DEMAND FOR MONEY IN THE TRANSITION ECONOMY: THE CASE OF THE CZECH REPUBLIC 1993–2001

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Abstract

In this paper we strive to present a somewhat internationalised view of demand for money as applied to the Czech Republic. We extend the traditional money demand function, consisting purely of domestic variables, to include certain foreign determinants that probably affect the demand for money in a small open transition economy. We do so in the case of both narrow and broad money. For the purposes of generalisation and robust estimates we employ several estimation techniques, namely the Johansen procedure, ARDL, DOLS and ADL. We also consider the aspect of the stability of such estimates. Finally, we analyse the possible effects on prices and output of disequilibria on money market. We have found that a liquidity gap probably has a significant influence on both prices and output.

Keywords:
Demand for money, transmission mechanism, transition, Czech Republic, cointegration

JEL Classification:
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Outline

1. INTRODUCTION

Demand for money is a very important concept in the history of economic thought and one of the most popular concepts in theoretical and empirical economics. The main objective of this paper is to present, theoretically and empirically, a somewhat internationalised view of demand for money as applied to the Czech Republic from the beginning of the Czech economy to the present. In this paper we extend the traditional money demand function, consisting purely of domestic variables, to include certain foreign determinants that probably affect the demand for money in a small open transition economy. We do so in the case of both narrow and broad money.

We divide our paper into four main parts. The first and second parts introduce the transmission mechanism of monetary policy in the transition period, demonstrated mainly using the Czech transition case. The third part focuses on the demand for money in a small open transition economy. These parts deal mainly with general transition problems and the Czech economic reality. Finally, we present an empirical analysis of demand for money phenomena in the case of the Czech Republic. For the purposes of generalisation and robust estimates we employ several estimation techniques, namely the Johansen procedure, ARDL, DOLS and ADL. We also consider the aspect of the stability of such estimates. Finally, we analyse the possible effects on prices and output of disequilibria on the money market. We have found that a liquidity gap probably has a significant influence on both prices and output.

2. MONEY DEMAND AND THE TRANSMISSION MECHANISM OF MONETARY POLICY IN THE CZECH REPUBLIC

The transmission mechanism of monetary policy is the term used to describe the various routes via which changes in central bank monetary policy affect output and prices. Economists often refer to several important channels through which monetary policy may affect prices and output. For instance, there are a number of routes through which changes in interest rates may affect the quantity of money, domestic demand and output. Changes in central bank interest rates affect real demand and output because in the short run inflation expectations are unchanged and the movements in nominal interest rates are reflected in changes in real interest rates.

The impact of changes in interest rates, under the ceteris paribus condition, can be described through three main effects: (i) the substitution effect, (ii) the income effect and (iii) the wealth effect. First, the substitution effect can be identified when an increase in interest rates reduces the attractiveness for economic agents (individuals, households and companies) of spending now rather than later. In this case domestic credit, the quantity of domestic money and real demand all decrease. A decrease in interest rates has opposite effects. Second, the income effect can be distinguished when higher interest rates re-distribute income from borrowers, such as the young and the government, to savers, such as the middle-

aged. This increases the spending power of savers but reduces that of borrowers. Since savers have a lower propensity to spend than borrowers, total expenditures decline. In addition, if lending rates increase more than rates of return on assets, total incomes – and therefore spending – decrease. Finally, the wealth effect arises because higher interest rates usually reduce the prices of assets such as houses and shares. This decline in wealth discourages individuals from spending their current income.

2.1. Transmission Channels of Monetary Policy – Overview of the Related Literature

Girardin and Horsewood (2001) study the transmission channels of monetary policy in the partial equilibrium context and the general equilibrium context. Taylor (1995), Meltzer (1995, 1999) and Mishkin (1996) describe the existing theoretical work on the transmission of monetary policy shocks to the real economy. From the theoretical point of view three main series of monetary policy transmission channels can be distinguished. These are: (i) the interest rate channel, (ii) the credit channel and (iii) the exchange rate channel.

In the first series of channels, the money transmission channel, monetary policy reacts through changes in money supply. In the case of increased money supply, the reaction of central bank finally leads to a rise in short-term interest rates. We often call this the liquidity effect. It induces an increase in the cost of capital, leading to a fall in aggregate demand through lower investment spending by economic agents (i.e. households and firms).

In the second series of channels, the asset price channel, we focus almost exclusively on asset prices, i.e. on the exchange rate, share prices[1] and especially on interest rates. This channel (in an open economy) operates through the exchange rate, which impacts directly on the consumer price index via changes in the domestic value of imports. The reaction of the exchange rate to interest rates is quite fast, as is the transmission of monetary policy to inflation in the domestic economy. If prices and nominal wages are rigid, this reaction can also lead to changes in domestic economic activity because of substitution between domestic and foreign goods. Monetary policy can also affect the whole spectrum of relative asset prices and real wealth through share prices. This is addressed by Meltzer (1995), who describes changes in money supply which are associated with a change in short-term interest rates and thus lead agents to change their holdings of equities and cash balances. He describes that a fall in share prices can moderate private spending through two channels, namely: (i) Tobin's q-theory of investment and (ii) wealth effects. Meltzer (1999) refers to portfolio-rebalancing effects, which play a major role in the transmission mechanisms of a quantitative easing through short-term or long-term market operations. He emphasises that

1 Initial studies, where monetary policy was measured by changes in M1, found that easier monetary policy had a negative impact on equity prices. However, interpreting the results of such studies was difficult since changes in M1 could reflect changes in money demand as well as supply. Recent studies have measured changes in monetary policy more carefully. For example Sellin (2001) found that monetary policy impacts positively on share prices.

the extent to which portfolio effects can play a role depends on the difference in the "moneyness" (i.e. the opportunity cost of holding each monetary asset) between the assets bought and sold by the central bank.

In the third series of channels, the bank-lending channel[2], we include the credit market in our analysis. Here, imperfect information is also a major feature. We refer to work by Bernanke and Gertler (1995), who show that a restrictive monetary policy shock can generate a fall in bank deposits which will lead banks to reduce their lending. This is associated with a rise in moral hazard and a fall in the net worth of firms. Kasyap and Stein (1994) show in this context that the impact of monetary policy may be substantially different depending on the degree of weakness of banks' balance sheets or on the type of borrower, which is different in the case of small and large companies. It can be concluded that some of these different channels may very well coexist and complement each other. This is shown by Kashyap and Stein (1994), who analyse the links between the credit channel and the traditional money channel.

Recent papers on the transmission mechanism focus mainly on the general issue (improving the knowledge of transmission channels) and on specific problems (transmission channels in transition economies, highly inflationary economies, dollarised economies, the eurozone, etc). There is a group of interesting papers relating to transition and developing countries, presented by Montinel (1990) and Barran, Coudert and Mojon (1996). These deal with empirical issues and modelling rather than developing any new theories. Clearly, transmission mechanism theory provides the basis for the analysis of many economic problems. In our context, it is a demand-for-money phenomena. The empirical papers on the transmission mechanism and the effects of monetary policy primarily employ VAR models. This approach provides a good tool for studying the dynamics of the economy in the aftermath of a monetary policy shock. Numerous studies using the VAR monetary model have been carried out in the United States and in Europe. BIS (1998) gives a description of monetary policy transmission in emerging market economies.

2.2. Transmission Channels of Monetary Policy in Small Open Transition Economies

In most transition economies, the initial conditions and the process of transformation have been similar, i.e. for more than ten years there have been simultaneous periods of internal and external liberalisation and a process alignment with the more developed countries. The internal liberalisation has been brought about by price liberalisation in a higher inflation environment, restructuring of industries, adoption of new tax systems, etc. The external liberalisation has been caused by trade liberalisation and, in particular, by external convertibility of national currencies and liberalisation of capital accounts. Generally it can be concluded that the launch of the reform process

[2] The term "balance-sheet channel" is often used.

was coupled with greater economic uncertainty[3] (and in some countries by political instability) and the absence of developed financial markets. In this situation, can the central bank, in the medium run, locate a credible, functional and predictable monetary policy transmission mechanism?

All these transformation problems in transition countries can seriously obstruct the very effectiveness of the monetary policy on which the authorities rely heavily to achieve macroeconomic stabilisation. This is especially true for the process of setting money supply targets, maintaining the stability of the exchange rate, ensuring that the state receives seigniorage, etc. In the presence of currency substitution,[4] households can easily switch between domestic and foreign currencies. This, in turn, can make the money supply process endogenous and increase the instability of money demand, impairing the ability of the monetary authorities to conduct effective policies and destabilising the domestic banking system. It can be concluded that the main problem for the CNB was to transform its set of monetary policy instruments from non-market ones (direct credit limits, interest rate ceiling) to market ones.

Figure 1: The Stages of Transmission

It is obvious that during a transition period it is more difficult to find and analyse the channels of the transmission mechanism than in developed countries. The reasons for these difficulties are the poor quality of data (short time series and frequent changes in methodology) and the existence of transitional shocks (privatisation, liberalisation, tax reform, convertibility of the exchange rate, price deregulation, etc.). During the transition period, monetary policy decisions generally involve a higher degree of uncertainty. The main problem faced by the authorities during transition is to define a stable policy rule and to set the operational target of monetary policy according to this rule. Monetary transmission in the Czech Republic can be divided into the following periods. In the initial period the central bank sets its operational target[5] according its policy rule. And in the second period of transmission the money market reacts to the change in the operational target. This assumes that both the demand for money and the money supply are included in the central bank reaction function. We should emphasise that an evaluation of monetary transmission requires us to

[3] This implies a high and volatile nominal exchange rate and inflation, large budget and current account deficits, and the establishment of new national currencies (in the countries of the former Soviet Union, the new countries of the former Yugoslavia, and in the Czech Republic and Slovakia).
[4] See Komárek and Melecký (2001)
[5] The Czech National Bank changed its operational target several times between 1993 and 1998, when an inflation targeting regime was introduced.

analyse two main relationships: (i) the setting of long-term interest rates by commercial banks, and (ii) the demand for money. The first phenomenon shows some monetary policy inconsistency, i.e. during the Czech transition one of the signals of monetary restriction – high real interest rates – was not followed by slow growth in the money supply. The second phenomenon, the demand for money, is analysed in the next main section of our working paper. During the course of monetary transmission, real variables are ultimately affected by financial variables.

3. MODELLING MONEY DEMAND IN THE CZECH REPUBLIC

3.1. Overview of Related Literature

Recent papers on money demand focus mainly on empirical issues and modelling rather than on developing any new theories, although some new determinants are incorporated into the money demand function, especially those related to the concept of an open economy.

Clearly, the theory of money demand provides a basis for analysis of the determinants of money demand and has consequently been incorporated into the vast majority of recent textbooks on monetary economics and/or macroeconomics. However, there are some interesting publications that review previous empirical research (Laidler (1993) and Ericsson (1998)) and recent trends in the research on money demand (Hoffman and Rasche (1996) and Sriram (1999)) and/or concern themselves with other theoretical issues or alternatives (Laidler (1990), Goodhart (1989) and Milbourne (1987)).

The empirical papers on aggregate money demand primarily employ cointegration analysis, although there is some work dealing with issues on the microeconomic level (Mulligan and Sala-I-Martin, 1996). The most frequently used cointegration technique is the Johansen procedure. This is well described in Johansen and Juselius (1990), Enders (1995), Harris (1995), Doornik and Hendry (2000) and Hoffman and Rasche (1996). The Johansen procedure is a multi-equation technique. Another multi-equation approach that is sometimes used is the ARDL procedure described in Pesaran and Pesaran (1997) and Pesaran, Shin and Smith (1996). Recently, many researchers have also been employing single-equation techniques such as DOLS and DGLS in response to research on the efficiency of various cointegration techniques (Stock and Watson, 1993). This research provides support for the use of these two single-equation techniques, as they are sufficiently effective and in some respects even preferable to multi-equation techniques. Another desired characteristic of the money demand function is stability of the estimated relationship. As the cointegration technique is applied to the higher integrated variables, or systems of such variables, some special tests of stability have to be adopted to inspect this property. These tests are well described in Doornik and Hendry (2000) and Hansen (1992).

The research on money demand is mostly conducted within the framework of a closed economy, as many authors argue that domestic determinants are superior to foreign or international ones. They leave only limited space for improving the explanatory power of such "domestic" money demand functions. There exist many papers on the money demand of developed countries which also use cointegration techniques, among them Hendry S. (1995), Brouwer and Subbaraman (1993), Coenen and Vega (1999), Hayo (1999) and Hendry, Ericsson and Prestwich (1997). On the other hand, there is a lack of internationally available literature on the analysis of money demand in transition countries, especially those in Central Europe. We are aware of several papers on money demand in Central European transition countries (Klacek and Šmídková (1995), Hanousek, Kubín, Tůma (1995), Kozel (2000) and Arlt, Guba, Radkovský, Sojka and Stiller (2001)). However these either do not use cointegration techniques and/or operate only within the framework of a closed economy.

As international financial markets have been undergoing substantial deregulation over the last decade or two, additional investment opportunities have arisen and many residents of developed countries have changed their habits associated with portfolio items. There is, in addition, the phenomenon of dollarisation, something that often emerges in open countries in transition. Giovannini and Turtelboom (1992) provide an excellent review of the literature on currency substitution in its broad sense. Furthermore, several authors present particular views on worldwide dollarisation, e.g. Doyle (2000), but papers on dollarisation in transition economies are rather rarer – see Aarle and Van Budina (1995). These papers, however, do not concentrate on currency substitution (in its broad sense) from the literal point of view of the money demand function. Even though papers on money demand incorporating determinants associated with currency substitution and/or capital mobility are rather rare, some researchers do cover this area (Vega, 1998), albeit more as a side issue.

3.2. Some Methodological Issues Concerning Money Demand Analysis

The money demand function covers variables some of which are discrete and others continuous. At first glance this does not imply any problems, since we can multiply these variables with each other as the mathematical notation of money demand requires. However, the different natures of the variables might be rather confusing in some respects. First, we use certain similar end-of-period data in the analysis based on yearly data frequency and quarterly frequency, whereas the continuous data (e.g. the scale variable) change. Second, when we use end-of-period data, say in yearly frequency, these may include some seasonal pattern that could bias the estimates of particular coefficients[6]. Third, we consider the interpretation of discrete variables transformed into averages more useful and clear for the purpose of applying the results obtained, because the equilibrium average growth of money, for example, is more applicable from the monetary

[6] For example, each year the demand for money (especially narrow) rises substantially at Christmas. The estimated coefficients in the money demand function are then probably biased upwards somewhat relative to the case where we use the yearly average of the money aggregate.

authority's point of view than is the equilibrium growth rate of money in terms of end-of-period data.

These arguments lead us to the use of end-of-period variables transformed into averages. Although at this stage several alternatives for transforming discrete variables into continuous variables are possible, in this work we respect the demands of simplicity and a unified approach. This means that the chosen methodology will be clear, easily interpretable and thus applicable. Moreover, it will be reasonable both for narrow and broad money, which are analysed jointly in this paper[7]. We thus use the simple arithmetical average of the end-of-period values for the three months in the current quarter plus the end-of-period value for the preceding month. We employ such averaging to obtain genuinely continuous variables after transformation.

We seasonally adjust only the scale variable, since the other variables do not imply any significant seasonal pattern after transformation (from discrete to continuous).

Further, we use an approach that proceeds from general to specific. Thus we begin with an estimation of the broad model and later we move to a parsimonious version of this model estimation. Moreover, we employ several cointegration techniques – both single-equation and multi-equation – so as to obtain robust results. These are: the Johansen technique and the ARDL method as the representatives of the multi-equation techniques; and DOLS, DGLS and ADL as the representatives of the single-equation techniques.

Finally, despite the presumption of economic theory that agents are not subject to money illusion and so demand real money holdings, we estimate money demand in nominal terms. We do so for one reason in particular. Although economic theory implies demand for real money holdings in terms of a specific monetary-aggregate-to-price-level ratio, it does not specify how to measure these particular variables. If we are concerned with a specific monetary aggregate, then several ways of measuring the price level are possible. In the case of transitional economies, the different measures of price development evolve in different patterns and are subject to the severe shocks that stem from deregulation of prices, transformation of tax policy, liberalisation of foreign trade, etc. Thus it is preferable to estimate money demand in nominal terms and then test the restriction of unit price elasticity. In this respect we follow the work of, for example, Brand and Cassola (2000), Muscatelli and Spinelli (2000), Peytrignet and Stahel (1998), Vega (1998), Hoffman and Rasche (1996), and Hendry S. (1995)[8].

[7] As exponential averaging might be considered somewhat arbitrary, the weighted average might be seen as the most suitable choice. In the case of quarterly data (as we use in our analysis) the aggregate M1 could well be weighted by some scale variable (most probably industrial production, which is published monthly) as the transactional motive is dominant for this aggregate. However, when we move to broad money there is no such explicit dominant variable at this level, since the speculative motive – which is determined by a group of variables – prevails here.

[8] Hendry S. (1995, pp. 34) further states in this context that the assumption of real money as an explained variable imposes neutrality of money in both the short run and long run.

3.3. Theoretical Base

The primary motive underlying the demand for narrow money is to finance transactions and smooth differences between income and expenditures. This so-called transaction motive of holding money forms the basis for all models of money demand concerning narrow money. Narrow money is also held for the purpose of unexpected expenditures – the precautionary part of the demand for money. According to the transaction and precautionary motives of holding money, variables approximating transactions such as income, expenditure and wealth, or some proxy variable of activity, are key components of any money demand equation. Finally, money represents one possible form of wealth allocation. This motive of holding money can be explained by Keynes's speculative motive or by general portfolio theory. In this respect, the Baumol-Tobin inventory model and the rather more sophisticated Miller-Orr model imply a negative relation between money demand and the opportunity cost of holding money (interest rate(s)). The speculative motive also presumes a negative relation linking interest rates and money demand, whereas the portfolio models (represented by Friedman's model of money demand or, on the microeconomic level, by the Sprenkle-Miller model) include both a positive relation between money demand and the own rate of return and a negative relation linking money demand and the various rates of return on alternative assets.

To sum up, money may – according to modern economic theory – be demanded for at least two main purposes: first, as a stock for smoothing differences (gaps) between income and expenditure streams; and second, as one of several assets in a portfolio. Both motives lead to a long-run specification in which nominal money demand M^d depends on the price level P, a scale variable I, inflation π, and a vector of rates of returns on various assets:

$$M^d = g\,(P, I, \pi, R) \qquad (1)$$

The function g is assumed to be unit homogenous in P (meaning that agents are not subject to money illusion), increasing in I, decreasing in both inflation and those elements of R relating to assets excluded from the particular money aggregate, and increasing in those elements of R incorporated into the particular monetary aggregate.

For the purposes of econometric estimation the money demand equation is commonly written in log-linear form (after logarithmic transformation), as in equation (2):

$$m^d = \alpha_0 + \alpha_1 i + \alpha_2 p + \alpha_3 R^{own} + \alpha_4 R^{out} + \alpha_5 \pi + u \qquad (2)$$

where $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5 are the estimated coefficients and u the residual term of the estimated relation. R^{own} is the own rate of return on assets included in the particular monetary aggregate. R^{out} is the vector of rates of return on the assets excluded from this aggregate. Capital letters denote broad name and level and logs are in lowercase. The expected signs of the coefficients are α_1=1 (this would

reflect acceptance of quantity theory) or α_1=0,5 (this would support Baumol-Tobin theory), α_2 =1 (meaning that M^d is a linearly homogenous function in P) and $\alpha_3 \geq 0$, $\alpha_4 \leq 0$ and $\alpha_5 \leq 0$.

The modelling of the demand for a particular monetary aggregate predetermines the concrete variables representing own rate of return and the choice of the opportunity cost of holding such money. The empirical analysis may imply, according to applied test regarding restrictions on coefficients, that some opportunity cost of the type of money in question might be deemed equal to the coefficient for the own rate of return (α_3=α_4) and that the equation can be reduced to include the differential of those two variables.

3.4. M1 Aggregate

The construction of the model for narrow money takes into account the dominant role of transaction demand for money, approximated by aggregate demand (domestic absorption). As the measure of the domestic price level we employ the PPI index[9]. The next variables included in this model are the sight-deposit interest rate as the measure of the own rate of return on narrow money, and the short-term deposit interest rate as the rate of return on the closest substitute.

We are therefore dealing with an estimation of the traditional model for a closed economy, as described by equation (3):

$$m_1 = \beta_1 p + \beta_2 s + \beta_3 i^{own} + \beta_4 i^{out} + \xi \qquad (3)$$

where m_1 measures narrow money, p the price level, i^{own} the own rate of return on narrow money and i^{out} the rate of return on the closest substitute for narrow money and where ξ is the residual term.

3.4.1. DATA DESCRIPTION

We use monetary aggregate M1 as the representative of narrow money in the Czech Republic. The M1 aggregate consists traditionally of currency in circulation and sight deposits. *(data source: CNB database)*

The variable depicting price level development is approximated in this work by the PPI index[10]. We prefer this variable because it takes into account a relatively

[9] The argument for using the particular data series as an approximation of the variables in the demand for narrow money is given in the following section on data description.

[10] We apply this variable in response to the research on the level of households and firms undertaken by Melecky (2001a, 2001b). The results of this research suggest that the index of industrial production seems to be the most appropriate scale variable representative and that the PPI index is a better measure of the price level than is the CPI index, since firms hold a larger share of narrow money than do households. The shares in narrow money holdings are approximately as follows (period 1/1993-2/2001): currency in circulation avg. CZK 111 bn (median CZK 116 bn), sight deposits - households avg. CZK 151 bn (median CZK 152 bn), firms

stable basket of goods and services. We favour this variable to the GDP deflator since, especially in the case of transition economies, the production structure is still changing and evolving and thus this variable might be severely biased by hidden price developments. Finally, it is preferable for the variable representing the price level to be based on the same structure of goods and services as the scale variable (see next paragraph). *(data source: CNB database)*

As the measure of own rate of return on narrow money we employ the interest rate on sight deposits. This should be an appropriate approximation since currency in circulation has only a minority share in this aggregate according to principle of aggregation. *(data source: CNB database)*

The rate of return on alternative assets or assets not included in the M1 aggregate is represented by the interest rate on short-term deposits. We choose this variable because the portfolio motive of holding such money plays only a minority role relative to the transaction motive. So, since we are interested in the substitution effect (portfolio effect) that stems from changes in relative returns, such money is likely to be most intensively substituted with short-term deposits. Nevertheless, there are at least two alternatives. One is substitution with real assets, but this is limited by some allotment restrictions. The other is substitution with foreign money, although some degree of dollarisation (or Dmarkisation) of the domestic country must exist, either in the sense of direct substitution, where domestic money is substituted with foreign money for its unit-of-account or medium-of-exchange function; or indirect substitution, where domestic money is substituted with foreign money for store-of-value purposes (see, for example, Feige, Faulend, Šonje and Šošić (2000) or Gomis-Porqueras, Serrano and Somuano (2000)). We will consider this latter alternative later in this text. *(data source: CNB database)*

3.4.2. ESTIMATION RESULTS

We estimate equation (3) by applying various cointegration techniques to attain the desired robustness for our estimation result. The techniques employed are the Johansen procedure and the ARDL approach to cointegration as the representatives of multi-equation approaches, and DOLS, DGLS and ADL as the representatives of single-equation approaches. The estimation results are presented in Table 1:

CZK 155 bn (CZK 158 bn), insurance companies CZK 4 bn (CZK 4 bn). Furthermore, we have included various measures of the price level and transactions in an estimated model of similar form to that of equation (3) and the results indicate that the industrial production and PPI indices have the highest significance for their respective purposes.

Table 1: Estimates of Equation (3) Using Various Cointegration Techniques[11]

Variable	Estimation Methods					General Significance
	JOH(1)	ARDL(1)	DOLS	DGLS	ADL	
m1(-1)	-----	*0.65 (0.06)***	-----	-----	0.68 (0.08)***	0.67 (0.07)***
Ppi	0.64 (0.25)**	0.73 (0.26)***	1.01 (0.27)***	0.95 (0.24)***	0.23 (0.11)**	0.73 (0.25)***
Ipp	0.66 (0.23)**	0.44 (0.24)*	0.90 (0.30)***	0.80 (0.25)***	0.14 (0.08)*	0.66 (0.24)**
i_n	0.17 (0.07)***	0.18 (0.07)***	0.25 (0.07)***	0.23 (0.05)***	0.06 (0.03)**	0.18 (0.07)***
i_kr	-0.05 (0.005)***	-0.05 (0.007)***	-0.04 (0.004)***	-0.04 (0.004)***	-0.02 (0.003)***	-0.04 (0.005)***
constant	Unrestricted	0	-4.22 (1.68)**	-3.29 (1.03)***	0	3.76 (1.36)*

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). The last column of the table indicates the overall significance of the particular variable and the median of its estimated coefficients and standard errors. 0 denotes an acceptance of zero-restriction on the particular coefficient and ----- indicates that the given variable was not included in the estimated equation. In the case of multi-equation estimation methods (JOH, ARDL) the variables m_{cz}, *ppi*, *ipp*, i_n and i_{kr} are assumed to be endogenous. Moreover, application of these multi-equation methods shows that the variables *ppi*, i_n and i_{kr} seem to be weakly exogenous in the case of the JOH(1) estimation and *ppi* and i_{kr} likewise in the case of the ARDL(1) estimation.

Based on the estimations presented, we can conclude that all the considered variables (determinants) affect the demand for narrow money in the manner suggested by economic theory. Individually, the development of the M1 aggregate shows medium persistence at about 0.67%, i.e. high significance. The PPI as a measure of the price level also appears to be highly significant, as suggested by the theory. Nevertheless, the *a priori* assumption of price homogeneity seems to be false in the case of the Czech Republic, since the coefficient of the PPI index has its median at 0.73. Approximation of the scale variable with the industrial production index appears to be significant at the 5% level, with its median at 0.66. The variables that account for the rate of return on narrow money and rate of return on short-term deposits perform very well (highly significant) as the representatives of the own rate of return and the opportunity costs of holding narrow money respectively. The former has its median at 0.18 and the latter at -0.04. The estimation results based on cointegration techniques are well supported by the NLS estimation presented in the appendix to this paper.

Furthermore, we incorporate inflation in the model to represent either the opportunity costs of holding money in relation to real assets according to portfolio theory, resulting in a negative relation to money demand, or an approximation of uncertainty as implied by the Sprenkle-Miller model, resulting in a positive influence on money demand. However, this variable does not perform well, probably just because of its ambiguity.

[11] The number in brackets indicates the maximum considered lag length of the endogenous variables.

Moreover, since the Czech economy is a relatively highly open economy we consider additional variables that would induce transaction demand. Specifically, we incorporate the real exchange rate to explicitly take into account the need to finance exports and imports. The real exchange rate should describe the effect of the price elasticity of foreign trade, since the income elasticity is already described by the scale variable. More specifically, the real exchange rate illustrates the fact that a depreciation thereof is likely to induce extra demand for domestic goods from abroad and the induced rise in domestic production implies a need for more money in the economy as the amount of transactions increases. Finally, we employ FDI as an explanatory variable. This variable should describe the effect of increasing capitalisation and the origination of new enterprises. Moreover, it would be better if we could divide the total FDI into that part which generates new enterprises and the remainder, since the former part has the highest multiplier effect on transaction money demand. The latter part of the FDI has a lower multiplier effect[12] and furthermore the peak effect of this part occurs most probably with a different lag. However, such a distinction cannot be made owing to the lack of particular data series.

Considering all the aforementioned aspects of the demand for narrow money in the Czech Republic and the expected important determinants of this money demand, we extend the estimated model of narrow money demand to the form described by equation (3a):

$$m_1 = \beta_1 ppi + \beta_2 ipp + \beta_3 i_n + \beta_4 i_t + \beta_6 re + \beta_7 fdi + \xi \qquad (3a)$$

where m_1 is the M1 monetary aggregate, *ppi* the PPI index, *ipp* the index of industrial production, i_n the interest rate on sight deposits, i_t the interest rate on short-term time deposits, *re* the real exchange rate and *fdi* foreign direct investment, and where ξ is the residual term. All variables are in logs except for interest rates, which are in percentage changes. β_1 to β_7 are estimated coefficients.

[12] Furthermore, the effect might have different peaks even within this subsection of FDI, since the capital is used to extend the potential of the particular corporation, but when it enters into use depends probably on the phase of the business cycle.

Table 1a: Estimates of Equation (3a) Using Various Cointegration Techniques[13]

Variable	Estimation Methods					General Significance
	JOH(1)	ARDL(1)	DOLS	DGLS	ADL	
m1(-1)	-----	*0.77 (0.05)***	-----	-----	0.67 (0.06)***	0.72 (0.06)***
ppi	0	0	0	1.01 (0.23)***	0	1.01 (0.23)
ipp	1.22 (0.15)***	0.99 (0.04)***	1.26 (0.31)***	0.84 (0.25)***	0.23 (0.07)***	0.99 (0.15)***
i_n	0.21 (0.05)***	0.12 (0.05)**	0.19 (0.06)***	0.24 (0.05)***	0.05 (0.02)***	0.19 (0.05)***
i_kr	-0.04 (0.004)***	-0.04 (0.007)***	-0.02 (0.005)***	-0.04 (0.004)***	-0.01 (0.002)***	-0.04 (0.004)***
reer	0.73 (0.21)***	0	0.68 (0.39)*	0	0.11 (0.06)*	0.68 (0.21)*
fdi(-4)	0.03 (0.01)***	0.06 (0.02)***	0.06 (0.03)**	0	0.02 (0.007)***	0.05 (0.02)**
constant	Unrestricted	0	-5.02 (3.26)	-3.85 (0.87)***	0	-3.85 (0.87)

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). The last column of the table indicates the overall significance of the particular variable and the median of its estimated coefficients and standard errors. 0 denotes an acceptance of zero-restriction on the particular coefficient and ----- indicates that the given variable was not included in the estimated equation. In the case of multi-equation estimation methods (JOH, ARDL) the variables m_{cz}, *ppi*, *ipp*, i_n and i_{kr} are assumed to be endogenous. Moreover, application of these multi-equation methods shows that the variables *ppi*, i_n and i_{kr} seem to be weakly exogenous in the case of the JOH(1) estimation and *ppi* and i_{kr} likewise in the case of the ARDL(1) estimation.

The inclusion of foreign determinants has at least two consequences. First, the real effective exchange rate alters the effect of price level movements approximated by the PPI index and results in exclusion of the PPI from the estimated equation. This may suggest that the price level is largely determined by exogenous variables such as the nominal exchange rate and commodity prices, as we can assume the general foreign price level is more stable than the domestic one in case of the Czech Republic. However, the overall results do not support this hypothesis. Also, the effect of foreign direct investment has its peak at the fourth lag. Despite its overall significance, its inclusion substantially affects the estimated period and thus also the estimation results. This problem would not be so important if we had longer time-series, but this is not currently possible in the case of Czech Republic. This effect should be the focus of further research.

As the application of the extended version of equation (3) to the Czech economy has almost no support from the NLS estimation, we prefer to finalise the general form into the relation described by equation (4):

$$m_1 = 0.73\,ppi + 0.66ipp + 0.18i_n - 0.04i_{kr} \tag{4}$$

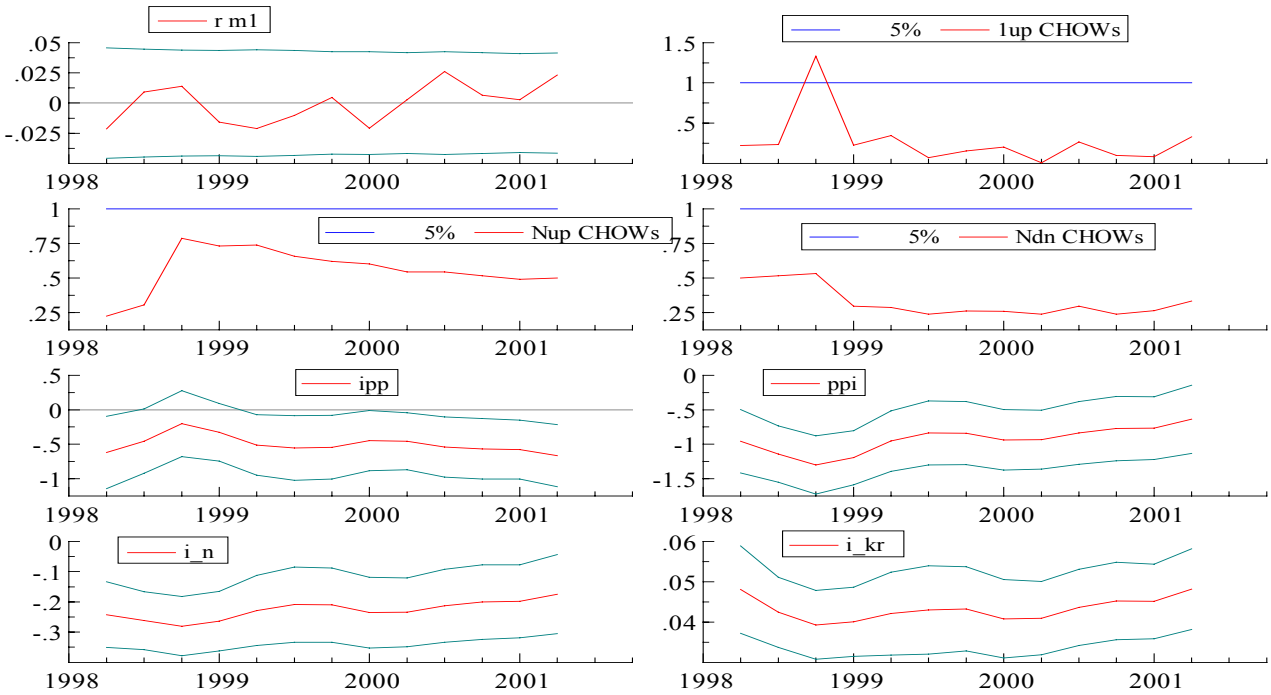
[13] The number in brackets indicates the maximum considered lag length of the endogenous variables.

To summarise, we cannot assume *a priori* price homogeneity, thus the estimation of nominal money demand seems to be more effective in the case of the Czech Republic. The coefficient of the scale variable suggests that the representative agent may be seen as rather risk averse, giving probable support to the Miller-Orr theoretical approach before that of Baumol-Tobin or quantity theory. This notion is further advocated by the significant influence of the own rate of return on narrow money stemming from portfolio theory, which is part of the Miller-Orr model. The opportunity cost of holding money is an important determinant, although with a somewhat lower coefficient. This is probably caused by the higher volatility of the interest rate on short-term deposits relative to narrow money[14].

3.4.3. Stability of the Narrow Money Demand Estimates

Since we are particularly interested in whether the estimations achieved are stable over time and therefore useful for forecasting purposes (in the sense of equilibrium money growth predictions), we apply a set of standard tests of stability. This consists of tests of coefficient stability and a test concerned with the overall stability of the estimated relation. These are, namely, a one-step-forecast test and one-step-forecast, a-step-forecast and breakpoint Chow-tests. The results of those tests applied to the estimation of equation (3) using the Johansen technique, which is probably most consistent with our general representation of the money demand estimation, are presented in Graph 1[15]:

Graph 1: Test of the Stability of the Equation (3) Estimation by JOH(1)



[14] For this purpose some authors prefer to employ long-term interest rates, since these are less volatile. What results is a somewhat higher coefficient for this variable.

[15] The tests applied to the DOLS and ADL estimation are presented in the appendix.

The stability testing of the estimated coefficients does not show any significant swings that would affect the predictive power of the JOH(1) estimate. However, although the tree of stability tests applied to the estimated equation suggests stability for the entire period under review, the Chow one-step-forecast test opposes this hypothesis. This indication is also present when the same test is applied to the ADL estimates (in the appendix). This finding may call for inclusion of an additional variable to eliminate the instability in the fourth quarter of 1998. In addition to the foreign variables considered in this work, i.e. FDI and REER (and implicitly also NEER), variables such as bilateral exchange rates (CZK/DEM and/or CZK/USD) and the terms of trade are worthy of particular consideration. This aspect should be the subject of further research.

3.5. M2 Aggregate

The M2 monetary aggregate model would represent demand for broad money in the Czech Republic. Furthermore, it should depict the portfolio or speculative motive of holding such money obtaining at this level of aggregation. In this paper we strive to respect the specific conditions of the Czech economy, i.e. the degree of development and sophistication of its financial markets and institutions. Generally, agents have a wide range of possibilities for allocating their wealth. More specifically, we assume that broad money (here M2) is one form of wealth allocation and that there is a spectrum of alternative assets. The institutions of the particular economy determine these alternative assets. The returns on such assets then represent the opportunity costs of holding wealth in the form of money. The agents' decision-making process about whether or not to keep their wealth in the form of money describes the money demand function.

In the Czech Republic the spectrum of alternative assets is less wide than in developed countries. This is mainly because of the low degree of development of the financial markets (especially for stocks and bonds) and/or difficult access for a wide range of agents to these markets (especially in the case of treasury bills and government bonds). Also, mutual funds are underdeveloped as regards investment in Czech assets. This undesirable situation is primarily due to the institutions in financial intermediation and is often seen in transitional economies and stems from the phenomenon of asymmetric information (see, for example, Mishkin (2001)) and a poor regulatory and legislative base for effective functioning of financial intermediation (through financial markets). Therefore we assume, under recent conditions, that the typical agent's portfolio consists, in the context of a closed economy, of money (here M2), real assets and credits. Interest rates on credits represent an agents' response to changes in such rates. That is agents increase their borrowing in the case of lowering interest rates on credits and vice-versa. Lower interest rates on credits may result in a situation where agents tilt their consumption more into the presence (investing in durables or other real assets) or strive to exploit investment opportunities. We also take into account the transactional motive of holding M2 money, as it includes narrow money.

Subsequently we operate in the context of an open economy. In this respect, in line with the implications of currency substitution theory we incorporate two foreign determinants of broad money demand – the bilateral CZK/DEM and CZK/USD nominal exchange rates[16] and the returns on foreign assets, as represented by the returns on U.S. Treasury Bills and German Treasury Bills expressed in CZK. The nominal exchange rates should describe the effect of direct currency substitution, whereas the returns on T-bills reflect the effect of capital mobility. However, the applied variables imply that we are analysing short-term, rather than long-term, capital movements, i.e. portfolio investment.

So once more we are striving to respect the main characteristics of the Czech economy from the point of view of both domestic and foreign determinants, i.e. an open economy in transition. Taking these together, we are concerned with estimating a model of the following form:

$$m_2 = \beta_1 p + \beta_2 s + \beta_3 i + \beta_4 lr + \beta_5 \pi + \beta_6 e + \beta_7 rx + \xi \tag{5}$$

where m_2 is broad money, s the scale variable, i an approximation of the own rate of return on broad money, lr the opportunity costs of holding broad money relative to the alternative of credit repayment, π represents the cost of holding money relative to real assets, e approximates the effect of direct currency substitution and rx is a proxy variable denoting capital mobility. For the purposes of the multi-equation estimation methods, we assume that the variables depicting the effect of currency substitution and capital mobility are exogenous from the perspective of the analysed system of variables[17]. All the other variables are deemed to be endogenous, with the aspect of weak exogeneity subsequently analysed within the framework of the multi-equation procedures.

3.5.1. ADDITIONAL DATA DESCRIPTION

We use time series of quarterly frequency that span the period from the second quarter of 1993 to the second quarter of 2001. Where the data are not of continuous form, we employ quarterly averages according to the discussion above. As we estimate the money demand function in log-linear form, we use logarithmic (*M2, CPI, IPP, RX*) and percentage (*i, lr, inf, e*) expression.

As the measure of broad money we employ the M2 monetary aggregate, which in the case of the Czech Republic consists of currency in circulation, sight deposits and time deposits in CZK, and deposits denominated in foreign currencies. *(Data source: CNB database)*

[16] We do not employ the nominal effective exchange rate, since for the analysis undertaken bilateral exchange rates seem to be superior for the purposes of examining currency substitution.
[17] Nevertheless, the exogeneity of these variables may be open to discussion, especially within the framework of a structural model, where the presence of an interest rate channel can be explicitly incorporated.

The own rate of return on M2-type broad money is approximated using the overall interest rate on deposits. However, the term structure of this interest rate does not entirely reflect the term structure of the M2 monetary aggregate, since the weights of interest rates on particular deposits are set according to the term structure of growth in the M2 aggregate. So it consists of the total rate on new deposits, and not on the existing stock, which would be more relevant for our purposes. Nevertheless, no interest rate of such structure is routinely published by CNB. *(Data source: CNB database)*

As regards the opportunity costs of holding M2 money, we only consider – in line with the institutional characteristics of the Czech economy – interest rates on credits. In this case we are able to apply the overall interest rate on the stock of credits as published by CNB. This rate is more relevant for our purposes, since agents' decisions are associated with the repayment of the existing stock of debts. *(Data source: CNB database)*

As explained earlier, inflation approximates the effect of the alternative costs of holding money compared to real assets. For this purpose we use CPI inflation, measured as the percentage change in the quarterly average CPI index. We annualise this inflation measure so that it can be compared to the other opportunity costs. *(Data source: CNB database)*

The nominal CZK/DEM and CZK/USD bilateral exchange rates are incorporated for the purpose of examining the effect of direct currency substitution. However, the implications of this may be somewhat reduced, since we do not include foreign currency in circulation. *(Data source: CNB database)*

Finally, we include returns on U.S. and German Treasury Bills expressed in CZK, since domestic residents are concerned in their investment decision-making with proceeds in terms of the domestic currency. We do not adjust the foreign nominal interest rate, since foreign price developments have no direct consequences for domestic investors. *(Data source: CNB database)*

3.5.2. ESTIMATION RESULTS

As noted above, we estimate the model of the demand for broad money in the form of equation (4) within the cointegration framework, since most of the data are assumed to be non-stationary in the case of the Czech Republic. Moreover, we apply several cointegration techniques, in the interests of robust results and possible generalisation of the estimated coefficients and the significance of the particular determinants of broad money demand. The estimation results for the Johansen technique (JOH), ARDL, DOLS, GDLS and ADL are given in Table 2:

Table 2: Estimates of Equation (4) Using Various Cointegration Techniques[18]

Variable	Estimation Methods					General Significance
	JOH(1)	ARDL(1)	DOLS	DGLS	ADL(1)	
m2(-1)	-----	*0.65 (0.09)***	-----	-----	0.79 (0.08)***	*0.72 (0.09)***
cpi	0.45 (0.17)**	1.69 (0.12)***	1.21 (0.06)***	1.23 (0.07)***	0.30 (0.16)*	1.21 (0.12)***
ipp	2.02 (0.23)***	0.71 (0.14)***	0.72 (0.09)***	0.63 (0.10)***	0.16 (0.06)***	0.71 (0.10)***
i	0	0	0	0	0	0
lr	0	-0.03 (0.004)***	-0.02 (0.002)***	-0.02 (0.003)***	-0.01 (0.002)***	-0.02 (0.003)***
inf(-1)	-0.02 (0.004)***	0	0	0	0	-0.02 (0.004)
czk/usd	6.34 (1.73)***	3.32 (1.25)***	0	0	0.84 (0.42)**	3.32 (1.25)**
Czk/usd(-1)	-0.56 (0.23)*	-0.42 (0.13)***	-----	-----	0	-0.49 (0.18)*
czk/dem	0	0	5.86 (0.54)***	6.21 (0.60)***	0	6.04 (0.57)*
Czk/dem(-1)	0	0	-----	-----	0	0
rx_usd	-5.72 (1.73)***	-3.35 (1.27)***	0	0	-0.92 (0.43)**	-3.35 (1.27)**
rx_usd(-1)	0	0	-----	-----	0	0
rx_dem	0	0	-6.21 (0.55)***	-6.58 (0.61)***	0	-6.39 (0.58)*
rx_dem(-1)	0	0	-----	-----	0	0
constant	unrestricted	-3.42 (0.73)***	-1.60 (0.50)***	-1.15 (0.55)***	-0.49 (0.44)	-1.38 (0.53)**

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). The last column of the table indicates the overall significance of the particular variable and the median of its estimated coefficients and standard errors. 0 denotes an acceptance of zero-restriction on the particular coefficient and ----- indicates that the given variable was not included in the estimated equation. In the case of multi-equation estimation methods (JOH, ARDL) the variables m_{cz}, *cpi, ipp, i, lr* and *inf* are assumed to be endogenous.

As we can see in Table 2, the development of the M2 aggregate displays relatively strong persistence with a high average significance of 72 per cent. Next, the estimation of money demand in nominal form appears to be desirable, as it varies between 0.45 and 1.69 across the various estimations, with a median of 1.21. This means that the nominal money demand function is not considered to be linear homogenous in relation to the M2 aggregate. However, the choice of price level measurement seems to be highly significant. Furthermore, the transaction motive approximated by IPP is noticeably present even in the demand for broader money, although the estimated coefficient is relatively variable across the different estimation methods, with the median lying at 0.71. We did not find any support for the approximation of own return on broad money using the total

[18] The number in brackets indicates the maximum considered lag length of the explanatory and/or endogenous variables.

interest rate on new deposits. This result confirms our hypothesis of the lower relevance of this variable for our purposes. On the other hand, the opportunity costs of holding money compared to credit repayment are in almost all cases highly significant. Nevertheless, the general estimation of its coefficient of semi-elasticity is rather small at around 0.02. As a representative of opportunity costs in relation to real assets, inflation has only little support from our estimation, even though strong significance was expected. Only in the case of the Johansen estimation methods based on VAR methodology does this variable appear to be highly significant. This would suggest either that inflation expectations are formed in a different pattern, requiring a combination of the adaptive and rational expectations approach, or that inflation represents both the alternative costs and the uncertainty in the domestic economy, which influences money holding in the opposite direction.

When we move to evaluating the effect of foreign variables on broad money demand, we are especially concerned with the aspects of currency substitution and capital mobility. The estimation of the CZK/USD coefficient varies according to its lag. The coefficient for the present CZK/USD value is generally significant, with the median lying at 3.32. The lagged value is significant only at the 10% level of significance and has the opposite sign to that expected from the theory. In the case of our estimates the coefficient for the present CZK/DEM value is significant only where the overall significance level reaches 10%, the median of these estimates being 6.04. Our estimates give no support for the inclusion of lagged CZK/DEM.

The capital mobility phenomenon is represented by the returns on U.S. and German Treasury Bills expressed in CZK. The present value of the return on U.S. assets denotes significance at the usual level, with the median of our estimations median lying at 6.39. Furthermore, the present value of the return on German assets shows significance only at the 10% level. The lagged values of the returns on both U.S. and German assets derive no support from our estimates.

Moreover, we have applied the NLS method to lend support to our conclusions stemming from the estimates presented. The results are given in the appendix to this paper and we can say that they are in compliance with our inference. If we were concerned only with determinants that are significant at the usual level (5%), the general form of broad money demand based on our estimates would be as shown in equation (5) (we do not explicitly consider the effect of persistence):

$$m_2 = 1.21cpi + 0.71ipp - 0.02lr + 3.32czk/usd - 3.35rx\_usd \qquad (6)$$

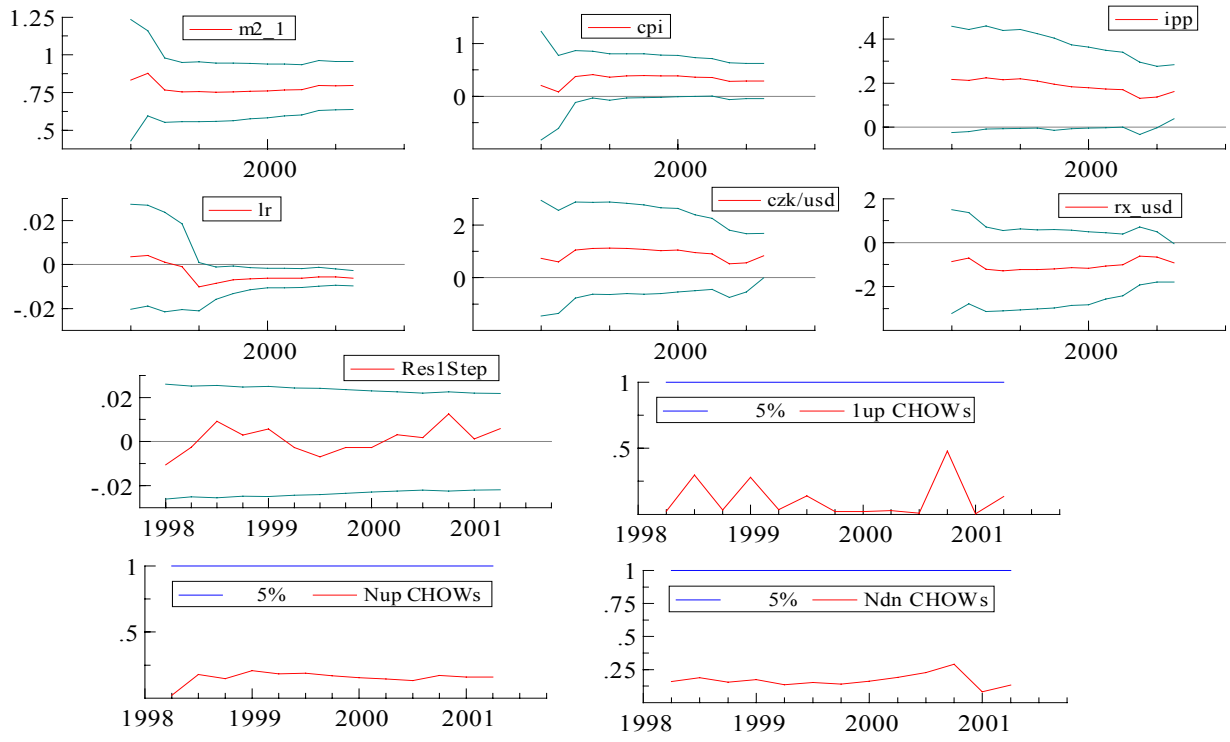
To summarise the results, we can state, based on our econometric analysis, that agents are concerned with real money holdings, although price homogeneity cannot be presumed. Despite our interest in broad money, the transaction motive forms part of such money demand. Furthermore, agents use the possibility of borrowing or repayment of credits in reaction to particular interest rate movements. The effect of direct currency substitution is well depicted by the

present value of the CZK/USD exchange rate. Finally, capital mobility is well characterised by the present value of the return on U.S. Treasury Bills expressed in CZK.

3.5.3. Stability of the Broad Money Demand Estimates

In addition to investigating the fitting ability of the estimated money demand function we would like to determine that the estimated money demand function embodies the necessary stability at least at the usual level of significance. This effort is primarily motivated by the desire for an effective predicting tool for equilibrium money growth. We therefore apply standard tests of stability such as the Chow tests and the one-step-forecast test. The results for the ADL[19] estimation are described in Graph 2:

Graph 2: The Stability of the ADL Estimation



The coefficient stability test applied to the ADL estimate indicates satisfactory development throughout the period under review. The same result is obtained both for the ADL estimation given here and for the JOH(1) and DOLS estimations given in the appendix. So we can regard the general form of these estimations symbolised by equation (6) as a satisfactory representative of broad money demand in the Czech Republic.

[19] For reasons of space we present here tests on the ADL estimates only, since this estimation is in our case closest to the general expression of the broad money demand estimation. We give results of tests on the JOH(1) and DOLS estimates in the appendix as representatives of the effective multi-equation and single-equation estimation techniques respectively.

3.6. Dynamics of Selected Variables and Policy Implications

Although we have made some recommendations about the equilibrium money growth ensuing from the above analysis (i.e. we have found pretty stable money demand functions that fit the M1 and M2 monetary aggregate data well in the case of the Czech Republic), there is still the interesting question of what if the central bank fails to keep money growth close to the equilibrium path for both aggregates. Although the system should converge towards equilibrium, i.e. the loading (speed of adjustment) on money should be negative, it is not likely that the error-correction term (the residual from the cointegration equation) will be entirely eliminated by itself and during one period.

All the recent work on cointegrating systems pursues the idea that there may be several variables that eliminate the error-correction term. In the case of money demand, the theory suggests it is likely that prices, output and interest rates move in such a way. These variables are mostly considered to be endogenous in the money demand context, but even variables that do not seem significant in the long run sometimes contribute to the elimination of error-correction terms in short run, i.e. via their dynamics.

The existence of an error-correction term and its consequent effect on the dynamics of certain variables also has its theoretical underpinning. For instance, a positive error-correction term would represent excessive money supply, hence there should be a negative loading (speed of adjustment) on the variable representing money. Likewise, there should be a positive speed of adjustment on the money variable in the output and price equations and in the equation of own rate of return. Furthermore, there should be a negative loading on variables that represent the opportunity cost of money and that can be, according to the theory, considered primarily endogenous, so that money demand can rise to offset any excess money supply.

In the next step we are interesting just in the dynamic (short-run) equation for variables such as *m1, ppi, ipp* and *i_n* in the case of M1 money demand and *m2, cpi, ipp* and *it_c* in the case of M2 money demand. We first present and comment on the former case, then address the latter case in the same manner. The results of the M1 money demand case are presented in Table 3:

Table 3: Loadings on Selected Variables (EC-models) – M1 Case

Loading on	Error-Correction Term of Estimation by					General Influence
	JOH(1)	ARDL	DOLS	DGLS	ADL	
m1	-0.38 (0.05)***	-0.35 (0.08)***	-0.37 (0.12)***	-0.41 (0.12)***	-1.07 (0.24)***	negative
ppi	0.04 (0.002)*	0.04 (0.02)*	0.07 (0.03)*	0.07 (0.03)*	0.10 (0.07)	positive
ipp	-0.19 (0.18)	-0.28 (0.16)*	0.28 (0.22)	0.18 (0.23)	-0.88 (0.49)*	*ambiguous*
dcpi	0.06 (0.04)	0.06 (0.03)*	0.09 (0.05)*	0.10 (0.05)*	0.18 (0.12)	positive
i_n	-0.55 (0.31)*	-0.51 (0.30)*	-0.18 (0.41)	-0.34 (0.42)	-1.60 (0.96)*	*negative*

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). However, because of some bias these are only indicative, since we have not estimated the parsimonious versions of each equation. Further, we use the similar pattern of equation formation for each variable it means that except the AR(1) process of the particular variable (in difference) the dynamic equation includes as the explanatory variables lagged differences of endogenous variables from and contemporaneous differences of all exogenous variables primarily included in cointegration equations. The last column of the table indicates the overall influence of the particular variable. The estimation method is OLS.

We can infer from the indicative estimations in Table 3 that in the case of M1 the dynamics (see speed of adjustment) of the *m1* variable pull the system quite strongly back to equilibrium or steady-state defined by cointegration relation. The loading on *ppi* also respects the *a priori* idea of a positive sign of low intensity. This result is further supported by the estimates of the loading on *dcpi* (i.e. inflation), which is of primary concern from the central bank viewpoint. This has somewhat greater strength. On the other hand, the loadings on *ipp* give ambiguous results (indication), and the speed of adjustment on the own rate of return on M1 money is not consistent with the theory.

The indicative loadings estimates for selected variables for the M2 case are presented in Table 4:

Table 4: Loadings on Selected Variables (EC-models) – M2 Case

Loading on	Error-Correction Term of Estimation by					General Influence
	JOH(1)	ARDL	DOLS	DGLS	ADL	
m2	-0.11 (0.03)***	-0.34 (0.08)***	-0.27 (0.18)*	-0.27 (0.18)*	-1.27 (0.34)***	negative
cpi	-0.07 (0.01)***	0.13 (0.09)	0.20 (0.10)*	0.20 (0.10)*	0.32 (0.26)	positive
ipp	0.13 (0.07)**	0.35 (0.37)	0.34 (0.46)	0.34 (0.46)	0.46 (1.07)	positive
dcpi	-0.07 (0.03)**	0.11 (0.09)	0.23 (0.11)**	0.23 (0.11)**	0.19 (0.27)	positive
i_t	0.60 (0.46)	1.09 (1.96)	-1.19 (2.45)	-1.19 (2.45)	3.08 (5.57)	*ambiguous*

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). However, these are only indicative because of some bias, since we have not estimated the parsimonious versions of each equation. Further, we use the similar pattern of equation formation for each variable it means that except the AR(1) process of the particular variable (in difference) the dynamic equation includes as the explanatory variables lagged differences of endogenous variables from and contemporaneous differences of all exogenous variables primarily included in cointegration equations. The last column of the table indicates the overall influence of the particular variable. The estimation method is OLS.

Although the estimation results show somewhat larger dispersion, they again suggest – based on the loadings of the *m2* variable – that the system converges to long-run equilibrium. This process is further intensified by the dynamics of the *cpi* variable, where the particular loading is generally positive[20] and has a larger coefficient than in the M1 case. The same conclusion might be made for the difference of the *cpi* variable. Moreover, the *ipp* variable shows positive dynamics in reaction to the positive error-correction term, so excessive money supply affects economic performance as well as price development. Finally, there is only ambiguous evidence for the own rate of return playing a role in the short-run adjustment mechanism pulling the money demand system back to the steady state.

So, we can conclude that the money demand relation still plays an important role in the transmission mechanism of monetary policy. In this respect, the diversion from equilibrium path of money growth has, based on our estimates, at least to consequences. A positive diversion, i.e. excessive money supply, leads to rising prices in the case of both M1 and M2 money and to increasing output in the case of M2 money. The intensity of the output feedback is somewhat higher, probably because the Czech economy was mostly in recession during the period analysed. The central bank should be aware of these potential consequences and use its operational tool(s) in such way as to keep money growth close to its equilibrium path. This supervision of money growth should help the central bank fulfil its primary objective.

[20] The negative coefficient of the *cpi* loading in the case of the JOH(1) estimate is probably due to the fact that inflation is perceived to be an alternative cost of holding M2 money in this case.

4. CONCLUSIONS

The beginning of this paper strives to illustrate the role of money demand in the transmission mechanism of monetary policy. In this respect we first point out three effects that are generally associated with changes in the operational tools of monetary policy, i.e. short-run interest rates. These are: the substitution effect, the income effect and the wealth effect. We continue by briefly reviewing the literature, focusing on various channels, namely the interest rate channel (relating mainly to the liquidity effect), the exchange rate channel (associated with the relative returns of various portfolio components) and the credit channel (which describes the consequences of monetary policy on banks' lending). We proceed by discussing some of the problems or aspects relating to the transmission mechanism of transitional economies, in particular the consequences of internal and external liberalisation, which significantly increase uncertainty in an economy. Both processes have also significantly expanded the range of portfolio allocation techniques. The resulting increase in currency substitution, among others, has influenced the effectiveness and predictability of monetary policy. Thus the transition process can make the money supply, for example, somewhat endogenous and increases the instability of money demand, or at least of the money demand typical of a closed economy.

Therefore, we subsequently analyse the empirical relevance in the case of Czech Republic of including selected foreign variables in the broad money demand function traditionally proposed by the theory. We do so by modelling the demand for domestic currency of a rather broad definition, including as explanatory variables various measures of the nominal exchange rate besides the traditional explanatory variables. These measures of the nominal exchange rate are meant to represent the return on foreign money. We use the following exchange rates: CZK/USD, CZK/DEM and the nominal effective exchange rate. We find that CZK/USD and CZK/DEM are superior to the NEER measure, since these two exchange rates have historically followed a different pattern than that suggested by the NEER and are likely to be more appropriate measures of the exchange rate effect on portfolio allocation decisions.

The empirical part concerning money demand analysis begins by modelling of narrow money demand in Czech Republic. As the dependent variable we use the M1 monetary aggregate, which comprises currency in circulation and sight deposits. In addition, we employ a traditional set of explanatory variables, i.e. a measure of price level development, a scale variable, the own rate of return and the opportunity costs of holding narrow money. Moreover, we include the real effective exchange rate and gross domestic foreign direct investment as foreign variables likely to affect narrow money demand in the case of the Czech Republic. We find all the traditional explanatory variables to be important for the development of the M1 aggregate. The inclusion of the real effective exchange rate does not seem to bring any additional information, altering in some estimates the effect of price level development. On the other hand, the inclusion of FDI does seem to be important for narrow money demand, although its peak effect comes only with the fourth lag. We prefer not to include this variable in the general expression for narrow money demand, since it significantly affects the range of

the estimated period and thus the estimates of other variables. However, its influence should be considered in further research.

To model the demand for broad money in the case of the Czech Republic we use the M2 aggregate. This comprises M1 plus time deposits and deposits in foreign currency. As in the M1 case, we employ the traditional set of explanatory variables and add certain foreign variables which, according to portfolio theory, probably influence decision-making concerning M2 money holdings. The interest rate on credits and inflation here represent the opportunity costs of holding M2 money, in keeping with our discussion of the institutional character of the Czech economy. The added foreign variables are the nominal CZK/USD and CZK/DEM exchange rates (to represent the return on foreign money holdings) and the return on U.S. and German assets expressed in Czech currency (to represent the effect of capital mobility). We find all the domestic explanatory variables except inflation to be important for M2 development. Nevertheless, these domestic variables leave ample room for a significant influence on M2 from currency substitution and capital mobility, i.e. the return on foreign deposits in USD and on U.S. assets.

In the last section of the empirical part we present and discuss estimates of the possible effect of disequilibrium money growth on important macroeconomic variables such as the inflation and output dynamics. We find that an excess of narrow and broad money supply significantly influences the dynamics of both these variables, which are of topical importance for policy makers. We conclude that in the case of Czech Republic the central bank should be aware of such possible effects. However, a thorough analysis of the influence of money disequilibria on inflation and real output should be conducted within a more structural framework.

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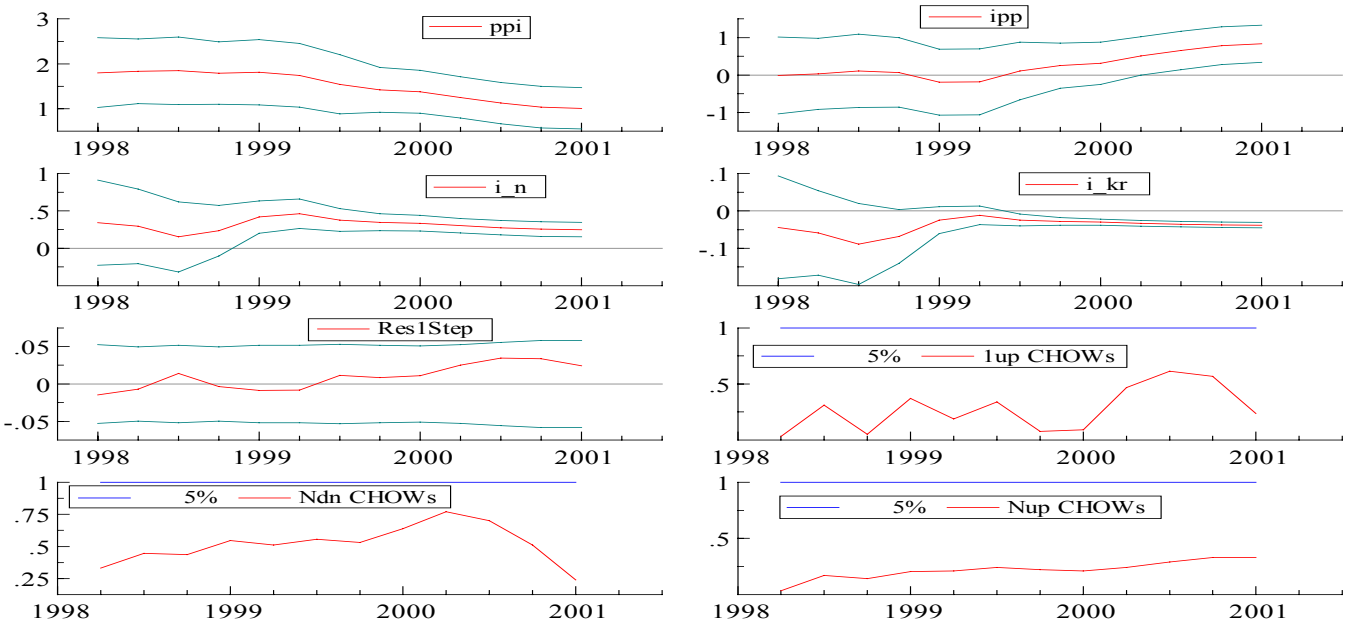
Appendix

Table 1A: Estimates of Equation (3) Using NLS

Variable	Estimation Method	General Significance (Supplementary)
	NLS	
m1(-1)	0.71 (0.07)***	1% significance level
Ppi	0.57 (0.26)**	1% significance level
Ipp	0.23 (0.15)	5% significance level
I_n	19.9 (7.60)***	1% significance level
i_kr	-6.83 (1.09)***	1% significance level
constant	0	10% significance level

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). The last column of the table indicates the supplementary overall significance of the particular variable and the median of its estimated coefficients and standard errors. 0 denotes an acceptance of zero-restriction on the particular coefficient.

Graph 1A: Test of Stability of the Equation (3) Estimation by DOLS



Graph 2A: Test of the Stability of the Equation (3) Estimation by ADL

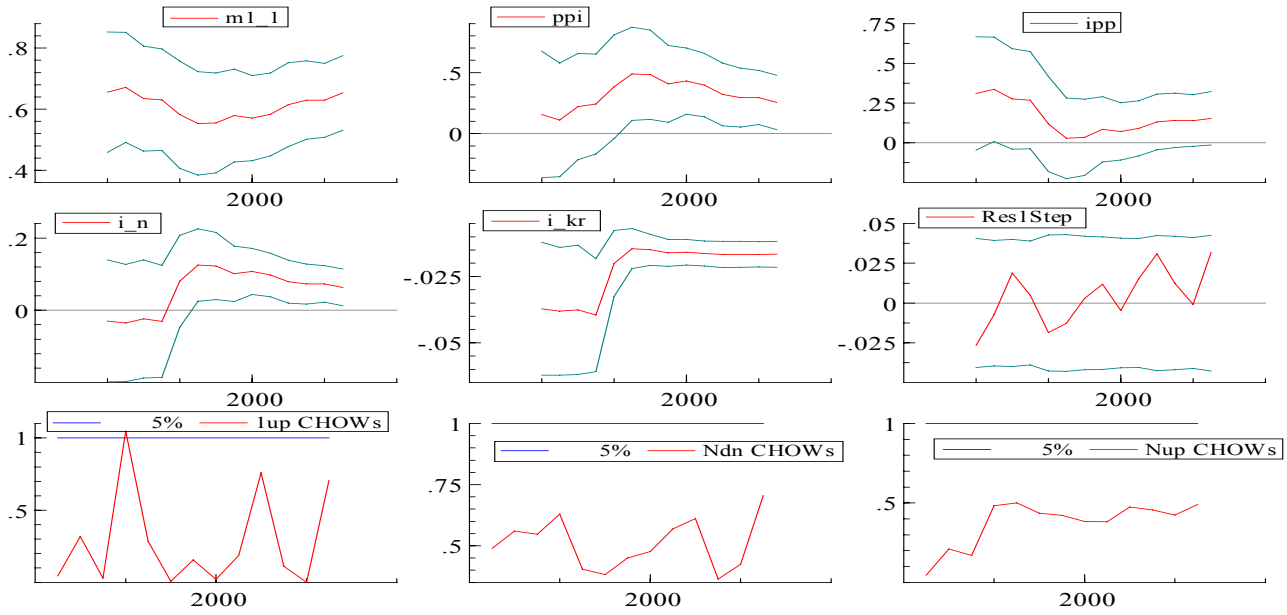
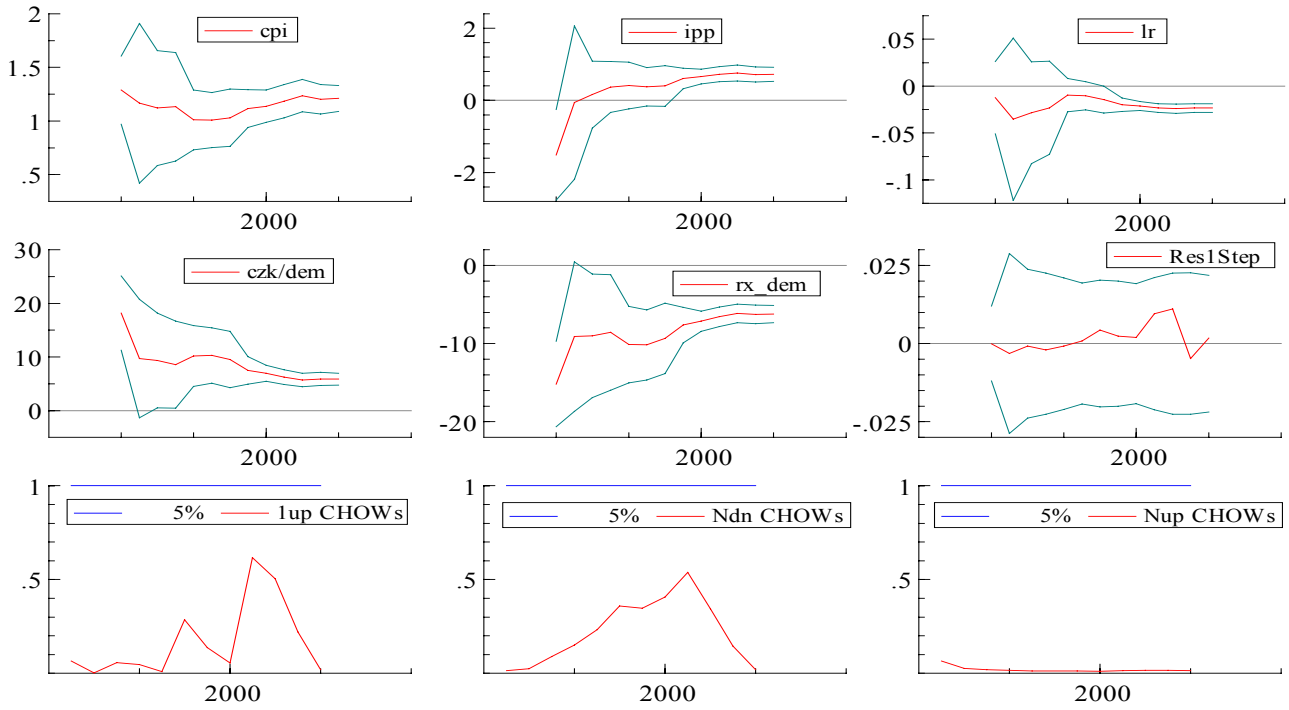


Table 2A: Estimates of Equation (4) Using NLS

Variable	Additional Estimation methods		General Significance (sup.)
	NLS	NLS(1)	
m2(-1)	0.88 (0.05)***	0.78 (0.05)***	0.82 (0.05)***
cpi	1.02 (0.65)*	2.16 (0.64)***	1.21 (0.12)**
ipp	0.51 (0.14)***	0.42 (0.12)***	0.63 (0.12)***
i	0	0	0
lr	-6.95 (2.01)***	-8.53 (1.80)***	1% significance level
inf	0	0	insignificant
czk/usd	30.36 (11.71)***	72.64 (15.57)***	5% significance level significant
czk/usd(-1)	-----	-69.12 (20.21)***	10% significance level
czk/dem	0	0	insignificant
czk/dem(-1)	-----	0	insignificant
rx_usd	30.96 (11.47)***	-67.92 (14.46)***	1% significance level
rx_usd(-1)	-----	62.59 (18.74)***	insignificant
rx_dem	0	0	insignificant
rx_dem(-1)	-----	0	insignificant

*, ** and *** indicate significance at 10%, 5% and 1% probability levels respectively (S.E. in brackets). The last column of the table indicates the supplementary overall significance of the particular variable and the median of its estimated coefficients and standard errors. 0 denotes an acceptance of zero-restriction on the particular coefficient and ----- indicates that the given variable was not included in the estimated equation.

Graph 3A: The Stability of DOLS Estimation



Graph 3A: The Stability of JOH(1) Estimation