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Abstract: The different degree of development of retail payment systems generates significant differences in the structure and operations of the financial system. These differences affect the degree of efficiency of the mechanisms of monetary policy transmission, including the bank-lending channel. Taking the case of Spain for 1992-2000, we show that banks appear to have taken advantage of the non-cash instruments to increase deposits and, therefore, to adjust their loan supply in the face of monetary policy tightening (76 words).

Key words: non-cash payments, monetary policy transmission, bank lending channel
JEL codes: E51, G21, O33

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1. Introduction.

The structure and development of financial and payment systems are likely to affect monetary policy transmission. Previous studies have provided evidence that the effects of monetary policy transmission –mainly, through the bank-lending channel-, differ when banks present different sizes, capitalization or liquidity (Kashyap and Stein, 2000, Kishan and Opiela, 2000)[1]. However, very few studies have looked at the impact of payment systems development on the mechanisms of monetary policy transmission. This issue may be particularly important in the creation of single currency areas, such as the European Monetary Union (EMU). In the case of EMU, the implementation of TARGET and the design of a new platform known as TARGET2 has produced a true unified large payment system. However, there still are many differences in the retail payment area (European Central Bank, 2003).

The disparities of retail payments across the countries of Eurosystem affects the degree of efficiency with which the mechanisms of monetary policy are transmitted. Both cash and non-cash instruments are used by consumer and business to facilitate the purchase of goods and services. Consumers hold an inventory of cash which is drawn down over time to make purchases, businesses hold cash to make change for cash purchases, and banks hold vault cash for re-supplying these inventories either through ATMs or at branch offices. These cash holdings, part of which are the reserves required by the central bank, are not available for banks to make loans or purchase securities since they are employed in the daily liquidity payments (i.e. deposit withdrawals). In the loan context, these cash holdings are an "idle asset" in the banking system. In contrast, non-cash payment instruments -debit and credit cards, direct debits, credit transfers- are a substitute method for making payments by consumers and businesses but the assets they debit are not idle –they are held as deposits and used by banks to make loans or purchase securities. Other things being equal, as the share of

[1] The bank lending channel focuses on the possible effects of monetary policy actions on the supply of bank loans. It only works when deposits and bonds are imperfect substitutes in the balance sheet of banks. In this case, following a reduction in liquidity, banks cannot turn freely to the bond market, due the external finance premium. Then, they must reduce the amount of loans they supply and/or further increase the interest rate they charge for loans, thus amplifying the initial effects of the monetary policy tightening (Bernanke and Blinder, 1992).

payments shift from cash to non-cash instruments, loanable funds in the banking system rises. This affects monetary policy since the sensitivity of a given change in interest rates on the stock of loanable funds –and hence economic activity- can change (Drehmann, Goodhart and Krueger, 2002). While this occurs slowly over time and will typically be in the same direction –that is, it is unusual to see a significant shift away from non-cash instruments- it does mean that the sensitivity of economic activity to changes in monetary policy is not stable but is a function of the development of the payment system. Such a modification of the operability of the bank lending channel necessarily influences the design and effectiveness of monetary policy (Bernanke and Blinder, 1992; Bernanke and Gertler, 1995). For this reason the ECB, in establishing its strategy of monetary policy, must carefully assess to what extent the banks operating in each member country have taken advantage of the development of payment systems —not only to improve payment services, but also to keep the clients´ financial needs covered, even when the measures adopted are meant to reduce lending.

These matters are the focus of the present article, with Spain as the laboratory where we undertake the empirical study. The reason why Spain is a good laboratory is twofold: 1) its strong roots in cash payments, despite the recent development of the electronic payment (European Central Bank, 2001); and 2) the high dependence of its economic agents on bank lending to finance the country´s growth (Bank of Spain, 2002).

Our analysis proceeds as follows. Section 2 offers a survey of previous evidence in the relevant literature on bank-lending channel. In Section 3 a theoretical model is then developed to show how the evolution of the retail payment system can modify deposit demand behaviour and bank loan supply. On the basis of these relationships, Section 4 describes the methodology used to estimate the magnitude of this impact over the period 1992-2000. In Section 5, the main results are presented, and finally the conclusions are drawn (Section 6).

2. Relevant background.

2.1. Bank-lending channel: Previous empirical evidence.

According to the theory of bank-lending channel, strict monetary conditions lead to an increase in market interest rates. The consequently higher cost of deposits —the main financial source of banks— can lead to a tightened bank loan supply (Bernanke and Blinder, 1988; Gertler, 1988; Kashyap and Stein, 1994). [1] The extent of this reduction will depend in part on: 1) the price elasticity of the money demand and, therefore, the balance-sheet structure of the financial institutions; and 2) the financial culture of users, as well as their habits in using the different payment instruments (Goodfried, 1995).

A number of indicators are used in the literature to approach the differential and distributive effects of monetary shocks on loan supply. Size is one of this indicators usually treated as a proxy of the magnitude of the costs of transactions, portfolio diversification, and the "too big to fail" hypothesis (Diamond, 1984; Kashyap and Stein, 1995)[2]. In this sense, it is expected that the smaller entities, which are usually characterized by greater external financial premiums, are obliged to limit their loan supply at higher financial levels when faced with increased funding costs (Kashyap and Stein, 2000).

Another widely used indicator is bank capitalisation. According to the theory of asymmetric information, banks with lower debt levels face an external financial premium that is inferior to those with higher financial leverage, which implies a reduced sensitivity of their loan supply when there are variations in interest rates (Stein, 1988). Likewise, the degree of liquidity can play a key role in the loan reaction of banks under changes in the intensity of monetary policy. When loan supplies tighten,

[2] The existence of the bank-lending channel requires two conditions that are necessary, but not sufficient (Bernanke and Blinder, 1988): 1) the non-fulfilment by the different economic agents of the proposition of irrelevance of the Modigliani-Miller structure of capital; and 2) the monetary policy measures adopted by the Central Bank affect banks loan supply. Some argue that these conditions are questionable for two reasons. Firstly, the loss of deposits can be compensated by other liabilities, such as CD´s (Goodfriend, 1995). Secondly, variation in the interest rate on liabilities set by banking institutions do not necessarily coincide with those of monetary policy interest rate. Moreover, the second assumption does not include the underlying aspects of the adjustment of interest rates issues on deposits when their availability is reduced (Hernando and Martínez-Pagés, 2003). In this sense, it is important to take into account that the development of non-cash payment instruments allows the potential increase of deposits even when rates go up (Paroush and Ruthenberg, 1986) It can also alters the degree of transfer of variations in the market interest rates upon bank deposits, as a consequence of the clients´ convenience for the payment services received (Sellon, 2002) .

financial intermediaries can sell their liquid assets to re-establish the initial conditions (Kashyap and Stein, 2000).

In the literature there are several European studies that challenge the validity of this hypothesis[3]. For instance, Favero, Giavazzi and Flabbi (1999) do not obtain favourable evidence of the bank- lending channel theory in their cross-sectional sample of German, Italian and Spanish banks in 1992. However, they demonstrate the existence of notable differences in the means through which the financial institutions of each country try to maintain their loan supply in times of monetary tightening. Whereas the smaller institutions of these three countries resort to attracting new deposits, the French banks use the "buffer" of capital. More recently, and using panel data, Altunbas, Fazylov and Molyneux (2002) study loan behaviour in the European Monetary Union to show that, in general, the loan supply of the least capitalized banks is more sensitive to variations in market rates. They also find favourable evidence for the lending channel among the less solvent banks operating in the smallest countries of the European Union. By country, it appears that the validity of the bank-lending channel is only confirmed for Spain and Italy.

Ehrmann, Gambacorta, Martínez-Pagés, Sevestre and Worms (2003) demonstrate that an increase in the monetary policy interest generates a substantial tightening in the bank loan supply within the EMU. These authors point out that, unlike in the United States, the differences in size or in the degree of capitalization do not give rise to significant distributive effects in the European context. Among the factors behind this finding appear to be the relatively minor problems of asymmetric information because of greater government control, the presence of bank networks, the low number of bank crises, and other aspects such as the degree of integration of the financial markets or the intensification of competition (Cottarelli and Kourelis, 1994; Fase and de Bondt, 2000; Sellon 2002). Distinguishing by country, Ehrmann, Gambacorta, Martínez-Pagés, Sevestre and Worms (2003) indicate that size - understood as a proxy of the degree of informational asymmetries- plays a significant role only in the

[3] Most of these studies rely on statistics from the international database Bankscope, which suffers from important deficiencies in comparison with the statistical series provided by national Central Banks (Ehrmann, Gambacorta, Martínez-Pagés, Sevestre and Worms, 2003; Hernando and Martínez–Pagés, 2003).

case of Spain. In these studies the level of capitalization does not appears to be relevant, but liquidity gives rise to distributive effects in Italy, Germany and Spain.

2.2. Recent trends in European payment systems and their relevance in the bank- lending channel.

In consonance with the rest of the European countries, the Spanish payment system have experimented a sharp transformation as a consequence of the incorporation of technological developments applied to banking activities. The intensification of competition and the continuous fall of the interest rates have narrowed the different income margins, which has led banking intermediaries to reconsider their operative strategies. For this reason banks have opted to expand their traditional activity of intermediation, that is, the development of financial innovations through off-balance sheet operations, and improve operative efficiency. Branches have been replaced by ATMs, and non-cash payment instruments have become widespread; and the lower cost and higher convenience of electronic instruments is changing the configuration of the payment system.

In recent years, the traditionally higher use of cash in payments in Spain has been compatible with certain modernization of payment habits. However, there still are some differences with some of the most advanced national payment systems of EMU. Over the period 1992-2000, the cash used for transactions –proxied by the value of banknotes and coins as a percentage of GDP- was greater in Spain than in EMU (Table 1). Although Spain relies relatively heavily on cash to make payments compared to EMU countries, the cash use has apparently fallen more markedly in Spain. As a result, the growth rate of non-cash payment instruments is clearly higher in Spain (47.23%) than in EMU (19.14%) over 1992-2000[4].

As far as banking activities are concerned, loans (as a percentage of GDP) grew in Spain at a higher rate than in EMU (72 and 35%, respectively during 1992-2000). The growth of the deposit base

[4] If, instead of looking at the values, we look at the number of transactions, the differences shown by Spain with regard to EMU are not so large, which shows that the average value of the transactions with the electronic payments in Spain is comparatively lower. Therefore, these instruments are largely diffused in Spain but they have not reached, quantitatively, the degree of development (in total value) evidenced in the EMU.

(as a percentage of GDP) was lower in Spain (31%) than in EMU (38%). This increase in bank business has been compatible with a fall in the average operating cost per asset during the sample period: -37% for Spain and –15% for EMU. The reduction in operating costs has been mainly motivated by the more intensive use of ATMs and electronic payments.

A tentative hypothesis from these trends may be that the development of the Spain´s retail payment system has contributed to increasing banks´ deposit base, and thereby to expanding their loan supply, even when monetary tightening takes place. Nonetheless, it is necessary to develop a theoretical model and undertake empirical estimations in which these relationships can be studied more accurately.

3. A theoretical model.

We now describe a model in which the evolution of the retail payment system alters the distributive effects of the monetary policy channels through banking institutions. That is, we study the extent to which the diffusion and use of the ATMs and the retail payment instruments have influenced the response of the loan supply and the deposit demand to changes in monetary policy and market interest rates. Departing from the model specified by Peek and Rosengren (1995), we incorporate: 1) the potentially expansive effect of the diffusion of non-cash payments and the use of the ATMs upon bank deposits, and finally upon their bank loan supply; 2) banks´ reliance on the interbank market for the necessary resources to resolve restrictions of liquidity deriving from a tightening of monetary conditions; and 3) the costs associated with the development of this activity.

We present a model of a representative bank *i* in period *t*. This bank is assumed to have three assets; required reserves (*rr*), liquid assets (*liq*) and loans (*loan*); and three liabilities, net interbank deposits (*dd*), deposits funding (*dep*) and capital (*cap*); The balance sheet constraints require:

$$rr + liq + loan = dd + dep + cap \tag{1}$$

dd are assumed to be inversely related to the market interest rate (i_0):

$$dd = a_0 - (a_1)i_0 \tag{2}$$

A bank is assumed to have market power in the *dep* market, and can, therefore, raise *dep* by raising its rate (i_{DEP}) above the mean market rate (i^*_{DEP}). The deposits base also increases with the value of transactions with non-cash instruments (*pay*). This results both from the increase of the opportunity cost of holding cash – in a context of expansion of interest-bearing and highly liquid deposit accounts-, and the greater convenience that the consumers experienced regarding the use of non-cash instruments (Paroush and Ruthenberg, 1986; Schneider, 1986; Zilberfarb, 1989). Thus:

$$dep = b_0 + (b_1)(i_{DEP} - i^*_{DEP}) + (b_2)pay \tag{3}$$

In agreement with the most recent developments in monetary theory (Humphrey, Kaloudis and Owre, 2004), the value attained by *pay* depends positively on the income level (*gdp*) and prices (*cpi*), as well as on average market deposit rate (i^*_{DEP}), that is:

$$pay = c_0 + (c_1)gdp + (c_2)cpi + (c_3)i^*_{DEP} \tag{4}$$

Banks hold a fraction (α) of *dd* in liquid reserves *rr* to face daily operations and fulfil requirements established by supervisory authorities, by which:

$$rr = \alpha dd \tag{5}$$

Given this restriction and assuming that the liquid assets are proportional to *dd*, these would be given by:

$$liq = d_0 + (d_1)dd - rr \tag{6}$$

Banks´ loan supply would depend on deposits funding, and on the sale of liquid assets and/or resources from the interbank market when the former are insufficient. [5] The market for bank loans is assumed to be imperfectly competitive. Individual banks can increase (decrease) loans by moving their rates (i_{LOAN}) below (above) the mean market rate (i^*_{LOAN}). Consequently:

$$loan = e_0 + (e_1)dep + (e_2)liq + (e_3)dd - (e_4)(i_{LOAN} - i^*_{LOAN}) \tag{7}$$

[5] Credit may be understood from a traditional intermediation perspective (only loans) or alternatively in a wider sense, where the measure of credit includes loans plus loan commitments.

The mean market rates (i^*_{DEP}, i^*_{LOAN}, and i^*_{LIQ},) with spread are fixed after establishing an intermediation margin (ϕ_j) over the monetary policy interest rate (i_0): [6]

$$i^*_{DEP} = f_0 + \phi_1 i_0 \tag{8}$$

$$i^*_{LOAN} = g_0 + \phi_2 i_0 \tag{9}$$

$$i^*_{LIQ} = h_0 + \phi_3 i_0 \tag{10}$$

Banks are assumed to maximize profits (Π),

$$\Pi = loan(i_{LOAN} - \Phi) + liq \cdot\ i_{LIQ} - dd \cdot\ i_0 - dep \cdot\ i_{DEP} - C \tag{11}$$

Profits include the interest income on loans ($loan \cdot i_{LOAN}$) net of loan loses ($\Phi \cdot loan$), and the interest on liquid assets ($liq \cdot i_{LIQ}$), minus the interest paid on interbank market ($dd \cdot i_0$), and non-bank deposits ($dep \cdot i_{DEP}$), and minus operating costs (C).

Equation (11) is maximized with respect to *dep* after eliminating *rr*, *dep*, *loan*, *liq*, i_{DEP} and i_{LOAN}. The first-order conditions are used to solve for *dep*. The same process is employed to solve for *loan* and *liq*. Testable hypothesis derived of bank lending channel theory can be obtained by taking the derivates of eliminating *loan*, *dep* and *liq* equation with respect to the monetary policy interest rate.

$$\frac{\partial loan}{\partial i_0} = e_1\phi_1\left(b_2c_3 - 1\right) + \alpha a_1\left(e_2d_1 - e_3\right) + e_4\phi_2 \tag{12}$$

$$\frac{\partial dep}{\partial i_0} = \phi_1\left(b_2c_3 - b_1\right) \tag{13}$$

$$\frac{\partial liq}{\partial i_0} = -\alpha d_1 a_1 \tag{14}$$

From equation (12), we deduce that the change in the monetary policy interest rate on a bank´s loan rate will be greater when: 1) the market power is lower, and 2) the volume of deposits employed in withdrawal from ATMs, credit card payments and liquidation of transactions by giro is greater. The magnitude of the latter will depend on the cost of opportunity of the deposits immobilized by this

[6] Unlike Kishan and Opiela (2000), we do not assume the margin set for the market rate on loans, deposits and

concept. The same happens if the resource to the interbank market to obtain liquidity is considerable, and its degree of response is high when faced with changes in the monetary policy interest rate. The magnitude of the impact will depend on the requirements of liquid reserves to which the bank is subject.

As expected (equation 13), an increase in the market rate on the part of the Central Bank has a negative impact on the bank´s profits, and even more so when: 1) the bank market power is lower; and 2) the opportunity cost for users of bank services to hold balances for payment purposes is higher.

Consequently, and based on the results obtained for a representative bank (equations 12 to 14), we find that the greater value of the operations using non-cash instruments, the lower the tightening of the loan supply. At the same time, the bank-lending channel theory indicates the degree to which these distributive effects are manifested will also depend on the size of the bank, the proxy variable of the market power, and the degree of solvency and liquidity.

4. Empirical approximation and data.

4.1. Specification and definition of variables.

The general equation to be estimated is given by: [7]

$$\Delta \log L_{it} = \alpha_i + \sum_{j=1}^{4} \beta_j \Delta \log L_{i(t-j)} + \sum_{j=1}^{4} \chi_j \left(bc_{i(t-j)} \cdot \Delta mpi_{t-j} \right) + \\ + \sum_{j=0}^{4} \delta_j \Delta mpi_{(t-j)} + \sum_{j=0}^{4} \phi_j \Delta z_{i(t-j)} + \varphi \Delta pay + \gamma \Delta pay \cdot bc_{it} + d_t + \varepsilon_{it} \qquad (15)$$

where, *L* shows means of loan supply; *mpi* represents the interest rate indicator of monetary policy; *bc* is a vector denoting the bank characteristics considered; *z* is the matrix of macroeconomic

liquid assets to be the same, as the costs of each activity may differ.

[7] Although the use of these specifications to reflect variation over time may be preferable to the VAR model and cross-section estimation, they have their limitations as well, and results must always be interpreted with care (Bond, 2002). Firstly, they do not permit a perfect identification of the relevant structural parameters that confirm the validity of the bank-lending channel as specified by Bernanke and Blinder (1988). Furthermore, a bias may be introduced by using variables with a solely temporal dimension, fundamentally the macroeconomic variables. Finally, by considering the variables in first differences, it is not possible to take into account possible relations of balance items derived from the theoretical model.

variables; *pay* shows a proxy of the development of the payment system at each point in time *t*; and Δ, *d* and ε are respectively identified as the operator difference, the vector of dummy time variables, and the error term. Finally, α symbolizes the fixed specific effect of each entity *i* [8].

Given the limitations of the public information, the definitions used for *L* are loans (*loan*), and "loans plus loan commitments" (*loancom*). [9] By including the latter, we have: 1) the "buffering effect" of the loan commitments, which can neutralize the contraction of the traditional loans supply (Morgan, 1998); and 2) the impact of product financial innovation on the bank loan supply. The indicator of monetary policy used was the three-month interbank interest rate (Kashyap and Stein, 2000; Kishan and Opiela, 2000).

We also consider the size, the degree of capitalization and liquidity of the banks. All bank-specific variables are demeaned which results in the sum of all included observations being equal to zero. This guarantees that the χ´s in (15) are not influenced by the level effect of Δ*mpi* on ΔL_{it} , and can be directly interpreted as the average monetary policy effects (Worms, 2003).

Size (*ta*) is defined as the difference between the value of the total assets (*A*) of each bank *i* in period *t*, and the mean value for each one of the periods of observation corresponding to the set of banks comprising the sample, that is:

$$ta_{it} = \log A_{it} - \left[1/N \sum_{i=1}^{N} A_{it} \right] \tag{16}$$

This process removes unwanted trends in size (namely, those trends resulting from the fact that size is measured in nominal terms).

The proxy variables of the degree of capitalization and liquidity are determined- as they are defined in ratios- by subtracting from the value of each observation the arithmetic mean of the total

[8] In order to obtain a random walk, four lags were incorporated; this number was found to minimize residuals, after trials with 1 to 12 lags. Since these variables are non-stationary, as verified by the Dickey Fuller test, they are considered in first differences.
[9] The public information available does not disaggregate between different types of lending.

sample. In this way, its variability is guaranteed over time. Hence, the variable degree of capitalization (*cap*) is defined as:

$$cap_{it} = K_{it} / A_{it} - \left[1/T \sum_{t=1}^{T} 1/N \sum_{i=1}^{N} K_{it} / A_{it} \right] \quad (17)$$

where *K* means the sum of Tier 1 and Tier 2 regulatory capital.

The variable of degree of liquidity (*liq*) is constructed similarly, representing the relative weight of the liquid assets (*LA*) in terms of total assets:

$$liq_{it} = LA_{it} / A_{it} - \left[1/T \sum_{t=1}^{T} 1/N \sum_{i=1}^{N} LA_{it} / A_{it} \right] \quad (18)$$

Our definition of *liq* is given by the sum of cash and deposits in Central Banks, net interbank deposits, Government bonds and other securities, divided by total assets.

The macroeconomic variables included in matrix *z* have been selected attending to their relevance for the loan demand (Fase, 1995). These variables are the logarithm of Gross Domestic Product (*gdp*), Consumer Price Index (*cpi*) and the level of risk assumed at bank level (*risk*), all expressed in bank-specific terms. This mean that, the *gdp* variable is defined as the weighted GDP of different regions of Spain *k* (*Comunidades Autónomas*) where the bank operates. The weighting factor is the number of branches each bank has in each region (S^k) with respect to its total network of branches (*S*); that is: [10,11]

$$gdp_{it} = \sum_{k=1}^{18} \left(S_{it}^{k} / S_{it} \cdot gdp_{t}^{k} \right) \quad (19)$$

Similarly, the Consumer Price Index, *cpi*, is given by:

$$cpi_{it} = \sum_{k=1}^{18} \left(S_{it}^{k} / S_{it} \cdot cpi_{t}^{k} \right) \quad (20)$$

[10] The regions considered are the 17 *Comunidades Autónomas* of Spain, and the two Spanish Territories in Africa (Ceuta and Melilla).

[11] By considering the map of regional information as a weight, we are able to reflect: 1) the diversity of economic, social and institutional conditions, determinant factors for the added value generated in the territories where they operate; 2) the response of the banks to the economic environment, as opening new branches is very often determined by economic dynamics rather than by strategic decisions (Jarayatne and Strahan, 1996).

Finally, the level of risk (*risk*) is given by the logarithm of the net provisions for risk and insolvency. [12] Although this indicator constitutes an *ex post* measure of risk, it stands as a good proxy of the level of risk of the bank, as it takes in both the materialized risk (via the component of reserves) and that anticipated (through provisions) (Ho and Saunders,1981; Borio, Furfine and Lowe, 2001). [13]

A priori, the signs of the long-term coefficients of the macroeconomic variables are ambiguous. The sign will be different if the "cash flow effect" dominates or if, alternatively, the "income effect" dominates in the short-run (Worms, 2003). For example, if the "cash flow effect" dominates, the coefficients of the lower order lags of *gdp* and *cpi* should be negative and positive respectively. In this case, a reduced income or a higher level of prices worsens the ability to finance expenditures internally and thereby leads to an increase in the demand for external finance. A similar argument can be employed with the risk variable. If the default risk of the loan portfolio increases, banks may increase loans in order to both enable firms to solve their liquidity problems and to meet a possible increase in loan demand. Therefore, the sign of the risk variable should be negative.

The expansive effect of the development of the retail non-cash payment system on deposit demand has been traditionally quantified by means of the number of credit cards issues, or the number of operations involving credit cards, giros or cheques. The use of these indicators may give rise to measurement errors since they do not represent development reached by the payment system but rather its diffusion and state (Viren, 1992). To solve this problem, the value of the operations with non-cash payment instruments (*noncashvalue*) is divided by the aggregate value of all payment (*allpayvalue*) – value of non-cash payments plus approximate value of cash payments-(Humphrey, 2004). [14]

[12] The public information available does not allow us to obtain *ex ante* measures of risk. Moreover, given that the values of these items can be negative, they are taken as absolute values. Once logarithms are applied, the previous sign is considered. In this way there is no loss of observations as a result of changes in the scale of the variable.

[13] Note that the inclusion of this variable may imply an underestimation of the possible effects of monetary policy on the bank loan supply through the terms of interaction. However, according to the literature, it is assumed that the impact of monetary policy on risk is less important than the influence of exogenous changes in the probability of credit default (Worms, 2003).

[14] We have estimated the value of cash as follows. From the Total Consumption reported in the National Accounts, we substract some items that are not paid by cash, which gives the point-of-sales value we use (POSsale). Subtracting the value of check, card and giro payments from POSsales gives an estimate of the value of cash payments at the retail side.

$$noncash = noncashvalue \Big/ allpayvalue \tag{21}$$

4.2. Methodology and data.

We estimate equation (15) employing dynamic panel data techniques. More specifically, we use the GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998), in view of its capacity to reduce inaccuracies and estimation bias, potentially resulting from the inclusion in the specification of lags of the dependent variable. This estimator is based on the simultaneous estimation of two equations. The first is the regression of equation (15) in differences, while the second refers to its estimation in levels. By applying both, we obtain consistent and efficient estimations provided that the instruments are adequate in terms of the properties of serial correlation of the model. Therefore, the instruments are, along with the lagged dependent variable (2 to 5 lags), the variables of the matrix *z* (1 to 5 lags), those relative to the bank characteristics (1 to 5 lags) and of the development of the payment system (1 lag), as well as those corresponding to the terms of interaction of the latter two groups of variables with the indicator of monetary policy (1 to 5 lags). [15]

It is assumed that the loan reaction of each bank depends lineally upon *bc*, which varies just as much from one bank to the next as it does over time. This linear dependence is accounted for by the terms of interaction $bc_{n,t-j} \cdot mpi$.[16] Then, under the assumption that the loan demand is homogeneous with respect to its interest rate elasticity for each bank, the interaction coefficient can be interpreted as the degree of heterogeneity of loan supply responses across banks. Moreover, by including *bc* we foresee the possible direct effects of this variable on the loan growth index *L*, already captured by the

[15] The instruments should be highly correlated with the variables for which they serve as instruments, while they should be uncorrelated with the disturbances. This can be assessed on the basic of autocorrelation (AR) tests and the Sargan test. In order to find the adequate lag length for the instrumental variables, every regression has been carried out several times, starting with lags 2 to 4 of the levels of the regression variables. Typically, a poorer instrumentalisation (for example, only lag 2, or lag 2 and 3) led to non-significant sum of coefficients of the lagged endogenous variables, which implies very large standard error of the long term coefficients of the other right-hand variables. In most cases, the AR test and the Sargan test pointed to an adequate instrumentalisation for a maximum 6 lags.

[16] In order to demonstrate the possible endogeneity between size, degree of liquidity or capitalization and the economic cycle indicators, specification (15) was estimated introducing additional terms combining each bank characteristic with *gdp* and *cpi*. The results are very similar, but they are not reported in this paper to simplify the

coefficients χ. In this way, the long-term coefficients (η) are given as the sum of the coefficients on the explanatory variable (Φ) divided by one minus the sum of the coefficients on the lagged dependent variable (β), that is:

$$\eta = \frac{\sum_{i=0}^{3} \Phi_i}{1 - \sum_{i=1}^{3} \beta_i} \tag{22}$$

These long term coefficients represent the distributive effects (differential impact) on loan supply, provided that the rest of the variables incorporated into the specification account adequately for the variations caused by the loan demand.[17] Hence, when the long-term estimated coefficients of the terms of interaction are not statistically different from zero, it cannot accepted that there exists a differentiated response on the part of the loan supply among the different banks.

Given the problems generated by the use of macroeconomic data in identifying variations in the loan supply caused by changes in monetary policy (Kashyap and Stein, 2000), we employed quarterly microeconomic data for the period 1992-2000.[18] As for the retail payment system variables, as there is no public information available for individual banks, we used aggregate data provided by the Blue Book of the ECB.[19] Their use is adequate because: 1) the objective of the present study is to analyse to what extent the development of the payment system has helped banks to expand their deposit demand, and in turn, their loan supply; and 2) there are important network economies in the payment area.

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analysis. Similarly the temporal variation was completely eliminated from the specification. The three variables (*mpi*, *gdp* y *cpi*) whose dimension is time-dependent are adequate for gathering the relevant temporal effects.

[17] The calculation of the long-term coefficients are employed for several reasons. First, they have a greater capacity of identification of trends. Secondly, their use avoids error in the interpretation of results due to the possibly alternating signs of the short-term coefficients with respect to the lag. Finally, their economic robustness and sensitivity are greater.

[18] This time horizon is especially interesting in view of the events taking place in the European context and within the Spanish economy. On top of the economic recession of 1992-1994, other big events were the liberalization of the movement of capital in 1993, the compromise by the European nations in 1996 to reach convergence in the main macroeconomic aggregates, the creation of the single currency, and intense financial innovation and liberalization. During this period the Spanish payment system also reached a high point in its development. Moreover, from this temporal horizon homogeneous information can be obtained on the balance and income statement of the banks and about the payment system.

[19] As the data provided by the ECB are annual, we generated quarter data by applying an ARIMA model (1,0,1) (Boeschoten, 1992).

The sample include 176 commercial and savings banks. Only the credit cooperatives and very small commercial banks were not included. In any event, the sample employed account for over 95 % of total assets of the banking sector in the period. Mergers were also empirical issue. We only report the results of this type of operation assuming that the bank merger is transferred to the start of the sample period by summing the balance-sheet items of the merging parties also for the time before the merger. This procedure restricts the individual effects of the merging banks to the same value over the entire observation period. This procedure is particularly adequate when banks merge in order to reduce costs by increasing size (Lang and Welzel, 1999; Carbó and Humphrey, 2004).[20]

5. Empirical evidence.

Equation (15) was estimated following the specifications defined in the above section.[21] We define the following models:

Model 1: *L=f (gdp, cpi, risk, mpi, noncash, mpi·ta, noncash·ta)*

Model 2: *L=f (gdp, cpi, risk, mpi, noncash, mpi·cap, noncash·cap)*

Model 3: *L=f (gdp, cpi, risk, mpi, pay, mpi·liq, noncash·liq)*

Model 4: *L=f (gdp, cpi, risk, mpi, pay, mpi·ta, mpi·cap, mpi·liq, noncash·ta, noncash·cap, noncash·liq)*

[20] We also treated mergers in alternative ways and the results were quite similar (not shown). The first alternative procedure is to eliminate merging banks after the merger. The resulting bank is considered as a newly created one (being completely independent of its predecessors). One implication of this procedure is that each of the merging banks is allowed to have its own individual effect, i.e. its own α (unobservable characteristic). Another implication is that the new bank is given its own individual effect, which may be different from the individual effects of one of the preceding bank or from the average of the preceding banks. This procedure is the adequate treatment of mergers if the main reason for the merger was to achieve scope economies, since different banks merge in order to broaden their spectrum of activities in order to realise advantages of combining these different characteristics. The second alternative ignores the existence of the bank merger, i.e. leaving the sample as it is. This may be adequate if the variables are defined as ratios rather than as stock or changes in stocks.

[21] Additionally, the analysis was undertaken for the deposit demand. The results show the impact of monetary tightening to be limited. The distributive effects appear not to be motivated by differences in size, or by the degree of solvency, but indeed by the degree of liquidity. Distinguishing between the different types of deposits, the results show that the growth of income has stimulated long-term deposits to a greater extent, although the impact of the rising market rates and the development of the payment system mainly influence short-term deposits.

As a consequence, the regression analysis was performed taking as the dependent variable *loan* and *loancom* (loans and loan commitments). In all cases, the pure effects of monetary policy and the development of the retail payment system are considered, as well as their distributive effects in terms of the definition of *bc*.[22] We have chosen to introduce the three main banks´ characteristics altogether: size, liquidity and capitalization. These characteristics are not independent from each other and including them separately in a model is likely to generate an omitted variable bias. The results corresponding to the long term coefficients of the complete model (Model 4) are shown in Table 2. In order to test the robustness of these results, the Appendix presents those relative to the Models 1 to 3. Table A1 (in the Appendix) displays the results when *loan* is employed as dependent variable, and Table A2 includes the results for *loancom* as dependent variable. [23,24]

As shown in Table 2, the development of the non-cash payments in Spain appears to have been utilised by banks to increase their deposit demand and, in turn, their supply of loans and of loan commitments. As for the narrow definition of credit, the results show that a 1 per cent increase in the non-cash payment indicator leads to an increase of around .212 per cent in loans for an average bank. The magnitude of this effect is slightly higher (.249) when the dependent variable is loans plus loans commitment). The higher use of low-cost electronic payments appear to have resulted in a larger base of intermediated resources. In this fashion, Spanish banks have taken advantage of the relative benefits in terms of cost, security and convenience of the ATM, credit card and giro use, enhancing at the same time the level of efficiency in channeling economic resources[25].

[22] Equation (15) is not estimated including a triple term of interaction made up of two bank characteristics and *noncash*, since in this case, we would not be employing adequate instruments (Arellano and Bond, 1991).

[23]In almost all of the following regressions the *p*-value of the Sargan test is lower than .2 . This is probably due to the comparatively large set of instrument variables used in the GMM estimations. Reducing the number of instruments generally produces unsatisfactory results, such as a negative sum of the coefficients of the control variables. Obviously, the dynamic structure of the model is relatively complex and can, therefore, only be adequately captured by a rich set of instruments Nevertheless, the AR test do not indicate a misspecification. The standard errors have been computed from heteroscedastic-consistent matrix (Robust-White procedure).

[24] The approach followed in models 1 to 4 is based on the assumption that we can capture the distributional effects of monetary policy according to the different bank-specific characteristics. In order to check the robustness of the direct effect of interest rate, *gdp*, prices and risk, we also estimate a second model without the interaction term (results not shown). In both cases the results are very similar.

[25] Although the higher use of ATMs for cash withdrawals initially tends to increase the use of cash, in the long run it reduces the inventory of cash needed to be idle (which, *ceteris paribus*, will expand loanable funds). This results from the fact that ATMs are more frequently visited to withdraw smaller amounts of cash than in the past when cash was only withdrawn from bank branches.

The impact of this development on the banking business depends largely on the structure of the bank's balance sheet. This impact can be observed through the analysis of the coefficients of interaction of the variable representing the development of non-cash payments in Spain, and for each of the bank characteristics. They show that the larger banks (having a greater proportion of liquid assets), followed by the most solvent banks, have benefited most from the evolution of the payment network to expand their loan supply. These are the banks that have widely developed their ATM networks, and liquidate and compensate the bulk of operations through electronic payment instruments.[26]

The increase in the cost of taking more interbank resources has a negative and significant effect on the growth of bank lending. Nonetheless, the magnitude of this coefficient shows that the effect of the tightening of monetary conditions for periods greater than one year does not appear to be relevant. [27] The limited magnitude of this impact (between .2 - .4 per cent by a 1 per cent increase in the monetary policy indicator) may be tentatively explained by the high level of debt of the Spanish families during the 1990s, and by the favourable environment of growth existing over that decade (Bank of Spain, 2002). When the endogenous variable is "loans plus loan commitments", the tightening is markedly more severe. These results suggest that the adjustment of loan demands, especially firms, occurs by resorting less to loan commitments, in light of the greater flexibility that this instrument presents compared with traditional lending (Saunders and Allen, 2004).

As for the impact of the macroeconomic context, as expected, the long term elasticity of the *gdp* is always positive and statistically significant. However, the income effect is more reduced when lending is analysed under a narrow perspective. The existence of such differences suggested that the economic

[26] We re-run the different regressions by substituting the non-cash payments indicator previously defined for the ratio "value of non-cash payment/(value of non-cash payments + value of cash withdrawals from ATMs)". In all cases, the results (not shown) are similar.

[27] The regression analysis was performed substituting the three-month interbank interest rate by the estimation of reaction function of the Central Bank, within a VAR-framework similar to Bernanke and Mihov (1998). Here the interest rate shocks are interpreted as the exogenous interest rate component. They indicate the deviation of the actual interest rate from the estimated Central Bank reaction (Taylor, 1993). In this case, the results (not shown) are quite similar to those obtained using a synthetic interest rate.

growth has led to the use of new financial instruments despite the strong roots of traditional loans. [28] At the same time, the response of loan to inflation, even if negative and significant, is limited. This is due to the notorious contraction of prices under the Spanish economy during the 1990s, especially during the second half of the decade, after the change in monetary policy adopted by the Bank of Spain in 1995. Finally, the variable *risk*, although positive, does not present an homogeneous pattern of significance. The impact of risk is statistically significant only when we include loans commitment in the loan definition. The fact that an increase in non-performing loans does not result in a reduction of traditional lending must be explained by the existence of long term consolidated relationships between the banks and their clients (Berlin and Mester, 1998). [29]

In line with the results reported by previous authors for the case of Spain (Hernando and Martínez-Pagés, 2003; Ehrmann, Gambacorta, Martínez-Pagés, Sevestre and Worms, 2003), the degree to which the tightening of monetary conditions affects loan supply of Spanish banks is not determined by the size of the banks.[30] The results show the opposite effect when the variable analysed is lending defined in a broad sense. On this basis, the supply of loan commitments of the smaller banks is more sensitive to variations in the market rate. All the evidence, then, suggests that small institutions adjust their loan supply preferentially through off-balance sheet transactions, in such a way that the reinforcement of this line of business means that loan tightening is less affected by rising market rates. Similar conclusions are drawn when the degree of capitalisation is included as a second bank characteristic. The analysis by bank type indicates that banks with a greater volume of assets also present a greater level of solvency. Finally, as the bank-lending channel theory predicts, the Spanish banks appear to have reduced the impact of monetary shocks by selling liquid assets. The coefficients corresponding to

[28] The analysis of short term coefficients shows that those corresponding to the contemporary, first and second lag are not significant, which appears to confirm the existence of *cash flow* effects. Meanwhile, the third and fourth lags are positively significant, as the credit movements are motivated by the *expected income* effect.

[29] The short-term coefficient analysis indicates that signs do not vary as the number of lags in the variable increases. Therefore, the hypothesis derived from the fulfilment of the financial balance channel cannot be confirmed.

[30] The discrepancy between the results obtained and those expected may result from compensation of the negative effect associated with the greater informative asymmetries with the positive effect derived from a greater degree of liquidity and capitalization on the part of the smaller banks (Kashyap and Stein, 1995). There is also a possible problem of identification, as in the computation of the coefficients of interaction, equal elasticity of the loan demand with respect to the type of interest rate for all banks in the sample is implicitly assumed,

this indicator are positive and highly significant. The impact of an increase of one percentage point in the monetary policy indicator on loans decreases on average by .099 (.239 when we employ loans plus loans commitments) when the liquidity ratio of a bank increased by one percentage point. [31] This finding implies that, in periods of a restrictive monetary policy, an average borrower from a less liquid bank tends to experience a sharper decline in lending than an average customer of a more liquid bank.

We also study the dynamics of the regression equation which permits to disentangle the "pure" effects of non-cash payments on loan supply from other effects. For this purpose, we depart from the point estimates of the coefficients in Table 2. Additionally, we assume that the paths of the other variables (i.e. set of macroeconomic variables, bank-specific characteristics) are held constant at their steady state path. Given that the variables are taken in first differences, this is equivalent to setting the parameter corresponding to the cyclical indicators and the interaction coefficients between the monetary policy indicator and the bank characteristics (size, capitalization and liquidity) equal to zero. We find that a one percentage rise in the share of non-cash payments in total payments value leads to an increase of .157 (.267) in the value of loans (loans plus loans commitments) supplied by an average bank. Employing a similar scheme, we can estimate the economic impact of a simultaneous change in the retail payment structure and the cyclical economic variables on loans. In this case, the impact of a one percentage point increase in *noncash* on *Δloan* (*Δloancom*) is equivalent to a .77 (.95) percentage point increase in *gdp*, or alternatively, a 3.06 (3.13) percentage points decrease in *cpi*.

6. Conclusions.

There are substantial differences on the structure of the retail payment systems across European countries. The effects of disparities in the retail payment systems affect the operative efficiency of the

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when in fact there is usually a variety due to client heterogeneity and the nature of the bank-client link (Loupias, Savinag and Sevestre, 2003).

[31] In order to capture the influences of institutional and regulatory factors and of the level of access to interbank market, we define alternative liquidity indicators. A first alternative indicator is defined by deducting cash and the deposits in Central Banks from our initial definition (*liq*). A second indicator is defined by also deducting interbank deposits. Both alternative indicators produce similar results (not shown). A third possibility is the use of two indicators simultaneously: on one hand, the sum of cash and deposits in Central Banks, Government bonds and other securities, and, on the other, interbank deposits. In this case, the results (not shown) indicate that both components are significant, although the coefficient of the former is higher.

mechanisms of monetary policy transmission. Furthermore, the greater or lesser adoption of non-cash instruments can alter the magnitude of the effects of variations in market rates on real variables. Banks can increase their deposits by a more extensive use of ATMs, credit cards at the points of sale, giros, and credit transfers. All three allow banks to cushion the effects of tightened monetary conditions upon the bank-loan supply.

We have looked at Spain to see how the evolution of the retail payment system can modify deposit demand behaviour and bank loan supply. The development of the retail payment system has helped Spanish banking institutions, to increase their non-bank deposits and, hence, their loan supply. This expansive effect has depended, to a much greater extent, on the implantation and acceptance of credit cards, and the generalized practice of cash withdrawal from ATMs, than on the development of those instruments used in the liquidation of large-scale payments such as bank giros. The relatively low cost of the instruments used in the liquidation of "face to face" transactions, together with the convenience and security of the ATMs and point of sale terminals, contribute to a higher level of efficiency in channelling economic resources. The influence of this development on the banking business is largely determined by the banks' balance sheet structure. The larger institutions- usually with higher liquidity- seem to benefit of the evolution of the payment network to expand their credit supply to a larger extent. Those institutions with high capitalization also take advantage of the payments development to expand their loan supply.

Although the tightening of monetary conditions have affected banks´ loan supply, the impact in Spain appears to be much lower that of the rest of the European countries, largely due to the pressure exerted by demand, associated with the high level of debt observed in Spanish households. This dimension does not seem to have heightened the degree of response of banks facing changes in monetary policy, just as the theory of bank-lending channels predicts, except when credit is understood in a broad sense. The larger institutions, with more diversified business structures, adjust their loan supplies by recomposing the off-balance sheet operations. We also observe that the more highly capitalized banks, generally larger as well, show a better development of operations off-balance

sheet, in such a way that the reinforcement of this line of business makes contractual relations in loans less vulnerable to increases in rates. At the same time, the loan tightening is lower for those banks that have a greater proportion of liquid assets.

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Table 1: Development of the Retail Payment System in Spain and in the EMU (In percentage)

	1992	1994	1996	1998	2000	Change
Spain						
Cash/GDP	10.2	11.1	9.9	9.6	8.9	-12
Value of transaction with non-cash instruments /GDP	2.35	1.94	3.92	3.28	3.46	47
Transferable Deposits/ GDP	33.2	33.4	30.2	37.3	43.5	31
Loans/GDP	54.9	59.8	70.8	83.2	94.6	72
Operating Cost/Total Assets	3.0	2.7	2.4	2.2	1.9	-37
EMU*						
Cash/GDP	5.5	5.6	5.4	5.5	5.4	-2
Value of transaction with non-cash instruments /GDP	7.00	7.87	7.61	8.14	8.34	19
Transferable Deposits/ GDP	20.6	21.6	21.6	24.3	28.5	38
Loans/GDP	85.2	88.7	91.3	102.2	115.4	35
Operating Cost/Total Assets	1.9	1.7	1.6	1.5	1.6	-15

Sources: OECD y BCE.

*Greece is not included due to missing data on most variables considered.

Table 2: Impact of the development of the retail payment system on *loan* and *loancom*.

Long term coefficients	Model 4 Dependent variable	
	loan	***loancom***
gdp	.252**	.274**
	(.248)	(.229)
cpi	-.065**	-.059**
	(.021)	(.090)
risk	.014	.030*
	(.019)	(.011)
mpi	-.118**	-.208**
	(.021)	(.012)
noncash	.212*	.249**
	(.026)	(.113)
mpi · ta	.001	.009*
	(.005)	(.004)
mpi · cap	.057	.086*
	(.259)	(.437)
mpi · liq	.099**	.239**
	(.113)	(.331)
noncash · ta	2.103**	2.749**
	(.879)	(.423)
noncash · cap	2.347**	2.547**
	(.289)	(.223)
noncash · liq	1.469**	2.598**
	(.208)	(.635)
AR1	.000	.000
AR2	.136	.134
Sargan Test	.229	.312

Notes: ****/*** denotes significance at 1 and 5 % levels. Number of observations: 4,572. Number of banks: 127. Estimation by GMM-system estimator using the robust two step method. Sargan test is a test of over-identifying restrictions (p-value reported), distributed as chi-squared under the null of instruments validity. M_j is a test of *j*th-order serial correlation in the first-differenced residuals. These are both distributed as standard normal under the null hypothesis. Asymptotic robust standard errors reported in parenthesis. Standard errors for the long run effect have been approximated with the delta method which expands a function of a random variable with a one-step Taylor expansion.

Appendix

Table A1: Impact of the development of the retail payment system on *loan*.

Long term coefficients	Model 1 ***bc**: ta*	Model 2 ***bc**: cap*	Model 3 ***bc**: liq*
gdp	.229*	.293**	.252**
	(.106)	(.111)	(.082)
cpi	-.024**	-.089**	-.029**
	(.016)	(.024)	(.004)
risk	.017	.030	.016
	(.011)	(.014)	(.010)
mpi	-.339**	-.329*	-.359**
	(.047)	(.158)	(.014)
noncash	.069*	.119*	.059**
	(.039)	(.112)	(.079)
mpi·bc	.004	.148	.039*
	(.010)	(.745)	(.387)
noncash·bc	3.287**	1.154**	1.059**
	(.798)	(.149)	(.389)
AR1	.000	.000	.000
AR2	.179	.139	.127
Sargan Test	.164	.156	.278

Notes: ****/*** denotes significance at 1 and 5 % levels. Number of observations : 4,572. Number of banks: 127. Estimation by GMM-system estimator using the robust two step method. Sargan test is a test of over-identifying restrictions (p-value reported), distributed as chi-squared under the null of instruments validity. M_j is a test of *j*th-order serial correlation in the first-differenced residuals. These are both distributed as standard normal under the null hypothesis. Asymptotic robust standard errors reported in parenthesis. Standard errors for the long run effect have been approximated with the delta method which expands a function of a random variable with a one-step Taylor expansion.

Table A2: Impact of the development of the retail payment system on *loancom*.

Long term coefficients	Model 1 *bc: ta*	Model 2 *bc: cap*	Model 3 *bc: liq*
gdp	.323*	.300**	.280**
	(.248)	(.369)	(.241)
cpi	-.103**	-.056*	-.060**
	(-.031)	(.108)	(.020)
risk	.049	.099	.069*
	(.036)	(.058)	(.041)
mpi	-0.436**	-.407**	-.397**
	(.136)	(.056)	(.051)
noncash	.179**	.179**	.944**
	(.069)	(.219)	(.300)
mpi·bc	.068*	.289*	.066*
	(.019)	(.127)	(.239)
noncash·bc	2.369*	3.562**	2.575**
	(.412)	(.139)	(.669)
AR1	.000	.000	.000
AR2	.122	.214	.183
Sargan Test	.346	.148	.168

Notes: ****/*** denotes significance at 1 and 5 % levels. Number of observations : 4,572. Number of banks: 127. Estimation by GMM-system estimator using the robust two step method. Sargan test is a test of over-identifying restrictions (p-value reported), distributed as chi-squared under the null of instruments validity. M_j is a test of *j*th-order serial correlation in the first-differenced residuals. These are both distributed as standard normal under the null hypothesis. Asymptotic robust standard errors reported in parenthesis. Standard errors for the long run effect have been approximated with the delta method which expands a function of a random variable with a one-step Taylor expansion.

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