



# The estimation of money demand in the Slovak Republic

*Ing. Viera Kollárová, Ing. Rastislav Čársky*  
National Bank of Slovakia

## INTRODUCTION

This article focuses on the estimation of money demand and the identification of any monetary-policy implications. Money demand models can be suitable tools with which to assess monetary developments. A stable relationship between money and the real economy should help the NBS to identify potential imbalances and inflationary pressures.

To begin with, we select the individual variables, including the definition of money that is to be used. The description of the variables also in-

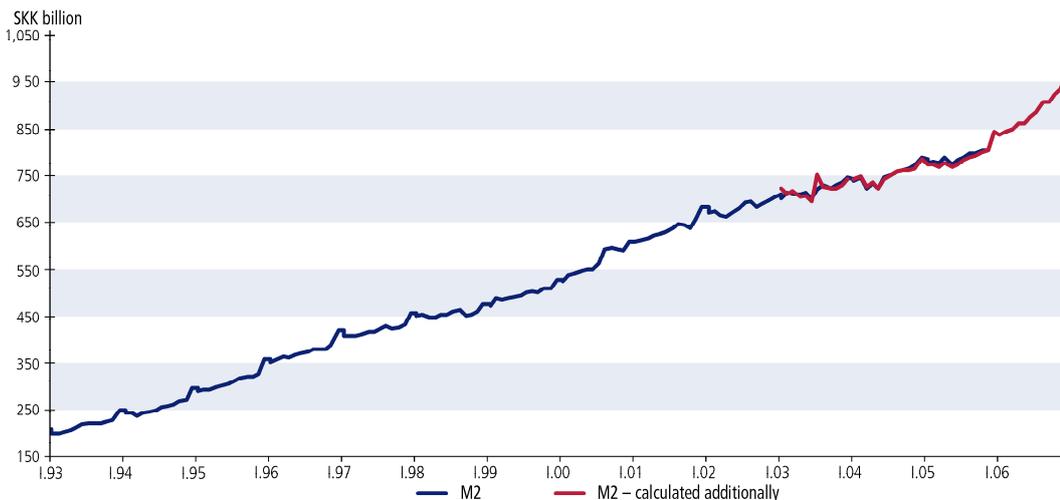
cludes an analysis of behaviour and economic significance in relation to money. The next part is devoted to the econometric estimation of the money demand function, and the final part focuses on the econometric interpretation of the estimated parameters and the potential for using the estimated equations to identify imbalances in the economy.

## SELECTION OF VARIABLES

### Definition of money

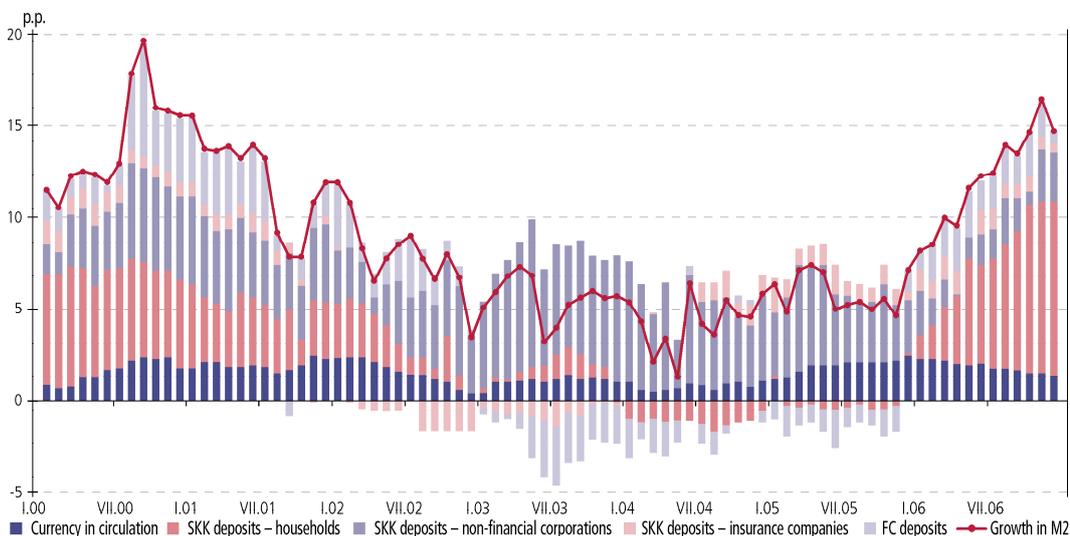
The variable representing money demand was

### Monetary aggregate M2 (1993 – 2006)



Source: NBS.

### Contributions of individual M2 components to its year-on-year dynamics



Source: NBS.

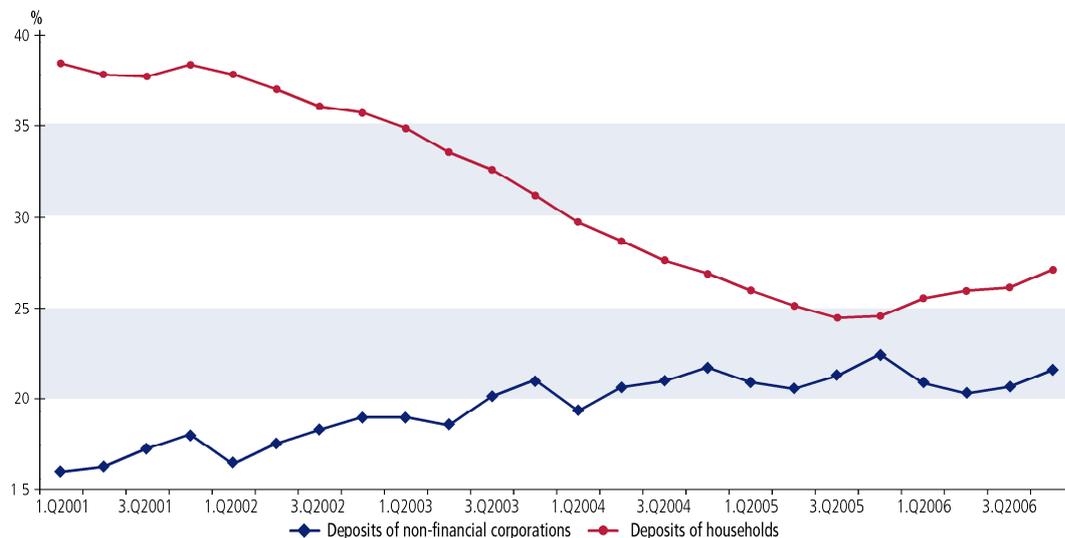


1 Definition of monetary aggregates:  
 $M0$  = currency in circulation outside banks;  
 $M1$  =  $M0$  + demand deposits and savings deposits redeemable without a period of notice, held by domestic non-banking entities (residents + non-residents, in SKK) vis-à-vis the domestic banking system – excluding funds of government and local authority bodies;  
 $M2$  =  $M1$  + time deposits and savings deposits redeemable at a period of notice (residents + non-residents, non-banking entities), denominated in SKK and including certificates of deposit + foreign currency demand deposits and time deposits (residents, non-banking entities) held vis-à-vis the domestic banking system – excluding funds of government and local authority bodies.

taken to be the M2 money supply, as defined in the NBS methodology<sup>1</sup> (until 2005). This variable was selected because the monetary aggregates in the ECB methodology have only been report-

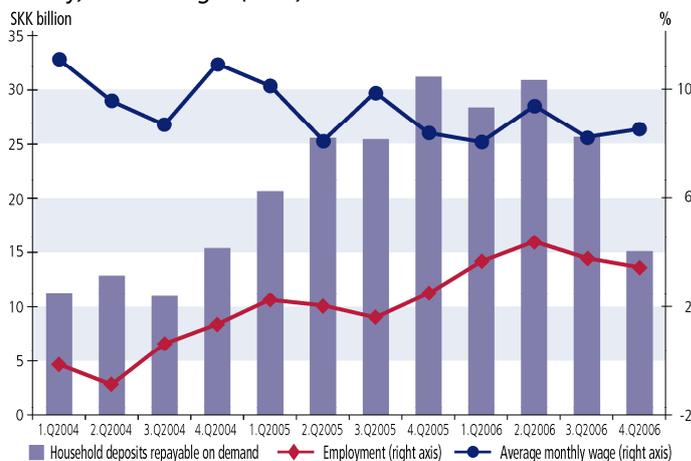
ed since 2003 and it is not possible to back-calculate them. In order to have a longer time series, the M2 money supply data were additionally calculated up to the present. Owing to dif-

**Deposits as a share in GDP (2001 – 2006)**



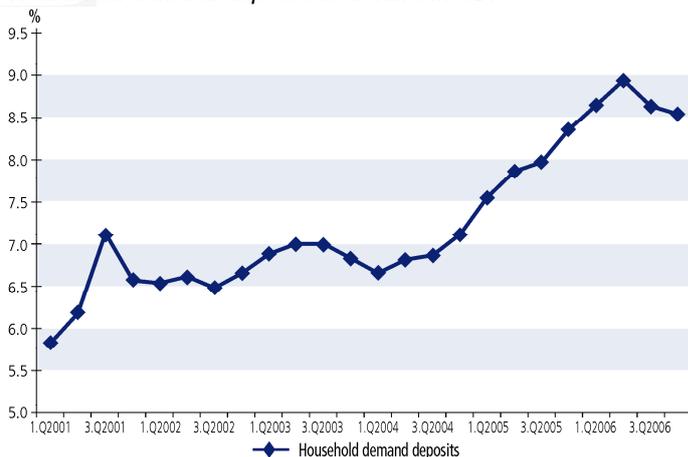
Source: NBS, Statistical Office of the Slovak Republic.

**Year-on-year increase in household deposits (in SKK bln) and growth in employment (according to labour force sample survey) and in wages (in %)**



Source: NBS, Statistical Office of the Slovak Republic.

**Household demand deposits as a share in GDP**



Source: NBS.

ferent methodologies, small differences may arise in the description of individual components of the money supply.

**Economic activity**

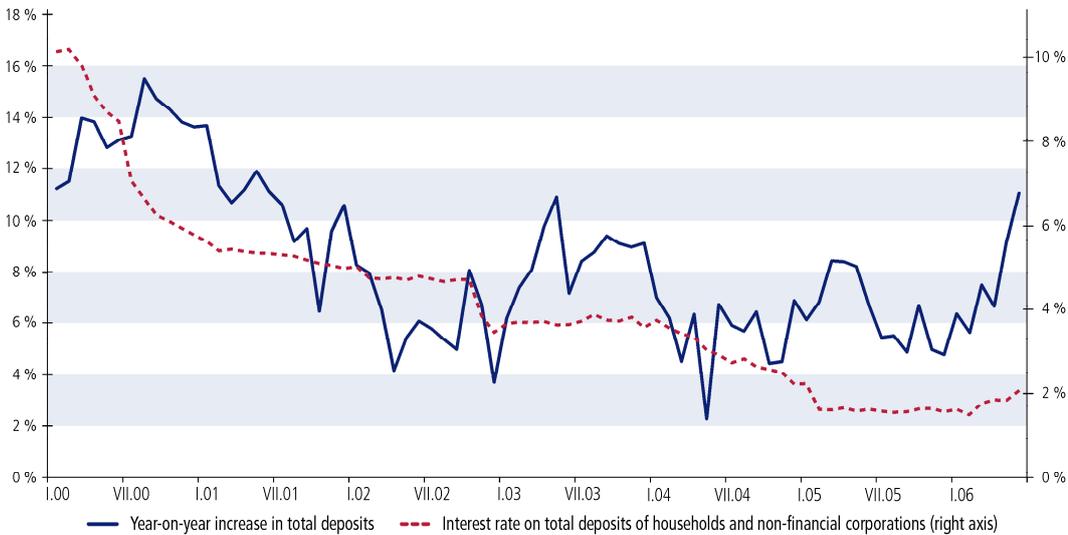
The variable that explains the relationship between money and economic activity is related to the transaction motive for holding money. For this 'scale variable', we selected real gross domestic product. We also considered, for example, retail turnover and industrial output, but these were deemed statistically insignificant.

Given that motives for holding deposits differ between sectors (corporate and household), the development of deposits share in GDP is also different. Whereas the corporate sector uses deposits mostly to service its transactions, households use them mainly as a form of saving. This is confirmed also by the differences in corporate deposits and household deposits share in GDP. While the ratio of corporate deposits (around 60% of which are demand deposits) is gradually increasing, the ratio of household deposits is in a long-term decline.

Some household deposits are, however, also related to the transaction motive for holding money and to economic activity, particularly in the case of demand deposits, that is, deposits repayable on demand. The improving situation in the labour market, wage developments, and above all employment growth, are gradually being reflected in the dynamics of demand deposit growth, and the ratio of these deposits to GDP is developing similarly to the ratio of corporate deposits. From 2001 to the end of 2006, their ratio recorded an almost identical increase of between 3 and 5 percentage points.



**Year-on-year increase in total deposits and the deposit interest rate**



Source: NBS.

**Own yield of money and alternative assets (financial innovation)**

Money is used not only as a medium of exchange, but also, especially among households, as a form of saving. The variables that explain the behaviour of deposits in regard to the saving motives of economic entities are usually the own yield of money or the yield of alternative assets into which savings may be allocated. As regards the type of deposits, the rate of return on individual assets should affect the behaviour of demand and savings deposits. If the own yield of money rises in comparison with the yield of alternative assets, the demand for money should also increase. Conversely, if the yield of alternative assets rises, interest in deposits will decline.

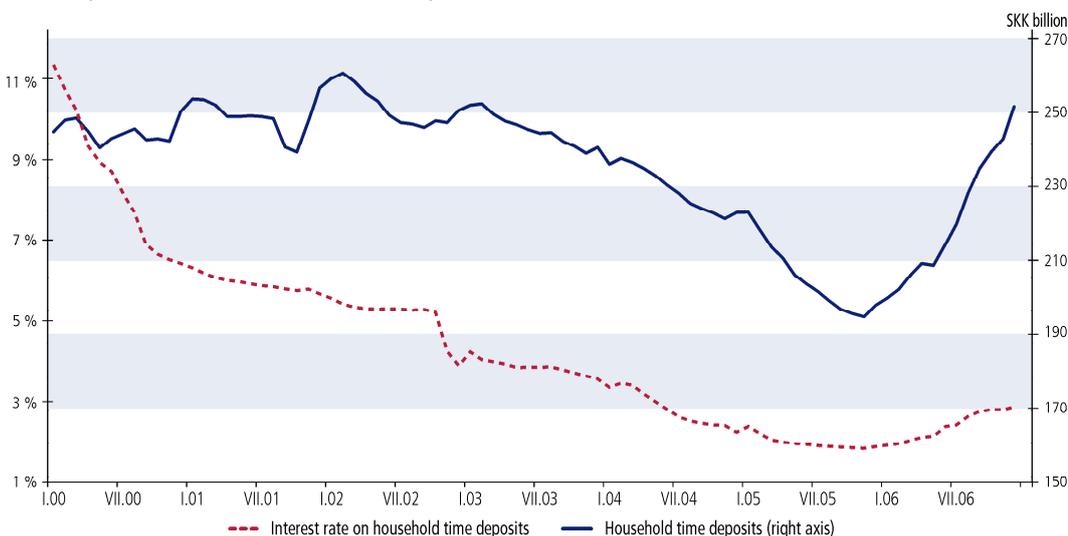
To approximate own yield, we selected the total interest rate on deposits of households and non-financial corporations. The following chart indicates the relationship between the interest rate on deposits and the development of deposits.

Household deposits show the most sensitivity

to interest developments. Since 2000, the NBS has been fixing the key interest rates (overnight sterilization rate, overnight refinancing rate, and the two-week repo tender limit rate). As the outlook for inflation gradually improved, the NBS lowered its key rates right up to 2005. This saw a sharp decline in interest on demand and savings deposits and consequently a decline in the use of these types of deposit.

As well as own yield of money, the uptake of deposits also affects the rate of return on alternative assets. The most accessible type of alternative financial asset are shares/units of mutual funds, whether money market funds or others, especially equity funds and bond funds (their ratio to the money supply currently stands at more than 10%).<sup>2</sup> Since a database of the returns on these funds is not available, we treated the amount of money invested in them to be the variable of alternative assets. The time series are, however, relatively short and are available only from 2004.<sup>3</sup> The following charts show that investments

**Time deposits of households and the deposit interest rate**

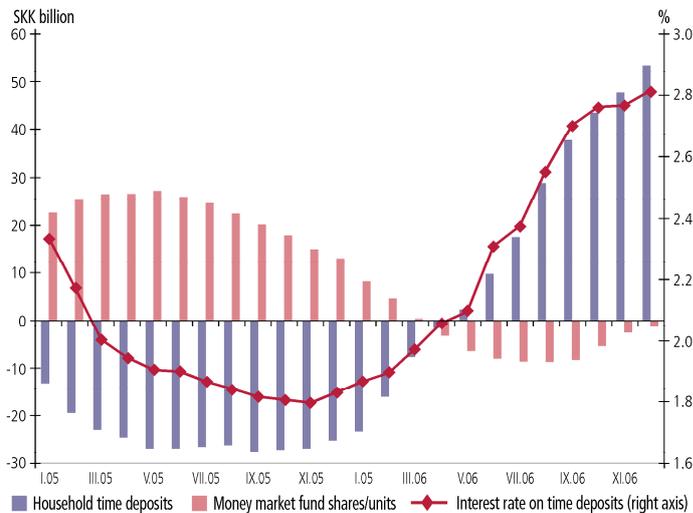


Source: NBS.

2 In the estimation of the money demand function, money market funds represent the alternative asset where money is defined as the M2 aggregate, and where the M3 aggregate is used they are included in it.  
3 Data on money market fund (MMF) shares are available on a monthly basis; data on shares/units of investment funds other than MMF are only available on a quarterly basis.

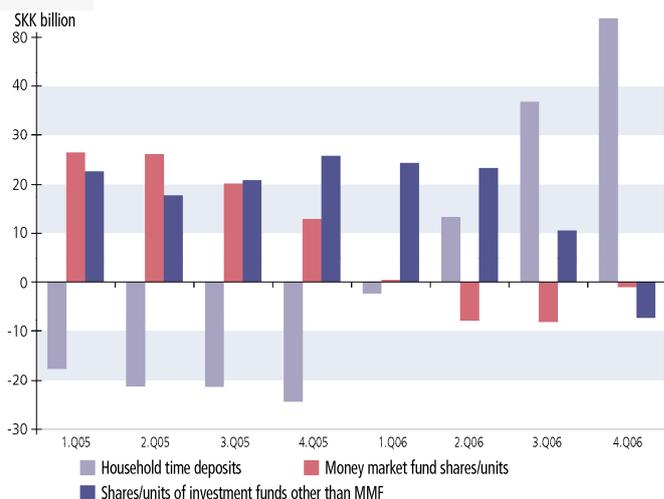


**Year-on-year growth in household deposits and mutual fund shares/units**



Source: NBS.

**Year-on-year growth in household deposits and mutual fund shares/units**



Source: NBS.

in mutual funds (especially money market funds) are used relatively flexibly as an alternative to deposits and react to changes in the returns on deposits.

The role of mutual funds as a substitute for deposits and the effect of deposit interest on the transfer of funds between each type of financial asset are also recorded by the ratios of deposits and mutual funds, or rather the aggregate of both of these products, to GDP. When interest decreased, the ratio of deposits to GDP fell, and the ratio of stocks and mutual fund shares rose. The aggregate ratio (of household deposits, shares/units of mutual funds) to GDP, i.e. the household savings rate in the economy, has remained constant with a slight decline in the previous period. That, however, may have been caused by the strong GDP growth in 2006.

The own yield of money is included in the long-run money demand equation, although considering the shortness of the time series for mutual funds, the variable describing the development of alternative assets vis-à-vis deposits is only included in the short-run part of the equation (in the long-run it is not significant).

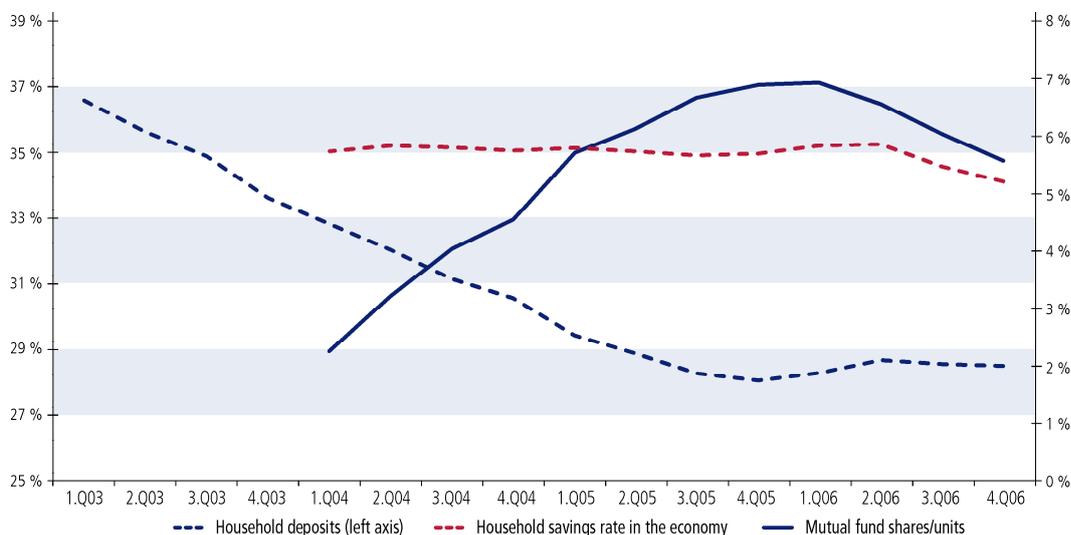
**Price level**

In studies of money demand, the price level is usually measured with the implicit deflator of GDP, the consumer price index or the producer price index. In this case, the selected deflator was the harmonized index of consumer prices adjusted for the effects of prices of energy and unprocessed food.

**Seasonality**

For modelling, we also applied seasonality expressing the increase in the money supply in the fourth quarter. This rise is caused by the fact that deposit interest is always credited at the end of the year.

**Deposits and mutual funds as a share in GDP**



Source: NBS, Statistical Office of the Slovak Republic.

Note: Mutual fund shares are the sum of money market fund (MMF) shares/units and shares/units of investment funds other than MMF, as reported since 2004.



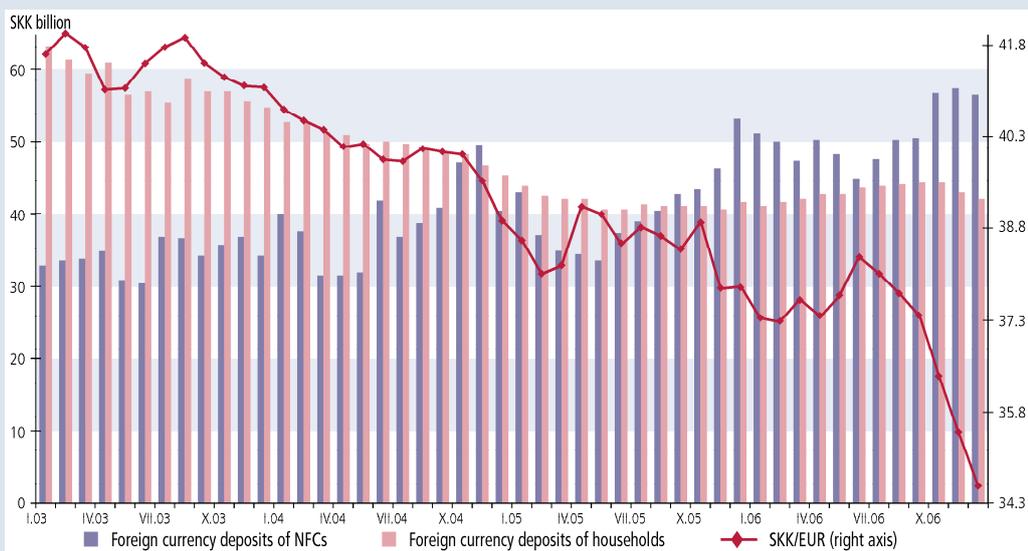
## FOREIGN CURRENCY DEPOSITS

The M2 definition of money used in modelling the money demand function presents a particular problem in the form of foreign currency deposits. These deposits are partially related to transaction requirements, especially in the case of corporate deposits, but they can simultaneously fulfil a savings function (such holdings may be partially speculative) which is more common for household deposits. If the SKK's exchange rate appreciates, the accounts value of foreign currency deposits declines and these deposits become less attractive given the expected loss (exchange rate). Such behaviour is most clearly displayed by household deposits, which were in an almost continuous decline until the end of 2005. This trend ceased in the last period.

By contrast, corporate deposits reacted only slightly to exchange rate developments, with a more marked reaction observed at the beginning of 2005. Despite the relatively volatile development, there is an apparent rising trend which is probably related to the increasing openness of the economy and the development of foreign trade.

The antagonistic trends in foreign currency deposits make it difficult to define a variable that explains their development. In seeking such a variable for the estimation of money demand, we tested economic openness and the exchange rate, but neither of them provided to be statistically significant.

*Foreign currency deposits of households and non-financial corporations expressed in SKK billion and the exchange rate SKK/EUR*



Source: NBS, Eurostat.

## ECONOMETRIC ANALYSIS

The money demand model was created on the basis of quarterly data, running from the 1st quarter of 2000 to the 4th quarter of 2006. The estimation does not date further back, because of the structural break in the character of the monetary-policy environment. Up to 1998, the NBS used a fixed exchange rate regime within a fluctuation band. This was gradually broadened from 10.5% in 1993 to 17.5%. Under the conditions of a fixed exchange rate, the effectiveness of monetary policy is limited and volatility may, by means of net foreign assets, be introduced into the development of monetary aggregates. In October 1998, the NBS abandoned the fixed rate regime, and in 1999 the economic environment reported gradual stabilization based on both, devaluation of the exchange rate and economic-policy measures. From 2000, the conduct of monetary policy shifted from quantitative implementation,

to qualitative implementation through the fixing of key interest rates – today's dominant tool of monetary policy. The previous period also saw certain changes in the monetary-policy environment, one being the introduction of inflation targeting (since 2005) and the other being entry into ERM II (in November 2005).

The length of the time series may considerably affect the scope for modelling money demand. All the variables used in the model are real, deflated by the HICP (excluding energy and unprocessed food). The estimation of the money demand function is made using two approaches: the Partial Adjustment Model (PAM) and the Vector Error Correction Model (VECM).

### 1. Partial Adjustment Model

It was decided to use several tools for the econometric analysis of money demand. The first of these is the partial adjustment model, through which the long-run equilibrium and short-run



4 ADF – Augmented Dickey-Fuller Unit Root Test.

adjustment may be presented. We begin with the following adjustment equation:

$$\ln\left(\frac{M2}{P}\right)_t - \ln\left(\frac{M2}{P}\right)_{t-1} = \gamma \left[ \ln\left(\frac{M2}{P}\right)_t^* - \ln\left(\frac{M2}{P}\right)_{t-1} \right]$$

The long-run money demand equation is as follows:

$$\ln\left(\frac{M2}{P}\right)_t^* = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln i_t$$

By means of a simple adjustment, we obtain the short-run equation that will include real money supply with a time lag,

$$\ln\left(\frac{M2}{P}\right)_t = \alpha_0 \gamma + \alpha_1 \gamma \ln Y_t + \alpha_2 \gamma \ln i_t + (1-\gamma) \ln\left(\frac{M2}{P}\right)_{t-1}$$

where:

M2 is the money supply (*lm2\_rep*);

P is the HICP excluding energy and unprocessed foodstuffs;

Y is real GDP (*lhdpsc*);

i is the real interest rate on deposits (*lirt\_rep*)

$\gamma$  – is the adjustment coefficient.

### Estimation

To the short-run equation there was added the variable *lplpf\_rep* (representing stocks and mutual fund shares/units) and *@seas(4)* (expressing seasonality). The model was estimated using the least squares method and the result is as follows (t-statistics are stated in brackets under the variable):

$$\begin{aligned} LM2\_REP = & -3.0245 + 0.3666 * LHDPSC \\ & [-2.9141] \quad [5.5308] \\ & + 0.8263 * LIRT\_REP + 0.5791 * LM2\_REP(-1) \\ & [4.1119] \quad [6.9665] \\ & - 0.0196 * LPLPF\_REP + 0.0344 * @SEAS(4) \\ & [-2.9262] \quad [4.5739] \end{aligned}$$

R-squared 0,9302      F-statistic 56,0080  
Durbin-Watson stat 1,9963

The estimation results refer to the positive elasticity of the money supply relative to GDP as well as the deposit interest rate. The statistical significance of stocks and mutual fund shares/units was also confirmed – the fact that their elasticity is negative confirms the hypothesis of substitution between them and household deposits. Our model also used a dummy variable representing seasonality, according to which the amount of the M2 money supply increased by 0.03% in the fourth quarter. This rise is probably caused by the crediting of deposit interest at the year-end. The model is also suitable for predicting the development of the money supply (as confirmed by an analysis using the CUSUM curve), although the forecasts may be slight overestimated. The money demand function is moderately unstable, as expressed by recursive estimations of the model's individual coefficients.

Based on the short-run and long-run equation, the adjustment coefficient  $\gamma$  may be expressed. This coefficient expresses the degree of adjustment of real money balances vis-à-vis the long-run equilibrium in the current period. In our case, the adjustment is equal to 0.42. As with the adjustment coefficient, equations can be used to express the long-run elasticity of M2 in relation to each variable.

The long-run money demand equation:

$$\ln\left(\frac{M2}{P}\right)_t^* = -7,18589 + 0,870901 * \ln Y_t + 1,963288 * \ln i_t$$

The description of long-run elasticities will be addressed at the end, along with the elasticities quantified with the estimation of the VECM model.

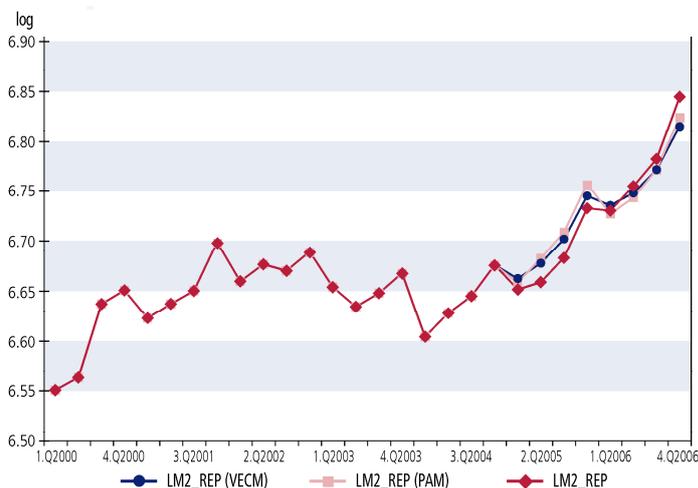
### 2. Vector Error Correction Model (VECM)

The VECM is the second approach used in modelling money demand. Under this approach, the simultaneous effect of all three variables (M2, GDP, deposit interest rate) on each other is estimated and the result is given as three equations. The result represents an estimation of the stationary time series. Each of the model's variables was tested for stationarity using the ADF test,<sup>4</sup> which found that they are non-stationary and integrated of the same order I(1).

Given that the other equations (estimation of GDP and the interest rate) have a low adjustment coefficient and the centre of our attention is the money supply, these equations are not used hereafter. The final estimated equation for M2 is given as follows (t-statistics are stated in brackets under each variable):

$$\begin{aligned} D(LM2\_REP) = & -0.3735 * (LM2\_REP(-1)) \\ & [-2.1239] \\ & - 0.8238 * LHDPSC(-1) - 1.5852 * LIRT\_REP(-1) \\ & [-6.1003] \quad [-6.0445] \\ & + 5.1818 - 0.4184 * D(LM2\_REP(-1)) \\ & [3.5791] \quad [-2.7348] \end{aligned}$$

Comparison of money demand models



Source: NBS.



$$+ 0.1135 * D(LHDPSC (-1)) + 0.0783 [0.9277]$$

$$* D(LIRT\_REP (-1)) - 0.0097 * LPLPF\_REP [0.1661] [-1.3620]$$

$$+ 0.0273 * @SEAS(4) [2.8635]$$

When designing the models, we considered various model specifications and various variables (inflation, gross output, 3-month BRIBOR). During the modelling, however, these were shown to be statistically insignificant, or rather their parameters had signs opposite to those we had expected on the basis of theory.

The two approaches presented here are the models with the best estimation results, that is, with the most accurate estimation based on dynamic forecasts generated ex post. This is also recorded by the chart for the period of the last 8 quarters (the chart also shows the logarithms of the values).

### PARAMETERS OF LONG-RUN EQUATIONS AND THEIR INTERPRETATION

In both approaches, the long-run elasticities are relatively similar, and as regards GDP, practically identical. The VECM model indicates money demand reacts more strongly to interest rates. The adjustment coefficients report approximately the same figures and are comparable with estimates made in the past.<sup>5</sup>

| Variable <sup>6</sup>  | PAM    | VECM   |
|------------------------|--------|--------|
| ln Y                   | 0.8709 | 0.8238 |
| ln i                   | 1.9633 | 1.5852 |
| Adjustment coefficient | 0.4209 | 0.3735 |

The long-run elasticity relative to GDP is lower than one, which indicates an increasing velocity of money in circulation. This result does not completely coincide with the analysis of transaction deposits under M2, which we looked at in the introductory part in the section on economic activity. By contrast, the rising ratio of corporate deposits and household demand deposits relative to GDP could indicate elasticity closer to, or slightly higher than, one.

One reason why the long-run elasticity of the scale variable is lower than one could be the fact that the short-run part of the equation includes the variable representing alternative assets from 2004, or that the long-run equation does not include this figure at all (shortness of the time series).

The absence of this variable may also be a cause of the relatively high long-run elasticity of long-run money demand in relation to own yield of money. In both equations it is substantially higher than one. That level, however, probably also reflects the monetary environment and processes taking place in the banking sector. In addition, the period for which we estimated the demand function was influenced by the complet-

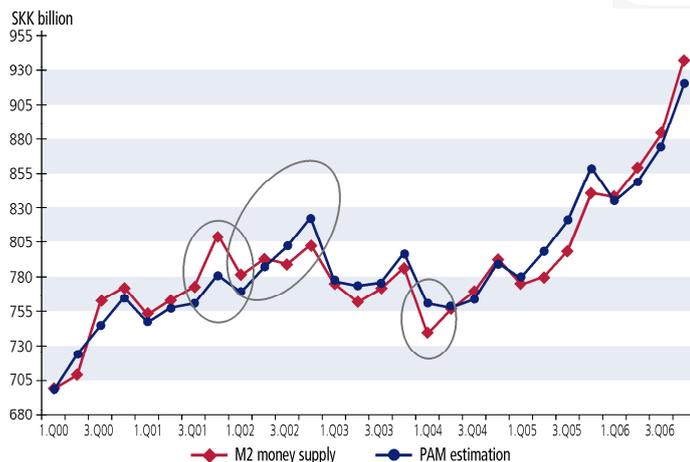
ed restructuring of selected banks and their privatization. In 2000, meanwhile, the NBS began the reporting of key interest rates and thereby shifted from a quantitative to qualitative implementation of monetary policy. Following a period in which deposits attracted very high interest (nominal interest rates were averaging 10% in 1998 and 1999), there was a relatively sharp decline in interest rates and so deposits became relatively less attractive, too. In this environment, households led the way in looking for alternative forms of saving.

### MONEY DEMAND AND THE IDENTIFICATION OF IMBALANCES

The difference between the equilibrium values of real M2, estimated from the long-run money demand equations and actual developments in the M2 aggregate (at constant prices), is known as the 'real money gap'. Its presence may signal the potential emergence of imbalances, assuming, however, that the money demand function is stable. In our case, this assumption is not fully met. At the same time, the long-run equation does not include the variable of alternative assets (mutual funds), which for our purposes is crucial to the modelling of the money demand function and was excluded from the long-run equation only because of the shortness of the time series. If the short-run money demand equation lacked this variable, it would also fail to give satisfactory results. For that reason, we calculated the real money gap as the difference between the actual stock of real M2 and the real M2 estimated from the short-run equation. The following identification and interpretation of the real money gap is therefore only for guidance.

A comparison of the ex post values of the real money supply and the values simulated with the partial adjustment model shows substantial difference in only three periods. The most substantial difference was identified at the end of 2001 and beginning of 2002, when the actual M2 value significantly exceeded the simulated values.

Actual stock of real M2 and PAM-simulated values



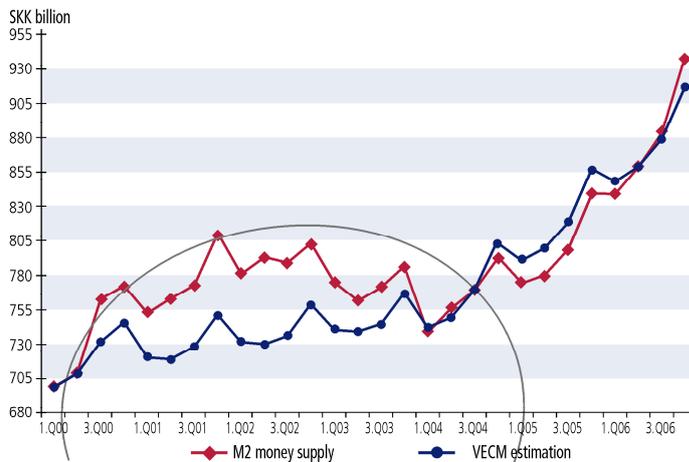
Source: NBS

5 Čársky R., Gavura M.: Modelling the money demand function in Slovakia; Biatec 11, 1997.

6 The following variables are used: Y = real GDP; i = real deposit interest rate; adjustment coefficient = the degree of adjustment of real money balances vis-à-vis the long-run equilibrium in the current period

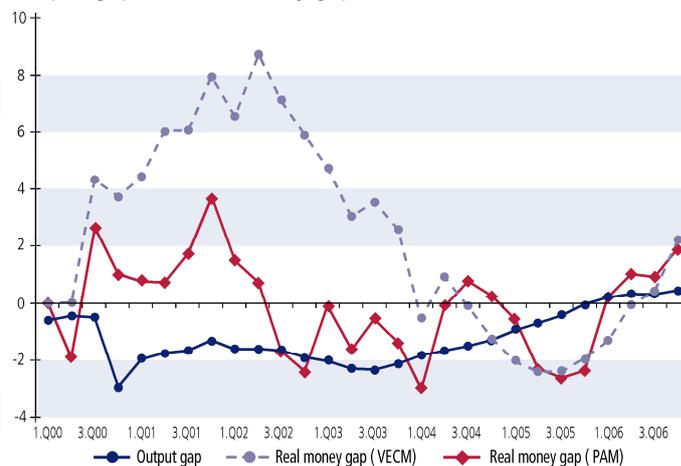


Actual stock of real M2 and VECM-simulated values



Source: NBS

Output gap and real money gap



Source: NBS

7 Portfolio shifts – movements between individual components and counterparts of the M3 money supply and shares/units of investment funds other than MMF.

8 The output gap is calculated on the basis of the NBS model MVF-UC (Multivariate Filter with Unobserved Components); the estimation includes the deviation of inflation from its target, which determines the development and size of the gap.

A factor in the money supply growth was the maturity in 2001 of bonds issued by the National Property Fund in a second wave of coupon privatization. This effect was reflected to lesser extent in subsequent quarters, and the M2 aggregate made a relatively quick return to equilibrium. Another difference in comparison with the real M2 was seen in the first quarter of 2004. This was related to an administrative change of 31 December 2003, when anonymous deposits were abolished as required under the harmonization of Slovak law with EU legislation.

A relatively long-run negative real money gap, in other words, a situation in which the actual stock of real M2 fluctuated below the simulated values, was recorded in 2005. It may have been a sign that money was at this time having a somewhat dampening effect on prices. Tests of the function's quality in terms of forecasting ability indicate, however, a slight tendency to overestimate (CUSUM test).

**Bibliography:**

- ARTL, J., GUBA, M., RADKOVSKÝ, Š., SOJKA, M., STILLER, V.: Influence of Selected Factors on the Demand for Money 1994-2000; WP No. 30, Prague 2001.
- BRAND, C., CASSOLA, N.: A Money Demand System for Euro Area M3, ECB, Working Paper No. 39, November 2000.
- ČÁRSKY, R., GAVURA, M.: Modelling the money demand function in Slovakia; Biatec no. 11, 1997.
- DREGER, CH., REIMERS, H. E., ROFFIA, B.: Long-run Money

In 2006, by contrast, the gap between the simulated and actual values indicates that the effect of money may be inflationary. This deviation is, however, low and falls within the margin of error for generated forecasts ( $\pm 2 \times$  the standard deviation of the estimation). Even so, the cause could as well be the strong economic growth (8.3% for 2006) and the increase in interest rates during the year; the main reaction to this came from households, with an increase in deposits and so-called 'portfolio shifts'<sup>7</sup>, which affected the money supply but not price developments.

Using the VECM model to compare the actual stock of real M2 and simulated values indicates that from 2000 to 2003 there was a long-run, enduring surplus of money in comparison with the money demand estimation. No satisfactory interpretation has been found for this gap. It came to an end in 2004, i.e. in the period when the variable of alternative assets join the function. This gap may have been caused by alternative money holdings (mutual funds shares/units) not being taken into account, and therefore the money demand function estimated by the VECM method appears to be less suitable for the identification of money market imbalances.

A comparison between gaps in the money market (difference between actual stock of real money balances and estimated money demand) and the output gap<sup>8</sup> indicates a similar development, although the levels do not correspond entirely. In 2000-2001, for example, when the output gap closed slightly, the positive real money gap widened. Conversely, the negative output gap increased in 2002-2003, accompanied by a narrowing of the positive real money gap. Since 2005, both the development and level of gaps in the money market and the output gap have begun to correspond.

**CONCLUSION**

Given the instability of the money demand function, its utilization for monetary-policy purposes is limited. The similar development of the output gap and real money gap only points to the requirement for money to service economic activity. If the overheating of economy were to be affected by a relative surplus of money, there should be a certain lag between the real money gap and output gap. The analysis did not, however, indicate such a relationship.

For the moment, therefore, the estimated money demand function may be used as an alternative/supplementary analytical tool for identifying potential imbalances in the economy, or for forecasting purposes.

- Demand in the New EU Member States with Exchange Rate Effects, ECB, Working Paper No.628, May 2006.
- KOMÁREK, L., MELECKÝ, M.: Demand for Money in the Transition Economy: The Case of the Czech Republic 1993 – 2001, Warwick economic research papers No. 614, December 2001.
- KUIJS, L.: Monetary Policy Transmission Mechanisms and Inflation in the Slovak Republic, IMF, WP/02/80, May 2002.
- VANCE, L. Martin: IMF Course: Basic Econometrics Using Eviews, November 2004.