THE ENDOGENOUS MONEY HYPOTHESIS: SOME EVIDENCE FROM SPAIN (1987-98)

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1.- Introduction

A major contention of Post Keynesian economics is that, in modern developed economies, the money supply is endogenous. Post Keynesians argue that, unlike commodity money, credit money comes into existence as a result of borrowing from the banks, and it is extinguished as a result of the repayment of bank debt (Kaldor and Trevithick, 1981). Whenever economic units choose to borrow from their banks, deposits and so bank money are created in the process. Whenever economic units choose to repay their bank loans, deposits are destroyed. In turn, the terms on which credit money is issued, i.e. the interest rate charged on bank loans and paid on bank deposits, play a crucial role in governing the rate of expansion of the money stock (Moore, 1989).

If money is endogenous, it is because: (i) causality runs from bank lending to deposits, and (ii) loan demand is strongly determined by nominal income. As a result, it is growth of nominal output that determines the expansion of the money stock over time and *not* the other way around. This view contrasts to the explicit or implicit acceptance of the high-powered base-"multiplier" approach to the determination of the money stock that appears in most textbooks. This approach assumes that, because the base consists of

the liabilities of the central bank (CB), that the CB has the ability to increase or reduce the quantity of the base at its discretion. In addition, from this approach it appears that, since changes in the multiplier can be forecast with a small margin of error, by controlling the base the CB can maintain the money stock within a value close to its target path (Moore, 1988, p.82).

Mainstream economists have been, so far, reluctant to accept the endogenous money hypothesis, as evidenced by the failure of endogenous money to appear as yet in any of the mainstream textbooks. One possible reason for the failure by Post Keynesians to persuade the mainstream lies on the relatively small amount of empirical evidence available on endogeneity. Such evidence comes mainly from the US (Moore, 1988, 1989; Palley, 1994), and has used the standard Granger causality tests. A recent empirical study for the G7 countries using cointegration techniques also lends support for the endogeneity thesis (Howells and Hussein, 1998). More empirical research based on other countries´ data is needed.

Although of secondary importance, a source of controversy between proponents of the endogeneity thesis, has been the significance ascribed by the accommodationist and structuralist approaches to the private initiatives of banks in accommodating increases in loan demand. Accommodationists assert that central banks (CBs) supply reserves as demanded in the process of targeting the short-term interest rate, and claim that accommodation reflects the willingness of commercial banks to grant credit on demand to credit-worthy borrowers acting as price-setters and quantity-takers in loan markets

(Moore, 1988). Structuralists place special emphasis on the banks initiatives, known as "liability management", aimed at increasing their loan/reserve ratio to accommodate loan demand (Pollin, 1991; Palley, 1996a). Accommodationists insist that CBs follow a policy regime based solely upon the setting of short-term (overnight) interest rates. Structuralists claim that CBs can also implement a policy regime based upon the quantitative control of the supply of reserves (Palley, 1996a, p.585).

The main purpose of this paper is to extend the search for evidence of money supply endogeneity to Spain, using Granger-causality tests. In the process, we intend to test the empirical significance of liability management practices as a source for loan demand accommodation. The information used for empirical testing is monetary time series data from the Spanish economy, covering the period 1987-1998. It encompasses the period stretching from the complete liberalization of commercial banks´ deposit and lending rates in Spain, up to the passing of monetary policy management from the Bank of Spain to the European Central Bank (ECB). Direct Granger-causality tests (Granger, 1969) were run between the monetary base, various money multipliers (using the M1, M2 and M3 money supply definitions) and bank lending to the non-bank private sector for the period considered. Overall the results lend strong support to the endogenous money hypothesis. They also lend support to both the accommodationist and structuralist approaches. Granger-causality was found to run *predominantly* from bank lending to the monetary base (and thus banks´ reserves), as consistent with the accommodationist approach. Granger-causality was also found to run from bank lending to the various money multipliers, as consistent with both approaches. The hypothesis

that liability management practices were a significant source for loan demand accommodation in Spain, over the period considered, cannot be rejected. Empirical analysis is extensively described in section 4.

2.- Theoretical Background

The purpose of this section is to provide a brief exposition of the endogeneity thesis as well as a description of the essential point of disagreement between acommodationists and structuralists. The exposition of the accommodationist approach is based on Basil Moore's ideas (Moore, 1988, ch.6). It heavily relies on US institutional arrangements, although it is argued in section 3 below, that the basic features are valid for the Spanish case over the period considered. The exposition of the structuralist approach is based on Pollin´s (Pollin, 1991, 1996) and Palley´s arguments (Palley, 1996a, 1996b, 1998). Since the tests devised by Pollin in his 1991 paper to discriminate empirically between the two approaches were subsequently (and I would argue successfully) criticized by both Moore (1991) and Palley (1991), we will focus on what is left of Pollin's argument.

2.1.- Theoretical controversy

The core of the endogeneity thesis is that the money supply is ultimately determined by the demand for bank lending. Loans create deposits. Repayment of loans destroys deposits. The demand for loans depends upon the "state of trade"[1], basically the level

[1] Until now, the source of the endogeneity has been identified as the costs and the volume of production. In a recent paper, Howells and Hussein (1999) have questioned the empirical evidence that credit demand is determined by the "state of trade". Following the observation that in the 1980s there was a major shift in the components of credit demand, as personal-sector borrowing overtook borrowing by firms, they show that the demand for credit is being fed by "speculative" as well as output factors.

of nominal output. In a growing economy, the norm is that nominal output grows every period. The normal case is for the flow of new lending and deposits to grow every period. As a result, the stock of bank loans and money expand over time. The former places CBs in such a position as to set the marginal cost to banks of obtaining liquidity. This is reflected in the level of short-term interest rates. Commercial banks will then charge this rate plus some mark-up on loans. Changes in short-term interest rates induced by CBs will influence the cost of borrowing, thereby affecting the willingness of the non-bank private sector to deficit-spend, and possibly the willingness of banks to grant credit. Interest rate rises will tend to slow down loan demand and money supply growth. Interest rate falls will tend to operate the opposite direction. Private sector (bank and non-bank) decisions remain the ultimate determinant of money supply expansion over time.

As argued above, two versions of the endogeneity thesis have developed within Post Keynesian economics over the last decade or so. We first review the accommodationist approach, and then we review the structuralist approach. The thoroughest exposition of the accommodationist approach is due to Moore (1988). According to Moore, the current Federal Reserve operating procedure is one of "reserve restraint" or "dirty" interest rate targeting. The supply of nonborrowed reserves (NBOR) responds automatically within the reserve maintenance period to shifts in the demand for reserves, which in turn is dependent on the amount of new loans granted. This occurs in such a way that these demand shifts need not have any effect on the federal funds rate, unless

the Fed so desires. The target interest rate may be changed on a discretionary basis, when a list of key variables deviate from the preferred behavior (according to the Federal reserve´s policy reaction function). The federal funds rate is not *directly* pegged by the Fed, according to this view. Moore argues that:

The Fed directly sets the discount rate, directly targets the volume of borrowed reserves, and directly determines the implicit cost of discount window funds by the degree to which it administers, monitors, and supervises discount-window borrowing, and so largely sets the slope of the upward-sloping supply of borrowed reserves functions...Once the discount rate, degree of restraint (nonborrowed reserves), and administrative discount-window procedures have been set, the federal funds rate is predetermined within a small range, ordinarily within fifty or sixty basis points. (Moore, 1991, p.124)

Banks borrowing from the window face two costs: the explicit cost of borrowing (the discount rate), plus implicit nonpecuniary costs. Banks which borrow frequently or in relatively large amounts come under closer scrutiny. Banks perceived to overuse the window may also be refused credit for a certain period of time (Moore, 1998, p.117). In general, it is argued that the Fed relies on a set of lending procedures to limit the amount individual banks borrow at the window, since it *intends banks to view the discount window only as a "last resort", that is, a residual source of funds when they face unexpected needs...This procedure imposes additional implicit surveillance costs on banks that borrow, the costs of providing information and negotiating with the Federal Reserve Bank plus the threat of possible future denial of access. These nuisance or*

"frown" costs are sufficient to keep most banks from making use of the window unless market rates rise substantially above the discount rate...A Federal Reserve decision not to provide nonborrowed reserves in the amounts the banks are required to hold will cause borrowing at the discount window to increase, as banks turn to the window to meet required reserves. Since access to the window is limited by frequency and amount, policies that force higher discount-window borrowing tend to raise short-term interest rates as banks use up their welcome at the window (Moore, 1988, p.118-9).

By supplying a volume of NBOR less than total required reserves (RR), the Fed is able to control the amount of discount-window borrowing. As borrowings from the discount window increase, the marginal *effective* total cost (discount rate plus frown costs) of obtaining reserves rises above the discount rate, after borrowed reserves (BOR) have increased beyond some frictional and variable amount (Moore, 1988, p.122). Through bank arbitrage, the federal funds rate rises *pari passu* above the official discount rate. Increases in NBOR relative to RR operate in a reverse direction to reduce short-term rates. Moore argues that since the CB *only* sets the supply price but *not* the supply quantity of reserves, the credit money supply function is *horizontal* in the market period, at an interest rate exogenously administered within some range[2] by the CB (Moore, 1991, p.405). If a variation in total RR leads to a sustained variation in the level of short-term interest rates, it is only because the CB desires it.

[2] Moore argues that the range will depend on the willingness and ability of the monetary authorities to intervene forcefully in financial and foreign exchange markets and that the range may differ widely over time and among different countries. A detailed discussion of this particular issue can be found in Moore (1988, p.266-76).

Having shown what, according to us, are the basic features of the accommodationist approach as far as CB behavior is concerned, we move on to present the fundamental objections raised by the structuralists. According to Pollin, the structural endogeneity theory is distinguished from the accommodative approach because it does *not* recognize any commitment on the part of the CB to pursue full accommodation of total RR. As a result, *when central banks choose to restrict NBOR, additional reserves, though not necessarily a fully adequate supply, are generated within the financial structure itself - through innovative liability management practices, such as borrowing in the federal funds market, Eurodollar market, and certificates of deposit markets* (Pollin, 1991, p.368). The argument is two-fold: (i) discount-window borrowing is *not* a close substitute for NBOR and (ii) the CB exercises its authority to *quantity-constrain* the reserves it supplies - it does not necessarily pursue a fully accommodative stance through open market operations (Pollin, 1991, p.373-4).

As for the first point, it is argued that administrative restrictions on discount window borrowing are real and effective. As a result, even though discount rates are typically below money market rates, banks and other intermediaries are generally reluctant to seek discount window funds except in emergencies. However, as shown above, this point is shared by Moore (1988), when he recognizes that banks borrowing from the discount window face two costs, the discount rate plus frown costs, so that *access to the window is limited by frequency and amount*. These quantity limits, Moore argues, are reflected in the spread between the discount rate and the federal funds rate.

As for the second point, it is argued that CBs operate under a set of constraints, which limit their ability to pursue accommodative open market operations (Pollin, 1991, p.374). Presumably, Moore's response to this second point might be framed as follows: If the CB does not supply all the reserves required by banks, and short-term market interest rates rise, it is *not* because the CB pursues a less than fully accommodating strategy. It is because the CB policy reaction function dictates, at a specific time, and under specific circumstances, that a rise in short-term interest rates should take place in order for *ultimate* policy goals to be attained. This point has been recently clarified by Moore:

The terminology "partial" or "complete" central bank accommodation, although widely used, should really be abandoned. It is misleading (and confusing) relic of the mainstream vision that the central bank exogenously controls the money supply. In the real world, the central bank always fully accommodates bank demand for reserves, in its role as residual supplier of system liquidity. In a closed economy, it also must always set the level of short-term interest rates. (Moore, 1998, p.176)

Therefore, whether or not an increase/fall in the demand for reserves ends up leading to a rise/fall in short-term interest rates -leaving liability management aside for the time being- will depend on the specific circumstances faced by the CB and the economy. The essence of the "reserve price setting" position is, according to Moore (1991, p.408), *that solvent individual banks can always obtain additional reserves at the market rate.* However, Pollin replied:

Liability management requires that intermediaries with insufficient reserves to meet loan demand pay market interest rates for funds acquired through federal funds borrowing, repurchase agreements, issuing certificates of deposits or rather similar practices. Intermediaries will acquiesce in paying market rates on such instruments only if they could not expect to obtain the funds they need more cheaply and/or readily through accommodative open market operations and discount window borrowing, frown costs included...In the aggregate, an institutional framework where no quantity constraint exists would not encourage the systematic practice of liability management. (Pollin, 1991, p.370-1)

But resort by banks to asset and liability management practices is not incompatible with the accommodationist approach. Lavoie (1996, p.282) recently argued that *it was never denied by horizontalists that higher interest rates would generate attempts to economize on cash or demand deposits. These portfolio adjustments, however important they may be, rank second to the expansion of balance sheets required by economic expansion -the income effects highlighted by horizontalists.*

How will such impetus for portfolio adjustments come about?. As said above, increases in RR (for instance brought about by increases in loan demand) would lead to interest rate rises only if the CB policy reaction function so dictates[3]. Nevertheless, it will

[3] In a recent paper, Palley coined the term "superstructuralism", to refer to a position according to which, private sector interest rates would change as loan demand changes even in the case where *the central bank holds the line on the federal funds rate* (Palley, 1998, p.171). This change in interest rates would be the result of banks´ balance sheet transformation -leading to changes in risk positions - brought about by increases in lending to the non-bank private sector. However, Palley himself admits that his own model

normally be the case that, as the economy expands, inflationary pressures may emerge at some point, which may prompt the CB to rise short-term interest rates. Reserve restraint will ensue. Individual banks will be able to obtain all the additional reserves they need at the new (higher) interest rate set up by the CB, and in this sense the reserve supply curve could be seen as being horizontal at the (new) higher short-term rate. But the rise in the federal funds rate will encourage banks to search for alternative sources of funds, with lower reserves requirements. The former may not be an attractive source of funds for banks when they are not running short of reserves and/or the federal funds rate is relatively low, but alternative sources of funds might become increasingly attractive for banks, as the federal funds rate reaches relatively higher levels.

If these alternative sources of funds consist of transformation of demand deposits into time deposits, or the issuing of certificates of deposit, the interest rate paid on them will be relatively higher than the interest rate paid on demand deposits. If we think of the alternative sources of funds as being the eurocurrency markets, then the higher cost may well take the form of higher transaction costs associated to currency exchange which, for a given borrowing rate, will turn them into a relatively expensive source of funds. In both cases, their use is only desirable when the federal funds rate has reached a relatively high level. As arbitrage between these markets and the federal funds market takes place, banks may be able to carry out a transformation of the asset and liability sides of their

is not "superstructuralist". Banks have buffer stock holdings of bonds, and they can swap those holdings with the Fed to obtain additional reserves needed to back and fund new loans (Palley, 1998, p.172). He further points out that, were those buffer stocks to be exhausted, his own model would become superstructuralist. Since we believe this second scenario to be rather uncommon, we restrict our consideration of the structuralist argument to the point developed below.

balance sheets, allowing them to raise their loan/reserve ratio[4]. Along with the transformation of banks' balance sheets, liability management may also include the discovering of new financial products aimed at further raising banks' loan/reserve ratio.

During a downswing we will observe a tendency for interest rates to fall as inflationary pressures in the economy weaken and, consequently, the CB relaxes its monetary policy. Both loan demand and deposit growth rates will slow down. Banks will feel less pressure to search for sources of funds with lower reserve requirements, as both their loan/reserve ratio and the federal funds rate fall. The former does *not* mean that banks will stop searching for new financial products which allow them to further raise their loan/reserve ratio. It simply means that the pressure to find these new products will now be lower and that, conceivably, other things being the same, *the rate of financial innovation will tend to slow down and, in a more general sense, the intensity of liability management (innovative or not) will decrease.*

Once innovative liability management has proved successful[5], the new financial products will be available thereafter *whatever the pressure banks have to find alternative sources of funds with lower reserve requirements.* Thus we would expect the loan/reserve ratio, and consequently the various money multipliers, to have an upward trend. Although both Moore and Palley argue that banks, as profit-maximizers, will

[4] The liability management process focuses, according to Palley (1996b, p.116) on inducing the non-bank private sector to shift away from demand deposits (which have high reserve requirements) and into time deposits and other long-term deposits (with low reserve requirements). In addition, he draws attention to the buffer stock role played by secondary reserves (mainly fixed-income financial assets such as government securities), which buffer variations in the liquidity position of the banking system.

continually be seeking to raise their loan/reserve ratio, it is reasonable to expect that both the intensity of liability management, and the rate of growth of money velocity[6] will rise when monetary policy is tightened and fall when monetary policy is relaxed.

But interest rate changes induced by the CB may not be the only impetus for carrying out portfolio adjustments. For example, Palley has recently argued that:

If the central bank buys assets from the private banks, then balance sheets will be transformed. Private banks will have to choose which assets to sell, and when they sell them, they will have an incentive to alter their liability positions, which are cross-linked to asset holdings. This is the essence of asset and liability management. Such balance sheet transformations will change risk positions, and this will likely lead to changes in the structure of interest rates...The above argument maintains that private-sector interest rates will change even if the central bank holds the line on the federal funds rate. This is what I call "superstructuralism". (Palley, 1998, p.171).

The former quotation suggests that, contrary to Lavoie´s comment above, the current discussion between accommodationists and structuralists is not so much about the relative importance of liability management as a source of loan demand accommodation. Rather, the discussion is about the variability of markups charged by banks as a result of

[5] According to Pollin (1996, p.498), a defining characteristic of a successful financial innovation is one in which the liquidity of higher yielding assets is increased, thereby allowing yield differentials to decline.

[6] As Rousseas (1992, p.94) points out, the Keynesian explanation of changes in velocity focuses on the activation of idle balances and the economizing of transactions balances in response to central bank-induced increases in the rate of interest. This explanation would entail a movement *along* a money

changes in risk positions in their balance sheet. Accommodationists remain committed to a stable markup, whose value is basically determined by the degree of monopoly of banks in loan and deposit markets. In contrast, structuralists recognize the existence of an impact of changes in banks´ risk position upon the level of markups. As a result, tests aimed at discriminating between the two approaches must use time series data of interest rates differentials.

2.2.- Causality

The question that emerges from the discussion above then is whether there is a sensible way of: (i) testing the endogenous money hypothesis and (ii) testing the significance of liability management as a source of loan demand accommodation. It is argued below that the test set up by Palley (1996b, p.118-20) to discriminate between the mainstream and the endogenous money approaches, and the accommodationist and structuralist approaches, performs adequately this task. Although the test can not easily discriminate between the accommodationist and structuralist approaches[7], it allows potential refutation of the accommodationist approach. It also allows testing of the significance of liability management practices for loan demand accommodation.

velocity curve in money velocity-interest rate space. The effect of liability management upon money velocity would rather take the form of an upward shift of the money velocity curve.

[7] Since it was argued above that discrimination between the two approaches would require using time series data on interest rate differentials.

As a result, once the various time series considered have been made stationary, or a cointegrating relationship[8] has been found to exist, if the endogenous money hypothesis is to be validated, we should find Granger-causality[9] running from bank lending to the monetary base and to the money supply. The endogenous money hypothesis will be refuted if Granger-causality is found to run from the monetary base to bank lending and to the money supply. If the accommodationist approach is to be validated, we should get the following results. First we should *not* be able to reject the null hypothesis that bank lending Granger-causes the monetary base (Palley, 1996b, p.118). In addition, we should be able to reject the null hypothesis that reserves (or the monetary base) Granger- cause bank lending.

As argued above, the structuralist approach cannot be confirmed or disconfirmed by Granger-causality tests between bank lending, the monetary base and the money multipliers. In this approach there is potential for bivariate causality between bank lending and reserves, and between bank lending and the different money multipliers (Palley, 1996b). Whatever the outcome of Granger-causality tests is, they won't give us any information about the possible (procyclical) variability of markups charged by

[8] A necessary condition for the estimation of an autorregressive distributed lag model - required for running a Granger causality test - is either the stationarity of the series involved in the model or the existence of a cointegrating relationship between the regressors and the independent variable. If that is not the case we would face the possibility of running spurious regressions (Granger and Newbold, 1974), and that regression coefficients might not actually converge to constants with increasing sample size as in the standard case (Phillips, 1986). Since it is unlikely that a cointegrating relationship between reserves, money multipliers and bank lending exists -for there is no theoretical basis for expecting such a relationship to exist- making the series stationary -if they are not- seems to be the only choice we have left when trying to run a Granger-causality test.

[9] Generally, for a pair of linear covariance-stationary time series X and Y, Granger (1969, p.428-9) proposed the following interpretation of X being causally related to Y: X causes Y if the past values of X can be used to predict Y more accurately than simply using the past values of Y. Formally, X is said to cause Y if and only if $\sigma_1^2 (Y_t : Y_{t-j}, X_{t-i}) < \sigma_2^2 (Y_t : Y_{t-j})$, where σ^2 represents the variance of forecast error and j=1,2,3,.....,n.

banks. In any case, Granger-causality that runs from bank lending to the money multipliers, or bivariate causality between them, will show that liability management practices were a significant source for loan demand accommodation.

3.- Monetary Policy in Spain in the last two decades

The purpose of this section is to review the most important developments in Spanish monetary policy in recent times. This section has two objectives. First to provide some useful insights into the institutional framework which has characterized monetary policy in Spain during the last two decades. Second to identify possible structural breaks in the time series used in the study. It will be argued that the specific institutional arrangements of monetary policy in Spain throughout this period did not significantly differ from US monetary policy (as described in section 2), thereby making it relevant to study both the possible endogenous determination of the money supply and the significance of liability management practices for loan demand accommodation. In addition, as will be shown in next section, a structural break in the form of a permanent level shift occurred in March 1990, in the aftermath of a substantial reduction in RR by the Bank of Spain. This may have a significant impact on the results of the unit root tests that will be implemented. Section (3.1) contains a general overview of monetary policy in Spain from the second half of the eighties, whereas section (3.2) focuses on some basic institutional features of monetary policy operational procedures.

3.1.- An overview of monetary policy in Spain

The choice of 1987 as the starting year for our study is due to two reasons. First, as pointed out above, banks´ lending and deposit rates were not completely liberalized in Spain until that year (Servicio de Estudios del Banco de España, 1997, p.93). Second, short-term interest rates became the basic monetary policy instrument[10] the same year (Rodríguez, Parejo, Cuervo and Calvo, 1998, p.124). In the 1980s, Spanish monetary policy was strongly influenced by Spain´s entry into the European Community, an event which took place in 1986. A consequence of that important political development was the need to reduce the volatility of both interest rates and the exchange rate. In the period 1984-1989 (June), monetary policy was still characterized by the setting of a growth rate for a broad monetary aggregate as an intermediate target. However, despite the setting of target growth rates for monetary aggregates throughout the 1980s a gradual shift in the monetary policy regime was already under way. The Bank of Spain attached increasing importance to a nominal exchange rate indicator of the peseta *vis a vis* the main European currencies (representing the main trade partners except Portugal and Greece) as an argument of its policy reaction function across this period. From 1988 onwards, the bilateral exchange rate against the Deutsche mark was substituted for the earlier exchange rate indicator.

In an attempt to reinforce the credibility of the Spanish monetary authorities, the peseta joined the European Monetary System (EMS) in June 1989, with a 6% fluctuation

[10] Before 1987 the Bank of Spain regulated banks´ reserves in an attempt to hit monetary targets.

margin in each direction. As a result of the new institutional arrangement, the broad monetary aggregate, previously used as an intermediate target, eventually turned into just another economic indicator. This turned short-term nominal interest rates into the main instrument used to keep the exchange rate within its fluctuation threshold. In addition, a widening of the fluctuation margins within the EMS, aimed at ending speculative attacks upon the weaker currencies, took place in summer 1993, allowing them to fluctuate as widely as ±15%.

Spanish monetary policy from 1987 to 1995 basically consisted of the maintenance of a target nominal value for the exchange rate *vis a vis* the main European currencies (in practice the Deutsche mark). The determination of the level of short-term interest rates aimed at making monetary and credit aggregates grow at a pace compatible with the sustainability of the long-run target exchange rate. Insofar as the achievement of this long-run target exchange rate entailed the convergence of the rate of inflation towards the average level prevailing in the core European economies, Spanish real interest rates had to remain relatively high. In a context of high capital mobility, high real interest rates led to powerful capital inflows, which put upward pressure on the peseta exchange rate against most other European currencies. The Bank of Spain abandoned the regime based upon an exchange rate target against the Deutsche mark in 1995, and an inflation-targeting strategy with no intermediate target, was adopted. The new monetary policy regime worked successfully until December 1998, when the launching of the Euro led to the transfer of monetary policy away from the Bank of Spain to the ECB.

3.2.- Monetary policy instruments

Prior to 1987, Spanish monetary policy was based on setting a target growth rate for the level of banks´ reserves. Thereafter Spanish monetary policy was based on the control of short-term nominal interest rates. Open-market operations became the basic instrument used for the determination of the degree of restraint of monetary policy. The former usually took place through repurchase agreements of Certificates of Deposit issued by the central bank[11](CDs) and Treasury Bills (TB), on a decennial (ten days) and daily basis, using the *striking-price* auction system[12]. As a result, the interest rate set by the Bank of Spain in the decennial auctions of CDs and TB became the reference interest rate for the interbank market and monetary policy. The Bank of Spain basically set the short-term rate of interest through the determination of the marginal interest rate of auctions in decennial open-market operations.

In addition to open-market operations carried out on a daily or a decennial basis, an additional monetary policy instrument in the form of a *last-resort credit device* was introduced. This was akin to the discount-window system described in section 2 for the

[11] In March 1990 the Bank of Spain implemented a substantial reduction, from 17 to 5 percent of total reserves banks had to keep in a central bank account at a zero interest rate as a proportion of selected liabilities (weighted by their relative maturity period and/or their liquidity). In order to avoid the consequences for the system that would have derived from a sudden increase in the volume of liquidity produced by that reduction in required reserves, the Bank of Spain issued Certificates of Deposit (which could only be traded among the institutions subject to required reserves maintenance and between these institutions and the CB) that would gradually reach maturity along a ten-year period. From March 1990 onwards, these financial assets were used by the Bank of Spain in the context of open-market operations (repurchase agreements) to regulate the volume of liquidity in the system (Servicio de Estudios del Banco de España, 1997, p.492).

[12] In *striking-price* auctions, bids are ranked by descending value and all successful bidders pay the uniform price of the lowest bid necessary to clear the market. In *bid-price* auctions, successful bidders pay the price that they bid (Howells and Bain, 1998, p.156).

US Fed operational procedures. However a slight difference exists. The discount rate set by the Fed is always lower than the Federal Funds rate, whereas the interest rate set by the Bank of Spain was always above the money market rate. The former is due to the fact that, as borrowing by individual banks from the Fed´s discount-window exceeds a certain threshold, *non-pecuniary* marginal costs of borrowing gradually increase, thereby encouraging banks to limit discount-window borrowing to exceptional cases. The Bank of Spain did not rely on the imposition of *non-pecuniary* costs upon the last-resort credit device interest rate. It simply set this rate slightly above the money market rate, thus encouraging banks to make use of this credit source only under exceptional circumstances. As a result the last-resort credit device became a marginal monetary policy instrument throughout the period considered.

We believe the institutional arrangements of monetary policy in Spain did not differ significantly from US monetary policy throughout the period considered. In particular we think that, within this institutional framework, it is still possible to argue that the reserves´ supply curve by the banks was horizontal at the interest rate set by the monetary authorities. We therefore conclude that all the conclusions of section 2, especially those referred to the test proposed, carry over to the current section.

4.- Empirical evaluation

The current section contains statistical analysis of monetary data from the Spanish economy. As said above, the main purpose of the analysis is to test the endogenous money hypothesis. By decomposing the money supply into the monetary base and the

money multipliers, we can also test the accommodationist approach and the significance of liability management as a source of loan demand accommodation. The sample period is 1987:01 - 1998:10. The data is in average monthly form, drawn from the *Boletín Económico del Banco de España.* The original time series were initially transformed by taking logarithms. All estimates were by ordinary least squares. The procedure followed had two stages. First, since stationarity is a requirement for the implementation of Granger causality tests (Granger, 1969, p.431), all series were checked for stationarity. This was done by means of graphical inspection and unit root tests. Graphical inspection included the observation of the behavior of the series, and their correlograms.

The unit root tests implemented were in standard and Perron´s version (depending on whether or not a structural break was observed) of the augmented Dickey-Fuller test. In the first case we used Mackinnon´s critical values (Davidson and Mackinnon, 1993, p.703) whereas in the second case critical values tabulated by Perron (Franses, 1998, p.151) were used. After having checked all series for stationarity, Granger-causality tests were run, using five different lag lengths for the autoregressive distributed lag (ADL) relations[13]. The variables definitions used throughout the analysis are the following[14]:

[13] Different lag lengths for each relationship were used to reduce the risk of a model specification problem. This could arise as the result of omitting relevant lagged values of the dependent variable.

[14] Monetary aggregates in Spain are defined the following way. M1comprises currency in the hands of the non-bank private sector plus sight deposits in the Bank of Spain and commercial banks. M2 comprises M1 plus demand deposits at savings banks. M3 basically comprised M2 plus time deposits at commercial banks until May 1991. In June 1991 the Bank of Spain broadened the M3 definition and included some additional financial assets. However we kept the old definition in order to get homogeneous time series covering all the period considered. Finally, Loans comprise credit granted by the banking system (deposit institutions) to the non-bank private sector.

LBM = log of monetary base

Lm1 = log of M1 money multiplier

Lm2 = log of M2 money multiplier

Lm3 = log of M3 money multiplier

LLoans = log of loans

4.1.- Stationarity analysis

Inspection of the logarimths of the series in levels showed that all variables displayed an upward trend. It also showed that all the variables except LLoans experienced a structural break[15]in the form of a permanent upward (downward for LBM) level shift in 1990:03. The result of the reduction in RR imposed by the Bank of Spain was a sudden fall in the monetary base, as banks were obliged to purchase Certificates of Deposits issued by the Bank of Spain. Insofar as money supply did not experience an equivalent fall, the multipliers shifted upwards.

Inspection of their correlograms showed that Lm1, Lm2 and Lm3 display the usual pattern for a non-stationary series with the autocorrelation coefficients dying out. The correlograms for LBM and LLoans were not so clear-cut, but somehow pointed in the same direction. Unit root tests suited for *trending*[16] time series were run and the results

[15] As indicated in the previous section, a substantial reduction in required reserves was implemented by the Bank of Spain in March 1990.

[16] Since all time series exhibit a trend, the appropriate unit root test format (see section 1 in the appendix) is that one which attempts to discriminate empirically between a trend-stationary process and a difference-stationary process (Johnston and DiNardo, 1997, p.224). In our case, since all variables were trending, the difference-stationary process was necessarily a random-walk with drift.

were compiled in Table 1 below. Augmented Dickey-Fuller (ADF) tests were run for all series. Critical values tabulated by Mackinnon (Davidson and Mackinnon, 1993, p.703) were used in the ADF test for LLoans. The presence of a permanent level shift in all the remaining series invalidated these critical values for a standard ADF test[17]. Asymptotic critical values tabulated by Perron (Franses, 1998, p.151) for ADF tests in the presence of a known level shift were used in the ADF tests run for Lm1, Lm2, Lm3 and LBM.

	t-value (lag length)	Critical values
Lm1	**-3.963 (3)****	**-3.30/-3.88**
Lm2	**-4.330 (5)****	**-3.30/-3.88**
Lm3	**-3.458 (5)***	**-3.30/-3.88**
LBM	**-6.844 (5)****	**-3.30/-3.88**
LLoans	**-2.0539(0)NR**	**-3.445/-4.032**

***** indicates that the null hypothesis $H_0{:}\gamma = 0$ can be rejected at the 5% significance level but can *not* be rejected at the 1% level.
****** indicates that the null hypothesis $H_0{:}\gamma = 0$ is rejected at the 1% significance level.
NR indicates that the null hypothesis $H_0{:}\gamma = 0$ can not be rejected at the 5% significance level.
The unit root test for LLoans also included a seasonal following the observation of the correlogram for DLLoans. The first number in the column containing the critical values corresponds to the 5% significance level whereas the second number corresponds to the 1% significance level. Finally, the numbers in parenthesis indicate the lag length used in the ADF test.

TABLE 1

The second column in Table 1 shows the t-values and the lag length used in the ADF test[18]. The third column shows the corresponding critical values. The test format used varied depending on whether a standard ADF or Perron´s version of the ADF test was run (see section 1 in the appendix). If the unit root hypothesis cannot be rejected, then the trending series is a random-walk with drift. As Table 1 shows, the unit root

[17] It has recently been argued that neglecting *level shifts* or *breaking trends* leads to spurious unit roots whereas neglecting *additive outliers* leads to a spurious finding of stationarity (Franses, 1998, p.148).

[18] The selection of the lag length was done according to the lag criterion (Hendry and Doornik, 1999, p.42) which consists of selecting the highest lag with a significant t-probability. As Johnston and DiNardo (1997, p.226) point out, if the series has been generated by a higher-order autoregressive process it is inadequate to run a simple Dickey-Fuller test. Instead an ADF test is required. The purpose of the additional lags in the test specification is to "whithen" the residuals (Hendry and Doornik, 1999, p.41).

hypothesis can be rejected for Lm1, Lm2 and LBM at the 1% significance level, but can only be rejected for Lm3 at the 5% significance level, and cannot be rejected at all for LLoans. These results indicate that all series, except LLoans and Lm3, are a trend stationary process. The fact that the unit root hypothesis can not be rejected for LLoans and Lm3 entails the need to check for the number of unit roots in these two series.

Inspection of the first-difference of LLoans and Lm3 (DLLoans and DLm3) revealed that the presence of a unit root was unlikely, since neither their mean nor their variance exhibited a trend. Inspection of their corresponding correlograms, provided additional support in the case of DLm3 since it appeared to be white-noise. DLLoans also appeared to be stationary. The high autocorrelation coefficient for the twelfth lagged value suggested the presence of a seasonal component. This was taken into account when running the corresponding unit root test.

Unit root tests were run for DLLoans and DLm3, in order to determine whether the series contained more than one unit root. The procedure used was the same for the series in levels, except that the ADF test format applied did not assume the presence of a time trend[19](see section 2 in the appendix). As Table 2 shows, the unit root null hypothesis can be rejected at the 1% significance level. The former implied that Lm3 and LLoans did not contain more than one unit root and were *integrated of order 1*.

[19] Since none of the two series exhibited a trend, the purpose of the ADF test was not to discriminate empirically between a trend-stationary process and a difference-stationary process. Rather, the purpose of this ADF test was to discriminate between a series that had been generated by a pure random-walk model (non-stationary) and a series that had been generated by a AR(1) process with drift, where the autocorrelation coefficient was less than unity, that is, by a stationary process (Johnston and DiNardo, 1997, p. 225).

	t-statistic with constant included (lags)	Critical values with constant included
DLm3	**-4.0084 (4) ****	**-2.884/-3.483**
DLLoans	**-9.777 (0)****	**-2.884/-3.483**

****** indicates that the null hypothesis H_0:$\gamma = 0$ is rejected at both the 1% and 5% significance level.
The unit root test for DLLoans includes a seasonal following the observation of the correlogram for DLLoans. The first numerical value in the column containing the critical values corresponds to the 5% significance level whereas the second value corresponds to the 1% significance level. Finally, the numbers in parenthesis indicate the lag length used in the ADF test. The critical values are those tabulated by Mackinnon since the series did not exhibit any structural break.

TABLE 2

The results allowed us to go ahead with the causality analysis. Since stationarity is a requirement for the implementation of the Granger-causality tests, and all series exhibited a trend, they all were transformed to induce stationarity. In the case of Lm1, Lm2 and LBM we detrended them, that is, we ran a regression on time (since they were found to be trend-stationary processes) whereas in the case of Lm3 and LLoans they were differenced once (because they were found to be a difference-stationary process and integrated of order 1). The detrended counterparts for Lm1, Lm2 and LBM are referred to as DTLm1, DTLm2 and DTLBM respectively[20]. The stationary counterparts for both Lm3 and LLoans are referred to as DLm3 and DLLoans.

4.2.- Granger-causality tests

Once the postulated hypotheses had been stated in section (2.2), it remained to set up an operational definition of causality in Granger´s sense. The following definition

[20] The regressions we estimated to detrend the variables had the form:

$$y_t = \alpha_0 + \alpha_1 (t - 1999{:}03) + \alpha_2 t + u_t$$

represents a slight reformulation of the original one for two-variable models which appears in Granger (1969, p.431), modified to account for the case of *non-zero* mean variables[21]. Let X_t and Y_t be two *stationary* time series with non-zero means. The simple causal model is

$$Y_t = a_0 + \sum_{i=1}^{n} a_{1,t-i} Y_{t-i} + \sum_{i=1}^{n} a_{2,t-i} X_{t-i} + \varepsilon_i \qquad (1)$$

$$X_t = b_0 + \sum_{i=1}^{n} b_{1,t-i} Y_{t-i} + \sum_{i=1}^{n} b_{2,t-i} X_{t-i} + \eta_i \qquad (2)$$

where ε_t and η_t are taken to be two uncorrelated *white-noise* series.

The definition of causality proposed by Granger implies that X_t is causing Y_t provided some a_2 is not zero. Similarly, Y_t is causing X_t if some b_1 is not zero. If both of these events occur, according to Granger´s definition (Granger, 1969, p.428), there is said to be a *feedback* or bivariate relation between X_t and Y_t. The results from the Granger causality tests between bank lending to the non-bank private sector, the money multipliers for the M1, M2 and M3 aggregates, and the monetary base, are shown in Table 3. The first column contains the explanatory and dependent variables in each test and its result. A => means that the left-hand side variable Granger-causes the right-hand side variable, whereas a ?> means just the opposite. The remaining columns contain the

The corresponding detrended series was u_t.

[21] A similar autoregressive distributed lag model appears in Palley´s work with US data (Palley, 1996b, p.118).

results of the F-tests[22] for five different values of the lag length in equations (1) and (2). The first value in each column represents the F-statistic, whereas the numbers in parenthesis correspond to the probability that the null hypothesis be true.

	18 Lags	12 Lags	9 Lags	6 Lags	3 Lags
DLLoans=>DTLBM	**1.4997 (0.1099)**	**2.0742 (0.0248)****	**2.6457 (0.0081)*****	**2.42 (0.0303)****	**1.2933 (0.2795)**
DTLBM=>DLLoans	**1.4491 (0.1301)**	**1.9626 (0.0351)****	**2.2469 (0.0238)****	**1.1908 (0.3157)**	**0.51729 (0.6711)**
DLLoans =>DTLm1	**1.6169 (0.0735)***	**1.8429 (0.0505)***	**2.09343 (0.0357)****	**2.4343 (0.0294)****	**2.9229 (0.0364)****
DTLm1=>DLLoans	**1.459 (0.1259)**	**1.7711 (0.0626)***	**1.4769 (0.1649)**	**3.022 (0.0087)*****	**1.0498 (0.3729)**
DLLoans=>DTLm2	**1.3915 (0.1568)**	**1.5188 (0.1290)**	**1.9828 (0.0476)****	**2.6429 (0.0191)****	**3.7539 (0.0126)****
DTLm2 =>DLLoans	**1.2684 (0.2292)**	**1.6772 (0.0824)***	**1.4983 (0.1570)**	**2.8198 (0.0132)****	**0.88343 (0.4516)**
DLLoans =>DLm3	**1.6423 (0.0672)***	**1.7005 (0.0770)***	**1.5329 (0.1448)**	**2.1494 (0.0525)***	**2.7976 (0.0427)****
DLm3 ?> DLLoans	**0.63617 (0.8613)**	**0.89753 (0.5520)**	**1.0444 (0.4096)**	**0.80011 (0.5717)**	**0.14891 (0.9302)**

******* indicates that the null hypothesis can not be rejected at the 1% level
****** indicates that the null hypothesis can be rejected at the 1% significance level but can *not* be rejected at the 5% level.
* indicates that the null hypothesis can be rejected at the 5% significance level but can *not* be rejected at the 10% level.

TABLE 3

The first comment we should make in relation to the results in Table 3 is that, overall causality *predominantly runs from bank lending to all the remaining variables*. This is the most important finding of this study, and it lends strong support for the endogenous money hypothesis, independently of the specific approach supported.

[22] The null hypotheses for the corresponding F-tests for Granger-causality in equations (1) and (2) are $H_0: \sum_{i=1}^{n} a_{2,t-i} = 0$ and $H_0: \sum_{i=1}^{n} b_{1,t-i} = 0$ respectively.

As Table 3 shows, bank lending Granger-causes *both* the monetary base (and therefore reserves) and all the money multipliers. *This result is compatible with both the accommodationist and the structuralist approaches*. It also shows the significance of liability management practices as a source for loan demand accommodation in Spain over the period considered. However, as argued above, this result does not confirm or disconfirm the structuralist approach. Finally, there is some evidence to support Granger causality running from DLBM (9 and 12 lagged values), DTLm1 (6 and 12 lagged values) and DTLm2 (6 and 12 lagged values) to DLLoans, although the evidence here is *not* so clear-cut as in the opposite direction.

A second comment refers to the different effect of bank lending upon the various money multipliers. Bivariate causality appears to exist for the M1 and M2 money multipliers, but is non-existent for the M3 money multiplier. This result does not have any straightforward explanation. A possible form of liability management practice by banks in the context of increased loan demand is to induce its customers to shift away from demand deposits and into time deposits through interest rate changes (Palley, 1996b, p.116). If this was the case, we would expect the M3 rather than the M2 and M1 money multipliers to exhibit bivariate causality with bank lending, since the latter would be subject to a *substitution* effect (shifting away from demand deposits and into time deposits) that might weaken the otherwise dominating *income* effect (demand deposits expansion brought about by increased bank lending). The result we had was precisely the opposite.

One explanation is strictly econometric: Lm3 was differenced rather than detrended, because we could not reject the unit root null hypothesis at the 5% significance level. We assumed that the underlying process was a random-walk with drift, rather than a trend-stationary process (TSP). In order to sort this out, we repeated the Granger-causality test assuming that Lm3 was actually a TSP (we detrended Lm3). The result we got was the following:

	18 Lags	12 Lags	9 Lags	6 Lags	3 Lags
DLLoans => DTLm3	**1.9658 (0.0204)****	**2.0598 (0.0260)****	**2.5279 (0.0112)****	**2.3992 (0.0316)****	**3.1212 (0.0279)****
DTLm3 ?> DLLoans	**0.63316 (0.8613)**	**1.3496 (0.2026)**	**0.76796 (0.6461)**	**0.78188 (0.5857)**	**0.25704 (0.8562)**

**** indicates that the null hypothesis can be rejected at the 1% significance level but can *not* be rejected at the 5% level.
* indicates that the null hypothesis can be rejected at the 5% significance level but can *not* be rejected at the 10% level.

TABLE 4

As Table 4 indicates, the results were approximately the same as before. Bank lending was found to Granger-cause the M3 money multiplier, but the latter was not found to Granger-cause the former. It seems that the explanation for this puzzling result is not of the econometric type. A second possible explanation is that the sort of bank balance sheet liability side transformation that seems to come about in the aftermath of loan expansion does not predominantly entails shifting away from demand deposits and into time deposits, *but* shifting away from demand deposits and into other alternative financial assets issued by banks, which have not been included under the M3 definition we used. Testing of this hypothesis would require analyzing Granger-causality between bank lending and monetary aggregates broader than M3, a task which exceeds the purpose of the present study.

The third and final comment refers to the relative importance of substitution and income effects of bank lending expansion upon money supply. As Palley (1996b, p.116) points out, whether the narrow money supply (M1 and M2 in our case) rises in response to increased lending is ambiguous, owing to offsetting income and interest rate effects. The induced rise in loans and nominal income increases the demand for checkable deposits, but the subsequent rise in interest rates reduces demand. Insofar as the same pattern applies to currency demand, the narrow money supply only rises if the income effect prevails. What emerges from the results above is that the income effect *dominates.* Both the M1 and M2 money multipliers are positively correlated with bank lending. The income effect also dominates in the M3 money multiplier case.

5.- Conclusions

The main purpose of this paper was to test the Post Keynesian position that the supply of credit money is endogenous. This hypothesis was tested using Spanish time series data for the period 1987-98. Granger-causality tests were run between the monetary base, bank lending and various money multipliers. The empirical evidence is strongly consistent with the hypothesis that in Spain, over the period 1987-1998, the money supply was credit-driven and demand-determined. Granger-causality was found to run predominantly from bank lending to the base, and to the money supply, rather than from the base to loans and to the money supply, as the mainstream view maintains. The results are also consistent with both the accommodationist and structuralist

approaches. Since Granger-causality was found to run predominantly from bank lending to the different money multipliers, we cannot reject the hypothesis that liability management practices were a significant device for accommodation of loan demand in Spain over the period considered. Additional empirical research, focusing on possible procyclical variations in interest rates differentials, is required in order to be able to discriminate between the accommodationist and structuralist approaches.

APPENDIX

Section 1

The test format used to discriminate empirically between a trend-stationary process and a difference-stationary process $(H_0{:}\gamma = \alpha - 1 = 0)$ was:

$$\Delta y_t = (\delta_0((1-\alpha) + \alpha\,\delta_1) + \delta_1(1-\alpha)t + \gamma\, y_{t-1} + \sum_{i=1}^{i=s} y_{t-i} + \varepsilon_t \qquad (3)$$

for a standard ADF test and

$$\Delta y_t = (\delta_0(1-\alpha) + \alpha\,\delta_1) + \delta_1(1-\alpha)t + \omega\, I_t(t\,?\,\tau) + \lambda_1 I_t(t=\tau) + \lambda_2 I_t(t=\tau+1) + \gamma\, y_{t-1} + \sum_{i=1}^{i=s} y_{t-i} + \varepsilon_t \qquad (4)$$

for the Perron version of an ADF test.

Section 2

The ADF test format $(H_0{:}\gamma = \alpha - 1 = 0)$ we used to discriminate between a simple random-walk and a AR(1) process with constant where the first-order autocorrelation coefficient is less than unity was (Johnston and DiNardo, 1997, p.225):

$$\Delta y_t = \delta_0((1-\alpha) + \gamma\, y_{t-1} + \sum_{i=1}^{i=s} y_{t-i} + \varepsilon_t \qquad (5)$$

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