THE FINANCIAL SECTOR IN THE SNEPQ MODEL

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This paper will also appear as a chapter in a forthcoming book about an econometric model for the Swedish economy written together with Reinhold Bergström, Villy Bergström and Christian Nilsson.

12.1 INTRODUCTION[1]

One objective of the SNEPQ model is to incorporate the link between the financial and real sectors. The model focuses on quantitative effects of different fiscal and monetary policies on, for instance, employment, the rate of inflation and the current account.

The starting point is the identification of balance sheets for the financial sector. Subject to these identities and the restrictions that are imposed on different variables as a result of economic policy and regulations, behavioral equations are formulated.

In the next section of this chapter a brief description is given of the development of financial markets since 1970. In section 3 the model is specified. Demand equations for the non-bank private sectors for currency, deposits and foreign loans are tested in section 4. In section 5 we discuss the determinants of the short and the long term rates of interest. A reaction function for the central bank is also presented in this section. The final section presents a static solution of the financial models for the endogenous variables.

12.2 DEVELOPMENTS IN FINANCIAL MARKETS SINCE 1970

The characteristics of financial markets in Sweden have changed drastically over the period 1970-86. During the 1970s the financial markets were heavily regulated, while successive deregulation took place in the 1980s. The short and long term interest rates are now market determined and secondary markets for bonds have developed. Still, in 1986 (the last year of our sample period) some regulations existed such as various types of exchange control: for instance, non-residents could not hold SEK denominated debt instruments - see Table 12.1 below.[2] These controls were finally abolished in 1988-89.

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[1] I would like to thank Villy Bergström, Reinhold Bergström, Christian Nilsson, Anders Vredin and Magnus Henrekson for comments and valuable suggestions on previous drafts of this chapter.

[2] As shown by Englund, McPhee and Viotti (1985b), covered interest parity (CIP) holds for capital movements in the short run for the 1980s. This means, as pointed out by Henrekson (1987), that a non-residents can benefit from the high Swedish interest rate in his own country by buying Swedish Crowns on the forward market and investing his money at the ongoing domestic interest rate.

Monetary policy has changed as a consequence of these shifts of regime. Before the 1980s, "l'ancien regime", the policy objective was not only to keep the exchange rate steady. Banks and insurance companies were forced, through liquidity ratios, to hold housing and government bonds issued at a lower rate of interest than the ongoing regulated rate. This constituted an implicit taxation. The interest rate was also regulated and fixed over a long term for the bulk of deposits and lending. The regulation of interest rates aimed at stimulating capital formation and keeping housing rents and the interest cost of farmers down. A prerequisite for this policy was of course strict controls for foreign exchange and capital flows.

The pros and cons of the regulations have been much discussed by economists. One effect was the creation of a "grey" credit market.[3] New institutions that were not covered by the regulations grew up. The increase in public debt made it necessary to speed up changes in the financial system towards a freer market. As shown in Figure 12.1 (where general government debt is expressed as a share of GDP), debt increased in the mid 1970s.

Banks were in fact forced to deliver a growing part of their customers' deposits to the government and were left with bonds that could not be sold. The incidence of the deposit tax thus fell on the depositors. Banks and insurance companies became warehouses for over-valued bonds.

Figure 12.1 *General government debt - shares for different holders*

Part of this development is evident from Figure 12.1. Note that at the same time as the government started to borrow abroad, the share of government debt for banks and insurance companies also increased. This was accomplished though regulation. The central bank's share of the debt was been kept below - in some years well below - 10 percent of GDP during the period. The central bank has thus not used the "printing press" to a great extent to finance the debt. Various measures were used to avoid that.

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[3] **This discussion was begun in the mid 1950s by Hansen, Lundberg and Senneby. See Lindbeck (1969) for a survey.**

Table 12.1 Major steps in the deregulation of the Swedish credit market

Permission for corporations and municipalities to borrow abroad	1974
Deregulation of banks deposit rates	1978-79
Deregulation of interest rate on corporate bonds	1980
Deregulation of lending rates by insurance companies	1980
Banks permitted to issue certificates of deposits	1980
Liquidity ratios for banks abolished	1983
Deregulation of banks lending rates	May 1985
Loan ceiling on bank lending lifted	Nov 1985
Marginal placement ratios for banks and insurance companies abolished	1986
Relaxation of foreign exchange controls on stock transactions	1986-88
Remaining foreign exchange controls lifted	July 1989

Source: Henrekson (1988)

To finance the increase in public debt the government had to go outside the deregulated domestic credit market; i.e. to the domestic private sector directly and to the international capital market. To finance debt on the domestic private market the rate of interest must be in accordance with the alternative market rate (which despite the regulations existed among banks and companies) and the creation of a secondary market became necessary. Therefore the credit and bond markets were deregulated. The major steps in this process are summarized in Table 12.1

The primary target for monetary policy under the new regime is to keep the exchange rate fixed. Since 1977, when Sweden left the "European currency snake", the value of SEK is linked to a currency basket (a weighted index). The index is allowed (since 1985) to move ± 1.5 percent. In theory as well as in practice the central bank can influence capital flows and thus control the exchange rate in three different ways. The bank can influence the short term interest rate, which affects the capital inflow (open market operation). Secondly, it can change its own position in the forward market, which might influence borrowing or lending in foreign currency. Thirdly, the central bank has an option to create variations in the currency index (± 1.5 percent) which will have an effect on the expected rate of return and thus on the foreign exchange flow.

12.3 MODELING THE FINANCIAL SECTOR

The radical changes that have taken place in the financial market are of course an obstacle for model builders. The structure of the financial sector has changed but the number of observations for different stages (if these can be identified) is very limited.

The changes in market regimes have made it almost impossible to use a consistent portfolio model for the private sector's demand for and supply of securities for the whole sample period.[4] Neither can we use the model of Gottfries, Persson and Palmer (1989) for a regulated market because our sample period covers different regimes. Our approach is eclectic and rather similar to the "residual-asset approach" employed, for instance, in the BOF4 model (Tarkka and Willman (1990)).

We have not had the possibility to either obtain or to construct data that comprehend all categories needed for a satisfactory empirical analysis of portfolio behavior. Due to this fact the "non-bank private sector" in our model consists of households, insurance companies and non-financial corporations. The sector is thus very heterogeneous. This would make a portfolio analysis of the sector less worthwhile.

The analysis is also limited in the sense that the model does not take into account the market revaluation of existing bonds that occurs when the interest rate changes.[5] We have been forced to make this assumption inasmuch as the secondary market for bonds is a very recent invention in Sweden; it has existed only since the end of 1983. Consequently, there are too few degrees of freedom to model portfolio adjustment empirically for banks and the rest of the non-bank private sector.

We assume that the banks' holding of bonds is exogenous during the whole sample period. As already mentioned the banks were, up to the middle of 1983, forced to hold a certain amount of housing and government bonds because of the liquidity ratio. The variable can thus be seen as exogenous, in a proper sense, up to the first half of 1983. For the rest of the period the variable is also assumed to be exogenous.

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4 This strategy was proposed by Brainard and Tobin (1968). See also The Bank of England Econometric model (Patterson et.al (1987)) and Kottas (1990) for a recent empirical application or Vredin (1988) and de Grauwe (1983) for a more theoretical discussion.

5 See Agell and Persson (1988) for a discussion of portfolio models with endogenous prices.

We do not consider the existence of a stock market or markets for consumer durables and real estate where claims of either type of capital can be sold or bought at costs other than the replacement value. The capital stock (machinery and buildings) for the economy as well as real estate (houses and land) are thus valued in accordance with the general price level. As discussed in Chapter 3 (Private Consumption Expenditures) we do not distinguish between durable and non-durable consumer goods. In the consumption function we use consumption expenditures as the dependent variable. Consumer durables are treated in the ordinary National Account fashion; consumer durables are assumed to be consumed during the period in which they are bought.

12.3.1 The model

We start by showing the balance sheets for the financial sector. The model is then formulated subject to the identities (deducted from the balance sheets), assumptions concerning asset markets and the restrictions imposed on different variables by policy and regulations.

Five sectors are identified - four domestic and one foreign: general government (central and local government and social security sector), the central bank, the commercial banks, the non-bank private sector (i.e. households, insurance companies and non-financial corporations) and the foreign sector. The balance sheet or "budget restrictions" for these sectors are listed below.

$$\widehat{SKULD} = \overline{BCBNY} + \overline{BANK} + BA + \overline{FBB} + \overline{BU}$$
(General Government) (12.1)

$$VR + \overline{BCBNY} + UTLRB = SE + BRES + \overline{RESTRB}$$
(Central Bank) (12.2)

$$BRES + \overline{BANK} + \overline{BBOST} + LB = INLA + UTLRB + \overline{RESTB}$$
(Banks) (12.3)

$$BA+\overline{FBB}+SE+\overline{RESTRB}+INLA+\overline{RESTB}=\overline{BBOST}+LB+SUT+\overline{SDI}+WA$$
(Non-bank private sector) (12.4)

$$\overline{BU} + SUT + \overline{SDI} + \widehat{SBB} = VR$$
(Foreign sector) (12.5)

The variables, which are all stocks and measured in SEK current prices, are defined as follows:

BRES	total reserves for banks,
BA	non-bank private sector holdings of government bonds (exclusive FBB),
BANK	bank holdings of government bonds,
BBOST	housing bonds,
FBB	insurance company holdings of government bonds,
BCBNY	central bank holdings of government bonds,
BU	foreign holding of government bonds,
INLA	deposits from the non-bank private sector
LB	loans to the non-bank private sector,
RESTB	residual in the banking sector,
RESTRB	other liabilities in central bank,
BRES	reserves (voluntary and required),
SE	currency in circulation,
SKULD	accumulated general government debt,
UTLRB	borrowed reserves (central bank credit to banks),
VR	foreign reserves,
WA	private sector financial net wealth,
SBB	accumulated current account,
SDI	accumulated net direct investments, and
SUT	loans to the non-bank private sector from abroad,

There are seven asset markets in the model: domestic bonds, currency in circulation, deposits, borrowed and total reserves for banks and domestic and foreign loans. A number of assumptions concerning the asset markets are made in order to simplify the model. We assume that:

1) the supply of foreign loans is infinitely elastic at the going rate of interest,

2) the demand for currency is demand determined - there is no price of this asset,

3) required reserves for banks do not yield interest, and

4) domestic loans are perfect substitutes for deposits.

With these assumptions the number of markets in the model can be reduced to three with endogenous prices, namely the market for domestic bonds, banks borrowed reserves and deposits.

As will be discussed later, the supply functions for these assets are not modelled explicitly. We formulate functions with the interest rate as the dependent variable (short term, long term and penalty rate of interest).

These reduced form "interest rate functions" are specified in a rather ad hoc manner (see section 12.5).

We also model a demand function for deposits but not for banks borrowed reserves and domestic bonds. Implicitly we are assuming equilibrium in these markets. In fact we have too few endogenous variables in the financial sector to specify demand functions for these two assets. The limited number of endogenous variables is of course a consequence of the number of exogenous variables. Assumptions about the exogenous variables are based on regulations in the financial markets.

Our approach regarding the demand for banks' borrowed reserves and domestic bonds is similar to the "residual-asset approach". The term "residual-asset approach" refers to the fact that demand and supply functions for some assets are not explicitly specified. Rather, demand for and supply of certain securities are obtained as residuals of the sectors' budget constraints.

12.3.2 Exogenous variables

Before we specify the theoretical underpinnings of the behavioral equations that are used in the empirical model, the restrictions imposed on variables in Equations (12.1) - (12.5) will be discussed. Above some variables in the equations we are use a circumflex (^) to denote that the variable is predetermined in the financial sector but endogenous in the SNEPQ model, while a bar (-) over a variable means that it is exogenous.

The financial sector includes two "predetermined" variables. Accumulated central government debt (SKULD) is the sum of the budget surplus and the sector's change in assets. As pointed out in Chapter 11 (The Public Sector), it is net lending by the general government that adds to the debt. The accumulated current account (SBB) is the other "predetermined" variable. The current account is the sum of export minus import of goods and services plus transfers to abroad and net interest payments. All these variables are also determined in the real sphere of the model.

Starting with Equation (12.1) it should be noted that both the central banks' holdings of government bonds (BCBNY) and foreign holdings of government bonds (BU) are exogenous and assumed to be government parameters.

Both banks and insurance companies have been forced by regulations to keep government bonds in their portfolios. Despite the fact that the regulations were abolished during the 1980s, we assume that both the insurance companies' and the banks' (BANK) holdings of government bonds are exogenous for the whole sample period.

Other liabilities on the balance sheet of the central bank (RESTRB) are assumed to be exogenous. This variable consist mainly of different types of funds (apart from the central bank's own capital) - both voluntary and compulsory. For instance the "investment fund system" is included here. Even the funds emanating from schemes to squeeze the liquidity of firms and local government in the middle of the 1980s are included here.[6]

The balance sheet of banks includes housing bonds (BBOST) which is assumed to be exogenous. As has been pointed out, the banks were forced to hold government bonds until the mid 1980s. On the balance sheet the residual (RESTB) treated as exogenous because we have chosen to hold the banks' net financial wealth constant.

Accumulated net direct investment is also regarded as exogenous, as can be seen in Equation (12.4) and (12.5). Direct investment either from abroad or from Sweden has been regulated for almost the whole sample period, which made it easy to decide how this variable should be treated.

12.3.3 Endogenous variables and behavioral equations

The structure of the model (including the assumptions about the asset markets) and the exogenous variables leave us with the following twelve endogenous variables:

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6 This policy was used quite often during the 1980s in order to make it possible to finance a larger part of government debt in the central bank without increasing liquidity in the economy. The measure can hence be seen as a temporary check on the central bank's "printing press". As can be seen from Equation (2), an increase in holdings of government bonds (BCBNY) in the central bank can be neutralized, ceteris paribus, if RESTRB increases by the same amount. We have used this variable as a proxy for regulatory monetary policy and it is also included as an argument in the consumption function.

BA	non-bank private sector holdings of government bonds,
INLA	deposits from the non-bank private sector
LB	loans to the non-bank private sector,
SE	currency in circulation,
SUT	loans to the non-bank private sector from abroad,
WA	private sector financial net wealth,
BRES	bank reserves (voluntary and required),
UTLRB	borrowed reserves (central bank credit to banks),
VR	foreign exchange reserves,
KRA	short term rate of interest,
IR	long term rate of interest, and
RST	penalty rate for borrowing in the central bank.

The first six endogenous variables (BA, INLA, LB, SE, SUT and WA) can be traced back to the balance sheet of private sectors. If for the moment we neglect the WA-variable, the other five variables represent demand from the non-bank private sector and can be modelled as a portfolio demand system.

The reserves of banks (BRES) and the reserves borrowed by banks (UTLRB) appear on the balance sheet of the central bank as well as of the banks. Banks in Sweden have always been allowed to borrow an unlimited amount from the central bank. The central bank can be said to have conducted an "open discount window" policy for 16 of the 17 years of our sample period. First the banks could borrow any amount at a given interest rate - the so called "penalty rate". In 1985 the central bank changed this policy and the penalty rate became a function of how much the banks borrowed from central bank.

The short term rate of interest is the yield on deposits and the long term rate is the yield on bonds. Banks costs for borrowing from the central bank are given by the penalty rate. The penalty rate is controlled by the central bank but we have chosen to treat this variable endogenously in the model. A "reaction function" for this variable is formulated in section 12.5.3.

The wealth variable (WA) is also set endogenous. The net financial wealth of the non-bank private sectors is, by definition, identical with the accumulated net lending. Hence there should be a link with the real sphere of the economy. Letting net lending and thus net financial wealth be determined in the real part of the model, the WA variable should be "predetermined" in the financial sector. Due to the sector division in the financial model and the fact that we have excluded the market for shares in our model, this condition is not fulfilled empirically. This is one reason for loosening the ties between the real and financial sectors and keeping the net financial wealth variable endogenous.[7]

Of the five endogenous variables representing the non-bank private sector's demands for assets (BA, INLA, LB, SE and SUT) we model three, namely the demand for deposits (INLA), currency (SE) and foreign loans (SUT). Modelling these three demand equations and taking into account the previously discussed five budget restrictions for the sectors included in the financial model (Equations (12.1)-(12.5)) together with Equation (12.6), below, will solve for the remaining five endogenous variables; Ba, LB, WA, UTLRB and VR. These variables can thus be obtained from the identities presented above.[8]

Before proceeding to our empirical results we will point out that the banks' demand for reserves (BRES) consists of required and voluntary reserves. Equation (12.6) is an identity where the required reserve ratio (exogenous) multiplied by deposits is equal to required reserves. Voluntary reserves, held in the central bank, are exogenous.

$$BRES = KK*INLA + VOLr \qquad (12.6)$$

where KK is the reserve requirement ratio, and
VOLr is banks' voluntary reserves held in the central bank

7 Another reason for keeping the variable endogenous is that the WA variable is used as an argument in the consumption function of the model. If the variable were to be kept exogenous, it would merely display the "real balance" effect in the consumption function (the WA variable is deflated by a price index in the consumption function). Keeping the WA variable endogenous means that not just the "real balance" effect is incorporated in the consumption function but also the financial "wealth effect".

8 For instance, the non-bank private sector's holdings of government bonds, (BA) is the only endogenous variable in that sector which can be seen from Equation (1) and can therefore be computed from the equation

12.4 THE NON-BANK PRIVATE SECTOR'S DEMAND FOR SECURITIES

As noted, we have chosen to model the demand for deposits (INLA), currency (SE) and foreign loans (SUT). As mentioned above, we have not been able to either to obtain or construct data that comprehend all categories that are needed for a satisfactory empirical analysis of portfolio behavior. Therefore, the sector is very heterogeneous making a portfolio analysis of the sector less appealing.[9]

The three demand equations are all expressed as shares of net financial wealth. We use a stock adjustment scheme to model the optimal holding of securities.[10] The estimated equations will now be discussed.

12.4.1 Deposits

It is worth stressing some facts about the composition of the (aggregated) deposit variable. During the 1980s this variable consisted of ordinary deposits, "special deposits" and certificates of deposit. The last two forms of deposit can be seen as almost perfect substitutes, responding to an interest rate freely set by the banks. These deposits are large and usually short term. It is mainly corporations that hold special deposits and certificates of deposit.

In the 1970s the interest rate of ordinary deposits was regulated for the first eight years (see Table 12.1). Banks were not allowed to issue

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9 This heterogeneity of the aggregated data also meant that we have not been able to use the same variables in all three demand functions. Ideally, in a system of portfolio demand functions, the interest rates for all the securities are included in the system as arguments along with other variables that might be of importance. The rate of interest for the security in question will give the "own interest rate elasticity", while the rate of interest for other securities will give the "cross interest rate elasticity". In the empirical analysis the effects of "cross interest rates" turned out to be statistically significant only in the demand function for currency.

10 Assuming that the desired amount of a security (Y^*) held is a function of other variables (f(..)). The relationship can be written as follows:

$Y^*=f(..)$

The values of Y^* are not directly observable but the relationship between the actual and desired levels of the variable Y my be specified as follows:

$Y-Y_{-1}=\lambda(Y^*-Y_{-1})$

The coefficient l is called the "adjustment coefficient" since it indicates the rate of adjustment of Y to Y^*. Combining the two equations and solving for Y^* we obtain

$Y=\lambda f(..)+(1-\lambda)Y_{-1}$

This equation can be estimated and the adjustment coefficient identified.

certificates of deposit. Special deposits were thus the only deposits with an interest rate freely set by the banks. This heterogeneity in the deposit variable has to be considered when the results are discussed.

The ratio between deposits and net financial wealth will, in our specification of the demand equation, depend upon net wealth itself, the nominal gross domestic product, the real short term rate of interest and net lending in the business sector. We did a few experiments with the functional form of the equation. The equation reported below gave the best result:

$$\begin{aligned} INLA/WA = {} & \underset{(0.10)}{0.43} + \underset{(0.02)}{0.06}*D3 - \underset{(0.02)}{0.13}*D4 + \underset{(0.03)}{0.15}*D864 - \underset{(0.06)}{0.16}*MDEF + \\ & \underset{(0.05)}{0.19}*(KRA-(CDEF/CDEF_{-1}-1)*100)*FSN/WA + \\ & \underset{(0.08)}{1.1}*GDP*PQN/WA - \underset{(0.17E-06)}{0.7E-06}*WA + \underset{(0.06)}{0.34}*INLA_{-1}/WA_{-1} \qquad (12.7) \end{aligned}$$

R-Squared (adj) = 0.9964, D-W = 2.03, Period 1970:4 - 86:4

where D3 and D4 are seasonal dummies for the 3rd and the 4th quarters,
INLA is deposits from the non-bank private sector
WA is private sector financial net wealth,
D864 is a dummy for the last quarter 1986,
MDEF is a dummy with the value 1 for the period 1973:3 - 1986:4,
GDP is the gross domestic product,
PQN is the price deflator for GNP,
KRA is the short term interest rate,
CDEF is the price deflator for private consumption, and
FSN is net lending in the business sector.

The estimated equation reveals a rather rapid adjustment when the "optimal or desired" share (of deposits to net financial wealth) deviates from the actual share. This follows from the last estimated parameter in Equation (12.7), which indicates that almost 65 percent of the deviation will be adjusted within one period (quarter).

The first independent variable used in Equation (12.7), apart from the dummy variables, is the ratio between nominal GDP and net financial wealth. This variable represents the transaction motive. The larger the ratio, the more "liquid" assets are needed for transactions. The "long-run" elasticity of deposits with respect to income turns out to be 0.88. This estimate seems to be reasonable compared to other empirical estimates reported for Sweden.[11]

The last part of the variable (KRA-(CDEF/CDEF$_{-1}$-1)*100)*FSN/WA represents the "excess" savings to wealth in the business sector, viz. FSN/WA.[12] Normally, companies' net investment outlays outweigh the disposable income (i.e. profit) in the sector, which means that net lending in the business sector is negative. In the short-run, however, profit and net investment vary a great deal and therefore also net lending. The estimated parameter shows a positive sign, which indicates that the deposit-wealth ratio is positively correlated with the FSN/WA variable, for a given rate of real short term interest. The variable captures changes in profits due to business cycle effects. According to our estimates, changes in the business sector's net lending will "spill over" to deposit.

The FSN/WA variable interacts with the real rate of interest. The deposit-wealth ratio (dependent variable) is thus positively correlated with the real rate of short term interest, for a given value of the FSN/WA variable. A higher real interest rate results in a higher deposit-wealth ratio. The logic behind this phenomenon is quite straightforward; a larger part of a given surplus of net lending will be deposited if the real interest rate increases.

This correlation between the variables discussed above fits a general belief, among bankers, about behavior in business sector. In periods of high liquidity in the business sector the demand for special deposits (the 1970s) and certificates of deposit (the 1980s) increased. Included in the "banker's hypothesis" is the suspicion that the rate of return is crucial in this context.

Net financial wealth is also included as an argument in Equation (12.7). The sign of the estimated parameter indicates that if net financial wealth

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11 See Lybeck (1975) and Berg et al (1981). Englund et al (1987) report lower elasticity for the demand for money using an error correction model.

12 The non-bank private sector consists of households, insurance companies and non-financial corporations. The business sector's net lending is thus part of the non-bank private sector's net wealth. As discussed, we are not modelling any separate demand functions for these sectors. Net lending for the business sector is included in the non-bank private sector's demand function for deposits for reasons that are discussed below.

increases, the left-hand ratio will decrease. Thus deposits are negatively correlated with the square of net financial value. This variable can be said to capture the non-linear elements of the demand function.

The estimated equation also reveals that the seasonal pattern for the third and fourth quarters deviates from the first (and implicitly the second). We also included a dummy variable (MDEF) for changes in the definition of the aggregate of deposits (and consequently in the definition of money) that took place in the first half of 1973. We also included a dummy (D864) to capture the effects of the deregulation of financial markets in the fourth quarter 1986.

12.4.2 Currency

The demand function for currency is estimated in ratio form. As in the previous demand function, the dependent variable is deflated by net financial wealth. We have followed the Baoumollian inventory approach with a stock adjustment mechanism incorporated. The ratio of private consumption to net financial wealth is used to capture the transaction motive. The demand for consumption expenditures is the variable used in most empirical studies of currency demand functions. From a logical point of view consumption ought to be correlated with transactions in the economy.

In the previous function (demand for deposits) we used nominal GDP to catch the transaction motive. The logic behind that specification is that the demand for deposits is determined by the aggregated economy. The demand for currency is different. A recent survey shows that households keep more then 80 percent of the currency in circulation (see Bergman et al (1989)). This indicates that the demand for private consumption might be a more important determinant than GDP.

The estimated function is:

$$SE/WA = \underset{(0.002)}{-0.002} \cdot D4 - \underset{(0.0002)}{0.001} \cdot KRA + \underset{(0.01)}{0.40} \cdot CP \cdot CDEF/WA + \underset{(0.03)}{0.15} \cdot SE_{-1}/WA_{-1} \qquad (12.8)$$

R-Squared (adj) = 0.9967, D-W = 1.53, Period 1970:4 - 86:4

where CP is private consumption expenditures, fixed prices,
CDEF is the price deflator for private consumption,
KRA is the short term rate of interest.
WA is private sector financial net wealth, and
SE is currency in circulation,

From Equation (12.8) it can be seen that an increase in the short term interest rate has a negative effect on the left-hand variable. That is what we would expect; the interest rate represents the opportunity cost of holding money. The computed (long-run) interest rate elasticity for currency holdings turns out to be -0.07. An increase in the rate of interest from 10 percent to 11 percent (i.e. one percentage point or 10 percent) will thus decrease the amount of currency held by the non-bank private sector by -0.7 percent. The value of the computed elasticity is in accordance with other Swedish empirical studies.[13]

The demand for money will increase when nominal private consumption expenditures (CP*CDEF) increase according to the so-called transaction motive. The impact effect is estimated to 0.4, which means that the currency-wealth ratio will change by less then half of the change in the consumption-wealth ratio. A better way of clarifying the relationship between currency and nominal private consumption is to compute the (long-run) elasticity between the two variables. The elasticity is about unity - 1.08 to be precise. Even this estimate is in accordance with earlier reported studies.

The estimated parameter for the last variable on the right-hand side of Equation (12.8) equals 0.15, which indicates that 85 percent of the deviation between the desired and the actual currency-wealth ratio adjusts within the period. Thus the demand for currency adjusts very rapidly, which seems reasonable.

12.4.3 Foreign loans

The third behavioral equation is the ratio between foreign loans and net wealth. Arguments in this equation are the trade balance,, and the interest rate differential together with the realized relative exchange rate changes between SEK and US dollars. The latter variable is a proxy for

13 See Lybeck (1975), Berg et al (1981), Englund et al (1987), Markowski (1988) and Gottfries et al (1989)

the expected changes in the exchange rate. A stock adjustment mechanism is incorporated.

Before we discuss the specification of the model we have to recall some institutional facts. During the period the possibilities for companies to borrow abroad were regulated. From the beginning of 1974 companies were allowed to take loans with five years maturity or longer. In 1979 that time was reduced to 2 years. From the end of 1986 the regulations were removed.

In the specification of the interest rate difference we have used the domestic short term interest rate and the interest rate on Eurodollars. From this difference we have deducted the relative change in the exchange rate between SEK and US dollars. All the variables that are included in our measure of the interest difference should be "expected values". We have assumed "static preferences" and used the actual value of the relative change in the exchange rate in the estimation.

Before discussing the result of the estimated equation it is worth mentioning that the trade balance (HBN) is included to capture the effect of short term credits to finance imports and exports. The expected sign of the parameter of this variable should be negative. Borrowing abroad will contribute to the financing of a deficit in the trade balance.

$$
\begin{aligned}
SUT/WA = {} & \underset{(0.011)}{0.029} \cdot D1 + \underset{(0.009)}{0.023} \cdot D2 - \underset{(0.009)}{0.021} \cdot D4 + \underset{(0.030)}{0.029} \cdot D864 + \\
& \underset{(0.0006)}{0.0021} \cdot ((KRA_{-1} - ED_{-1})/4 - (KUSA_{-1}/KUSA_{-2} - 1) \cdot 100) + \\
& - \underset{(0.12)}{0.49} \cdot HBN \cdot 10^5 + \underset{(0.03)}{0.90} \cdot SUT_{-1}/WA_{-1}
\end{aligned}
\qquad (12.9)
$$

R-Squared (adj) = 0.940, D-W= 1.41, Period 1970:4 - 86:4

where
- SUT is loans to the non-bank private sector from abroad,
- WA is private sector financial net wealth
- HBN is the trade balance at current prices,
- KRA is the short term domestic interest rate,
- ED is the Eurodollar interest rate, and
- KUSA is the exchange rate between SEK and US dollars

Equation (12.9) gives the expected signs on the coefficients of the variables. Institutional factors seem to influence the non-bank private sector's foreign debt-wealth ratio in a systematic way in the second and fourth quarters compared to the first and the third. The dummy variable for the third quarter was not significant, which indicates that the constant for the first and the third quarter might be the same.

The coefficient of the trade balance shows the expected sign. The parameter of the lagged value of the left-hand variable amounts to 0.9. According to the stock adjustment mechanism scheme we employ, this indicates that 10 percent of the gap between desired and actual values of the foreign loan-wealth ratio will be closed in a single period. The estimated adjustment process is thus slow and the mean lag (when 50 percent of the adjustment has taken place) will be 9 quarters. One explanation for this slow adjustment might be that foreign exchange controls prevailed during the sample period.

The interest rate difference (including the actual change in the exchange rate) is specified with a one-period lag. The presence of a lag can presumably also be explained by the regulations. Foreign exchange controls may have delayed the effect of changes in the interest rate difference. It should be mentioned that we also experimented with different specifications to test for effects of regulations but without any success.

The calculated long run elasticity of the stock of foreign securities with respect to the short term domestic interest rate for the sample period is around 0.1. (*N. B.*, the elasticity is calculated with allowance for the net financial wealth variable.) Foreign securities are thus sensitive to changes in the domestic interest rate. For the sample period the mean value of the domestic interest rate is around 10 percent. An increase in the interest rate by one percentage point, ceteris paribus, results in a change in capital inflow of one percent. The mean value of net foreign lending is SEK 32 billion, so a one percentage point increase in the domestic interest rate will, ceteris paribus, increase the capital inflow by around 0.3 billion. The reported elasticity regarding the interest rate seems to be in accordance with Markowski (1989) but much higher than results reported by Englund et al (1987).

12.5 THE RATE OF INTEREST

As discussed in section 3.1, our model consists of three assets markets with endogenous prices; short and long term rates of interest and the penalty rate of interest. In this section models will be specified for both a short and a long term rate of interest. The long term interest rate will be linked to the short term rate by means of a term structure. At the end of this section a reaction function for the central bank is presented.

12.5.1 Short-term rate

A rather eclectic approach has been used in modeling the short term interest rate. We have assumed that the short term interest rate is a function of required reserves, the penalty rate and a measure of the liquidity in the economy. The penalty rate and required reserves are, as already discussed, instruments of the central bank.

The last variable included in the interest function is the ratio between money (SE + INLA) and nominal GDP. The ratio is equal to the inverse of the velocity of money. We expect a negative sign of the parameter of this variable; if the inverse of velocity increases the interest rate will fall and vice versa. The model fits data best if a lagged value of the penalty rate is introduced. The estimated function has the following form:

$$KRA = \underset{(0.06)}{0.72} * RST + \underset{(0.06)}{0.27} RST_{-1} + \underset{(0.04)}{0.08} * KK - \underset{(0.10)}{0.39} * (SE + INLA)/(GDP * PQN) \qquad (12.10)$$

R-Squared (adj) = 0.9973, D-W= 1.21, Period 1970:4 - 86:4

where KRA is the short term rate of interest,
RST is the penalty rate for borrowing in the central bank,
KK is the required reserves for banks,
M3 is the money stock (SE+INLA)
GDP is the gross domestic product, and
PQN is the price deflator for GNP

The penalty rate is an important determinant of the short term interest rate according to Equation (12.10). Allowing for the period of adjustment, an increase in the penalty rate will raise the short term interest rate by the same amount; the long run effect of a change in the penalty rate is equal to unity.

An increase in required reserves by one percentage point will increase the short term interest rate by 0.08 percentage points. The elasticity of the rate of interest with respect to required reserves is of the same magnitude. An increase in required reserves from 2 to 3 percent (50 percent) will, ceteris paribus, increase the short term interest rate by 0.4 percent.

The last variable in Equation (12.10) is the inverse of the velocity of money. The estimated coefficient has the expected negative sign. The calculated elasticity is around -0.1. The 15-20 percent drop in the inverse of the velocity during the 1980s (a result of a tight monetary policy) has, ceteris paribus, increased the short term interest rate by 1.25-1.5 percent.

The determination of the short term interest rate not only implies that the penalty rate and the required reserves have a direct impact. Via the inverse of the velocity of money, changes in the real sector will affect the financial sector.

12.5.2 Long-term rate

The long term rate of interest is an important determinant of capital formation. As examined in Chapter 4 the long term rate of interest appears as an argument in the cost of capital. To determine the long term interest rate we have assumed that there exists a term structure of interest rates, i.e. a yield curve. We model the curve with the long term rate of interest as dependent and the short term rate as independent variable. To get the equation to work properly we have added a dummy variable to cope with effects of regulations in the early 1970s. The following equation was used:

$$\underset{(0.56)}{IR=6.78} + \underset{(0.09)}{0.07{*}KRA} + (\underset{(0.63)}{-5.93} + \underset{(0.09)}{0.12{*}KRA} + \underset{(0.04)}{0.73{*}IR_{-1}}){*}D74\text{-}86 \qquad (12.11)$$

R-Squared (adj) = 0.9650, D-W = 1.20, Period 1970:4 - 86:4

Where IR is the long term rate of interest,
KRA is the short term rate of interest, and
D74-86 is a dummy variable that is equal to one after the 1st quarter of 1974

Equation (12.11) consists of two parts; one for the period before 1974 (when the market were heavily regulated) and one from 1974 to 1986. The interesting period is the last one. Rewriting Equation (12.11) in terms of its long run values for the last period we obtain:

$$IR=3.14 + 0.75*KRA \qquad (12.12)$$

Equation (12.12) can be seen as derived from a "yield curve". The intercept shows the value of the "mark up" between the two rates of interest for the hypothetical case that the short-rum rate of interest is zero. The coefficient of the KRA-variable shows the increment of the "mark up" when the short term rate changes.

12.5.3 Reaction function of the central bank

The simple idea behind a reaction function for the central bank is that the bank will change the penalty interest rate due to changes in certain economic conditions. The reaction function assumes that the desired level of the penalty rate is a function of the Eurodollar rate of interest, the ratio between the domestic and international rates of inflation, net lending in the business sector, the current account and private consumption expenditures.

We have formulated the reaction function according to the following effects of the independent variables. Increase in the Eurodollar rate of interest and the relative rate of inflation will lead to a capital outflow. An increase in the penalty rate will push up the domestic interest rate and thus prevent an outflow of capital. The current account, business sector net lending and the nominal level of private consumption are also variables in the reaction function. Thus, indirectly all endogenous variables in the SNEPQ model are included in this function.

When the SNEPQ model is used for simulation with the reaction function included, a specific monetary regime is assumed implicitly. We assume a state of non-accommodating monetary policy. Any policy experiment that influences the independent variables of the reaction function will result in changes in the penalty rate, which in turn will affect the short term interest rate and the rest of the endogenous variables in the financial sector.

The estimated reaction function for the central bank is;

$$RST = \underset{(0.04)}{0.14} * ED - \underset{(0.04E\text{-}3)}{0.15E\text{-}3} * BB + \underset{(0.50)}{0.86} * P/Put - \underset{(0.16E\text{-}4)}{0.46E\text{-}4} * FSN +$$

$$\underset{(0.06E\text{-}4)}{0.14E\text{-}4} * CDEF * CP + \underset{(0.07)}{0.69} * RST_{-1} \qquad (12.13)$$

R-Squared (adj) = 0.8990, D-W = 1.75, Period 1970:4 - 86:4

Where
- RST is the penalty rate of interest,
- ED is the Eurodollar (3 month) interest rate,
- BB is the current account (nominal),
- P/Put is the relative rate of inflation; domestic - foreign,
- FSN is net lending in the business sector,
- CP is private consumption, at constant prices, and
- CDEF is the price deflator for private consumption

The coefficients of Equation (12.13) all have the expected signs. The Eurodollar rate of interest as well as the relative domestic-foreign price level have a positive effect. That is of course what can be expected; if the Eurodollar rate of interest rises the domestic rate also has to go up, otherwise foreign reserves will be drained. The same argument holds for an increase in relative price; to stop an outflow of capital when the domestic rate of inflation is higher then in the rest of the world, the rate of interest has to be higher.

If the current account turns in to the red the interest rate has to increase to get the necessary foreign capital inflow to finance the deficit. Net lending by the business sector is an indicator of demand for credit in the economy. Large negative net lending indicates high demand for credit to finance investment spending. A lower deficit indicates lower investment spending or that higher profit is easing the demand for credit.

The nominal value of private consumption is also assumed to be an important factor behind the central bank's decisions about the level of the penalty rate. Given the values of all the other variables in the reaction function, an increase in the nominal value of private consumption will have an effect on the rate of interest in the economy.

12.6 SOLVING THE FINANCIAL MODEL

We have chosen to show the static solutions for most of the financial variables that are endogenous.[14] Eight endogenous variable will be presented graphically in the following order:

Figure 12.2 BRES total bank reserves (voluntary and required),
Figure 12.3 INLA deposits from the non-bank private sector
Figure 12.4 L loans to the non-bank private sector,
Figure 12.5 SE currency in circulation,
Figure 12.6 UTLRB banks' borrowed reserves,
Figure 12.7 VR foreign exchange reserves,
Figure 12.8 SUT loans to the non-bank private sector from abroad,
Figure 12.9 KRA short term interest rate.

These figures will be found at the end of the paper

In the diagrams the solved values are shown together with the actual values. We have also included two standard statistical measures in the graphs; squared correlation coefficient (r^2) and root-mean-squared error (RMSE). We will make some brief comments about the variables in the order the graphs appear.

Total bank reserves (BRES) are defined as an identity - see Equation (12.6). Only one endogenous variable is included in that identity: deposits from the non-bank private sector (INLA). The required reserve ratio (KK) interacts with this endogenous variable. The fit of the BRES variable is thus entirely dependent on how well the solved values for deposits from the non-bank private sector (INLA) coincide with the actual values. As can be seen from Figure 12.2, the actual and fitted values for the BRES variable almost coincide. That indicates that the solved value for deposits from the non-bank private sector (INLA) also show a good fit. From Figure 12.3 it can be seen that this is the case.

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14 We have excluded the solution for the non-bank private sector's holdings of treasury bills (BA) due the fact that this variable's fitted values will be identical with its actual values. This is a consequence of how the model is formulated. As can be seen from Equation (1) (the balance sheet for the General Government) all variables except BA are exogenous or predetermined. This means that when we only solve the financial sector, fitted and actual values will coincide for the BA variable. For the WA variable. the sum of residuals in all the endogenous variables in Equation (4) will be almost zero. The effect will be that the fitted and actual values of the WA variable coincide.

Figure 12.3 displays the non-bank private sector's deposits in banks. Recall that the variable consists of ordinary deposits, special deposits and certificates of deposit. The static solution of the model fits data well. The absolute values of the deviations increase during the 1980s. This is probably caused by changes in monetary regimes.

Compared with deposits the deviations between actual and fitted values for bank loans to the non-bank private sector are greater, which can be seen in Figure 12.4. The deviations start to increase during the 1980s and for some observations in the 1980s the residuals are quite big. One explanation of this phenomenon might be the loan ceilings that where introduced occasionally during the 1980s. They set a maximum for the volume of credit expansion by individual banks. We have experimented (using dummy techniques) with some of the behavioral equations without success. The overall performance of the variable is, however, acceptable.

The only thing to point out in Figure 12.5 (currency in circulation) is deviations that occur in the last year of the sample period. For all other periods the model solution seem to be very close to the actual values of currency in circulation.

So far the model behaves well. Coming to Figure 12.6 one might think that this is no longer so. Big residuals appear for some observations. The banking sector consists of commercial banks, saving banks and cooperative banks. From time to time there have been different rules for reserves and capital base requirements for these banks, which of course affect their demand for borrowed reserves. In such a highly aggregated model as SNEPQ this institutional structure distorts the simulation results.[15]

The solved values of foreign exchange reserves (VR) and non-bank private sector loans from abroad (SUT). - which can be seen in Figures 12.7 and 12.8 - show acceptable fits. The statistical measures are satisfactory.

Figure 12.9 presents fitted and actual values for the short term rate of interest. We have specified a behavioral equation for the short term rate

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15 Its also worth mentioning that we have experimented with modeling banks' demand for borrowed reserves. The result of the test was unsatisfactory.

of interest in section 5.1 and the simulation results for the dependent variable are satisfactory.

12.7 A FINAL COMMENT

Some policy simulations are presented In Chapter 14. For instance, an increase in government consumption by SEK 1 billion, in real terms, (the simulations start in the 1st quarter 1977) will increase the short term rate of interest by 0.8 percentage points after a few years. An increase in government consumption affects both the current account and the budget surplus which in turn, although simultaneously, affects the rate of interest.

Next, let the government real transfers to households increase with SEK 1 billion. This income increment for households will result in, among other things, a rise in the rate of interest, though this is smaller then the one reported above. This phenomenon is a result of the well known fact that the multiplier is greater for an expansion of government consumption than for an increase in transfer payments.

If the income of the OECD countries increases by one percent it will have an effect on exports. As a consequence the current account and budget surplus will improve. Foreign reserves will also increase despite the fact that the non-bank private sector's loans from abroad will decrease. The effect on the rate of interest will be negative; all three rates will decrease by around 0.3 percentage points.

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Figure 12. 1

GENERAL GOVERNMENT DEBT

Shares for Different Holders – percent of GDP

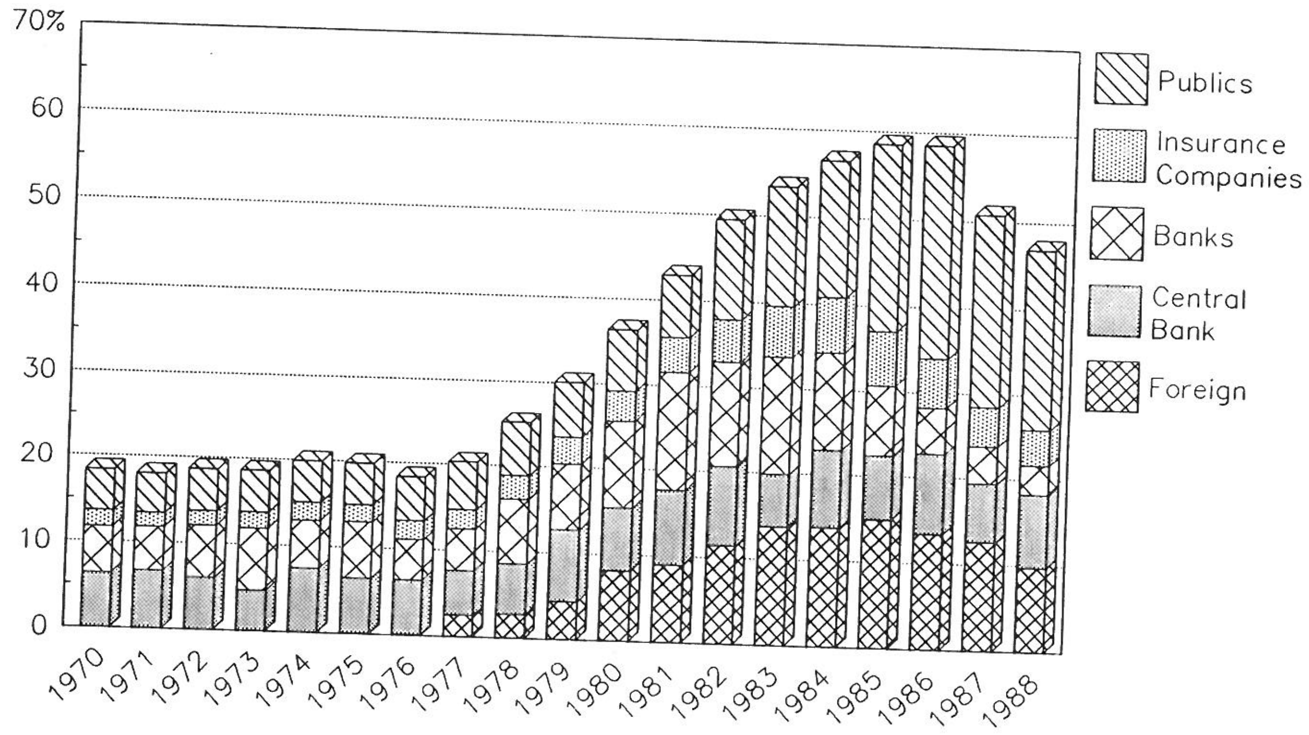

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Figure 12. 2

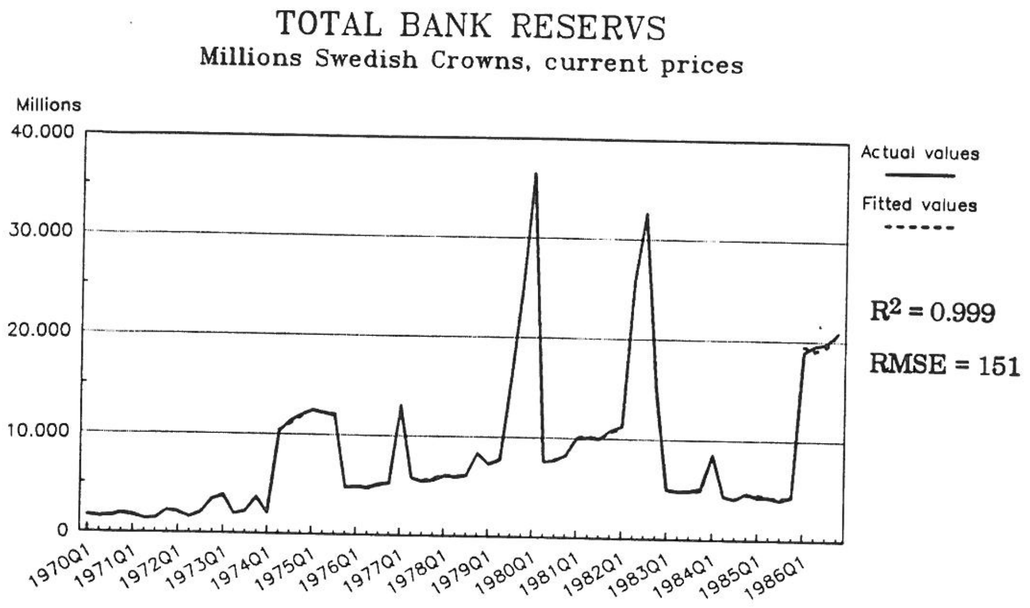

Figure 12. 3

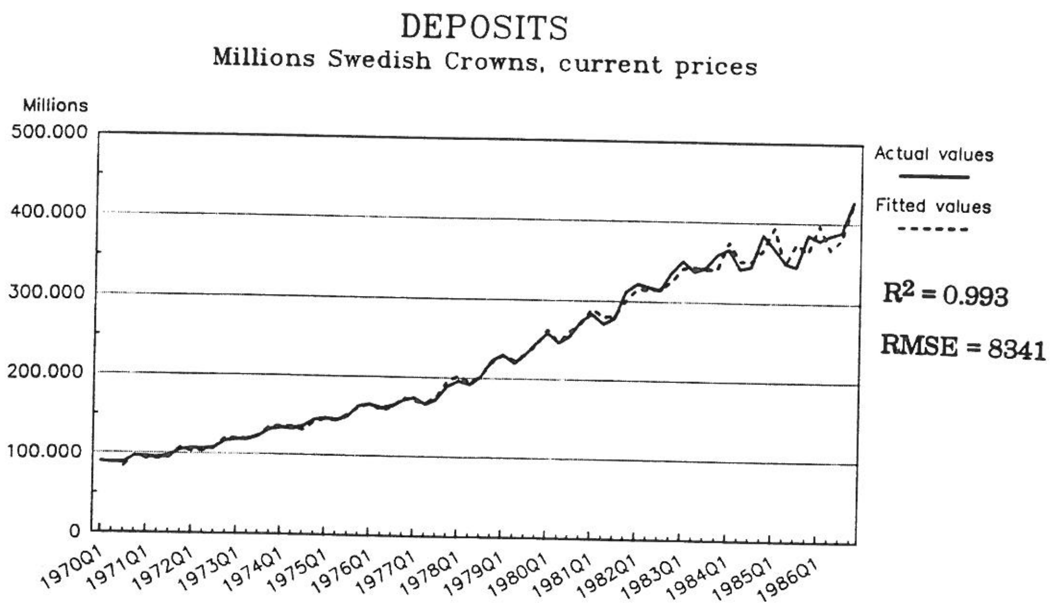

Figure 12. 4

LOANS TO THE NON-BANK PRIVATE SECTOR
Millions Swedish Crowns, current prices

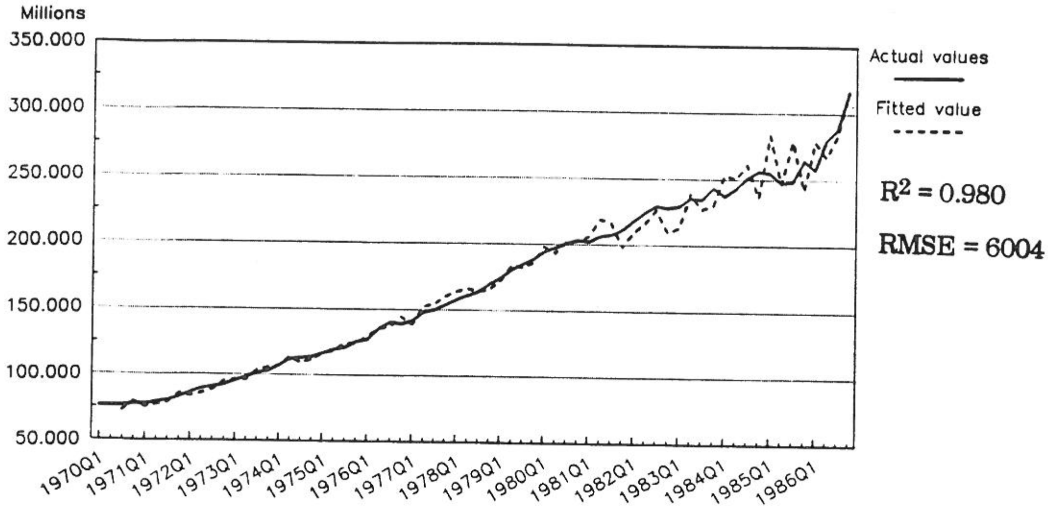

Figure 12. 5

CURRANCEY IN CIRCULATION
Millions Swedish Crowns, current prices

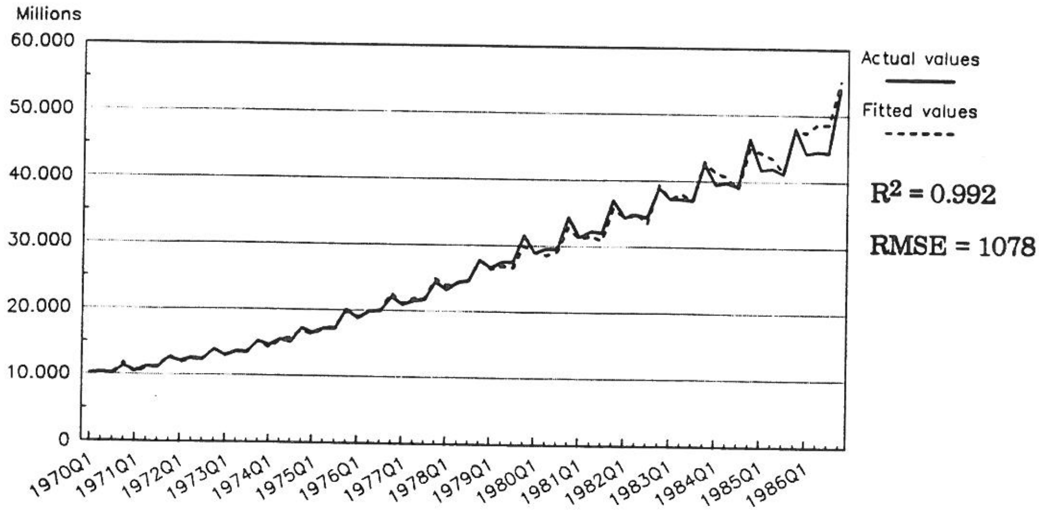

Figure 12. 6

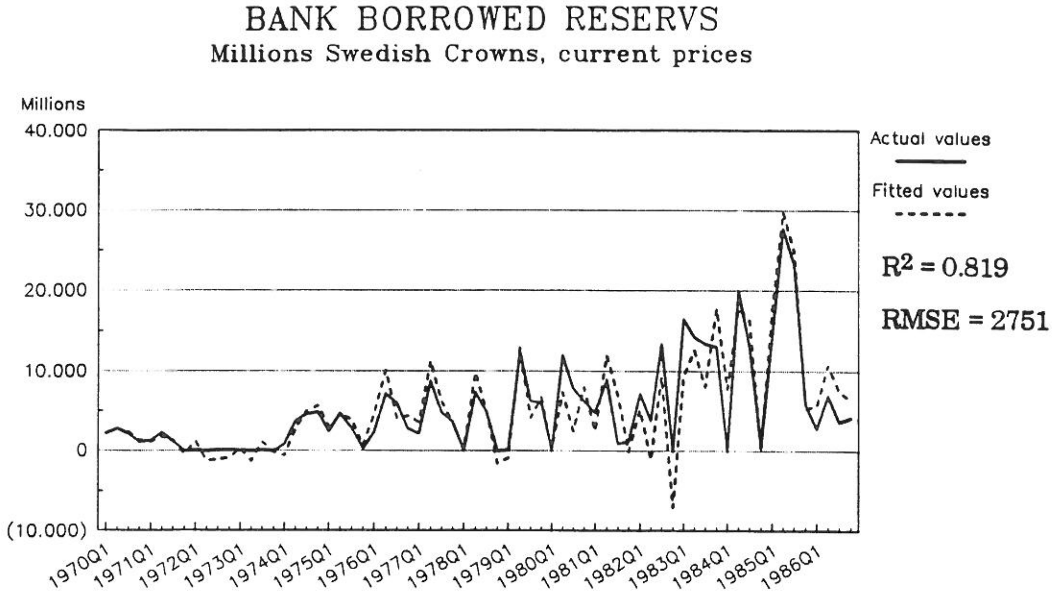

Figure 12. 7

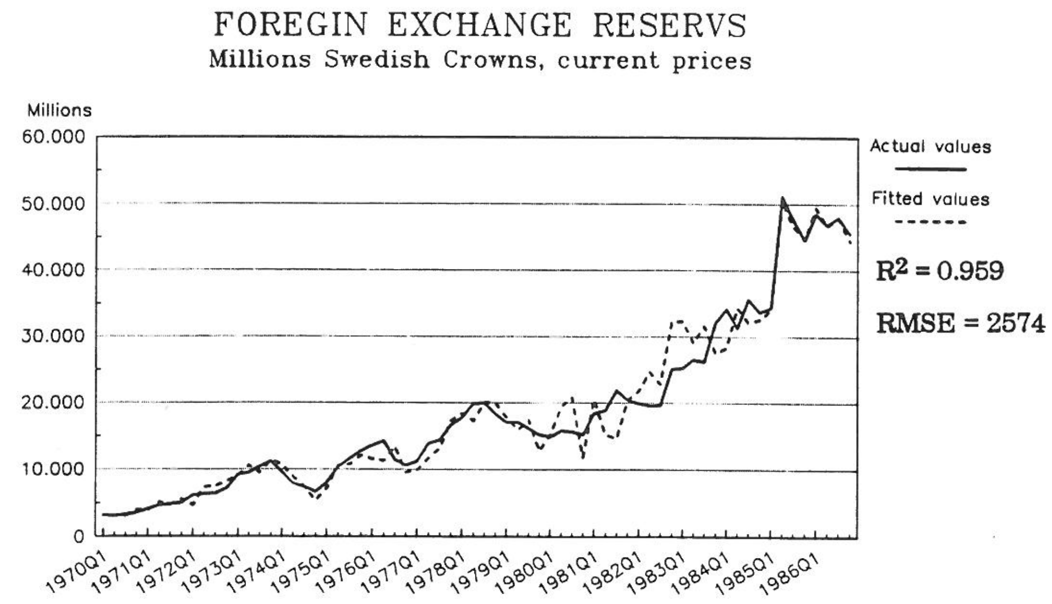

Figure 12. 8

FOREGIN LOANS TO THE NON-BANK PRIVATE SECTOR
Millions Swedish Crowns, current prices

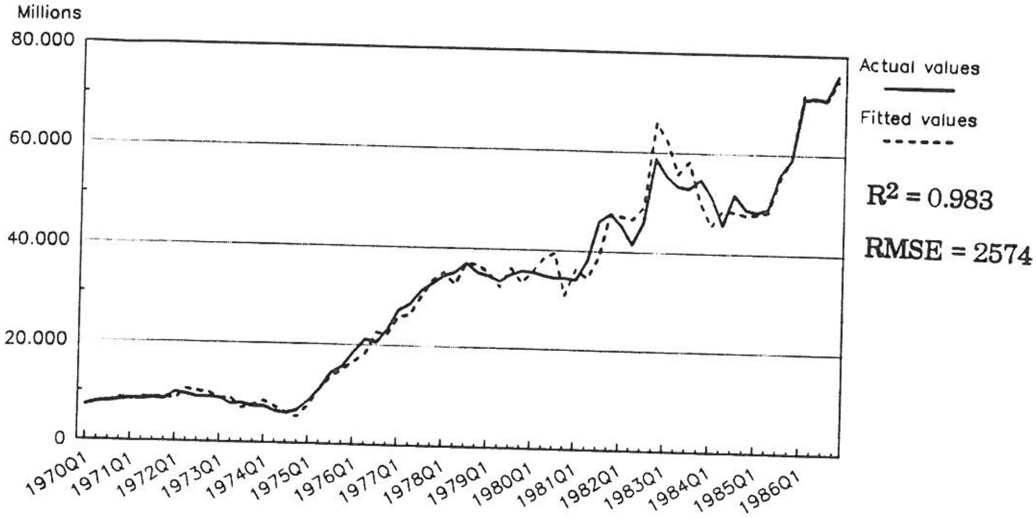

Figure 12. 9

SHORT RUN INTEREST RATE