THE FINANCIAL BLOCK IN THE ECONOMETRIC MODEL KOSMOS

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1. INTRODUCTION

This paper describes the general structure and the relations of the financial block in the econometric model KOSMOS. The paper is confined to a description of the model - simulation results will be reported elsewhere (cf. Kragh and Markowski [1997]).

Since the early 1980-ies, the Swedish financial sector has undergone dramatic changes, whereby a system of detailed regulations has been completely dismantled. On September 22, 1983, the liquidity ratio requirement, forcing banks to invest in priority (low-interest) housing and government bonds, was abolished. On September 20, 1984, a similar requirement from the insurance companies and the National Pension Fund (*AP-Fonden*) was limited to comprise only the purchase from the issuing agent. The requirement was abolished altogether in December 1986. On May 13, 1985, the recommended average bank lending rate was repealed. Finally, on November 21, 1985, the bank lending regulation was abolished and the Central Bank interest rate scale was introduced. Furthermore, on June 1, 1989, exchange controls were abolished. Some years later, on November 19, 1992, a long period of basket peg for the Swedish krona came to an end and the currency was floated.

The deregulatory measures listed above significantly affected the functioning of the financial sector and most probably contributed to the deep crisis of the banking sector in the beginning of 1990-ies, which ended by the government issuing a blanket guarantee for all bank deposits and bailing out (and taking over) two major banks.

The deregulation of the financial sector increased its importance for the economy and brought about a renewed interest in financial variables. This interest is compound by the issue of the European Monetary Union and the independent policy stance of the Central Bank, which has identified a low inflation rate (quantified as 1%-3% *p.a.* in the longer run) as its only policy target.

The increasing importance of financial variables prompted econometric studies of this sector. Lybeck [1975] constructed a disequilibrium model of the regulated financial system. Markowski [1989] and Kragh and Markowski [1988] studied the interaction between the financial and real sectors of the economy in a deregulated environment. Kottas [1990] included an extensive financial portfolio choice model in the Stockholm University Model. Recently, another econometric model, SNEPQ, was complemented with a financial sector (cf. [Berg *et al.* 1993]).

The financial sector affects KOSMOS through its impact on investment, private consumption, foreign trade and capital flows. The links are the interest rates, the exchange rate and the money stock. The financial sector is, however, modelled in much more detail than what would be needed to determine those variables. This is so, since we believe that modelling changes in financial portfolios of economic agents, and in particular the way government budget deficit is financed, is of interest in itself.

The model includes seven sectors (Central Bank, central government, banks, mortgage institutions, private and social insurance, non-financial business and households, foreign) and nine asset categories (certificates, bonds, bank deposits, loans, equity, net foreign assets, notes and coin, insurance savings and claims on the National Savings Scheme). Emphasis was laid on modelling demand for bonds and certificates, which in turn affects the bond rate and the money stock. Sector demand for equity is - with two exceptions - determined exogenously, due to problems with modelling yield on equity and changes in market value.

Despite the relatively large number of assets the model is rather simple, any refinements having been left to subsequent model versions. The approach is eclectic. At the core of it lies the portfolio balance model[1], but the portfolio in question is defined narrowly to include only net foreign assets, certificates, bonds and (bank deposit) money. The remaining assets

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[1] The choice of the model is briefly discussed in the introductory part of the chapter on the portfolio model below.

are assumed to be acquired for other reasons than pure portfolio investment and their purchase is assumed to be effected before any portfolio decision is taken. Furthermore, the portfolio choice is assumed to take place in two steps, the first decision referring to the choice between foreign and domestic assets.

The model's data base consists of a flow-of-funds matrix (or its stock-value counterpart) derived from the Financial Accounts published by Statistics Sweden. Annual Financial Accounts time series for 1986-94 were distributed by half-years (and in some instances quarters) using other sources, in particular the data compiled by the Central Bank. Despite much effort, we were not always able to reconcile time series coming from different sources.

The quality of the data is in some respects rather poor, although a major effort has been made to compile a good statistical data base for the project. One of the problems, but definitely not the only one, is the uncertainty regarding the extent to which assets are reported at market value as opposed to nominal value.

The poor quality of the data and the limited number of observations available affected the estimation strategy. While statistical inference often is difficult in small samples (in particular when only asymptotic distributions for the test variables are known), data problems and apparent measurement errors made test results the more dubious. In formulating equations, theory and considerations relating to the desired simulation properties of the model were given precedence over test results. Furthermore, the OLS estimator was employed, since instrumental variable methods can result in large small-sample bias when instruments are correlated with the error term or are only weakly correlated with the endogenous explanatory variables (cf. Bound, Jaeger and Baker [1995]). Standard computer printout is shown for all the equations as a general information for the reader.

A rather uncommon approach was employed in order to improve the reliability of the estimates. Regressions were - whenever possible - based on quarterly data, the resultant

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equations being subsequently transformed into semi-annual form to conform with the requirements of KOSMOS. To this end, a theory of temporal aggregation of equations was developed in Ruist [1996].

I am indebted to Börje Kragh, Erik Ruist, Lars-Erik Öller and Thomas Url for numerous discussions, advice and help during the work on the model. The collaboration of Börje Kragh was crucial for the design of the overall structure of the model. Thomas Url has directly contributed to the formulation of a number of equations. The insights provided by Erik Ruist helped us to overcome the problems encountered in temporal aggregation of the estimated equations. ,

Outstanding research assistance was provided by Jan Alsterlind, who shouldered the responsibility for programming and for the construction of the model data base. The Financial Accounts data base was prepared by Erik Lind.

The structure of the paper is as follows. A theoretical portfolio model is outlined in the next chapter. Thereafter, the empirical model is described in general terms. The two subsequent chapters deal with the determination of the exchange rate and of the interest rates, respectively. The seven final chapters deal with the seven sectors of the model, giving an account of the demand for and supply of assets by sector.

2. THE PORTFOLIO BALANCE MODEL

Demand for the four most important assets is here modelled using the portfolio balance approach (cf. Branson and Henderson [1985]). The choice of the latter, rather than of any of the models in the spirit of Fleming and Mundell (cf. Fleming [1962], Mundell [1963], Dornbusch [1976] Buiter and Miller [1981], Devereux and Purvis [1990]) was directed by our view that domestic and foreign bonds are considered by economic agents to be different assets.

In the Mundell-Fleming model, perfect capital mobility is assumed together with uncovered interest rate parity, implying that domestic and foreign non-money assets are perfect substitutes. On the other hand, the *imperfect* substitutability between domestic and foreign bonds is a central feature of the portfolio balance approach. Consequently, uncovered interest rate parity does not hold in this class of models. The investors opt for a diversified portfolio of both domestic and foreign assets, all having specific risk and return characteristics. The optimal portfolio composition depends on these characteristics, the stock demand for each asset being furthermore a function of total wealth. The latter feature introduces the distinction between stock (i.e. long run) and flow (i.e. short run) equilibria.

Below, we first outline the theoretical aggregate portfolio model and then show how this model is disaggregated in the present context.

2. 1 THE AGGREGATED THEORETICAL MODEL

The portfolio balance model in its general form is formulated and analysed in Branson and Henderson [1985] and Pentecost [1993]. What follows is a stylised version of our empirical model.

The aggregate portfolio problem is here defined for the total private sector, the government and the central bank being left aside. There are four assets in the model: money (M),

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domestic short term paper (C), domestic (long-term) bonds (B) and foreign assets (F). The yield on money is zero and the yields on the remaining assets are denoted by r^s, r^l and r^f, respectively.

It is assumed that only one type of foreign assets is demanded, or -alternatively - that all the foreign assets held domestically are seen as a homogeneous aggregate whose dominating feature is the exchange risk involved.

Domestic private wealth (W) is allocated between the four financial assets:

$$(1) \qquad\qquad W = M + C + B + E\,F\,,$$

where E is the exchange rate (defined as the price of foreign currency in terms of the domestic currency) and E F is the value of foreign assets measured in domestic currency.

The portfolio allocation decisions are assumed to be taken sequentially. First, it is decided whether to take a foreign exchange risk or not, i.e. whether to invest in domestic or foreign assets:

$$(2) \qquad\qquad E\,F = f(r^s, r^f + \varepsilon, W)\,,$$

where

r^s - domestic short-term interest rate,

r^f - foreign interest rate,

ε - expected rate of depreciation of the domestic currency.

The remaining part of private wealth

$$(3) \qquad\qquad W^d = W - E\,F = M + C + B$$

is then allocated between the domestic financial assets:

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(4) $M = m(r^s, r^l, Y, W^d)$

(5) $C = c(r^s, r^l, Y, W^d)$

(6) $B = b(r^s, r^l, Y, W^d)$

where

    r^l - domestic long-term interest rate,

    Y - domestic nominal output.

It is postulated that the three financial assets are gross substitutes, i.e. that an increase in
e.g. the (long-term) bond rate *ceteris paribus* gives rise to a substitution out of both
certificates and money into bonds. Domestic output captures the transactions demand for
money and is, therefore, expected to affect positively the demand for money and negatively
the demand for the remaining two assets.

The asset demand functions are homogenous of degree one in (domestically invested)
financial wealth, output and prices. This means, among other things, that private agents are
not subject to money illusion.

Equation (3) implies the following restrictions on the asset demand functions:

(7) $m_i + c_i + b_i = 0$, $i = 1, ..., 3$; $m_4 + c_4 + b_4 = 1$,

where m_i, c_i, b_i are the derivatives of the functions m, c and b, respectively, with respect to
their i-th argument. Thus, a change in any of the yields affects the distribution of the existing
wealth between the three assets, while an increase in (domestically invested) financial wealth
is completely allocated between them. It follows that only two out of the three asset
demand equations (4)-(6) are independent.

All the asset markets are assumed to be constantly clearing, so demand in each market
always equals the given supply:

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(8) $\quad\quad\quad\quad\quad\quad\quad\quad$ $E\ \overline{F} = f(r^s, r^f + \varepsilon, W)$,

(9) $\quad\quad\quad\quad\quad\quad\quad\quad$ $\overline{M} = m(r^s, r^l, Y, W^d)$,

(10) $\quad\quad\quad\quad\quad\quad\quad\quad$ $\overline{C} = c(r^s, r^l, Y, W^d) + c^f(r^s - \varepsilon, r^l - \varepsilon, r^f, E\ W^f)$,

(11) $\quad\quad\quad\quad\quad\quad\quad\quad$ $\overline{B} = b(r^s, r^l, Y, W^d) + b^f(r^s - \varepsilon, r^l - \varepsilon, r^f, E\ W^f)$,

where W^f, c^f and b^f are foreign wealth and foreign demand for domestic certificates and bonds, respectively, and bars denote stock supplies (thus, e.g. $\overline{C}$ denotes the available supply of domestic certificates).

Market equilibrium conditions for domestic certificates and bonds include foreign demand for the respective asset. Foreign demand is expressed in domestic currency and is a function of - among others - the foreign interest rate and foreign wealth. In accordance with the assumption that domestic money is not held abroad there is no foreign demand for domestic money.

Foreign demand for foreign assets is not explicitly included in the foreign asset equation. Instead, it is assumed that variation of foreign demand is reflected in changes in r^f.

Given the supply of each asset, the portfolio model can be employed to determine the optimal portfolio composition and the equilibrium yields in the asset markets. One additional point will help to identify the model's endogenous variables.

The expected rate of depreciation of the domestic currency, ε, can be defined as:

(12) $\quad\quad\quad\quad\quad\quad\quad\quad$ $\varepsilon = \log(E^e) - \log(E)$,

where E^e is the expected level of the exchange rate one period ahead. Upon substitution of this definition into the asset demand equations (8)-(11), the expected depreciation rate is replaced by the current level and the expected future level of the exchange rate.

Since only two equations defining the demand for domestic assets are independent, we drop the equilibrium condition for money (M). The demand for this asset can instead be computed as a residual from the wealth identity (3), given W^d.

We are, thus, left with three asset markets in which three equilibrating variables can be determined. For exogenous W, Y, $\overline{F}$, $\overline{C}$, $\overline{B}$, r^f, E^e equations (3), (8), and (10)-(13) can be solved for the equilibrium values of r^s, r^l and E. In fact, the theoretical model can be transformed to give two interest-rate equations and an exchange-rate equation, which subsequently can be estimated.

In the disaggregated model below, an alternative approach is pursued under the assumption that the short-term interest rate, r^s, is given exogenously, being under the control of the central bank. The supply of certificates, $\overline{C}$, is then determined endogenously, given the demand for certificates and the short-term interest rate.

2. 2 THE DISAGGREGATED THEORETICAL MODEL

The disaggregated model includes the same categories of financial assets as the aggregated one but the number of domestic sectors is increased to include, besides the government and the central bank: banks, mortgage institutions, insurance and the remaining private agents (here somewhat inappropriately called the corporate-and-household or residual sector).

Money is now defined as bank deposits, giving the yield r^b. Thus, in the disaggregated model, money is a liability of the banking sector rather than of the central bank. The deposit rate is not included in the foreign demand functions, in accordance with the assumption that domestic money is not held abroad.

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Mortgage institutions are - together with the government - suppliers of bonds and certificates and are assumed not to invest in these (nor in foreign) assets. In the disaggregated model we thus have three asset portfolios instead of one. The portfolio of the corporate-and-household sector looks exactly the same as the portfolio in the aggregate model above. The asset portfolios of the banks and of the insurance companies include only domestic bonds and certificates. (The variation of the foreign assets and bank deposits of these two sectors is in reality very limited; in the empirical model they are therefore assumed to be determined on different grounds than portfolio allocation considerations.) The sectoral asset demand functions are assumed to have properties analogous to those of the aggregate model.

Assuming government and mortgage bonds and government and mortgage certificates, respectively, are considered to be perfect substitutes, we have four asset markets, as was the case in the aggregated model. Dropping the (bank deposit) money market (analogously to the aggregated model), we have three market equilibrium equations and four wealth identities:

$$(13) \qquad E \ \overline{F} = f(r^s, r^f + \varepsilon, W^r) \ ,$$

$$(14) \qquad \overline{C} = c^b(r^s, r^l, W^b) + c^i(r^s, r^l, W^i) + c^r(r^s, r^l, r^b, Y, W^{rd}) + c^f(r^s - \varepsilon, r^l - \varepsilon, r^f, E \ W^f),$$

$$(15) \qquad \overline{B} = b^b(r^s, r^l, W^b) + b^i(r^s, r^l, W^i) + b^r(r^s, r^l, r^b, Y, W^{rd}) + b^f(r^s - \varepsilon, r^l - \varepsilon, r^f, E \ W^f),$$

$$(16) \qquad W^r = M + C^r + B^r + E F \ ,$$

$$(17) \qquad W^{rd} = W^r - E F = M + C^r + B^r \ ,$$

$$(18) \qquad W^b = C^b + B^b \ ,$$

$$(19) \qquad W^i = C^i + B^i \ ,$$

where

    r^b - domestic interest rate on bank (money) deposits,

    and the superscripts b, i, r denote the bank, insurance and residual sectors,

    respectively. (Thus, e.g. $b^i(\bullet)$ is the insurance sector's demand for bonds.)

The bank deposit rate, r^b, reflects banks' deposit management policy. As a first approximation, let us assume that banks are passive in this respect and that the deposit rate follows the short-term interest rate:

(20) $$r^b = r^s - b,$$

where b is a positive constant.

Introducing, once again, the assumption described in equation (12) above, we can replace the expected depreciation rate, ε, with the expected and actual exchange rate levels.

Given the supply of each asset, total wealth by sector, output, foreign interest rate and the expected exchange rate, equations (13)-(15) and (17) can be solved for the short-term and long-term interest rates and the exchange rate.

2. 3 SOLVING THE MODEL: ASSET DEMAND SYSTEM VS INTEREST RATE EQUATION

As mentioned above, in the certificate market the (short) interest rate is assumed to be a policy parameter. Thus, in equation (14) the supply is endogenous, conditional on the given short-term rate of interest.

As for the other two asset markets, the most straightforward approach is to estimate the sector demand functions involved and to employ them to solve the system for the equilibrium interest rates. In particular, there are four asset demand functions in the bond market. However, this approach is often considered to be awkward from the technical point of view. The system can give volatile interest rates, or converge very slowly (if at all), due

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to the low precision of interest elasticity estimates and the highly simultaneous nature of the econometric model that it is imbedded in.

An alternative approach, often chosen in this context, is to solve the theoretical system for the interest rates and then to estimate the thus derived interest rate functions. This could be possible for the exchange rate (as long as the assumption of only one sector holding foreign assets were maintained) but would involve a complicated non-linear functional form for the bond rate under any standard specification of the demand equations.

In the case of the latter market, we therefore postulate (and estimate) a simplified interest rate function together with standard asset demand functions for three out of four sectors. The demand for bonds in the remaining sector, which in this case is the bank sector, is computed as a residual. The implicit asset demand function corresponds to the assumption that banks act as market makers in the bond market and always stand ready to buy and sell bonds in the secondary market or to underwrite a new bond issue.

A similar approach is also employed for the foreign exchange market. Even if foreign debt management still plays a limited role in the portfolios of the insurance and mortgage debt sectors, simplified relations for their foreign assets/liabilities are introduced in the empirical model.

3. GENERAL OUTLINE OF THE EMPIRICAL MODEL

3. 1 PORTFOLIO COMPOSITION AND SPECIFICATION OF PORTFOLIO RELATIONS

The theoretical portfolio model above includes only assets. In the empirical model, financial balances include both assets and liabilities. In most cases, stocks of financial liabilities are assumed to be determined on different grounds than portfolio allocation considerations and are therefore not included in the portfolio.

However, foreign assets of the corporate-and-household sector are defined on a net basis (assets minus liabilities), under the assumption that the yield spread between foreign assets and liabilities available to domestic agents is constant and that they carry the same (foreign exchange) risk. This portfolio asset can thus take on a negative value. Other sectors have either foreign assets or foreign liabilities, depending on whether they are (institutional) investors or (institutional) borrowers. Furthermore, simple liability portfolio models are constructed for mortgage institutions and the government.

Equity is not included in the financial portfolios in the model. In principle, this means we are assuming that decisions regarding purchase of shares are not based on the same principles as decisions pertaining to portfolio investment. In practice, the main reasons for excluding equity are problems with modelling the yield on shares.

For each portfolio, net wealth is determined after allowance has been made for the non-portfolio items. Thus, the latter items are assumed to have precedence over portfolio management.

The basic portfolio model is specified in a linear form, under the assumptions that demand for assets is proportional to wealth and that it reacts to interest rate differentials rather than levels. The latter assumption means that the demand for any asset is not affected by a uniform (absolute) change in all interest rates and that interest rate coefficients in each demand equation sum to zero[2].

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[2] This refers to the coefficients of the individual rates rather than those of the interest rate *differentials*.

The yield on foreign assets is represented by the foreign short-term interest rate, r^{fs}, however, in the bond demand equation the long-term foreign interest rate, r^{fl}, is introduced. Foreign wealth is assumed to be represented by the corresponding domestic variable, under the assumption that both exhibit similar trends.

The *aggregated model* thus has the following form:

$$(21) \qquad (E\ \overline{F})/W = f_0 + f_2\ (r^{fs} + \varepsilon - r^s)\ ,$$

$$(22) \qquad \overline{C}/W^d = c_0 + c_2\ (r^l - r^s) + c_3\ (r^b - r^s) + c_4\ (r^{fs} + \varepsilon - r^s) + c_5\ (Y/W^d)\ ,$$

$$(23) \qquad \overline{B}/W^d = b_0 + b_2\ (r^l - r^s) + b_3\ (r^b - r^s) + b_4\ (r^{fl} + \varepsilon - r^s) + b_5\ (Y/W^d)\ ,$$

W and W^d having been defined in equations (1) and (3), respectively. The money market equilibrium equation is excluded, following the discussion of the aggregated theoretical model above.

Chart FF.1 Treasury bill (dashed line) and bank deposit (solid line) interest rates
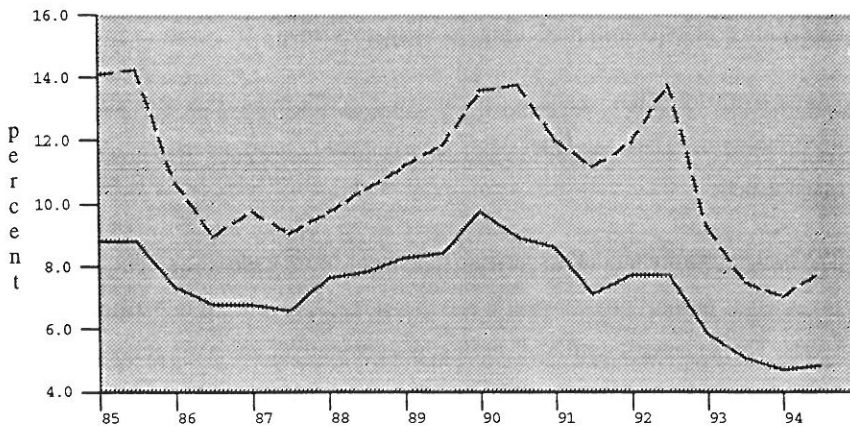
Tests of the explanatory power of the bank deposit rate indicated that its contribution is practically nil. This can be taken as a confirmation of the assumption formulated in equation

(20) above. The assumption is further corroborated by Chart FF.1, showing the high correlation between the short-term and deposit rates (correlation coefficient = 0.88). Consequently, the deposit rate was eliminated from the asset demand functions. The yield on deposit money is assumed to be represented by the short-term rate.

As for the ***disaggregated model***, its asset demand relations are assumed to have the same form as those in the aggregated model. In particular, they are formulated as linear portfolio-share equations which include the relevant interest rate spreads.

Disaggregated asset demand equations are defined for each sector. In line with the discussion in the section on the solution of the theoretical model above, simplified exchange rate and bond interest rate equations are introduced. They are derived from the corresponding aggregated-model equations.

3. 2 SECTORS OF THE MODEL

The model includes seven sectors, defined in terms of the Financial Accounts. They are listed below with their definitions and abbreviated names.

Central Bank (CB)
Central Government (Gov)
Banks   - commercial, savings and co-operative banks,
Insurance sector (Ins)   - social security funds, insurance companies and
                                   pension funds,
Mortgage institutions (Mor)   - mortgage institutions and credit companies,

Corporate-and-household
(or Residual) sector (Res)   - local government, non-financial enterprises, finance
                                   companies, investment companies and funds,
                                   households,
Foreign sector (For).

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3. 3 MODEL ASSETS

The model includes nine asset categories: certificates, bonds, (bank deposit) money, net foreign assets, loans, equity, notes and coin, insurance savings and claims on the National Savings Scheme. Government and mortgage-institution bonds are treated as perfect substitutes; the same applies to certificates. As the model is designed now, there is no need to distinguish between demand for bonds (or certificates) issued by the government and for those issued by mortgage institutions. This distinction is, however, upheld on the supply side.

Certificates of deposit and non-bank holdings of Central Bank certificates are in the data reckoned as certificates, but their supply is not modelled. While they are present in the model for reasons of realism, they hardly affect anything. Banks' holdings of Central Bank certificates are included in "banks' net borrowing from the Central Bank", which - being a net item - thus differs from other loan variables.

3. 4 SECTOR BALANCE SHEETS

The financial balance sheets for the sectors of the model are shown in Table FF.1. In the table, holdings of certificates and bonds are not disaggregated by issuing sector. By the same token, liabilities in the form of certificates and bonds are not disaggregated by holding sector. Detailed balance sheets with distributions by issuing and holding sectors are given in the appendix.

In the model, banks' net foreign currency liabilities include only their portfolio investment (and borrowing). Foreign-currency loans taken on behalf of the corporate-and-household sector are here (in contrast to the Financial Accounts) included in net foreign liabilities of the latter sector. Furthermore, the residual sector's insurance savings refer to individual insurance savings; collective insurance policies as well as social security pension rights are not considered to be anybody's asset. Instead, they are included in the net wealth of the

insurance sector. In the table, sectors are referred to by the abbreviations given in parenthesis after the sector name.

Table FF.1 Balance sheets for the sectors of the financial model.

Central Bank (*CB*)

Assets	Liabilities
Net loans to *Banks*	Notes and coin
Bonds	*CB* certificates
Certificates	Net wealth
Foreign reserves	

Central Government (*Gov*)

Assets	Liabilities
Loans to *Res*	SEK certificates
Foreign loans	SEK bonds
Domestic equity	Foreign currency liabilities
	National Savings Scheme
	Net wealth

Banks

Assets	Liabilities
Bonds	Deposits of *Res*
Certificates	Net foreign currency liabilities
Advances and loans to *Res*	Net borrowing from *CB*
Domestic equity	Certificates of deposit
	Net wealth

Mortgage Institutions (*Mor*)

Assets	Liabilities
Loans to *Res*	SEK certificates
	SEK bonds
	Foreign currency liabilities
	Net wealth

Insurance Sector (*Ins*)

Assets	Liabilities
Bonds	Insurance savings of *Res*
Certificates	Net wealth
Foreign assets	
Loans to *Res*	
Domestic equity	

Corporate-and-Household (or Residual) Sector (*Res*)

Assets	Liabilities
Notes and coin	Loans from *Banks*
Bank deposits	Loans from *Gov*
Certificates	Loans from *Mor*
Bonds	Loans from *Ins*
Insurance savings	Net foreign currency liabilities
National Savings Scheme	Equity debt to *Banks*, *Gov*, *Ins*
	Net equity debt to *For*
	Net wealth

<u>**Foreign Sector** (*For*)</u>

Assets	**Liabilities**
Foreign currency liabilities of *Gov*	Foreign reserves of *CB*
Net foreign currency liabilities of *Banks*	Foreign assets of *Ins*
Foreign currency liabilities of *Mor*	Loans from *Gov*
Net foreign currency liabilities of *Res*	National net foreign debt
SEK bonds	
SEK certificates	
Net equity claim on *Res*	

3. 5 MONETARY POLICY IN THE MODEL

In the model, the Central Bank conducts monetary policy by controling the short term interest rate. This is achieved through open marken operations in the certificate market, i.e. through control of supply of (government and mortgage institution) certificates.

Technically, the short interest rate is exogenous to the model and thus is the monetary policy instrument (the long rate being endogenous). The Central Bank's holdings of certificates are endogenous and computed as a residual from the Bank's financial balance sheet. The banking sector's borrowing from the Central Bank, another variable of importance for monetary policy, is computed as a residual from the banking sector's balance sheet. This set-up gives results that can readily be interpreted in terms of certificate supply control.

The following example will elucidate the functioning of the certificate market in the model. For the sake of clarity, a *ceteris paribus* assumption is here introduced, though it would hardly hold in an actual simulation with the model.

Assume that the Central Bank decides to increase the short rate of interest. The increase in the (exogenous) short rate gives rise to an increase in demand for certificates on the part of the corporate-and-household, insurance, bank and foreign sectors. *Ceteris paribus* (and in

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particular with no change in the long rate), the rise in demand for certificates results in a corresponding decrease in bank deposits and demand for bonds.

Bank deposits affect directly the financial balance sheet of the banking sector. Smaller demand for bonds results in a corresponding increase in the bond holdings of banks, since the latter are assumed to be the market maker in the bond market. Both lower bank deposits and higher bank sector bond holdings generate a corresponding increase in banks' borrowing from the Central Bank. This increase gives finally rise to an equally large decrease in the Central Bank's certificate holdings.

The sale of certificates by the Central Bank is interpreted as the open market operation that has caused the interest rate increase. The rise in banks' borrowing from the Central Bank is here seen as reflecting the tighter money market, corresponding to a higher interest rate level. A further discussion of the role of open market operations in the model is given in the sections on the Central Bank's demand for certificates and banks' borrowing from the Central Bank.

3. 6 THE DATA

The data base of the model consists of a double-entry system, where a sector's asset is another sector's liability. The only exceptions are the net financial wealth values, each of them appearing only once, but these items sum to zero and thus cancel out. In each period, the system thus constitutes a 63×63 creditor/debtor matrix for the seven sectors and nine assets of the model. Since asset stocks are expressed in nominal values (and neglecting valuation changes for equity and foreign assets), the first difference of this matrix gives us the flow-of-funds matrix.

The model data base was derived from the annual Financial Accounts (*Finansräkenskaper-na*). The annual figures for 1986-94 were subsequently distributed into half-years and (in some cases) quarters using the corresponding higher frequency series from other sources, mainly the Central Bank. Cubic spline interpolation was employed when no higher

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frequency pattern series was available. Quarterly Financial Accounts were used sparsely, since their coverage in terms of data sources in many instances is much more limited than for the annual accounts.

In an attempt to reduce the number of items in the sector balance sheets in the model, we have excluded smaller and less variable items from the original Financial Accounts' balances. As a result, the model's sector balance sheets include an "other liabilities" term, introduced in order to make the sum of assets equal to the sum of liabilities. In simulations, the "other liabilities" terms are assumed to be constant at their respective values for the period immediately preceding the beginning of the simulation period.

Historical time series for "other liabilities" are shown in Charts FF.2.-FF.3. The trendwise development in some of the series was deemed to depend on structural adjustment processes which already are accomplished.

A transformed and aggregated version of the creditor/debtor matrix for the end of 1994 is given in Table FF.2. The table employs the same sector name abbreviations as above. "Other assets" in the last row of the table correspond to the statistical discrepancy "other liabilities"

Chart FF.2 "Other liabilities" in the sector balances in the model
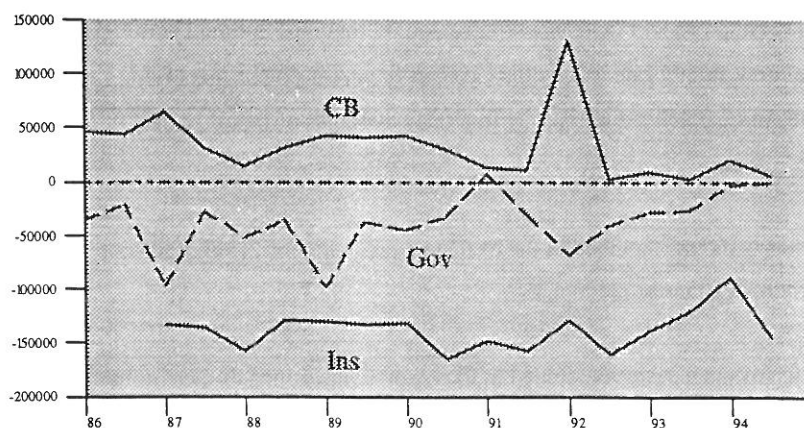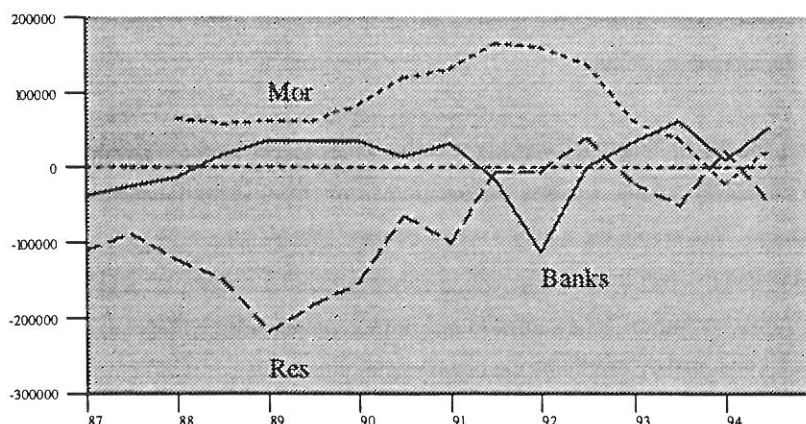

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Chart FF.3 "Other liabilities" in the sector balances in the model

discussed above. The liabilities were transformed into assets by changing their sign. By the same token, net wealth - which usually is included on the liabilities side - in the table is shown with opposite sign. It should be noted that in the table each row and each column sums to zero.

All stocks are expressed in millions of kronor.

The bond rate (r^l) is represented by the effective rate on five-year government bonds. The money-market (short-term) rate (r^s) is the (discount) rate on three-month treasury notes. The foreign short rate (r^{fs}) is represented by the three-month Euro-Deutsch Mark rate and the foreign long rate (r^{fl}) by the German five-year government bond rate. All the interest rates in quarterly equations are quarterly averages of monthly data in percentage points *p.a.*

Other variables included in the exchange rate equation are described in the section on the monthly exchange rate equation.

A list of the variables included in the reported equations of the empirical model is given at the end of the paper.

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Table FF.2 Financial asset holdings in 1994:2 (negative numbers denote liabilities).

	CB	Gov	Banks	Mor	Ins	Res	For
Certif.	2118	-237631	48789	-75629	47959	163394	51000
Bonds	34775	-574957	190858	-827948	733520	308026	135726
Deposits	-77063	15084	-603555	0	0	665534	0
NFA	173034	-344771	-1829	-73056	25519	-241170	462273
Loans	0	172470	434353	1059263	69752	-1735838	0
Equity	0	18739	4126	0	151283	-174148	0
Notes	-68803	0	0	0	0	68803	0
Ins. Sav.	0	0	0	0	-223732	223732	0
NSS	0	-53932	0	0	0	53932	0
O.Assets	-5836	325	-54456	-24750	143807	46035	-105125
Net Wealth	-58225	1004673	-18286	-57880	-948108	621700	-543874

Notes: Assets:
      NFA - net foreign assets,   Ins. Sav. - individual insurance savings,
      NSS - National Saving Scheme.   O.Assets - other assets,
    Net Wealth is shown with opposite sign.
    Sectors:
      CB - Central Bank,   Gov - central government,   Mor - mortgage institutions
      Ins - private and social insurance,   Res - corporate-and-household sector,
      For - foreign sector

3. 7 FINANCIAL BALANCE SHEET IDENTITIES

In the form presented in the Appendix below, the assets and liabilities of the model form a double entry system. This means that each asset is a liability of some other sector and that the sum of the net wealth of all sectors is zero. Furthermore, in each sector's balance sheet the sum of all assets is equal to the sum of all liabilities.

Under the assumption that certificates and bonds issued by different sectors are perfect substitutes, the model was subsequently transformed into the form shown in the section on sector balance sheets above. In this form, certificate and bond holdings, respectively, were aggregated without distinction of issuing sector. Analogously, certificate and bond liabilities, respectively, were aggregated without distinction of holding sector.

In order to preserve the properties of the double entry system in any of the above model forms, balance sheet identities are introduced into the model. Equality of the asset and liability sides in a sector's balance sheet is ensured by determining one balance sheet item as a residual. This means that in model simulations e.g. one asset is computed as the sum of all liabilities minus the sum of all remaining assets in the sector.

As mentioned in the section on the portfolio choice model, one of the double-entry system identities is superfluous, being implied by the remaining ones. Thus, in our seven-sector model we have introduced seven out of eight identities. Six balance sheet identities are imposed through residual computation of one item, the foreign sector being left out. The variables computed as a residual are:

> certificate holdings in the *Central Bank*'s balance sheet,
> net borrowing from the Central Bank in the *banking sector*'s balance sheet,
> bank deposits in the *corporate-and-household sector*'s balance sheet,
> bond holdings in the *insurance sector*'s balance sheet,
> supply of certificates in the *mortgage institutions*' balance sheet and
> supply of bonds in the *central government*'s balance sheet.

Furthermore, the net wealth in the corporate-and-household sector is computed as the sum

of the remaining net wealth variables with reversed sign, making sure that the net wealth variables sum to zero.

Analogously to net wealth, other liabilities - the residuals in the data-bank balance sheets mentioned in the section on data above - should also sum to zero. This should in principle hold due to the way other liabilities are determined in the model (assumed to be constant at their respective values for the period preceding the beginning of the simulation period). However, in order to make possible corrections to this item, the other liability identity was also introduced into the model. First, other liabilities in the foreign sector (all the items of its balance sheet being determined elsewhere) are computed as a residual from the sector's balance sheet. Subsequently, other liabilities in the corporate-and-household sector are computed as the sum of all the other "other liabilities" with reversed sign.

The method of residual asset was also employed to ensure equality between demand and supply in bond and certificate markets. Banks' holdings of bonds are computed as the difference between supply and demand (other than banks') for bonds. The equality between demand and supply for certificates is then automatically maintained by property of the double entry system.

3. 8 TEMPORAL AGGREGATION OF EQUATIONS ESTIMATED ON QUARTERLY AND MONTHLY DATA

Our basic data bank covers the period 1986-94. This leaves us with at most 18 semi-annual observations. However, a number of series are available on a quarterly basis, since interpolation of the annual Financial Accounts data was in many cases performed using quarterly pattern variables. Some of the behavioural equations were therefore estimated on higher frequency data, in order to improve the precision of estimates. They were subsequently expressed in semi-annual form in order to conform with the remaining equations of KOSMOS.

The semi-annual form of the monthly exchange rate equation was derived in Markowski [1995a] from a summation of six consecutive lags of the monthly equation. The semi-annual form of the quarterly interest rate equation was derived in an analogous way in Markowski [1995b].

Ruist [1996] derives the general form of three operators which transform monthly and quarterly equations into the semi-annual ones. The problem is to express the variables and the lag structure of a higher frequency equation in terms of lower frequency data definitions and period length. The equation is assumed to have been estimated on higher frequency data and is not to be reestimated on lower frequency time series.

The effect of temporal aggregation on the coefficient of a variable depends on the variable's definition and its form in the equation. Ruist considers three types of variables: flow variables (e.g. GDP), average values for a period (e.g. interest rate or price) and end-of-period stocks (e.g. money supply). The dependent variable is assumed to belong to one of the first two types. For each of the three types of variables he considers the coefficient of the level, lagged level and first difference of the variable in question. Lags shorter than a half-year are approximated through linear interpolation or through an error-variance minimising procedure. It is pointed out that extremely poor semi-annual approximations are obtained for end-of-period stocks that do not show a regular development.

Below, in transforming the estimated quarterly equations into semi-annual form we have made use of the formulae provided by Ruist [1996]. The three operators derived in his paper were designed to provide exact temporal aggregations of the left-hand-side variables of the form: y, Δy and $y - \varphi\, y_{-1}$, respectively. In fact, the second operator is a special case of the third one, with $\varphi = 1$. The third operator eliminates the need to approximate the lagged dependent variable, since the latter can be moved to the left-hand side of the equation and then be exactly transformed into the semi-annual form. The third operator implies different approximations of the right-hand side variables than the first one.

In general, it is difficult to assess the price paid for the exact transformation of y_{-1}, in terms of the approximation error in the remaining right-hand-side variables. Ruist shows, however, that for the monthly model $y - y_{-1} = x$, $x = \phi x_{-1} + \eta$ (η being a random variable and ϕ a constant) the approximation error (defined as the difference between the semi-annual aggregates of the left-hand and right-hand sides) is much larger when the first operator is employed instead of the second one. In fact, the error variance depends on ϕ and is approximately three times as large for $\phi = 0.1$ and six times as large for $\phi = 0.9$.

As already mentioned, the formulae provided by Ruist are not applicable to equations with end-of-period stock variables on the left-hand side. In the case of our asset demand equations, the dependent variables are defined as first differences of such stocks. Since changes in stocks are (net) flows, the first operator was directly applicable.

While performing temporal aggregation of the equations, we encountered variables of another type than those considered by Ruist. In particular, problems occurred when ratios of variables of different types were included. Below, we show the approximation rules employed in those instances in aggregation from *quarterly to half-yearly* equations. Points 1-4 are based on the assumption that neither stock nor flow variables change much between two consecutive quarters. Ultimo stock variables are denoted by *stock* or s and flows by *flow* or f with lower case letters denoting quarterly data and upper case letters denoting semi-annual aggregates.

1. *flow/stock* was treated as a flow variable and approximated by FLOW/STOCK
    (cf. the example in Ruist [1996]).

2. *stock/flow* was approximated with 4*STOCK/FLOW,
    since for the first operator we need $(s_1/f_1)+(s_2/f_2)$ and we have $S = s_2$ and $F = f_1 + f_2$,
    assuming $s_1 \approx s_2 (= S)$ and $f_1 \approx f_2$ and thus
    $$f_1 * f_2 = (F/2)**2 = [(f_1 + f_2)/2]**2 = [(f_1 + f_2)**2]/4$$
    we get $(S/f_1) + (S/f_2) = S*(f_1+f_2)/(f_1*f_2) = 4*S/(f_1 + f_2) = 4*S/F$.

3. *log(stock/flow)* was approximated by 2*log(2*STOCK/FLOW),
    since we need $\log(s_1/f_1)+\log(s_2/f_2)$ and we have $S = s_2$ and $F = f_1 + f_2$,

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under the same assumptions as above

we get $\log(S/f_1) + \log(S/f_2) = \log[(2*S)/(f_1 + f_2)]**2 = 2*\log[(2*S)/F]$.

4. *log(flow/stock)* was approximated by $2*\log[FLOW/(2*STOCK)]$,
   (see above).

5. *Intercept and three seasonal dummies*, $k + k_2*d_2 + k3*d3 + k4*d4$
   (where d_i - seasonal dummy variables, k and k_i - coefficients)
   were approximated by the semi-annual intercept $2*k + k_2$
   and a seasonal dummy for the second half-year $(k_3 + k_4 - k_2)*D_2$,
   since we then get the seasonal intercepts $2*k + k_2$ for the first half-year
   and $2*k + k_3 + k_4$ for the second half-year.

4. THE EXCHANGE RATE

The exchange rate equation was derived and reported upon in Markowski [1995a]. This work, which actually preceded the construction of the complete model, was based on seventeen monthly observations. Subsequent attempts to improve on the estimation results using 24 monthly observations proved unsuccessful. Since the extreme data shortage (due to the fact that the Swedish krona has been floating only since November 1992) makes any statistical inference hardly possible, we have decided to retain the original equation, which we consider to be a qualified guess rather than anything else.

Below, we summarise the results concerning the exchange rate equation. The reader is referred to Markowski [1995a] for details.

4. 1 DERIVATION OF THE EXCHANGE RATE EQUATION

The exchange rate equation is derived from the foreign exchange equilibrium equation (21), with $f_0 = 0$ (this assumption being in this special case inconsequential). The equation, which defines stock equilibrium, is written as

$$(24) \qquad E \, \overline{F} = z \, W , \qquad\qquad z = f_2 \, (r^{fs} - r^s) + f_2 \, \varepsilon$$

and then differenced to conform with the definition of flow supply, to be employed below.

In the differenced equation

$$(25) \qquad D(\, \overline{F}) \, E = D(z) \, W + z_{-1} \, D(W) - F_{-1} \, D(E),$$

the last two terms (representing the effect of net wealth variation and valuation gains, respectively) are neglected as being of secondary importance for the explanation of foreign currency flows. Substituting for z, we thus obtain

(26) $D(\overline{F}) E = [\, f_2\, D(r^{fs} - r^s) + f_2\, D(\varepsilon)\,]\, W$.

The flow supply of net foreign assets to the private sector is by definition equal to the sector's capital balance with reversed sign, since the capital balance reflects changes in net foreign *liabilities* rather than assets. The capital balance is here derived from the balance of payments identity, which states that the sum of the current account balance and the (private and public) capital account balance equals the change in the official foreign reserves.

Since equation (24) defines the market-clearing portfolio investment, i.e. that part of foreign capital flows which actually depend on exchange rate expectations, the supply variable is further redefined to exclude non-market-clearing flows (e.g. direct investment). From the balance of payments identity we then obtain:

(27) $(-CapBmc)\, E = (CurrB) + (CapBGov)\, E + (CapBnmc)\, E - (DFO)\, E$,

where

      CapBmc   - private sector capital account balance excluding non-market-clearing
                            transactions,
      CurrB   - current account balance,
      CapBGov - government capital balance,
      CapBnmc - non-market-clearing private sector capital account transactions (i.e.
                            transactions that do not depend on exchange rate expectations),
      DFO   - change in the Central Bank's foreign reserves,
all capital account variables being expressed in foreign currency.

Substituting $(-CapBmc)\, E = D(\overline{F})\, E$ into (26) and using (12) we obtain

(28) $D(\log(E)) = D(\log(E^{\varepsilon})) - D(r^s - r^{fs}) + (1/f_2)\,[(CapBmc)\, E]/W$.

Thus, according to our equation, the relative change in the exchange rate is determined by the expected rate of change of the exchange rate, the change in the interest rate differential and the market-clearing net capital flow in relation to the financial wealth. Note the unit coefficients in front of the first two variables.

As for the expectations formation, the rational expectations approach did not prove successful for the extremely short and turbulent period at our disposal. Following H.M. Treasury [1990], it is instead assumed that the exchange rate is expected to obey a simple error-correction mechanism of the form:

(29) $D(\log(E^e)) = \tau \, D(\log(E^s)) - \delta \, [\log(E)_{-1} - \log(E^s)_{-1}]$,

where
$\quad E^s$ - the long-run sustainable exchange rate,
$\quad \tau, \delta$ - coefficients, $\tau, \delta > 0$.

Equation (29) can be obtained by applying the error-correction mechanism to the actual rate and then combining it with static expectations, $\hat{e} = e$ (cf. Wallis et al. [1985]).

The long-run sustainable exchange rate, E^s, can in principle be determined from either (or a mixture) of the two distinct assumptions regarding the arbitrage possibility in the goods market. If domestic and foreign goods are assumed to be perfect substitutes, purchasing power parity should prevail and the real exchange rate should in the long run be constant. If, on the other hand, domestic and foreign goods are not substitutable (the so called Armington assumption), the long-run sustainable exchange rate is the one that brings the current account balance to zero (the balance being in this case affected by the price elasticities of the domestic and foreign demand).

In both cases, non-optimal exchange rates can probably be sustained for very long periods of time through appropriate adjustment of the interest rate differential, making the country a long-run importer or exporter of capital.

Since most of the products in the international trade indeed are very close substitutes, the long-run real exchange rate is here assumed to be constant, as long as - as explained above - the interest rate differential remains constant. Consequently, the long-run sustainable nominal rate is determined by the (long-run) relation between domestic and foreign prices and the interest rate differential:

(30) $$\log(E^s) = \log(p^d/p^f) - \beta (r^s - r^{fs}) + \alpha ,$$

where

  p^d/p^f - long-run relation between domestic and foreign prices,
  β, α - coefficients, $\beta > 0$.

Upon substitution of equation (30) into (29) and of the latter into equation (28) we finally obtain our exchange rate equation:

(31) $$D(\log(E)) = \tau D(\log(p^d/p^f)) - (\tau \beta + 1) D(r^s - r^{fs}) - \delta [\log(E)_{-1} - \log(p^d/p^f)_{-1}]$$
$$- \delta \beta (r^s - r^{fs})_{-1} + (1/f_2) [(CapBmc) E]/W + \delta \alpha .$$

As can be seen, equation (31) is overidentified, since five structural parameters (τ, β, δ, f_2 and α) are determined by six estimated coefficients.

4. 2 MONTHLY EXCHANGE-RATE EQUATION

The exchange rate is here defined as the effective exchange rate index for fourteen OECD countries[3] . The index was computed as a weighted, geometric mean, with weights based on the sum of exports, imports and capital flows by currency in 1993. The interest rate differential is expressed as a monthly rather than an annual rate and as a fraction rather than a percentage[4] .

The market-clearing capital flow is defined as the private sector capital account balance (including the Central Bank lending to banks in foreign currency) minus the (net) direct investment and the (net) portfolio equity investment. (The two latter items represent the structural, i.e. non-market clearing, flows.) This definition of the market-clearing net capital

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[3] Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, The Netherlands, Norway, Switzerland, UK, USA.

[4] Consequently the interest rate differential was divided by 1200. i.e. multiplied by 0.00083.

flow exactly corresponds to equation (27) and includes both trade credit and the errors and omissions item in the balance of payments.

The scale variable, financial wealth (W), was in the original, earlier work represented by SEK M3 and this approximation has been retained here. SEK M3 is defined as the sum of currency in circulation, bank deposits in SEK and the National Savings Scheme (*Allemanssparande*), the latter for the depositor being comparable with a time deposit. The definition of SEK M3 excludes foreign currency deposits and certificates of deposit. The variable was lagged in the estimated equation, in accordance with the practice of discrete differencing, in order to limit the degree of simultaneity of the model.

The relation between the domestic and foreign prices is expressed in terms of tradables rather than overall consumer prices, since the exchange rate is here postulated to be primarily affected by foreign-trade arbitrage. The domestic price is defined as the export price index for manufactures, 1991=100. The foreign price is a weighted import-price index (1991=100) for the 14 OECD countries mentioned above, computed using the Swedish export shares as weights. The ratio of the two price indices was employed as an approximation of the long-run price relation.

OLS estimation of equation (31) gave the following results (the standard test statistics are here reported only as a general information to the reader):

(32) $d\log(E)$

$$= \underset{(0.73489)}{0.49863 * d\log(RP)} - \underset{(\ \ NC)}{18.7000 * D(r^s - r^{fs})} - \underset{(1.24051)}{0.36243 * \log(E_{-1}/RP_{-1})}$$

$$\underset{(1.22788)}{- 12.8915 * (r^s - r^{fs})_{-1}} + \underset{(0.83879)}{0.58920 * CapF/M3SEK_{-1}} + \underset{(1.36584)}{0.07587}$$

Sum Sq	0.0032	Std Err	0.0163	LHS Mean	-0.0003
R Sq	0.2197	R Bar Sq	-0.0405	F 4, 12	0.8444
D.W.(1)	1.5393	D.W.(12)	0.4214	Est.per. 1993:8-94:12	

where

E   - effective exchange rate index expressed in SEK per foreign currency unit,

RP   - relation between Swedish prices and foreign prices (as explained in the text),

E/RP - real exchange rate,

CapF - change in net foreign liabilities of the private sector, due to market-clearing
            transactions, SEK mill. (as explained in the text),

M3SEK   - SEK M3 (excluding certificates of deposit and including the National
            Saving Scheme).

The coefficient of the second variable in equation (32) was constrained to the value shown, in accordance with the (overidentified) form of equation (31) above. The coefficients and the fit of the estimated equation were relatively little affected by the constraint. The equation correctly indicates most of the turning points, but the amplitude of its variation is much more limited than that of the dependent variable. Consequently, it appears that the equation implies a reasonable reaction pattern for the exchange rate, but that it is likely to underestimate its variation.

Upon comparison of equations (32) and (31), we can derive the estimated values of the structural coefficients in equations (28), (29) and (30). We thus obtain:

(28') $D(\log(E)) = D(\log(E^e)) - D(r^s - r^{fs}) + (1/1.70) [(CapBmc) E]/W$.

(29') $D(\log(E^e)) = 0.499\ D(\log(E^s)) - 0.362\ [\log(E)_{-1} - \log(E^s)_{-1}]$,

(30') $\log(E^s) = \log(p^d/p^f) - 35.57\ (r^s - r^{fs}) + 0.209$.

When the interest rate differential in equation (30') is expressed in percent per annum, the coefficient β becomes 0.03. This means that - according to our results - an increase of the interest rate differential by one percentage point *p.a.* in the long run results in an appreciation of the currency by approximately three percentage points. The corresponding short run effect is approximately half as large.

The coefficient f_2 (equal to 1.70), describing the portfolio reaction to changes in the relative yield on foreign assets, implies a relatively high degree of capital mobility. The corresponding number in the Treasury model is 0.9 (cf. Wallis et al. [1985]). The coefficient β amounts there to 0.013 on a per annum basis, it should be - however - borne in mind that equation (30) is in the Treasury model specified in a different way. The coefficients τ and δ (above equal to 0.499 and 0.362, respectively) are, on the other hand, rather close to those of the Treasury model (0.5 and 0.28, respectively).

As already mentioned, the above results are only tentative. The specification of the model itself was restricted by lack of data. In principle, the long-run relation between domestic and foreign prices (p^d/p^f in equation (30)) should be modelled more thoroughly. Furthermore, the sustainable exchange rate level (E^s) could be linked to the net foreign debt. However, our attempts to introduce additional variables led to such a high degree of arbitrariness in the results, that we decided to postpone these efforts until considerably longer time series are available.

5. INTEREST RATE DETERMINATION

5. 1 QUARTERLY LONG-TERM-BOND INTEREST RATE EQUATION

Different approaches to the determination of the long-term (bond) interest rate were tested in Markowski [1995b]. The portfolio balance approach, which was represented by the preferred habitat equation, was there rejected, since the supply of bonds did not seem to have any explanatory power in the equation. The preferred approach assumed that the equilibrium (real) interest rate was determined in the joint market for long and short term loanable funds.

One could suspect, that the rejection of the preferred habitat equation was at least partly caused by data problems. Today, we have a longer and much more reliable bond supply series, due to continued work on the data base, and in particular to the use of the Central Bank statistics for quarterly distribution of the annual Financial Accounts data. These new data were employed in the estimation of the bond interest rate equation derived from the aggregated portfolio model above.

Due to data shortage, the function was estimated on quarterly data (cf. Markowski [1995b] for a discussion of data problems) and then transformed into semi-annual form required by KOSMOS.

The estimated equation was obtained from the bond market equilibrium equation (23) by solving it for $(r^l - r^s)$. The spread between the foreign and domestic interest rates (adjusted for the expected depreciation of domestic currency), which represents the variation in foreign demand for krona-denominated bonds, was allowed to affect the equation only beginning in 1990:1, when foreign investors *de facto* entered the Swedish market.

We have decided to exclude data prior to 1986 from our sample, due to the process of gradual deregulation and transformation of the Swedish financial sector that took place in the first half of the 1980's (cf. the Introduction).

Tests for the order of integration, as well as cointegration tests, are hardly reliable in very short samples. In our case, the sample covers less than one decade. Still, we can note that both the regressand and the regressors in the equation appear, according to the Dickey-Pantula test (cf. Dickey and Pantula [1987]), to be integrated of order one.

Unconstrained OLS estimation of the long-term and short-term relations in one step, using quarterly data for 1986:2-94:4, gave the following results:

(33) $D(r^l - r^s)$

= $0.05846 * D[100 *(\overline{B} - B^{cb})/W^d] + 0.17861 * df90 * D(r^{fl} + \varepsilon - r^s)$
    (0.70800)   (5.35819)

  - $0.24954 * (r^l - r^s)_{-1} + 0.18434 * [100 *(\overline{B} - B^{cb})/W^d]_{-1} - 10.3567$
    (2.70893)   (3.71519)   (3.68569)

Sum Sq	11.7446	Std Err	0.6257	LHS Mean	0.0595
R Sq	0.6248	R Bar Sq	0.5747	F 4, 30	12.4869
D.W.(1)	1.3964	D.W.(4)	2.2945	Est. per. 1986:2-94:4	
Norm Chi^2(2) 0.33		ARCH Chi^2(4) 6.27		RESET F(2,28) 0.29	

where
   $\overline{B}$ - supply of SEK bonds, i.e. sum of outstanding government and mortgage
              institution bonds,
 B^{cb} - Central Bank holdings of (government) bonds,
   W^d - domestic portfolio investments (i.e. holdings of bonds, certificates and bank
              deposits) of the banking, insurance and corporate-and-household sectors,
   df90 - dummy variable equal to zero up to and including 1989 and 1 thereafter and
 $D(X) = X - X_{-1}$.

Chart FF.4 Actual (solid line) and fitted (dashed line) values for the unrestricted bond rate equation
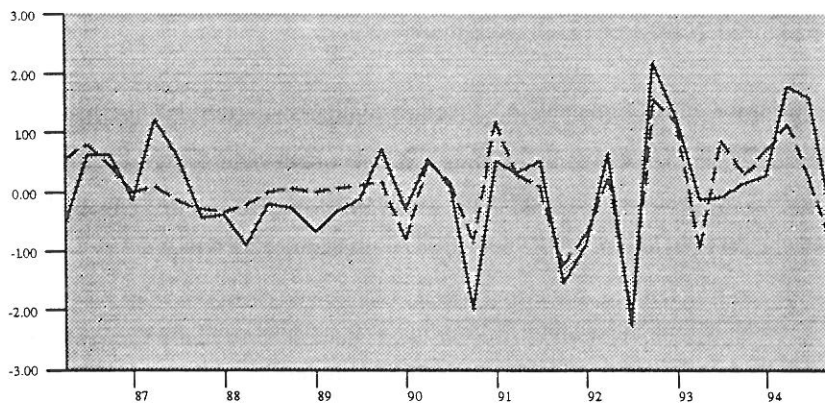
The income term was excluded as having little explanatory power (probably due to the small number of observations, it actually had a positive sign). Inclusion of the bond supply term in logarithmic form hardly changed anything in the results.

Chart FF.5 Actual (solid line) and fitted (dashed) values for the unrestricted bond rate equation estimated for 1986:2-91:4. Outside-sample forecasts shown for 1992-94
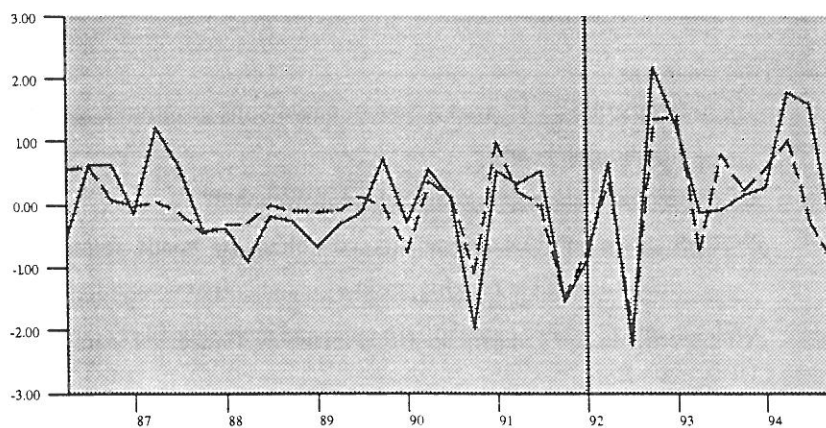
The expected exchange rate depreciation (in percent), ε, was computed using equation (29') obtained from the estimation of the exchange rate equation (cf. the section on the monthly exchange rate equation). The monthly expectations equation was adapted to quarterly data using the third operator in Ruist [1996] (cf. the section on temporal aggregation above). Thus, the quarterly equation has the form:

$$\varepsilon = 100 * [0.658 * D(\log E^s) - 0.740 *(\log E_{-1} - \log E^s_{-1})],$$

where

E^s - the long-run sustainable exchange rate and

multiplication by 100 is employed to express ε in percent.

The sustainable exchange rate, E^s, was computed using equation (30') obtained from the estimation of the exchange rate equation (cf. the section on the monthly exchange rate equation). In this case, adaptation to quarterly data did not result in any changes in the original equation.

The fit of the equation is illustrated in Chart FF.4. Outside-sample forecasts for 1992-94 are shown in Chart FF.5. (Note that the charts show *changes* in the interest rate spread.)

Equation (33) implies the following long-term relation:

(34) $r^l = r^s + 0.7387 * [100 *(\overline{B} - B^{cb})/W^d] - 41.7991$.

The fact that the spread between the foreign and domestic interest rates does not enter the long-run relation (its coefficient being very close to zero) can be due to the limited period during which this variable is present in the sample.

The coefficient of the supply term indicates that the spread between the long and short interest rates has to be increased by approximately 0.7 percentage points, if the share of

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bonds in the investors' portfolio is to increase by one percentage point. This is considerably more than the corresponding result from separate estimation of the long-run relation only, where the required increase in the interest rate spread is only 0.25 percentage points. We can note that neither of the long-run relations passed the Dickey-Fuller cointegration test.

In absolute terms, and at 1994 levels, the above long-run relation means that an increase of the outstanding bond stock by SEK 10 billion (i.e. by approximately 0.7%) *ceteris paribus* would require a 0.3 percentage points increase in the bond rate.

It could be reasonably expected that demand for bonds (as defined in equation (23)) is affected by the *expected* interest rate development. However, when a moving average of changes in inflation was introduced (representing a backward-looking expectations mechanism), the - already low - coefficient of the supply term was strongly reduced. No other expectations indicator, such as the inflation rate, government debt or PSBR, added to the explanatory power of the equation.

Generally, and possibly due to the limited number of observations, the equation is not very robust with respect to its specification. In particular, the coefficient of the lagged supply term is affected by the inclusion of additional variables.

Our results are not strong enough to give definitive support to the hypothesis of a segmented market as opposed to the loanable funds model. As can be seen in Charts FF.6 and FF.7, the bond rate is more correlated with the treasury bill rate (R = 0.77) than with the (relative) supply of bonds, where the correlation actually is negative (R = -0.52). On the other hand, in Chart FF.8 the interest rate *spread* does show a positive correlation with bond supply (R = 0.41). This could mean that the long and short rates are primarily determined by the same factors, but the spread between them is (to a smaller extent) affected by the relative supply of bonds.

The fact that the interest spread equation is formulated in the error correction form implies that the long-term equilibrium interest spread is obtained gradually, through a sequence of

Chart FF.6 Bond (solid line) and treasury bill (dashed line) interest rates
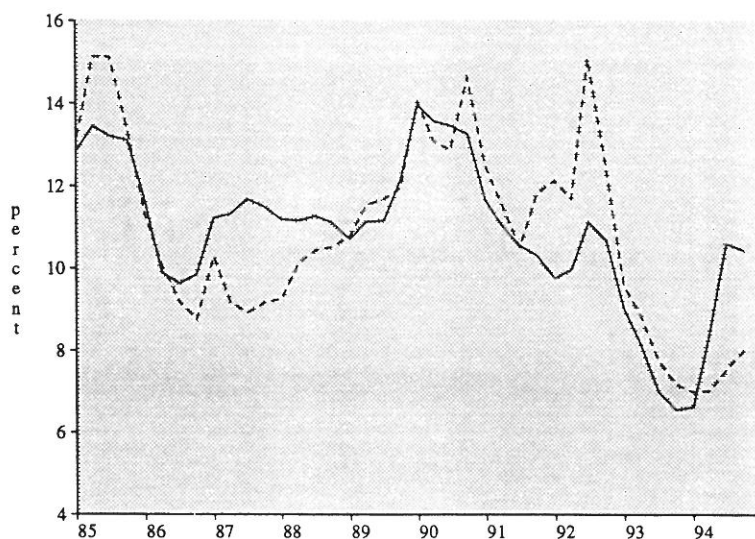
short-term equilibria. This is in contrast with the text-book idea of instantaneously adjusting interest rates and efficient financial markets. However, while we can easily impose on the model an interest rate which immediately adjusts to changes in the estimated asset demand equations, no such relation gets any support from the data. This comes out starkly in equation (33), where the impact of supply changes is almost nil and the adjustment coefficient is only 0.25. Attempts to include lead changes in the bond stock, to allow for possible rational expectations, met no success.

At the same time, on theoretical grounds we would expect the interest rate spread to exhibit a stronger reaction to the short-term variation in bond supply. In an attempt to impose this requirement on the equation without giving up the hope for some degree of data coherence, we have employed mixed estimation (cf. Theil and Goldberger [1961] or Kmenta [1971]). This method, which combines the classical and Bayesian approaches to estimation, makes it possible to define in advance a distribution for a parameter and to let this prior affect the results of classical regression. The parameter distribution is defined by its mean and standard deviation.

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Chart FF.7 Bond interest rate (solid line) and the share of bonds in the portfolio (dashed line), percent
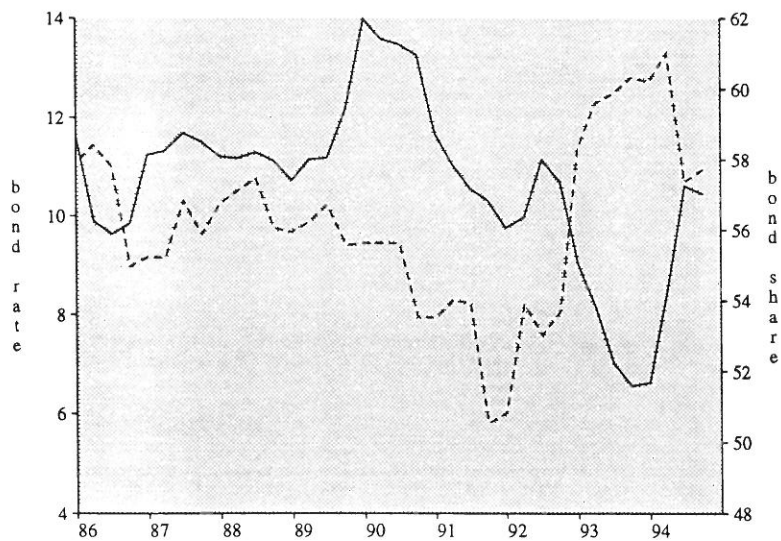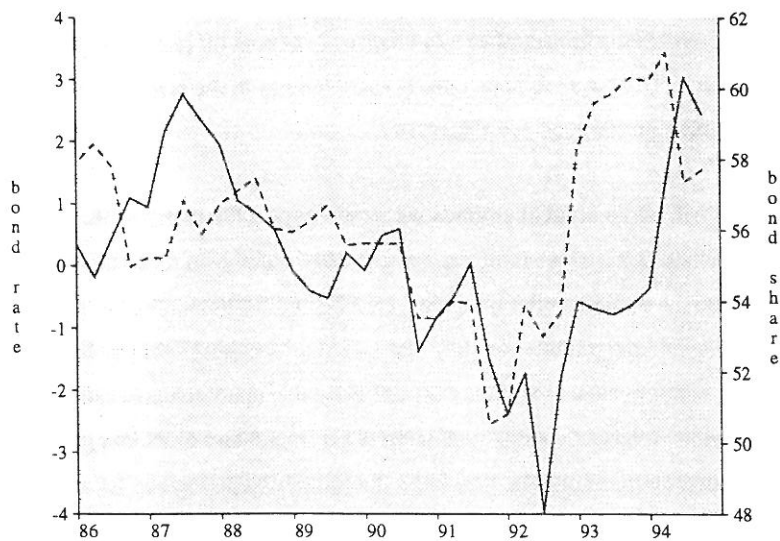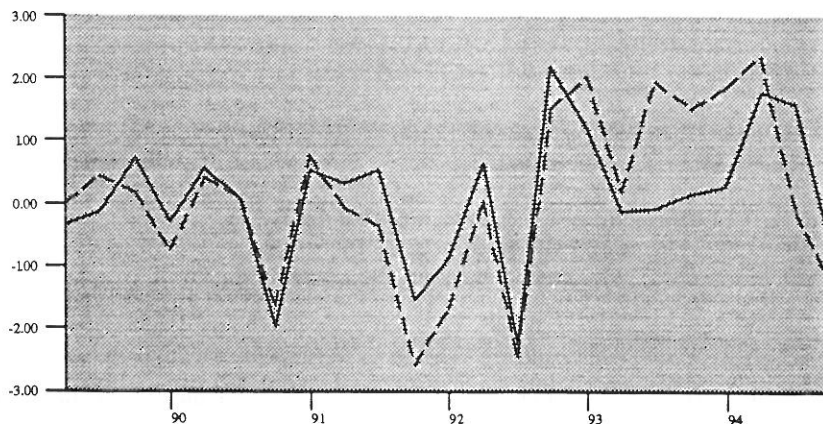

Chart FF.8 Long-short interest rate spread (solid line) and the share of bonds in the portfolio (dashed line), percent

Chart FF.9 Actual (solid line) and fitted (dashed line) values for the restricted bond rate
      equation

After a number of preliminary regressions, we reestimated equation (33) with three priors.
The mean values for the distributions of the coefficients of the change in (relative) supply of
bonds, lagged interest spread and lagged bond supply were set to 0.6, -0.5 and 0.8,
respectively. The standard deviations for all the three distributions were set to 0.01.
Furthermore, a shorter estimation period was employed. The following results were
obtained:

Chart FF.10 Actual (solid line) and fitted (dashed) values for the restricted bond rate
equation estimated for 1989:2-92:4. Outside-sample forecasts shown for 1993-94.
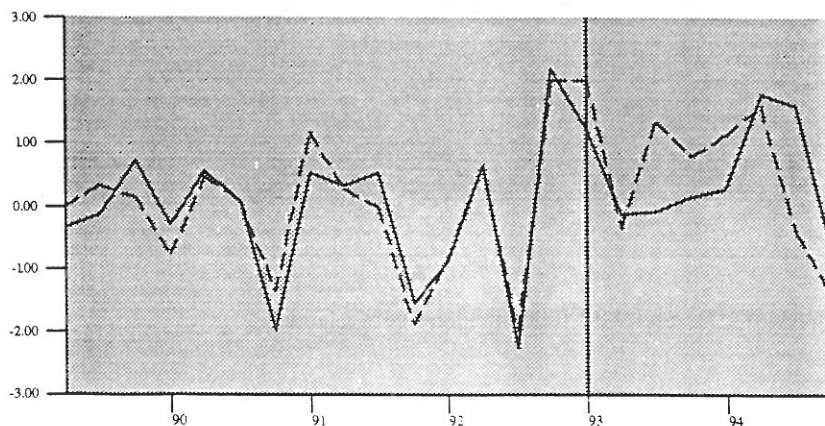
(35) $D(r^l - r^s)$

$= 0.37237 * D[100 *(\overline{B} - B^{cb})/W^d] + 0.15306 * df90 * D(r^{fl} + \varepsilon - r^s)$
    (3.96755)   (2.91975)

$- 0.44257 * (r^l - r^s)_{-1} + 0.43181 * [100 *(\overline{B} - B^{cb})/W^d]_{-1}$ $- 24.2174$
    (4.24776)   (6.34713)   (6.34619)

Sum Sq	17.9140	Std Err	0.9976 LHS Mean 0.1091
R Sq	0.3238	R Bar Sq	0.1735 F 4, 18 2.1546
D.W.(1)	0.8930	D.W.(4)	2.1364 Est. per. 1989:2-94:4

The fit of the equation is illustrated in Chart FF.9. Outside-sample forecasts for 1993-94 are shown in Chart FF.10. As can be seen upon comparison with the corresponding charts for equation (33), the fit of equation (35) is apparently worse in 1993. The bond-rate forecasts derived from the fitted values of the two equations are compared in Chart FF.11.

Chart FF.11 Bond rate (solid line) and its equation forecasts derived from the unrestricted (dotted) and restricted (dashed) equations
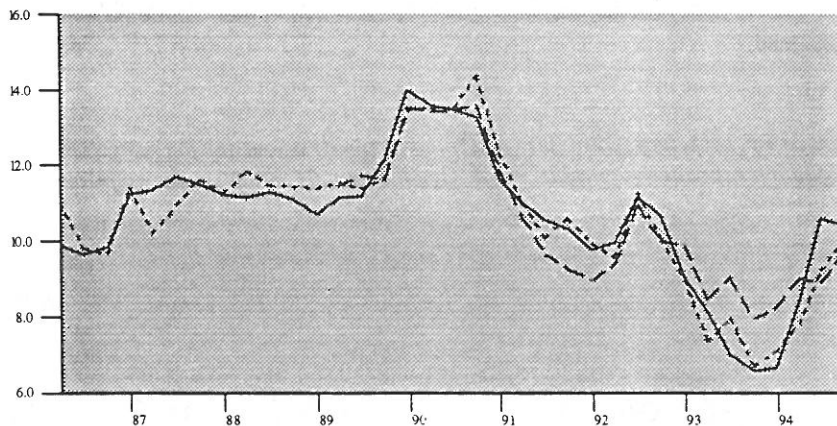
Equation (35) implies the following long-term relation:

(36) $r^l = r^s + 0.9757 * [100 *(\overline{B} - B^{cb})/W^d] - 54.9866$.

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Thus, equation (35) implies a lower interest sensitivity of bond demand (i.e. a higher coefficient for the bond stock) than equation (33). In terms of the effects of bond supply on the long-term interest rate, equation (36) implies that - at 1994 levels - an increase of the outstanding bond stock by SEK 10 billion (i.e. by approximately 0.7%) *ceteris paribus* would require a 0.41 percentage points increase in the bond rate.

5. 2 SUPPLY OF BANK LOANS: DETERMINATION OF THE BANK LENDING RATE

Direct bank lending is in the model assumed to be demand-determined (cf. the section on the demand for bank lending in SEK). The supply side of the bank loan market is given by the relation determining the bank lending rate.

Once again, banks are assumed to be passive and to follow the money market rate in setting their lending rate. Thus, *in the long run*, the spread between the lending rate and the short interest rate is assumed to be constant. This assumption is even more called for in view of the fact that the deposit rate is assumed to strictly follow the short rate.

Chart FF.12 The spread between the bank lending rate and the short interest rate, percent
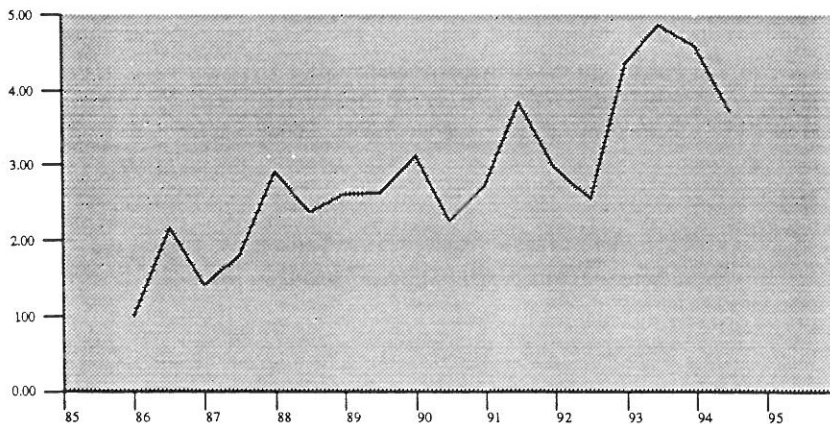
One possibility is to assume that the spread simply is constant, both in the long and in the short run. This assumption appears to be true for the last few years, but was certainly not so before. The development of the spread from the beginning of the deregulated period up to 1994 is illustrated in Chart FF.12.

Another possibility is to assume a gradual adjustment to the above mentioned long-run condition. In both cases, the assumption of long-run interest spread constancy is based on theoretical reasoning and has no support in the available data. It is, however, easy to argue that changes in the banking sector (such as the banking crisis and the opening of the market for new entrants) during the period under study could have caused deviations from the long run behaviour.

A simple adjustment equation estimated with OLS on semi-annual data has the following form:

(37)

$D(r^a)$

$$= \quad 0.68443 * D(r^s) - 0.32350 * (r^a-r^s)_{-1} + 1.02304$$
$$\quad\;\; (7.90047) \qquad\quad (2.48896) \qquad\qquad (2.59844)$$

Sum Sq   4.2505 Std Err   0.5510 LHS Mean -0.0103
R Sq   0.8222 R Bar Sq 0.7967 F 2, 14   32.3601
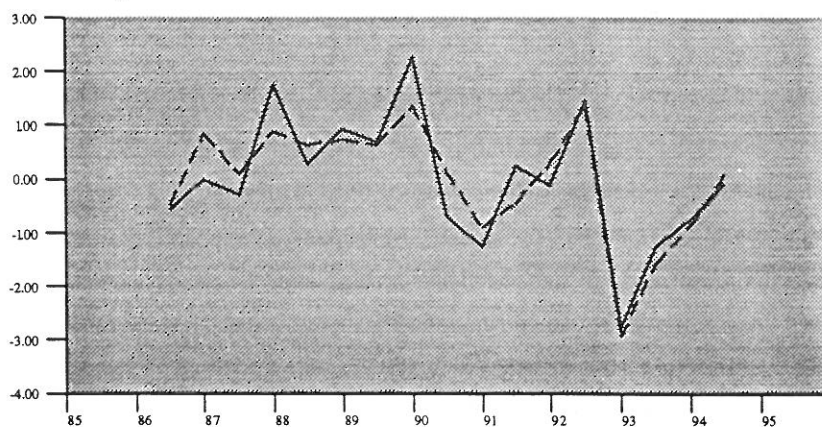D.W.(1) 2.5549 D.W.(2) 2.3003 Est. per. 1986:2-94:2

where
        r^a - average interest rate on bank loans and advances, percent *p.a.*
        r^s - short (three-month Treasury bill) interest rate, percent *p.a.*

The fit of the equation is illustrated in Chart FF.13.

Chart FF.13 Actual values (solid line) and fitted values (dashed) for the bank lending rate equation

5. 3 BANK DEPOSIT RATE

The bank deposit rate in the model is represented by the short interest rate (cf. the portfolio composition section in the general outline of the empirical model).

6. THE CORPORATE-AND-HOUSEHOLD SECTOR

6. 1 BANK DEPOSITS

Bank deposits of the corporate-and-household sector are computed as a residual in the sector's portfolio. This is done in two steps. First, the portfolio wealth (W^{rd}) - or the total amount of money allocated to the domestic portfolio investment - is computed as a residual from the sector's financial balance sheet. In the present case, the sum of certificates (C^r), bonds (B^r), bank deposits (M) and claims on the National Savings Scheme is obtained. Then, bank deposits are computed as a residual portfolio asset. Here, this means that the sector's bond and certificate holdings and claims on the National Savings Scheme are subtracted from the portfolio wealth.

6. 2 QUARTERLY DEMAND EQUATIONS FOR BONDS AND CERTIFICATES

Long-run demand for bonds and certificates, respectively, was specified as:

$$(38) \qquad C^r/W^{rd} = c^r_0 + c^r_2 (r^l - r^s) ,$$

$$(39) \qquad B^r/W^{rd} = b^r_0 + b^r_2 (r^l - r^s),$$

where

the superscript r denotes the corporate-and-household (or residual) sector.

The output term, Y/W^{rd}, did not contribute to the explanatory power of any equation.

OLS estimation of the two long-run relations gave the following results:

$$(40) \qquad B^r/W^{rd} = \begin{array}{cc} 0.02046 * (r^l - r^s) & + 0.23443 \\ (7.59890) & (58.6924) \end{array}$$

Sum Sq	0.0194	Std Err	0.0239	LHS Mean	0.2370
R Sq	0.6294	R Bar Sq	0.6185	F 1, 34	57.7433
D.W.(1)	0.7334	D.W.(4)	1.2830	Est. per. 1986:1-94:4	

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(41) $\qquad C^r/W^{rd} \quad = -0.02084 * (r^l - r^s) + 0.10908$
$$\qquad\qquad\qquad\qquad (5.52142) \qquad\qquad (19.4808)$$

Sum Sq   0.0381   Std Err   0.0335   LHS Mean   0.1065
R Sq   0.4728   R Bar Sq   0.4572   F 1, 34   30.4860
D.W.(1)   0.3778   D.W.(4)   1.6077   Est. per. 1986:1-94:4

We can note that the estimated interest rate sensitivity is for the two assets almost exactly the same. According to the equations, an increase by one percentage point of the long-run

Chart FF.14 Actual (solid line) and fitted (dashed line) values for the residual sector's bond share equation
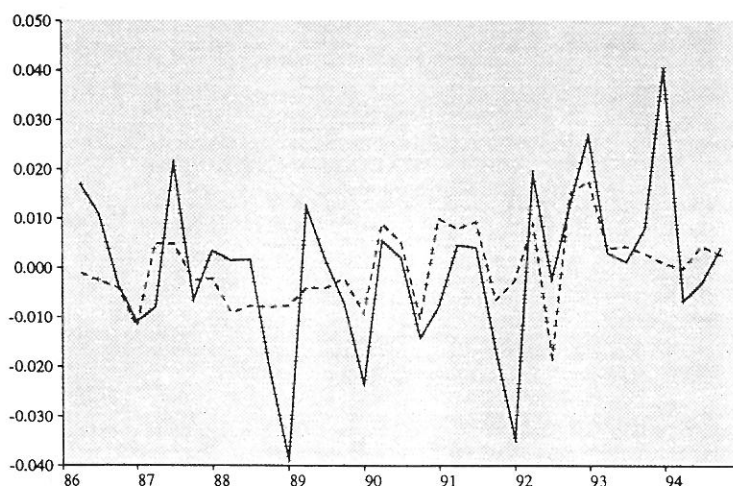

spread between the long and the short rates gives rise to an increase of the share of bonds in the portfolio by approximately two percentage points and an equally large decrease of the share of certificates. At 1994 levels, this implies that an increase of bond holdings of the corporate-and-household sector by SEK 10 billion (i.e. by approximately 3.25%) *ceteris paribus* would require a 0.41 percentage points increase in the bond rate.

The short-term relations include, in addition to the usual terms, the expected change in the bond rate. An *expected decline* in the bond rate makes it worthwhile to invest in bonds

today, since their market value is likely to increase in the future. By the same token, if the bond rate is *expected to increase*, one should invest in certificates rather than in bonds, postponing the investment in bonds until a higher rate is offered.

Attempts to model the expected bond rate through changes in government debt, PSBR and inflation rate were not successful. The expected change in the bond rate is, therefore, represented by its actual change, under the assumption of static expectations.

Chart FF.15 Actual (solid line) and fitted (dashed line) values for the residual sector's certificate share equation
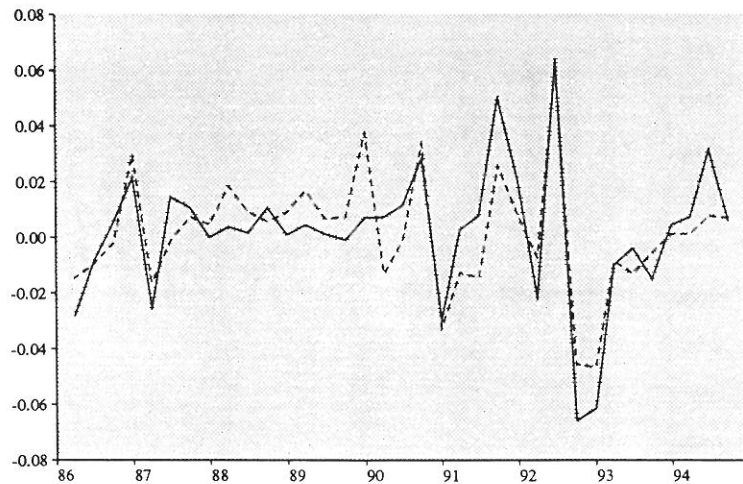
OLS estimation of the short-run relations gave the following results:

$$(42) \qquad D(B^r/W^{rd}) = 0.00774 * D(r^l - r^s) - 0.00392 * D(r^l)$$
$$\qquad\qquad\qquad (2.80160) \qquad\qquad (1.41685)$$

$$\qquad - 0.17052 * [(B^r/W^{rd}) - (B^r/W^{rd})*]_{-1} - 0.00054$$
$$\qquad\qquad (1.49676) \qquad\qquad\qquad\qquad (0.21731)$$

Sum Sq	0.0065	Std Err	0.0145	LHS Mean	-0.0001	
R Sq	0.2477	R Bar Sq	0.1749	F 3, 31	3.4017	
D.W.(1)	1.8506	D.W.(4)	1.2353	Est. per.	1986:2-94:4	

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(43) $D(C^r/W^{rd}) = -0.01790 * D(r^l - r^s) + 0.01600 * D(r^l)$

$\qquad\qquad\qquad\quad$ (7.08202) $\qquad\qquad$ (6.06896)

$\qquad\qquad -0.04814 * [(C^r/W^{rd}) - (C^r/W^{rd})^*]_{-1} + 0.00315$
$\qquad\qquad$ (0.60346) $\qquad\qquad\qquad\qquad\qquad$ (1.33756)

Sum Sq	0.0060	Std Err	0.0139	LHS Mean	0.0016
R Sq	0.7232	R Bar Sq	0.6964	F 3, 31	26.9948
D.W.(1)	1.5439	D.W.(4)	1.6947	Est. per. 1986:2-94:4	

where

$[(B^r/W^{rd}) - (B^r/W^{rd})^*]$ is the residual from equation (40),

$[(C^r/W^{rd}) - (C^r/W^{rd})^*]$ is the residual from equation (41) and

$(B^r/W^{rd})^*$ and $(C^r/W^{rd})^*$ denote the estimated equilibrium values for the two
portfolio shares.

*Chart FF.16 Actual holdings of bonds (solid line) and the equation forecast (dashed line)
derived from the residual sector's bond share equation*
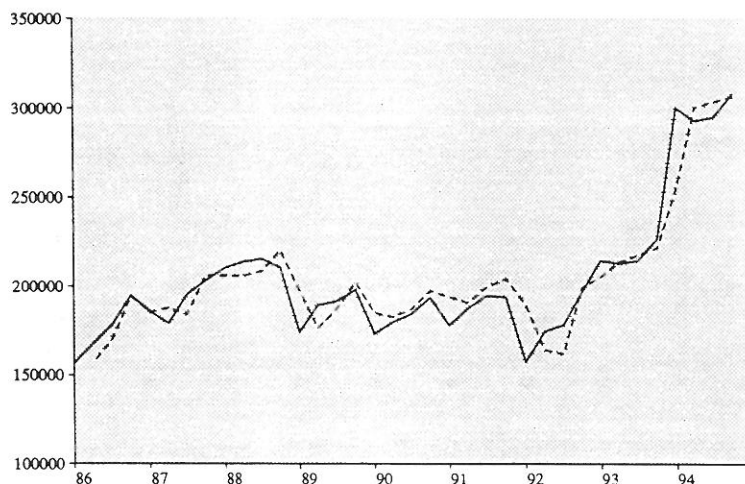
The fit of equations (42) and (43) is illustrated in Charts FF.14 and FF.15, respectively. The
precision of the estimates appears to be rather weak. This may be due to data problems as

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well as to the specification of the model. The implied equation forecasts for the stock levels, derived from the respective equations, are shown in charts FF.16 and FF.17.

While the long-run asset shares in our model depend on the interest rate differential rather than on the interest rate levels, in the short run reactions to changes in the long rate and the short rate differ. A one percentage point increase in the bond rate gives rise to an increase in the share of bonds in the portfolio of approximately 0.38 percentage points. A corresponding decrease of the short rate causes the bond share to increase by 0.77 percentage points. The reason for this difference is, as pointed out above, that a bond rate increase in the model gives rise to expectations of further interest rate increases.

Chart FF.17 Actual holdings of certificates (solid line) and the equation forecast (dashed line) derived from the residual sector's certificate share equation
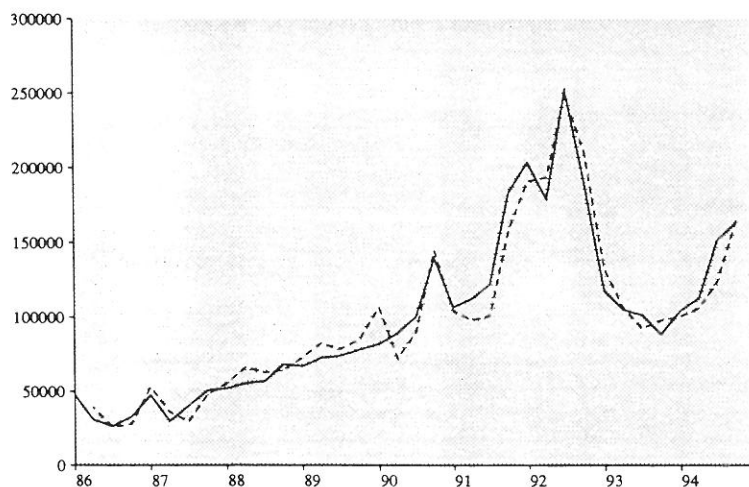
An alternative interpretation could be that changes in the short rate are interpreted as signals of monetary policy changes, while long-rate changes are not. Accordingly, since the long rate usually moves less than the short one, a decrease in the short rate would indicate a steeper yield curve in the future and an increase - a flatter yield curve.

The share of certificates in the portfolio decreases by approximately 0.19 percentage points upon a one percentage point increase in the bond rate. The remaining 0.19 percentage points needed to cover the increase in the bond share are taken from money balances. The reaction of the certificate share to a corresponding decrease of the short rate is almost ten times as large: approximately -1.8 percentage points. Out of this, 0.77 percentage points is invested in bonds, the rest being temporarily transferred to money deposits.

The portfolio asset reactions to yield changes are summarised below:

	Short run effect		Long run effect	
	1% increase in r^l	1% decrease in r^s	1% increase in r^l	1% decrease in r^s
B	0.4%	0.8%	2.1%	2.1%
C	-0.2%	-1.8%	-2.1%	-2.1%
M	-0.2%	1.0%	0	0

According to our results, money is affected by portfolio redistribution due to yield changes in the short run but hardly in the long run, the long run yield elasticities of bond and certificate shares being practically equal. (The fact that the money share actually increases by a fraction of a promille when the interest spread grows larger should be attributed to estimation error.) This is fully compatible with the role of money as a (short-term) buffer stock and the assumption that in the long run money is held for other reasons than the yield it renders. Such reasons could be liquidity, transactions needs, precaution. Thus, since in the long run money is not affected by interest changes, the three portfolio assets are not gross substitutes. Furthermore, in the short run they are gross substitutes only with respect to the long rate.

While the sector's bond holdings move towards their long-run value at a very slow pace, the certificate holdings are almost three times as slow. In fact, they appear to be much more affected by the short-term factors than by the deviation from the long-run position. On the other hand, the short-term sensitivity of certificate holdings in respect of the short rate is only slightly lower than the long-run one, while in the case of bond holdings this difference

is very large. Thus, it appears that bond holdings are rather stable, only slowly adjusting to interest rate variations, while certificate holdings react stronger.

6. 3 INSURANCE SAVING AND CLAIMS ON INSURANCE COMPANIES

Insurance saving of the corporate-and-household sector includes private (i.e. not collective) insurance of physical persons, mainly life and pension insurance of the household sub-sector. The data for this variable are here defined as transactions on the insurance-saving account (*försäkringssparande*) of the household sector in the Financial Accounts. These

Chart FF.18 Ratio of insurance payments to gross income, percent
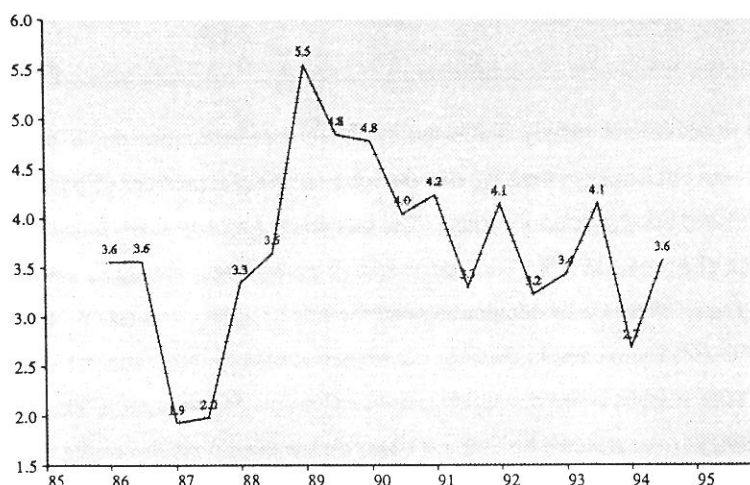
payments exceed the accruals to the corresponding stock of liabilities of the insurance sector. Thus, net increases in the stock of claims of the corporate-and-household sector on the insurance sector are smaller than the amount of payments made by the former sector. The difference is due to insurance benefits being paid out of the accumulated funds. Furthermore, part of the insurance premium constitutes a charge for the services provided by the insurance company.

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The flow of insurance saving (payments) and the accruals to the corresponding stock are both modelled in a simplified way. The stock of insurance savings has developed along a linear trend since 1989. The increases of the last years may be due to the discussion on the reform of the national pension system, which probably will imply lower pensions from the National Pension Fund for those in higher income brackets.

The flow of insurance payments is here determined as a (seasonally) fixed proportion of *gross income*, defined as the sum of wages and salaries, net trading surplus, net interest income and dividends received by households. Insurance payments are related to gross income rather than disposable income, since they (up to a certain amount) are tax deductible. As can be seen in Chart FF.18, the ratio of insurance saving to gross income has been decreasing since 1989. It is possible that this ratio is now about to stabilise, since it is close to the levels of the mid-eighties.

Employing the ratios of 1994, insurance payments in the model amount to 2.7% and 3.6% of gross income in the first and second half-year, respectively.

The liability stock of insurance companies (i.e. the stock of insurance savings) in the model is computed as the sum of the flow of insurance saving and the previous period's stock reduced by a (seasonally) fixed share of the latter. The reduction represents paid out insurance benefits. Using the 1994 ratios, the decrease in the stock due to outward payments in the model constitutes 1.3% and 1% of the stock in the first and second half of the preceding year, respectively.
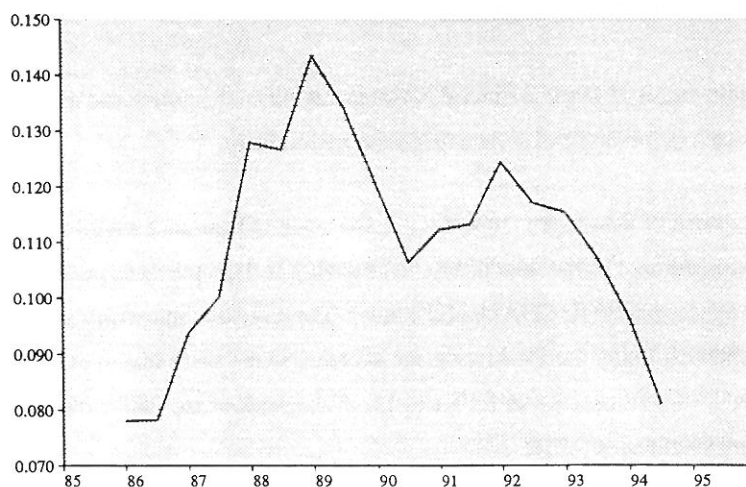
6. 4 CLAIMS ON THE NATIONAL SAVINGS SCHEME

Claims on the National Savings Scheme (*Allemanssparande*) are for the owner comparable to time deposits with a commercial bank, though they in reality are a form of government borrowing. The scheme itself is administered by banks. It is available only to private persons. Withdrawals are subject to a 1% fee but are otherwise not restricted. Deposits are,

on the other hand, limited to SEK 2000 per month (including payments to the National Shareholding Scheme (*Allemansfonder*)).

Up to and including 1990, yields on the Scheme's liabilities were tax exempt. In 1991 and 1992 they were taxed at a lower rate than other interest income. Since 1993 they are taxed at the standard rate. The yield on the Scheme's liabilities is somewhat (less than one percentage point) higher than the yield on banks' time deposits. As can be seen in Chart FF.19, since 1989 the Scheme has been losing importance as household financial asset, along with its becoming a finacially less interesting investment form.

*Chart FF.19 Ratio of claims on the National Savings Scheme to bank deposits*

Although claims on the National Savings Scheme in the model are considered to constitute part of the money stock (which is an asset of the corporate-and-household sector), we need to separate them out as one of the liabilities of the government. This is done in a simplified way, by assuming that they constitute a fixed proportion of the residual sector's bank deposits. Employing the 1994 values, claims on the National savings Scheme constitute 8% of bank deposits. In order to limit the variability of the asset, this proportionality rule is applied to its changes rather than to the levels.

6. 5 DEMAND FOR CERTIFICATES OF DEPOSIT

Certificates of deposit are issued by banks and are mainly held by the corporate-and-household sector. In the Riksbank's statistics they are usually included in the money stock, under the supposition that they constitute a substitute to bank deposits. In terms of our model they have, however, to be separated out as a form of certificates, comparable to (though probably less liquid than) those issued by the government or by the mortgage institutions.

Certificates of deposit constitute a minor asset in the residual sector's balance; since 1986 they have varied between SEK 3 billion and SEK 8.5 billion (cf. Chart FF.20) without

Chart FF.20 Certificates of deposit (solid line) held by the corporate-and-household sector, SEK million
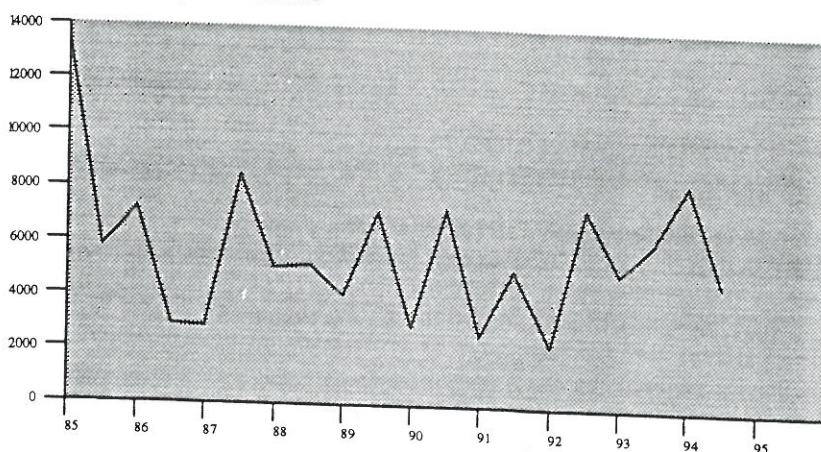
showing any trendwise development nor any considerable relation to the overall certificate stock. In relative terms, their share of the total certificate stock has fallen from 15.7% on the average in 1986 to 4.7% in 1994. In the model, the stock of certificates of deposits is assumed to be constant in absolute terms at the level of the latest value registered (SEK 4700 million in 1994:2).

6. 6 QUARTERLY DEMAND EQUATION FOR NOTES AND COIN

Notes and coin include here only the holdings of the corporate-and houshold sector. The minimal holdings of other sectors are neglected. Notes and coin are held purely for transactional purposes. They are thus postulated to depend on domestic demand for goods and private services (public services being in general not paid for) and on the level of domestic interest rate, the own interest rate of notes being zero.

It appears that there has been some change in the relation between notes and domestic demand in recent years. A shorter estimation period (1989-94) was therefore employed, resulting in a better fit in the last years of the sample. The following relation was estimated using OLS:

(44)

$$dlog(N^r)$$

$$= \quad 0.15675 * dlog(Dem) - 0.00617 * D(r^s)$$
$$\quad (0.91183) \qquad\qquad (2.02415)$$

$$\quad - 0.30834 * log(N^r/Dem)_{-1} - 0.00434 * r^s_{-1} - 0.47300$$
$$\quad (1.55130) \qquad\qquad (1.34630) \qquad\quad (1.89852)$$

$$\quad + 0.07278 * SEAS2 + 0.06668 * SEAS3 + 0.19269 * SEAS4$$
$$\quad (3.80774) \qquad\qquad (4.48893) \qquad\qquad (5.87500)$$

Sum Sq	0.0048	Std Err	0.0172	LHS Mean	0.0095
R Sq	0.9692	R Bar Sq	0.9557	F 7, 16	71.8932
D.W.(1)	1.5394	D.W.(4)	1.1137	Est. Per.	1989:1-94:4

where

N^r - holdings of notes and coin by the corporate-and-household sector

Dem - current-price domestic demand excl. public services,

i.e. GDP - public consumption - exports + imports,

SEASi - seasonal dummy equal to 1 in the i-th quarter, zero otherwise, i = 2, 3, 4

and other symbols were defined above.

All the variables in equation (44) appear to be stationary. The fit of the equation is illustrated in Chart FF.21.

Chart FF.21 Actual (solid line) and fitted (dashed) values for the notes and coin equation estimated for the period 1989:1-94:4
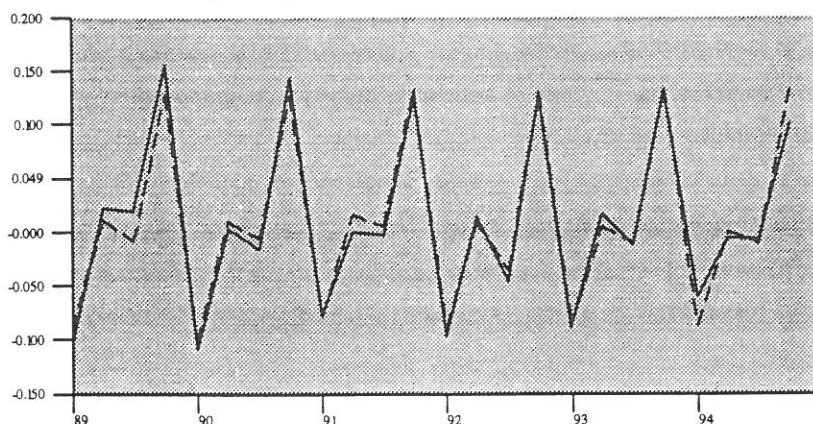
6. 7 QUARTERLY DEMAND EQUATION FOR BANK LENDING IN SEK

The definition of domestic bank lending in the Finacial Accounts includes loans both in SEK and in foreign currency. This is in agreement with the directive of the IMF in that foreign-currency claims on domestic residents are treated as domestic lending. We have computed bank lending in SEK by subtracting domestic bank lending in foreign currency from total domestic bank loans.

Domestic bank lending in foreign currency was in turn computed using the assumption that banks actually borrow foreign currency on behalf of their domestic customers rather than take a currency risk, i.e. that banks have foreign-currency liabilities corresponding to their foreign-currency claims on domestic residents. Since the foreign-currency liabilities corresponding to the foreign-currency claims on *non-residents* can be netted out, domestic bank lending in foreign currency was computed as the difference between *net* foreign

liabilities of the banks and their net foreign currency position (i.e. their strategic portfolio). The latter was approximated using the recommendation of the banking sector's supervisory body, *Finansinspektionen*, as 10% of banks' own capital (more exactly: of net wealth as defined by the Financial Accounts). Bank loans according to Finacial Accounts and bank lending in SEK, computed in accordance with the above method, are shown in Chart FF.22.

Bank loans can be employed to finance real economic activity (here understood to include non-finacial investment, production and consumption) or *financial* investment. We believe that the demand for SEK loans needed to finance real activity by far exceeds the "speculative" demand. Bank borrowing of the finacial enterprises included in the definition of the corporate-and-household sector is minimal. Finance companies have no bank loans at all, while bank loans of investment companies and funds during thirteen out of the fifteen years 1980-94 amounted to less than 3% of total bank lending (4% of SEK lending).

Chart FF.22 Domestic bank loans according to Financial Accounts (dashed line) and bank lending in SEK (solid line). End-of-year stock data. SEK million.
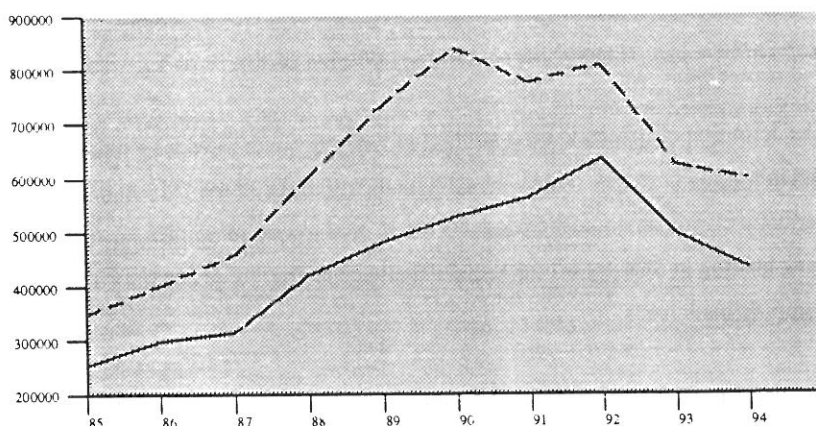
Consequently, in the model SEK bank loans do not constitute part of the sector's financial portfolio. They are seen exclusively as a means of financing economic activity, their role as a source of funds for financial investment being not considered. Demand for SEK bank loans is thus postulated to be affected by domestic demand and the relative cost of bank

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financing as compared to other sources of finance. The basic relation is postulated to have the following form:

(45) $\qquad \log(L^r/\text{Dem}) = a_1 + a_2\,(r^a\text{-}r^s) + a_3\,(r^{fs} + \varepsilon \text{ - } r^s).$

L^r denotes Swedish krona bank loans demanded by the corporate-and-household sector. Dem is the (nominal) domestic demand for goods and private services. The first term in brackets represents the difference between the costs of bank loans (r^a) and money-market financing. It can also be seen as the spread between bank lending and deposit rates. The second term in brackets represents the difference between the costs of borrowing abroad ($r^{fs} + \varepsilon$) and domestically.

Thus, according to the postulated relationship, the ratio between SEK bank loans and domestic demand is constant as long as the relative cost of borrowing is constant. Below, a corresponding dynamic equation is estimated in the error-correction form using OLS:

(46)

$d\log(L^r)$

$\qquad = \quad 0.35822 * d\log(L^r)_{-1} + 0.84338 * d\log(\text{Dem}) - 0.15746 * \log(L^r/\text{Dem})_{-1}$
$\qquad\qquad (2.82088) \qquad\qquad\quad (2.62932) \qquad\qquad\qquad (2.08030)$

$\qquad\quad - 0.02527 * (r^a\text{-}r^s)_{-1} + 0.00352 * (r^{fs} + \varepsilon \text{ - } r^s)_{-1} + 0.13486$
$\qquad\qquad (3.31874) \qquad\qquad (2.84797) \qquad\qquad\qquad\quad (2.22169)$

$\qquad\quad + 0.08393 * \text{SEAS2} + 0.10226 * \text{SEAS3} - 0.03659 * \text{SEAS4}$
$\qquad\qquad (3.06312) \qquad\qquad (5.34375) \qquad\qquad (0.56190)$

Sum Sq   0.0409   Std Err   0.0375   LHS Mean   0.0159
R Sq   0.7394   R Bar Sq 0.6676   F 8, 29   10.2872
D.W.(1) 2.0209   D.W.(4) 2.0278   Est.per.   1985:3-94:4
H   -0.2479
Norm Chi^2(2) 1.05   ARCH Chi^2(4) 1.89   RESET F(2,28) 1.26

65

where

    L^r - SEK bank loans and advances to the corporate-and-household sector,

    Dem - current-price domestic demand excl. public services,

        i.e. GDP - public consumption - exports + imports,

    r^a - average interest rate on bank loans and advances, percent *p.a.*

   SEASi - seasonal dummy equal to 1 in the i-th quarter, zero otherwise, i = 2, 3, 4

    and other symbols were defined above.

The fit of equation (46) is illustrated in Chart FF.23. Outside sample forecasts for the period 1991-94 are shown in Chart FF.24. Inclusion of changes in the interest rate differentials did not improve the explanatory power of the equation. We can note that the impact of the change in the log of domestic demand is relatively close to 1, which appears to confirm our contention about the close relationship between domestic demand and bank loans.
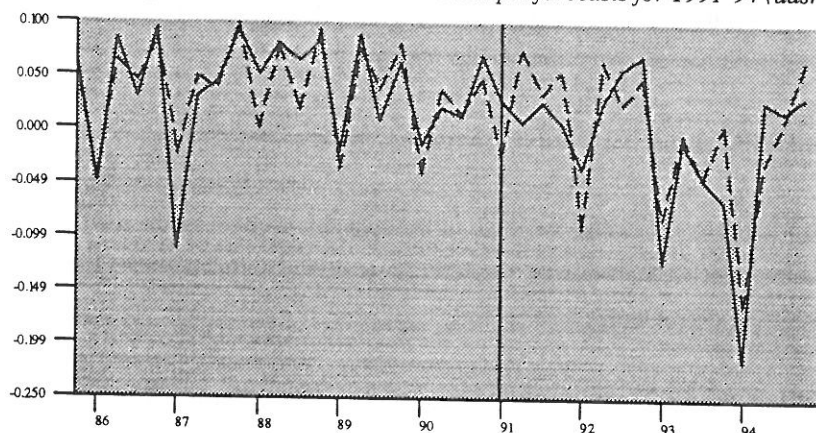

The static solution to equation (46)

(47) $\qquad \log(L^r/\text{Dem}) = \text{constant} - 0.16\ (r^a - r^s) + 0.022\ (r^{fs} + \varepsilon - r^s)$

Chart FF.23 Actual (solid line) and fitted (dashed) values for the bank lending equation estimated for the period 1985:3-94:4

66
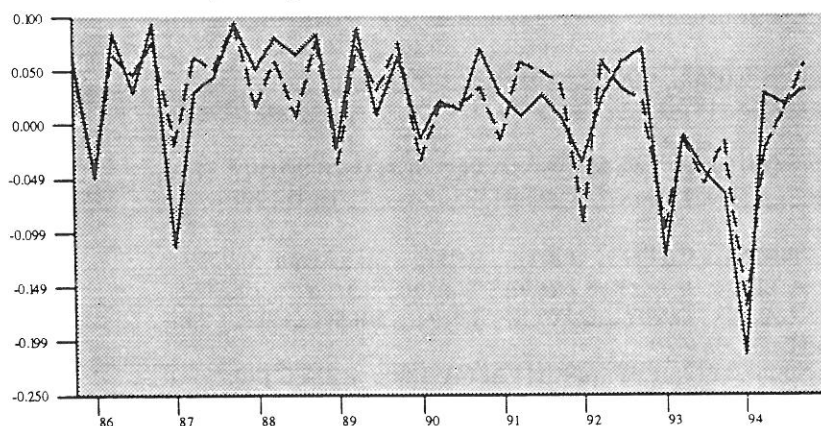
Chart FF.24 Actual (solid line) and fitted (dashed) values for the bank lending equation estimated for the period 1985:3-90:4. Outside sample forecasts for 1991-94 (dashed)

can be interpreted as a long-run relationship, if the left-hand side and the two terms on the right-hand side of equation (47) are assumed to be non-stationary. In fact, over the decade under study, 1985-94, the three terms exhibit a trendwise upward development, in the case of the dependent variable combined with a quick drop during the last three years of the sample. Formal Dickey-Pantula tests, which for such a short time span are not reliable, indicate that the dependent variable is I(1), and the interest rate differentials are I(0), however with serious doubts about the foreign-domestic interest rate differential.

While the turbulent changes in the financial markets during the decade under study could explain temporary non-stationarity of all the terms involved, we are inclined to believe that in long run equilibrium they all should be stationary.

6. 8 NET FOREIGN-CURRENCY LIABILITIES

The net foreign-currency liabilities of the sector are the difference between the interest bearing debts and assets denominated in foreign currency. They include foreign-currency loans arranged through the intermediation of local banks.

The change in net foreign liabilities is equal to the sector's capital account balance. It can thus be computed from the balance of payments identity (cf. the section on the exchange rate determination). According to this identity

Private capital bal. = Δ(Foreign reserves of CB) - Current account bal. - Gov't capit. bal.

The change in net foreign liabilities of the corporate-and-household sector equals the difference between the private capital balance and the capital balances of the banking, insurance and mortgage loan sectors.

The introduction of the foreign assets/liabilities of the (private) institutional sectors is a deviation from our theoretical model, where only the corporate-and-household sector has foreign assets. This deviation is, however, limited in view of the minor role attributed to foreign asset/liability management by those sectors. At a conceptual level, the computation of net foreign liabilities as a residual from the private capital balance introduces the same kind of assumptions as our approach to the bond rate determination. An alternative approach would be to exclude the institutional sectors' capital balances from the exchange rate determination, analogously to net foreign equity flows.

6. 9 DOMESTIC EQUITY DEBT

Equity is treated in the Financial Accounts in a way different from other assets. It is defined to include, besides corporate equities, also capital participations and net additions to capital of quasi-corporate enterprises (*aktier, andelar, insatser*). It is divided into three parts: domestic shares quoted on the stock exchange, domestic shares not quoted on the stock exchange and foreign shares. The first of these items is given at the current market values, the second one at book values (or purchase price) and the third one "as far as possible" at current market values. In the latter case, the current market values refer mainly to the exchange rate employed and it is not clear how the foreign-currency price of these shares is determined.

Shares are included in the Finacial Accounts as both assets and - in the case of enterprises - liabilities. When total assets and net finacial wealth are computed in the Finacial Accounts, domestic shares not quoted on the stock exchange and foreign shares are excluded. On the liability side, all shares are excluded when total liabilities are computed. In this way, equity is excluded from the double entry system which forms the basis of the Financial accounts.

In our model, three sectors - banks, insurance sector and central government - have assets in the form of domestic shares (both those quoted and not quoted on the stock exchange). These claims correspond to the domestic equity debt of the corporate-and-household sector. Foreign shares are included only in the *net foreign equity debt* in the balance of the corporate-and-household sector.

Thus, in the model, the equity debt of the the corporate-and-household sector is defined as the sum of the equity holdings of other sectors.

6. 10 NET WEALTH

The net wealth of the corporate-and-household sector is computed using the net lending (*finansiellt sparande*) identity, which states that the sum of net lending in all sectors is zero. Changes in the sector's net wealth are thus obtained as the difference between the current account balance (which is the foreign sector's net lending with reversed sign) and the sum of net lending in the remainig sectors.

7. THE BANKING SECTOR

7. 1 DEMAND FOR BONDS

Banks' holdings of - both mortgage institutions' and government's - certificates and bonds constitute a significant part (between one fourth and one third) of their total assets. The bulk of these holdings consists of bonds, the share of certificates being as high as 8% only in 1994.

In the model, it is assumed that banks play the role of market makers in bonds. This means that they passively buy and sell these securities (and underwrite new issues) in accordance with the needs of other sectors. Consequently, banks' holdings of bonds can be determined as the difference between the supply and demand in the market in question.

The above market-making assumption can be disputed on the ground that banks have their own strategic (investment) portfolio. Nevertheless, in the model the market-maker role is given precedence over the investor role.

7. 2 DEMAND FOR CERTIFICATES

In the model, banks' certificate holdings do not include the Central Bank certificates, which are reckoned within the banks' net borrowing from the Central Bank. Banks' holdings of the mortgage institutions' and government's certificates are - as mentioned in the previous section - limited in size. At the same time, they are relatively volatile and not easy to model in the present, simplified framework.

Since no portfolio choice function could be successfully estimated, banks' certificate holdings are assumed to be in the long run proportional to bank deposits. The holdings are also assumed to be affected by the difference between the long and short interest rates. The equation., estimated by OLS, has the following form:

(48)

$$D(C^b/M)$$

$$= -0.50905 * (C^b/M)_{-1} - 0.00416 * (r^l-r^s)_{-1} + 0.02044$$
$$\quad (1.61627) \qquad\qquad (0.94159) \qquad\qquad (1.79889)$$

Sum Sq   0.0045   Std Err   0.0178   LHS Mean 0.0034
R Sq   0.1579   R Bar Sq 0.0375   F 2, 14   1.3121
D.W.(1) 2.0229   D.W.(2) 1.4833   Est. per. 1986:2-94:2

where

      C^b - certificate holdings of the banking sector,

      M - bank deposits of the corporate-and-household sector.

As can be seen in Chart FF.25, the fit of the equation is not very good, especially in the last years of the sample. This might be due to gradual build-up of banks' certificate stock but estimation for a shorter time period did not give any better results. The equation was estimated on semiannual data, since the corresponding quarterly equation appeared to be even worse (possibly because of the volatility of the dependent variable or problems connected with the distribution of bank deposits by quarters).

Chart FF.25 Actual (solid line) and fitted (dashed) values for the banks' certificate holdings equation

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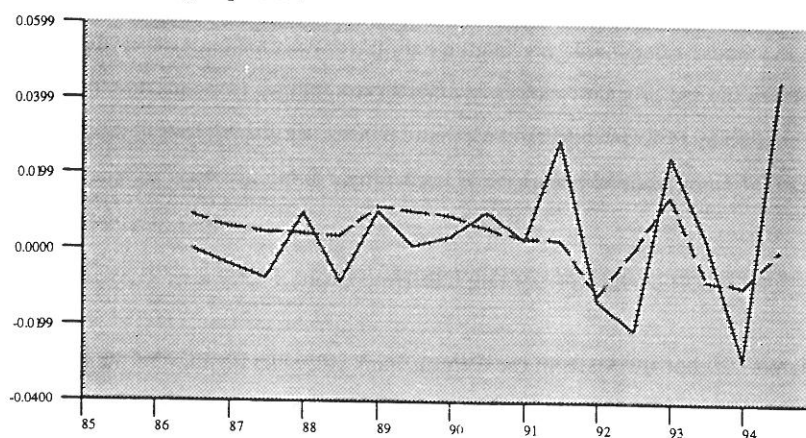
7. 3 DOMESTIC EQUITY

The domestic equity holdings of the banks are assumed to be constant.

7. 4 NET FOREIGN LIABILITIES

Net foreign liabilities of the banking sector in the Financial Accounts exclude banks' foreign-currency claims on domestic residents. The latter are accounted as part of domestic lending (cf. the section on demand for bank lending in SEK). Thus, while banks' foreign borrowing on behalf of their customers is included in their net foreign liabilities, the corresponding claim on domestic residents is not. Meanwhile, banks take no currency risk in this case, since both the liability and the claim are denominated in foreign currency.

In order to compute the net foreign liabilities of the banking sector which correspond to the currency risk taken, i.e. the net foreign strategic portfolio of the banks, we make use of the recommendation of the Swedish Financial Supervisory Authority (*Finansinspektionen*), which is issued for prudential purposes and appears to be closely adhered to by the banks. According to this recommendation, banks' open position in foreign currency should not exceed 10% of their own capital. Since 1995, this limit has been increased to 15% for primary dealers, which include all the major commercial banks.

In the model's data bank, net foreign liabilities of the banking sector were approximated as 10% of the sector's net financial wealth. In simulations beyond 1994, this percentage will be increased to 15%. In order to limit the variability of this balance item, its accruals (rather than the stock) will be computed as 15% of the accruals to the financial wealth.

7. 5 NET BORROWING FROM THE CENTRAL BANK

Banks' net borrowing from the Central Bank is the net position of the banking sector *vis-a-vis* the Central Bank. It thus includes deposits with the Central Bank (also reserve

requirements, before they were abolished), holdings of the Central Bank certificates and loans from the Central Bank.

In the model, banks are assumed to passively adjust their net balance with the Central Bank in order to close the discrepancy between the demand for their assets and the demand for their liabilities. Banks' net borrowing from the Central Bank is, consequently, computed as a residual item in the banking sector's financial balance.

From the point of view of the Central Bank, these adjustments of banks' net balance position constitute the Central Bank's monetary policy action. Measures aiming at increasing the liquidity of the banking sector (comparable to the repurchase agreements, i.e. repos) result in more net borrowing by the banks from the Central Bank. Conversely, measures aiming at restraining the liquidity (comparable to reverse repos) result in less net borrowing.

The implications of this approach for the functioning of the certificate market in the model are elucidated in the section on the Central Bank's demand for certificates.

7. 6 NET WEALTH

Proper modelling of the net wealth of the banking sector would require the introduction of interest flows to and from the sector. Since such an approach is beyond the scope of this model, the net wealth will be determined through a simplifying assumption.

In the model, the accruals to the net wealth of the banking sector are assumed to constitute a fixed proportion of the accruals to risk-weighted total assets. Risk weighting is introduced here to account for the capitalisation requirement enforced since 1990 by the Swedish Financial Supervisory Authority (*Finansinspektionen*). According to this requirement, an increase in risky assets requires a higher capitalisation rate (i.e. own capital to assets ratio) than a corresponding increase in less risky assets. Although the Financial Accounts' net

wealth is a deficient measure of the capital base, the net wealth will be more adequately modelled when allowing for the capitalisation requirement.

The risk-weighting system stipulates the weight 0 for government paper, 0.2 for claims on mortgage institutions and banks, 0.5 for banks' own housing loans and 1 for remaining assets. Due to asset aggregation in the model (where, in particular, mortgage securities and government securities are treated as perfect substitutes), our weighting scheme (which attempts to account for the shares of these two types of assets) is somewhat arbitrary. In the model, certificates are given the weight 0.1, bonds 0.2 and other assets the weight 1. The differential ratio of net wealth to risk-weighted assets was set to 0.15, approximately the average 1992 level and three times higher than the average 1994 level, which was badly affected by the recent bank crisis and (probably) measurement errors.

The assumption that net wealth is determined by the capitalisation requirement can be interpreted as implying that (non-modelled) bank fees are adjusted to secure adequate capitalisation. The implicit bank fee flows are directly reflected in the variation of the net wealth of the corporate-and-household sector. Since, in the model, the latter variable is directly affected by changes in other sector's net wealth (cf. the section on the net wealth of the corporate-and-household sector), *e.g.* an implicit increase in bank fees results in a corresponding decrease in the net wealth of the corporate-and-household sector.

8. THE INSURANCE SECTOR

8. 1 LENDING TO THE CORPORATE-AND-HOUSEHOLD SECTOR

Loans of the insurance sector include inter-group loans (*koncernkrediter*) of the private insurance companies. As can be seen in Chart FF.26, lending to the corporate-and-household sector over the last decade varied between approximately SEK 60 billion and SEK 72 billion. During the same period, the share of loans in total assets of the sector (as defined in our model) was almost halved from approximately 14% to 7%.

Chart FF.26 Insurance sector's lending to the corporate-and-household sector (solid line, left scale) and its share in insurance sector's total assets (dashed line, right scale)
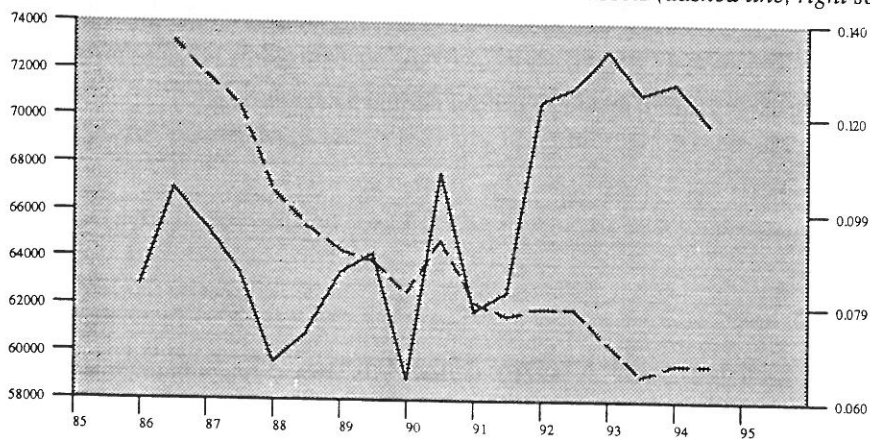
As the level of loans appears to have been relatively stable since 1992, in our model loans of the insurance sector are assumed to be constant at the latest known level (SEK 69.8 billion in 1994:2).

8. 2 DOMESTIC EQUITY

Shares constitute a significant part (28% in 1993[5]) of the total assets of the private insurance companies and a much smaller part (7.8% in 1993[6]) of the assets of the National Pension Fund (*AP-fonden*). The insurance sector's equity holdings were relatively variable during the past decade. We have, therefore, included in the model a relationship that relates investment in equity to a crude approximation of the relative yield on shareholding. In particular, the share of equity in the total assets of the sector is explained by the relation of the yield on fixed capital in industry to the yield on financial bonds (i.e. to the long interest rate).

The equation was estimated using OLS on semi-annual data for the period 1987:1-94:2. Semi-annual data were chosen in order to avoid the troublesome task of distributing by quarters the relative yield variable, which was originally computed for the (semi-annual) real part of KOSMOS (cf. Markowski and Ernsäter [1994], Appendix). The estimation results, based on sixteen observations, are certainly not particularly reliable and the standard statistics are shown merely as general information to the reader:

(49)

$D(S^i/IA)$

$$= 0.14026 * D(rci) - 0.18276 * (S^i/IA)_{-1} + 0.25891 * rci_{-1} - 0.22936$$
$$\quad (0.85082) \qquad (1.13497) \qquad\qquad (2.36835) \qquad (2.12917)$$

Sum Sq	0.0031	Std Err	0.0160	LHS Mean	-0.0006
R Sq	0.3876	R Bar Sq	0.2345	F 3, 12	2.5316
D.W.(1)	1.1379	D.W.(2)	2.0508	Est. Per.	1987:1-94:2

---

[5] Total assets are here defined to include foreign shares and domestic shares which are not quoted on the stock exchange. In the Financial Accounts, these items are usually not included in total assets.

[6] See the previous footnote.

where

    S^i - domestic equity holdings of the insurance sector,

    IA - total assets of the insurance sector,

    rci - ratio of the yield on fixed capital in industry to the yield on five-year government bonds.

The fit of the equation is illustrated in Chart FF.27.

Chart FF.27 Actual (solid line) and fitted (dashed) values for the insurance sector's equity holdings equation
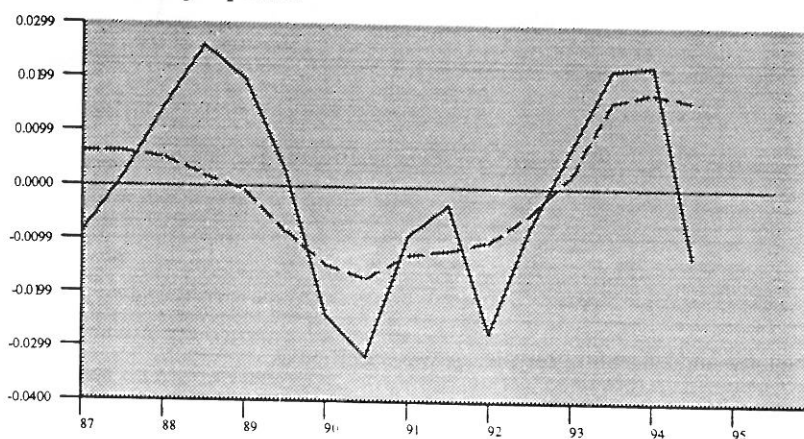

The large residuals during the period 1988-89 may depend on the fact that our relative yield variable does not adequately reflect gains in the real estate market.

8. 3 QUARTERLY DEMAND EQUATION FOR CERTIFICATES

The domestic portfolio of the insurance sector includes mainly bonds. Certificates are a minor item and bank deposits are negligible. The sector's certificate holdings increased in a trendwise manner between 1986 and 1991, from approximately SEK 4 billion at the end of 1986 to SEK 49 billion at the end of 1991. The share of certificates in the domestic

portfolio, defined to include only bonds and certificates, exhibited the same trendwise increase and it appears that an increase of the desired certificate stock took place during this period (cf. Chart FF.28).

Chart FF.28 Share of the insurance sector's certificate holdings in the portfolio comprising bonds and certificates
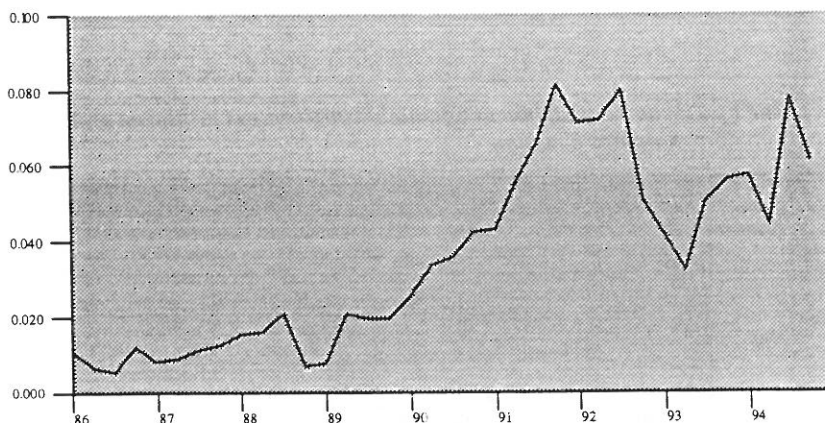
The long-run demand for certificates was specified as:

(50)
$$C^i/W^{id} = c^i_0 + c^i_2 (r^l - r^s) ,$$

where

C^i - domestic certificate holdings of the insurance sector,

W^{id} - total domestic portfolio assets (bonds plus certificates) of the insurance sector and other symbols were defined above.

This relationship was estimated in a dynamic form, using OLS. To avoid the effects of the initial built-up phase, the estimation period was limited to 1991:1-94:4. The estimation results are based on seventeen observations and are thus not particularly reliable; the standard statistics are shown merely as general information to the reader:

(51)

$$D(C^i/W^{id})$$

$$= -0.00475 * D(r^l - r^s) - 0.62813 * (C^i/W^{id})_{-1} + 0.03852$$
$$\quad (1.65130) \qquad\qquad (2.84472) \qquad\qquad (2.89717)$$

Sum Sq	0.0021	Std Err	0.0128	LHS Mean	0.0012	
R Sq	0.4132	R Bar Sq	0.3230	F 2, 13	4.5778	
D.W.(1)	2.0286	D.W.(4)	1.4061	Est. per.	1991:1-94:4	

The fit of the equation is illustrated in Chart FF.29.

Chart FF.29 Actual (solid line) and fitted (dashed) values for the insurance sector's certificate demand equation
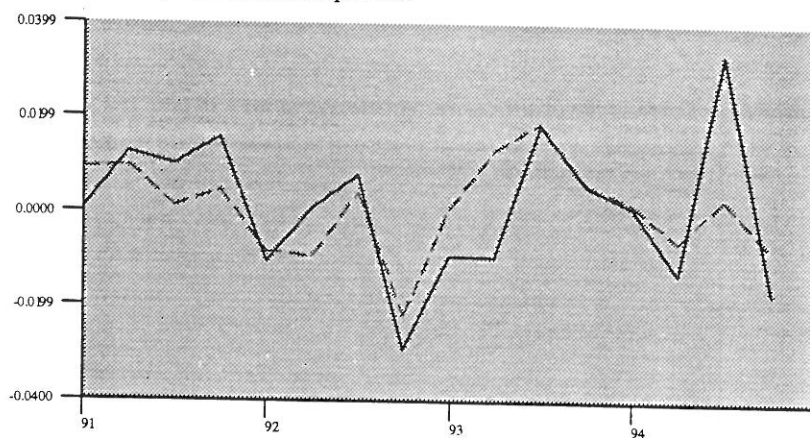
Equation (51) appears to be consistent with the stylised facts that emerged upon analysis of the data. The share of certificates in the portfolio is largely constant and rather small (close to 6% in the static solution), some degree of sensitivity to the relative yield can, however, be observed.

8. 4 DEMAND FOR BONDS

The insurance sector's holdings of bonds are computed as a residual in its portfolio (cf. the section on bank deposits).

8. 5 FOREIGN ASSETS

Foreign assets of the insurance sector constitute a minor part of the sector's total assets. As can be seen in Chart FF.30, the share of foreign assets in total assets (as defined in our model) increased gradually during the period 1989-92 and then stabilised at approximately 2.5%. By all standards, there is still room for the share of foreign assets to increase, but the insurance sector is apparently wary of the risks involved.

Chart FF.30 Share of the insurance sector's foreign assets in total assets
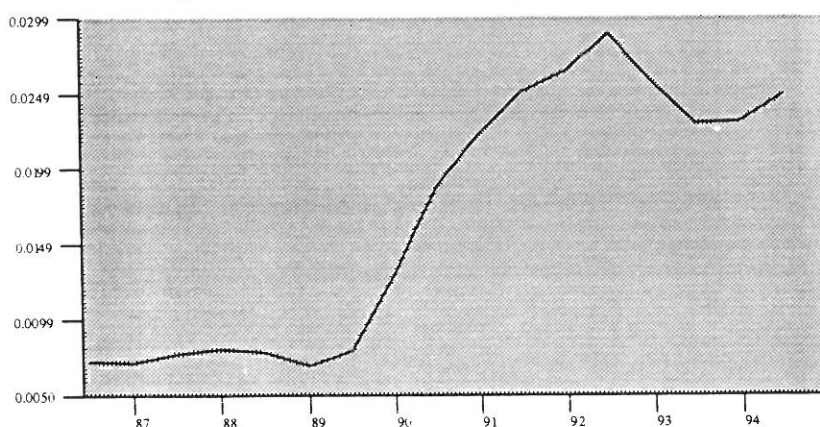
As a first approximation, in our model the share of foreign assets in the sector's total assets will be assumed to be constant at the latest known value. Thus, foreign assets will constitute a fixed proportion of the total assets.

8. 6 NET WEALTH

Net wealth of the insurance sector consists of the net wealth of private insurance companies and pension funds and of the net wealth of social security funds. The former includes liabilities following from collective insurance policies (e.g. collective pension insurance negotiated by the Trade Unions and financed by employers' contributions): the latter consists mainly of social security pension rights.

The share of collective insurance liabilities in the *net wealth of private insurance companies* increased from 68% in 1985 to 91% in 1994. The remaining part of the net wealth proved, however, cumbersome to model. We have, thus, chosen to model the net wealth of private insurance companies in a simplified manner as one item. Changes in the net wealth here reflect solely changes in the collective insurance and in the domestic interest income.

Since collective insurance mainly consists of wage-related pension insurance, new collective insurance liabilities are a function of paid wages and salaries. Historically, collective insurance was mainly connected with the private sector; one can, however, expect the public-sector-specific pension schemes in the future to be constructed in a similar manner as those of the private sector. Therefore, new collective insurance liabilities are here based on total wages and salaries.

Net accruals to the collective insurance liabilities in the model are determined by two factors: new liabilities, computed as a fixed percentage (8%) of total wages and salaries, and paid out benefits (decrease in old liabilities), approximated by 10% of the previous period's net wealth.

The social security funds (mainly *AP-fonden*, the National Pension Fund), are generally funded through compulsory contributions which are proportional to earned income (excluding capital income). An approximation of these contributions is here based on total wages and salaries and obtained as a fixed proportion (13%) of the latter variable.

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Analogously to the case of the private insurance companies, the paid out benefits are approximated by 10% of the previous period's net wealth.

Moreover, the net wealth of the insurance sector is affected by the inflow of interest on their domestic bonds and certificates. As those two types of securities constitute the major part of the sector's assets, the yield on other assets is neglected.

The semi-annual interest on the stock of certificates is computed by applying the (annual) short-term interest rate divided by 2. The yield on the stock of domestic bonds is computed using the following assumptions:

a) interest is paid with a delay of one period, consequently interest payments are based on the holdings of the previous period,

b) the average bond maturity is 5 years,

c) bonds are redeemed and new bonds issued in such manner that each maturity has the same share of the bond stock,

d) bonds are issued at the current long-term interest rate.

As a result of the above assumptions, the interest on bonds is obtained by applying to the previous period's bond stock the arithmetic average of the long-term interest rates for the period t-1 to t-10. The result is divided by two to obtain the semi-annual figure.

In sum, the net wealth of the insurance sector is affected by three factors: an increase equal to 21% (8% + 13%) of total wages and salaries, a decrease equal to 10% of the previous period's net wealth and an increase equal to the yield on the sector's domestic bonds and certificates. The coefficient of wages and salaries is to be treated as an exogenous parameter, since part of it (pertaining to collective insurance) is subject to negotiations and the other part (pertaining to social security) is determined by the parliament.

A dynamic prediction based on this approach and starting 1989:1 is illustrated in Chart FF.31 together with the actual net wealth variable.

Chart FF.31 Net wealth of the insurance sector (solid line) and a dynamic projection for this variable starting 1989:1 (dashed line)
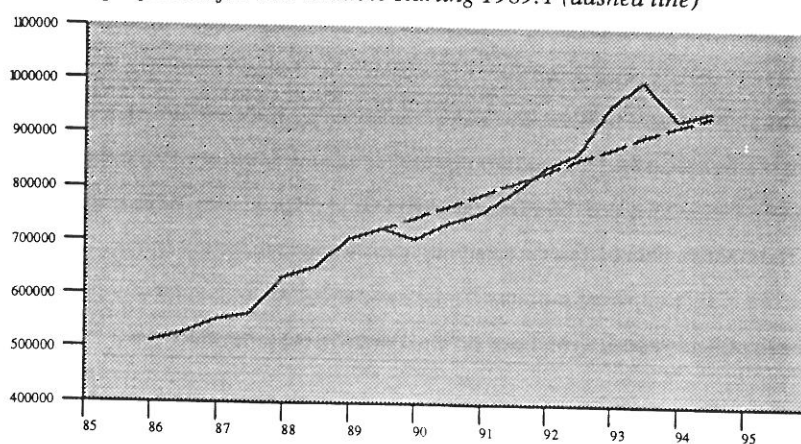
9. THE MORTGAGE INSTITUTIONS

9. 1 LENDING TO THE CORPORATE-AND-HOUSEHOLD SECTOR

Mortgage loans, collateralised by real estate, constitute the bulk of the assets of mortgage institutions. The main determinant of demand for mortgage loans is investment in construction. Thus, we are interested in capturing the relationship between construction investment (mainly dwellings) and loans of mortgage institutions. For the purposes of our model, we can limit ourselves to a general relationship, without any need to model it in detail.

Housing investment is in the construction phase financed by short-term bank loans. Once the building is finished, a long-term mortgage loan is arranged. Thus, there is a time lag between the undertaking of a fixed investment and the mortgage loan. On the other hand, the National Accounts data on fixed investment register outlays during a given period of time rather than separate projects. Thus, fixed investment data for a given period partly refer to projects about to be finished and partly to those newly started.

An inspection of the data indicates that changes in mortgage lending have much higher correlation with the contemporaneous construction investment than with the lagged one. This could result from short production periods for construction but could also indicate a relationship between the level of construction activity and demand for mortgage loans.

In the model, it is assumed that 80% of the (non-industrial) construction investment in the current period and 20% of that same investment in the previous period give rise to new mortgage loans. The (relatively limited) construction investment by industry is here excluded under the assumption that it is financed from other sources.

The stock of mortgage loans is furthermore assumed to be affected by amortisation of older loans. This amortisation is here to set to 1.25% of the previous (semi-annual) period's stock, under the assumption that the average loan term is 40 years.

Our assumptions regarding gross additions to the mortgage loan stock as derived from the loan data and from the construction investment series are illustrated in Chart FF.32.

Chart FF.32 Gross additions to the mortgage loan stock constructed from the loan stock (solid line) and from the construction investment* (dashed line)
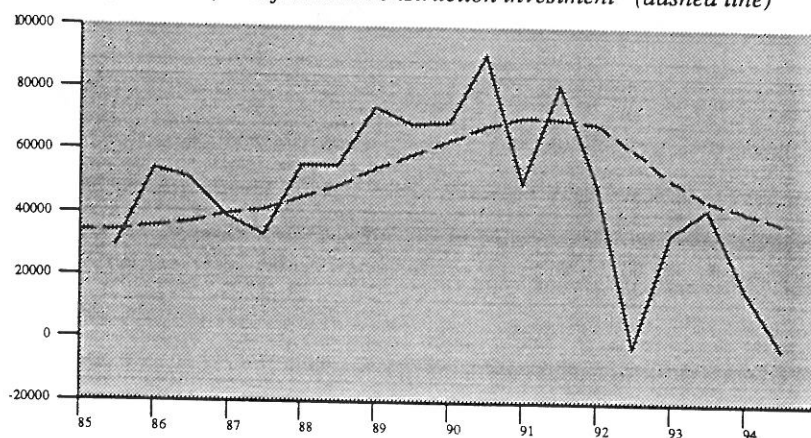

* The solid line represents $s_t - 0.9875\ s_{t-1}$ and the dashed line $0.8\ ic_t + 0.2\ ic_{t-1}$, where s_t denotes the stock of mortgage loans and ic_t the non-industrial construction investment at current prices.

As can be seen in the chart, the simplifying assumptions regarding the demand for mortgage loans do not permit us to trace the additions to the loan stock in any detail. This can be due to our having neglected two important factors. The first one refers to the percentage of the building's value that on average is covered by the mortgage loan. The second refers to the rate of accelerated amortisation, reflecting attempts to lower the debt burden. In fact, the data indicate a direct inverse relation between changes in the long-term interest rate and changes in the loan stock. As mentioned above, in the context of the present model it was not deemed worthwhile to introduce further complications into the relation modelled.

Dynamic projections for the mortgage loan stock, based on the above assumptions and beginning in 1989:1, are shown together with the actual stock in Chart FF.33.

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Chart FF.33 Mortgage loan stock (solid line) and dynamic projections starting in 1989:1 (dashed line)
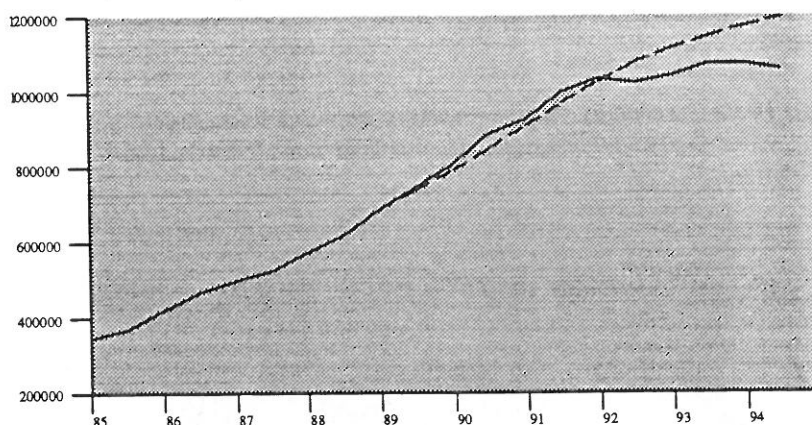

9. 2 SUPPLY OF BONDS AND CERTIFICATES IN SEK

SEK bonds constitute the bulk of the mortgage institutions` liabilities. They are the main vehicle for (fixed-rate) housing loan financing. Certificates are used to match the flexible-rate assets. They are also employed for gradual redemption of maturing bond issues, in order to smooth the need for bond financing.

The share of bonds in the sum of domestic bonds and certificates is illustrated in Chart FF.34. Since the first years can be regarded as an introductory phase for certificates, the certificate stock starting practically from zero, the end of the period under study probably is of greatest interest. During this period the share of bonds was on the whole relatively stable, varying between 90% and 94%. Thus, one possible simplifying assumption for the determination of the bond stock in the model would be to set it at, say, 92% (the 1994:2 value) of the sum of bonds and certificates.

An alternative approach would be to let the supply of bonds be affected by the spread between the long and the short rates. The interest rate effect could manifest itself both on

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Chart FF.34 Share of the mortgage institutions' bonds in the sum of SEK bonds and certificates
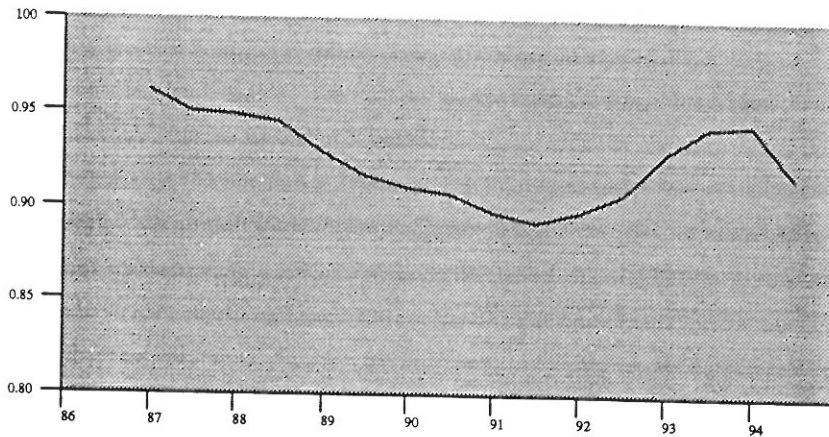
the supply side (higher bond rate causing larger certificate issues) and on the lending side (higher long rate causing a smaller share of fixed-rate loans).

Assuming the decision on foreign borrowing is taken first, the share of bonds in domestic borrowing could be explained by the following (quarterly) equation:

(52)

$dlog(B^m)$

$$= 1.00000 * dlog(B^m+C^m) - 0.02955 * log(B^m/(B^m+C^m))_{-1}$$
$$(\quad NC) \qquad\qquad (0.73238)$$

$$- 0.00241 * (r^l-r^s)_{-1} - 0.00441$$
$$(2.94241) \qquad\qquad (1.43824)$$

Sum Sq	0.0010	Std Err	0.0057	LHS Mean	0.0245
R Sq	0.9602	R Bar Sq	0.9576	F 2, 31	374.022
D.W.(1)	0.6256	D.W.(4)	2.2324	Est. per.	1986:3-94:4

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where

B^m - stock of bonds of the mortgage institutions,

C^m - stock of certificates of the mortgage institutions

and other symbols were defined above.

The equation was estimated with OLS on quarterly data after some manipulations. First, the coefficient of $dlog(B^m+C^m)$ was constrained to 1 in order to limit the variability of the bond supply introduced into the model. When estimated freely, this coefficient was equal to 1.05. Second, extrapolated bond stock data for 1986 were employed. The fit of the equation is illustrated in Chart FF.35.

The equation can be interpreted as indicating that in the short run there is a tendency to finance through bonds a fixed share of the accruals to domestic lending (the short-run elasticity being one). In the long run, however, the share of bonds depends on the interest rate spread, so new bond issues are affected if earlier issues resulted in e.g. an excessive share of bonds.

Equation (52) is to be introduced into the model in the first place. Fixed bond share might be employed as an alternative assumption.

Once the bond liability stock is determined, the outstanding **stock of certificates** can be obtained as a residual from the sector's financial balance sheet.

9. 3 SUPPLY OF FOREIGN-CURRENCY BONDS

The stock of mortgage institutions' foreign-currency bonds in relation to the sector's total assets (i.e. loans) is shown in Chart FF.36. As can be seen, the current share of foreign-currency bonds is close to 7%. Meanwhile, the official target share of one of the biggest mortgage institutions, *Stadshypotek*, is 20% (the current share for this institution alone being also 7%).

Chart FF.35 Actual (solid line) and fitted values (dashed line) for the mortgage institutions' bond supply equation
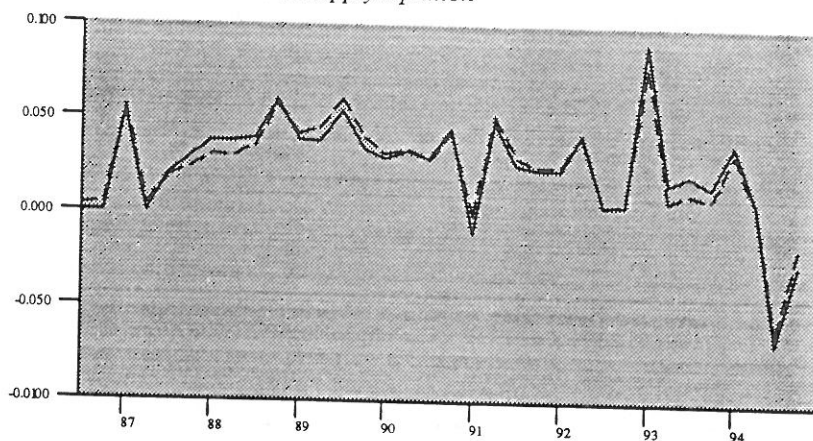

In the model, the accruals to foreign currency bonds are assumed to constitute 7% of the accruals to lending (i.e. total assets). In this way, the long run ratio of the two stocks is 7%.

The above simplifying assumption neglects the effect of domestic and foreign interest rates on foreign borrowing. In actual fact, a long-run relation between the share of foreign borrowing and the difference between the domestic and foreign long-term interest rates (adjusted for the expected depreciation rate) could be estimated. Unfortunately, this relation gave little guidance in regard of the short-term movements of foreign borrowing. Since the estimates in practice were based solely on the decrease in the share of foreign borrowing in 1991-92 (the period preceding the floating of the krona), they were not deemed reliable enough to be included in the model.
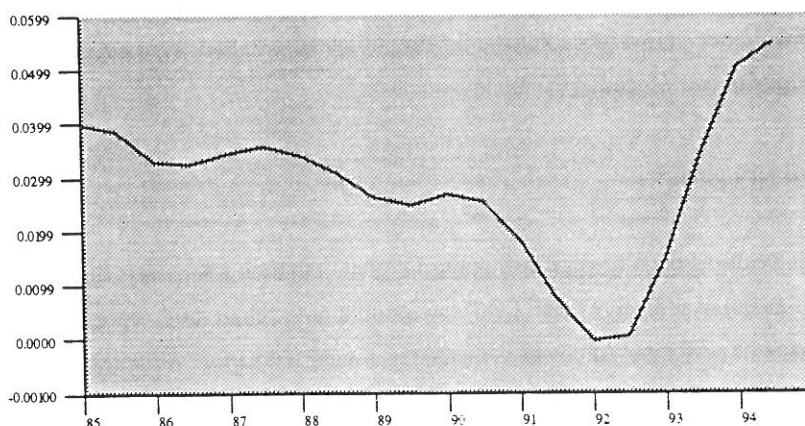
9. 4 NET WEALTH

Net wealth of the mortgage institutions in relation to their total assets (loans), as defined in our model, is plotted in Chart FF.37. According to the chart, after a period of accelerating losses the sector has rapidly consolidated its financial position. Although probably broadly true, this picture might indicate some data problems.

Chart FF.36 Share of foreign-currency bonds of the mortgage institutions in total assets
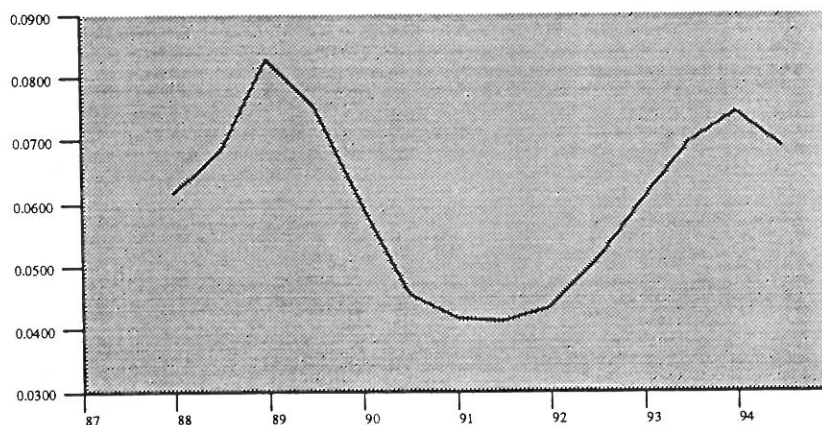
The recent increase in the net wealth ratio reflects higher capitalisation requirements. In the model, this higher net wealth ratio is assumed to be maintained. Thus, the net wealth of the mortgage institution is postulated to be maintained at the 1994 value of 5.5% of total assets. In order to limit the variability of this balance item, the accruals to the net wealth (rather than the stock) will be computed as 5.5% of the accruals of total assets.

Chart FF.37 Net wealth of mortgage institutions in relation to their total assets

10. CENTRAL GOVERNMENT

10. 1 NET WEALTH

The net financial wealth of the central government is the cumulated sum of its net lending (*finansiellt sparande*). It is a negative number, since the government has actually been a net borrower. In absolute terms, the net wealth is smaller than the government debt, as it constitutes the difference between the sector's financial assets and liabilities.

The accruals to the net wealth of the central government are determined in the real part of the model and are thus exogenous to the financial model. These accruals are an important policy variable. They are crucial in the sense that they determine the supply of government debt and as such affect the bond interest rate and the portfolio choice of the institutional investors.

10. 2 FOREIGN-CURRENCY BORROWING

The amount of the central government's foreign-currency borrowing is subject to a political decision. The current level of the Central Bank foreign reserves and the wish not to affect the expectations about future depreciation of the currency are among the factors considered.

The share of foreign borrowing in total government debt is illustrated in Chart FF.38. As can be seen in the chart, this ratio has varied roughly between 20% and 30%. For the last few years, it has been close to 30%.

In the model, it is assumed that the accruals to foreign debt will amount to 30% of the central government borrowing requirement. This gives a 30% long-run ratio of foreign debt to total government debt. As already mentioned, the 30% share of foreign-currency borrowing is considered as a policy parameter that can be subject to change.

Chart FF.38 Ratio of the central government's foreign-currency borrowing to total government debt
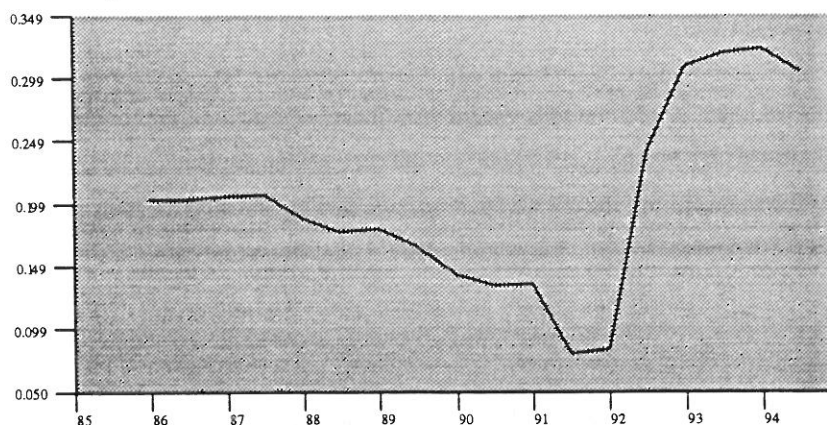
10. 3 SUPPLY OF CERTIFICATES AND BONDS

The share of short-term borrowing in new issues of government securities is determined by the current duration target. This target is here considered as a policy parameter. Under the assumption that government debt is issued in the form of a few benchmark loans with standardised characteristics, fixed duration of total debt stock can be translated into a fixed share of short-term debt in total debt.

In the model, it is assumed that the **short-term debt** constitutes 30% of the (net) increase in total domestic debt. To allow for the possible substitution (on the part of the borrower, i.e. the government) between the liabilities on the National Savings Scheme (*Allemanssparande*) and government certificates, the short-term debt is defined as the sum of the two. Given that the liabilities of the National Savings Scheme are demand determined, the increase in the issue of government certificates makes up for the difference between the increase in short-term debt and the increase in the liabilities of the National Savings Scheme.

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A possible alternative assumption is that the stock of government certificates is constant, at - say - SEK 200 billion (close to the 1994 average). In contrast to the fixed share, the fixed level assumption is more plausible for a stable or decreasing total debt stock. This is so, since government certificates play an important role in the money market and there would be a need to replace them with a similar instrument, if their stock were to decrease significantly.

The determination of the accruals to the **supply of government bonds** is implicit in the above assumption about the supply of certificates. This is because in the model all increase in total domestic debt, that is not satisfied by certificates or the National Savings Scheme, has to have the form of bonds. The bond stock can thus be computed as the difference between the domestic debt of the government and the stocks of certificates and of the National Saving Scheme's liabilities.

10. 4 LENDING TO THE PUBLIC

The central government's lending to the corporate-and-household sector is a heterogeneous item. Besides all kinds of loans, in the model it also includes net addition to the capital of public service corporations (*insats i statliga affärsverk*). In terms of the (seasonally adjusted) current-price GDP, lending to the public decreased from 18% in 1985 to 11.5% in 1994. Since 1990 this ratio stabilised, however, round 12-13%.

In the model, the ratio of lending to the public to the seasonally adjusted current-price GDP is in principle assumed to be constant in the long run. The long-run ratio is set to 11%. The seasonally adjusted GDP is represented by a two-term moving average.

In order to limit the variability of the asset, in practice only the marginal ratio is kept constant, by assuming proportionality between the *changes* in the lending to the public and the changes in GDP. For a growing GDP, the long run ratio of the levels of the two variables approaches the proportionality constant.

10. 5 FOREIGN LENDING

Central government loans given to other countries are mainly a form of foreign aid. They are thus subject to political decisions, even if the policy on the whole has been rather stable. In the model, the increase in the loan stock is assumed to constitute a fixed share of the current-price GDP a year earlier. This share is set to 0.3% in the first half-year and 0.5% in the second half-year, respectively.

10. 6 DOMESTIC EQUITY

The domestic equity holdings of the central government are assumed to be constant.

11. THE CENTRAL BANK

11. 1 DEMAND FOR BONDS

The Central Bank's holdings of bonds (in practice government bonds) are assumed to be constant.

11. 2 DEMAND FOR CERTIFICATES

The Central Bank's holdings of domestic certificates are in reality confined to those of the government. This does not have any consequences for the model, since the government and mortgage institution certificates are treated as perfect substitutes.

In the model, the Central Bank is assumed to control the short-term rate of interest which is the one obtaining in the certificate market. Consequently, the Central Bank is postulated to undertake in the certificate market the open market operations necessary to keep the interest rate at the desired level. The open market operations have the form of transactions between the Central Bank and the banks. Since in the model the short interest rate is an exogenous policy parameter, the volume of open market operations becomes endogenous. This can be interpreted as the Central Bank deciding on the desired interest rate level and then performing open market operations until this desired level is achieved.

The Central Bank's holdings of certificates are in the model determined as a residual in the Central Bank's financial balance sheet. This means that they fully adjust to changes in the remaining items of this balance sheet. In particular, a change in banks' net borrowing from the Central Bank is accompanied, *ceteris paribus*, by an equal change in the Central Bank's certificate holdings. This technical arrangement corresponds to the Central Bank intervening in the certificate market in order to affect the interest rate. The variation of banks' net position *vis-à-vis* the Central Bank is then seen as a result of this intervention. Changes in the Central Bank certificate holdings resulting from variation in other (than banks' borrowing) items of the Central Bank finanancial balance sheet are, according to this

approach, interpreted as the open market operations undertaken in order to stabilise (i.e. keep constant) the interest rate.

The amount involved in the open market operation is defined as the change in the Bank's certificate holdings. This reflects the Central Bank's market-clearing role in the certificate market, since - by properties of the double-entry system - the Central Bank holdings are equal to the difference between the supply and demand in the certificate market (defined to exclude the Central Bank).

In model simulations, the Bank's stock of certificates may actually become negative. It would then become a liability rather than an asset. This is interpreted as the Bank having sold the Central Bank certificates for want of those of the government.

11. 3 SUPPLY OF CENTRAL BANK CERTIFICATES

The Central Bank certificates are the Bank's own securities issued since 1993 for monetary policy purposes. In 1994, they accounted for approximately 55% of the banking sector's certificate holdings and approximately 20% of both the insurance sector's and residual sector's certificate holdings.

In the model, Central Bank certificates are treated as perfect substitutes for those issued by the government and mortgage institutions, but they must be separated out as an item in the Central Bank's financial balance sheet. The latter includes only the Central Bank certificate holdings of the insurance and corporate-and-household sectors, the banking sector's holdings being included in banks' net borrowing from the Central Bank.

The supply of Central Bank certificates to the insurance and corporate-and-household sectors is constant in the model. This assumption does not affect the latter sectors' respective demand for certificates, which is determined as an aggregate, without distinction of issuing sector. As mentioned in the section on the Central Bank's demand for certificates, a possibility of an increase in the supply of Central Bank certificates is built into the model.

Such an increase would be understood to have occurred if the Central Bank's stock of government certificates became nagative.

11. 4 FOREIGN RESERVES

Under the floating exchange rate regime, the official foreign reserves are a policy parameter, since the Central Bank can affect the exchange rate through interventions in the foreign exchange market. Changes in foreign reserves are, therefore, in principle exogenous to the model. For simulation purposes, however, some simple assumption is usually called for. The most commonly used assumption is that changes in foreign reserves are zero. An alternative assumption, employed in our model, is that the central government attempts to avoid affecting the exchange rate through capital account transactions. This means that government's capital transactions are sterilised by the Central Bank and, consequently, that changes in the foreign reserves are equal to the government's capital account balance. Foreign holdings of government SEK bonds are in this context approximated as 60% of total foreign holdings of SEK bonds (cf. the section on foreign demand for SEK bonds).

11. 5 NET WEALTH

The net wealth of the Central Bank is built up out of its profits upon the decision of the Board. The remaining profits are transferred to the government: During the period under study, the net wealth of the Central Bank varied between 24% and 46% of total assets (as defined in the model). Most of the time, this share was rather close to 35%. It is probable that it is going to be somewhat lower in the future, more in line with the 31% value of 1994.

In the model, the net wealth of the Central Bank is assumed to constitute a fixed proportion, namely 31%, of total assets.

12. THE FOREIGN SECTOR

12. 1 QUARTERLY DEMAND EQUATION FOR SEK CERTIFICATES

Foreign holdings of SEK certificates are in the model limited to the holdings of government certificates. Foreign purchases of these securities started on a larger scale only in 1991. The period 1991-94 was certainly too short and too turbulent (recall the krona crisis in 1992) to warrant estimation of a regression equation. The equation shown below is therefore to be considered as a convenient assumption. (Test statistics are reproduced as general information for the reader.)

The theoretical underpinnings of the equation postulate that the long-run share of SEK certificates in the foreign portfolio is a function of the foreign/domestic interest rate differential adjusted for the expected rate of depreciation of the krona. The foreign portfolio is represented by the domestic supply of SEK certificates, under the assumption that both exhibit similar trends. The foreign interest rate is represented by the German short-term rate. The expected currency depreciation rate is defined in the same way as in the bond-rate equation.

OLS estimation on a sample of 15 quarterly observations gave the following results:

(53)

$$D(C^f / \overline{C})$$

$$= -0.45194 * (C^f / \overline{C})_{-1} - 0.00185 * (r^{fs} + \varepsilon - r^s)_{-1} + 0.06193$$
$$\quad (3.23452) \qquad\qquad (2.37730) \qquad\qquad\qquad (3.75510)$$

|					
Sum Sq	0.0023	Std Err	0.0140	LHS Mean	0.0078
R Sq	0.4849	R Bar Sq	0.3991	F 2, 12	5.6484
D.W.(1)	2.4376	D.W.(4)	1.5835	Est. per. 1991:2-94:4	

where

C^f - foreign holdings of government SEK certificates.

$\overline{C}$ - total supply of SEK certificates.

The fit of the equation is illustrated in Chart FF.39.

Chart FF.39 Actual values (solid line) and fitted values (dashed) for the equation for foreign holdings of SEK certificates
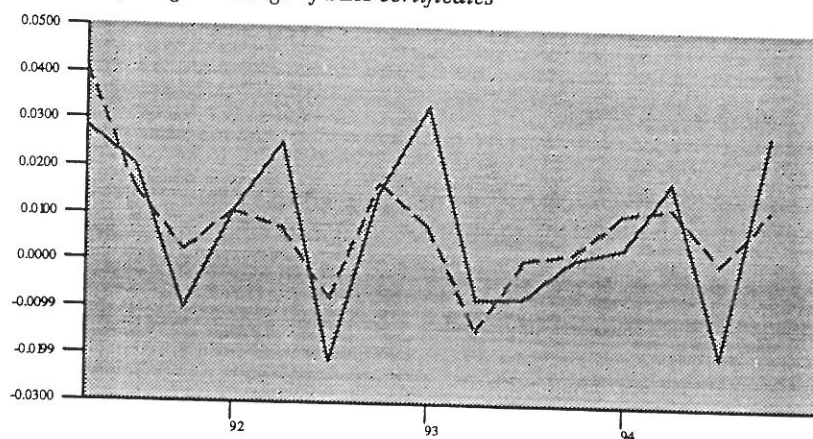
12. 2 QUARTERLY DEMAND EQUATION FOR SEK BONDS

Foreign holdings of SEK bonds consist of both government bonds and housing bonds. In 1994, government bonds amounted to 60% of the stock. As in the case of certificates, the short sample available does not justify regression estimation. Therefore, once again, we will consider the estimated equation as a convenient assumption, test statistics being reproduced only as general information for the reader.

The long-run share of SEK bonds in the foreign portfolio is assumed to be a function of the foreign/domestic interest rate differential adjusted for the expected rate of depreciation of the krona. The foreign portfolio is represented by the domestic wealth variable (cf. the bond interest rate equation), under the assumption that both exhibit similar trends. Another candidate for the scale variable was the domestic supply of SEK bonds, assuming the latter can represent the variation in Sweden's share in a neutral world bond portfolio, foreign investors usually employing these shares as benchmarks. We have opted for the domestic

wealth, since its inclusion resulted in a higher interest rate sensitivity. The foreign interest rate is represented by the German long-term rate. The expected currency depreciation rate is defined in the same way as in the bond-rate equation.

OLS estimation on a sample of 15 quarterly observations gave the following results:

(54)

$D(B^f/W^d)$

$$= -0.37682 * (B^f/W^d)_{-1} - 0.00012 * (r^{fl} + \varepsilon - r^l)_{-1} + 0.02589$$
$$\quad (1.75008) \qquad\qquad (0.28708) \qquad\qquad\qquad (1.62905)$$

Sum Sq	0.0006	Std Err	0.0071	LHS Mean	0.0007
R Sq	0.2488	R Bar Sq	0.1236	F 2, 12	1.9870
D.W.(1)	1.0574	D.W.(4)	2.3495	Est. per 1991:2-94:4	

where
B^f - foreign holdings of SEK bonds,
W^d - domestic wealth (certificates, bonds and money).

The fit of the equation is illustrated in Chart FF.40.

Chart FF.40 Actual values (solid line) and fitted values (dashed) for the equation for foreign holdings of SEK bonds
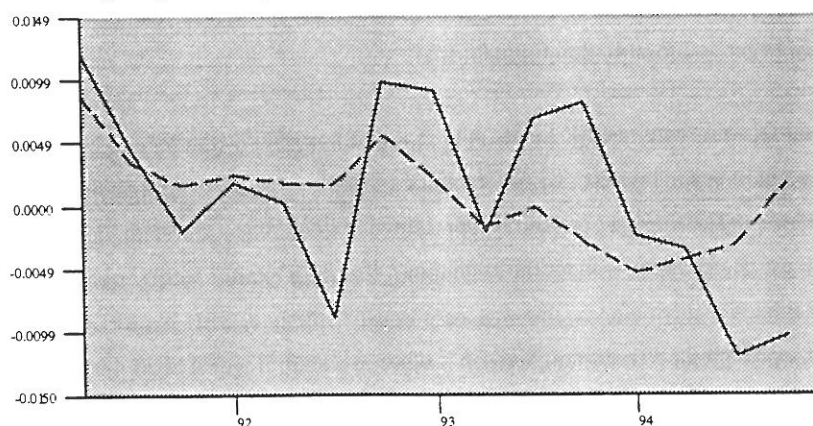
12. 3 DEMAND FOR NET EQUITY

Foreign net equity holdings in the model are defined as foreign holdings of domestic equity minus the corporate-and-household sector's holdings of foreign equity. The variable is negative throughout the period under study, indicating a net claim on the foreign sector. However, this claim decreased from more than SEK 100 billion in 1991-92 to approximately SEK 3.5 billion in 1994.

It is possible that the Financial Account's stock series include sizeable valuation changes (and/or measurement errors) since net stock accruals differ significantly from the corresponding capital account series published by the Central Bank. The largest differences can be observed in 1989-90.

As already mentioned, a thorough modelling of demand for equity is outside the scope for this model, mainly because of the problems with modelling equity yields. Modelling net equity holdings poses even bigger problems, which are furthermore compound by the extremely poor data quality. Since foreign share flows are necessary to close the model, we have resorted to simplifying assumptions and assumed that the net equity flow depends on changes in an aproximative measure of relative yield on equity. The scale variable is GDP.

Thus, according to our assumptions, the ratio of net equity flow to the (seasonally adjusted) current-price GDP is a function of the variation (in current and previous half-year) of the relation between the yield on fixed capital in industry and the yield on bonds. Thus, the sign of the net flow depends on the sign of changes in the relative yield on equity.

OLS estimation on semi-annual data gave the following results:

(55)

$$D(S^f)/(GDP_{-1}+GDP_{-2})$$

$$= \quad 0.21936 * D(rci+rci_{-1}) - 0.00249$$
$$\quad (3.69987) \qquad\qquad (1.08101)$$

Sum Sq	0.0017	Std Err	0.0099	LHS Mean -0.0008
R Sq	0.4461	R Bar Sq	0.4135	F 1, 17 13.6890
D.W.(1)	0.8903	D.W.(2)	1.7596	Est. per. 1985:2-94:2

where

S^f - domestic equity holdings of the foreign sector net of foreign equity holdings of the residual sector,

rci - ratio of the yield on fixed capital in industry to the yield on five-year government bonds.

The fit of the equation, which is based on only 19 observations, is illustrated in Chart FF.41.

Chart FF.41 Actual (solid line) and fitted (dashed) values for the foreign equity equation
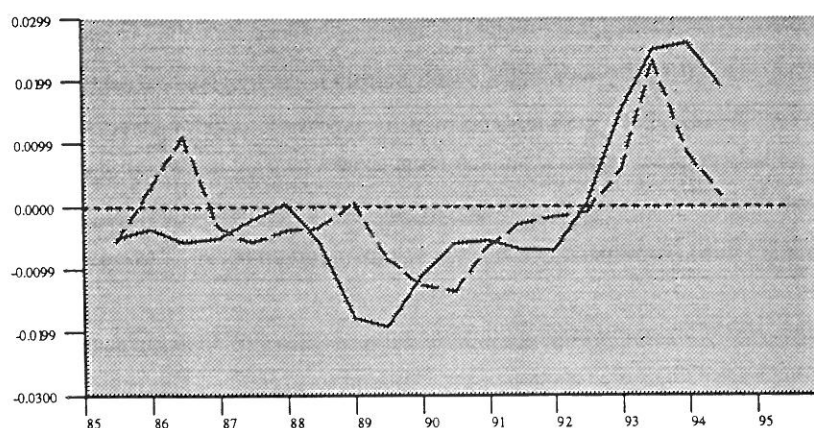
The fit of the equation is rather poor and one could question whether it at all is reasonable to use the whole period 1985-94, in view of the far-reaching changes (such as the abolition of exchange controls and floating of the krona) that have taken place during those years. However, estimation over a shorter period resulted in larger swings in the dependent variable, it was therefore deemed more cautious to opt for the above equation.

One result of this choice is that in steady state (when D(rci) = 0) we have an outflow (i.e. purchase of foreign shares) on the equity account. This outflow amounts to 0.25% of the

GDP during the preceding 12 months. Estimation over a shorter period (1989:2 -94:2) would result in an inflow.

12. 4 NATIONAL NET FOREIGN DEBT

The net wealth of the foreign sector is within the context of the model by definition equal to the national net foreign debt. In contrast to the Financial Accounts, this variable is here defined to include (net) shareholding.

In the model, the change in foreign net wealth is given by the current account balance, since the latter constitutes the net lending of the foreign sector with reversed sign. Thus, the net wealth of the foreign sector is computed as the previous period's net wealth *minus* the current account balance.

In the model's data bank, the national net foreign debt is computed as the sum of other sectors' net wealth with reversed sign.

13. LIST AND DEFINITIONS OF VARIABLES IN THE EMPIRICAL MODEL

The following list gives the definitions of the variables included in the reported equations of the empirical model.

$\overline{B}$ - supply of SEK bonds, i.e. sum of outstanding government and mortgage institution bonds,

B^{cb} - Central Bank holdings of (government) bonds,

B^f - foreign holdings of SEK bonds,

B^m - stock of bonds of the mortgage institutions,

B^r - bond holdings of the corporate-and-household sector,

$\overline{C}$ - total supply of SEK certificates,

C^b - certificate holdings of the banking sector,

C^f - foreign holdings of government SEK certificates,

C^i - domestic certificate holdings of the insurance sector,

C^m - stock of certificates of the mortgage institutions

C^r - total certificate holdings of the corporate-and-household sector,

CapF - change in net foreign liabilities of the private sector, due to market-clearing transactions, SEK mill. (as explained in the text),

Dem - current-price domestic demand excl. public services, i.e. GDP - public consumption - exports + imports,

df90 - dummy variable equal to zero up to and including 1989 and 1 thereafter and

E   - effective exchange rate index expressed in SEK per foreign currency unit,

E/RP - real exchange rate,

E^s — the long-run sustainable effective exchange rate of the krona,

IA — total assets of the insurance sector,

L^r — SEK bank loans and advances to the corporate-and-household sector,

M — bank deposits of the corporate-and-household sector,

M3SEK — SEK M3 (excluding certificates of deposit and including the National Saving Scheme).

N^r — holdings of notes and coin by the corporate-and-household sector,

r^a — average interest rate on bank loans and advances, percent *p.a.*

r^{fl} — foreign long rate of interest (five-year German government bond rate), percent *p.a.*

r^{fs} — foreign short rate of interest (three-month Euro-Deutsch Mark rate), percent *p.a.*

r^l — long rate of interest (five-year government bond rate), percent *p.a.*

r^s — short rate of interest (three-month treasury note rate), percent *p.a.*

rci — ratio of the yield on fixed capital in industry to the yield on five-year government bonds,

RP — relation between Swedish prices and foreign prices (as explained in the text),

SEASi — seasonal dummy equal to 1 in the i-th quarter, zero otherwise. i = 2, 3, 4

S^f — domestic equity holdings of the foreign sector net of foreign equity holdings of the residual sector,

S^i — domestic equity holdings of the insurance sector,

W^d — domestic portfolio investments (i.e. holdings of bonds, certificates and bank deposits) of the banking, insurance and corporate-and-household sectors,

W^{id} — total domestic portfolio assets (bonds plus certificates) of the insurance sector,

W^{rd} — portfolio wealth (i.e. the sum of certificate and bond holdings, bank deposits and claims on the National Savings Scheme) of the corporate-and-household sector,

ε — expected rate of depreciation of effective exchange rate of the krona, percent *p.a.*

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15. APPENDIX . FINANCIAL BALANCE SHEETS FOR THE SECTORS OF THE MODEL

Below, we give the exact financial balance sheets for the seven sectors of the model, as they are derived from the Financial Accounts. Each sector is attributed a single letter of alphabet which is subsequently used to designate its assets and liabilities. Thus, for example, the assets of the Central Bank are denoted A1, A2, ... through A5. The liabilities of the Central Bank are denoted as A6, A7, ... through A9. These names are given in front of each item. The name of the asset corresponding to a given liability (and *vice versa*) is given in parentheses after the item description. Each item which is an asset of one sector and a liability of another sector thus has two names.

Sector definitions and comments on foreign liabilities and insurance savings given above in connection with Table FF.1 apply here. Furthermore, it should be noted that beginning in 1994, the central government is neither allowed to borrow from nor to deposit funds with the Central Bank (cf. items A2 and A7).

Sector A   <u>Central Bank (*CB*)</u>

    Assets   **Liabilities**

A1 Net loans to *Banks* (B8)   A6 Notes and coin (F1)

A2 Short-term lending to *Gov* (E7)   A7 Deposits from *Gov* (E2)

A3 *Gov* bonds (E6a)   A8a Certificates held by *Res* (F3d)

A4 *Gov* certificates (E5a)   A8b Certificates held by *Ins* ((D2c)

A5 Foreign reserves (G6)   A9 Net wealth

Sector B   <u>Banks</u>

    Assets   **Liabilities**

B1a *Gov* certificates (E5b)   B5 Deposits of *Res* (F2)

B1b *Mor* certificates (C3a)   B6 Certificates held by *Res* (F3c)

B2a *Gov* bonds (E6b)   B7 Net foreign currency liabilities (G4)

B2b *Mor* bonds (C2a)   B8 Net borrowing from *CB* (A1)

B3 Advances and loans in SEK to *Res* (F8b)   B9 Net wealth

B4 Domestic equity (F9a)

Sector C   <u>Mortgage Institutions (*Mor*)</u>

    Assets   **Liabilities**

C1 Loans to *Res* (F8a)   C2a Bonds held by *Banks* (B2b)

                                           C2b Bonds held by *Ins* (D3b)

                                           C2c Bonds held by *Res* (F4b)

                                           C2d SEK bonds held by *For* (G2d)

                                           C2e Foreign-currency bonds (G2b)

                                           C3a Certificates held by *Banks* (B1b)

                                           C3b Certificates held by *Ins* (D2b)

                                           C3c Certificates held by *Res* (F3b)

                                           C4 Net wealth

Sector D   <u>Insurance Sector (*Ins*)</u>

Assets

D1 Foreign-currency assets (G7)

D2a *Gov* certificates (E5c)

D2b *Mor* certificates (C3b)

D2c *CB* certificates (A8b)

D3a *Gov* bonds (E6c)

D3b *Mor* bonds (C2b)

D4 Loans to *Res* incl. inter-group loans (F8c)

D5 Domestic equity (F9c)

Liabilities

D6 Insurance savings of *Res* (F5)

D7a Net wealth of private insurance ent.

D7b Net wealth of social security

Sector E   <u>Central Government (*Gov*)</u>

Assets

E1 Loans to *Res* (F7)

E2 Deposits with *CB* (A7)

E3 Domestic equity (F9b)

E4 Loans to *For* (G8)

Liabilities

E5a Certificates held by *CB* (A4)

E5b Certificates held by *Banks* (B1a)

E5c Certificates held by *Ins* (D2a)

E5d Certificates held by *Res* (F3a)

E5e SEK certificates held by *For* (G3b)

E5f Foreign-currency certificates (G3a)

E6a Bonds held by *CB* (A3)

E6b Bonds held by *Banks* (B2a)

E6c Bonds held by *Ins* (D3a)

E6d Bonds held by *Res* (F4a)

E6e SEK bonds held by *For* (G2c)

E6f Foreign-currency bonds (G2a)

E7 Short-term borrowing from *CB* (A2)

E8 National Savings Scheme (F6)

E9 Net wealth

Sector F   <u>Corporate-and-Household (or Residual) Sector (*Res*)</u>

Assets	Liabilities
F1 Notes and coin (A6)	F7 Loans from *Gov* (E1)
F2 Bank deposits (B5)	F8a Loans from *Mor* (C1)
F3a *Gov* certificates (E5d)	F8b SEK loans from *Banks* (B3)
F3b *Mor* certificates (C3c)	F8c Loans from *Ins* (D4)
F3c Bank certificates (B6)	F9a Equity debt to *Banks* (B4)
F3d *CB* certificates (A8a)	F9b Equity debt to *Gov* (E3)
F4a *Gov* bonds (E6d)	F9c Equity debt to *Ins* (D5)
F4b *Mor* bonds (C2c)	F9d Net equity debt to *For* (G5)
F5 Insurance savings (D6)	F10 Net foreign-currency liabilities (G1)
F6 National Savings Scheme (E8)	F11 Net wealth

Sector G   <u>Foreign Sector (*For*)</u>

Assets	Liabilities
G1 Net foreign currency liabilities of *Res* (F10)	G6 Foreign reserves of *CB* (A5)
G2a *Gov* foreign-currency bonds (E6f)	G7 Foreign-currency assets of *Ins* (D1)
G2b *Mor* foreign-currency bonds (C2e)	G8 Loans from *Gov* (E4)
G2c *Gov* SEK bonds (E6e)	G9 National net foreign debt
G2d *Mor* SEK bonds (C2d)	
G3a *Gov* foreign-currency certificates (E5f)	
G3b *Gov* SEK certificates (E5e)	
G4 Net foreign currency liabilities of *Banks* (B7)	
G5 Net domestic equity (F9d)	

FINANSIELLT BLOCK I KOSMOS
SVENSK SAMMANFATTNING

I föreliggande uppsats beskrivs den allmänna strukturen samt de enskilda relationerna i det finansiella blocket av den ekonometriska modellen KOSMOS. Uppsatsen är begränsad till själva modellbeskrivningen, simuleringsresultat redovisas i Kragh och Markowski [1997].

Den finansiella modellen omfattar sju sektorer (Riksbanken, staten, banker, mellanhandsinstitut, privat- och socialförsäkring, utlandet samt en övrigsektor som inkluderar bl. a. icke finansiella företag, kommuner och hushåll) och nio tillgångskategorier (certifikat, obligationer, bankinlåning, lån, aktier, utländska tillgångar netto, sedlar och mynt, försäkringssparande och - slutligen - allemanssparande). Vikten lades i första hand vid modellering av efterfrågan på obligationer och certifikat som i sin tur påverkar den långa räntan och penningmängden. Sektorefterfrågan på aktier är - med två undantag - bestämd exogent, bl. a. på grund av svårigheter med att modellera aktieavkastning.

Den finansiella sektorn påverkar resten av KOSMOS *via* räntorna, växelkursen och penningmängden, vilka har effekter på fasta investeringar, privat konsumtion, utrikeshandel och kapitalflöden. Den finansiella modellen är dock mera detaljerad än vad som krävs för att bestämma enbart de finansiella länkarna. Detta beror på att modellering av förändringar i de finansiella portföljerna - och i synnerhet olika sätt att finansiera statens budgetunderskott - ansågs vara av intresse *per se*.

Modellens struktur är ganska enkel, trots det relativt stora antalet tillgångar. Eventuella förfiningar av modellsambanden samt endogenisering av ytterligare variabler har lämnats till senare modellversioner. Ansatsen är eklektisk. Den utgår från en portföljvalsmodell, men portföljen ifråga begränsas till certifikat, obligationer, bankinlåning och utländska nettotillgångar. Anskaffning av de övriga tillgångarna antas bero på andra hänsyn än portföljinvesteringar. Själva portföljbeslutet antas vara sekventiellt; i första steget väljer man mellan utländska och inhemska tillgångar medan i andra steget bestäms sammansättningen av den inhemska portföljen.

Vår analys av sektorportföljerna indikerar att anpassning till avkastningsvariationer sker i de flesta inhemska sektorer endast på marginalen. Porföljandelar påverkas ganska litet av räntevariationer. Det enda undantaget utgörs av övrigsektorn vars långsiktiga ränteelasticitet uppgår till 2. Man kan också notera att obligationer är volymmässigt ett mycket större investeringsobjekt än certifikat.

Modellens databas har kompilerats ur Finansräkenskaperna vars årsdata för perioden 1986-94 fördelades på halvår (och i vissa fall även på kvartal) med hjälp av data från andra källor. Databasen bildar för varje period en 64×64 matris där en sektors tillgång är en annan sektors skuld.

Eftersom de tillgängliga tidsserierna var korta, tillämpades en ganska ovanlig metod för att öka de skattade parametrarnas tillförlitlighet. Regressionsskattningar gjordes, där det var möjligt, på kvartalsdata; de skattade ekvationerna transformerades sedan till halvårsekvationer för att uppnå överensstämmelse med övriga KOSMOS. I detta syfte använde vi en teknik för temporal aggregering av ekvationer, för ändamålet utvecklad i Ruist [1996].

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