equation is significantly negative does not imply the existence of the lending channel. Moreover, the sign of θ_3 is not unambiguously negative, as the term $(\alpha_4\lambda_3 - \lambda_4\alpha_3)$ in (4.3) may be either positive or negative.

In order to identify (the sign of) α_1 we need to impose some restrictions on the model. For instance, the coefficient θ_3 will be certainly negative if $(\alpha_4\lambda_3 - \lambda_4\alpha_3) > 0$. Also, it turns out that if we assume what we shall call the "spread condition" i.e., that $\lambda_3 = -\lambda_4$ in (3.3) and $\alpha_3 = -\alpha_4$ in (4.1), θ_3 reduces to

$$\theta_3 = \frac{\alpha_1\lambda_3\beta_3\gamma_4}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{4.5}$$

which is expected to be negative. In this case, θ_3 will be zero if (and only if) $\alpha_1 = 0$, given that by assumption we must have the other parameters in (4.5) different from zero. Thus, under this hypothesis, if in equation (4.2) the estimated θ_3 is significantly negative we may conclude for the existence of the lending channel not only because $\alpha_1 > 0$, but also because α_3 cannot be very large (else the estimated θ_3 will be very small). In any case we cannot say anything about the importance of the credit channel, because we cannot obtain an estimate for α_1. We also note that the "spread condition" cannot be tested nor imposed during the estimation process.

[6] We note however that some authors have also estimated equations with bank reserves as a regressor (see, for instance Favero *et al* (1999)), but in this case, with no interest rate. According to (4.2) a general reduced form equation should consider both the central bank interest rate and bank reserves as regressors.

As a second point we note that even under the “spread condition” the possibility of inferring the signs of α_1 and α_2 crucially depends on the additional assumptions of loan interest rate homogeneity (λ_3 in the loan demand and α_3 in the loan supply being the same, for instance, for large and small banks or for liquid or illiquid banks) and money interest rate homogeneity (γ_4 in money supply and β_3 in the money demand being the same for large and small banks or for liquid or illiquid banks)[7]. If one of these assumptions does not hold the corresponding source of heterogeneity will show up in different expressions for θ_3 and θ_4 in the reduced form (4.2) and the “spread condition” would no longer be sufficient to ensure the identification of the sign of the coefficients α_1 and α_2.

In practice, whether the above simplifying assumptions are seen as “too much restrictive” or rather as “acceptably restrictive” to allow interesting conclusions is ultimately a matter of sensitivity of the empirical researcher. In our opinion, both the “spread” condition as well as the loan supply interest rate homogeneity condition appear as important restrictions. In particular we note that θ_3 and θ_4 in equations (4.4) and (4.5) depend on α_3 and, as we have seen in the previous section, the importance of the lending channel (also) depends on α_3, so that in order to test for the relative importance of the lending channel across different banks it appears that we should also allow the loan supply own interest rate (semi) elasticity to vary according to the specific bank characteristic[8].

Thirdly, it is readily seen that resorting to bank specific characteristics does not help to uncover the bank-lending channel. In fact, θ_4 is not a function of α_1 and as z_t measures differences (of bank size, liquidity ratio, etc.) from the average (size, liquidity ratio, etc.), $\alpha_2 z_t$ measures banks specific supply shifts *vis-à-vis* the aggregate average supply shift given by α_1[9]. So, the coefficient θ_4 (to the extent that it is a function of α_2)

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[7] It may be argued that interest rate money demand homogeneity is not likely to hold if large banks, say, attract a larger proportion of large depositors, as they presumably do with larger borrowers.

[8] We shall argue bellow in the empirical section that in order to draw interesting conclusions on the relative importance of the lending channel for two different banks (in terms of size, liquidity, etc.) we must allow not only the coefficient of deposits to vary across banks (as we did in (4.1) through the coefficient α_2), but also to allow the coefficient of l_t to vary across different banks (by introducing a term such as $\alpha_6 l_t z_{it}$ in (4.1)). However, it turns out that the reduced form approach is not capable of dealing with such a generalisation, as in this case the reduced form coefficients θ_j are a non-linear function of the z_{it} variable, raising insurmountable estimation and interpretation problems.

[9] In fact if the variable z_t were correctly defined, we would expect the aggregate interaction effect across banks, for each time period, given by

allows one to distribute the average effect (given by α_1) across banks, (according to their size, liquidity, etc.), but the existence of a lending channel, at the aggregate level, rests always and solely on the coefficient θ_3 of r_t in (4.2). In this sense we may say that by resorting to panel data does not help solving the identification problem of the reduced form equation, but only to avoid some potential bias due to, otherwise, neglected heterogeneity in the banks supply schedule.

Notice also that, in principle, we cannot have $\theta_3 = 0$ and $\theta_4 > 0$ because in this case the average lending channel will eventually be zero ($\alpha_1 = 0$) and banks with size, liquidity or capitalisation ratios above average would exhibit a downwards supply shift and not an upwards supply shift as the lending channel predicts.

Finally we note that the reduced form equation and the interpretation of the corresponding coefficients in (4.2) depend on the underlying structural model. This includes not only the specific loan supply and demand equations, but also the demand and supply functions for money and the type of monetary policy instrument used by the central bank (discount interest rate, open-market operations or the required reserves coefficient). In general, we note that the general reduced form (4.2) is consistent with a huge set of different structural models, provide they have $\ln y_t$, π_t, r_t, $\ln(R/P)_t$ and z_t as the exogenous variables, and that the specific reduced form varies according to the monetary policy instrument used by the central bank.

In the context of the reduced form approach an alternative equation to (4.2) could be obtained if one assumes that deposits are perceived as exogenous at the bank level. This equation can be derived from a simple structural model involving only the credit demand and credit supply equations. This framework seems to be quite a reasonable one, as the existence of the lending channel rests on the assumption of deposits exogeneity at the aggregate level i.e., that deposits are determined by the central bank monetary policy[10]. If we assume that at the bank level, deposits as well as the bond interest rate are exogenous, then we may stick to a "structural model" consisting only of equations (3.3) and (4.1). In this case the reduced form equation reads as

$$\ln(C/P)_t = \theta_0 + \underset{(+)}{\theta_1} \ln y_t + \underset{(-)}{\theta_2} \pi_t + \underset{(+)}{\theta_3} \ln(D/P)_t + \underset{(-)}{\theta_4} \ln(D/P)_t z_t + \underset{(?)}{\theta_5} i_t \tag{4.6}$$

$$\sum_{i=1}^{N} \theta_4 z_{it}$$

to add up to zero (with some possible exceptions that will be discussed in the empirical section, below).

[10] We note that the exogeneity of deposits, at the aggregate level is a pre-condition for the existence of the credit channel. The assumption of deposits exogeneity will be discussed below in the empirical section.

where now deposits and the bond interest rate appear as regressors instead of the monetary policy interest rate and where

$$\theta_3 = \frac{\alpha_1 \lambda_3}{\lambda_3 - \alpha_3} \tag{4.7}$$

$$\theta_4 = \frac{\alpha_2 \lambda_3}{\lambda_3 - \alpha_3} \tag{4.8}$$

Now we can see, that in this case, there is no identification problem as we have $\theta_3 > 0$ if and only if $\alpha_1 > 0$ (and α_3 is not very large) [11]. Similarly for θ_4. Thus, estimating equation (4.6) (or a dynamic generalisation of equation (4.6)), with first differenced variables (to account for data non-stationarities) would probably be a sensible way to proceed when the time series dimension of the data does not allow resorting to estimation techniques capable of dealing with the endogeneity of some regressors, which will necessarily arise if we try to directly estimate some "structural" equation, namely the credit supply function (4.1). We deal with this issue in the next section.

5. Defining an alternative empirical approach

Given the difficulties with the reduced form approach pointed out in the previous section we will try to identify the existence of the credit channel by directly estimating the supply curve (3.4) or (4.1) or some generalisation of these equations. However, as it is well known, the direct estimation of structural equations raises an estimation as well as an identification problem.

The identification of demand and supply schedules is discussed for instance in Intrilligator *et al.* (1996, p. 528) and in Zha (1997). The basic idea is that the supply curve is identified provide the demand curve includes at least one explanatory variable that does not enter the supply equation. We assume that deposits and the bond interest rate are exogenous at the bank level and so our working model should be perceived as being composed solely of the credit demand and credit supply curves. Under this assumption, we can see that, as they stand, the supply curve (3.4) and the demand curve (3.3) are identified. The supply curve is identified because the demand curve includes $\ln y_t$ as an

[11] We note that in rigour one still needs the loan interest rate homogeneity assumption (α_3 and λ_3 not dependent on the bank specific characteristics).

additional regressor and the demand curve is identified because the supply curve includes $\ln(D/P)$ as an additional regressor.

Notice that for estimation purposes we do not need to specify the demand schedule. All we need is to be aware of the existence of such a function with one regressor that does not enter the supply function. In terms of the model defined by (3.3) and (3.4), identification will be "lost" if we also include $\ln y_t$ in equation (3.4). Some readers will probably argue that this is likely to be the case, because the supply of credit by banks could also depend on GDP as a measure of the "risk" or uncertainty in the economy. Of course in the limiting case one could argue that any variable entering the demand curve should also enter the supply curve. In this case the identification will be impossible and there will not be a way out of this process. Thus, in the analysis that follows we implicitly assume that for each estimated supply function there is a corresponding demand function, which allows identifying the estimated supply function. This only requires that we assume the existence of a demand equation, which includes a regressor not included in the supply equation.

This alternative approach has the advantage of not requiring the imposition of any sort of "spread condition" or any type of homogeneity condition to obtain the identification of the lending channel. Also it allows one to get (direct) point estimates of the relevant coefficients, which is not the case of the "reduced form" approach. Last but not least, this alternative approach is immune to the specific type of monetary policy instrument assumed to be used by the central bank. This again contrasts with the reduced form approach in which the specific equation does depend on the type of instrument used by the central bank, as we mentioned in the previous section. But, of course the now proposed alternative approach also depends on two critical assumptions: deposits exogeneity and econometric identification of the supply curve. In our opinion the "econometric identification condition" is not a very restrictive assumption as it is customarily assumed in the relevant literature whenever separate supply and demand schedules are estimated. The assumption of deposits exogeneity is probably the major limitation of our approach, but we argue below that this seems to be an issue deserving further research also at the theoretical level.

Let us now address the estimation issue. So far in the literature the empirical models, using panel data, have been estimated with variables in first differences to circumvent the potential non-stationarity problem arising from the time-series dimension of the data. However it is well known that in most cases this approach does not solve the inconsistency problem, especially if the estimated model still includes specific effects and lagged endogenous variables[12].

On the other hand, this approach neglects from the start the possibility of a levels relation among the relevant variables. In other words these approach discards the possibility of a long run effect of monetary policy on deposits and credit. This is at odds with the usual approach in the literature, which postulates a levels relationship for the money (or credit) demand, in which the (real) stock of money (or credit) is modelled as a function of GDP, say, and the levels of some relevant interest rates.

During the last five years or so a very important strand of the literature on models of panel data has been concerned with the analysis of the consequences of using panels with a large time-series dimension. The main results available so far concern unit root and cointegration tests on panel data as well as the asymptotic properties of some well known estimators when the variables in the model are integrated of order one, I(1) and T (the time dimension) and N (the cross section dimension) are large.[13]

In the empirical section below we basically estimate loan-supply functions, which are generalisations of (3.4) or (4.1). These equations must be seen as cointegrating relations, which in the limit can be estimated for individual banks. Being static relations, the estimated coefficients should be read as the long run effects. By introducing interaction effects as in (4.1), this approach also allows testing whether the long run effect of monetary policy differs across banks, according to size, liquidity or capitalisation ratios.

Under the assumption of cointegration Phillips and Moon (1999) have shown that the Pooled OLS estimator (POLS) is consistent when T and N tend to infinity and has a normal limit distribution, provide the condition $(N/T) \rightarrow 0$ is met. Notice that asymptotic normality is specific to panel data, as it does not hold in pure time-series data. The rate of consistency depends on the initial assumptions about the model. The condition $(N/T) \rightarrow 0$ indicates that this asymptotic theory results are likely to be useful in practice when N is moderate and T is large. We can expect such data configuration when we have panels with a large time-series dimension and where the relevant cross-section dimension is not very large.

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[12] See Alvarez and Arellano (1998) for a survey on the asymptotic properties of various estimators, in dynamic panels, with stationary regressors.

[13] In what concerns the asymptotic properties of the estimators important papers are Phillips and Moon (1999), Kao and Chiang (2000), Pedroni (1996), Pesaran, Shin and Smith (1999), Binder, Hsiao and Pesaran (2000), Pesaran and Shin (1995). Interesting surveys on the subject are Phillips and Moon (2000), Baltagi and Kao (2000) and Banerjee (1999).

In the empirical section below we use 8 years of quarterly data (32 quarterly observations) for 18 banks (we only consider the case of a complete panel). With T=32 and N=18 the asymptotic theory with the $(N/T) \to 0$ condition, becomes the useful reference.

If we assume that the true model is heterogeneous (different parameters for different individuals or banks) the estimators are $\sqrt{N}$ consistent for the so-called long-run average coefficients. Super-consistency is not obtained because the effect of heterogeneity in the cointegration parameters is to slow down the rate of convergence of the pooled estimator.

If we assume that the underlying model is homogeneous (the same coefficients for all the individuals) the POLS estimator (which corresponds to the within estimator) is $\sqrt{NT}$ consistent and has a limiting normal distribution, under the additional assumption of strictly exogenous regressors, but is consistent (not super-consistent) if the regressors are correlated with the residuals, because of the persistence of bias effects.

For the case of a homogeneous panel with endogenous regressors the authors suggest using the Panel Fully-Modified OLS estimator (PFMOLS). This estimator is a simple generalisation of the well-known Fully-Modified OLS estimator introduced in Phillips and Hansen (1990) for pure time-series models. The PFMOLS estimator is $\sqrt{NT}$ consistent and has a normal limit distribution[14].

In addition to POLS and PFMOLS two other estimators were also suggested in the literature for non-stationary panel data: the corrected OLS (PCOLS) and the dynamic OLS (PDOLS)[15].

6. Monetary policy and banking sector developments in Portugal during the nineties

During the second half of the 80's economic policy in Portugal was driven by the need to implement the Single Market programme. Fundamental changes in the economic policy framework as well as in the banking sector occurred in this period. These include

[14] The fully modified OLS is constructed by making corrections for endogeneity and serial correlation to the OLS estimator. The endogeneity correction use the so called "long-run" covariance matrix defined for the residuals of the model and the first differences of the regressors, while the serial correlation correction uses elements from this matrix and also from the so-called "one sided long-run" covariance matrix. The expressions for the computation of the PFMOLS estimator may be seen in Phillips and Moon (1999) or Kao and Chiang (2000).

[15] See, for instance, Kao and Chiang (2000).

liberalisation measures as the opening up of the banking sector to private initiative and the beginning of the process of elimination of administrative controls on interest rates, on bank credit as well as on capital movements. The credit limits were abolished by 1991. Since then monetary policy has focused on the setting of cash reserves for the banking system to control liquidity growth. With the revision of the Banco de Portugal statute, in 1995, price stability became explicitly the primary objective of the central bank, subject to the overall economic policy of the government.

In order to approximate the Portuguese regime to those of most EU members and to create an operational framework similar to the one that would be adopted by the European Central Bank the Banco de Portugal also introduced new policy instruments and new forms of intervention in the money market. A daily credit facility was created (1993), allowing banks subject to minimum reserve requirements to raise funds overnight at pre-announced rates, as well as an absorption facility (1994)[16]. In November 1994 the reserve requirement regime was redefined. Its major change was the reduction in the minimum reserve requirement ratio from 17 per cent (remunerated) to 2 per cent (non-remunerated). The consequent liquidity sterilisation was achieved through the issuing of Deposit Certificates by the Banco the Portugal.

Exchange rate stability became progressively the intermediate target to reach the final goal of price stability. In 1992 the escudo joined the ERM and the remaining capital controls were removed. With this decision monetary policy had to be used almost exclusively to ensure that the exchange rate was kept within the ERM fluctuation bands.

The explicit restrictions on the composition of banks' assets, namely the compulsive investment in public debt, were removed and the legally imposed segmentation of banking activities was gradually eliminated, culminating in the establishment of universal banking in late 1992.

With the opening up to private initiative the banking sector expanded fast. Between 1984 and 1989 the number of banks operating in Portugal increased from 14 to 27 and between 1989 and 1997 this number more than doubled to 58[17]. State-owned banks continued to hold the bulk of banking business until late in the decade, but the presence of new banks modified considerably the competitive context in which Portuguese banks operated. The last step in the liberalisation of the Portuguese banking system was the re-privatisation process of nationalised banks that started in 1989, gradually transferring to

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[16] The interest rate of the absorption facility sets a lower limit to very short-term money market rates. Its upper limit was set by the overnight credit facility rate. Within that band money markets were stabilised through repos, which made the repo rate the most important one for steering markets.

[17] In the end of 2000 there were 62 institutions.

private management most of banking business. More recently, as in the other European markets, the prospect of EMU largely motivated a process of take-overs that has intensified since 1994. Through this process the largest Portuguese bank groups aimed at being able to compete in the enlarged European market.

The framework where the Portuguese banks operated changed significantly in consequence of the liberalisation process summarised above, affecting necessarily their behaviour, in particular their loan supply. On the other hand the changes observed in credit aggregates also reflected the different demand conditions created under the impact of European integration first and the participation in EMU afterwards.

The upward shift on households' permanent income resulting from European integration affected private consumption and consequently the loan demand by households. Furthermore, the adjustment of the capital stock to a new output trend has translated into an increase in investment of non-financial firms that has also been reflected in their demand of bank financing. At the same time, the stability of the exchange rate since mid-1993 and the decline of the inflation rate allowed a sustained and significant reduction of both short and long run interest rates. The decrease in nominal interest rates, perceived as being permanent, reduced the liquidity constraints of the economic agents also contributing to the strong growth in overall credit demand.

Chart 1 shows aggregate quarterly figures on the evolution of bank loans granted to the private non-financial sectors of the economy as well as the evolution of aggregate deposits held with the banks by the private non-financial sectors[18]. After the deceleration in the recession period between 1992 and 1994 (average annual growth rate in real terms of 5.4 per cent), in 1995-1997 credit resumed the upward trend of the early nineties (average annual growth rate in real terms of 14 per cent in this period compared to 16 per cent in 1991) and strongly accelerated in 1998 and 1999 (annual growth rate in real terms of 24 per cent). Until 1994 deposits behave very much like credit (even though with a slightly smaller annual growth rate), but from 1995/1996 onwards they clearly exhibited a much smaller growth rate than this aggregate (5.2 per cent in real terms during the period 1995-1997 and 6 per cent in 1998/1999). As a matter of fact, during the nineties, the decline in interest rates reduced the incentives to save and deposits became less attractive *vis-à-vis* alternative instruments (e.g. the acquisition of shares in the re-privatisation process, or the investment in mutual funds that showed up in a developing financial market).

[18]Those figures have been computed from data on the sample of banks for which consistent series throughout the period 1990-1998 may be obtained. This is the sample of banks used in the econometric estimations presented in this paper. It is described with more detail in the next subsection.

Chart 1

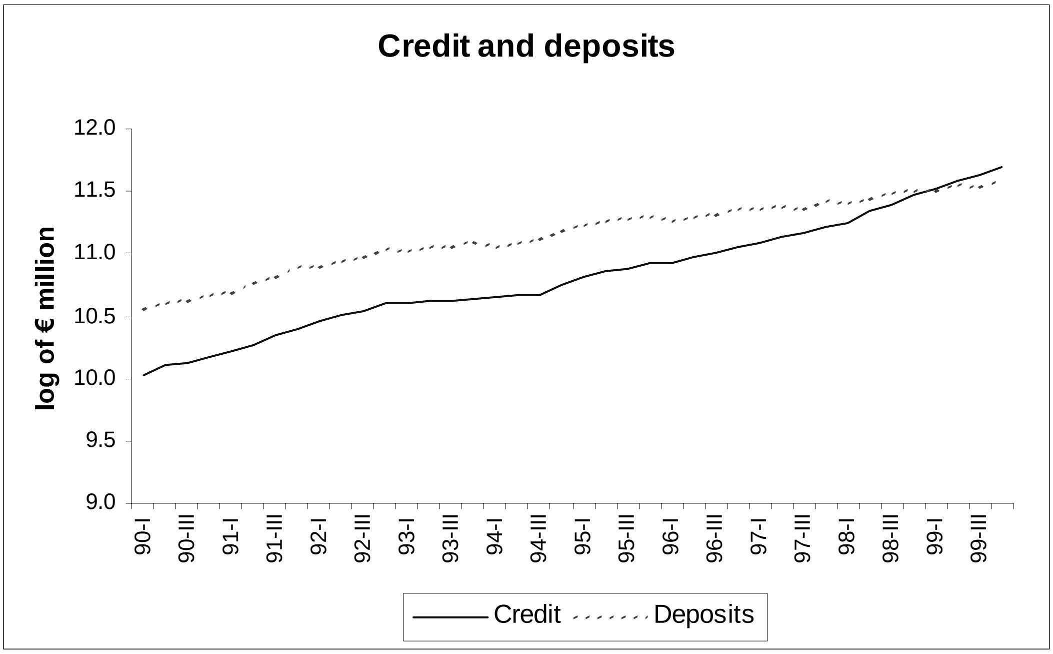
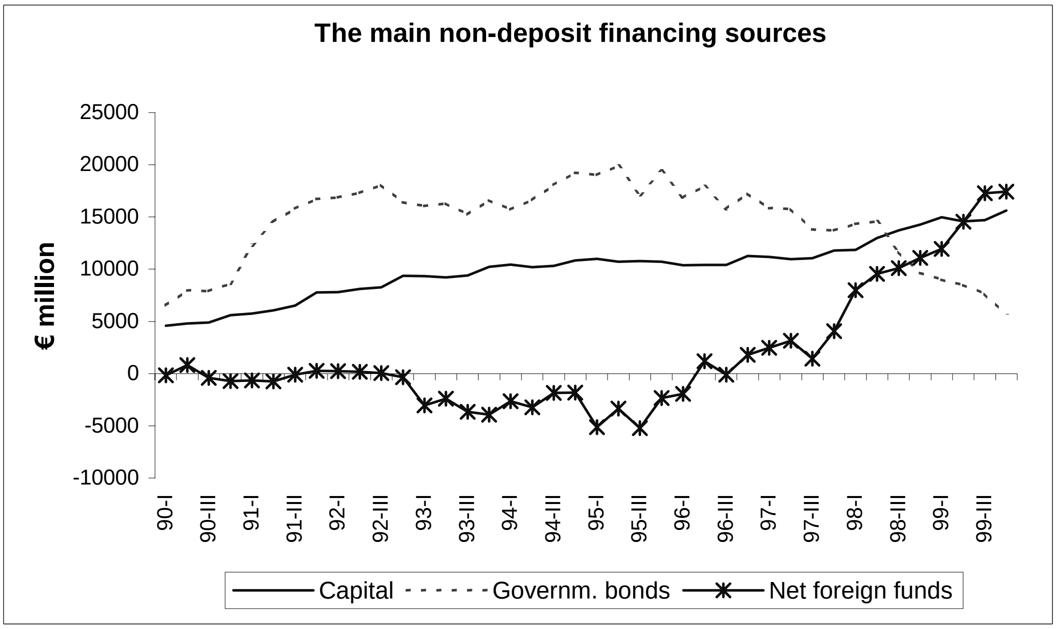


Chart 2



This apparently diverging developments in credit and deposits have been the consequence of a significant change in the framework where the Portuguese banks operate. Even before the Stage Three of EMU, with the elimination of capital controls on the one hand and a significant reduction of the exchange risk of the escudo on the other, the Portuguese banks have had easy access to financing in international money markets. As we shall see these developments are likely to be responsible for the “structural break” undergone by our estimated relations in the next section.

Chart 2 presents the evolution of the main non-deposits financing sources. It can be seen that the increase in the growth rate of loans coincided with a decrease of the government bonds in banks’ portfolios and an increase in the (net) funds obtained in the international money markets. Banks partly substituted their investment in government securities by credit to private non-financial sectors. This whole process seems basically to have started in 1995 and accelerated in 1998. As a matter of fact, the weight of government securities in banks’ balance sheets declined significantly from 19.5 per cent of total assets in 1992 to 5.7 per cent in 1998 (13.4 per cent in 1995). Portuguese banks have also been financed through credit/deposit operations with foreign banks. The weight of deposits held by foreign MFIs on total liabilities increased from 5.8 per cent in 1992 to 15.3 per cent in 1998 (11.8 in 1995). In 1995 the Portuguese banks in our sample were net creditors in the international money market but this situation was reversed as of 1996.

7. Empirical evidence using micro bank data for Portugal

In the empirical analysis on the incidence of the credit channel in the transmission of monetary policy for the Portuguese economy, we use balance sheet information on a sample of banks for which consistent data throughout 1990/1-1998/4 is available.

The process of bank mergers that occurred during the sample period has been taken into account by treating bank groups as individual institutions and by repeating back through the whole sample period the structure of groups prevailing in 1998. Merging banks for which data for the complete period was not available were excluded from the sample. The implementation of these criteria left us with a sample of 18 banks[19].

[19] Data on banks’ balance sheet items were taken from the data reported by the Portuguese banks to the Banco de Portugal for the purpose of compilation of aggregate monetary statistics. Since the third quarter of 1997 the definitions of balance sheet items comply with the “ESCB implementation package”, some of the series having been recollected back so that comparable series on the main items may be obtained.

Table 1

Main banks' balance sheet items as a percentage of the total assets: all banks

	1992	1995	1998
Assets			
Credit to private non-financial sector	42.5	37.2	38.8
Domestic money market	2.3	3.4	5.1
Government securities	19.5	13.4	5.7
Deposits in foreign MFIs	5.7	14.6	10.9
Liabilities			
Deposits of private non-financial sector	65.6	55.8	42.8
Domestic money market	2.1	3.2	4.8
Capital	9.5	7.7	6.0
Deposits of foreign MFIs	5.8	11.8	15.3

Average total assets of the 18 banks in our sample, amounted to €12.5 billion in December 1998 (87 percent of the assets of the whole banking system)[20]. For one third of these 18 banks total assets stood above the average level. In 1998 these 6 largest banks, each with total assets greater than €6 billion, could be seen as large banks in absolute terms, their market share in terms of total assets (of the 18 banks) being 87 per cent.

From Table 1, which presents the average structure of banks' balance sheets for some selected years, we can see that for the 18 banks in our sample, credit granted to the private non-monetary domestic sectors of the economy amounted to approximately 39 per cent of their total assets in 1998, 3.7 and 3.3 percentage points less than in 1992 and 1995 respectively. On the liabilities' side of the balance sheet total deposits held by the private non-monetary sector with the 18 banks decreased from 65.6 per cent of total assets in 1992 to 42.8 per cent in 1998.

Table 2 presents the balance sheet structure separately for the 6 largest banks, 4 medium size banks and the 8 smallest banks in the sample. Tables 3 and 4 separate respectively the most and the less liquid and the most and the less capitalised banks[21].

[20] In December 1998, the credit and deposits in these 18 banks amounted to 96 per cent and 98 per cent of the total credit and total deposits, respectively.

[21] The criteria to define the sub-samples were based on average size, liquidity and capitalisation of each bank in the whole sample period.

Table 2

Main banks' balance sheet items as a percentage of the total assets according to bank size

	6 largest banks			4 medium size banks			8 smallest banks		
	1992	1995	1998	1992	1995	1998	1992	1995	1998
Assets									
Credit to private non-financial sector	42.0	36.6	38.0	46.9	53.2	65.1	46.0	31.5	24.0
Domestic money market	2.2	3.4	5.8	2.5	3.0	0.8	3.8	2.9	0.9
Government securities	20.5	13.8	6.0	10.7	8.0	1.9	10.8	13.8	5.0
Deposits in foreign MFIs	5.4	15.1	11.2	8.4	10.1	10.1	9.9	12.7	7.8
Liabilities									
Deposits of private non-financial sector	66.8	57.1	44.0	62.5	62.4	57.1	41.0	27.5	12.3
Domestic money market	1.7	3.0	5.1	2.7	4.1	3.6	11.4	6.1	2.7
Capital	9.5	7.8	6.3	9.1	8.3	6.0	11.2	5.3	1.5
Deposits of foreign MFIs	5.2	11.4	15.0	8.9	9.1	13.7	15.4	20.5	20.9

According to data in Table 2 the credit share is the highest for banks of medium size and the smallest for the small size banks. In turn, the deposit share is larger in large/medium banks and decreased in all types of banks. The proportion of assets invested in government securities is on average larger for large banks but it has decreased rapidly in all banks from 1995 to 1998. Larger banks have been net creditors in the domestic money market while smaller banks have been net debtors. In the international money market, large and medium size banks were net creditors in 1995 but they became net debtors in the most recent years. Smaller banks reinforced their debtor position.

Data on Table 3 shows that the credit share diminishes when liquidity increases (as one would expect) but there is no regularity in the deposits share according to the liquidity ratio. Also, there seems not to be any regularity concerning the weight of foreign money market operations or the weight of investment in government securities in total assets according to the liquidity ratio, during the sample period.

Table 3

Main banks' balance sheet items as a percentage of the total assets according to bank according to bank liquidity

	6 most liquid banks			4 medium liquidity banks			8 less liquid banks		
	1992	1995	1998	1992	1995	1998	1992	1995	1998
Assets									
Credit to private non-financial sector	37.7	34.1	34.8	49.0	40.1	43.5	50.4	50.7	44.1
Domestic money market	2.6	3.6	7.1	1.7	3.1	3.4	2.4	2.6	0.6
Government securities	22.6	13.3	5.5	16.0	14.7	7.0	9.8	7.5	1.5
Deposits in foreign MFIs	6.7	15.9	13.2	3.6	13.4	8.2	8.6	9.7	7.9
Liabilities									
Deposits of private non-financial sector	63.5	50.7	38.1	70.6	66.1	53.0	56.4	45.8	31.7
Domestic money market	2.2	4.1	7.5	1.1	1.0	1.1	6.9	7.0	2.9
Capital	9.7	7.3	6.3	9.2	8.3	6.1	10.0	7.4	3.4
Deposits of foreign MFIs	6.8	13.6	17.1	3.1	8.2	12.2	11.4	14.7	16.3

From Table 4 one concludes that the credit share is basically the same regardless the capitalisation ratio, but no clear tendency exists for the deposits share. On the other hand there seems to be a tendency for less capitalised banks to exhibit larger shares of government bonds and for more capitalised banks to exhibit a larger share of deposits of foreign MFIs.

Let us now focus on the econometric results. As expected, some preliminary tests showed that in the last years of the sample the relation between credit granted to private sector and deposits underwent a huge structural break. As the consequences of this structural break seem to be more damaging for the estimated models when we introduce data for 1998 we decided to exclude the observations for this last year from the analysis.

Table 4

Main banks' balance sheet items as a percentage of the total assets according to bank according to bank capitalisation

	6 most capitalised banks			4 medium capitalisation banks			8 less capitalised banks		
	1992	1995	1998	1992	1995	1998	1992	1995	1998
Assets									
Credit to private non-financial sector	43.7	41.9	39.9	42.4	37.3	41.3	42.3	36.5	35.6
Domestic money market	2.9	2.9	0.9	2.6	4.1	6.9	1.7	2.4	3.6
Government securities	10.6	10.6	2.3	19.0	12.3	6.1	21.8	15.4	5.6
Deposits in foreign MFIs	10.7	15.1	12.7	5.8	16.6	12.7	4.8	11.7	8.4
Liabilities									
Deposits of private non-financial sector	55.3	47.4	33.8	65.2	57.6	47.7	68.1	54.1	38.1
Domestic money market	3.4	4.2	2.6	1.8	3.6	6.3	2.4	2.5	3.3
Capital	11.2	9.5	5.0	10.0	8.4	6.9	8.4	6.4	4.9
Deposits of foreign MFIs	11.9	18.5	16.1	5.7	12.3	15.9	4.9	10.1	14.3

As we have seen the intensification of credit growth in 1998 is likely to be the result of a progressively reduced exchange risk, which strongly reduced the "true" cost of external financing, not captured by our available measure. For this reason we think that it is not sensible to use data later than 1997 to test the existence and importance of the credit channel, at the country level, for EU countries, because monetary policy was no longer set at the country level and the funds available to the banks were also no longer defined at the country level.

Of course this option further reduces the time dimension of our panel to eight years of quarterly data, which may appear as a very short sample given the cointegration approach followed in this paper. We notice however that in case of panel data the cross-section dimension of the data also plays an important role in establishing the properties of the estimators. Also, for the cointegration approach to be valid the ultimately decisive criterion is always the outcome of the cointegration tests. As it will be pointed out below, the null of non-cointegration is always strongly rejected in our estimated equations and this clearly legitimates our approach.

As explained in section 5 we directly estimate loan-supply functions, which are generalisations of (3.4) and (4.1). However an important point regarding these equations is now in order. The basic loan-supply specification estimated in this section includes bank capital as an additional regressor. We may justify the introduction of such regressor on two different grounds. In econometric terms, one can argue that if it is not included, then deposits would be the single variable capturing “scale” effects in our supply function and the results would likely be biased towards favouring the conclusion of the existence of the credit channel i.e., $\alpha_1 \neq 0$ in equation (3.4) or (4.1). In order to overcome this criticism we may include additional regressors in our estimated equations to account for the bank specific characteristics that explain the part of the growing trend in bank credit not accounted for by growth in deposits or other included regressors[22]. The introduction of the bank capital in our estimated equation may also be justified on theoretical grounds. For instance, Courakis (1988) develops a model for banking behaviour in which banks, in order to maximise profits, are assumed to decide on the amount of each asset (reserves, loans, securities, etc.) and each liability (money market funds, certificates of deposits, etc.) that they are able to control. Balance sheet items not controlled by the bank or that the bank cannot manipulate in the short run are treated as exogenous (capital, for instance). The author shows that in this case the amount of each asset held by the bank (liabilities are treated as negative assets) is a function of the interest rates on all the assets (including liabilities) as well as of the levels of the items assumed exogenous to be bank.

So, in the context of the Courakis model our loan supply function can be interpreted as resulting from a profit maximising behaviour of a bank in which both deposits and capital are treated as exogenous. The bank is assumed to choose the volume of credit, securities and external finance, in order to maximise the expected profits for a given level

[22] In these situations it is customary to include a linear time trend into the regression (or several time trends, which in the limit may be bank specific). This linear trend, which is usually seen as a proxy for all the omitted regressors is better justified in terms of the cointegration results. If the variables (integrated of order one with a non zero drift) are deterministically cointegrated there is no need for the introduction of time trends, but if the variables are only stochastically cointegrated then we need to “explain” the deterministic part of the credit growth not accounted for by the included regressors, by introducing a time trend (or bank specific time trends) into the regression. In our case there seems to be no need for the use of such time trends.

of deposits and capital. The possibility of other forms of external financing alternative to deposits and capital (money market funds, certificates of deposits, etc.) is taken into account by introducing into the credit equation an interest rate representing the cost of such funds. Our basic equation now reads as:

$$\underset{}{\ln(C/P)^{s}_{it}} = \alpha_{0i} + \underset{(+)}{\alpha_1 \ln(\mathrm{D/P})_{\mathrm{it}}} + \underset{(+)}{\alpha_2 \ln(K/P)_{it}} + \underset{(+)}{\alpha_3 l_t} + \underset{(-)}{\alpha_4 i_t} + \underset{(-)}{\alpha_5 s_t} + \underset{(-)}{\alpha_6 \pi_t} \tag{7.1}$$

where s_t stands for the cost of external financing alternative to deposits or capital. We argue that if $\alpha_1 > 0$ this is evidence of the existence of a lending channel, provide α_3 is finite (not very large). We note that equation (7.1) is also in line with the loan-supply function derived in Kashyap and Stein (1995). In the theoretical model suggested by these authors the supply of loans depends on the loan security spread, on the volume of deposits (assumed to be out of the bank control), on the cost of raising non-deposits external finance, as well as on the uncertainty surrounding the future expected deposits.

The variable s_t is supposed to proxy the cost of external funds available to the banks (funds alternative to deposits or capital). After 1995, s_t is also expected to measure the costs of funds obtained abroad in other EU countries. Assuming that the uncovered interest rate parity (UIP) holds we use the short-term interest rate on Portuguese interbank money market (Lisbor) as a proxy for the total cost of external funds at the Portuguese banks disposal during the sample period[23].

As size, liquidity and capitalisation ratios may be important sources of heterogeneity in banks loan-supply functions, the estimated equations also include several interaction effects that account for these heterogeneity sources.

Under the assumption of cointegration equation (7.1) – which explicitly allows for levels specific effects captured by the coefficients α_{0i} – may be estimated using POLS, PCOLS, PDOLS or PFMOLS. We have seen above that the POLS estimator is consistent, but not superconsistent, if the regressors are correlated with the residuals, and that they may exhibit substantial biases in finite samples. Simulation results also show that the PCOLS estimator does not significantly improve over simple POLS (see, for instance, Baltagi and Kao (2000))[24]. In contrast PFMOLS is superconsistent even when the

[23] After 1995 s_t may be seen as being equal to the sum of the short-term interest rate abroad, s_t^*, plus the exchange risk premium, φ_t, so that according to the UIP we have $s_t = s_t^* + \varphi_t$. It can be seen from the data that exchange risk premium, measured by $\varphi_t = s_t - s_t^*$ is decreasing over time, converging to zero by 97/98.

[24] This is likely to be case for Portuguese data given our small sample.

regressors are correlated with the residuals and the corresponding estimators also have a normal limit distribution.

Using the software recently developed by Chiang and Kao (2001) we estimated our equations using the POLS, PCOLS, DPOLS and the PFMOLS estimators. The results obtained by the first three estimators are basically similar. In such regressions most coefficients appear non-significantly different from zero or wrong signed. In contrast the results supplied by the PFMOLS estimator are quite reasonable in terms of both sign and magnitude. The small sample, the correlation in the residuals as well as the endogeneity of some of the regressors probably explains these differences. For this reason, below we only present and comment the PFMOLS results.

The reported equations below only consider two and not three interest rates as (7.1) would suggest. The point is that due to strong colinearity it is very difficult to separately estimate the coefficients associated with the interest rates. But the fact is that in this case the exclusion of i_t from (7.1) is likely not to have damaging consequences for the interpretation of the results of the estimated equations[25].

As a matter of fact i_t turned out to be non-significant in the estimations. Therefore in the regressions reported in Table 5, which were obtained using PFMOLS, it was excluded. Below each coefficient is the computed t-statistic, which is asymptotically normal distributed. For each equation several cointegration tests were computed (but are not reported for space reasons). The null of a unit root in the residuals was always rejected, so that all the equations presented in Table 5 are valid cointegrating relations[26].

Column 1 displays the results of our basic specification (equation (7.1)) with α_4 set equal to zero). It can readily be seen that all the coefficients are statistically significant and exhibit the expected sign for a loan-supply function. This, of course, is a strong piece of evidence favouring our identification approach[27].

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[25] If we, quite realistically, assume that i_t and s_t are cointegrated we may write $i_t = s_t + k + \varepsilon_t$ where k is a constant and ε_t a purely stochastic stationary process. The relevant part of the model may be written as $\alpha_3 l_t + \alpha_4 i_t + \alpha_5 s_t = \alpha_3 l_t + (\alpha_4 + \alpha_5) s_t + \alpha_4 k + \alpha_4 \varepsilon_t$, so that by not introducing i_t into the estimated model we are subsuming the terms $\alpha_4 k$ and $\alpha_4 \varepsilon_t$ into the constant and the residuals of the resulting model respectively, without significant consequences on the remaining estimated coefficients. However, the coefficient on s_t should now be seen as being equal to $(\alpha_4 + \alpha_5)$.

[26] The panel cointegration tests computed by the NPT 1.2 package developed by Chiang and Kao (2001) include the five panel cointegration tests developed in Kao (1999) and four panel cointegration tests developed in Pedroni (1997).

[27] The fact that all the estimated coefficients have the right sign does not, of course, completely rule out the possibility of our estimated equation being a biased estimator of the true supply schedule. This will be the

Even though the estimated coefficients of l_t and s_t do not seem to be much different in absolute terms, the null hypothesis of their being equal in magnitude (the "spread condition") is statistically rejected. In fact the t-statistics for this restriction are always larger than two (see, bottom line of Table 5). Thus, we proceed without imposing such restriction in the estimated loan-supply equations.

Given that the coefficient of $\ln(D/P)$, α_1, is significantly positive and the coefficient of l_t, α_3, is finite we conclude that there is evidence of the existence of a credit channel in the transmission of monetary policy in Portuguese bank data. However the coefficient of l_t (and also the coefficient of s_t) appears to be somewhat high and we have seen that a high interest rate elasticity of credit supply reduces the importance of the credit channel.

By comparing the results in columns (1) and (2) we also see that the conclusion on the existence of the credit channel does not depend on whether or not the estimated regression includes bank capital as an additional regressor.

The remaining equations in Table 5 interact the explanatory variables in our basic equation with three bank specific characteristics, which we see as potential important sources of bank heterogeneity: size, liquidity and capitalisation. In the table these three variables are denoted by z_{it}. Our general formulation in this case reads as

$$\ln(C/P)^s_{it} = \beta_{0i} + \beta_1 \ln(\mathrm{D/P})_{\mathrm{it}} + \beta_2 \ln(\mathrm{D/P})_{\mathrm{it}} z_{it} + \beta_3 \ln(K/P)_{it} + \beta_4 \ln(K/\mathrm{P})_{\mathrm{it}} z_{it} + \beta_5 l_t + \beta_6 l_t z_{it} + \beta_7 s_t + \beta_8 s_t z_{it} + \beta_9 \pi_t + \beta_{10} z_{it} \quad (7.2)$$

where interactions appear in all the potentially relevant variables.

In the case of size and capitalisation the z_{it} variable is taken in the form of differences from each time period average, i.e.,

$$z_{it} = x_{it} - \frac{1}{N}\sum_{i=1}^{N} x_{it} = x_{it} - \bar{x}_t \quad (7.3)$$

---

case if our specified equation is not stable in the 6-dimensional space defined by $[\ln(C/P), \ln(D/P), \ln(K/P), l, s, \pi]$. In turn, this instability is likely to occur if some relevant decision variable is missing in our estimated equation. However, the possibility of we being estimating a demand equation instead of a supply equation is completely out of the question, given the signs of the estimated coefficients.

where x_{it} stands for the log of total assets, as a measure of size and for the capital ratio as a capitalisation indicator[28]. By defining size and capitalisation in this way we ensure that the z_{it} variable captures pure differential effects. For each time period, the z_{it} variable averages to zero, being negative for banks whose specific characteristic (size and capitalisation ratio) is below average (these will be called small or less capitalised banks) and positive for banks whose specific characteristic is above average (these will be designated large or well capitalised banks). In case of liquidity the z_{it} variable is instead taken in the form of differences from a per-bank average, i.e.,

$$z_{it} = x_{it} - \frac{1}{T}\sum_{t=1}^{T} x_{it} = x_{it} - \bar{x}_i \qquad (7.4)$$

where x_{it} stands for the liquidity ratio as a measure of bank liquidity[29]. The rationale for such a definition is the following. Theoretically, if anything, banks are expected to react to monetary policy according to their own concept of positive or negative excess liquidity. But, the concept of excess liquidity is bank specific and so it has to be seen as the difference between the actual liquidity ratio and what (in the banks' opinion) is its optimum liquidity ratio (which is expected to vary according to bank size, the degree of bank risk aversion, the customers mix, etc.). If, a monetary policy shock occurs when the liquidity ratio is above the optimum (long run equilibrium) liquidity ratio, the bank reaction will be smaller (less lending channel effect) than otherwise. Definition (7.4) assumes that the bank specific long run equilibrium liquidity level may be proxied by the bank average liquidity ratio during the sample period[30]. If, with the z_{it} variable as defined in (7.4) we compute the average banks reaction to changes in deposits we get from (7.2)

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\partial \ln(C/P)_{it}}{\partial \ln(D/P)_{it}} = \frac{1}{N}\sum_{i=1}^{N}(\beta_1 + \beta_2 z_{it}) = \beta_1 + \beta_2(\bar{x}_t - \bar{x}) \qquad (7.5)$$

---

[28] The capital ratio is computed as "capital and reserves" over total assets.

[29] The liquidity ratio is computed as the sum of cash plus inter-bank deposits plus government securities divided by total assets.

[30] In samples in which general positive excess liquidity during a large period of time is not compensated by an equally long period of negative excess liquidity, it may be the case that the sample average liquidity ratio is not a good proxy for the long run equilibrium liquidity ratio. This is also to be the case whenever the time dimension of the panel is too short (so that it does not allow computing a meaningful bank average liquidity ratio) or too long (in this case one should allow for a time varying optimum long run equilibrium liquidity ratio)

Table 5

PFMOLS estimates of equations (7.1) and (7.2)

Regressors	(1)	(2)	Size (3)	Size (4)	Liquidity (5)	Liquidity (6)	Capitalisation (7)	Capitalisation (8)
$\ln(D/P)_{it}$	0.615	0.721	0.676	0.490	0.633	0.717	0.409	0.713
	(24.83)	(28.99)	(14.61)	(10.86)	(18.38)	(21.34)	(14.97)	(26.26)
$\ln(D/P)_{it}.z_{it}$			0.156	0.049	-0.051	0.027	-3.947	-0.747
			(8.16)	(2.80)	(-0.75)	(0.54)	(-16.23)	(-6.97)
$\ln(K/P)_{it}$	0.156		-0.525		0.130		0.470	
	(3.00)		(-10.11)		(2.74)		(7.89)	
$\ln(K/P)_{it}.z_{it}$			-0.101		0.022		6.462	
			(-3.03)		(0.13)		(12.14)	
l_t	19.318	16.734	17.953	22.262	14.787	12.839	22.187	16.617
	(15.00)	(12.96)	(16.14)	(18.91)	(12.10)	(10.34)	(18.01)	(12.40)
$l_t z_{it}$			0.523		101.926	111.513	24.639	
			(0.81)		(8.40)	(9.30)	(1.79)	
s_t	-15.905	-14.442	-11.767	-16.110	-11.835	-10.801	-17.096	-13.595
	(-11.85)	(-10.77)	(-10.22)	(-13.24)	(-9.55)	(-8.59)	(-13.63)	(-10.08)
$s_t z_{it}$			-1.410		-72.969	-79.466	13.953	
			(-2.26)		(-6.38)	(-7.10)	(1.04)	
π_t	-2.504	-1.114	-7.538	-6.476	-0.470	0.635	-5.114	-3.069
	(-2.24)	(-1.02)	(-7.66)	(-6.45)	(-0.45)	(0.61)	(-4.70)	(-2.76)
z_{it}			0.411	0.214	-8.213	-9.005	-6.589	-0.444
			(5.04)	(3.55)	(-13.27)	(-14.26)	(-5.15)	(-1.32)
Spread restriction	(4.30)	(2.98)	---	(8.79)	---	---	---	(3.81)

Legend:

t-statistics in parenthesis.

$\ln(D/P)$ = natural log of total deposits deflated by the consumer price index

$\ln(K/P)$ = natural log of total capital deflated by the consumer price index

l_t = interest rate on long term loans in decimals (five year loans)

s_t = short term interest rate on Portuguese money market in decimals (Lisbor)

π_t = inflation rate in decimals (fourth differences of log CPI)

z_{it} = measure of bank specific characteristic (size, liquidity or capitalisation) where $\bar{x}$ is the overall average liquidity ratio (computed over all banks for the whole sample period). From (7.5) we conclude that (7.4) allows one to account for periods of general (positive or negative) excess liquidity for the banking sector as whole. This is a very important issue in the Portuguese banking system, as we will see below.

For expository purposes let us take the model in column (3) of Table 5. The fact that the coefficient on $\ln(D/P)_{it} z_{it}$ is positive means that the coefficient on deposits is lower for small banks and so in the Portuguese case the supply of loans of small banks is less deposit dependent than that of large banks. In other words, everything else equal, we would conclude that the credit channel is less important for small banks. This conclusion runs against to what one could expect according to economic theory.

As shown in section 3, one cannot, in general, conclude on the relative importance of the credit channel just by looking at the coefficient of deposits, because the importance of the credit channel also depends on the slope of the supply curve that is on the coefficient of l_t. So, if we allow for a changing coefficient on deposits according to bank size, we must also allow for a changing coefficient of the loans interest rate, l_t, according to size (and similarly for the coefficient of s_t). In other words, in terms of equation (7.2), to conclude on the relative magnitude of the credit channel for two different banks one has to look not only at the coefficient of $\ln(D/P)_{it} z_{it}$, β_2, but also at the coefficient of $l_t z_{it}$, β_6, as the effect of a decrease in the coefficient of deposits could be offset by an increase on the coefficient of the loans-interest rate, and vice versa.

In our case it turns out that the coefficients on the interaction terms $l_t z_{it}$ and $s_t z_{it}$ are both not statistically different from zero and so, we may definitely conclude that small Portuguese banks are less dependent on deposits than large banks or, in other words, the credit channel appears to be less important for small banks[31]. We recognise that the lack of evidence of larger non-deposit external financing costs for smaller banks does not come as a large surprise in the Portuguese case. Portugal is a small country with a not very large number of banks and in which even the smaller banks are large enough not to be discriminated in the access to markets for non-deposits external funds[32].

[31] We note that the coefficient of $\ln(K/P)$ in column (3) is wrong signed, but the above conclusion still holds for the model in column (4), which was estimated after dropping $\ln(K/P)_{it}$ and $\ln(K/P)_{it} z_{it}$ and after checking that the coefficients on $l_t z_{it}$ and $s_t z_{it}$ were still statistically not different from zero. However in column (4) the estimated coefficient of $\ln(D/P)_{it} z_{it}$ is much smaller and the t-statistic is not very high in relative terms.

[32] We recall that according to Table 2 small banks were net debtors in the domestic money market while large banks were net creditors.

Columns (5) and (6) display the models with liquidity as the bank specific characteristic. The first important point to note is that both the coefficients of $\ln(D/P)_{it} z_{it}$ and $\ln(K/P)_{it} z_{it}$ are statistically not different from zero. The fact that the coefficient of $\ln(D/P)_{it} z_{it}$ is zero means that in the Portuguese case the dependence of banks on deposits does not depend on the bank liquidity ratio[33]. On the other hand, it turns out that the coefficient of the credit interest rate is lower for illiquid banks[34] (as the coefficient of $l_t z_{it}$ is positive) and this means that the supply curve is flatter. This reduces the importance of the credit channel for the illiquid banks. As we have seen, due to the existence of credit ceilings and compulsory minimum ratios of public debt, the Portuguese banks displayed a huge liquidity ratio at the beginning of the sample period, which steadily decreased later (after 1995 banks were also able to progressively sell the public debt to foreign banks). This also means that in our case, using the sample average to proxy the long run equilibrium liquidity ratio is probably not a good solution, because it implies that (almost) all the banks exhibited excess liquidity during the first half of the sample and scarcity of liquidity during the second half of the sample, when in fact it may have been the case as the data suggest (the liquidity ratio further decreased in 1998) that the liquidity ratio was above the true long run equilibrium level all over the sample period. So, it may well be the case that the coefficients of $l_t z_{it}$ and of $s_t z_{it}$ appear significantly different from zero because they are capturing the effects of a potential structural break occurring in the period, as we shall see below. All in all, a sensible conclusion seems to be that liquidity in the Portuguese banks, during the nineties has not played the role of a shield against monetary policy shocks.

Columns (7) and (8) display the two models estimated with the capitalisation ratio as the interaction variable. In this case we have $\beta_2 < 0$ and $\beta_6 = \beta_8 = 0$, and thus, we can definitely conclude that the credit channel appears to be more important for less capitalised banks.

Let us now address the stability issue. The above conclusions are valid under the implicit assumption that the models estimated in Table 5 are stable. But if we look again at Chart 1 we immediately realise that during 1996 and 1997 the credit growth rate increased relative to the deposits growth rate, coinciding with the increase in the external non-deposits funds coming from abroad (actually, this characteristic in the data is still

[33] We note that this conclusion depends on the fact that the liquidity variable is defined as in (8.4). If we rather define liquidity as in (8.3) the coefficient of $\ln(D/P)_{it} z_{it}$ appears significantly different from zero and negative. This result shows that the way the z_{it} is defined really matters for the empirical analysis.

[34] Remember that an illiquid bank is one for which the current liquidity ratio is below the long run equilibrium liquidity ratio (proxied by the sample average liquidity ratio).

Table 6

PFMOLS estimates of equation (7.6)

Regressors	(1)	(2)	Size (3)	Size (4)	Liquidity (5)	Liquidity (6)	Capitalisation (7)	Capitalisation (8)
$\ln(D/P)_{it}$	0.513 (21.68)	0.707 (29.16)	0.600 (13.80)	0.438 (10.01)	0.527 (15.31)	0.716 (21.23)	0.290 (10.89)	0.679 (26.06)
$\ln(D/P)_{it}.d_{96}$	0.239 (6.48)	0.046 (2.63)	0.157 (4.89)	0.046 (2.90)	0.215 (5.99)	0.004 (0.22)	0.224 (6.06)	0.087 (5.00)
$\ln(D/P)_{it}.z_{it}$			0.151 (8.36)	0.044 (2.61)	0.245 (3.62)	0.067 (1.35)	-3.934 (-16.82)	-1.074 (-10.39)
$\ln(K/P)_{it}$	0.296 (4.85)		-0.415 (-7.59)		0.292 (4.95)		0.601 (8.75)	
$\ln(K/P)_{it}.d_{96}$	-0.293 (-5.88)		-0.161 (-3.68)		-0.321 (-6.72)		-0.240 (-4.85)	
$\ln(K/P)_{it}.z_{it}$			-0.102 (-3.15)		-0.412 (-2.49)		5.918 (11.46)	
l_t	15.146 (11.94)	12.655 (9.72)	17.031 (15.72)	17.772 (15.99)	12.137 (9.75)	9.411 (7.29)	17.169 (13.88)	12.959 (9.75)
$l_t d_{96}$	15.090 (2.59)	11.453 (1.94)	9.225 (1.87)	17.582 (3.32)	12.720 (2.36)	4.388 (0.79)	16.397 (3.03)	9.039 (1.56)
$l_t z_{it}$			0.746 (1.23)		102.367 (8.54)	123.174 (10.16)	24.914 (0.37)	
s_t	-9.808 (-7.13)	-9.565 (-6.74)	-9.648 (-8.28)	-10.852 (-8.52)	-7.597 (-5.78)	-6.804 (-4.94)	-9.501 (-7.35)	-8.604 (-6.14)
$s_t d_{96}$	-25.165 (-2.80)	-16.445 (-1.79)	-16.648 (-2.19)	-25.452 (-3.09)	-21.572 (-2.59)	-4.363 (-0.50)	-25.734 (-3.09)	-13.877 (-1.54)
$s_t z_{it}$			-1.179 (-1.91)		-74.449 (-6.61)	-91.884 (-8.15)	20.347 (1.59)	
π_t	-3.632 (-3.42)	-1.211 (-1.14)	-8.316 (-9.00)	-7.439 (-7.67)	-1.386 (-1.36)	0.502 (0.48)	-7.019 (-6.75)	-4.176 (-3.90)
z_{it}			0.349 (4.52)	0.276 (4.75)	-8.515 (-13.71)	-9.215 (-14.18)	-5.193 (-4.25)	-1.045 (-3.20)
Spread restriction	(-1.45)	(-0.56)	---	(0.02)	---	---	---	(-0.15)

Legend: see Table 5.

stronger during 1998 and 1999). This fact raises the question of whether the conclusions above still apply once we allow for the possibility of a structural break in the last two years of the sample.

To investigate this issue we "interacted" the variables in our basic specification with a dummy variable, which is zero for the first six years of data (1990/1 to 1995/4) and equals 1 for the two last years of the sample (1996/1 to 1997/4). This variable is denoted by d_{96} in Table 6 below and in our new equation whose basic formulation now reads as

$$\begin{aligned}\ln(C/P)^s_{it} = {} & \beta_{0i} + \beta_1 \ln(\mathrm{D/P})_{\mathrm{it}} + \alpha_1 \ln(\mathrm{D/P})_{\mathrm{it}} d_{96} + \beta_2 \ln(\mathrm{D/P})_{\mathrm{it}} z_{it} \\ & + \beta_3 \ln(K/P)_{it} + \alpha_3 \ln(K/\mathrm{P})_{\mathrm{it}} d_{96} + \beta_4 \ln(K/\mathrm{P})_{\mathrm{it}} z_{it} + \\ & + \beta_5 l_t + \alpha_5 l_t d_{96} + \beta_6 l_t z_{it} + \beta_7 s_t + \alpha_7 s_t d_{96} + \beta_8 s_t z_{it} + \beta_9 \pi_t + \beta_{10} z_{it}\end{aligned} \tag{7.6}$$

Notice that model (7.6) collapses into model (7.2) for the period 1990/1-1995/4. For the period 1996/1-1997/4, the coefficient of $\ln(D/P)$ is given by $(\beta_1 + \alpha_1)$ and similarly for the coefficients of $\ln(K/P)$, l_t and s_t.

First, it is important to note that according to Table 6 there seems to be a strong evidence of a structural break occurring in the two last years of the sample. In fact, with the exception of the model in column (6), the coefficients of the variables of the model interacted with the dummy variable d_{96} are in general significantly different from zero. It seems however that our liquidity variable basically accounts for the structural break occurred in the last part of the sample. In fact, in the Portuguese case, the liquidity ratio may be seen as a sort of "summary" variable that encompasses the main changes that the Portuguese banking sector underwent over the nineties[35].

[35] The results of the two models displayed in columns (5) and (6) of Table 6 are somewhat puzzling. According to the model with the capital variable in column (5) there seems to be a structural break, as the coefficients of the variables interacted with the dummy variable are significantly different from zero. However, a different conclusion emerges when we look at the model in column (6), as the coefficients of the variables interacted with the dummy variable are all not different from zero. There are two alternative econometric explanations for such an outcome: 1) if model in column (5) is the true model the results obtained in column (6) stem from an omitted regressors misspecification bias and 2) if the model in column (6) is the true model the results in column (5) are due to an over-parameterisation of the estimated model. Of course, in this latter case it would mean that the introduction of the liquidity ratio in our basic specification is sufficient to account for the structural break. Notice that the model in column (6) in table 6 reduces to the model in column (6) of table 5 if we drop the (non significant) coefficients of the variables interacted with the dummy variable.

Also important to note is that now the spread restriction is met for the period 1996/1997, even though it is still not met for the period 1990/1995[36].

However the most important point is that all the relevant conclusions drawn above from Table 5 remain valid for Table 6. In fact, the first two columns allow us to conclude for the existence of the credit channel ($\beta_1 > 0$ and $\beta_5 > 0$, but finite). From columns (3) and (4) we conclude that large banks are more deposit dependent than small banks. From column (5) and (6) we once again conclude that the dependence of banks on deposits does not depend on the bank liquidity ratio and that the supply curve of illiquid banks is flatter (as the coefficient of $l_t z_{it}$ is positive). And once again from columns (7) and (8) we conclude that the credit channel is more important for the less capitalised banks.

A cautionary note on the above conclusions is now in order. A puzzling result emerging from Table 6 is that the estimated α_1 is always positive (with the exception of the model in column (6)). At a first thought one would expect this coefficient to be zero or even negative to reflect the "expected" smaller banks' dependence on deposits, given the possibility of access to foreign markets for external funds after 1995. We note however that the coefficient of deposits is expected to measure the percentage increase of credit associated to an increase of one percent in deposits. All else equal, if during a given time period the data exhibit an increase in the credit growth rate larger than the increase in the deposits growth rate, this will tend to show up in a larger coefficient β_1 (i.e., $\alpha_1 > 0$) unless due account is taken in the model for this potential "structural break". But in the Portuguese case there seems to be a reasonable explanation for the coefficient α_1 to be positive in Table 6. One important feature of the Portuguese aggregate bank data is the huge decrease of liquidity throughout the sample period. The liquidity ratio decreased from 37.4 per cent in 1992 to 27 per cent in 1995, to 21 per cent in 1997 and further to 17.1 per cent in 1998. The evolution of the liquidity ratio very much reflects the changes the banking sector underwent during the nineties. In the beginning of the nineties, the existence of credit limits forced banks to operate with excess liquidity. After the abolition of credit limits in 1991 the banks were theoretically free to get rid of that excess liquidity, but then the exchange rate crisis of 1992 occurred. Only after the economic downturn of 1993-1994 banks were able to finance an increasing demand for credit by selling their Portuguese government bond holdings to foreign banks. This resulted in a reduction of the liquidity ratio, which probably explains why banks appear more deposit dependent in the two last years of the sample ($\alpha_1 > 0$) in Table 6. So, in the Portuguese case it may well be the case that for liquidity reasons bank deposit dependency has increased over time in

[36] The bottom row of Table 6 reports the t-statistics for the restriction $(\beta_5 + \alpha_5) + (\beta_7 + \alpha_7) = 0$, which is the spread condition for the period 1996/1-1997/4.

contrast to what the possibility of accessing foreign markets could suggest. The reasonability of this explanation is enhanced by the fact that the apparent larger dependence of deposits disappears in the model of column (6), which accounts for liquidity effect[37].

But, of course, the fact that the estimated α_1 is positive may alternatively be seen as a sign that we are not being able of correctly modelling the structural break occurred in last two years of the sample. From this point of view there are also some reasons that could be invoked to explain why it might also be the case that the estimated equations are not adequately capturing the entire relevant characteristics of the data. One major limitation of our approach regards the theoretical model behind our estimated equation. As we have seen, underlying our estimated equation is the assumption that banks cannot control deposits and capital (in the sense that these are not decision variables of the banks when they maximise profits) but are able to control the amount of external funds (other than deposits and capital). How realistic this assumption is in the Portuguese case is an open issue. Of course deposits are not completely controlled by banks, but they do not seem to be completely exogenous either[38]. At least in the medium or long run it seems reasonable to argue that banks may be able to influence the amount of their own deposits. The same argument applies to capital as it includes non-distributed profits. So, treating deposits and capital as totally exogenous, as we did, is probably an oversimplification. We note, however that our approach is still valid even if deposits are endogenous, but then we

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[37] Also, if we include the liquidity variable as an additional regressor in the model of column (8) of Table 6 to account for the structural break it turns out that the coefficients of $l_t d_{96}$ and $s_t d_{96}$ become clearly non significant (the t statistics drops to 0.17 and –0.01, respectively) and the coefficient of $\ln(D/P)d_{96}$ even tough still remaining significantly different from zero, its point estimate as well as its t-statistics also decrease (to 0.054 and 3.23, respectively). This result highlights two important aspects: i) the inclusion of the liquidity ratio as an independent variable in the model of column (8) accounts for most of the detected structural break and ii) the fact that the coefficient of $\ln(D/P)z_{it}$ still remains significant is an important piece of evidence that capitalisation in the model is not simply proxying the structural break, but rather explaining bank behaviour.

[38] If deposits were completely controlled by banks, the central bank would no longer be able to control the aggregate deposits and so, there would not be any lending channel at the aggregate level. In a theoretical model of the lending channel, Stein (1998) allows interbank competition for deposits, but clearly assumes that the central bank can control the bank reserves. It is not clear how these two assumptions may be reconciled at an aggregate level. It seems to us that if one assumes that the central bank can control the aggregate amount of deposits, then banks can only be allowed to compete for a “market share” of deposits. But in this case the obvious adding up restriction must be taken into account.

need some other assumption to ensure identification of the loan supply schedule (and also a different theoretical model to justify including the deposits variable as a regressor in our supply equation).

On the other hand treating external funds as completely endogenous when the supply conditions of these funds completely changed during the estimation period with the possibility of accessing funds from foreign banks, is also probably not a satisfactory simplification.

Another potential explanation for the results is that our measure of costs of external funds (the Lisbor interest rate) may not be a good proxy for the true costs of external funds for banks, which in turn may explain why the "spread condition" is rejected for the period 1990/1995.

Finally, the changes that the banking sector underwent during the nineties, which include the alterations of the competitive context with the huge increase in the number of banks, the re-privatisation process and several merging operations, are also potential explanations for some of ours somewhat puzzling results.

At this stage a potential interesting question is whether the conclusions obtained in this paper compare with the ones that would have been obtained under the reduced form approach. Appendix 2 reports the results of this alternative approach. Equations (4.2) and (4.8) are first estimated with variables in levels using the panel cointegration approach. For comparison purposes dynamic versions of these two equations with differenced variables are also estimated. The general conclusion is that the reduced form approach does not allow any interesting conclusion on the existence on the bank-lending channel.

8. Conclusions

This paper investigates the existence of a bank-lending channel using quarterly data on the Portuguese banks for the period 1990-1997.

In contrast to previous approaches which basically resort to (dynamic) reduced form equations for bank credit with variables in differences, this paper proposes an alternative approach by estimating directly a "structural" loan supply schedule with variables in levels, thereby exploiting recent cointegration results for nonstationary panel data.

We conclude for the existence of a lending channel in Portuguese data and that the importance of this channel is larger for the less capitalised banks. Size as well as liquidity does not appear to be relevant bank characteristics to determine the importance of the lending channel. However, the existence of a "structural break" during the sample period reflected by the possibility of Portuguese banks to access external funds from foreign EU banks suggests that these empirical results should be interpreted cautiously.

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Appendix 1 - Reduced form equations of the model in section 4

In this appendix we derive the reduced form equations for l_t and $\ln(C/P)_t$ corresponding to model discussed in section 4, i.e., the model composed of equations (3.1), (3.2), (3.3) and (4.1) with $\gamma_2 = 0$.

For ease of presentation we start by repeating the equations of the model:

$$\ln(D/P)_t^d = \beta_0 + \underset{(+)}{\beta_1}\ln y_t + \underset{(-)}{\beta_2}\pi_t + \underset{(-)}{\beta_3} i_t \tag{A1.1}$$

$$\ln(D/P)_t^s = \gamma_0 + \underset{(+)}{\gamma_1}\ln(\mathrm{R/P})_t + \underset{(+)}{\gamma_3} i_t + \underset{(-)}{\gamma_4} r_t \tag{A1.2}$$

$$ln(C/P)_t^d = \lambda_0 + \underset{(+)}{\lambda_1} lny_t + \underset{(-)}{\lambda_2}\pi_t + \underset{(-)}{\lambda_3} l_t + \underset{(+)}{\lambda_4} i_t \tag{A1.3}$$

$$\ln(C/P)_t^s = \alpha_0 + \underset{(+)}{\alpha_1}\ln(\mathrm{D/P})_t + \underset{(-)}{\alpha_2}\ln(\mathrm{D/P})_t z_t + \underset{(+)}{\alpha_3} l_t + \underset{(-)}{\alpha_4} i_t + \underset{(-)}{\alpha_5}\pi_t \tag{A1.4}$$

From (A1.1) and (A1.2) we get the equilibrium solution for the money market:

$$i_t = \mu_0 + \underset{(-)}{\mu_1} \ln(R/P)_t + \underset{(+)}{\mu_2} \ln y_t + \underset{(-)}{\mu_3}\pi_t + \underset{(+)}{\mu_4} r_t \tag{A1.5}$$

$$\ln(D/P)_t = \delta_0 + \underset{(+)}{\delta_1} \ln(R/P)_t + \underset{(+)}{\delta_2} \ln y_t + \underset{(-)}{\delta_3}\pi_t + \underset{(-)}{\delta_4} r_t \tag{A1.6}$$

where

$$\mu_0 = \frac{\gamma_0 - \beta_0}{\beta_3 - \gamma_3}; \qquad \underset{(-)}{\mu_1 = \frac{\gamma_1}{\beta_3 - \gamma_3}}; \qquad \underset{(+)}{\mu_2 = -\frac{\beta_1}{\beta_3 - \gamma_3}}$$

$$\underset{(-)}{\mu_3 = -\frac{\beta_2}{\beta_3 - \gamma_3}}; \qquad \underset{(+)}{\mu_4 = \frac{\gamma_4}{\beta_3 - \gamma_3}}; \tag{A1.7}$$

$$\delta_0 = \frac{\gamma_0\beta_3 - \beta_0\gamma_3}{\beta_3 - \gamma_3}; \qquad \underset{(+)}{\delta_1 = \frac{\beta_3\gamma_1}{\beta_3 - \gamma_3}}; \qquad \underset{(+)}{\delta_2 = -\frac{\beta_1\gamma_3}{\beta_3 - \gamma_3}}$$

$$\underset{(-)}{\delta_3 = -\frac{\beta_2\gamma_3}{\beta_3 - \gamma_3}}; \qquad \underset{(-)}{\delta_4 = \frac{\beta_3\gamma_4}{\beta_3 - \gamma_3}}; \tag{A1.8}$$

Similarly, from (A1.3) and (A1.4) we get the equilibrium solution for the credit market:

$$l_t = \varphi_0 + \underset{(-)}{\varphi_1} \ln(D/P)_t + \underset{(+)}{\varphi_2} \ln(D/P)_t z_{it} + \underset{(+)}{\varphi_3} \ln y_t + \underset{(?)}{\varphi_4}\pi_t + \underset{(+)}{\varphi_5} i_t \tag{A1.9}$$

$$\ln(C/P)_t = \rho_0 + \underset{(+)}{\rho_1} \ln(D/P)_t + \underset{(-)}{\rho_2} \ln(D/P)_t z_{it} + \underset{(+)}{\rho_3} \ln y_t + \underset{(-)}{\rho_4}\pi_t + \underset{(?)}{\rho_5} i_t \tag{A1.10}$$

where

$$\varphi_0 = \frac{\alpha_0 - \lambda_0}{\lambda_3 - \alpha_3}; \quad \varphi_1 = \underset{(-)}{\frac{\alpha_1}{\lambda_3 - \alpha_3}}; \quad \varphi_2 = \underset{(+)}{\frac{\alpha_2}{\lambda_3 - \alpha_3}}$$

$$\varphi_3 = -\underset{(+)}{\frac{\lambda_1}{\lambda_3 - \alpha_3}}; \quad \varphi_4 = \underset{(?)}{\frac{\alpha_5 - \lambda_2}{\lambda_3 - \alpha_3}}; \quad \varphi_5 = \underset{(+)}{\frac{\alpha_4 - \lambda_4}{\lambda_3 - \alpha_3}} \tag{A1.11}$$

$$\rho_0 = \frac{\alpha_0\lambda_3 - \alpha_3\lambda_0}{\lambda_3 - \alpha_3}; \quad \rho_1 = \underset{(+)}{\frac{\alpha_1\lambda_3}{\lambda_3 - \alpha_3}}; \quad \rho_2 = \underset{(-)}{\frac{\alpha_2\lambda_3}{\lambda_3 - \alpha_3}}$$

$$\rho_3 = -\underset{(+)}{\frac{\alpha_3\lambda_1}{\lambda_3 - \alpha_3}}; \quad \rho_4 = \underset{(-)}{\frac{\alpha_5\lambda_3 - \alpha_3\lambda_2}{\lambda_3 - \alpha_3}}; \quad \rho_5 = \underset{(?)}{\frac{\alpha_4\lambda_3 - \alpha_3\lambda_4}{\lambda_3 - \alpha_3}} \tag{A1.12}$$

Finally substituting (A1.5) and (A1.6) into (A1.9) and (A1.10) we get the reduced form equations for l_t and $\ln(C/P)_t$. The reduced form for $\ln(C/P)_t$, which is equation (4.2) in the main text, reads as:

$$\begin{aligned}\ln(C/P)_t = {} & \theta_0 + \underset{(?)}{\theta_1} \ln y_t + \underset{(-)}{\theta_2} \ln y_t z_{it} + \underset{(?)}{\theta_3} r_t + \underset{(+)}{\theta_4} r_t z_{it} \\ & + \underset{(?)}{\theta_5} \pi_t + \underset{(+)}{\theta_6} \pi_t z_{it} + \underset{(?)}{\theta_7} \ln(R/P)_t + \underset{(-)}{\theta_8} \ln(R/P)_t z_{it} + \underset{(?)}{\theta_9} z_{it}\end{aligned} \tag{A1.13}$$

where

$$\theta_1 = \rho_1\delta_2 + \rho_3 + \rho_5\mu_2 = \frac{-\alpha_1\lambda_3\beta_1\gamma_3 - \lambda_1\alpha_3(\beta_3 - \gamma_3) - \beta_1(\alpha_4\lambda_3 - \alpha_3\lambda_4)}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{A.14}$$

$$\theta_2 = \rho_2\delta_2 = -\frac{\alpha_2\lambda_3\beta_1\gamma_3}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{A1.15}$$

$$\theta_3 = \rho_1\delta_4 + \rho_5\mu_4 = \frac{\alpha_1\lambda_3\beta_3\gamma_4 + (\alpha_4\lambda_3 - \alpha_3\lambda_4)\gamma_4}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{A1.16}$$

$$\theta_4 = \rho_2\delta_4 = \frac{\alpha_2\lambda_3\beta_3\gamma_4}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \tag{A1.17}$$

$$\theta_5 = \rho_1\delta_3 + \rho_4 + \rho_5\mu_3 = \frac{-\alpha_1\lambda_3\beta_2\gamma_3 + (\beta_3 - \gamma_3)(\alpha_5\lambda_3 - \alpha_3\lambda_2) - \beta_2(\alpha_4\lambda_3 - \alpha_3\lambda_4)}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \quad \text{(A1.18)}$$

$$\theta_6 = \rho_2\delta_3 = \frac{-\alpha_2\lambda_3\beta_2\gamma_3}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \quad \text{(A1.19)}$$

$$\theta_7 = \rho_1\delta_1 + \rho_5\mu_1 = \frac{\alpha_1\lambda_3\beta_3\gamma_1 + \gamma_1(\alpha_4\lambda_3 - \alpha_3\lambda_4)}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \quad \text{(A1.20)}$$

$$\theta_8 = \rho_2\delta_1 = \frac{\alpha_2\lambda_3\beta_3\gamma_1}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \quad \text{(A1.21)}$$

$$\theta_9 = \rho_2\delta_0 = \frac{\alpha_2\lambda_3(\gamma_0\beta_3 - \beta_0\gamma_3)}{(\lambda_3 - \alpha_3)(\beta_3 - \gamma_3)} \quad \text{(A1.22)}$$

Appendix 2 – Empirical results of the reduced form approach

For comparison purposes in this appendix we report the main results obtained under the so-called reduced form approach. We basically estimate equation (4.2) (imposing $\theta_7 = \theta_8 = 0$) and (4.6) in levels and a dynamic version of these two equations after differencing the variables to account for non-stationarity.

The estimated equations in levels read as:

$$\ln(C/P)_t = \theta_0 + \underset{(?)}{\theta_1 \ln y_t} + \underset{(-)}{\theta_2 \ln y_t z_{it}} + \underset{(?)}{\theta_3\pi_t} + \underset{(+)}{\theta_4\pi_t z_{it}} + \underset{(?)}{\theta_5 r_t} + \underset{(+)}{\theta_6 r_t z_{it}} + \theta_7 z_{it} \quad \text{(A2.1)}$$

$$\ln(C/P)_t = \theta_0 + \underset{(+)}{\theta_1 \ln y_t} + \underset{(-)}{\theta_2\pi_t} + \underset{(+)}{\theta_3 \ln(D/P)_t} + \underset{(-)}{\theta_4 \ln(D/P)_t z_t} + \underset{(?)}{\theta_5 i_t} \quad \text{(A2.2)}$$

where r_t in (A2.1) stands for the three month interbank money market interest rate as a measure of the central bank monetary policy interest rate and i_t in (A2.2) stands for the bond market interest rate.

Table 7 bellow records the main results for these two equations using the PFMOLS estimator. We note that the expected sign of the coefficients of the variables $\ln y_t$ and π_t in (A2.1) and (A2.2) may differ, so that, for instance, while a negative coefficient of $\ln y_t$

is possible in (A2.1) it is not acceptable in (A2.2). Similarly for the inflation variable $_t$. We also note that all the estimated equations in Table 7 are valid cointegrating equations, as the null of non-cointegration is strongly rejected according to the cointegration tests referred to in the main text.

Table 7

PFMOLS estimates of equations (A2.1) and (A2.2)

	Model (A2.1)			Model (A2.2)		
	Size (1)	Liquidity (2)	Capitalisation (3)	Size (4)	Liquidity (5)	Capitalisation (6)
$\ln y_t$	0.314 (0.63)	0.295 (0.38)	0.314 (0.55)	0.226 (0.47)	0.090 (0.18)	0.117 (0.20)
$\ln y_t z_{it}$	0.933 (3.26)	-1.007 (-0.16)	-62.636 (-8.25)			
π_t	-5.618 (-4.63)	-0.219 (-0.12)	-5.618 (-4.09)	-2.03 (-1.61)	2.783 (2.10)	1.168 (0.84)
$\pi_t z_{it}$	0.912 (1.28)	-215.71 (-13.39)	-81.044 (-4.47)			
r_t	-0.445 (-0.64)	-3.051 (-2.76)	-0.445 (-0.56)			
$r_t z_{it}$	-0.130 (-0.31)	252.39 (23.20)	-22.847 (-1.90)			
$\ln(D/P)$				0.283 (6.30)	0.716 (20.78)	0.705 (26.27)
$\ln(D/P) z_{it}$				0.026 (1.50)	0.043 (0.97)	-0.699 (-6.39)
i_t				-1.936 (-2.13)	-1.790 (-1.85)	-2.963 (-2.94)
z_{it}	-6.813 (-2.87)	-8.221 (-0.15)	515.293 (8.20)	0.531 (8.86)	-1.732 (-11.05)	-0.548 (-1.62)

Legend: i_t is the interest rate on bonds; for the remaining variables see Table 5

Looking first to the results of equation (A2.1) we conclude that the reduced form approach does not allow us to draw any interesting conclusion on the existence of the bank-lending channel. In fact only for the model in column 2, i.e., model with liquidity as the interaction variable, is the coefficient of the interaction term significantly different from zero and positive (with the coefficient of r_t significantly negative). However, in this equation the coefficient of the interaction term $\pi_t z_{it}$ is wrong-signed casting strong doubts on any conclusion drawn from such a model.

For equation (A2.2), which as explained in the main text is obtained under the assumption that deposits and the bond interest rate are exogenous at the bank level, we note that the coefficient of deposits is significantly different from zero in the three columns (4), (5) and (6), but that the coefficient of the interaction term is significantly different from zero (and correctly signed) only in the equation with the capitalisation indicator. So, the reduced form approach assuming deposits as exogenous allow us to draw the same conclusion as the "structural" approach followed in the main text, i.e., there is evidence of the existence of the lending channel (the coefficient of deposits is significantly different from zero and positive) and the importance of the lending channel is larger for the less capitalised banks. We note however that this approach implicitly assumes loan supply interest rate homogeneity, which as explained in the main text may be seen as a restrictive assumption if the aim is to compare the importance of the credit channel for different banks.

The dynamic version of equation (4.2) or (A2.1) (without bank reserves) is obtained taking one lag of each regressor after differencing to allow for data non-stationarity and reads as:

$$\begin{aligned}\Delta \ln C_t = {} & \alpha_{0i} + \alpha_1 \Delta \ln C_{t-1} + \sum_{j=0}^{1} \beta_j \Delta \ln y_{t-j} + \sum_{j=0}^{1} \gamma_j \Delta \ln y_{t-j} z_{it-1} \\ & + \sum_{j=0}^{1} \delta_j \pi_{t-j} + \sum_{j=0}^{1} \varphi_j \pi_{t-j} z_{it-1} + \sum_{j=0}^{1} \mu_j \Delta r_{t-j} + \sum_{j=0}^{1} \lambda_j \Delta r_{t-j} z_{it-1} + \theta z_{it-1}\end{aligned} \tag{A2.3}$$

From an econometric point of view estimating a model in first differences may be optimal if the variables in levels are not cointegrated or if the time dimension of the panel is not large enough to allow the panel cointegration approach.

Given the inclusion of lags of the dependent variable model (A2.3) was estimated using the GMM estimator as suggested by Arellano and Bond (1991) [39]. This method ensures efficiency and consistency of the estimators provide the instruments are adequately defined to take into account the serial correlation properties of the residuals. Briefly, this estimator is obtained by taking first differences of model (A2.3) and

[39] To implement the GMM we have used the DPD98 for Gauss. We also tried to estimate model (A2.3) with more lags of each variable, but for these cases it was not possible to obtain the GMM estimator.

estimating the resulting model by instrumental variables. As instruments we used lags 2 and 3 of the second difference of the log of loans, lag 2 of the first difference of the bank characteristics and lag 2 of the first difference of the interaction terms $\Delta r_t z_{it-1}$ and $\Delta r_{t-1} z_{it-1}$. The macroeconomic variables ($\ln y_t$ and π_t and r_t) were assumed exogenous. The adequacy of the instruments was tested with the autocorrelations test AR(1) and AR(2), which test for the first and second order autocorrelation in the residuals, and the Sargan test, which tests the independence of the instruments and the residuals.

For the GMM results, in Table 8, we conclude that the coefficients of Δr_t and Δr_{t-1} for models with size and liquidity are not statistically different from zero and so no interesting conclusion can be drawn. For the equation with capitalisation these coefficients are marginally significant but on the other hand the coefficients of the interaction terms are wrong signed (even though non significant), so that also in this case no interesting conclusion can be drawn. Furthermore, it turns out that most of the coefficients in the three equations estimated by GMM appear as statistically non different from zero.

For comparison purposes Table 8 also reports the results of the conventional Within estimator, which, as it is well known, under this framework does not ensure consistency of the estimators. However in all the three models the estimates for the coefficient of Δr_t and Δr_{t-1} are not statistically different from zero.

Table 9 reports the results for the dynamic equation:

$$\begin{aligned}\Delta \ln C_t = \alpha_{0i} + \alpha_1 \Delta \ln C_{t-1} + \sum_{j=0}^{1} \beta_j \Delta \ln y_{t-j} + \sum_{j=0}^{1} \gamma_j \pi_{t-j} \\ + \sum_{j=0}^{1} \delta_j \Delta \ln D_{t-j} + \sum_{j=0}^{1} \mu_j \Delta \ln D_{t-j} z_{it-1} + \sum_{j=0}^{1} \lambda_j \Delta i_{t-j} + \theta z_{it-1}\end{aligned} \tag{A2.4}$$

which should be seen as the dynamic version of equation (A2.2). Once again in the case of the GMM estimator almost none of the estimated coefficients appear to be significantly different from zero.

Finally, for the results obtained with the Within estimator we note that the coefficients of $\Delta \ln D_{t-j}$ have the correct sign, but the coefficients of $\Delta \ln D_{t-j} z_{it-1}$ are not significantly different from zero.

Table 8

GMM and Within estimates of equation (A2.3)

	Size		Liquidity		Capitalisation	
	Within (1)	GMM (2)	Within (3)	GMM (4)	Within (5)	GMM (6)
$\Delta \ln C_{t-1}$	-0.084 (-1.39)	-0.165 (-1.24)	-0.050 (-0.73)	0.429 (0.43)	-0.095 (-1.50)	-0.034 (-0.43)
$\Delta \ln y_t$	0.460 (0.64)	0.110 (0.09)	0.056 (0.07)	6.922 (0.77)	0.478 (0.66)	0.166 (0.17)
$\Delta \ln y_{t-1}$	1.027 (1.53)	0.312 (0.34)	0.804 (1.02)	13.107 (0.68)	1.049 (1.60)	0.412 (0.48)
$\Delta \ln y_t z_{t-1}$	-0.124 (-0.28)	-2.402 (-1.03)	-9.398 (-0.74)	-147.012 (-1.09)	4.253 (0.37)	36.997 (1.71)
$\Delta \ln y_{t-1} z_{t-1}$	-0.382 (-1.01)	-1.085 (-0.73)	-12.810 (-1.50)	-34.400 (-0.29)	12.500 (1.23)	12.335 (0.81)
π_t	-0.713 (-0.89)	-0.64 (-0.24)	-0.95 (-1.19)	2.197 (0.55)	-0.715 (-0.90)	-0.740 (-0.39)
π_{t-1}	1.474 (1.85)	2.682 (1.74)	1.583 (1.90)	-5.850 (-0.66)	1.489 (1.88)	2.733 (2.11)
$\pi_t z_{t-1}$	0.618 (1.41)	-4.909 (-1.25)	-0.607 (0.07)	-581.654 (-0.59)	-4.228 (-0.39)	89.994 (2.17)
$\pi_{t-1} z_{t-1}$	-0.888 (-2.03)	-3.472 (-1.67)	1.009 (0.12)	293.158 (0.52)	8.573 (0.78)	-11.589 (-0.42)
Δr_t	-0.561 (-0.92)	-2.045 (-0.82)	-0.499 (0.90)	-5.196 (-0.52)	-0.564 (-0.91)	-1.915 (-1.80)
Δr_{t-1}	-0.590 (-0.76)	-2.220 (-1.16)	-0.600 (-0.79)	-4.994 (-0.57)	-0.607 (-0.81)	-2.122 (-1.78)
$\Delta r_t z_{t-1}$	0.368 (1.05)	7.209 (1.82)	21.407 (1.65)	-313.126 (-0.44)	4.096 (0.46)	-25.099 (0.53)
$\Delta r_{t-1} z_{t-1}$	-0.039 (-0.09)	4.491 (1.52)	15.269 (1.19)	-283.745 (-0.45)	-10.747 (-1.62)	-2.121 (-0.05)
z_{t-1}	-0.060 (-1.50)	0.877 (1.69)	0.263 (0.93)	14.464 (0.75)	3.937 (0.31)	-4.403 (-1.47)
AR1 (p-value)		0.02		0.45		0.02
AR2 (p-value)		0.50		0.67		0.89
Sargan(p-value)		0.21		0.94		1.00

Table 9

GMM and Within estimates of equation (A2.4)

	Size		Liquidity		Capitalisation	
	Within (1)	GMM (2)	Within (3)	GMM (4)	Within (5)	GMM (6)
$\Delta \ln C_{t-1}$	-0.110 (-1.49)	-0.283 (-1.33)	-0.127 (-1.66)	-0.075 (-0.92)	-0.125 (-1.74)	-0.050 (-0.64)
$\Delta \ln y_t$	0.162 (0.27)	0.685 (0.47)	-0.025 (-0.04)	0.399 (0.54)	0.143 (0.23)	0.503 (0.61)
$\Delta \ln y_{t-1}$	0.753 (1.27)	-0.808 (-0.54)	0.696 (1.12)	0.747 (0.96)	0.850 (1.41)	0.350 (0.74)
π_t	-0.350 (-0.43)	3.048 (0.60)	-0.508 (-0.61)	-0.717 (-0.46)	-0.423 (-0.53)	-0.422 (-0.31)
π_{t-1}	0895 (1.10)	-1.635 (-0.35)	0.974 (1.14)	2.166 (1.14)	0.964 (1.20)	1.501 (1.02)
$\Delta \ln D_t$	0.088 (1.22)	-1.922 (-0.96)	0.123 (2.80)	0.224 (0.86)	0.088 (1.92)	-0.021 (-0.07)
$\Delta \ln D_{t-1}$	0.086 (1.29)	-0.698 (-0.89)	0.029 (0.72)	-0.046 (-0.52)	0.29 (0.75)	-0.100 (-0.66)
$\Delta \ln D_t z_{t-1}$	-0.014 (-0.43)	-0.948 (-0.92)	-0.006 (-0.02)	2.697 (1.88)	0.709 (1.50)	0.453 (0.36)
$\Delta \ln D_{t-1} z_{t-1}$	0.038 (1.16)	-0.300 (-0.63)	0.097 (0.44)	1.852 (1.36)	-0.192 (-0.12)	-0.484 (-0.30)
Δi_t	0.002 (0.37)	-0.005 (-0.18)	0.003 (0.46)	0.009 (0.95)	0.002 (0.38)	-0.0004 (-0.03)
Δi_{t-1}	0.002 (0.25)	-0.008 (-0.27)	0.002 (0.22)	0.0002 (0.02)	0.001 (0.09)	-0.009 (-0.49)
z_{t-1}	-0.083 (-1.85)	1.126 (1.06)	0.053 (0.57)	-1.866 (-1.94)	0.516 (2.02)	-0.038 (-0.02)
AR1 (p-value)		0.16		0.04		0.02
AR2		0.81		0.37		0.83
Sargan (p-value)		0.71		0.40		0.27

Legend: i_t is the interest rate on bonds; for the remaining variables see Table 5

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