A Structural Quarterly Monetary Model for Belgium

by

J. VUCHELEN (*)

Centrum Ekonometrie en Management Science
Vrije Universiteit, Brussel

I. Introduction

In this study we present a quarterly monetary model for Belgium. Compared to previous monetary models for Belgium (Vuchelen [17] or [21], Heremans, Sommariva and Verheirstraeten [9] and Clavajio-Kervyn [7] (†)), we concentrate on the money market and the determination of the short term interest rate. Other differences are the introduction of the management of the government debt, the special attention paid to the behavior of commercial banks and the size of our model (62 equations, 25 of which are behavioral ones). The main instruments of monetary policy are explicitly included in the analysis. We tried moreover to represent some instruments in another way than by simple dummy variables.

The plan of the paper is as follows. In the next section we present a general survey of the model. Section III deals with the determination of the money supply. This requires the study of the asset allocation process of the commercial banks and the private sector. In section IV we explain the process determining

(*) Comments on a previous version of the paper were given by Daniel De Roo, André Drama's, Yvan Guillaume and Françoise Thys.
(†) A paper by P. Reding [15] has also to be mentioned here.
All references are to be found on p. 538.
the short term interest rate. Section V is reserved to the government sector, i.e. debt management and the interest rates on Treasury bills and government bonds. In the next section we treat the loan market. In sections VII and VIII we explain other interest rates and definitions. The last section contains static and dynamic simulation results.

II. Survey of the model

The theory behind our monetary model is the Brunner-Meltzer approach (see e.g. [4]). This approach assumes a generalized substitution between money and all other assets (real and financial ones). The substitution is not perfect so that each market must be analyzed. In our model however we will not analyze the output market: we are more interested in the analysis of the equilibria on the financial markets and we take as given, real, foreign and domestic policy variables. Another feature of the Brunner-Meltzer approach is that all prices are determined by a market clearing mechanism i.e. by the intersection of a demand and a supply schedule. The principal advantage of this approach is that it requires the estimation of structural relations so that it is easier to take particular monetary policy instruments into account.

This interest rate determination process has been applied in our model to the short term rate, the loan rate and the long term rate on government bonds.

The short term interest rate is determined so as to equalize the residual demand for domestic borrowing by the commercial banks and the supply by non-monetary financial institutions; the residual demand being defined as the difference between the total demand for domestic borrowing and the borrowing at the discount window of the National Bank.

The loan rate is determined by the equilibrium between the supply of loans by the commercial banks and the demand for loans by the private sector.

Concerning the determination of the rate on government bonds we have to aggregate the demand by the commercial banks and the private sector to obtain the total demand. The supply of bonds is derived from an equation explaining the composition of the government debt (the total debt is exogenous).

The other part of the government debt, Treasury bills, is an important variable in the determination of the money stock. The
reason is that Treasury bills detained by the National Bank are endogenous in our model: the total supply of Treasury bills is determined by the debt management equation so that the residual supply i.e. the Treasury bills not demanded by the commercial banks and the financial non-monetary institutions, must be taken up by the National Bank. In this way we make a strong link between the government budget constraint and the monetary sector. This link is much more pronounced than in other models. The procedure normally followed consists in excluding the government sector or in taking the total supply of government bonds as exogenous. Treasury bills are traditionally excluded from the analysis (2).

Treasury bills detained by the National Bank is one element determining the money base. Other endogenous variables (borrowing at the National Bank, net foreign assets of the private sector and net foreign borrowing by the commercial banks) have also to be added to the exogenous adjusted money base in order to obtain the money base.

Demand deposits are determined by the product of a money multiplier and the money base (less the reserves of the commercial banks). Substitution of demand deposits in the different asset allocation ratios of the private sector makes it possible to obtain the money stock.

Concerning the explanation of the behavior of the commercial banks, we have proceeded in the following way: we determine first total liabilities i.e. total deposits plus domestic and foreign borrowing. An asset allocation model is then developed to explain how this total is distributed over the different assets.

Three points have still to be mentioned: the treatment of monetary policy instruments, the link with the real sector and the dynamic aspect of the model.

Concerning the instruments of monetary policy we have tried to construct variables measuring more accurately the strength of the discretionary instruments. The usual procedure of introducing dummy variables is indeed not very efficient.

Different kinds of real variables appear in our model but three have a relatively large influence. First, we have price indices which

(2) Another procedure is to aggregate bonds and Treasury bills.
are used to deflate some variables or to construct a price expectation variable. Second, disposable income acts as a proxy for the level of transactions and is also used to construct a permanent income series. Third, besides permanent income we also use net worth series. Here the value of the capital stock has an influence.

The model is dynamic since it incorporates different lagged variables. Observe however that these variables are mainly monetary variables such as lagged dependent variables or lagged interest rates. This implies that the influence of the real sector on the monetary sector does not need time: the monetary sector however needs time to absorb this influence.

To estimate the different equations we have used the ordinary least squares method. The values in parentheses below the coefficients are t-values. The coefficient of determination (RS), this coefficient corrected for degrees of freedom (RSC), and the Durbin-Watson statistic (DW) are also reported.

The sample period is, for most of the equations, 1963-I to 1974-IV i.e. 48 observations.

III. The Money Stock

A. The balance sheet of the National Bank

The balance sheet of the National Bank can be written as:

\[ \text{IR} + \text{GSTNB} + \text{GLNB} + \text{NREN} + \text{H} + \text{OA} = \text{CB} + \text{MRF} + \text{MRB} + \text{ODB} + \text{C} + \text{OL} \]  \hspace{1cm} (1)

where

- IR : Net international reserves (excluding export acceptances)
- GSTNB : Treasury bills detainted by the National Bank
- GLNB : Long term government bonds detainted by the National Bank
- NREN : Net claims on the Government Securities Market Stabilization Fund
- H : Borrowing by the commercial banks (including export acceptances)
- OA : Other assets
- CB : Currency detainted by the commercial banks
- MRF : Monetary reserves of the non-banking financial sector
- MRB : Monetary reserves of commercial banks
- ODB : Other deposits of commercial banks
- C : Currency detainted by the non-banking public
- OL : Other liabilities
Defining: \[ \text{GSNB} = \text{GSTNB} + \text{NREN} \]
\[ \text{ONB} = \text{OA} - \text{MRF} - \text{OL} \]
\[ \text{RRB} = \text{CB} + \text{MRB} + \text{ODB} \]

allows us to write the balance sheet of the National Bank as:

\[ \text{IR} + \text{GSNB} + \text{GLNB} + \text{H} + \text{ONB} = \text{RRB} + \text{C} \]  \hspace{1cm} (2)

Most of the variables in this expression are, as will become clear later, endogenous. The previous expression is therefore used to obtain the balancing item ONB:

\[ \text{ONB} = \text{RRB} + \text{C} - \text{IR} - \text{GSNB} - \text{GLNB} - \text{H} \]  \hspace{1cm} (3)

Total reserves of the banking sector also include postal deposits and currency issued by the Treasury. Neglecting the last variable, enables us to write:

\[ \text{RB} = \text{RRB} + \text{PDB} \]  \hspace{1cm} (4)

where PDB: postal deposits detained by the commercial banks

RB: total reserves of the commercial banks

Therefore:

\[ \text{ONB} = \text{RB} - \text{PDB} + \text{C} - \text{IR} - \text{GSNB} - \text{GLNB} - \text{H} \]  \hspace{1cm} (5)

B. The money base

The money base is defined as the sum of the net monetary liabilities of the National Bank and the Treasury. The balance sheet of the National Bank is given by expression (A.2). The balance sheet of the Treasury is:

\[ \text{CDEF} = \text{GSNB} + \text{GLNB} + \text{CTP} + \text{CTB} + \text{PDP} + \text{GSF} + \text{GLB} + \text{GLP} + \text{GFOR} + \text{PDB} \]  \hspace{1cm} (1)

where CDEF: Cumulated deficit.

CTP: Currency issued by the Treasury and detained by the public.

CTB: Currency issued by the Treasury and detained by the commercial banks.

PDP: Postal deposits detained by the public.

PDB: Postal deposits detained by the commercial banks.

GSF: Treasury bills detained by the financial non-monetary institutions.

GSB: Treasury bills detained by the commercial banks.

GLB: Government bonds detained by the commercial banks.
GLP : Government bonds detained by the public (including financial non-monetary institutions).
GFOR : Foreign debt.

The monetary liabilities of the Treasury are the sum of currency and postal deposits:

\[ MLT = CTP + CTB + PDP + PDB \] (2)

Adding these liabilities to the balance sheet of the National Bank leads to an expression for the money base (3):

\[ B = IR + GS NB + H + ONB + MLT + GLNB \] (3)

\[ = CTP + CTB + PDB + RRB + C + PDP \] (4)

Using expression (A.4) and neglecting the currency issued by the Treasury and detained by the commercial banks leads to:

\[ B = IR + GS NB + GLNB + H + ONB + MLT \] (5)

\[ = CTP + PDP + RB + C \] (6)

The first equation defines the sources of the money base. These can be broken down into five components:
1) IR: external source
2) H: borrowing by the commercial banks
3) GS NB + GLNB: financing of the Treasury by the National Bank
4) MLT: money base creation by the Treasury
5) ONB: other sources of money base creation.

The first component, the external source of money base creation, is the cumulated sum of the balance of payments surpluses and deficits. The four other components represent internal sources of base creation.

The change in international reserves can be divided into flows resulting from the current account and from the capital account. The last flow is further split up into capital movements of the private sector, the commercial banks, the foreign sector and the government (the \( \Delta \)-operator indicates changes per unit of time):

\[ \Delta IR = XM - \Delta NFAP + \Delta NFBB + \Delta FPD + \Delta GFOR \] (7)

---

(2) The reason for including the monetary liabilities of the Treasury in the money base is that they possess the medium of exchange property.
where XM : surplus on the current account balance
NFAP : net foreign assets of the private sector
NFBB : net foreign borrowing by the commercial banks
FDP : foreign postal deposits.

In our model we will not consider the money base as completely exogenous. The exogenous component, the adjusted base, is defined as:

$$BA = B + NFAP - NFBB - H - GSNB$$  \hspace{1cm} (8)

where BA : the adjusted money base.

C. The behavior of the commercial banks

1) Introduction

One of the most important sectors in a monetary model is certainly the commercial banking sector. The reason is twofold: first, monetary policy works especially through the commercial banking sector and secondly it is, at least in Belgium, one of the only places where the private sector exerts a direct influence on monetary magnitudes. A great deal of attention must thus be paid to the specification of the behavioral equations of the commercial banking sector. In the following paragraphs we will explain these equations. We start by explaining how commercial banks allocate their liabilities over the different assets. We then turn to the determination of domestic and foreign borrowing of the banks. These two liabilities, together with total deposits, are indeed the total liabilities of the commercial banks:

$$TW = D + T + FDD + HT + NFBB$$  
$$= DF + HT + NFBB$$

where TW : total liabilities of the commercial banks
D : demand deposits
T : time deposits
FDD : deposits in foreign currencies
HT : total domestic borrowing
DF : total deposits.

The balance sheet constraint implies:

$$TW = RB + GSB + GLB + SUCR + REST$$

where SUCR : loans
REST : other assets.
The allocation ratios are defined as the percentage share of each asset:

\[ RBDDT = \frac{RB}{TW} \cdot 100 \]
\[ SUCRDT = \frac{SUCR}{TW} \cdot 100 \]
\[ GSBDDT = \frac{GSP}{TW} \cdot 100 \]
\[ GLBDDT = \frac{GLB}{TW} \cdot 100 \]
\[ RESTDT = \frac{REST}{TW} \cdot 100 \]

2) Explanation of the allocation ratios

i) Optimal allocation ratios

The optimal allocation ratios can be derived from a profit maximization behavior assumption under a balance sheet constraint taking uncertainty into account (see Parkin [14] or Vuchelen [19] for more detail). Observe that we consider the relative shares of the different assets in the total balance sheet whereas Parkin f.e. is considering absolute magnitudes.

\[ y_i^* = A r_i + h \]

where \( y_i^* \) : desired relative asset shares vector
\( r_i \) : interest rates vector
\( h \) : vector of intercepts

Uncertainty is reflected in the coefficients of the matrix \( A \) and the vector \( h \).

As a result of the balance sheet constraint the elements of the \( h \)-vector sum to one hundred; those of the \( A \)-matrix, for a given interest rate, to zero.

The different allocation ratios are thus explained by the rates of return on all assets.

The vector of interest rates contains four rates of return (the Treasury bill rate, the difference between the long term rate and an average of past rates, the loan rate and the rate on five-year bonds issued by financial institutions) and two interest rates reflecting the cost of foreign and domestic borrowing (the Euro-dollar rate and the private discount market rate). Observe that the Eurodollar rate was not covered. The reason is that there
are no data on the free exchange market forward premium or discount available for the period 1963-I - 1969-I. Therefore we have introduced as two separate variables the premium on the official exchange market (for the period 1963-I - 1969-I) and the premium on the free exchange market (for the period 1969-II - 1974-IV).

It is obvious that this is a static optimization approach. Two extensions must be made: monetary policy variables have to be introduced and the adjustment mechanism has to be specified.

ii) Monetary policy instruments

A lot of discretionary monetary policy instruments were used in Belgium over the sample period. Special attention must however be paid to a correct specification: the usual procedure of introducing dummy variables is not desirable. The reasons are:
— we neglect information
— we cannot take into account the relative strength of monetary policy
— multicollinearity can be very important.

For these reasons we have tried to construct variables representing the relative strength of monetary policy instruments. This was not possible for all instruments. We think however that this first attempt has been successful: the coefficients of the instruments have generally the correct sign and are relatively significant. We have retained the following monetary policy instruments: discount ceiling (DHP), loan ceiling (DCR), control of foreign assets and liabilities of the commercial banks (DBB), monetary reserve coefficient on deposits (DMD) and on loans (DMC) and the investment coefficient (DBK). The last instrument was used by the National Bank in order to oblige banks to invest a minimum amount of their liabilities in government paper.

iii) The dynamics of bank-portfolio adjustment

In the previous paragraphs we considered an expression describing the allocation of total liabilities over the different assets.

We observed there that we were talking about an optimal allocation pattern. Since we cannot assume that the optimal allocation is observed in every quarter we have to specify an adjustment mechanism.

An obvious mechanism is the standard stock adjustment model. The problem with this mechanism is that it implies undesirable values for the speed of adjustment when the balance sheet is
taken into account. A generalization of this adjustment mechanism can however be found but then we have to introduce four extra variables. This creates problems since we have already 19 explanatory variables. For this reason, and in order to capture somewhat a possible credit rationing effect, the lagged loan rate is introduced. The idea is that we think that a slow adjustment of the commercial banks to changing loan rates is the main reason for disequilibria in the allocation ratios.

The five estimated equations are reported in table 1. Since all equations contain the same explanatory variables the balance sheet constraint will be satisfied. One annoying fact can however be expected: due to multicollinearity between interest rates it will be difficult to obtain significant coefficients. This is indeed observed in table 1: of the 35 interest rate coefficients only 20 have a t-ratio higher than 1 (12 higher than 2).

It is important to note however that most of the own rates of return are significant (the two exceptions are the Treasury bill and the five-year bond rate) and that the supply of loans is very sensitive to changes in other interest rates.

Concerning the instruments of monetary policy we can state that all instruments have a significant effect on one or more assets. One instrument, the minimum government securities investment obligation, does not have the correct effect on the directly affected assets i.e. short and long-term government securities. The loan ceilings and the two monetary reserve variables are effective in reducing the supply of loans.

Note that we need only four of the previous five equations since the fifth asset can be derived as a residual. Of course it does not make any difference which asset we consider as being the «residual one» since we have estimated the banking asset model in a coherent way.

The allocation of liabilities over the different bank assets being explained, we turn now to the determination of the liabilities which are under direct control of the banks i.e. foreign and domestic borrowing.

3) *Domestic and foreign borrowing by commercial banks*

Total liabilities of commercial banks can be divided into two parts: deposits which are only indirectly under control through interest rate changes, advertising, a.s.o., and borrowing which are under complete control. Here we will explain total domestic and foreign borrowing. Total domestic borrowing is the sum of
borrowing at the National Bank (rediscounting) and borrowing at other (non-banking) financial institutions. We will see later that the division of domestic borrowing between rediscounting and other domestic borrowing is crucial for the determination of the short-term interest rate.

Net foreign borrowing is the difference between foreign liabilities and assets. Traditionally, Belgian banks borrow more than they invest in foreign countries.

The approach followed in explaining the two variables is similar to the one used for the asset allocation ratios. The basic difference is that we now explain absolute magnitudes instead of relative shares. For this reason we have introduced total deposits (DF) as a scale variable.

\[
NFBB_t = -43.6166 + 0.1845 \text{DF}_t - 3.0126 \text{RED}_t \\
(0.02) \\
+ 1.9687 \text{RSCH}_t + 0.7289 \text{DGRM}_t + 1.0291 \text{RKR}_t \\
(0.01) \\
+ 0.0167 \text{RKR}_{t-1} + 0.8895 \text{RHWI}_t + 8.0621 \text{R5Y}_t \\
(0.01) \\
+ 1.6288 \text{DHP} - 39.6029 \text{DCR} - 2.6725 \text{DBB} \\
(1.87) \\
+ 6.3225 \text{DMD} - 3.8893 \text{DMC} - 12.1643 \text{DBK} \\
(2.44) \\
- 2.3435 \text{FPFI} - 1.5242 \text{FPVR}_t + 0.2567 \text{DUM1} \\
(0.88) \\
+ 1.5856 \text{DUM2} + 3.3999 \text{DUM3} \\
(0.97) \\
\]

\[
\text{RS} = 0.984 \\
\text{RSC} = 0.973 \\
\text{DW} = 2.24
\]

\[
\text{HT}_t = 40.9077 + 0.1164 \text{DF}_t + 5.9788 \text{RED}_t - 3.6750 \text{RSCH}_t \\
(0.78) \\
+ 4.9232 \text{DGRM}_t - 0.2416 \text{RKR}_t + 0.8998 \text{RKR}_{t-1} \\
(2.19) \\
- 4.3118 \text{RHWI}_t - 0.3811 \text{R5Y}_t + 0.8316 \text{DHP} \\
(1.98) \\
- 45.7100 \text{DCR} + 4.4637 \text{DBB} + 1.0283 \text{DMD} \\
(1.01) \\
- 4.8699 \text{DMC} - 3.1092 \text{DBK} + 6.3859 \text{FPFO}_t \\
(1.62) \\
+ 5.9161 \text{FPVR}_t - 3.7720 \text{DUM1} - 4.2675 \text{DUM2} \\
(3.33) \\
- 3.4168 \text{DUM3} \\
(1.91)
\]

\[
\text{RS} = 0.953 \\
\text{RSC} = 0.920 \\
\text{DW} = 1.79
\]
## TABLE 1

Allocation ratios of commercial banks

<table>
<thead>
<tr>
<th></th>
<th>RED_t</th>
<th>RSCH_t</th>
<th>DRGM_t</th>
<th>RKR_t</th>
<th>RKR_t-1</th>
<th>RHWI_t</th>
<th>R5Y_t</th>
<th>DHP</th>
<th>DCR</th>
<th>DBB</th>
<th>DMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBDDT</td>
<td>-0.1704</td>
<td>0.3427</td>
<td>-0.3030</td>
<td>-0.0448</td>
<td>-0.2050</td>
<td>0.2655</td>
<td>-0.2031</td>
<td>0.0125</td>
<td>8.5035</td>
<td>0.0880</td>
<td>0.8817</td>
</tr>
<tr>
<td>(0.65)</td>
<td>(0.86)</td>
<td>(0.95)</td>
<td>(0.12)</td>
<td>(0.64)</td>
<td>(1.02)</td>
<td>(0.51)</td>
<td>(0.11)</td>
<td>(1.34)</td>
<td>(0.32)</td>
<td>(2.58)</td>
<td></td>
</tr>
<tr>
<td>GSBDT</td>
<td>-1.0289</td>
<td>-0.4570</td>
<td>0.4370</td>
<td>-0.6023</td>
<td>1.2331</td>
<td>2.6653</td>
<td>-2.1288</td>
<td>0.8936</td>
<td>26.4256</td>
<td>1.1240</td>
<td>0.5782</td>
</tr>
<tr>
<td>(1.81)</td>
<td>(0.53)</td>
<td>(0.64)</td>
<td>(0.73)</td>
<td>(1.78)</td>
<td>(1.77)</td>
<td>(2.73)</td>
<td>(3.73)</td>
<td>(1.94)</td>
<td>(1.91)</td>
<td>(0.78)</td>
<td></td>
</tr>
<tr>
<td>GLBDDT</td>
<td>-0.5396</td>
<td>1.1527</td>
<td>2.1430</td>
<td>0.4367</td>
<td>0.2761</td>
<td>-0.9904</td>
<td>-3.3414</td>
<td>-0.4601</td>
<td>17.2138</td>
<td>-1.3471</td>
<td>0.0484</td>
</tr>
<tr>
<td>(1.22)</td>
<td>(1.72)</td>
<td>(4.05)</td>
<td>(0.68)</td>
<td>(0.51)</td>
<td>(2.27)</td>
<td>(5.50)</td>
<td>(2.46)</td>
<td>(1.62)</td>
<td>(2.93)</td>
<td>(0.081)</td>
<td></td>
</tr>
<tr>
<td>SUCRDT</td>
<td>2.2392</td>
<td>-1.9040</td>
<td>-0.9726</td>
<td>0.1787</td>
<td>-0.2768</td>
<td>-1.5580</td>
<td>2.9213</td>
<td>-0.3328</td>
<td>17.0271</td>
<td>0.7082</td>
<td>1.3871</td>
</tr>
<tr>
<td>(4.06)</td>
<td>(2.28)</td>
<td>(1.48)</td>
<td>(0.22)</td>
<td>(0.41)</td>
<td>(2.87)</td>
<td>(3.86)</td>
<td>(1.43)</td>
<td>(1.20)</td>
<td>(1.24)</td>
<td>(1.94)</td>
<td></td>
</tr>
<tr>
<td>RESTDT</td>
<td>-0.5003</td>
<td>0.8656</td>
<td>-1.3071</td>
<td>0.0317</td>
<td>-1.0273</td>
<td>-0.3824</td>
<td>-2.7520</td>
<td>-0.1132</td>
<td>-0.6882</td>
<td>-0.5731</td>
<td>-0.1212</td>
</tr>
<tr>
<td>(1.50)</td>
<td>(1.61)</td>
<td>(3.08)</td>
<td>(0.29)</td>
<td>(2.51)</td>
<td>(0.90)</td>
<td>(5.21)</td>
<td>(0.67)</td>
<td>(0.06)</td>
<td>(1.46)</td>
<td>(0.30)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>DMC</th>
<th>DBK</th>
<th>FPOFO, D_1</th>
<th>FPOV, D_2</th>
<th>DUM1</th>
<th>DUM2</th>
<th>DUM3</th>
<th>Constant</th>
<th>RS</th>
<th>RSC</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBDDT</td>
<td>0.4658</td>
<td>-0.5487</td>
<td>-0.0216</td>
<td>-0.6197</td>
<td>-0.6932</td>
<td>-1.7256</td>
<td>-2.0095</td>
<td>-3.5449</td>
<td>0.845</td>
<td>0.750</td>
<td>2.00</td>
</tr>
<tr>
<td>(1.25)</td>
<td>(0.96)</td>
<td>(0.06)</td>
<td>(2.54)</td>
<td>(2.97)</td>
<td>(7.84)</td>
<td>(8.04)</td>
<td>(0.50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSBDT</td>
<td>0.3258</td>
<td>-3.2135</td>
<td>-0.0899</td>
<td>-1.4577</td>
<td>0.1946</td>
<td>1.7512</td>
<td>1.2027</td>
<td>-19.4193</td>
<td>0.973</td>
<td>0.956</td>
<td>2.02</td>
</tr>
<tr>
<td>(0.39)</td>
<td>(2.60)</td>
<td>(0.12)</td>
<td>(2.77)</td>
<td>(0.39)</td>
<td>(3.69)</td>
<td>(2.23)</td>
<td>(1.25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GLBDDT</td>
<td>-0.2626</td>
<td>1.6508</td>
<td>-1.2565</td>
<td>0.3825</td>
<td>-0.1635</td>
<td>-0.1005</td>
<td>1.2210</td>
<td>67.2670</td>
<td>0.906</td>
<td>0.848</td>
<td>2.05</td>
</tr>
<tr>
<td>(0.42)</td>
<td>(1.72)</td>
<td>(2.16)</td>
<td>(0.93)</td>
<td>(0.42)</td>
<td>(0.27)</td>
<td>(2.67)</td>
<td>(5.66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUCRDT</td>
<td>-1.6912</td>
<td>0.4451</td>
<td>2.2093</td>
<td>2.0899</td>
<td>0.2311</td>
<td>-0.5194</td>
<td>-0.1807</td>
<td>69.8859</td>
<td>0.894</td>
<td>0.829</td>
<td>1.87</td>
</tr>
<tr>
<td>(2.71)</td>
<td>(0.37)</td>
<td>(3.05)</td>
<td>(4.09)</td>
<td>(0.47)</td>
<td>(1.13)</td>
<td>(0.35)</td>
<td>(4.72)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESTDT</td>
<td>1.1722</td>
<td>1.6663</td>
<td>-0.8403</td>
<td>-0.3950</td>
<td>0.4310</td>
<td>0.3933</td>
<td>-0.1335</td>
<td>14.1887</td>
<td>0.950</td>
<td>0.919</td>
<td>1.99</td>
</tr>
<tr>
<td>(2.20)</td>
<td>(2.00)</td>
<td>(1.80)</td>
<td>(1.22)</td>
<td>(1.09)</td>
<td>(1.14)</td>
<td>(0.48)</td>
<td>(1.34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- $D_1$: equal to one before 1969/II; zero afterwards.
- $D_2$: equal to zero before 1969/II; one afterwards.
These results do not need much comment. The two interest rates reflecting the cost of borrowing (RED and RHWI) have the correct sign. The sign and magnitude of the monetary policy instrument coefficients are interesting since they give a direct indication of the offsetting of monetary policy actions by commercial banks. Concerning the rediscounting ceiling (DHP) and monetary reserves on loan (DMC) we see that no offsetting actions occur; the offsetting occurs however for the other relevant instruments: control of foreign borrowing by the commercial banks (DBB) and monetary reserves on deposits (DMD).

The investment coefficient instrument has twice a negative coefficient. A priori we would have expected a positive sign: more investment in government paper would increase borrowing to make it possible to maintain investments in other assets. The explanation for not observing this is that, as we see it, the investment coefficient was not very effective: commercial banks reacted to the larger purchase of bonds by a lower purchase of Treasury bills reducing in this way total investments in government paper. A detailed examination of the investment obligation shows that this explanation is a possibility.

4) Postal deposits detained by the commercial banks

The portfolio model of the banking sector explains the total reserves of the banking sector: these are the sum of monetary reserve, deposits at the National Bank and currency issued by the National Bank and the Treasury.

First we note that, due to a lack of data, we will neglect currency issued by the Treasury. The item postal deposits has however to be explained since we need this variable for the government budget constraint.

The estimated equation is:

\[
PDBDRB_t = 0.3302 + 0.3525 \left( \frac{PDB}{RB} \right)_{t-1} - 0.1945 DUM1
\]

\[
(6.11) \quad (2.67) \quad (-4.08)
\]

\[-0.2658 DUM2 - 0.1850 DUM3
\]

\[-6.71 \quad -4.73\]

\[+ 0.0116 REDCO_t - 0.1185 DMD - 0.0462 DMC
\]

\[1.75 \quad -3.32 \quad -1.24\]

\[RS = 0.698 \quad RSC = 0.645 \quad DW = 1.95\]
Postal deposits detained by the commercial banks are obtained as:

\[ \text{PDB}_t = \text{PDBDRB}_t \cdot \text{RB}_t \]

D. The behavior of the private sector

In this section we will explain the behavior of the private sector. The private sector can allocate its wealth over a whole range of financial and real assets. The allocation process will in general depend upon rates of return, income, wealth, expected inflation, a.s.o. The following general demand function can be specified:

\[ A = A (R, YR, YP, P, P^e, W) \]

where

- A: currency, currency issued by the Treasury, demand, time, foreign currency or postal deposits.
- R: vector of interest rates.
- YR, YP, W: income, permanent income and wealth.
- P, P^e: price level and expected inflation.

All assets are assumed to be gross substitutes i.e. the demand for an asset depends positively on its own rate of return and negatively on the rates of return of the other assets. The interest rates on time deposits are R3M and RGD. This last interest rate is paid on large deposits; these deposits accounted for nearly fifty percent of total time deposits at the end of 1973. The interest rate on loans (RKR) will have a negative effect on all demand equations since an increase in this rate, given net worth of the private sector, reduces the demand for loans and thus reduces the demand for other assets.

Currency, demand and postal deposits do not have an explicit rate of return (except demand deposits but this rate is very low (0.50 percent) and constant). Non-pecuniary rates of return are difficult to construct so that we have neglected them. The expected rate of inflation is however an approximation for the real rate of return on these assets. Assuming that no asset is an inferior good implies that all income and wealth elasticities are positive.

As stated before we will not estimate demand functions for the different assets. Instead we scale the assets with respect to demand deposits to obtain allocation ratios:

\[ \text{CDDDD} = \frac{C}{D}; \quad \text{CTPDDD} = \frac{CTP}{D}; \quad \text{PDPDDD} = \frac{PDP}{D}; \]
\[
\text{TDHH} = \frac{T}{D}; \quad \text{FDDDD} = \frac{FDDD}{D}
\]

These five ratios will be our dependent variables. If we assume logarithmic asset demand functions it is obvious that the elasticity e.g. of the currency to demand deposit ratio with respect to the interest rate on time deposits (R3M) is equal to:

\[
c_1 = C_1 - D_1
\]

where \(C_1\): elasticity of the currency demand function with respect to the three-month time deposit interest rate.

\(D_1\): elasticity of the demand for demand deposit function with respect to the three-month time deposit interest rate.

Since \(C_1\) and \(D_1\) are negative no \textit{a priori} sign can be stated for \(c_1\). If:

\[
|C_1| > |D_1| \quad \text{we will have} \quad c_1 < 0
\]
\[
|C_1| < |D_1| \quad \text{we will have} \quad c_1 > 0
\]

This problem arises for most elasticities of the allocation ratios (an exception is the three-month time deposit rate elasticity of the TDDD-ratio). It is obvious from this discussion that the elasticities of the demand for demand deposits are crucial in the determination of the elasticities of the different ratios. A further discussion of this demand is thus necessary.

Three possible approaches can be taken here. First we can view demand deposits as being a closer substitute for time deposit than are the other assets. Demand deposits would thus initially serve the « store of wealth » function. The implication is that the elasticities of demand deposits with respect to the two time deposit rates would be larger than the interest rate elasticities of the other assets. This in turn implies positive interest rate elasticities for all the allocation ratios. Second, demand deposits can be considered as transaction balances with a low interest rate elasticity. In this case currency, postal and time deposits would include a demand for precautionary balances. The interest elasticities would now be exactly the inverse of those stated above. We feel that the large currency to demand deposit ratio and the fiscal fraud in Belgium give an \textit{a priori} support to this view.

Third, we can look at demand deposits as being an aggregate of the demand by the household and the business sector. The demand by the first sector would be interest inelastic while the
demand by the business sector would be interest elastic. In this case we would observe a negative elasticity of the allocation ratios with respect to the three-month time deposit rate and a positive elasticity with respect to the interest rate on large deposits. The estimated equations are:

\[
\log \text{CDDD}_t = 0.5412 - 0.1831 \log \text{W}_t + 0.1914 \log \text{RKR}_t \\
(2.16) \quad (—2.42) \quad (2.63)
\]

\[
- 0.0955 \log \text{R3M}_t - 0.0538 \log \text{RGD}_t \\
(—1.97) \quad (—1.73)
\]

\[
+ 0.7083 \log \text{CDDD}_{t-1} - 0.0069 \text{ DUM1} \\
(6.51) \quad (—1.38)
\]

\[
+ 0.0106 \text{ DUM2} + 0.0118 \text{ DUM3} \\
(2.02) \quad (2.40)
\]

\[\text{RS} = 0.990 \quad \text{RSC} = 0.988 \quad \text{DW} = 2.56\]

\[
\log \text{CTPDDD}_t = 0.8674 - 0.4205 \log (\text{WMV/P})_t \\
(3.44) \quad (—3.62)
\]

\[
+ 0.0596 \log \text{R3M}_t - 0.0599 \log \text{RGD}_t \\
(1.78) \quad (—1.78)
\]

\[
+ 0.6317 \log \text{CTPDDD}_{t-1} - 0.0030 \text{ DUM1} \\
(6.01) \quad (—0.58)
\]

\[
- 0.0015 \text{ DUM2} + 0.0203 \text{ DUM3} \\
(—0.28) \quad (3.62)
\]

\[\text{RS} = 0.990 \quad \text{RSC} = 0.988 \quad \text{DW} = 2.12\]

\[
\log \text{PDPDDD}_t = 0.4619 - 0.2284 \log (\text{WVM/P})_t \\
(2.71) \quad (—3.07)
\]

\[
+ 0.2313 \log \text{R5Y}_t - 0.0696 \log \text{R3M}_t \\
(1.92) \quad (—1.24)
\]

\[
- 0.0471 \log \text{RGD}_t + 0.6996 \log \text{PDPDDD}_{t-1} \\
(—1.45) \quad (7.26)
\]

\[
- 0.0171 \text{ DUM1} + 0.0181 \text{ DUM2} \\
(—2.63) \quad (2.81)
\]

\[
- 0.0081 \text{ DUM3} \\
(—1.25)
\]

\[\text{RS} = 0.959 \quad \text{RSC} = 0.951 \quad \text{DW} = 2.34\]

\[
\log \text{TDDD}_t = —0.4249 + 0.0976 \log \text{WMV}_t \\
(—2.39) \quad (1.96)
\]
\[ + 0.6894 \log \text{TDDD}_{t-1} - 0.1529 \log \text{RKR}_t \]  
\( (5.60) \)  
\( (-1.67) \)

\[ + 0.0498 \log \text{RGD}_t + 0.2459 \log \text{R5Y}_t \]  
\( (1.02) \)  
\( (1.96) \)

\[ + 0.0219 \text{DUM}1 - 0.0062 \text{DUM}2 \]  
\( (3.30) \)  
\( (-0.97) \)

\[ + 0.0359 \text{DUM}3 \]  
\( (5.29) \)

\[ \text{RS} = 0.972 \quad \text{RSC} = 0.966 \quad \text{DW} = 2.24 \]

\[ \log \text{FDDD}_t = 2.4534 + 6.8601 \log \text{YR}_t - 1.6727 \log \text{R3M}_t \]  
\( (2.69) \)  
\( (3.98) \)  
\( (-3.55) \)

\[ + 2.1306 \log \text{RKR}_t + 0.6528 \log \text{RGD}_t \]  
\( (2.61) \)  
\( (2.69) \)

\[ - 12.7470 \log \text{P}_t - 0.0025 \text{DUM}1 \]  
\( (-5.38) \)  
\( (-0.08) \)

\[ + 0.0156 \text{DUM}2 + 0.0164 \text{DUM}3 \]  
\( (0.50) \)  
\( (0.53) \)

\[ - 13.1766 \log (\text{YR/YP})_t + 0.2834 \text{DZI} \]  
\( (-2.97) \)  
\( (5.38) \)

\[ \text{RS} = 0.813 \quad \text{RSC} = 0.757 \quad \text{DW} = 1.56 \]

where DZI: dummy variable equal to one after 1967 (imposition on business firm to have a postal or bank account).

These results mostly favor the second option for demand deposits i.e. these can be considered as having a low interest elasticity. Observe that the elasticity of time deposits with respect to the interest rate on large deposits is not much larger than the elasticity of demand deposits with respect to the same interest rate. From this and the coefficients of the interest rate on large deposits in the other regressions follows that this interest rate influences only demand and time deposits (\*).

The results show further that the elasticity of the demand for currency with respect to the loan rate is larger than the elasticity of the demand for demand deposits. As could be expected time deposits are not very sensitive to the loan rate.

\(*\) This supports also the third option for demand deposits.
Concerning income and wealth variables we see that demand deposits are more elastic than currency, currency issued by the Treasury and postal deposits. The inverse holds for time deposits.

E. Government deposit ratio

The government deposit to demand deposit ratio is explained by the same variables as are the allocation ratios of the private sector. In principle we should also introduce variables capturing the behavior of the government. We tried several variables but the results were negative. We therefore assumed that the behavior of the government is largely dominated by slowly changing institutional factors. These are captured by the lagged dependent variable.

\[
\log \text{GDEPDD}_t = -0.7026 + 0.6035 \log \text{GDEPDD}_{t-1} \\
\quad - 0.1298 \log \text{R3M}_t + 0.1619 \log \text{RGD}_t \\
\quad + 0.1131 \log \text{WMV}_t - 0.0027 \text{DUM1} \\
\quad (1.60) \\
\quad (1.20) \\
\quad (-0.14) \\
\quad (-0.075 \text{DUM3} \\
\quad (0.21) \\
\quad (-0.38) \\
\text{RS} = 0.702 \\
\text{RSC} = 0.644 \\
\text{DW} = 2.37
\]

F. The money stock

We will not consider separately a money supply and a money demand: we derive instead an equilibrium expression for the money stock which takes supply as well as demand factor into account. The money base is defined as:

\[
B = CTP + C + RB + PDP
\]

The reserves of the commercial banks are determined, given total deposits, by the bank portfolio allocation model. The above expression determines thus the sum of postal deposits, currency and currency issued by the Treasury in the hands of the private sector i.e.:

\[
B - RB = CTP + C + PDP
\]

On the other hand we have different ratios describing the behavior of the public and the government:
\[ CTPDDD = \frac{CTP}{D} = CTP \ldots ; \quad CDDD = \frac{C}{D} = C \ldots ; \]
\[ TDDD = \frac{T}{D} = T \ldots \quad PDPDDD = \frac{PDP}{D} = PDP \ldots ; \]
\[ GDEPDDD = \frac{GDEP}{D} = GDEP \ldots ; \]
\[ FDDD = \frac{FDD}{D} = FDDD \ldots \]

These equations determine seven variables \( D \), \( CTP \), \( C \), \( T \), \( PDP \), \( GDEP \) and \( FDD \).

The easiest way to find the solutions is to divide the expression \( (B - RB) \) by \( D \):
\[ \frac{B - RB}{D} = \frac{CTP + C + PDP}{D} \]
\[ = \frac{CTP \ldots + C \ldots + PDP \ldots}{DELTA} \]
\[ = \frac{DELTA}{D = \frac{B - RB}{DELTA}} \]

By using the different allocation ratios we find solutions for \( CTP \), \( C \), \( T \), \( PDP \), \( GDEP \) and \( FDD \). The following two money stocks can also be calculated:

\[ SM1 = C + CTP + PDP + D + GDEP \]
\[ SM2 = SM1 + T + FDD \]

IV. The Short term Interest Rate (\(^5\))

A. Introduction

In the following paragraphs we will present the equations composing the short term interest rate model. As already stated in

\(^5\) The short term interest rate model is developed in more detail in Vuchelen [22].
the summary survey of the model we explain the short term interest rate as the solution of an equilibrium process on the «out-of-bank» market. Here we take the view that commercial banks have a global demand for domestic borrowing. One part of this takes the form of rediscounting at the National Bank. The residual demand for domestic borrowing is the supply of commercial paper on the out-of-bank market which is confronted to the demand of the financial non-monetary institutions: the equilibrium determines the short-term interest rate. This process is explained in more details below. We will first explain the interest rate we retained as representing the cost of total domestic borrowing in the commercial banking model. Then regressions are presented for the demand for rediscounting at the National Bank and the demand for commercial paper by the financial institutions. In the last part of this section we also try to show how realistic our short-term interest rate determination model is.

B. Cost of total domestic borrowing

The Belgian out-of-bank market consists of two parts: on one part of the market commercial paper that is rediscountable at the National Bank is traded whereas on the other part non-rediscountable paper can be sold. The market is regulated by the Institute of Rediscout and Guarantee (IRG). This official institute fixes the interest rates on both markets.

In our model we use and explain both interest rates: the rate on non-rediscountable paper is our short-term interest rate since this rate is heavily influenced by money market forces. The rate on rediscountable paper is in our model the relevant cost of domestic borrowing by commercial banks. Strictly speaking, as observed, this rate measures only the mobilization cost of rediscountable paper.

This rate however depends on the money market rate and the discount rate. The first rate (in our model the rate on the non-rediscountable paper) represents the cost of funds for the IRG. If however the Institute cannot borrow enough on the money market it will have to rediscount paper at the National Bank. This means a loss of income since the interest rate charged to commercial banks is generally lower than the discount rate. The interest rate on discountable paper on the private discount market can thus not decrease very much below the discount rate. The rate will be lower than the discount rate since the IRG borrows at a lower rate on the money market.
These complex interactions lead to the following equation:

\[
RHWI_t = -0.4846 + 0.2027 \text{ RCP}_t + 0.7964 \text{ RDIS}_t
\]

(3.85) \hspace{2cm} (9.93)

\[
\text{RS} = 0.946 \quad \text{RSC} = 0.944 \quad \text{DW} = 1.38
\]

Observe that the sum of the two regression coefficients is equal to one. The constant represents then the equilibrium profit for commercial banks as a result of the existence of the private discount market.

C. Borrowing by the commercial banks and the National Bank

As observed above total domestic borrowing of the commercial banks are explained by the banking asset allocation model. Here we are only interested in that part of domestic borrowing which takes the form of rediscording at the National Bank.

The desired division of total borrowing between rediscording at the National Bank and borrowing on the commercial paper market depends on relative cost i.e. on the discount rate and the commercial paper rate. In another study (Vuchelen [20]) we found that borrowing at the National Bank could also reflect an expected discount rate effect i.e. borrowing would increase when a rise in the discount rate is anticipated and vice versa. This effect is captured by the introduction of the change in the Euro-dollar rate covered with the forward premium on the official exchange market.

That the premium on the official exchange market is relevant here reflects the concern of the National Bank with the trade balance: a deficit indicates a higher forward rate and thus an expected restrictive policy move.

In the equation reported below the rediscout ceiling does not appear as an explanatory variable. The reason is that this instrument of monetary policy has its main impact on total domestic borrowing (HT). It is important to note that the discount rate is very significant. This is in sharp contradiction with the results obtained by other Belgian researchers (see Vuchelen [20] p. 594 for a survey of these results). The last point we have to make is that the speed of adjustment is surprisingly high (0.82). This coefficient is even not significantly different from one.
\[ H_t = 1.0824 + 0.5176 HT_t - 3.5447 \text{ RDIS}_t \]
\[
\begin{array}{ccc}
(0.44) & (7.91) & (-3.32) \\
\end{array}
\]
\[ + 2.3474 \text{ RCP}_t + 0.7331 (\text{ REDCO}_t - \text{ REDCO}_{t-1}) \]
\[
\begin{array}{ccc}
(2.54) & (2.64) \\
\end{array}
\]
\[ + 0.1884 H_{t-1} - 4.7847 \text{ DUM1} - 2.6821 \text{ DUM2} \]
\[
\begin{array}{ccc}
(1.75) & (-2.89) & (-2.01) \\
\end{array}
\]
\[ - 3.5762 \text{ DUM3} \]
\[
\begin{array}{cc}
(2.68) \\
\end{array}
\]
RS = 0.926 \quad RSC = 0.910 \quad DW = 1.90

D. **Demand by financial institutions for commercial paper**

Only financial institutions (including insurance companies and pension funds) are allowed to buy commercial paper on the private discount market.

The demand for commercial paper by the financial institutions depends in the first place on the interest rate on commercial paper. A second explanatory variable is the discount rate: this rate measures the opportunity cost when commercial papers have to be rediscounted afterwards at the National Bank (in fact, the expected discount rate would be the relevant variable here). Other explanatory variables take the rates of return on other investment possibilities into account. An increase in the interest rate on Treasury bills reduces therefore the demand for commercial paper by the financial institutions. An increase in the long-term interest rate or in the Eurodollar market would, a priori, also decrease this demand. As the equation shows this is not the case. An explanation is however not difficult to find.

An increase in the long-term interest rate means a capital loss on government securities and thus an increase in the total risk of the portfolio of the financial institutions. They react to this by investing more in short-term assets of which commercial paper is one component. The same reasoning can be applied to an increase in the Eurodollar rate since this rate is a proxy for the expected movement in the other interest rates.

Monetary policy instruments were used in the past to control the asset allocation process of financial institutions. A ceiling on the granting of loans clearly reduces the demand for commercial paper. The obligation to invest a minimum amount of the assets in government securities increases the demand for commercial paper by the financial institutions since in this way the total risk of the portfolio remains unchanged.
$$HREST_i = 15.0948 + 3.9708 \text{RCP}_i - 3.5777 \text{RDIS}_i$$

(5.89) (4.37) (-2.66)

$$- 3.4145 (\text{RSCH}_i - \text{RSCH}_{i-1})$$

(-2.40)

$$+ 3.0829 (\text{RLT}_i - \text{RLT}_{i-1})$$

(1.46)

$$+ 1.0190 (\text{RED}_i - \text{RED}_{i-1})$$

(1.64)

$$- 4.5831 (\text{RCP}_{i-1} - \text{RCP}_{i-2}) - 2.8377 \text{DQCR}$$

(-3.51) (-2.55)

$$+ 6.7540 \text{DQBK} + 2.4546 \text{DUM1} - 1.6176 \text{DUM2}$$

(4.83) (1.95) (-1.06)

$$- 0.3561 \text{DUM3}$$

(-0.25)

$$\text{RS} = 0.771 \quad \text{RSC} = 0.699 \quad \text{DW} = 2.38$$

where \text{DQBK} : dummy variable representing the investment obligation.

\text{DQCR} : dummy variable representing the loan ceiling policy.

E. The short-term interest rate

The short-term interest rate is the solution of the demand for commercial paper by the financial institutions and the supply by the banking sector. In our notations we can summarize this equilibrium process as:

$$\text{RHWI} = \text{RHWI} (\text{RCP, RDIS}) : \text{total domestic borrowing of the banking sector.}$$

$$\text{HT} = \text{HT} (\text{RHWI, . . .}) : \text{interest cost of domestic borrowing.}$$

$$\text{H} = \text{H} (\text{RDIS, RCP, . . .}) : \text{borrowing at the National Bank.}$$

From these three relations we can derive a supply function of commercial paper on the private discount market (SCP):

$$\text{SCP} = \text{HT} (\text{RHWI} (\text{RCP, RDIS}), . . .) - \text{H} (\text{RDIS, RCP, . . .})$$

This supply function determines, together with the demand for commercial paper by the financial institutions (HREST), the short term interest rate. This short term interest determination process tries to take some institutional aspects into account. Even
if this first attempt is quite successful we think it is worthwhile to point out some shortcomings.

As explained, the Institute of Rediscout and Guarantee buys commercial paper that it rediscouts at the National Bank when it cannot borrow enough on the money market. This implies that there is not much direct borrowing of the commercial banks at the National Bank: banks are used to sell most of their commercial paper to the I.R.G. and it is this Institute that borrows at the National Bank. This aspect is not present in our model: we have worked as if banks were rediscouting directly at the National Bank. Further work must be done on this point. A second point is that the exchange of commercial paper between banks is delated from our model. This is, of course, the result of the aggregation process. The implication is however that this interbanking commercial paper sale does not affect the interest rate. A lack of data explains why we could not take this point into account.

V. The Government Sector (6)

a) Introduction

In this section we explain all financial variables relating to the government i.e. the composition of the government debt, the demand for government paper by the private and banking sector and the different interest rates. Note that the total government debt is exogenous in our model; once our model will be linked to a real sector model this variable will however become endogenous.

The total government debt (the Government sector includes in our model the Government Security Market Stabilization Fund) can be written as:

\[ GTOT = GSTT + GLTT + GFOR \] (1)

where

- \( GTOT \): total government debt
- \( GSTT \): total domestic short-term debt
- \( GLTT \): total domestic long-term debt
- \( GFOR \): total foreign debt (exogenous)

Total short-term debt is equal to:

\[ GSTT = GSB + GSNB + GSF + CTP + CTB + PDP + PDB \] (2)

(6) This sector is explained in more detail in a forthcoming paper (Vuchelen [24]).
where GSF: Treasury bills detained by the financial non-monetary institutions.

Some of the components of the short-term debt are completely determined by demand factors. Since we explain the management of the government debt later it is necessary to exclude these components from our short-term debt definition. We therefore write:

\[ TS = GSTT - PDP - PDB \]  \hspace{1cm} (3)

\[ = GSB + GSNB + GSF + CTP + CTB \]  \hspace{1cm} (4)

Since we do not have exact data about the currency issued by the Treasury and detained by the commercial banks (CTB) we neglect this variable. This can, anyway, only lead to a small error. Our definition of the short-term government debt is thus:

\[ TS = GSB + GSNB + GSF + CTP \]  \hspace{1cm} (5)

For the long-term domestic debt we have:

\[ GLTT = GLP + GLB + GLNB \]  \hspace{1cm} (6)

where GLNB: government bonds detained by the private sector

GLP: long-term debt of the government to the National Bank (exogenous)

We are now able to define government debt which is under control of the government:

\[ TDEB = TS + GLTT \]  \hspace{1cm} (7)

\[ = GSB + GSNB + GSF + CTP + \]

\[ GLP + GLB + GLNB \]  \hspace{1cm} (8)

\[ = GSTT - PDP - PDB + \]

\[ GLP + GLB + GLNB \]  \hspace{1cm} (9)

Now we will explain the supply of government debt. In our framework this consists in determining the (TS/TDEB)-ratio. The total debt (TDEB) is exogenous.

From the supply of government bonds we deduct the exogenous long-term debt of the government to the National Bank. The «residual» supply and the sum of the two demand components determine the equilibrium quantity of bonds and their price i.e. the long-term interest rate.
The supply of short-term Treasury bills is allocated in the following way. First we determine the interest rate on Treasury bills. Given this rate, we explain the demand for Treasury bills by the banking and the non-banking financial sector. The currency issued by the Treasury and detained by the private sector is also determined by demand elements. The residual supply is assumed to be taken up completely by the National Bank.

In short we assume that the interest rate on bonds is determined on the bond market; the interest rate on Treasury bills is set by the Treasury (*) with reference to the interest rate on the private discount market. This seems to be a defensible procedure since in this way we can take into account the openness of the Belgian monetary system.

b) The supply of government debt

The supply of government debt is generally neglected in econometric models. However, it is important to know what part of the government debt are in short-term Treasury bills. In our monetary model we explain the management of the government debt. We use the normal definition of debt management: changing the composition of a given amount of government debt. The relevant government debt in our model is the sum of Treasury bills and long-term government bonds. Debt management is then defined as the determination of the percentage of Treasury bills in the total government debt.

The large amount of government debt in Belgium supports our assumption that an explanation of debt management is possible. Before explaining our results it is necessary to give a brief survey of the possible approaches to debt management. Generally it is assumed that debt management must be countercyclical i.e. lengthening the debt during a boom (i.e. decreasing liquidity and net worth (as a result of the increase in the long-term interest rate)) and shortening the debt during a recession. The disadvantage of this policy is that the interest cost of the debt increases: the government borrows long-term when the long-term rate is high. A second disadvantage is that the supply of short-term assets will decrease and so lower the short-term interest rate. Since this rate is generally the relevant interest cost for the finance of speculative transactions this can have de-stabilizing effects. A second

(*) In practice the National Bank fixes this rate.
possible approach to debt management is the minimization of the interest cost of the debt: the government should borrow long (short) when the long (short) term interest rate is low.

A more sophisticated version takes practical considerations into account: long (short) term debt must be issued when interest rates are expected to increase (decrease).

It can be expected that the policy chosen by the government is directly dependent on the magnitude of the debt. In Belgium e.g. the government debt decreased as a percentage of gross national product from 75 percent in 1950 to 48 percent in 1973 (*). An a priori belief in the minimization of interest costs as a debt management aim is thus defensible.

When the objective of debt management is the cost minimization of the interest charges, we expect that the share of short-term securities is a decreasing function of the short-term interest rate and an increasing function of the long-term rate. The signs of the derivatives with respect to the discount rate, the average of past long-term rates and the Eurodollar rate are not so easily determined.

An increase in the discount rate can be interpreted as a sign of later interest rate increases; on the other hand it can be a sign of a deterioration in economic activity and interest rate decreases (this is the classical difficulty of interpreting discount rate changes). In the first case we expect a negative and in the second case a positive sign.

Nearly the same difficulty is present with respect to the average of past long-term rates. If interest rate expectations are regressive we expect a positive sign; if expectations are extrapolative we expect a negative sign.

Concerning the coefficient of the monetary policy instrument DBK, we expect a positive sign: the government will take advantage of the larger demand to issue bonds at a lower rate. The expected signs of the different coefficients, when an interest cost minimization is the relevant aim of the debt management policy, are very well supported by the data:

(*) Compare this with the figures for the United States: 125 % in 1946 and 40 % in 1971 (Musgrave-Musgrave [13], p. 568).
\[
\text{TS}_{t,100} = \frac{-15.1107 - 0.8494 \text{RSCH}_t + 3.7321 \text{RLT}_t}{\text{TDEB}}
\]
\[
(-2.75) \quad (-2.21) \quad (3.36)
\]
\[
-2.2334 \text{DBK} + 3.0184 (\text{RDIS}_t - \text{RDIS}_{t-1})
\]
\[
(-2.76) \quad (3.59)
\]
\[
0.6931 \text{RED}_t + 2.8511 \text{DUM1}
\]
\[
(-2.59) \quad (4.44)
\]
\[
+ 2.1037 \text{DUM2} - 0.5412 \text{DUM3}
\]
\[
(3.14) \quad (-0.81)
\]
\[
+ 0.8301 ((\text{TS/TDEB})_{t,-1}) \cdot 100
\]
\[
(8.14)
\]

RS = 0.792 \quad RSC = 0.741 \quad DW = 2.43

As can be seen the discount rate and the change in this rate have a positive sign, implying that an increase in this rate would be interpreted by the government as a sign that interest rates will decrease in the near future.

One possible explanation is that an increase in the discount rate would be a sign of a restrictive monetary policy: loan ceilings, e.g. could be imposed. This would, given total assets of the commercial banks, lead to an expected increase in the demand for bonds (best substitute for loans). Another explanation is possible when we allow for an inflow of capital as a result of the higher interest rates: it would be easier for the government to place debt on the money market.

In general we find the results of the various equations quite interesting and stimulative. They show that the assumption of interest cost minimization explains relatively well the Belgian debt management.

c) The demand for Treasury bills

i) The interest rate on Treasury bills

Short-term government securities take two forms in Belgium (apart from differences in maturity): first we have the traditional Treasury bills and second, the certificates of the Government Market Security Stabilization Fund (GMSSF). This institute executes the open market policy but practically only tries to stabilize the price of government bonds. As already observed, we will not make any distinction between the two kinds of short-term government debt: we aggregate them under the label Treasury bills.

How the interest rates on the different kinds of Treasury bills are determined in practice needs some explanation.
The interest rates on 6, 9 and 12 months Treasury bills and on GMSSF-certificates are fixed after consultation of the market i.e. after the market participants have been asked to make offers about the rate and the quantity they are willing to purchase. All bills are however sold at the same rate. The interest rate on very short-term Treasury bills (1, 2 and 3 months) is fixed by the National Bank and the Treasury by taking the rate on GMSSF-certificates into account. The total amount of bills issued is sold to the National Bank. Usually the National Bank buys only bills when it has already found a buyer. If the National Bank holds the short-term Treasury bills in its portfolio this is counted as part of the Treasury debt to the National Bank.

We have assumed that the three-month Treasury bill rate could be taken as the relevant yield on Treasury bills. This implies that we have to specify a price setting function for the National Bank and the Treasury.

It is clear that the money market rate will have the dominant influence. Further we can expect the discount rate and the Euro-dollar rate to have some influence. A more difficult question relates to the effect of the investment-coefficient which obliges commercial banks and financial institutions to invest part of their assets in government securities. From our equations explaining the debt management we know already that the investment-coefficient reduces the supply of Treasury bills. From this results logically a decrease in the interest rate on Treasury bills.

This is supported by the data:

\[
RSCH_t = -0.3721 + 0.4838 RCP_t - 0.2384 DBK_t
\]

\[
\begin{align*}
(-3.06) & \quad (9.77) \\
& \quad (-2.57)
\end{align*}
\]

\[+ 0.1355 RED_t + 0.4130 RSCH_{t-1}\]

\[
\begin{align*}
(3.94) & \quad (10.10)
\end{align*}
\]

\[RS = 0.988 \quad RSC = 0.987 \quad DW = 1.41\]

**ii) Treasury bills detainted by the financial non-monetary institutions**

The financial non-monetary institutions in Belgium include life insurance companies, private saving banks, public saving banks and public credit institutions. This mixed composition of private and public institutions makes it somewhat difficult to explain their holdings of Treasury bills. It is indeed possible that the government
exerts some pressure on the public institutions to hold, in periods of financial difficulties, more Treasury bills than they would like to.

The approach taken is that we assume that the Treasury bills detained by the financial non-monetary institutions depend positively on the Treasury bill rate and negatively on the interest rates of competing financial assets.

One difficulty is that we could not find a significant scale variable. The reasons, we assume, are that we did not try the correct ones (it is of course not so obvious which one this is) and the lack of a trend in the amount of Treasury bills that financial non-monetary institutions detain.

Concerning monetary policy we have introduced two instruments: the loan ceiling and the minimum investment obligation in government securities. The last instrument has of course a positive effect. The loan ceiling, as the next equation shows, has a negative impact. This is explained by the fact that government bonds are a better substitute for loans than Treasury bills. Since the risk of bonds is even lower than the risk of loans, a management policy allowing the portfolio to reach a fixed level of risk would result in the observed behavior. We also remark that loan ceilings are effective in periods of high interest rates so that a capital gain can be made when government bonds are bought.

The introduction of the difference between the long-term rate and an average of past rates reflects an expectation effect. Assuming the presence of regressive expectation, an increase in the bond rate relative to the average of past rates implies an expected capital gain on bonds. This explains the negative sign of the DGRM-variable.

The last fact to note about the equation is that the coefficient of the lagged interest rate on Treasury bills is only marginally less than the coefficient of the unlagged rate. This implies that the Treasury bills detained by financial non-monetary institutions are not very interest elastic in the medium run.

\[
\text{GSF}_t = -31.4050 - 1.6449 \text{REDCO}_t + 11.3267 \text{RLT}_t \\
\quad (2.21)
\]

\[
+ 11.5761 \text{RSCH}_t - 3.295 \text{PRED}_t - 12.5134 \text{DGRM}_t \\
\quad (3.06) \quad (2.14) \quad (3.40)
\]
\[ -11.2381 \text{ RSCH}_{t-1} - 11.0370 \text{ DQCR} + 18.6449 \text{ DQBK} \]
\[ (\text{— 3.38}) \quad (\text{— 3.59}) \quad (\text{5.13}) \]
\[ + 10.9504 \text{ DUM1} + 9.5453 \text{ DUM2} - 3.3230 \text{ DUM3} \]
\[ (\text{3.66}) \quad (\text{2.88}) \quad (\text{— 1.08}) \]
\[
\text{RS} = 0.847 \quad \text{RSC} = 0.797 \quad \text{DW} = 1.55
\]

iii) Treasury bills detained by the National Bank

So far, we have explained the total amount of short-term government debt, the demand by the banking and the financial non-monetary sector. Since the currency issued by the Treasury is also an endogenous element, market equilibrium can be fulfilled by considering the Treasury bills detained by the National Bank as residual.

We think that this procedure comes close to the Belgian situation. The reason for this is that the interest rate on Treasury bills is fixed by the National Bank and this institution also sells the Treasury bills. An error made in fixing the interest rate thus results automatically in a larger or smaller amount of Treasury bills in the portfolio of the National Bank.

From expression (5) we can derive:

\[ \text{GSNB} = \text{TS} - \text{GSB} - \text{GSP} - \text{CTP} \]

d) The bond market

i) The demand for bonds by the private sector

Government bonds are one of the most important assets detained by the private sector. The demand depends upon relative rates of return and the portfolio constraint. Among other things, we will also observe a decrease in the holding of government bonds when the expected inflation rate increases.

We estimated the demand for bonds in current prices instead of in constant prices as would theoretically be correct. The reason is that financial non-monetary institutions, whose liabilities are fixed in nominal terms, are here part of the private sector.

The portfolio constraint is the net worth of the private sector in market prices. As significant competing rates of return, we found only the interest rate on three-month time deposits and the rate on five-year bonds issued by financial intermediaries. The own rate of return was specified as a distributed lag over past changes. We found that this specification was better able to take expectation
effects into account. An increase in the long term rate will increase the holdings of bonds if expectations are regressive or if people think they will hold their bonds until they expire. We believe the last explanation to be the correct one, due to the small amount of bonds traded on the secondary bond market.

Observe that we could not find an effect of the investment coefficient which obliged non-monetary financial institutions to invest a minimum percentage of their assets in government bonds.

\[ GLP_t = 241.7469 + 0.1176 \, WMV_t \]
\[ (7.51) \quad (21.32) \]
\[ + \sum_{i=0}^{4} W_i \left( RLT_{t-i} - RLT_{t-i+1} \right) - 6.4615 \, R3M_i \]
\[ (-1.72) \]
\[ - 18.7810 \, R5Y_t - 7.3808 \, PEXP_t + 1.5457 \, DUM1 \]
\[ (-3.10) \quad (-1.75) \quad (0.42) \]
\[ - 1.0866 \, DUM2 + 1.3292 \, DUM3 \]
\[ (-0.30) \quad (0.37) \]

\[ W_0 = 18.145 ; \quad W_1 = 24.371 ; \quad W_2 = 21.686 ; \quad W_3 = 14.183 ; \]
\[ (4.14) \quad (4.79) \quad (4.61) \quad (2.81) \]

\[ W_4 = 5.681 \]
\[ (1.29) \]

\[ RS = 0.974 \quad RSC = 0.966 \quad DW = 1.56 \]

ii) The long term interest rate is determined on the bond market by the equilibrium between the supply of and the demand for government bonds. The total supply of bonds is given by the debt management equation. From this supply we subtract the government bonds detained by the National Bank.

The demand for government bonds is composed of two parts: the demand by the banking and by the private sector. The bond market equilibrium is (9):

\[ TDEB_t - TS_t - GLNB_t = GLP_t + GLB_t \]

(9) It is interesting to note that the price expectation effect is about 0.17.
VI. The loan market

i) The demand for loans

The demand for loans by the private sector in real terms is explained by a general portfolio approach: an increase in the loan rate will reduce the demand for loans whereas an increase in the rates of return on assets increases the demand for loans. Expected inflation raises also the demand for loans since this reduces the expected real burden of the loan.

The expected rate of inflation has been introduced as a distributed lag over past inflation rates. Concerning the lag in the effect of the loan rate on the demand for loans we have obtained the best results by introducing the non-lagged and the one quarter lagged rate.

\[
\frac{\text{DECR}}{\text{PN}}_{t, 100} = -54.7323 - 14.3312 \text{ RKR}_t - 11.3193 \text{ RKR}_{t-1} \\
\quad \quad \quad (-1.65) \quad (-2.58) \quad (-2.21) \\
+ 19.6075 \text{ RLT}_t + 15.2397 \text{ RGD}_t \\
\quad \quad \quad (2.11) \quad (5.43) \\
+ 0.1636 (W/P_{t, 100} - 5.3767 \text{ DUM1}) \\
\quad \quad \quad (12.37) \quad (-1.40) \\
- 3.1699 \text{ DUM2} - 4.6199 \text{ DUM3} \\
\quad \quad \quad (-0.80) \quad (-1.10) \\
+ \sum_{i=0}^{5} W_i (P_{t-i} - P_{t-i-1}) P_{t-i-1}
\]

\[
W_0 = 180.12 \quad W_1 = 277.25 \quad W_2 = 305.14 \quad W_3 = 277.59 \\
(1.47) \quad (2.11) \quad (2.66) \quad (1.76)
\]

\[
W_t = 208.36 \quad W_5 = 111.34 \\
(1.02) \quad (0.65)
\]

RS = 0.988 \quad RSC = 0.984 \quad DW = 1.45

ii) The interest rate

The interest rate on loans is determined by the intersection of the supply of and the demand for loans:

\[
\frac{\text{SUCRDT} \cdot \text{TW}_t}{100} = \frac{\text{DECR}_t \cdot \text{PN}_t}{100}
\]
VII. Other interest rates

i) *Interest rate on time deposits*

The interest rate on three-month time deposits is an important variable since it is one possible opportunity cost for holding money. Generally the rate on time deposits is explained by a price-setting function derived from a profit maximization approach. In Belgium this approach needs however to be modified since the rate on time deposits is not completely under control of the banking system.

Until 1962 the rate on three-month time deposits was linked rigidly to the discount rate i.e. every discount rate change resulted, without any lag, in a change of the time deposit rate. Between 1962 and 1972 the time deposit rate was fixed after the Belgian Banking Association and the National Bank discussed the opportunity of a change. In principle there was no longer a link between the three-month time deposit rate and the discount rate. In practice however the link was still observed although less tight than before 1962. From 1972 on, the time deposit rate is set by the commercial banks after consultation with the saving banks and the National Bank. The commercial banks play the role of leader in the determination of the interest rate on time deposits. The other interest rates on deposits are determined by the Public Credit Institutions and by the saving banks. To explain the interest rate on three-month time deposits we have to take this institutional environment into account. This has been done by introducing the discount rate. The liquidity of the banking sector is captured by the change in the ratio of total loans to total deposits.

\[
R3M_t = -0.3007 + 0.3838 \times \text{RDIS}_t \\
\quad + 0.2822 \times (\text{RDIS}_{t-1} - \text{RDIS}_{t-2}) \\
\quad + 1.8700 \times (\frac{\text{SUCR}}{\text{DF}})_t - (\frac{\text{SUCR}}{\text{DF}})_{t-1} \\
\quad + 0.5526 \times R3M_{t-1} + 0.1211 \times \text{DUM1} + 0.0096 \times \text{DUM2} \\
\quad + 0.1409 \times \text{DUM3} \\
\quad \text{RS} = 0.988 \quad \text{RSC} = 0.986 \quad \text{DW} = 1.68
\]

It is interesting to know what this equation implies as to the equilibrium relationship between the rate on time deposits
and the discount rate. Solving this equation for equilibrium values leads to:

\[ R3M = -0.6721 + 0.8578 \text{ RDIS} \]

The equilibrium rate on time deposits is thus well below the discount rate.

ii) Interest rate on five-year bonds issued by financial institutions

Financial institutions issue bonds of different maturities. These are freely transferable between individuals and this is not a negligible advantage due to the fiscal evasion possibilities. The rate of these bonds can be fixed freely by financial institutions. In practice, however, Public Credit Institutions played the role of leader in this price-setting behavior. This leadership was recognized in 1972.

The price-setting function for the interest rate on five-year bonds must thus reflect primarily the behavior of the Public Credit Institutions. Important variables are the rates of return on competing financial assets. These are first of all, time deposits at commercial banks and government bonds. Observe that the rate of return on government bonds is also an indicator of the yield on assets earned by the financial institutions.

The equation we retained is:

\[ R5Y_t = 0.6708 + 0.0895 R3M_t + 0.8476 R5Y_{t-1} + 0.4100 \text{ DGRM}_t \]

\[ (2.69) \quad (1.78) \quad (13.66) \quad (6.33) \]

\[ RS = 0.974 \quad RSC = 0.972 \quad DW = 1.84 \]

iii) The interest rate on large deposits

The distinction between small and large deposits was introduced in June 1964 (large deposits are in principle deposits larger than 10 million Belgian francs). The interest rate on these large deposits could be fixed freely by the commercial banks (as observed, this was not the case for the interest rate on three-month time deposits) until the last quarter of 1969. At that moment, the five largest banks agreed to fix the interest rate jointly. Since the alternative investment possibility for large deposits is the Eurodollar market it is clear that the three-month Eurodollar rate is the main explanatory variable of the interest rate on large deposits.
The other variable is the discount or premium on the forward exchange market. As usual in Belgium we face the problem of choice between the official or the free forward exchange rate. A priori, we would expect the forward rate on the free market to be the relevant one. As results turned out, the premium on the official market has a significant negative effect. This is explained by the fact that the premium on the official market is probably a good indicator of future exchange rate movements.

\[
\text{RGD}_t = 0.0891 + 0.9936 \text{RED}_t + 1.2838 \text{FPVR}_t
\]
\[
(0.03) \quad (24.68) \quad (12.14)
\]
\[-0.2707 \text{FPOF}_t \\
(4.41)
\]

\[
\text{RS} = 0.982 \quad \text{RSC} = 0.980 \quad \text{DW} = 1.62
\]

**VIII. Definitions and other relations**

i) *Wealth*

Net wealth of the non-banking public is defined as:

\[
\text{W} = \text{D} + \text{T} + \text{GLP} + \text{PDP} + \text{CTP} + \text{C} + \text{CAP} - \text{DECR}
\]

i.e. as total financial assets plus capital less loans.

Real net wealth is defined as: \(\text{W}/\text{P}\).

Net wealth at market value (WMV) is obtained by replacing GLP (government bonds detainted by the private sector) by its market value.

This value calculated as:

\[
\text{GLP}_t \left(\frac{\text{RLTO25}_t}{\text{RLT}_t}\right)
\]

where \(\text{RLTO25}_t = \frac{1 - 0.25}{(1 - 0.25)^{10}} \sum_{i=0}^{10} 0.25^i \text{RLT}_{t-i}\)

ii) *Permanent income*

Permanent income is widely used as a proxy for wealth in demand for money, loan, savings, consumption, a.s.o., functions. Since permanent income is not observable, an empirical approximation is necessary.

A series for permanent income can be calculated as \((\lambda, \text{is the speed of adjustment} ; \ g \text{the secular rate of growth of income}) :\)
\[ YP_t = \lambda Y_t + (1 - \lambda) (1 + g) YP_{t-1} \]

by setting \( YP_{1960} = Y_{1960} \)
\[
\lambda = 0.394 \\
g = 0.013
\]

These coefficients were obtained by estimating a consumption function. Two comments have to be made. First, the sum of the weights is not equal to one. This is quite obvious if we write:

\[
\sum_{i=0}^{\infty} \lambda (1 - \lambda)^i (1 + g)^i = \frac{\lambda}{1 - (1 - \lambda)(1 + g)}
\]

\[
= \frac{\lambda}{\lambda - g + \lambda g} > 1 \text{ since } \lambda g < g
\]

\[
= 1.021
\]

Observe that the weights reported by Friedman ([25], p. 147) do not really sum to one.

The second comment relates to the time shape of the weights. The 15 significant weights are: 0.394; 0.242; 0.149; 0.091; 0.056; 0.034; 0.021; 0.013; 0.008; 0.005; 0.003; 0.002; 0.001; 0.001 (Σ = 1.021).

These weights imply the following yearly weights:

- first year: 0.876 or 85.8 percent of the total weight
- second year: 0.124 or 12.1 percent of the total weight
- third year: 0.018 or 1.8 percent of the total weight
- fourth year: 0.003 or 0.3 percent of the total weight

iii) Covered Eurodollar rate

Two covered Eurodollar interest rates are used in the model:

\[ \text{REDCO}_t = \text{RED}_t + \text{FPOF}_t \]
\[ \text{REDCV} = \text{RED}_t + \text{FPVR}_t \]

iv) Average of past bond rates

\[ \text{RGEM}_t = 0.25 \sum_{i=0}^{3} \text{RLT}_{t-i} \]

v) Difference between long term rate and average of past bond rates

\[ \text{DGRM}_t = \text{RLT}_t - \text{RGEM}_{t-1} \]
vi) Net foreign assets of the private sector

One major problem encountered when estimating an equation explaining the net foreign asset position of the private sector is that no statistical data are readily available. We have constructed our series in the following way. From the change in international reserves we have subtracted the current account of the balance of payments (national account figures), the change in the foreign debt of the government and the change in the net foreign borrowing position of the commercial banks. This series, the change in the net asset position of the private sector, has then been added to a stock figure for 1962 which we obtained in another study (Vuchelen [18]). The theoretical approach followed in explaining this dependent variable is similar to the portfolio approach developed by Branson (Branson-Hill [3] and Branson [2]). The idea is that the flow of capital depends on changes in interest rates, not levels. Wealth of the private sector, valued at market prices, is taken as the budget constraint. Two modifications were made to the theoretical derived equation. First we introduced the change in the current account to capture short-term capital movements linked to international trade. Secondly, we introduced a dummy variable to capture speculation.

\[
\text{NFAP}_t - \text{NFAP}_{t-1} = -5.7837 - 0.0353 (\text{WMV}_t - \text{WMV}_{t-1}) \\
\quad (-2.58) (-1.78) \\
\quad + 0.092 (\text{WMV}_{t-1} - \text{WMV}_{t-2}) \\
\quad (4.32) \\
\quad + 0.2852 (\text{XM}_t - \text{XM}_{t-1}) \\
\quad (2.52) \\
\quad + 0.0007 (\text{WMV}_t \cdot \text{RED}_t - \text{WMV}_{t-1} \cdot \text{RED}_{t-1}) \\
\quad (1.18) \\
\text{RED}_{t-1} = 0.0027 (\text{WMV}_t \cdot \text{RKR}_t) \\
\quad (-2.73) \\
\quad - \text{WMV}_{t-1} \cdot \text{RKR}_{t-1}) + 0.0037 \\
\quad (4.56) \\
(\text{WMV}_t \cdot \text{RGD}_t - \text{WMV}_{t-1} \cdot \text{RGD}_{t-1}) \\
\quad + 0.0005 (\text{WMV}_t \cdot \text{FPOF}_t) \\
\quad (1.87) \\
\quad - \text{WMV}_{t-1} \cdot \text{FPOF}_{t-1}) + 0.0009 \\
\quad (1.18)
\]
\[ (WMV_t \cdot FPVR_t - WMV_{t-1} \cdot FPVR_{t-1}) \\
+ 0.0569 \text{NFAP}_{t-1} + 10.7359 \text{SPE} \\
(1.45) \\
(6.09) \\
+ 1.0429 \text{DUM1} + 2.9599 \text{DUM2} \\
(0.64) \\
(1.81) \\
+ 1.4980 \text{DUM3} \\
(0.97) \\
\]

\[ RS = 0.861 \quad RSC = 0.806 \quad DW = 1.92 \]

where \text{SPE} : dummy variable equal to one in 1968-III and 1972-III, equal to minus one in 1971-II and 1971-IV.

**IX. Testing the Model**

Different possibilities exist for testing an econometric model. We could e.g. simulate over the sample period, forecast beyond the sample period, simulate different economic policy measures, calculate the reduced form . . .

We have tested our model, up to now, by static and dynamic simulations over the sample period. The difference between static and dynamic simulations is that when simulating in a static way the lagged endogenous variables are those observed; dynamic simulations retain the values calculated by the model. The main advantage of dynamic simulations is that they allow an evaluation of the dynamic properties of the model.

In table 3 we report summary statistics for static and dynamic simulations over the period 1970 I-1974 IV. These summary statistics are:

- \text{TCA}: observed average quarterly rate of growth
- \text{TCA}: calculated average quarterly rate of growth
- \text{ME}: mean error
- \text{SD}: standard deviation of the mean error
- \text{U}: Theil's inequality coefficient
- \text{UM}: partial coefficient of inequality due to central tendency
- \text{US}: partial coefficient of inequality due to unequal variation
- \text{UC}: partial coefficient of inequality due to imperfect co-variation

On average we can say that the simulation results are relatively good. Interesting is also the fact that the dynamic simulations give, on average, results which are comparable to those of the static simulations. The weak points of the model are however
<table>
<thead>
<tr>
<th>Variable</th>
<th>TCG</th>
<th>STATIC SIMULATION</th>
<th>DYNAMIC SIMULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TCA</td>
<td>ME</td>
<td>SD</td>
</tr>
<tr>
<td>RCP</td>
<td>1.60</td>
<td>1.75</td>
<td>-0.05</td>
</tr>
<tr>
<td>RSCH</td>
<td>1.42</td>
<td>1.71</td>
<td>0.00</td>
</tr>
<tr>
<td>RHWI</td>
<td>0.82</td>
<td>0.88</td>
<td>0.00</td>
</tr>
<tr>
<td>R3M</td>
<td>0.96</td>
<td>0.76</td>
<td>-0.04</td>
</tr>
<tr>
<td>RGD</td>
<td>1.65</td>
<td>1.82</td>
<td>0.00</td>
</tr>
<tr>
<td>RKR</td>
<td>1.64</td>
<td>1.79</td>
<td>0.22</td>
</tr>
<tr>
<td>RLT</td>
<td>0.97</td>
<td>0.67</td>
<td>-0.06</td>
</tr>
<tr>
<td>RLT025</td>
<td>0.65</td>
<td>0.61</td>
<td>-0.03</td>
</tr>
<tr>
<td>RGEM</td>
<td>0.76</td>
<td>0.67</td>
<td>-0.01</td>
</tr>
<tr>
<td>DGRM</td>
<td>2.84</td>
<td>0.52</td>
<td>-0.05</td>
</tr>
<tr>
<td>R5Y</td>
<td>1.05</td>
<td>0.72</td>
<td>-0.07</td>
</tr>
<tr>
<td>B</td>
<td>2.02</td>
<td>2.03</td>
<td>-3.11</td>
</tr>
<tr>
<td>CDDDD</td>
<td>-1.33</td>
<td>-1.76</td>
<td>0.00</td>
</tr>
<tr>
<td>CTPD33D</td>
<td>-1.67</td>
<td>-1.95</td>
<td>0.00</td>
</tr>
<tr>
<td>PDPD33D</td>
<td>-1.43</td>
<td>-1.33</td>
<td>0.00</td>
</tr>
<tr>
<td>DELTA</td>
<td>-1.36</td>
<td>-1.68</td>
<td>0.00</td>
</tr>
<tr>
<td>TDDD</td>
<td>0.61</td>
<td>0.29</td>
<td>-0.01</td>
</tr>
<tr>
<td>FDDDD</td>
<td>-1.72</td>
<td>-9.04</td>
<td>0.01</td>
</tr>
<tr>
<td>D</td>
<td>3.29</td>
<td>3.56</td>
<td>-2.67</td>
</tr>
<tr>
<td>C</td>
<td>1.91</td>
<td>1.74</td>
<td>-1.96</td>
</tr>
<tr>
<td>CTP</td>
<td>1.62</td>
<td>1.54</td>
<td>-0.10</td>
</tr>
<tr>
<td>PDP</td>
<td>1.80</td>
<td>2.18</td>
<td>-0.32</td>
</tr>
<tr>
<td>T</td>
<td>3.92</td>
<td>3.87</td>
<td>-6.15</td>
</tr>
<tr>
<td>FDD</td>
<td>1.50</td>
<td>-5.80</td>
<td>2.35</td>
</tr>
<tr>
<td>GDEPD</td>
<td>0.13</td>
<td>0.49</td>
<td>0.00</td>
</tr>
<tr>
<td>GDEP</td>
<td>3.42</td>
<td>4.07</td>
<td>-1.19</td>
</tr>
<tr>
<td>SM1</td>
<td>2.54</td>
<td>2.66</td>
<td>-5.95</td>
</tr>
<tr>
<td>SM2</td>
<td>2.93</td>
<td>2.97</td>
<td>-9.34</td>
</tr>
<tr>
<td>DF</td>
<td>3.55</td>
<td>3.59</td>
<td>-6.47</td>
</tr>
<tr>
<td>HT</td>
<td>3.86</td>
<td>3.08</td>
<td>-0.68</td>
</tr>
<tr>
<td>NFBB</td>
<td>5.23</td>
<td>4.45</td>
<td>-1.85</td>
</tr>
<tr>
<td></td>
<td>TCO</td>
<td>STATIC SIMULATION</td>
<td>DYNAMIC SIMULATION</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCA</td>
<td>ME</td>
</tr>
<tr>
<td>TW</td>
<td>3.68</td>
<td>3.66</td>
<td>-9.77</td>
</tr>
<tr>
<td>RBDDT</td>
<td>0.64</td>
<td>1.23</td>
<td>-0.01</td>
</tr>
<tr>
<td>GSBD T</td>
<td>-7.85</td>
<td>-5.35</td>
<td>-0.15</td>
</tr>
<tr>
<td>GLB</td>
<td>0.85</td>
<td>1.03</td>
<td>0.24</td>
</tr>
<tr>
<td>SLCD T</td>
<td>0.16</td>
<td>-0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>REST DT</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.16</td>
</tr>
<tr>
<td>RB</td>
<td>4.35</td>
<td>4.93</td>
<td>-0.27</td>
</tr>
<tr>
<td>GS B</td>
<td>-4.45</td>
<td>-1.89</td>
<td>-1.73</td>
</tr>
<tr>
<td>GLB</td>
<td>4.67</td>
<td>4.72</td>
<td>-1.44</td>
</tr>
<tr>
<td>DECR</td>
<td>3.84</td>
<td>3.58</td>
<td>-5.74</td>
</tr>
<tr>
<td>REST</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.78</td>
</tr>
<tr>
<td>PDB</td>
<td>-2.60</td>
<td>2.12</td>
<td>-0.27</td>
</tr>
<tr>
<td>TS</td>
<td>-0.75</td>
<td>-0.47</td>
<td>-2.84</td>
</tr>
<tr>
<td>GS F</td>
<td>3.82</td>
<td>2.54</td>
<td>2.21</td>
</tr>
<tr>
<td>MLT</td>
<td>1.42</td>
<td>2.10</td>
<td>-1.21</td>
</tr>
<tr>
<td>GLS T</td>
<td>0.13</td>
<td>0.63</td>
<td>-4.03</td>
</tr>
<tr>
<td>GLT T</td>
<td>2.54</td>
<td>2.38</td>
<td>4.28</td>
</tr>
<tr>
<td>GTOT</td>
<td>2.99</td>
<td>2.96</td>
<td>8.33</td>
</tr>
<tr>
<td>H</td>
<td>1.77</td>
<td>1.84</td>
<td>-1.15</td>
</tr>
<tr>
<td>HRE S</td>
<td>7.47</td>
<td>6.23</td>
<td>-0.77</td>
</tr>
<tr>
<td>GSNB</td>
<td>-5.78</td>
<td>3.38</td>
<td>-7.37</td>
</tr>
<tr>
<td>IR</td>
<td>2.92</td>
<td>2.57</td>
<td>-1.33</td>
</tr>
<tr>
<td>ONB</td>
<td>0.00</td>
<td>0.00</td>
<td>3.84</td>
</tr>
<tr>
<td>W</td>
<td>1.42</td>
<td>1.43</td>
<td>0.86</td>
</tr>
<tr>
<td>WMV</td>
<td>3.22</td>
<td>3.27</td>
<td>1.15</td>
</tr>
<tr>
<td>NFAP</td>
<td>4.87</td>
<td>4.93</td>
<td>-0.89</td>
</tr>
<tr>
<td>REDCO</td>
<td>1.47</td>
<td>1.47</td>
<td>—</td>
</tr>
<tr>
<td>REDCV</td>
<td>1.57</td>
<td>1.75</td>
<td>—</td>
</tr>
<tr>
<td>YP</td>
<td>1.33</td>
<td>1.33</td>
<td>—</td>
</tr>
</tbody>
</table>
the loan rate and the borrowing of the Treasury at the National Bank. The main reason why the loan rate is not always simulated as we would like, is that the interaction between total deposits of the commercial banks and the supply of loans is very large. This is because the allocation ratios of the private sector (especially the currency and time deposit ratios) are very elastic with respect to the loan rate. Since loans take up about 85 percent of total deposits it is obvious that this is the origin of the problem.

That the borrowing by the Treasury at the National Bank is not always predicted correctly is not surprising since economic policy can also exert an influence here. We think however that the main idea of the approach corresponds to reality. Furthermore we may not forget that these borrowings are calculated as a residual i.e. as the difference between the supply of Treasury securities and the demand by the banking and non-banking financial sector. However this error does not affect the money base.

X. Conclusion

In this paper we have presented a quarterly monetary model for Belgium. The main feature of this model is that we have tried to take as much as possible structural factors into account. Examples of this are the determination of the short term interest rate and the explanation of the management of the government debt. Even if this attempt can be described as relatively successful, more work is required. Particularly, we feel that more attention should be paid to the influence of non-monetary financial institutions. The lines of business of these institutions are no longer very distinct from those of commercial banks. This fading away of dividing-lines in the financial sector is already very clear when monetary policy over the past years is studied.

The second field where more work is required is the linking of the monetary model with the foreign sector. This lack of a well-thought link is a shortcoming of all presently existing Belgian monetary models. Considering the open nature of our economy this is somewhat surprising. Note however that few data are available and that the existence of a dual exchange market does not facilitate the task.

A monetary model is of course very useful on its own but, if one wants really to test the model, one should make forecasts. Here we have to rely, for the exogenous real variables, on the existing models of the real sector. One comment however should
be made. The now existing models of the real sector do not include many monetary variables. A linking of a monetary and a real sector model results, at this moment, in a one-way linking: real variables will influence monetary ones but there will be no feed-back.

As can be concluded from these comments and others made in the text, still a lot of work has to be done on the Belgian monetary sector. We not only need to broaden the content of the existing models but also to make a more detailed study of particular relations.
Appendix

**List of endogenous variables**

1) **B** : Monetary base.
2) **C** : Currency in the hands of the private sector.
3) **CDDDD** : Currency to demand deposit ratio.
4) **CTP** : Currency issued by the Treasury.
5) **CTPDDDD** : Ratio of currency issued by the Treasury to demand deposits.
6) **D** : Demand deposits.
7) **DECR** : Banking loans to the private sector.
8) **DELTA** : One over money multiplier.
9) **DF** : Total deposits.
10) **DGRM** : Difference between long term bond rate and moving average of past rates ($\text{RGEM}_{t-1}$).
11) **FDD** : Deposits in foreign currency.
12) **FDDDD** : Ratio of deposits in foreign currency to demand deposits.
13) **GDEP** : Government deposits.
14) **GDEPDD** : Ratio of Government deposits to demand deposits.
15) **GLB** : Government bonds detained by the banking sector.
16) **GLBDDDT** : Ratio of GLB to TW multiplied by hundred.
17) **GLP** : Government bonds detained by the private sector.
18) **GLTT** : Total long term government debt.
19) **GSB** : Treasury bills detained by the banking sector.
20) **GSBDDT** : Ratio of GSB to TW multiplied by hundred.
21) **GSF** : Treasury bills detained by non-monetary financial institutions.
22) **GSNB** : Treasury bills detained by the National Bank.
23) **GSTT** : Total short term Government debt.
24) **GTOT** : Total Government debt.
25) **H** : Borrowing of commercial banks at the National Bank.
26) **HREST** : Borrowing of commercial banks at the non-monetary financial institutions.
27) **HT** : Total domestic borrowing of the commercial banks.
28) **IR** : International reserves.
29) **MLT** : Monetary liabilities of the Treasury.
30) **NFBB** : Net foreign borrowing of the commercial banks.
31) **NFAP** : Net foreign assets of the private sector.
32) **ONB** : Net other assets of the National Bank.
33) PDB : Postal deposits of the commercial banks.
34) PDBDRB : Ratio of postal deposits detained by the banks to total reserves.
35) PDP : Postal deposits of the private sector.
36) PDPDDD : Ratio of postal deposits to demand deposits.
37) RB : Reserves of the commercial banks.
38) RBDT : Ratio of RB to TW multiplied by hundred.
39) RCP : Short term interest rate.
40) REDCO : Eurodollar rate covered by the premium on the official exchange market.
41) REDCV : Eurodollar rate covered by the premium on the free exchange rate.
42) REST : Net other assets of the commercial banks.
43) RESTDT : Ratio of REST to TW multiplied by hundred.
44) RGD : Interest rate on large deposits.
45) RGEM : Moving average of the present and past long term rates.
46) RHWI : Interest rate on domestic borrowing of the commercial banks.
47) RKR : Loan rate.
48) RLT : Interest rate on government bonds.
49) RLTO25 : Weighted average of present and past bond rates.
50) RSCH : Interest rate on Treasury bills.
51) R3M : Interest rate on three-month time deposits.
52) R5Y : Interest rate on five year bonds issued by financial institutions.
53) SM1 : Money stock (narrow definition).
54) SM2 : Money stock (broad definition).
55) SLICRTD : Ratio of DECR to TW multiplied by hundred.
56) T : Time deposits.
57) TDDD : Ratio of time deposits to demand deposits.
58) TS : Total Treasury bills.
59) TW : Total liabilities of the commercial banks.
60) YP : Permanent income.
61) W : Net worth of the private sector.
62) WMV : Market value of the net worth of the private sector.

List of exogenous variables

BA : Adjusted monetary base.
CAP : Market value of the capital stock.
DBB : Monetary policy instrument : control of foreign borrowing of the commercial banks.
DBK : Monetary policy instrument: investment coefficient for commercial banks.
DCR : Monetary policy instrument: loan ceilings for commercial banks.
DHP : Monetary policy instrument: rediscount ceiling for commercial banks.
DMC : Monetary policy instrument: monetary reserves on loans granted by commercial banks.
DMD : Monetary policy instrument: monetary reserves on deposits of commercial banks.
DQBK : Monetary policy instrument: investment coefficient for non-monetary financial institutions.
DQCR : Monetary policy instrument: loan ceilings for non-monetary financial institutions.
FDP : Foreign postal deposits.
GFOR : Foreign government debt.
GLNB : Long term government bonds detained by the National Bank.
P : Implicit national account deflator of total consumption (1970 = 100).
RDIS : Discount rate.
RED : Three-month Eurodollar rate.
TDEB : Total domestic government debt.
YM : Current account of the balance of payments (quarterly rate).
YR : Disposable income (annual rate).

REFERENCES
