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Money Supply and Money Demand in Poland, 1990-1992

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Money Supply and Money Demand in Poland, 1990-1992*)

Introduction

This paper examines the behaviour of money supply and money demand in Poland under the present market-oriented reforms. We start with an analysis of the money supply, outlining the policy pursued by the monetary authorities and the behaviour of the main monetary aggregates. In order to choose a method appropriate for identifying the money demand function, an answer to the question is needed whether the money supply was determined exogenously or endogenously. The critical criterion for identifying the money demand function is the behaviour of the monetary authorities. Therefore, the problem of money exogeneity (endogeneity) is the element linking our analysis of money supply with that of money demand.

It is rather hazardous to make estimates of the demand for money in a country undergoing both stabilization and transformation into a market economy. The demand for money shifts as a result of stopping hyperinflation, sharp increases in interest rates, declining output, and the introduction of new financial instruments. Another problem we faced was that of equilibrium in the money market. The methods used to identify the money demand function assume that money supply equals money demand, whereas targeting both the rate of monetary expansion and the interest rate (as was the practice in Poland during the reference period) may easily lead to disequilibrium in this market. There was also the problem of the rather small number of observations. This makes us very cautious in interpreting the estimated demand money functions. On the other hand, we decided not to extend the period analysed and to include observations coming from the time prior to market-oriented reform.

The outline of the paper is as follows: section 1 analyses the supply of money, i.e. high-powered money, narrow money (M1) and broad money (M2); it presents instruments of monetary policy and discusses money exogeneity. Section 2 sketches the methodological framework used to model the money demand function, and provides the results of our estimates. Lastly, section 3 presents a summary and the conclusions drawn from the preceding discussion.

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1. Money supply: basic developments

1.1 Reserve money (M0)

Reserve money (reserve base or high-powered money) is money created by the central bank. There are three sources of reserve money, namely, foreign reserves (net), credits to the government, and credits to banks and the non-financial sector (net). Cash in circulation and in banks' vaults, domestic banks' deposits and foreign exchange accounts at the central bank are the main uses of the reserve base.

Stocks of high-powered money and those of cash in circulation are reproduced in Graph 1. Their growth rates were highly variable: at the beginning of the reference period they were relatively high, in the course of 1991 they decreased but did not stabilize (Graph 2). The rate of growth of the monetary base was noticeably less variable than that of cash in circulation.

The structure of the sources of reserve money changed considerably during the period analysed (Tables 1a, 1b). In 1990 there was a conspicuous increase in net foreign reserves (in nominal terms), from Zl 9.8 bn at the end of 1989 to Zl 38.2 bn at the end of 1990. Their share in the monetary base rose from 34.6% in 1989 to about 46% in 1990. Thus, rising foreign reserves acted on the increasing money supply. This was only partially neutralized by the surplus of the government budget. However, the main source of money creation in 1990 was net outstanding credit to banks and the non-financial sector. Its share in high-powered money rose from 49.9% in 1989 to about 55% in 1990. In the course of 1991 net foreign reserves fell and were therefore reducing the expansion of the money supply. Credit to banks and the non-financial sector remained the most important source of money creation. It accounted for 30% of the monetary base. It is worth noting that in contrast to 1990 net credit to the government was an important source of growth in the money supply. Data for 1992 are not comparable with those for 1990-1991. Therefore we present statistics obtained from both the "old" and the "new" system of money accounting for 1991. For 1992 only data on relative changes in the sources of high-powered money can be compared with data for previous years. Table 1b shows that net credit to the government was the source of base money which increased most. Note that in 1992 its rate of growth outpaced the rate of growth of other sources of the monetary base much more than in 1991.

High-powered money in real terms increased throughout 1990 after an initial fall at the start of reforms. In 1991-1992 it remained practically constant (with the exception of the second quarter of 1992; Graph 3). It is worth noting that during the period under

investigation the level of the real monetary base did not return to that of 1989. Real rates of growth of the monetary base (Graph 2) were highly variable in 1990. Then they stabilized relatively, but nonetheless they were still quite variable. From the first quarter of 1991 to the third quarter of 1992 the real growth rates of high-powered money were negative or close to zero. Only at the end of the reference period did the real monetary base show a higher growth rate.

1.2 Narrow money (M1)

The stocks of narrow money are reproduced in Graph 1. M1 was slightly more variable than cash in circulation. This was due to the increased variability of demand deposits. At the beginning of the reference period they expanded considerably (both in nominal and real terms) as the flight from money characteristic of hyperinflation came to a halt and because the developing private sector (mostly trade) needed demand deposits for current transactions.

In real terms M1 behaved in a way somewhat different from that of real high-powered money. It increased quite rapidly after an initial fall in the first quarter of 1990. However, like the real monetary base, it appeared to be stable from the third quarter of 1990 (Graph 3). In 1990 the growth rates of narrow money were relatively high, but noticeably less variable than in 1991-1992.

1.3 Broad money (M2)

Broad money increased at a rather stable rate throughout the analysed period. Stocks and rates of growth of M2 in nominal and real terms are shown in Graphs 1-3. Broad money was less variable than narrow money; the same applies to their rates of growth.

An increase in the interest rate boosted time deposits. For most of the time the real interest rate was positive. As in the case of demand deposits, the 1990 increase in time deposits resulted also from the private sector's development. There was a clear-cut change in the structure of broad money: the share of domestic money increased whereas that of foreign currency was falling. This was the result of the relatively low rate of return on foreign currency deposits and a change in the financial system of

settlements between commercial banks and exporting units.[1] In 1992, however, the process of de-dollarization stopped.

Real M2 behaved unlike real M1 (Graph 3). Initially it fell much more than narrow money, but then grew sharply for two quarters. From the third quarter of 1990 to the end of 1991 it remained constant. In 1992 M2 started to rise but at the end of the reference period was still well below the level it had attained in the last quarter of 1989. Real time deposits (a component of M2) increased rather slowly during the reference period; they were nearly constant from the third quarter of 1990 to the first half of 1992, and grew only in the second half of 1992, but still did not exceed 60% of the level observed in the last quarter of 1989. Like real growth rates of high-powered money, real growth rates of broad money tended to be relatively high and variable in 1990. Then they varied less, but still their variability coefficient was rather high.

In the course of 1990-1992 sources of M2 changed considerably (Table 2). The tendencies were the same as in the case of high-powered money, therefore we stress only the most important of them. There was a clear-cut increase in the share of credit to the government and a drop in credits to business and households. While in 1990 credit to the government reduced total money supply, in 1991 it accounted for about one-third of total money supply, to reach the share of 46.3 per cent in 1992. In 1992 the share of credits for business and individuals fell considerably, from 74.2 to 59.2 per cent, i.e. by 15 percentage points. Graph 4 shows that while to the last quarter of 1991 credit for business grew at a rate similar to that of total money, in 1992 money outpaced them noticeably.

1.4 Instruments of monetary policy and money supply controllability

The central bank directly determines the stock of high-powered money, while the actual stock of M2 results from the behaviour of banks and other financial institutions able to create money, and from the behaviour of the general public. It can be influenced only indirectly by the market rate of interest, by the interest rate on refinancing credit, by required and voluntary reserves, as well as by the currency-deposit ratio. The last factor is determined not only by economic but also by psychological factors.

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1) Under the new law, exporters are obliged to sell foreign exchange to commercial banks as soon as they receive a payment from their customers.

Monetary policy in Poland during 1990-1992 relied on five instruments: (i) the interest rate, (ii) ratio of obligatory reserves, (iii) the exchange rate, (iv) open market operations, and (v) credit limits. The relevance of each instrument varied over time. At the beginning of the stabilization programme, monetary policy relied on instruments (i)-(iii), whereas since the second half of 1990, credit limits (v) seem to have been the most important one.

The **rate on refinancing credit** (since 1991 the **rediscount rate**[2]) was supposed to be positive in real terms[3]. Nonetheless, *ex post* it turned out to be negative in periods of increased unexpected inflation. Because commercial banks set interest rates in some relation to the central bank's rate, this aimed at stimulating deposits and reducing demand for credits. Due to big differences between refinancing- and market rates of interest, in 1990 (February-October) the central bank determined the minimal rate on deposits and the maximal rate on credits granted by commercial banks. Relatively high interest rates were also to support the fixed exchange rate and to prevent it from speculative attacks (Gotz-Kozierkiewicz, 1992).

The **system of obligatory reserves** was supposed to be an instrument of liquidity control in the banking system[4]. An increase in the ratio of obligatory reserves induces a fall in the credit multiplier and raises the cost of acquiring deposits. This in turn may boost the rate of interest on credits and decrease the rate on deposits.

Obligatory reserves included two parts: an amount transferred to an interest-free account in the NBP[5] and a cash reserve in bank's vaults declared by the bank to be maintained. Changes in ratio of obligatory reserves in 1990 aimed at decreasing liquidity in the banking system. It was therefore augmented from 9 per cent in the first quarter of 1990 to 24 per cent at the end of that year, i.e. by 15 percentage points. In 1991 the ratio of obligatory reserves did not change, only in 1992 it was gradually reduced. At the end of the year it was 10 per cent on time deposits and 23 per cent

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2) Up to the end of 1990 the rate on refinancing credit was the basic rate of the central bank. It mostly concerned credits granted for central investment. From 1991 the rediscount rate took over the role as the NBP's basic rate. It is the rate on credits granted to commercial banks for refinancing purposes.

3) This concerns the refinancing rate. The rediscount rate was noticeably lower than the refinancing rate. This was needed to encourage banks to rediscount bills, a newly introduced financial instrument. The real rediscount rate was negative just when the real refinancing rate was negative.

4) In some developed market economies obligatory reserves are not treated as an instrument of liquidity control, but rather as a factor reducing the risk of depositors.

5) In accordance with the new regulations, an interest rate on a part of the obligatory reserves was introduced in May 1992. It was half as high as the rediscount rate of bills of exchange.

on demand deposits. Resources in foreign exchange accounts were not subject to calculation of obligatory reserves.

The exchange rate was treated as a nominal anchor, i.e. as a factor stabilizing domestic prices. In other words, it was to be kept fixed, even though inflation was expected to persist. As a result the real exchange rate was to appreciate, keeping import prices stable (Letter of Intent, 1989). A fixed exchange rate was applied from the beginning of the reforms until May 1991, when Polish zloty was devalued and the new exchange rate was set in relation to a basket of foreign currencies. From October 1991 to the end of the reference period a so-called "real exchange rate policy" was adopted, which actually meant a crawling peg regime. In addition, in the first quarter of 1992 the Polish zloty was devalued by 12 per cent with respect to the basket of foreign currencies. In 1990 exchange rate stimulated exports, but this feature tended to disappear in 1991. The devaluation of 1992 was meant to reverse this tendency.

Open market operations started in the second half of 1990 with auctions of short-term NBP bills. They were supposed to reduce the banking system's liquidity. With a relatively high cost of acquiring deposits and credit limits (see below), NBP bills (and later treasury bills) were often the sole possibility for profitable short-term investment of free liquidity. Open market operations with treasury bills started in the second half of 1991. They were supposed to cover temporary shortages in the state budget. Commercial banks were the most important group of purchasers of treasury bills. In 1991 demand for bills was 1.4 per cent lower than the offer, while in 1992 demand exceeded the offer by 14.2 per cent. A plausible reason for the increase in demand for treasury bills in 1992 was the poor financial standing of firms. High risk resulting from crediting firms stimulated banks to buy commercial papers instead. Open market operations reduced the iquidity of the banking system as shown in Table 3.

Credit limits were in use since the second half of 1990. They were imposed on credits granted to the socialized sector by state-owned banks and on credits to the government. Limits were imposed according to the amount of credits granted by banks during the year they were set up. This amount was then adjusted to the increase in credits resulting from the monetary policy targets. In 1991 and 1992 limits concerned all economic agents, including households and other banks.

Credit limits may indirectly increase the rate of interest. They lessen competition among banks: those subject to limits cannot grant credits, while those which are not, profit from this monopolistic situation. The introduction of the credit limits seemed

necessary because other instruments (the interest rate and a high ratio of obligatory reserves) were not able to dampen the increase in domestic credits. While in 1990 and 1991 high interest rates and the credit limits efficiently reduced demand for credit, in 1992 the credit limits were much higher than the amounts demanded. This implies that the money market showed some symptoms of disequilibrium.

Broadly speaking, monetary policy can be conducted either by money-stock or by interest-rate targeting. However, the two variables cannot be targeted simultaneously if equilibrium in the money market is to be sustained. Otherwise, non-clearing markets appear, creating a need for the imposition of administrative money demand constraints. If the interest rate is targeted and the market rate differs from the targeted level, money supply should be adjusted. On the other hand, if money supply is targeted, the central bank has to allow the interest rate to adjust in a way that equates money demand with money supply. In practice, however, in some developing countries both variables are targeted (Gotz-Kozierkiewicz, 1992). This was also the Polish practice under the stabilization plan and market-oriented reform. Money targeting seemed to be indispensable to stopping hyperinflation. On the other hand, the interest rate was fixed at a predetermined level. Once money stock targeting was adopted, this practice seemed to be rational. Namely, evidence from money stock targeting shows that it is a cause of persistent, relatively high interest rate volatility and of decreased responsiveness of money demand to changes in market interest rates (Walsh, 1982).

There are good possibilities for money control in Poland, since no money creating financial institutions exist other than banks[6]. On the other hand, financial instruments are only just being introduced, which renders money control difficult. There is also another aspect of money control. Namely, monetary policy itself may impede efficient control. This is not only the case with interest rate targeting but also with money stock targeting. In Poland tight monetary policy based on money stock targeting resulted in the creation of "money surrogate". With limits on credits, a relatively high interest rate and poor financial standing of firms, firms tended to credit one another. Unpaid liabilities became money surrogate. This was beyond the central bank's control. If this kind of money (defined as net receivables of firms) were included in M2, there would have been 8.5 per cent more actual broad money at the end of 1990[7], and 3.7 and 6.8 per cent more at the end of 1991 and 1992, respectively. We would like to stress that there is an important difference between "money surrogate" and what is usually

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6) In fact non-bank savings and loan institutions are developing. It is, however, difficult to estimate the magnitude of deposits and of loans granted; compared with those ofbanks these are plausibly not very large at present.

7) Because of a lack of data net receivables for 1990 are actually data for January 1991.

called "money" – the former cannot be a base for any further process of money creation.

Data on money control efficiency are presented in Table 4.[8] It shows that in 1990 and in 1992 nominal money targets substantially differed from the actual levels (by 41.3 and 12.3 percentage points respectively). In the first case greater than targeted growth in nominal money was due to an unexpected surplus in the foreign trade balance and to an increase in credits to business and individuals. In 1992 there was also an unexpected increase in net foreign reserves, partially due to a higher than planned devaluation of the Polish currency. Also, in 1992 credits to firms and individuals were by almost 16 percentage points lower than the target. It is not clear to what degree this phenomenon resulted from deficient demand for credits by the business sector and how much this was due to the fact that banks were reluctant to grant credits, since they could buy more profitable and practically risk-free treasury bills.

In 1991 the difference between planned and actual nominal money was only 2.5 percentage points. Unfortunately, we cannot present disaggregated data on credits for that year, because we lack comparable data on net credits to the budgetary sector. It is noteworthy that credits to business and households were to increase by 72.6 per cent in nominal terms. Actually they grew about 10 percentage points less than targeted .

Realization of targets in real terms was not successful either in 1990 or in 1991. In 1992 the gap between targeted and actual money was about 3 percentage points only.

To sum up, in 1991 nominal money was hit, whereas in 1992 the real money supply target was affected. Another problem is that actual structure of money creation factors noticeably differed from the planned one. The most important feature was the expansion of bank credits to the government and the contraction of credits to the non-budgetary sector.

1.5 Money supply: exogenous or endogenous?

The notion of money exogeneity (or endogeneity) raises many doubts. Up to recently this was often confused with money supply controllability by policy measures (for examples see Dornbusch, Fischer, 1987). Currently one believes that there may be

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8) We are aware of the fact that the word "efficiency" is not quite appropriate, since differences between targets and realization may occur for political reasons, or targets may be revised according to changing conditions.

exogeneity without any possibility of the variables being manipulated by policy. The key point in the problem of exogeneity is the direction of causality, whether it moves from money to other variables or from other variables to money (Desai, 1987).

Money exogeneity (endogeneity) crucially depends on the type of money, as well as on the development of the money market and the banking system of a country. While under the gold standard or a fixed exchange rate money was exogenous, under the modern credit system it tends to be rather endogenous. The more developed the money market is with various non-bank financial intermediaries, the less exogenous and by the same token, the more endogenous money will be. The development of money substitutes has the same influence on the degree of money exogeneity (endogeneity). Banks and other financial institutions have more possibilities of choosing financial instruments that are profitable in given circumstances. The degree of money exogeneity is also influenced by the exchange rate system. As it is well known, under the fixed exchange rate system, domestic monetary policy is less autonomous than under a floating exchange rate, with the possibility of stopping undesirable capital flows that are crucially dependent on the development of financial instruments. Therefore, an important factor endogenizing money supply is an inflow of foreign reserves due to increased exports. This is a case of causality from past output to money. We consider such a case as money endogeneity, but some authors classify it as "weak exogeneity".[9] The money supply increases since the central bank buying foreign exchange increases high-powered money.

As we have mentioned, the banking system and the money market are underdeveloped in Poland. These are factors that exert an influence towards money exogeneity. On the other hand, a larger than expected inflow of foreign reserves in 1990 and 1992 had a reverse impact on the character of money supply. This was a result of the restrictive monetary policy with credit rationing and depressed domestic demand and of the Polish currency's over-devaluation (the two factors menioned last were more characteristic for 1990 than for 1992). In other words, tight monetary policy put into motion forces that acted on money endogeneity.

We think that the utilization of credit limits may also serve as a helpful hint about money exogeneity, i.e. if they are not fully used, this means that credits actually grew less than they could have done with a given increase in deposits. As mentioned

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9) Desai (1987) provides a simple definition of weak exogeneity. He considers a small model, consisting of four variables: P (price level), R (real interest rate), Y (real output), and M (money stock). These variables are subdivided into three non-monetary variables, P, Y, R, labelled X, and money, M. There are exogenous variables, such as tastes or technology, and international variables, labelled Z. M is weakly exogenous if it is influenced by the past values of X, and Z, though not by the current values of X.

above, in 1992 demand for credits by firms and individuals was much lower than the level of limits. In other words, the money supply did not change in response to the central bank's expectations, but to demand in the economy.

After having identified factors acting towards both money exogeneity and money endogeneity, we tested the relationship between high-powered money and broad money to answer the question whether money was rather exogenous or endogenous. A high correlation between the two variables means that changes in broad money result from changes in high-powered money rather than from current shifts in demand in the economy. The test shows that there was a statistically significant correlation between the two variables. It was, however, rather weak, with adjusted R^2 equal to 0.49. The correlation between high-powered money in time *t* and broad money in time *t+1* turned out to be even weaker, with adjusted R^2 = 0.32 only, but it was still statistically significant.

The main results of our analysis of money supply are as follows: (i) changes in foreign reserves (assets) were an important factor that made money supply differ from targets in 1990 and 1992, and which also endogenized the money supply; (ii) credit limits impeded excessive monetary growth in the second half of 1990 and presumably in 1991; throughout 1992 demand for credits to business and individuals was lower than existing limits (iii) even though the correlation between reserve money and M2 was statistically significant, it was rather weak, which allows us to conclude that the money supply was rather demand-determined.

2. Money demand

The question whether the money demand function is stable is an important issue in economic theory and policy. If money demand is rather volatile, as the Keynesian and neo-Keynesian theory predicts, then to avoid excessive output fluctuations due to changes in expenditures, some accommodating money supply policy is needed. On the other hand, monetarist theory assumes that money demand is rather stable. Then, if money supply is known, both the slope and position of the LM curve can be better determined than the IS curve. With the IS curve shifting in an unpredicted way, the output level is stabilized if money supply grows at a steady rate. Thus, stable money demand allows output control (Poole, 1970). In the following section we estimate the demand for both narrow and broad money. We start with a summary of methods used for estimating money demand. Next we discuss plausible determinants of money demand and present the results of our estimates.

2.1 The demand for money – econometric issues

Money demand is estimated under the necessary assumption that money demand equals money supply, because only data on money supply are available. In reality, however, the long-run equilibrium in the money market may get disturbed. To capture possible lags in returning to equilibrium, a partial adjustment model is commonly used, where only a fraction (β) of the actual monetary stock adjusts to the desired level. The bigger β, the faster the adjustment. A key point in the estimate is the selection of exogenous and endogenous variables. If money supply is assumed to be demand-determined rather than exogenously determined,the following model (in the logarithmic form) may be used as was done in many previous studies:

$$m_t = a_o + a_1 y_t + a_2 \pi_t \qquad a_1 \geq 0; \quad a_2 \leq 0 \tag{1}$$

where m_t stands for real money balances (the log of), y_t is a scale variable (the log of), and π_t represents the opportunity cost of holding money, either in the log-form (Goldfeld, 1973, Goldfeld and Sichel, 1990) or not (Financial Programming, 1992), the choice depending on the empirical results; a_0, a_1, a_2 stand for a constant, the income elasticity of money demand, and the elasticity (or semi-elasticity) of the opportunity cost of holding money. The partial adjustment model of money demand (in log-form) is:

$$m_t = b_0 + b_1 y_t + b_2 \pi_t + b_3 m_{t-1} \tag{2}$$

where

$b_0 = \beta a_0$
$b_1 = \beta a_1$
$b_2 = \beta a_2$
$b_3 = 1-\beta$

If, on the other hand, money supply is exogenous rather than demand-determined, the interest rate should be treated as endogenous and estimated as in Laidler (1980), e.g.,

$$r - r_{-1} = \mu (r^* - r_{-1}) + w \tag{3}$$

where r stands for the real interest rate, r^* is the long-run equilibrium value of the real interest rate and w is a disturbance term.

Our analysis of money supply leads us to use (1) or (2) rather than (3). As we have shown, money was endogenous to some extent. Moreover, interest rates could not be used as in estimate (3), because they did not meet the condition of equilibrating demand and supply on the money market. Only the interest rate on interbank loans

was solely determined by the market forces. Other rates were more or less controlled by the monetary authorities.

Presenting (1) and (2) we said that y_t is a scale variable. Thus, the question arises what variable should be chosen to obtain a stable money demand function. Estimates related to the Keynesian money demand theory usually use GDP (GNP) in real terms, whereas those related to monetarist theory rather use permanent income, measured as a weighted average of past and current GDP (GNP). According to statistical evidence for the USA, before 1973 both GNP and permanent income were equally good as proxies for transactions, and during a period of a substantial shift in money demand, permanent income did not outperform GNP (Goldfeld, Sichel, 1990). Some authors suggest that since some components of GDP are more money consuming than others, GDP needs to be disaggregated and either consumer spending, or personal disposable income, or even final sales could be treated as scale variables to produce a more stable money demand function (Mankiw, Summers, 1986). In some econometric studies real wages were also found to have a systematic influence on money demand (Laidler, 1985)[10].

Theory predicts that the income elasticity of money demand ranges between one-third and one. In the Baumol–Tobin model it is one-half. If, however, transaction costs (brokerage fees) are assumed to be related to the time needed to go to the bank and thus to the wage rate, which in turn is positively correlated with the level of income, the overall income elasticity would then be greater than one-half (Mulligan, Sala-i-Martin, 1992). There are also models predicting the elasticity to be unity.

We hypothesized that demand for narrow and broad money could be determined by (i) real income (y_t), or alternatively (ii) real wages (w_t), (iii) the real interest rate on 3-months savings deposits (r_t)[11], (iv) the current inflation rate (p_t) and (v) the real exchange rate (x_t). Factors (iii) and (iv) capture the opportunity cost of holding money. As it is often practised in studies of the demand for money in countries where the financial liabilities of the banking system to the private sector represent the greatest part of the latter's financial assets, real interest rates (or the exchange rate) are often

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10) Normally, real wage rates are introduced as a proxy variable for the brokerage fee, which plays a key role in transactions and precautionary theories of money demand.

11) As a rule, more than one interest rate is included in estimated equations. Transaction theories, implying that short-term market securities (e.g., treasury bills) were the closest alternative to holding money, therefore correctly proxied the opportunity cost of holding money. On the other hand, theories connected with portfolio analysis included yields on longer-term financial assets, sometimes even equities. We used only one interest rate, the inflation rate, and the exchange rate as a better reflection of the opportunity cost of holding money, because securities and equities have only started in the Polish economy; a tentative introduction of long-term interest rates on time deposits did not improve our results.

treated as a proxy for the yield on financial assets relative to real assets, i.e. as the opportunity cost of holding money (Financial Programming, 1992, see also Lahiri, 1991: DeLorme, Kamerschen, Lopez, 1993). Money demand grows with real income, whereas an increase in inflation reduces it. The economic agents switch to other financial or real assets to avoid the depreciation of their money holdings. The influence of the real interest rate is different in the case of M1 and M2. An increase in the real interest rate on time deposits should reduce demand for M1 and increase demand for M2. The role of the real exchange rate regarding money demand is more complicated. Demand for the domestic currency increases, whereas demand for foreign currency deposits falls after a devaluation of the domestic currency. If inflation persists and the exchange rate remains fixed, it tends to appreciate in real terms. Then, demand for foreign exchange gradually rises, because import becomes cheaper compared with domestic production. Importer sell their domestic currency deposits to buy foreign exchange. Also, when the economic agents think that the exchange rate has appreciated too much and they expect a devaluation, they tend to buy foreign currencies and therefore demand for domestic money falls further. It increases once again after a devaluation. Hence, an exchange rate appreciation does not exclude an increase in demand for the domestic currency, but this effect vanishes as soon as the domestic currency is overvalued and import tends to crowd out domestic output. Put it other words, we cannot say, *ex ante*, whether the coefficient of elasticity or semi-elasticity should turn out to be negative or positive.

In our estimates we use quarterly data. In the case of money we could use data on the last-day-of-quarter flow of funds only, instead of quarterly averaged data. This was due to changes in Polish monetary statistics introduced in 1992, which resulted in a lack of comparability of some data. Since there are no data on quarterly GDP, we decided to use our estimate of this variable.

2.2 Empirical results: demand for M1

We used three equations to estimate the demand for narrow money. First, we checked for the autocorrelation of the time series of M1. We obtained a weak autocorrelation effect for the one-quarter lag. Next, we estimated demand for money according to Goldfeld's "basic" equation (1). We obtained the following solution, where m^1, and y are the natural logarithms of real narrow money and the gross domestic product (GDP), (p) is the inflation rate and (r) stands for the real interest rate on 3-months time deposits:

$$m_t^1 = 4.399 + 0.143y_t - 0.009p_t - 0.013r_t. \qquad (4)$$

The income elasticity of our estimation (0.143) is noticeably lower than that predicted by the Baumol-Tobin model. This means that demand for money increases by 0.143 per cent if income rises by 1 per cent. The semi-elasticities of both opportunity cost variables, i.e. the inflation rate and the real interest rate are negative as expected. However, the results we obtained are statistically significant, with adjusted R^2=0.979 and the standard error of estimation SEE=0.028. For the details of fitting data see Table 6 and Graph 5.

Next, we introduced real wages into the equation to replace real income. Namely, we hypothesized that real wages could serve as a better proxy for aggregate demand than output in the period of falling investment. In fact, the solution

$$m_t^1 = 4.224 + 0.172 w_t - 0.008 p_t - 0.012 r_t \qquad (5)$$

where w stands for the logarithm of real wages, was slightly improved as far as "income" elasticity of money demand was concerned, but the statistical fit was somewhat worse than in (4), see Table 6 and Graph 6.

The results obtained in (5) led us to use real wages as a proxy for aggregate demand and to try and introduce the real exchange rate as an additional variable explaining the money demand function. Thus, we obtained (6):

$$m_t^1 = 3.007 + 0.417 w_t - 0.009 p_t - 0.012 r_t + 0.005 x_t \qquad (6)$$

where x is the index of the real exchange rate.

Here the "income" elasticity (0.417) is close the one predicted by the Baumol–Tobin model. It is interesting that this occurred only when we introduced the real exchange rate to the equation. The semi-elasticity of money demand with respect to the real exchange rate is relatively low and positive. This means that during the reference period in general the real appreciation of the Polish currency[12] slightly increased rather than diminished demand for domestic currency deposits. This was plausible due to an increase in demand for the domestic currency after a sharp devaluation in January 1990. Since the beginning of 1991 the real appreciation tended to reduce demand for narrow money (see Graph 6 and Graph 7; the former shows estimated money demand as a function of the inflation rate, real wages and the real interest rate, whereas the latter also includes the real exchange rate). The fit is satisfactory: adjusted R^2= 0.975, SEE=0.0299 (for the details of fitting see Table 6 and Graph 7).

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12) After an initial devaluation in January 1990, the Polish currency tended to appreciate in real terms, except for the third quarter of 1991, and the second and last quarters of 1992. During the 1990-1992 period it appreciated by 56.9 per cent. This means that the element x of our equation was falling.

A tentative introduction of the logarithm of lagged real narrow money worsened the fitting; the elasticity of current money demand with respect to lagged supply was relatively low, implying that if disequilibrium occurred, money demand would adjust rather quickly.

To check if our money demand function holds, we tested it with data on the first and second quarters of 1993, i.e. the period that is beyond our analysis. In other words, using actual data on inflation, real wages, the interest rate and the exchange rate we produced data on hypothetical money demand. In the first quarter it was 2.6 percentage points higher than actual supply, whereas in the second quarter it exceeded actual supply by 2 percentage points.

2.3 Empirical results: demand for M2

In estimates of demand for M2 we followed the same pattern. As a first step we estimated (1) and (2) and then looked for further solutions. We checked for the autocorrelation effect. For M2 it was slightly bigger than for M1.

We did not obtain good results using (1). Both, the interest rate and the logarithm of income fitted poorly. Adjusted R^2 was 0.735. Therefore, we once again used (the logarithm of) real wages as a scale variable. The results were slightly better, but the real interest rate still fitted poorly. Our next step was to check if introducing lagged M2 (logarithm of) would improve the estimation. We hypothesized that the autocorrelation of M2 could influence the disturbance term. We obtained:

$$m_t^2 = 2.7357 + 0.1803y_t - 0.1552p_t + 0.273m_{t-1}^2 \qquad (7)$$

where m^2 represents broad money in real terms (log of), y is real income (log of), and p stands for the logarithm of the inflation rate. Constant terms and coefficients of y, p, and m_{t-1} are those of equation (2). They therefore correspond to b_0, b_1, b_2 and b_3, respectively. This implies that the coefficient β, reflecting the speed of adjustment of money demand to disequilibrium in the money market is 0.727 and can be considered to be rather high. Put in another way, money demand adjusted fairly quickly during 1990-1992.

Here, the result is superior to the previous one, but still not satisfying. All variables fit better than before, also adjusted R^2 is noticeably higher (Table 7, Graph 8). The elasticity coefficient on income, however, is significantly lower than expected. This time income serves better than wages as a scale variable and the logarithm of the inflation rate produces better results than the inflation rate itself.

Other attempts to find a better estimate were rather unsuccessful. We tried including the exchange rate and/or the interest rate in the equation. We considered the exchange rate as extremely important in the estimation of demand for M2, since a considerable part of the population's wealth used to be stored in foreign exchange. Unfortunately, both variables either in logs or in levels fitted poorly. Similar difficulties are reported in Tarka (1992). Differences between our estimation and the actual data started in the second quarter of 1991. Whereas our equation predicted a sharp increase in the demand, the actual data show a very weak one. On the other hand, from the beginning of 1992 simulated demand was significantly lower than the actual data. This may be a reflection of a temporary disequilibrium or of a misspecification of the function. Taking into account that besides inflation there is no other opportunity cost of holding money the latter is quite plausible.

3. Conclusions

The main results of sections 1 and 2 can be summarized in the following propositions:

(1) Credit limits were the main instrument of monetary policy during the period from the third quarter of 1990 to the fourth quarter of 1992.

(2) Monetary policy became highly restrictive from the fourth quarter of 1990: simultaneously the ratio of obligatory reserves was increased, and credit limits were imposed. Our tentative opinion is that this aggravated the output decline in 1991.

(3) Only in 1991 the monetary authorities effectively controlled the supply of total money in nominal terms. It must be stressed, however, that the actual amount of credits granted to the business sector and to households was much lower, whereas that of credits granted to the government sector was much higher than the target.

(4) Money supply was endogenous to some extent; we ascribe this fact mainly to the influence of bigger than expected changes in foreign reserves.

(5) The demand for money (M1) was determined by wages (used as a proxy for income), the interest rate on three-months time deposits, the inflation rate and the exchange rate. The interest rate on long-term deposits did not play any significant role. We were not able to specify the function of demand for broad money (M2).

(6) There are a few potential factors that may now and in the future induce a destabilizing impact. The first is inflation. If it accelerates, which is not implausible, there will be a shift from demand for financial assets towards real assets. Money market development and the introduction of new financial instruments, especially for firms, is another potentially disturbing factor.

Tables and graphs

Table 1a

Stock of high-powered money and factors determining the creation of money by the central bank, in Zl 1,000 bn
(table based on balance sheet of NBP)

	High-powered money (reserve money)		Net credit to government[1)]		Net credit to financial and non-financial sector	Net foreign assets		Net other items (residual data)
	Old	New	Old	New		Old	New	Old
1989	28.3		4.4		14.0	9.8		0.1
1990	83.4		-7.7		45.8	38.2		7.1
1991	110.1	117.3	19.7	32.6	35.2	31.0	37.0	24.2
1992		155.6		108.8	-4.1		57.6	
as percentage of total reserve money								
1989	100.0		15.5		49.9	34.6		0.4
1990	100.0		-9.2		54.9	45.8		8.5
1991	100.0	100.0	16.8	27.8	30.0	28.2	31.5	22.0
1992		100.0		69.9	-2.6		37.0	

1) Since 1991 including NBP securities
Sources: 1989 &1990 NBP Annual Report 1990, pp. 32, 33 and Annex IV. Sprawozdanie NBP z realizacji polityki pienieznej w 1990 roku, p. 47; 1991 & 1992 Information Bulletin NBP, 1/1992, p. 17, Annex Tables 4 and 5; Information Bulletin NBP, 2-3/1992, pp. 16, 17 and Annex Table 3; Information Bulletin NBP, 13/1992, pp. 16, 17, 18 and Annex Table 3.

Table 1b

Increase in stock of high-powered money and of factors determining the creation of money by the central bank in Zl 1,000 bn (table based on balance sheet of NBP)									
	High-powered money (reserve money)		Net credit to government[1)]		Net credit to financial and non-financial sectors	Net foreign assets		Net other items (residual data)	
	Old	New	Old	New		Old	New	Old	New
1990-1989	55.1		-12.1		31.8	28.4		7.0	
1991-1990	26.7		27.4		-10.6	-7.2		17.1	
1992-1991		38.3		76.2	-39.3		20.6		-19.2
as percentage of total increase in reserve money									
1990-1989	100.0		-22.0		57.7	51.5		12.7	
1991-1990	100.0		102.6		-39.7	-27.0		64.0	
1992-1991		100.0		199.0	-102.6		53.8		-50.1
Source: Table 1a.									

Table 2

Stock of broad money and factors determining the creation of money by the banking system, in Zl 1,000bn
(table based on the consolidated balance sheet of the banking system)

	Broad money (total money supply)		Net credit to government		Credits to business and individuals		Net foreign reserves assets		Net other items (residual data)	
	Old	New	Old	New	Old	New	Old	New	Old	New
1989	95.8		6.5		33.5		15.4		40.4	
1990	188.8		-11.0		118.2		76.6		4.9	
1991	280.9	261.0	32.0	88.3	191.8	193.6	71.3	77.8	-14.1	-98.8
1992		411.1		190.2		243.5		132.3		-154.8
as percentage of total broad money										
1989	100.0		6.8		35.0		16.1		42.2	
1990	100.0		-5.8		62.6		40.6		2.6	
1991	100.0	100.0	11.4	33.8	68.3	74.2	25.4	29.8	-5.0	-37.9
1992		100.0		46.3		59.2		32.2		-37.7

Sources: For 1989 and 1990 NBP Information Bulletin 4/1991, Table 2; for 1991 NBP Annual Report 1991, p. 52; for 1992 NBP Information Bulletin 13/1992, Table 5.

Table 3

Decline of liquidity of the banking system							
	Balance of NBP bills in circulation	Balance of treasury bills in circulation and deriving from auction, purchase costs			Liquid reserves[a)]	Liquidity of the banking system	
		Total	of which bought by commercial banks				
	1)			2)	3)	4=1:3	5=(1+2):3
	1,000 bn Zl	1,000 bn Zl	% of total	1,000 bn Zl	1,000 bn Zl	in %	in %
1990	0.5	-			14.7	3.4	
1991	1.8	6.8	92.3	6.3	15.3	11.8	52.9
1992	-	49.9	78.4	39.1	22.7		172.2

a) Current accounts of banks' with NBP and cash in banks' vaults less declared cash.

Sources: Sprawozdanie z realizacji polityki pienieznej w 1990 roku, p. 60; NBP Annual Report 1991; NBP Information Bulletin 13/1992; Fundacja Edukacji i Badan Bankowych, Analizy Zeszyt 1, 1993, p. 35.

Table 4

Money supply according to NBP classification target (forecast) and actual
1990-1992, in Zl 1,000 bn
(table based on consolidated balance sheet of the banking system)

		1989	1990		1991		1992	
		actual	target	actual	target	actual	target	actual
Total money 1,000 bn Zl	1)	95.8	149.3	188.8				
	2)			190.5	276.2	280.9	407.9	
	3)					261.0		411.1
Increase in money stock, 1,000 bn Zl			53.5	93.0	85.7	90.4	127.0	150.1
Domestic assets net[a] 1,000 bn Zl	1)	42.2	86.6	132.2				
	2)			116.2	205.6 b)	209.6	302.0	
	3)					183.2		278.8
Increase in domestc assets net 1,000 bn Zl			44.4	90.0	79.3 b)	93.4	92.4	95.6
Foreign reserves net 1,000 bn Zl	1)	51.5	69.4	107.3	113.7 b)			
	2)			74.3		71.3	105.8	
	3)					77.8		132.3
Increase in foreign reserves net 1,000 bn Zl			17.9	55.8	6.4 b)	-3.0	34.5	54.5
Nominal and real annual growth in %			%	%	%	%	%	%
Total money, nominal growth in %			55.8	97.1	45.0	47.5	45.2	57.5
Total money, real growth in %			-33.1	-43.6	9.8	-8.1	6.1	9.2
Domestic assets net, nominal growth in %			105.2	213.3	62.9 b)	80.3	44.1	52.2
Domestic assets net, real growth in %			-11.8	-10.3	23.4 b)	12.5	5.3	5.5
Foreign reserves net, nominal growth in %			34.8	108.3	6.0 b)	-4.0	48.4	70.1
Foreign reserves net, real growth in %			-42.1	-40.4	-19.7 b)	-40.2	8.5	17.
Consumer price, December to December, annual growth in %			132.8	249.3	32.0	60.4	36.8	44.3

a) For 1989 and 1990 net domestic credits only. - b) According to Bank i Kredyt 1/1991, Zalozenia polityki pienieznej na 1991 rok. - c) For 1989 and 1990 foreign assets (methodological change).

Sources: 1) Sprawozdanie NBP z realizacji polityki pienieznej w 1990 roku. - 2) Zalozenia polityki pienieznej na 1992 rok (projekt) and Sprawozdanie NBP z realizacji polityki pienieznej w I kwartale 1991, p. 2. - 3) Information Bulletin NBP 1991 and NBP Monthly Bulletin 13/1992.

NBP Monthly Information Bulletins: 2/1991, 1/1992, 2-3/1992, 11-12/1992.

Table 5

Data from the consolidated balance sheet of the banking system, Zl 1,000 bn								
		1989	1990		1991		1992	
		actual	target	actual	target	actual	target	actual
1)	Credits for businesses and individuals	33.5	78.0	118.2	196.8	191.8	271.8	
						193.6		243.5
	Increase in credits to businesses and indiv.		44.5	84.8	82.8	73.6	80.0	49.9
	Nominal growth in %		132.8	252.8	72.6	62.3	41.7	25.8
	Real growth in %		0.0	1.0	30.8	1.2	3.6	-12.8
2)	Net credits to budgetary sector	6.4	6.3	-11.0				
				-9.2		32.0		
	new system					88.3		190.2
	new system			-9.2		91.8	143.1	
	Increase in net credits to budget		-0.1	-17.4	4.5	41.2		
						101.0	51.3	101.8
3) =1 +2	Net credit total	39.9	84.3	107.2		223.8		
	new system					285.4		433.7
	Increase in net credits		44.4	67.3	87.3	116.6		
	new system					174.6	131.3	148.3
4)	Domestic assets, net	42.2	86.6	132.2				
				116.2		209.6	302.0	
						183.2		278.8
5)	Other items, net (residual data)	2.3	2.3	25.0		-14.2		
				9.0		-102.2		

Sources: Sprawozdanie NBP z realizacji polityki pienieznej w 1990 roku; NBP Monthly Information Bulletins: 2/1991; 1/1992 2-3/1992; 11-12/1992; 13/1992; Information Bulletins NBP 1990, 1991; Zalozenia polityki pienieznej na 1992 rok (projekt); Bank i Kredyt, 1/1991 Zalozenia polityki pienieznej na 1991 rok.

Table 6

Money demand estimates for Poland, IQ 1990 - IVQ 1992

4)
lnM1=F(GDP, dP/P, r)
$m_1=a_0+a_1y+a_2p+a_3r$ $R^2=0.984$ $R_a^2=0.979$ SEE=0.028 $F_{3,8}=168.5$ P=1E-07

			Independent Variables			
			y=ln(GDP)	p=dP/P	r	
		a_0	a_1	a_2	a_3	
		4.399	0.143	-0.009	-0.013	
	SE		0.057	0.001	0.002	
	T		2.494	-12.546	-6.909	
	P_V		0.037	0.000	0.000	

5)
lnM1=F(W,dP/P,r)
$m_1=a_0+a_1w+a_2p+a_3r$ $R^2=0.978$ $R_a^2=0.970$ SEE=0.033 $F_{3,8}=120.4$ P=5E-07

			Independent Variables			
			y=ln(W)	p=dP/P	r	
		a_0	a_1	a_2	a_3	
		4.224	0.172	-0.008	-0.012	
	SE		0.115	0.001	0.003	
	T		1.492	-6.719	-4.385	
	P_V		0.174	0.000	0.002	

6)
LnM1=F(W,dP/P,r,x)
$m_1=a_0+a_1w+a_2p+a_3r+a_4x$ $R^2=0.984$ $R_a^2=0.975$ SEE=0.030 $F_{4,7}=109.7$ P=2E-06

			Independent Variables			
			y=ln(W)	p=dP/P	r	x
		a_0	a_1	a_2	a_3	a_4
		3.007	0.417	-0.009	-0.012	0.005
	SE		0.183	0.001	0.002	0.003
	T		2.275	-7.512	-4.883	1.631
	P_V		0.057	0.000	0.002	0.147

R_a^2 - Adjusted R^2 a_i - Regression coefficient $F_{i,j}$ - F-statistic of regression
SEE - Standard error of equation $T = a_i : SE$
SE - Standard error of parameter P_V - Significance of explanatory variable P - Significance of regression

Table 7

Money demand estimates for Poland, IQ 1990 - IVQ 1992						
7) lnM2=F(GDP, dP/P, $M2_{t-1}$) $m_2=a_0+a_1y+a_2p+a_3m_{t-1}$		R^2=0.863	R_a^2=0.811	SEE=0.057	$F_{3,8}$=16.754	P=8E-04
			independent variables			
			y=ln(GDP)	p=ln(dP/P)	m_{t-1}=ln($M2_{t-1}$)	
		a_0	a_1	a_2	a_3	
		2.736	0.180	-0.155	0.273	
	SE		0.119	0.023	0.124	
	T		1.510	-6.737	2.203	
	P_V		0.170	0.000	0.059	

R_a^2 - Adjusted R^2 a_i - Regression coefficient $F_{i,j}$ - F-statistic of regression
SEE - Standard error of equation $T = a_i : SE$
SE - Standard error of parameter P_V - Significance of explanatory variable P - Significance of regression

All equations were obtained with max. R-square regression methods.

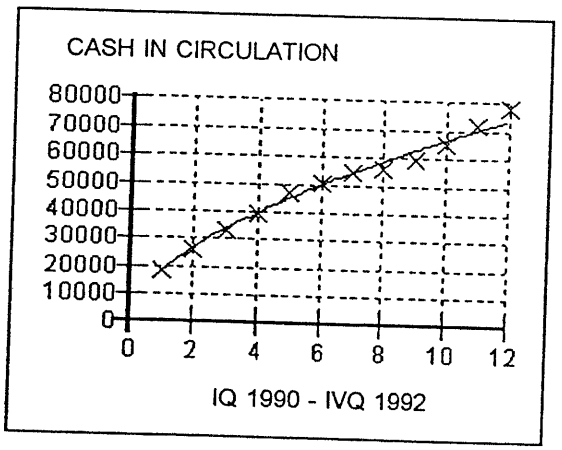
wrobel.tab(working)

Graph 1

Stocks of money, end of quarter

in zloty billion

(a)



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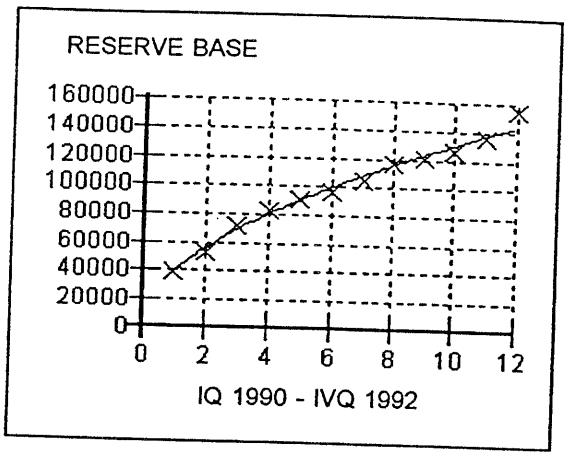

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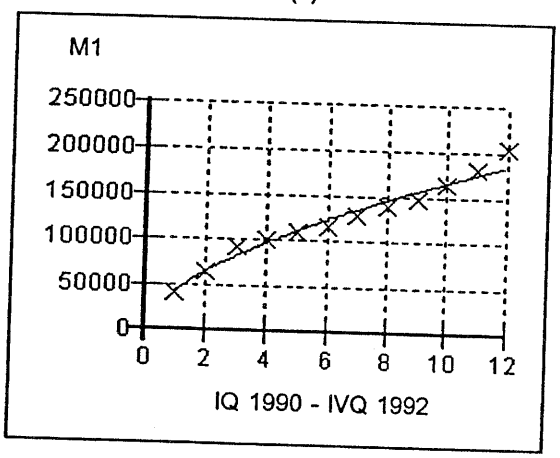

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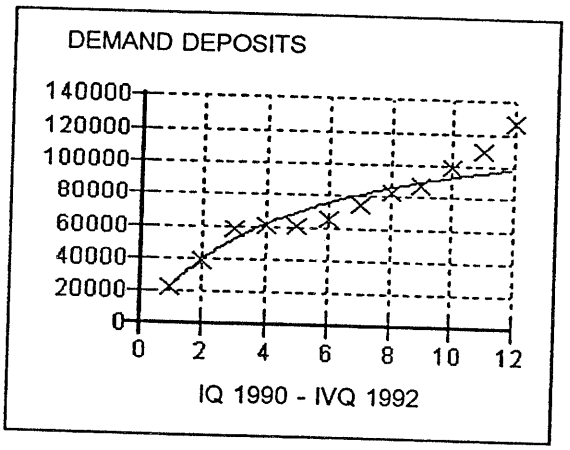

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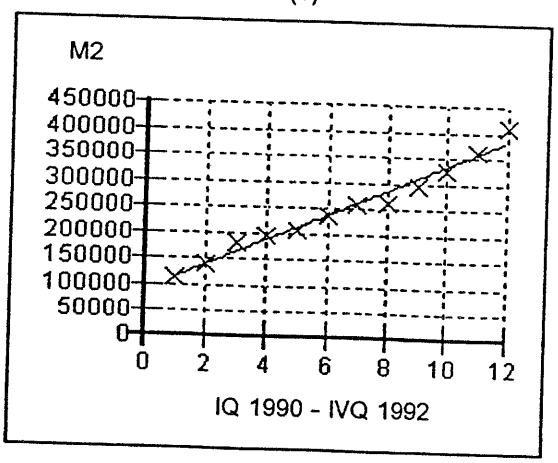

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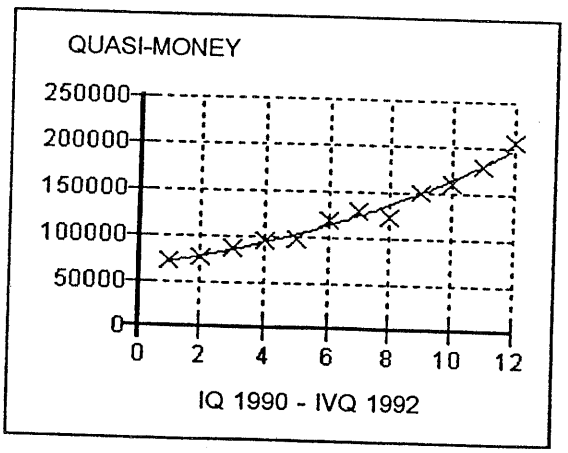
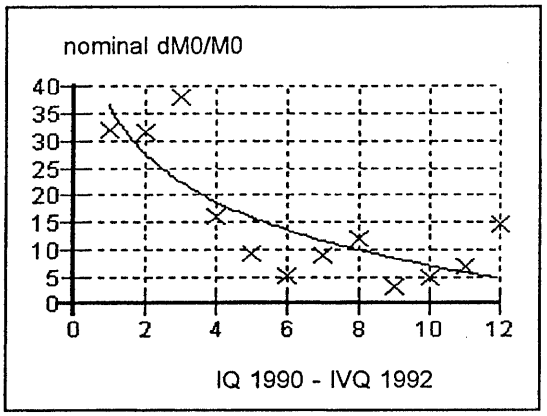


Graph 2

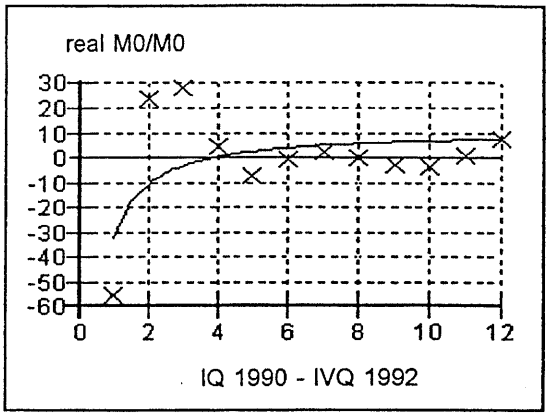
Nominal and real growth of money supply

in % against previous quarter

(a)



(b)



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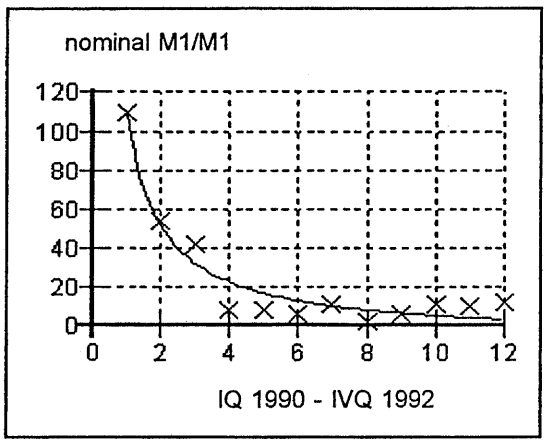

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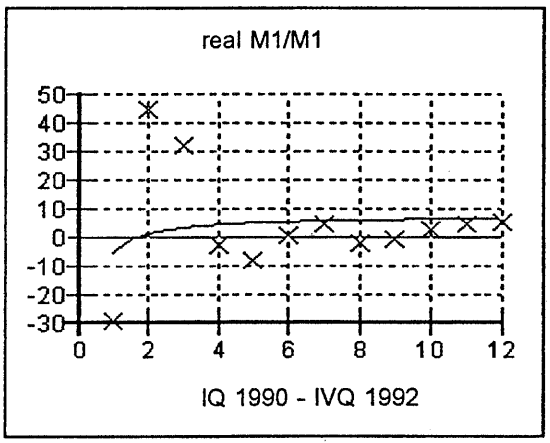

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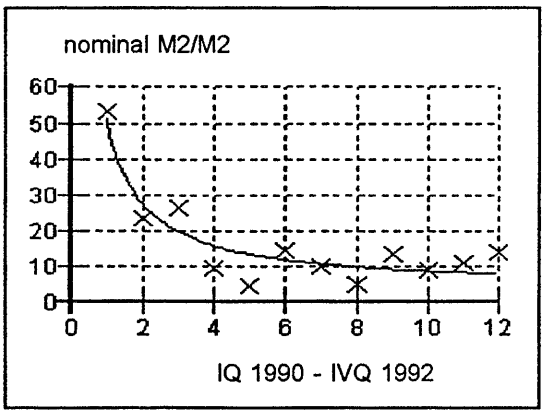

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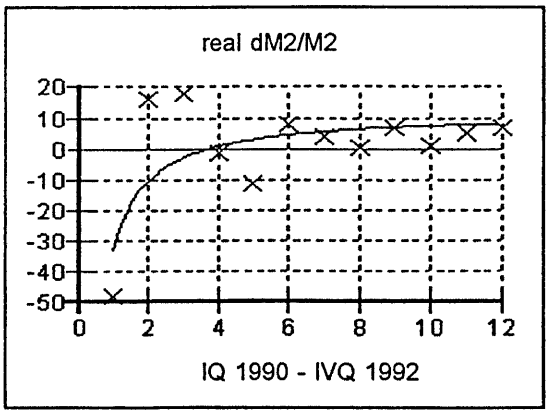
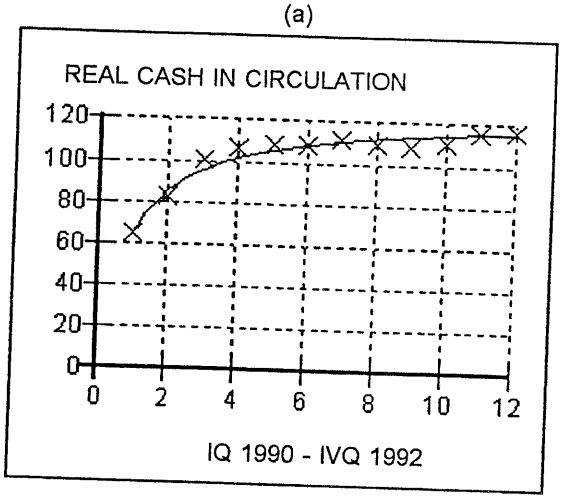


Graph 3

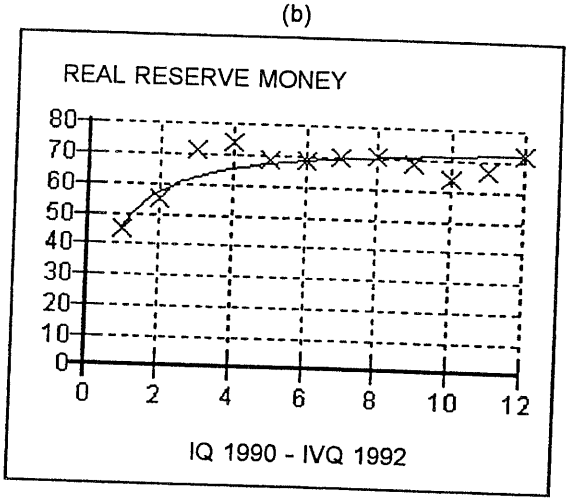
Stocks of money

index numbers, IQ 1989 = 100

(a)



(b)



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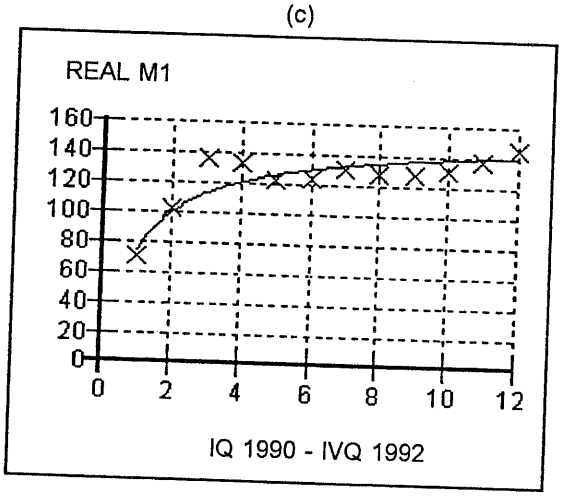

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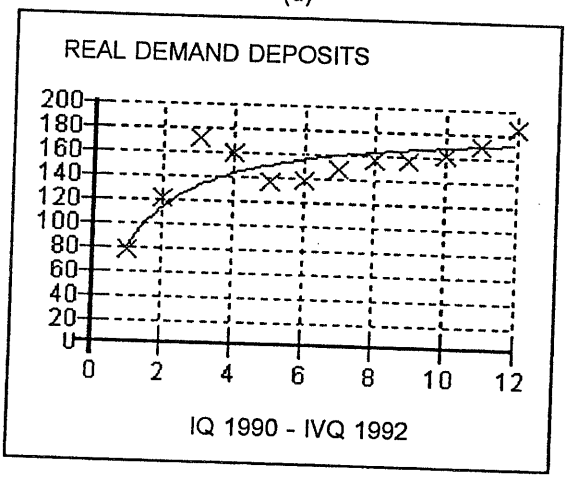

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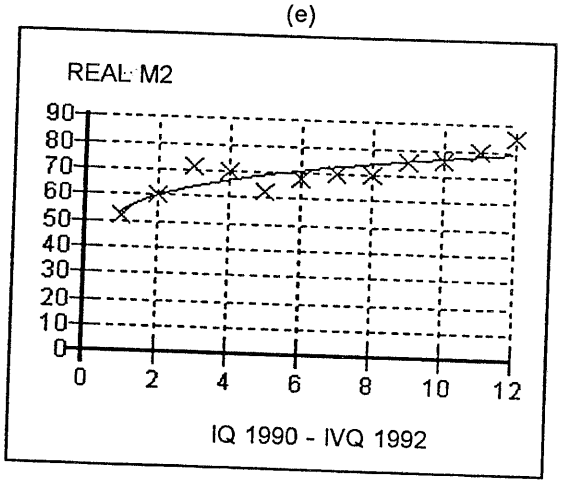

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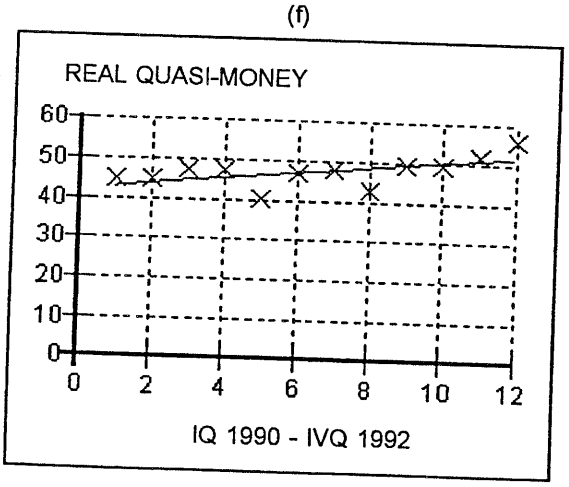
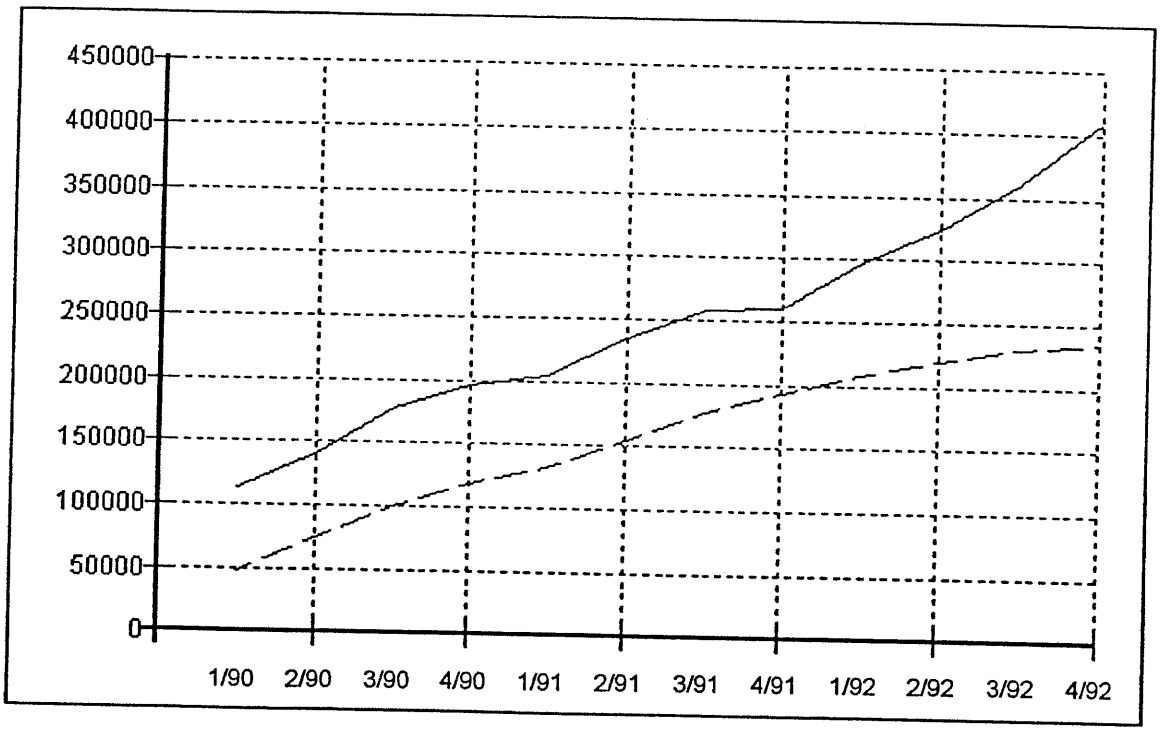


Graph 4

Stocks of M2 and credits to businesses and individuals

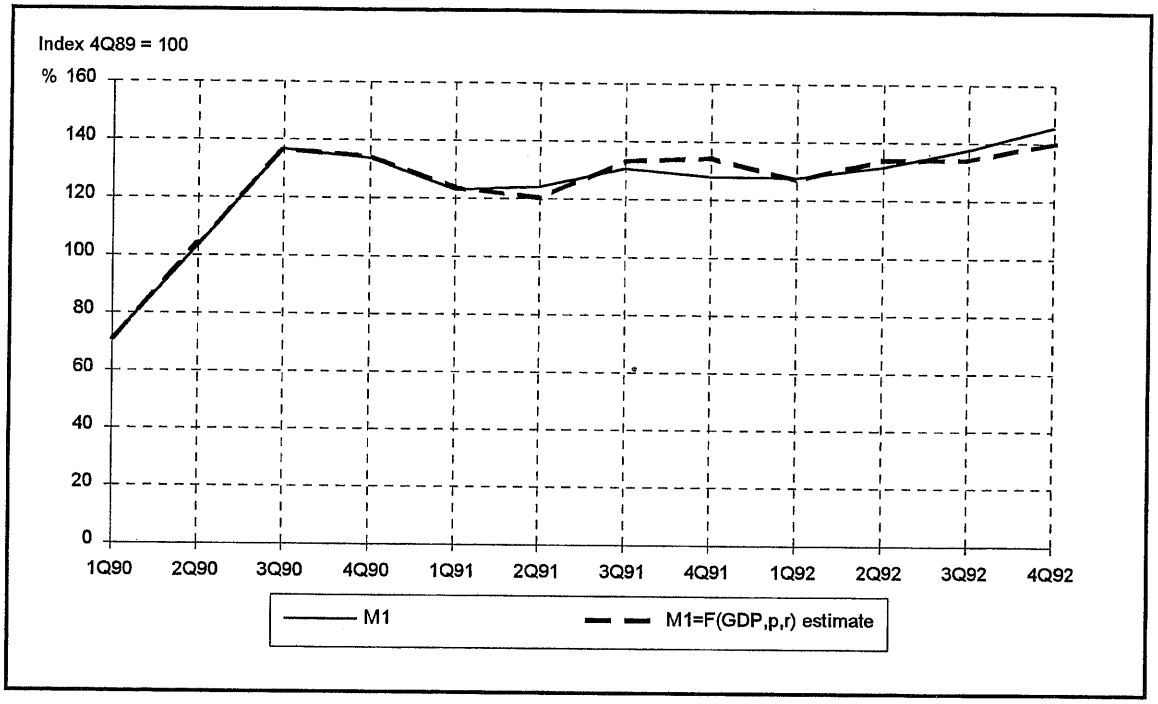
in zloty billion, IQ 1990 – IVQ 1992



Empirical results: demand for M1

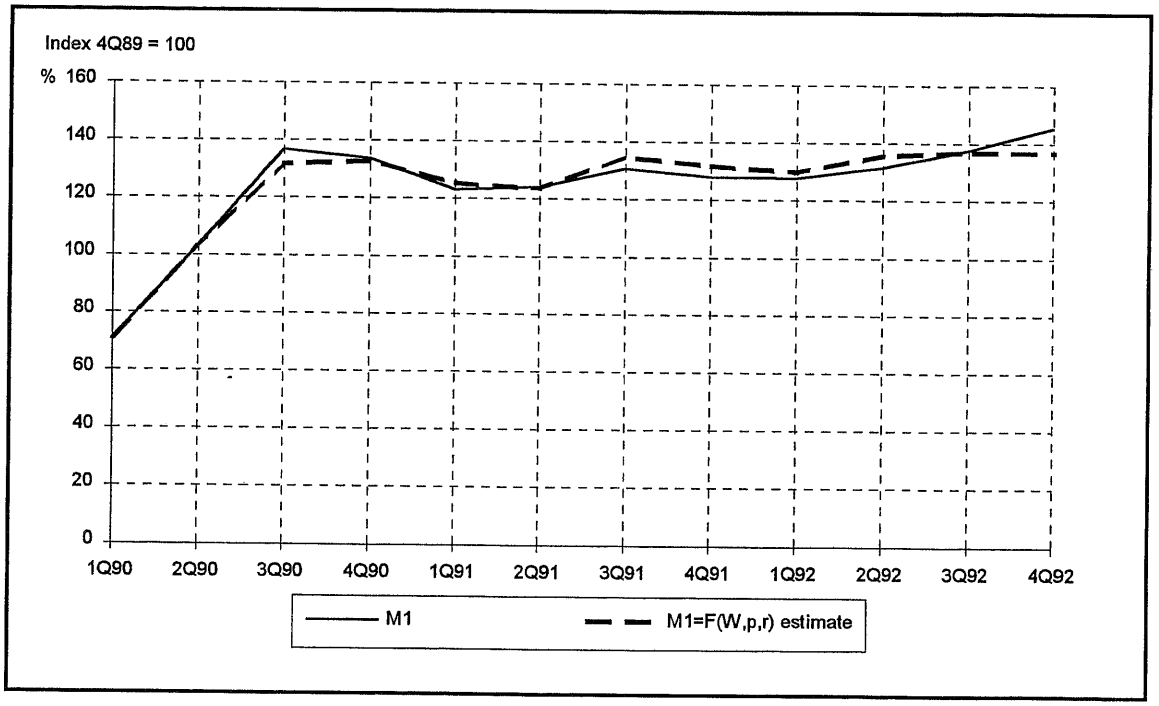
Graph 5

M1 = F (GDP, p, r)



Graph 6

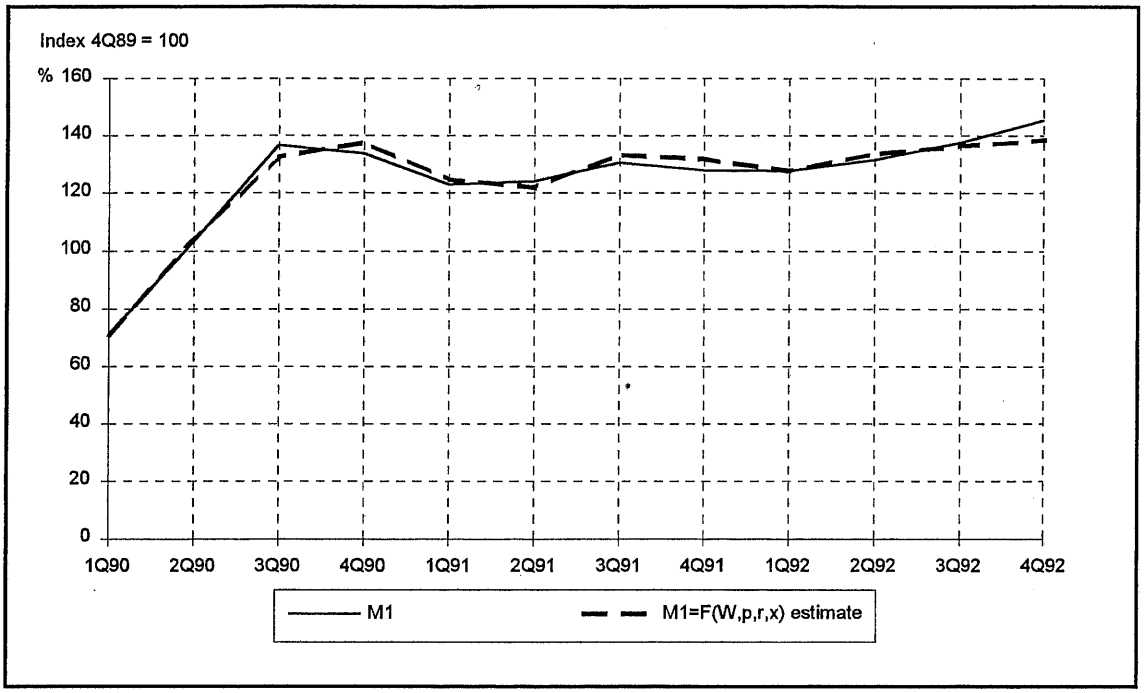
M1 = F (W, p, r)



Empirical results: demand for M1

Graph 7

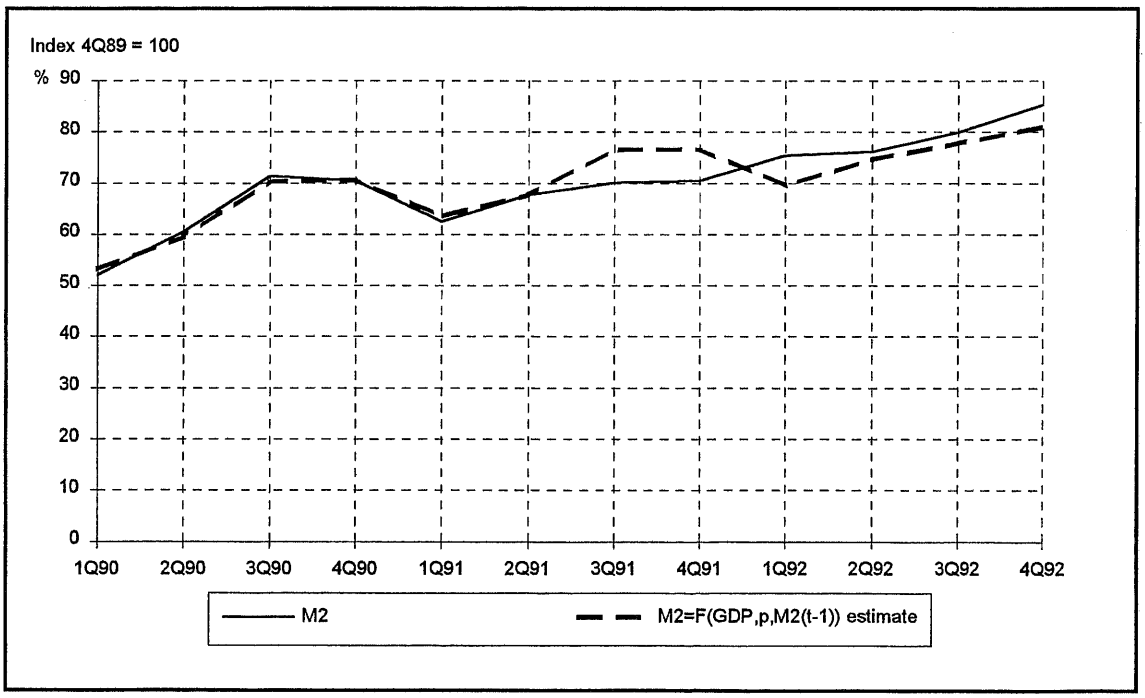
M1 = F (W, p, r, x)



Empirical results: demand for M2

Graph 8

M2 = F (GDP, p, M2(t-1))



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