The BOF4 Quarterly Model of the Finnish Economy

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PREFACE

Purpose and use of the BOF models

The building of a large-scale macroeconometric model (which was to be known as the BOF or Bank Of Finland model) was started at the Bank of Finland in 1970. The aim of this work was to develop a model which would be suitable for forecasting and for evaluation of alternative macroeconomic scenarios. The first version of the model became operational in 1973.

In accordance with the initial goals, the BOF model has, over the years, developed in to a central tool of forecasting and economic analysis at the Bank. In connection with forecasting, the model is also regularly used to generate alternative scenarios for assessing various uncertainties in forecasting assumptions and for evaluating policy alternatives necessary to alleviate the imbalances which turn up in the forecasts. Although the model is intended mainly for the internal use of the bank, calculations have also been carried out for some government committees and working groups.

The development work of the model accumulates empirical research on the Finnish economy. Although the model work draws on the results of different partial studies, the model is also used as an analytical tool in various applied research projects. In addition, the data base of the model has been frequently used in research external to the model, since it constitutes the most comprehensive quarterly description of the Finnish economy.

There is much international cooperation in the construction of macroeconomic models. The Bank of Finland has participated in this cooperation through the BOF models. Since 1973, the model has been a part of the global econometric model of the international project LINK, and the Bank has participated in the forecasting and research meetings of the project. At the Nordic level, the modelling teams of the Scandinavian central banks, finance ministries and statistical offices have been the main partners in cooperation.

The BOF4 Model

The present version of the model, BOF4, represents the fourth generation in the development of the Bank of Finland's quarterly macroeconomic models. The BOF4 version was introduced in early 1987, but it was entirely revised shortly afterwards as a result of a change in the base year of the official national accounts.

The size of the model has increased somewhat compared to the preceding BOF3 version of the model: instead of about 200 equations the model now contains some 270 equations. On the one hand, this is due to the decision to disaggregate business investment and the stock of fixed capital by sector in the same way as production, employment and price formation are disaggregated. On the other hand, the treatment of general government as a production sector of its own has increased the number of sectors in the model from four to five.

The theoretical properties of the model closely resemble the previous version of the model. Thus, production and employment are determined by aggregate demand in the short run, but as a result of price and wage adjustment, the long-run properties of the model are neo-classical, i.e. determined from the supply side. Several improvements have been made in the modelling of the supply side, however. Owing to the disaggregation of the stock of fixed capital by sectors, the approach of the BOF4 model is more consistent than that of its predecessors, and it also closely follows the standard textbook treatment of the supply side. The technology assumption regarding the production of value-added in the five sectors has been changed from the earlier Cobb-Douglas specification to CES production functions. This change has required respecification of the wage, price, employment and investment equations.

One of the main reasons for constructing the BOF4 model is the structural change that has occurred in the Finnish financial markets. The earlier generations of the BOF models were constructed to take into account the administrative regulation of interest rates which previously prevailed in the Finnish credit market. The deregulation of interest rates and the money market in the mid-1980s has, however, made it possible to apply standard macro-economic models in Finland, which assume unregulated financial markets.

This development has been taken into account in the structure of the BOF4 model. The financial sector of the model is now constructed entirely in the mainstream tradition of macroeconomic modelling, assuming that market-clearing interest rates equilibrate the demand for and the supply of money. An attempt has been made to take into account the effects of financial deregulation on e.g. the interest elasticities of foreign capital movements and the demand for money.

The present publication

This book has been compiled from a series of reports published in the Bank of Finland's Discussion Paper series in 1988 - 1990. Only minor changes and corrections have been made to the original papers during the editing of the book, which presents the model as it stood in the autumn of 1989.

The previous generations of BOF models have been presented in the Bank of Finland's publication series D:29 (BOF1, 1972) and D:59 (BOF3, 1985). The BOF2 version used in the latter half of the 1970's has not been fully documented in a single publication, but it was reviewed in a report published in 1976 on fiscal policy effects (D:38) and in a number of articles and unpublished mimeographs. All in all, the BOF model project has given rise to dozens of published reports, the most important of which are listed in a bibliography at the end of the book.

The first chapter describes the macroeconomic foundations of the BOF4 model and presents results from simulation experiments carried out with it. The following chapters review the structure of the model block by block. A complete list of equations and variables is given in an appendix. To avoid repetition, the actual equations are not presented in the text. Rather, reference is made to the list of equations in the appendix.

This publication does not include the flexible exchange rate version of the model, which has been presented in a separate article by Alpo Willman (Finnish Economic Papers vol. 2, no. 1, 1989). We have not been able to include the completely revised housing market block, which was built during the autumn of 1989.

The authors of each chapter are separately indicated. They were assisted in the building and documenting of the BOF4 model by Anne Kolehmainen, Aila Koivunmaa and Maritta Lavikko. The word processing was done by Päivi Lindqvist and the language was checked by Malcolm Waters.

Helsinki, May 1990

Heikki Koskenkylä Kari Puumanen

CONTENTS

Juha Tarkka, Hanna-Leena Männistö and Alpo Willman

I MACROECONOMIC FOUNDATIONS AND SIMULATION PROPERTIES OF THE BOF4 MODEL

Abstract

This paper describes the structure and simulation properties of the Bank of Finland's macroeconometric model BOF4. This paper first appeared in the Bank of Finland Discussion Paper series in January 1990, series no. 2/90. A preliminary version was presented in the Nordic symposium of economic modelling in Oslo, September 12 - 14, 1989.

BOF4 is a quarterly, medium-sized macro model of the Finnish economy, consisting of about 70 behavioural equations. Including accounting identities and technical linkages of variables, the overall size of the model is about 270 equations. It replaced the previous (BOF3) model version in 1987, and has been used regularly thereafter for forecasting and policy analysis.

The macrotheoretical foundations of the model are in the conventional IS-LM-AS framework adapted for the analysis of an open economy. The relation of the BOF4 model to this analytical framework is discussed in the first part of the paper with the help of a simplified, theoretical "prototype" version of the model.

In the second part of the paper, the simulation properties of the actual model are described. The ability of the model to replicate actual economic developments are tested by means of historical (ex post) simulations. Finally, the responses of the model to international shocks and economic policy actions are examined with another set of simulation experiments.

The behaviour of the model in simulation experiments highlights the "neoclassical synthesis" properties of the model: the short-run results are strongly demand-determined, while the supply side influences dominate in the long run.

I.1 Introduction and Summary

The BOF4 model of the Finnish economy is a quarterly econometric model developed and used at the Bank of Finland. The current BOF4 version has been operational since the beginning of 1987. It represents a fourth generation in the development of large scale, quarterly macroeconometric models in the Bank after the work on such models was initiated in the beginning of the 1970's. This paper presents an overview on the structure and properties of the BOF4, including some simulation results to illuminate the working of the model.[1]

The purpose of the model is to serve as an aid to short- and medium-term forecasting and policy analysis. As a research effort, the model provides a basis for accumulating applied econometric results, which otherwise might remain isolated and not appropriately utilized. Finally, the performance of the model is a kind of test for the mainstream macroeconomic paradigm which has been employed in the construction of BOF4. One of the outstanding features of the model is that its structure follows rather closely - notwithstanding certain extensions and attempts to disaggregate further - the standard open economy version of the "IS-LM-AS" model, widely used in applied economic analysis.

Technically, the model is a system of 272 equations. These may, somewhat arbitrarily, be classified in the following way:

70	stochastic behavioural equations
30	stochastic technical linkages of variables
6	input-output equations determining production
9	input-output equations determining prices
157	definitions and accounting identities
272	total number of equations

[1]The earlier versions, BOF1, BOF2 and BOF3 are documented in "A Quarterly Model of the Finnish Economy" (1972), "Suomen Pankin suhdannemalli" (1976), and in Tarkka and Willman (1985). Preliminary list of equations of the BOF4 model is published as Tarkka and Willman (1987).

The data of the model consists of 352 variables, excluding dummies. As the number of endogenous variables equals 272, the number of equations, there are 80 variables which remain exogenous in the system. The data are quarterly, seasonally adjusted where appropriate, and mostly from national accounts, balance of payments and banking statistics sources. A number of variables which do not exist on a quarterly basis in the official sources have been constructed specifically for the BOF model.

The most important differences of the present model from the previous and extensively documented BOF3 version are the following: (1) the disaggregation of fixed investment and stocks of fixed capital by sectors; (2) the use of the inverted production functions to solve for the required labour inputs; (3) the change in the technology assumption from Cobb-Douglas to CES technology in the production of value added on each sector; (4) the separation of public services form private services to a sector of its own; and (4) the use of market rates of interest to transmit monetary influences to the real side of the model, instead of the bank lending rate and credit rationing proxy which were used in the previous version.

The economic content of BOF4 may be briefly characterized as follows. The short-run determination of production, incomes and employment is governed by aggregate demand as in the Keynesian income-expenditure model. In BOF4, 16 different categories of aggregate demand and 5 categories of imports are distinguished. These determine the real value added on 5 production sectors by means of a compact input-output framework. In the course of time, however, the supply side comes to play an increasingly dominant role. Wages and prices respond to possible discrepancies between demand and supply on the product and labour markets, and there is a gradual convergence towards a supply-determined long-run growth path of the economy. In this way, the model belongs to the "neoclassical synthesis" tradition of macroeconomics as defined, e.g., by Parkin (1982).

Consistent modelling of the supply side was emphasized in building the BOF4 model. The supply side of the labour market consists of a labour force participation equation (labour supply) and wage equations which include the Phillips curve effect. The modelling of the supply side of the goods market is based on an assumption of a CES value added production function for each of the five production sectors. Inverted production functions are used to solve for required labour inputs; the production functions are also used in calculating marginal costs of production and marginal products of fixed capital, which drive the price and investment equations of the model. Thus the model takes into account the supply-side effects of fixed investment on the stocks of fixed capital and on the development of productivity in the different sectors of the economy.

Expectations concerning future inflation, which are crucial for the wage-employment dynamics of the model, are assumed to be based on past inflation and on the deviation of the price of the Finnish exports of goods from the competitors' export prices. The inclusion of the latter term results from the fact that in the long-run the Finnish exporters are assumed to be price takers and, hence, domestic inflation can not permanently deviate from foreign inflation (both measured in a common currency). The long-run Phillips curve implied by the wage and price equations of the model is not constrained to be vertical. This means that inflation is allowed to have permanent effects on real wages in the model, contrary to the most extreme neoclassical position.

The modelling of the financial side of the economy follows the "monetary" tradition in the sense that the focus is on the supply of and demand for broad money. The market for other domestic financial assets is treated residually as is conventional in the IS-LM framework. Foreign assets are assumed to be imperfect substitutes to domestic assets. Taken together with the "monetary" approach of modelling the domestic financial markets this leads to the model of partial monetary autonomy first developed by Kouri and Porter (1974). The market rate of interest is used to link the financial part of the model to the aggregate demand equations. The short-term market rate of interest can be treated either as a policy instrument or as endogenous. In the latter case, the domestic credit extended by the central bank is treated as exogenous. Exchange rates are assumed fixed in the model.

The simulation results reported in this paper reveal the existence of the "traditional" short-run tradeoffs between employment, inflation and external balance of the economy in the model. At least in the case of fiscal policy, the real effects are weaker than in the previous BOF model versions, however. In the long run, the scope for macroeconomic stabilization policy is much more limited than in the short run. In particular, even when fiscal expansion is implemented in the regime of accommodating monetary policy, there is full crowding out effect of fiscal expansion on domestic production in the long run. In this process the Finnish exports to the western market play a central role; they decrease until the cost pressures caused by fiscal expansion are fully neutralized. In the case of exchange rate policy, real effects are similarly reduced in the long run by price and wage flexibility. And, finally, the room for manoeuvre of monetary policy is narrowed in the long run by cumulative balance-of-payments effects of monetary expansion or contraction.

The rest of this paper is organized as follows. In chapter 2 the theoretical structure of the BOF4 is described by means of a simple and aggregative "prototype" model containing most of the outstanding features of the full empirical model. The simulation properties of the model are discussed in chapter 3. Detailed tables on the results of the simulation experiments are presented in appendices 1 (on policy experiments) and 2 (on ex post forecast).

I.2 A Theoretical Prototype Model

A frequently encountered problem in studying an econometric model is the difficulty of "seeing the forest for the trees": the amount of detail that has to be included in any model that is intended to be useful in practice makes it hard to locate the crucial parts and relationships. In this section we present a simplified "prototype" version of BOF4, which contains the essential features of the full model. This is hoped to enable the reader to recognize the basic genre of the BOF4 model.

I.2.1 The Simplified Structure

Our prototype model differs from the actual BOF4 in that the sectoral disaggregation of production has been entirely omitted. The composition of aggregate demand has been simplified by skipping the separate treatment of inventories, housing investment, bilateral exports and so on. Most of the institutional details in the government sector and in the distribution of the disposable income have also been excluded. For example, indirect taxes and interest payments by the Government have been disregarded. Government deficit is assumed to be financed exclusively by domestic bond issues. The supply of labour is treated as exogenous, although it is somewhat wage and income elastic in the actual model.

The functional forms and dynamics of the equations have been strongly simplified so that the model is for the most part linear or log-linear, and dynamics consist only of a Phillips curve, two partial adjustment mechanisms, two stock-flow identities connecting the balance of payments to the money supply and investment to the fixed capital stock, and, finally the definitional link from the rate of change of prices to the real rate of interest.

The symbols used in the exposition of the prototype model are mostly conventional enough to be self-explanatory. Nevertheless, a list of symbols is given after the model has been presented.

The model is a model of a small, open economy. We distinguish between three goods: (i) a domestic good which is produced in the country and both exported and used at home, (ii) an imported good which is used to satisfy a part of domestic investment and consumption demand, and (iii) a foreign good which competes with the domestic good in the export market. The domestic good is produced with a technology which uses labour, capital, and the imported good as inputs. The production function is CES for the value added and the input coefficient of the imported input is a constant.

Aggregate Demand:

(1) $\log C = \mu_c \cdot \log Y_d + a \cdot \log[M/(P_c \cdot Y_d)] + (1-\mu_c) \cdot \log C_{-1}$ (Consumption)

(2) $I = \Delta K + d \cdot K_{-1}$ (Investment)

(3) $\Delta \log X = \Delta \log IM_f + b_0 \cdot \log(e \cdot P_f/P) + b_1 \cdot \Delta \log(IM \cdot e \cdot P_{im}/P)$ (Exports)

(4) $\log IM = c_0 \cdot \log Y - c_1 \cdot \log(e \cdot P_{im}/P)$ (Imports)

(5) $Y = C + I + G + X - IM$ (Goods Market Equilibrium)

(6) $Y_d = (P_y \cdot Y - T)/P_c$ (Real Private Disposable Income)

Consumption (equation 1) is mainly determined by real disposable income and liquid financial wealth of the private non-bank sector. The equation includes lagged consumption as an argument, which makes the equation compatible with the permanent income model with adaptive expectations on real income. The effects of interest rates and inflation are weak enough in the model to be excluded in this simplified version.

The modelling of investment follows the neoclassical approach. This is discussed below in connection with the other supply side equations. Equation (2) above shows gross investment as a function of replacement investment and of the net change of the stock of fixed capital.

The change in the demand for exports (equation 3) depends with unitary elasticity on the change in the volume of the imports of

Finland's trading partners as well as on the ratio of export prices to the prices of competitors' exports. Hence, the market shares of exports decrease (increase) as long as the export price is above (below) the competing world market price implying infinite price elasticity of the demand for the Finnish exports. The effects of Finland's bilateral trade with the Soviet Union are captured by the inclusion of the deflated value of imports in the export demand equation as an argument. In the full BOF4 model, a part of Finnish imports is satisfied by imports from the U.S.S.R. and bilateral exports adjust over time to achieve a balance in the bilateral trade.

Imports (equation 4) depend on the level of domestic activity as well as on the relative prices of imports and domestic goods.

Equation (5) is the usual goods market equilibrium condition. Real private disposable income is defined by equation (6).

Aggregate Supply: Productivity and Factor Demand

(7) $$\Delta \log N = \mu_n \{\log Y - \log[A \cdot \exp(\gamma \cdot TIME) \cdot (aK^{-\rho} + (1-a)N^{-\rho})^{-1/\rho}]\}$$ (Demand for Labour)

(8) $$MPN = h \cdot \exp(\gamma \cdot TIME) \cdot [a(K/N)^{-\rho} + (1-a)]^{-(\rho+1)/\rho}$$ (Marginal Product of Labour)

(9) $$MPK = j \cdot (Y/K_{-1})^{1+\rho} \cdot \exp(-\gamma\rho \cdot TIME)$$ (Marginal Product of Capital)

(10) $$\Delta \log K = \mu_k \cdot (MPK \cdot P_y/P_k - UC)$$ (Demand for Fixed Capital)

The supply side of the model consists of two parts. The first includes equations determining productivity and factor demand. The change in the actual labor demand is determined by the deviation of actual production from the level defined by aggregate CES production function (equation 7). In the long run this partial adjustment mechanism adjusts the labor demand towards the level defined by the inverted CES function. The partial derivatives of the production function define marginal products of labour and capital (equations 8 and 9). Technical progress is captured by the inclusion of a time trend in the productivity functions. It is worth noting that the marginal product of labour (equation 8) is measured in terms of K/N instead of Y/N. This practice makes sure that also in the short run a positive demand shock decreases the marginal product of labour. We thus avoid the notorious problem of short-run increasing marginal productivity, which in many models leads to perverse reactions of prices to demand shocks.

The modelling of the demand for fixed capital can be seen as a result of the neoclassical profit-maximization approach with convex adjustment costs. Assuming static expectations on relative prices and the marginal product of capital, this yields a formulation in which the rate of change of the capital stock reacts to the gap between the marginal product and the user cost of capital - the so-called quasi-rent on fixed capital (equation 10).

Aggregate Supply: Price and Wage Behaviour

(11) $\Delta \log W = d_0 \cdot INF^e + \mu_u \cdot \log(N/NF) + \mu_w \cdot \log(MPN \cdot P_y/W) + q$

(Adjustment of Nominal Wages)

(12) $INF^e = (1 - \alpha_0) \cdot [\pi + \alpha_1 \cdot \log(e \cdot P_f/P)] + \alpha_0 \cdot \Delta \log P_c$

(Expected inflation rate)

(13) $P = (1-a_1) \cdot W/MPN + a_1 \cdot e \cdot P_{im}$ (Price of Domestic Output)

(14) $P_y = P/(1-a_2) - e \cdot P_{im} \cdot a_2/(1-a_2)$ (Value Added Deflator)

(15) $P_c = (1-a_3) \cdot P + a_3 \cdot e \cdot P_{im}$ (Consumption Deflator)

(16) $P_k = (1-a_4) \cdot P + a_4 \cdot e \cdot P_{im}$ (Investment Deflator)

(17) $UC = i + d - INF^e$ (Real User Cost of Capital)

The wage/price part of the supply side contains three behavioural equations and four definitions. The nominal wage adjustment equation (11) includes a Phillips curve effect augmented with an inflation term and a measure of the "real wage gap". Here the Phillips curve effect of employment on wages is entered through the ratio of employment to exogenous labour supply; in the actual BOF4 model, however, the Phillips curve is a function of the unemployment rate and labour force participation is endogenized. In addition, the effects of changes in personal taxation are included. The real wage gap is measured by the ratio of real product wages to the marginal product of labour (note that social security payments do not exist in this prototype model).

The relationship of the wage equation (11) of our model to the standard expectations-augmented Phillips curve may deserve a brief comment. If in (11) the coefficient of the expected inflation rate were equal to one, the equation would produce classical or "perfect foresight" dynamics for wages. However, the coefficient is actually smaller than one (about 0.7 as inferred from the parameters of the full BOF4 model).

In equation (12) the expected inflation rate is defined as a weighted average of the long-run core and the actual average inflation rates. The definition of the core inflation rate brings the aspect of forward-lookingness into the expectation formation; market participants know that the more the domestic price level is above the competing foreign price level the lower the inflation rate has to be in the future to reverse the long-run price parity.

The prices of output are proportional to marginal cost of production (equation 13). It is assumed that the production of the domestic good requires real value added and the imported good in fixed proportions ($1-a_2$) and a_2. This implies also that equation (14) holds between the value added deflator and the prices of domestic and imported goods. Moreover, from (13) and (14) it can be seen that the value added deflator is proportional to W/MPN.

Private consumption and fixed investment are assumed to use the domestic good and the imported good in fixed proportions (equations 15 and 16). Note that although indirect taxes are not taken into account in this prototype model, they are included in the actual BOF4, where they considerably complicate the prices block of the model.

The equation (17) defines the real user cost of fixed capital as a function of the interest rate, the expected inflation rate and the depreciation coefficient of fixed capital. The actual formulas used in BOF4 are more complicated due to the inclusion of corporate tax parameters.

Government:

(18) $T = t \cdot P_y \cdot Y$ (Tax Function)

(19) $\Delta B = T - P_y \cdot G$ (Government Budget Constraint)

The tax function (equation 18) and the government budget constraint (equation 19) are shown here in an extremely simplified form. For example, the options of financing the government deficit by Central Bank credit or by foreign borrowing are here overlooked.

Financial Markets:

(20) $\Delta R = P \cdot X - e \cdot P_{im} \cdot IM + \Delta F$ (Balance of Payments)

(21) $F = f \cdot (i - i_f) \cdot Y \cdot P_y$ (Demand for Foreign Debt)

(22) $M = (m_0 - m_1 \cdot i) \cdot Y \cdot P_y + (1-\mu_m) \cdot M_{-1}$ (Demand for Broad Money)

(23) $S = s \cdot C \cdot P_c$ (Demand for Currency)

(24) $D = S + k \cdot (M - S) - R$ (Demand for Central Bank Credit)

(25) $M = R + D + L - CD$ (Money Supply by Credit Components)

In the simplified financial block, three types of assets are distinguished: net foreign assets, money, and domestic non-monetary assets. All domestic non-monetary assets are assumed to be perfect substitutes with each other. Accordingly, we need not deal with more than one domestic market rate of interest.

The balance-of-payments identity (equation 20) determines the change in the foreign reserves of the Central Bank as a sum of the trade balance and capital inflow.

The foreign capital movements - or, rather, the stock demand for foreign debt - are explained by a portfolio equation (21). Exogenous exchange rate expectations may be thought to be included in the foreign interest rate i_f. In the actual BOF4 model, the capital movement equation is estimated in the so-called Kouri-Porter form: in differences and with the domestic interest rate eliminated by inserting the inverted demand-for-money equation in its place.

The demand for broad money is given by equation (22). Here the inverse velocity depends linearly on the market rate of interest. In addition, a partial adjustment mechanism in a nominal form has been specified. The demand for currency (notes and coin) is a simple transactions relationship where the value of private consumption determines the need for transactions balances (equation 23).

The demand for domestic credit from the Central Bank is defined as the demand for currency plus the demand for required bank reserves (a fixed proportion k to deposit money M-S) minus foreign reserves (equation 24). Finally an identity (equation 25) decomposes the money supply into its "credit components". Domestic bank credit is here divided into central bank credit, credit from the deposit banks, and money market deposits at banks (which are treated as negative credit due to their exclusion from the definition of money). The identity (25) is capable only of determining the difference L - CD, a "net" bank credit concept. To determine separately both L and CD, an additional equation for the supply of gross bank credit L has been estimated in the complete BOF4 model. For the purposes of the present analysis that equation is not necessary, however.

The model may be solved with different assumptions on the monetary policy pursued by the Central Bank. In the version of the model presented here, the exchange rate is assumed to be fixed. However, as regards to the domestic side of monetary policy, the Central Bank may alternatively be assumed to peg the market rate of interest or fix its domestic credit. Under certain assumptions, the model can also be used to analyze monetary policy operating through quantitative control of bank lending (credit rationing).

List of Symbols:

B	the stock of government bonds outstanding
C	private consumption (real)
CD	money market deposits at banks
D	domestic credit of the central bank
d	depreciation rate of fixed capital
e	the exchange rate
F	the stock of net foreign debt
G	government consumption (real)
I	investment (real)
IM	imports (real)
IM_f	imports of foreign countries (real)
i	the rate of interest
i_f	the foreign rate of interest
K	the stock of fixed capital (real)
k	cash reserve requirement
L	bank credit (excl. central bank)
M	the supply of broad money
MPK	marginal product of capital
MPN	marginal product of labour
N	employment (=demand for labour)
NF	labour force (=supply of labour)
P	the price of domestic output
P_c	consumption deflator
P_f	the price of foreign goods in foreign currency
P_{im}	the price of imported goods in foreign currency
P_k	investment deflator
P_y	the value added deflator
R	foreign reserves (of the central bank)
S	currency
T	taxes
t	the tax rate
TIME	linear time trend
UC	real user cost of capital
W	the nominal wage rate
X	exports (real)
Y	production (real)
Y_d	private disposable income (real)

Negative subscripts denote lags.

I.2.2 The Short-Run Properties of the Model

A standard way to scrutinize the short-run properties of a model such as developed in equations (1) to (25) above is to derive the IS, LM, and AS schedules implicit in the model and to study the comparative statics of income, prices, and the interest rate when the model is subject to changes in its exogenous variables. The comparative statics analyzed below characterize the immediate impact effects of different exogenous changes on the model. In a longer perspective the properties of the model come to depend on the dynamics of the equation system, such as the accumulation of capital or the adjustment of real wages towards a labour market equilibrium. These processes are, however, so complicated that they are best studied by simulating the full model.

I.2.2.1 The IS Function

The IS schedule - or the aggregate demand for goods equation conditional on the rate of interest and the price level - may be derived by substituting the equations for the different demand components to equation (5), the goods market equilibrium condition. After using the equations for M, Y_d, T, B, ΔlogK, MPK, P^c, P_k and P_y to eliminate the respective variables, an IS curve of the following type is obtained:

$$(26) \qquad Y = IS(\underset{-}{i},\ \underset{(-)}{P},\ \underset{+}{e \cdot P_f},\ \underset{(+)}{e \cdot P_{im}},\ \underset{+}{G},\ \underset{-}{t},\ \underset{+}{IM_f},\ TIME,\ \underset{+}{DLAGS})$$

The signs of the partial derivatives of the IS function - i.e. the partial derivatives of aggregate demand holding the rate of interest and the price level constant - are shown below the equation. If the sings are ambiguous, we report in parenthesis the results of simulations with the relevant equations of the BOF4 model. Since the interest here is on comparative statics, the presentation of dynamics is simplified by collecting all lagged variables in a composite variable DLAGS. This contains, for example, the lagged stocks of financial assets and fixed capital. For static analysis, these are unimportant but they are of course crucial for the dynamics of the solution.

Mostly the interpretation of the signs of the partial derivatives of (26) is obvious. The rate of interest has a negative effect on aggregate demand because of the cost of capital effect on investment. The sign of the price level would be unambiguously negative, notwithstanding a positive effect of inflation on aggregate demand through the user cost of capital (17). In the actual BOF4 model, the negative effects of the price level on aggregate demand (i.e. the competetiveness effect on exports and imports and the real balance effect on consumption) by far dominate the cost of capital effect. It may be noted that the positive interest rate effect in the model is as such something of an artifact due only to the "backward-looking" inflation concept used in the cost of capital formula.

The partial effect of the exchange rate (defined as the price of the foreign currency in terms of the domestic currency) on aggregate demand (with a given rate of interest and a given price level) is also in principle ambiguous: There is a positive substitution effect through the price elasticities of imports and exports, and a negative income effect due to the reaction of the terms of trade. In the actual BOF4 model, the positive substitution effect dominates.

The effects of the fiscal policy variables (government consumption and the tax rate) and the growth of foreign markets are conventional. The time trend representing technical progress enters with a positive sign. This is because, with given prices, technical progress increases the marginal product of capital and hence boosts investment.

I.2.2.2 Aggregate Supply

The AS function - or the aggregate supply equation - may be derived by substituting the Phillips curve (11) and the expected inflation rate equation (12) to equation for the price level (14), and by using the productivity equations (7) and (8) to eliminate employment from the equation. The aggregate supply function is of the following type:

$$(27) \qquad P = AS(\underset{+}{Y},\ \underset{+}{e \cdot P_f},\ \underset{+}{e \cdot P_{im}},\ \underset{-}{NF},\ \underset{-}{TIME},\ SLAGS)$$

Again, the signs of the partial derivatives appear below the respective variables. The output variable Y has a positive sign so that an increase in the demand for goods pulls up the price level. This is partly because of the Phillips curve effect, and partly because of the less than infinite elasticity of substitution between labour and capital which implies decreasing marginal product of labour and, hence, increasing marginal costs of production when the stock of capital is predetermined.

The exchange rate and the price of imports have a positive effect on the prices of domestic goods because of the use of the imported goods as raw materials and also because of the effect of the cost of imports on consumer prices and hence on wages. The competitors' export price effect positively on the prices of domestic goods via expected inflation.

An increase in the supply of labour would cause a reduction in the price level through the Phillips curve effect. With a negative price elasticity of aggregate demand, this is a necessary part of the adjustment mechanism which works to equilibrate the labour market of the model in the long run.

Technical progress, represented by the time trend, increases productivity and lowers the marginal cost of production over time. This has a negative effect on the price level. Finally, all lagged variables in the aggregate supply function are represented by the composite variable SLAGS. Among these a particularly important one is the stock of fixed capital which links past invetment with current productivity and real wages.

I.2.2.3 The Monetary Equilibrium and the LM Function

The LM function indicates the equlibrium condition of the financial markets in the model. It may be derived from the demand for central bank credit equation (24) by substituting equations (20), (22) and (23) for foreign reserves, currency, and the broad money stock. After using the demand for foreign debt equation (21), this gives

$$(28) \qquad D = (1-k)\cdot s\cdot C\cdot P_c + k\cdot[(m_0 - m_1\cdot i)\cdot Y\cdot P_y + \mu_m\cdot M_{-1}] - P\cdot X + e\cdot P_{im}\cdot IM - f\cdot(i - i_f)\cdot Y\cdot P_y + F_{-1} - R_{-1}$$

Using yet the equations for consumption (1), exports (3) and imports (4), the definitions of private disposable income, value added and consumption deflators and the government budget constraint, the demand for central bank credit may be written in the following way:

$$(29) \qquad D = D(\underset{+}{Y}, \underset{+}{P}, \underset{-}{i}, \underset{+}{k}, \underset{+}{G}, \underset{-}{t}, \underset{(-)}{e\cdot P_{im}}, \underset{-}{e\cdot P_f}, \underset{-}{IM_f}, \underset{+}{i_f}, MLAGS)$$

This is also the LM function in the case of exogenous (or pegged) domestic interest rate. In this case the central bank credit D adjusts freely to equilibrate the financial markets. In the other polar case of exogenous central bank credit and flexible interest rate it is useful to view the LM function in the following form, solved for the interest rate:

$$(30) \qquad i = LM(\underset{+}{Y}, \underset{+}{P}, \underset{-}{D}, \underset{+}{k}, \underset{+}{G}, \underset{-}{t}, \underset{(-)}{e\cdot P_{im}}, \underset{-}{e\cdot P_f}, \underset{-}{IM_f}, \underset{+}{i_f}, ILAGS)$$

In the two forms of the LM function the lagged variables, consisting of the "beginning-of-period" stocks of financial assets, are included in the portmanteau variables MLAGS and ILAGS.

From (29) and (30) it can be seen that an increase in either prices or real output tightens the money market, causing the central bank credit to expand - or, if monetary policy is not accommodating, rising the rate of interest.

The monetary policy instruments of the model consist of the cash reserve requirement and either the rate of interest or the quantity of central bank credit. As is natural to expect, an increase in the cash reserve requirement either rises the interest rate or increases central bank credit. An increase in central bank credit has a negative effect on the rate of interest, and an analogous negative relationship holds between these variables also when the rate of interest is treated as exogenous.

The monetary effects of fiscal policy in the model may deserve a comment: As is shown in (29) and (30), expansionary fiscal policy - an increase in government consumption G or a cut in the tax rate t - tightens the money market also directly, not only through its effects on output as is more conventional in IS-LM models. The reason is the dependence of the demand for currency on consumption rather than on output in (23). This implies that anything which increases the average propensity to consume C/Y will increase demand for currency and ultimately the demand for central bank credit at a given level of Y. For example, a tax cut increases the share of private disposable income in Y and hence also C/Y.

The foreign variables have monetary effects mostly through the balance of payments. An increase in the growth of foreign markets, for example, has a positive effect on the balance of payments and hence a negative effect either on the demand for central bank credit or on the rate of interest. This partial result hodls also with the actual BOF4 model, where the resulting increase in Y is taken into account. An increase in the prices of foreign competitors P_f has similar effects.

The effects of import prices are uncertain as to their direction in the theoretical model. Even the balance-of-payments effects may go to either direction, since an increase of import prices may either improve or worsen the trade balance, depending on the price elasticity of imports. In addition, changes in import prices have effects on relative prices in the economy so that with a given price of domestic output, an increase in import prices rises consumer prices but lowers the value added deflator. The consumer price effect tightens the money market, while the value added deflator effect works in an opposite direction. Further, this ambiguity in the effects of import prices makes it impossible in priciple to ascertain the direction to which a change in the exchange rate would affect the money market. In the actual BOF4 model, however, the price elasticities of exports and imports are strong enough so that a devaluation improves the trade balance and has a loosening effect on money market.

As is natural to expect in a model with capital mobility, changes in the foreign rate of interest have effects on the domestic financial markets. If the domestic rate of interest is flexible, it follows partly the movements of the foreign rate. In the case of pegged domestic interest rate, an increase in the foreign rate has a positive effect on the demand for central bank credit.

I.2.2.4 Properties of the Short-Run General Equilibrium

Collecting the partial derivatives from the IS, AS and LM functions analyzed above (equations 26, 27, and 29 or 30) one can determine the total short-run impact effects of changes in exogenous variables on production, price level, and the interest rate (or on central bank credit, if the rate of interest is pegged).

The comparative statics of the model are presented in tables 1 and 2 for the cases of flexible and pegged interest rate, respectively.

TABLE 1. COMPARATIVE STATICS WITH A FLEXIBLE INTEREST RATE

	G	t	D	k	IM_f	$e \cdot P_f$	$e \cdot P_{im}$	i_f	NF
Y	+	-	+	-	+	+	(+)	-	+
P	+	-	+	-	+	+	(+)	-	-
i	+	-	-	+	(-)	(-)	(-)	+	(+)

TABLE 2. COMPARATIVE STATICS WITH A PEGGED INTEREST RATE

	G	t	i	k	IM_f	$e \cdot P_f$	$e \cdot P_{im}$	i_f	NF
Y	+	-	-	0	+	+	(+)	0	+
P	+	-	-	0	+	+	(+)	0	-
D	+	-	-	+	(-)	(-)	(-)	+	(+)

A comprehensive discussion of the effects of economic policy or other exogenous impulses in the model is presented in chapter 3, where simulation properties of the full BOF4 model are described.

I.3 Simulation Properties

I.3.1 Ex Post Simulations

In this chapter the simulation properties of the BOF4 model are analyzed. This is done using two kinds of simulation experiments: ex post forecasts and multiplier analyses. The ability of the model to forecast economic developments ex post is discussed first.

Ex post forecasts are a widely used method of evaluating the ability of macroeconomic models to replicate actual economic developments. These tests shed some light on the general reliability of the model, and may serve as diagnostic checks as well, revealing possible "weak spots" in the model structure. In ex post simulations, the model is simulated over a historical period so that the exogenous input of the model corresponds to the actual history of the exogenous variables. The resulting "forecast" is then compared to actual data of the endogenous variables.

In the following, we report results from two ex post simulation experiments. The first is a dynamic, within-sample simulation over the ten-year period from the beginning of 1976 to the end of 1985.

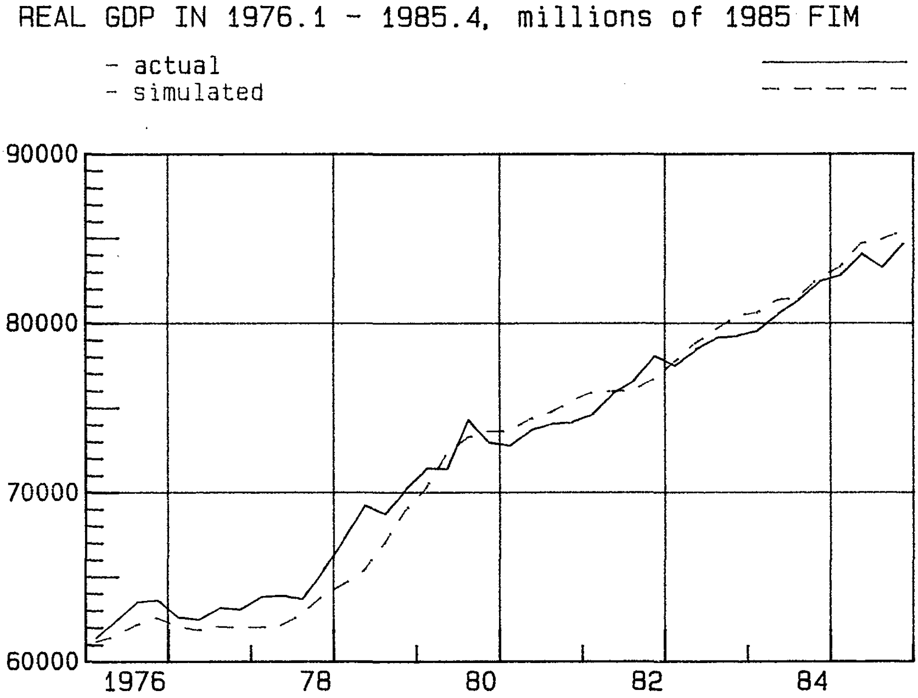
This simulation is "within sample" in the sense that the estimation period of most of the equations in the model extends from the 1960's up to 1985, and thus includes the simulation period in question. Furthermore, the constant terms of a number of equations were adjusted before the simulation to improve the overall tracking ability of the model. This calibration, which is also routine in actual forecasting work, compensates for outliers in the initial values of the endogenous variables of the model. It may also correct some of the simultaneous equations bias in the parameter estimates of the model, since the model has been estimated using the OLS method.

The simulation is "dynamic" in the sense that all lagged endogenous variables have their model-generated values for observations after the 1st quarter of 1976. This method allows possible forecast errors to cumulate in the dynamic structure of the model, just as in the actual use of the model in multiperiod forecasting of the future.

The short-term interest rate and the inflation expectations variable were held exogenous in the simulation. The latter was given values corresponding to the inflation forecasts made by the Economics Department of the Bank of Finland for the relevant periods.

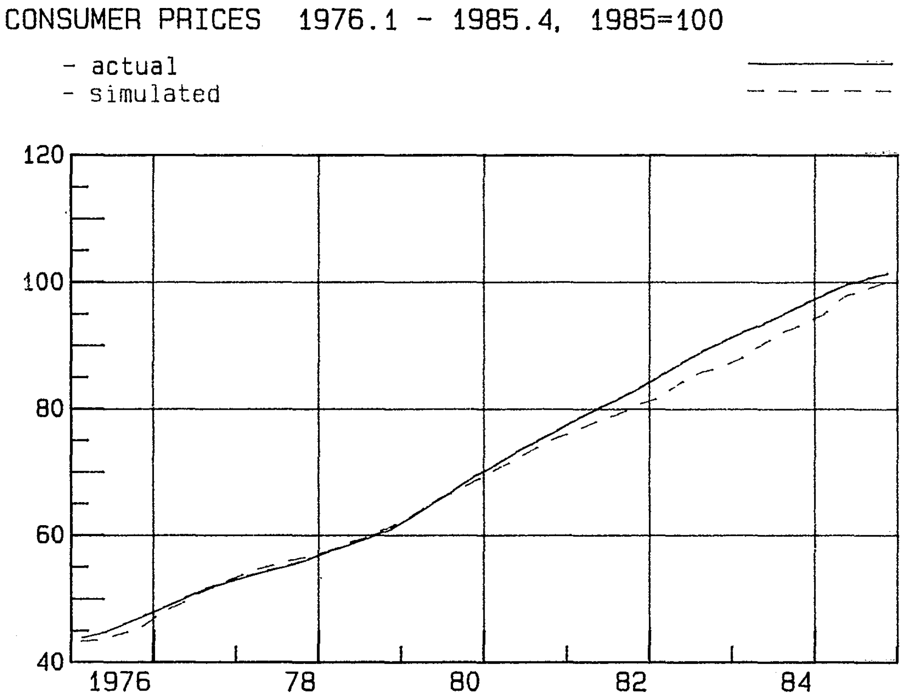
The ability of the model to replicate actual developments in real GDP is shown in fig. 1. It can be noted that the average growth rate of the ex post forecast of GDP is almost exactly right; the cyclical pattern seems to lag a couple quarters behind the actual cycle, at least in the major upswing of 1979 - 1980 which followed the espansionary policies adopted in 1977 and 1978.

FIGURE 1. RESULTS FROM THE DYNAMIC EX POST SIMULATION



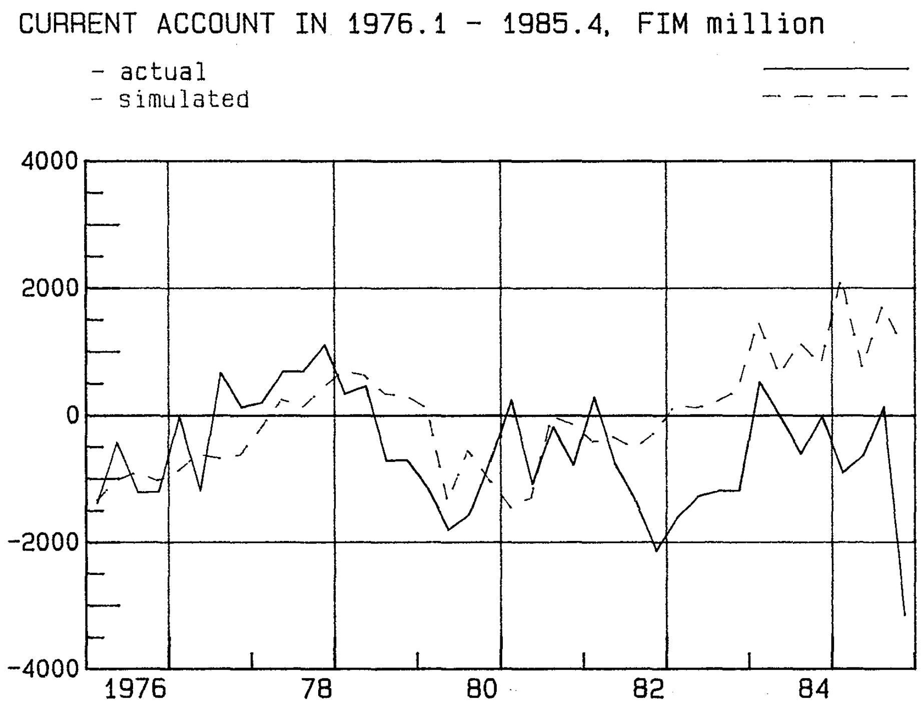
Inflation is a little slower in this ex post forecast than in actual history. Thus, by 1983 and 1984, the consumer price level is already underestimated by about 2 per cent. This is clearly visible in figure 2. Taking into account the length of the simulation, this discrepancy is not very serious, however.

FIGURE 2. RESULTS FROM THE DYNAMIC EX POST SIMULATION



Models often make relatively large errors in predicting trade deficits, budget deficits and other variables which are determined as differences of larger aggregates. As figure 3 shows, the calibrated BOF4 version does quite well in predicting the Finnish current account deficit for the first six years of the simulation. Thereafter, the model produces a better external balance than actually occurred. This result is probably due to the underestimation of the domestic price level, which was discussed above. Lower domestic prices may improve the current account through the overestimated competitiveness of domestic production in export and import markets.

FIGURE 3. RESULTS FROM THE DYNAMIC EX POST SIMULATION



A convenient way to summarize the forecast accuracy of a model over a given period of time is provided by error statistics such as the mean absolute errors made by the model. The mean absolute error MAE and mean absolute percentage error MAPE are defined as follows:

$$MAE = (1/T) \sum_{t=1}^{T} |F_t - A_t|$$

$$MAPE = (100/T) \sum_{t=1}^{T} |(F_t - A_t)/A_t|$$

where the period under scrutiny is from 1 to T, and F and A are the forecast and actual values, respectively, of a variable in period t.

MAPE's are often used to summarize forecast accuracy in the case of variables like production, expenditure, or price levels. For variables which can take both positive and negative values, MAPE's are not appropriate, however. They are also not very informative for variables which are originally in percentage form. MAE statistics are commonly used for these kinds of variables.

The error statistics of the BOF4 model in the within-sample ex post simulation are as follows:

TABLE 3. MEAN ABSOLUTE PERCENTAGE ERRORS (MAPE'S) IN SELECTED VARIABLES IN THE CALIBRATED, DYNAMIC SIMULATION FOR 1976 - 1985

Variable	MAPE
Real GDP	1.3
Private consumption	1.7
Public consumption	3.1
Private fixed investment	1.9
Total exports	3.1
Total imports	2.6
GDP deflator	2.4
Consumption deflator	1.9
Real wage rate	1.8
Broad money (M3)	3.7
Employment	3.7

TABLE 4. MEAN ABSOLUTE ERRORS (MAE'S) IN SELECTED VARIABLES IN THE CALIBRATED, DYNAMIC SIMULATION FOR 1976 - 1985.

Variable	MAE
Unemployment rate	1.0
Current account, % of GDP	1.5
Inventory investment, % of GDP	1.3

As such, these results give an encouraging picture of the "fit" of the BOF4 model within the sample period. Notably, the errors seem to be smaller than in the previous BOF3 version of the model (see

Tarkka and Willman (1985)). It should be pointed out, however, that comparisons between models on the basis of ex post simulations are in most cases difficult, if not impossible. This is so because different models have different sets of exogenous variables. Since exogenous variables are given their true historical values in the ex post simulations, increasing the degree of exogeneity tends to improve the apparent performance of the model (see e.g. McNees (1981)).

This point is illustrated by the case of public consumption in the BOF4 model. As can be seen in table 3 above, the mean absolute percentage error made by the model in forecasting public consumption is relatively large. This is because local government consumption is endogenous in BOF4. If it were exogenized, following the practice of most other macro models, the MAPE statistics would be improved, even though the usefulness of the model in ex ante forecasting or in policy analysis would probably decline.

The usefulness of the model outside the estimation period depends on the immunity or vulnerability of the model to structural changes which inevitably occur in the actual economy. This question may be assessed by comparing the performance of the model in out-of-sample simulations to the within-sample performance. This is the motivation for the second ex post simulation experiment which we report below.

The second ex post simulation is a dynamic simulation with the BOF4 model over the period 1986 (1st quarter) - 1988 (4th quarter). For most of the equations in the model, the data for this period has not been used in estimation. Exceptions can be found in the financial markets block of the model, where some equations have been estimated with more recent data. Consistent with the logic of simulating "post sample", the model has not been recalibrated, and the constant terms of the equations are thus as given by the OLS estimation.

The post sample simulation is run with endogenous interest rates. Correspondingly, the domestic credit of the Bank of Finland is exogenized. The resulting error statistics are as follows:

TABLE 5. MEAN ABSOLUTE PERCENTAGE ERRORS (MAPE'S) IN SELECTED VARIABLES IN THE DYNAMIC POST-SAMPLE SIMULATION FOR 1986 - 1988

Variable	MAPE
Real GDP	1.2
Private consumption	0.8
Public consumption	4.2
Private fixed investment	2.7
Total exports	3.7
Total imports	1.8
GDP deflator	2.1
Consumption deflator	2.5
Real wage rate	1.1
Employment	0.5

TABLE 6. MEAN ABSOLUTE ERRORS (MAE'S) IN SELECTED VARIABLES IN THE DYNAMIC POST SAMPLE SIMULATION FOR 1986 - 1988

Variable	MAE
Unemployment rate	0.8
Money market interest rate	4.0
Current account, % of GDP	1.0
Inventory investment, % of GDP	0.5

The forecast performance of the model in this experiment is again quite satisfactory by general standards. Furthermore, the error statistics suggest that the performance of the model does not deteriorate much outside the period of estimation, although the period of three years (12 observations) is obviously much too short to allow any definite conclusions. The trouble spot seems to be the short-term interest rate, which is systematically underestimated by the model in this experiment. The error is, however, smaller in the bond interest rates, which are the main links from financial conditions to the real economy in the model.

Detailed tables of the ex post forecast for 1986 - 1988 and the corresponding actual figures are presented for comparison in appendix 2 of this paper. The evidence in the tables suggests that the model does not capture the effects of the oil price collapse of 1986 quite satisfactorily (the prices of energy imports fell by about 47 per cent that year). On the export markets, the model interprets the corresponding fall in trading partners' import prices as a sign of weakened competitive position, which leads to underestimation of export performance in the forecast. On the domestic side, the pass-through of the oil price drop to domestic prices is clearly too fast.

I.3.2 Multiplier Analysis

Some simulation experiments with the BOF4 model are reported in the following to illustrate the main properties of the model. We analyze the responses of the model to various foreign shocks and domestic policy measures. Special emphasis is on the analysis of the "small open country" properties of the economy. These include the supply side determination of exports and the adjustment of the price level to PPP in the long run. The simulations also focus on the scope for fiscal, monetary and exchange rate policy.[2]

All simulations reported here were run with the fixed exchange rate version of the model, and in all but one case the short-term interest rate was treated as exogenous. In one of the simulations the domestic credit extended by the central bank is fixed, and the short-term market rate of interest equilibriates the money market.

Effects of various exogenous shocks to the economy are reported as differences of the shock solution from a baseline solution for 1990 - 1999. To characterize the baseline, some average figures are compared to those of the 1980's in table 1 below.

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[2]Selected earlier reports on the simulation properties of the BOF model are listed separately at the end of the references section of this chapter.

TABLE 7. ANNUAL AVERAGES OF THE BASELINE SOLUTION AS COMPARED TO ACTUAL DATA (1989 FORECAST), PER CENT

	ACTUAL 1980 - 1989	BASELINE 1990 - 1999
Volume of GDP, chg	3.5	2.0
Priv. cons. deflator, chg	7.2	4.4
Unemployment rate	5.0	5.8
Real rate of interest	5.0	6.3
Current account, % of GDP	-1.8	-3.1

In the baseline, growth of GDP slows down from the trend of the 1980's and averages 2 per cent annually. For the ten year period, the growth is rather stable (annual rates of GDP growth range from 1.5 % to 2.3 %). The underlying reason is a persistent current account deficit, requiring historically quite high interest rates. Unemployment rate increases accordingly from 4.2 % to 7.0 %.

All the simulations were run with exogenous nominal transfers from the central government to the other sectors of the economy. Income tax schedules, however, were endogenized to prevent bracket creep despite gradual inflation.

The following simulations are shortly described on the next pages. The detailed tables are presented in the appendix.

1. Sales tax rate increased by 1 percentage point.

2a. Public employment increased: Central government consumption and public value added increased by 1 billion 1985 FIM per quarter.

2b. As in 2a but with the flexible interest rate version of the model.

3. Export markets increased by 1 per cent.

4. World market prices increased by 1 per cent.

5. Short-term interest rate reduced by 2 percentage points.

6. Working-age population increased by 1000 persons.

I.3.3 Simulation 1: Sales Tax Rate Increased

The sales tax increase may be used to illustrate the effects of private domestic demand changes in the model. The tax is not quite neutral, however, since the Finnish sales (turnover) tax differs somewhat from a value-added tax. The tax base is modelled to consist of

93.3 % of the consumption of durables
74.3 % of the consumption of non- and semi-durables
6.3 % of the consumption of services
9.7 % of public consumption
29.1 % of fixed investment[3]
6.6 % of exports
32.0 % of value added, agriculture
28.6 % of value added, services etc.
15.4 % of value added, forestry, and
-9.3 % of value added, manufacturing.

It is worth noting that only a minor proportion of the consumption of services is included in the sales tax base.

In the baseline solution, the general sales tax is 16 % of the after-tax price, the average rate for industrial machinery and equipment 1.6 % and the rate for industrial buildings 0 %. In the shocked solution, the general sales tax rate is increased by one percentage point.

The main effects of the shock are reported as differences from baseline on page 1 in the appendix. The resulting price increases are, even in the short run, a little less than one per cent. In the

[3]Not including investment in manufacturing, for which there are two specific parameters in the model.

long run, a marked decline takes place in the prices before tax. Thus consumer prices, for instance, rise only by 0.4 % in the long run. The induced inflationary impulse to wages is temporary and real wages actually decrease over time by 0.5 - 0.8 % due to decreasing demand.

Domestic demand decreases somewhat; private consumption decreases by about half a per cent. A shift of domestic demand from the open sector and imports to the less comprehensively taxed closed sector (services) takes place.

Price competitiveness improves in the long run due to the Phillips curve mechanism and the loosening capacity constraints, and the temporary decrease in total exports turns into an increase. Bilateral exports follow the pattern of the decreasing imports. In net terms, however, increasing exports gradually compensate for the lost domestic demand.

Economic activity slows down during the first five years (the decrease in GDP is about half a per cent), and starts to recover towards the baseline level thereafter. This is reflected in a temporary decrease in employment by 13,000. The sensitivity of the unemployment rate to the level of GDP is in the short run pretty much in line with the so-called Okun's law, as is apparent from the following table.

TABLE 8. EFFECTS OF DEMAND-INDUCED GROWTH OF REAL GDP ON THE NUMBER OF EMPLOYED (PER CENT/PER CENT) AND ON THE UNEMPLOYMENT RATE (PERCENTAGE POINT/PER CENT)

year	Effect of GDP growth on Employment	Unemployment rate
1	0.19	-0.12
2	0.46	-0.20
3	0.59	-0.24
4	0.73	-0.28
5	0.91	-0.35

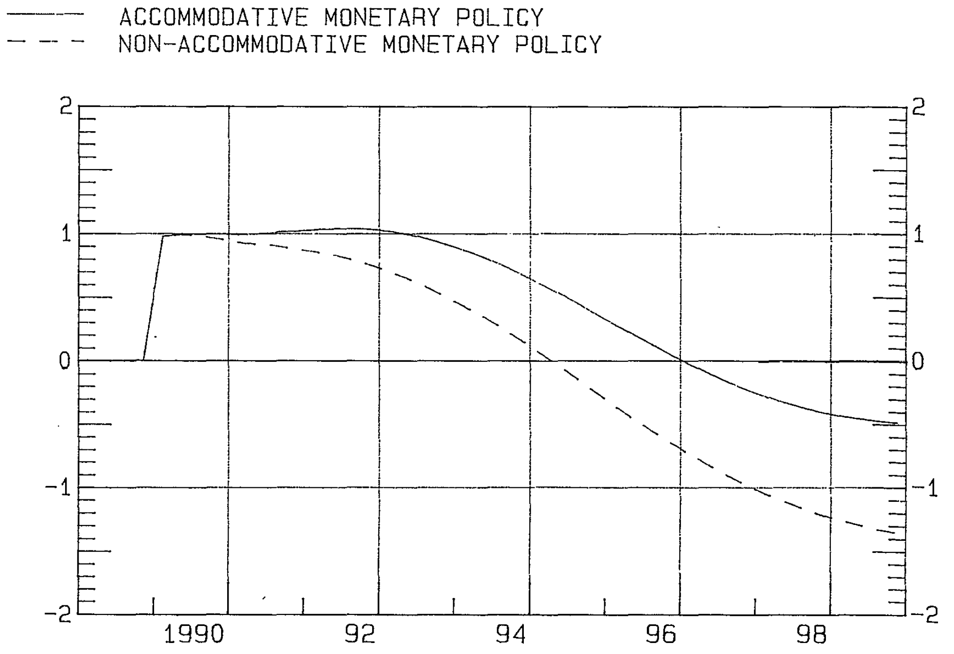
Central government revenue from sales tax increases in the first year by 3 FIM billion, reducing central government net borrowing by the same amount. Later on, government financial balance is further improved in the simulation because of the non-indexation of government transfers. As a result, the current account improves slightly.

I.3.4 Simulations 2a and 2b: Public Employment Increased

Increase in public employment was implemented by increasing central government consumption and public sector value added 1 billion 1985 FIM per quarter equalling to 1 per cent of GDP in 1990. The fiscal stimulus was assumed to be financed by domestic bond issues.

Simulation 2a was run with accommodating monetary policy (fixed money market interest rate) and simulation 2b was run with non-accommodating monetary policy (fixed central bank credit).

FIGURE 4. DYNAMIC MULTIPLIER EFFECTS ON GDP OF A SUSTAINED INCREASE IN PUBLIC EMPLOYMENT (SIMULATIONS 2a AND 2b, MILLION PER MILLION IN 1985 PRICES)



According to the simulations, crowding-out effects from fiscal policy are strong especially with non-accommodative monetary policy. Dynamic multipliers are shown in tables 9 and 10 below. Note that the definition of multipliers is the effect in real terms divided by the fiscal stimulus, also measured in real terms. The concept of the multiplier is thus analogous to that of the derivative. By contrast, in the appendix tables 2 and 3 the effects of the fiscal policy measures are in percentage deviations from the baseline.

Even with accommodative monetary policy, the multiplier effect on GDP is only slightly above one in the second and third year. Because of the shift of resources to the public sector with slow productivity, the GDP effect turns negative in the long run. Without this resource shift, the multiplier would converge to zero as is obvious from our stylized theoretical model. This is due to the small open economy assumption built in the model which leads to the supply-determination of open sector output in the long run.

TABLE 9. FISCAL POLICY MULTIPLIERS WITH ACCOMMODATING MONETARY POLICY: THE EFFECTS OF A BOND-FINANCED INCREASE IN PUBLIC EMPLOYMENT WITH INTEREST RATE FIXED

Year	1	2	3	4	5	10
GDP	0.99	1.01	1.04	0.97	0.78	-0.47
Imports, total	0.47	0.44	0.47	0.49	0.48	0.11
Exports, total	0.01	0.00	-0.04	-0.13	-0.26	-0.76
Multilateral (West)	-0.01	-0.02	-0.06	-0.15	-0.25	-0.67
Bilateral (East)	0.01	0.02	0.03	0.03	0.03	-0.01
Services	0.01	0.00	-0.01	-0.02	-0.04	-0.08
Private consumption	0.18	0.49	0.60	0.65	0.64	0.15
Public consumption	1.21	0.95	0.92	0.89	0.85	0.73
Private fixed investment	0.00	0.06	0.07	0.06	0.03	-0.33
Residential	0.02	0.06	0.06	0.07	0.07	-0.02
Non-residential	-0.01	0.00	0.01	-0.01	-0.04	-0.30
Domestic demand	1.45	1.45	1.54	1.59	1.51	0.40

An expansion in domestic demand increases domestic costs which, through losses in the competitiveness of Finnish goods on export markets, decreases the growth of exports until the original expansion in total production has been crowded out (this is called physical or labour market crowding-out). Hence, in the long-run fiscal stimulus produces a shift in resources from the open sectors of the economy to the closed sectors. After the completion of the adjustment process, which takes more than ten years, the magnitude of this resource shift equals the size of the original shock.

As exports are reduced by the fiscal expansion, the current account effect remains negative also in the long run. In the time horizon of ten years, the increase in the current account deficit is about one third of the size of the increase in central government spending.

If monetary policy is non-accommodative, fiscal expansion causes the domestic interest rate to increase. As a result of the 1 billion 1985 FIM shock, the money market rate increases immediately by 0.3 percentage points. The current account deficit is widened with the fiscal stimulus. Thus further increases of the interest rate are needed to keep the foreign reserves of the central bank at the baseline level (see table 3 in the appendix).

TABLE 10. FISCAL POLICY MULTIPLIERS WITH NONACCOMMODATING MONETARY POLICY: THE EFFECTS OF A BOND-FINANCED INCREASE IN PUBLIC EMPLOYMENT WITH CENTRAL BANK CREDIT FIXED

Year	1	2	3	4	5	10
GDP	0.98	0.90	0.81	0.61	0.29	-1.31
Imports, total	0.47	0.39	0.35	0.30	0.21	-0.40
Exports, total	0.01	0.00	-0.03	-0.11	-0.23	-0.68
Multilateral (West)	-0.01	-0.02	-0.05	-0.12	-0.21	-0.57
Bilateral (East)	0.01	0.02	0.03	0.03	0.02	-0.04
Services	0.01	0.00	-0.01	-0.02	-0.04	-0.07
Private consumption	0.17	0.44	0.46	0.42	0.32	-0.53
Public consumption	1.21	0.95	0.92	0.89	0.85	0.76
Private fixed investment	-0.01	0.01	-0.06	-0.17	-0.30	-1.01
Residential	0.01	0.03	0.02	0.00	-0.02	-0.19
Non-residential	-0.02	-0.03	-0.08	-0.17	-0.27	-0.82
Domestic demand	1.43	1.29	1.19	1.02	0.73	-1.03

As a result of the higher real interest rate, non-residential investment and the capital stock lag below their baseline level, turning the multiplier effect on GDP negative in the long run. Due to the reactions of imports to the lower activity, the negative current account effects are smaller than in the case with accommodating monetary policy. Equilibrium in the labour market requires that in the long run also real wages have to decrease as a result of fiscal expansion.

The scope for fiscal policy is limited by financial crowding out which is defined as the fraction of the increase in output which is crowded out by the tightening of the financial market (see Wallis (1987)). In figure 4, the size of the effect is measured by the difference between the two curves, and the phenomena is also described in the following table. By the sixth year, the GDP multiplier turns negative in the non-accommodating monetary policy case, reflecting total crowding-out.

TABLE 11. THE FINANCIAL CROWDING-OUT EFFECT, PER CENT

Year	Crowding-out
1	1.6
2	10.1
3	22.0
4	37.3
5	62.1
6	>100

The small multiplier effect on GDP in the BOF4 model reflects the fact that production is modelled to be supply-side determined in the long run. The BOF4 model is more supply-oriented than its predecessor, BOF3. The price-output split measured as the ratio of consumer price effects to GDP effects of a demand shock (in simulation 2a) increases from 0.1 in the first year to 1.1 in the fifth year. By the sixth year, the original 1 per cent increase in GDP has caused the consumer prices to increase by 1 per cent (see the tables 2 and 3 in the appendix). In the long run, however, price level parity with foreign markets will be restored through the adjustment of exports as described above.

In absolute terms, the increase in employment in the public sector is at most about 30 000. As the ratio of public production to total production is in the baseline about 15 %, the policy measure taken in these simulations is substantial. It is worth noting that the immediate increase in central government net borrowing is less than the increase in outlays due to increase in income tax revenue.

In the following table, financing of the increase in central government consumption expenditure is analyzed. In the first year, about one third of the fiscal policy expansion is financed "automatically" through induced increase in central government revenue, and only two-thirds remain to be entirely bond financed. In the long run, the fiscal expansion will be bond financed, since the positive activity effects are not permanent. Since non-accommodative monetary policy stabilizes the current account, it forces the government deficit to be financed from domestic sources.

TABLE 12. DEFICIT CONSEQUENCES OF THE BOND FINANCED FISCAL EXPANSION. INCREASE IN CENTRAL GOVERNMENT DEFICIT AND CURRENT ACCOUNT DEFICIT AS PERCENTAGE OF THE INCREASE IN CENTRAL GOVERNMENT CONSUMPTION EXPENDITURE

	Monetary policy regime:			
	Accommodative		Non-accommodative	
	Year:			
	1	10	1	10
Increase in central government deficit	68 %	97 %	69 %	130 %
Increase in current account deficit	37 %	41 %	36 %	10 %

I.3.5 Simulation 3: Export Markets Increased

In the previous simulation experiments, the responses of the model to different types of domestic demand impulses have been studied. Now we turn to export demand. In this simulation, export markets are increased by 1 per cent once and for all. Export markets are operationalized as the volume of imports of goods of Finland's 14 most important multilateral trading partners.

In the equation of multilateral exports, the elasticity of export demand with respect to market growth is constrained to unity for any time horizon. However, actual export growth is also influenced by prices. The one-year elasticity for multilateral exports with respect to relative export prices is -1.85 and the elasticity grows slowly to infinity in the very long run.

The response of export prices to demand depends, of course, on the exporters' supply behaviour. The price-volume split of the supply of exports, as inferred from the simulation, is almost zero in the short run and grows gradually to 0.53 towards the end of the 10-year horizon. So, the volume of (multilateral) exports (of goods) grows by about one per cent in the short run as a result of the increase in demand, but the effect diminishes over time, down to 0.16 per cent after ten years (see table 4 in the appendix).

In the short and medium run, the increase in exports has a positive effect on output and the domestic demand components. Both investment and consumption increase. The effect on investment is, however, quicker and also stronger in relative terms than the effect on consumption. Employment reacts with some lag: the effect on hours worked is about 0.3 per cent after three years, and starts to decrease thereafter.

Since imports react by less than exports, there is a positive effect on the external balance of the economy. This is further strengthened by an improvement in the terms of trade (this is about 0.2 per cent by the fifth year of the experiment).

The economy is, however, unable to sustain higher employment. Increased demand pulls up prices and costs, and market shares are lost in the export markets. This process continues until the economy has returned on the baseline path. Almost all of the adjustment to the original equilibrium seems to take place within the first ten years, which is an indication of the strength of the "supply side" in the model.

I.3.6 Simulation 4: World Market Prices Increased

In this simulation, all foreign currency prices are increased by 1 per cent. Note that inflation in foreign prices is not permanently accelerated; only the price level is permanently higher than in the baseline. This experiment reveals another aspect of the supply side influences in the model, namely the convergence towards PPP (purchasing power parity of domestic and foreign currencies) in the long run.

World market prices in the BOF4 model include all import prices, competing foreign prices on export markets and world market prices of sawngoods (timber; this appears in the Prices in forestry equation). Notwithstanding the effects on the value of foreign interest payments, the interpretation of the present simulation could just as well be a 1 per cent devaluation of the Finnish markka. Whichever the interpretation, the real effects of this experiment depend crucially on the adjustment pattern of domestic prices.

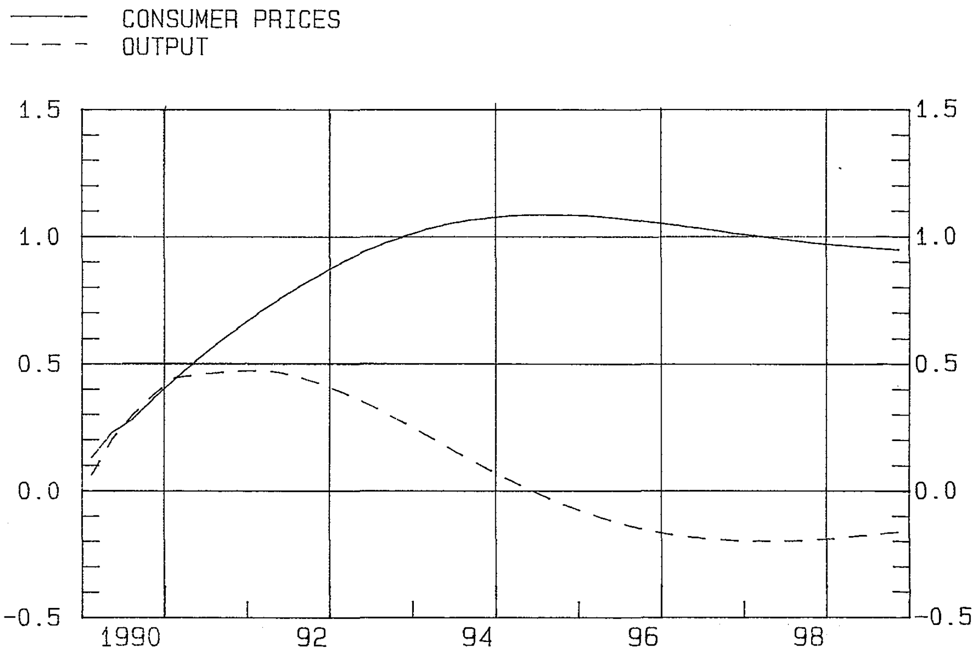
The results from the experiment are summarized in table 5 in the appendix. In the short run, price competitiveness of both exports and imports improves as a result of the rise in foreign currency prices. Relative export prices drop by about 0.4 per cent, and the initial effect on the competitive position of imports is even higher, varying across the different import categories. In the first year, exports increase by 0.62 per cent, imports decrease by 0.1 per cent and the trade balance improves by 270 million FIM.

The shift of demand from foreign to Finnish goods increases output and employment in the short and medium run. The elasticity of real GDP with respect to the foreign currency prices reaches its maximum, 0.46, in the second year after the shock. The elasticity of hours worked is highest in the third year (0.41). These estimates of the short-run real effects of devaluations or foreign price increases are higher than in many other Finnish studies, e.g. in the previous BOF3 version of the Bank of Finland model (see Tarkka and Willman (1985), pp. 403-409). On the other hand, the real effects disappear quicker than in the BOF3 model. This is because domestic prices adjust faster.

The domestic price level starts to rise immediately after the increase in foreign currency prices. Export prices react fastest, followed by the investment deflator. Consumer prices and the wage rate rise almost pari passu, and the GDP deflator appears to be the most sluggish price index. All this means that, according to the model, a devaluation or an increase in foreign prices does not lower the real consumption wage by much. However, real product wages fall in manufacturing and rise in services, increasing profit margins in the former sector and squeezing profits in the latter. The effects on relative prices are temporary, though. After five years, all prices have risen by the amount of the original foreign price shock, restoring old relative prices and the old purchasing power parity of the FIM.

The interaction of the real GDP effect and the price level effect is clearly visible in Figure 5.

FIGURE 5. ADJUSTMENT OF PRICES AND OUTPUT TO A SUSTAINED INCREASE IN WORLD MARKET PRICES BY 1 PER CENT



In considering the results from this experiment, one must note two qualifications: the money market interest rate and the nominal transfers distributed by the central government were exogenous in the simulation. The assumption of a fixed rate of interest may not be too crucial, since the demand for central bank credit is not affected too much in the simulation. The assumption that central government transfers are not adjusted for the higher prices which emerge in the simulation is, however, an important one. It means that fiscal policy is automatically tightened by the rise in foreign currency prices, with the result that activity effects are weakened and the favourable effects on the balance of payments are strengthened compared to the case of "indexed" government transfers. The extent of these modifications is studied in Tarkka and Willman (1985, pp. 404 - 406) with the BOF3 model.

I.3.7 Simulation 5: Short-term Interest Rate Reduced

Effects of a permanent reduction of the money market rate by 2 percentage points can be seen in table 6 in the appendix. All interest rates do not move by the same amount in the experiment, however. In the BOF4 model, there are term structure equations for two long-term interest rates (market yield on taxable debentures, and tax-free bonds), which itransmit the changes of the monetary policy variables to the demand for goods equations.

Market yield on tax-free bonds appears in the sectoral user cost of capital equations as well as in the private consumption equation. Reduction of the short-term interest rate by 2 percentage points reduces the yield on tax-free bonds by .4 percentage points in the first year and by .7 percentage points in the long run.

The immediate reaction of investment, especially in the price-elastic open sector of the economy, is substantial. Later on investment is further increased by accelerator effects from boosted domestic production. The increase in private fixed investment is 0.4 %, 1.2 % , and 2.1 % in the first, second, and third year, respectively, and 2.9 % in the tenth year. The adjustment of residential investment takes place more quickly but the increase is somewhat less than the increase in non-residential investment. The permanent increase in the level of the capital stock is of the same magnitude as in the previous BOF3 model.

By contrast, the direct effect on private consumption is weak, the 0.9 % increase in private consumption being mainly due to increase in real income.

There is a slight worsening of the price competitiveness due to wage increases, and multilateral exports decrease. That is almost balanced by the bilateral mechanism: bilateral exports follow the pattern of the increasing bilateral imports of raw oil, fuels and lubricants. Thus, total exports is only slightly affected by the interest rate change.

Production and imports adjust quickly to the increased level of total demand. In the long run imports increase by 1.2 per cent, and, owing to a larger capital stock, production increases by 0.6 per cent. As a result, employment increases in spite of the shift in factor demand from labour to capital. Wages increase as a result of a decreasing unemployment rate and slightly increasing labour productivity. In the long run real wages increase somewhat.

A reduction in the short-term interest rate decreases the demand for foreign capital immediately. A cut of two percentage points in the short-term interest rate results in an outflow of short-term foreign capital of FIM 6.9 billion in the first quarter and of FIM 0.1 billion in the second quarter. As, in addition, imports react strongly to the increase in economic activity, the current account also deteriorates and the foreign reserves of the central bank diminish substantially (by FIM 7.4 billion in the first year). Given such capital mobility, the scope for unilateral interest rate cuts is limited.

In an open economy with a fairly high degree of capital mobility, the Central Bank may be unable to conduct monetary policy in terms of interest rate targets. Therefore, it might be more realistic to analyze Finnish monetary policy under the assumption of a flexible short-term interest rate. The macroeconomic effects of open market operations (central bank credit) are described in Chapter VII, a report on the modelling of financial markets in BOF4.

I.3.8 Simulation 6: An Increase in Labour Supply

In the last simulation experiment we consider the strength of the equilibrating mechanisms on the labour market. This is done by assuming that the working-age population is permanently increased by 100 000 persons compared to the baseline. If the model has a strong tendency towards labour market equilibrium, an increase in the working-age population should cause a fall in wage rates, and quickly increase employment until the original unemployment rate and participation rate are restored. The speed of this mechanism is, of course, one of the central issues in macroeconomics.

The adjustment of the labour force, employment, real GDP and the wage rate after the population increase are described in the following table. The reactions of these key variables are measured as dynamic elasticities with respect to the working-age population.

TABLE 13. THE DYNAMIC ELASTICITIES OF KEY VARIABLES WITH RESPECT TO THE WORKING-AGE POPULATION

Year	1	2	3	4	5	10
Labour force	0.4	0.4	0.4	0.5	0.6	1.2
Employment	0.0	0.0	0.1	0.2	0.4	1.3
Real GDP	0.0	0.1	0.2	0.4	0.6	1.2
Wage rate	-0.1	-0.3	-0.6	-0.9	-1.1	-0.7

Note that the elasticity of the labour force is less than one in the short run, since the initial increase in the unemployment rate causes some people to withdraw from the labour market (this is known as the discouraged worker effect). The reaction of employment and output to the growth of the working-age population is very sluggish in the first years of the experiment. The adjustment does ultimately happen, however, so that after ten years the elasticities of output, employment, and the labour force with respect to the increase in population are in fact slightly above unity. There is thus some evidence of overshooting and cyclical adjustment. Eventually, however, the unemployment rate and the participation rate return to their original levels. This illustrates how the BOF4 model combines short-run Keynesian dynamics with asymptotically classical properties.

APPENDIX 1

SIMULATION RESULTS 1: INCREASE IN THE SALES TAX RATE

Sales tax rate increased permanently by one percentage point.
Interest rates fixed.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	-0.24	-0.38	-0.54	-0.62	-0.59	-0.08
Imports, total, %	-0.37	-0.45	-0.69	-0.88	-0.93	-0.50
Exports, total, %	-0.16	-0.35	-0.38	-0.28	-0.11	0.42
Private consumption, %	-0.53	-0.62	-0.82	-0.95	-1.00	-0.70
Public consumption, %	-0.22	-0.28	-0.27	-0.21	-0.16	0.06
Private fixed investment, %	0.03	-0.09	-0.58	-0.90	-0.95	-0.20
Domestic demand, %	-0.30	-0.41	-0.63	-0.80	-0.83	-0.36
GDP deflator, %	0.75	0.87	0.77	0.60	0.44	0.27
Private consumption deflator, %	0.81	0.94	0.85	0.71	0.57	0.45
Private investment deflator, %	0.45	0.56	0.48	0.35	0.23	0.13
Export goods deflator, %	0.08	0.14	0.11	0.01	-0.09	-0.18
Wage rate, %	0.32	0.34	0.19	0.00	-0.17	-0.36
Performed working hours, %	-0.12	-0.27	-0.44	-0.56	-0.61	-0.14
Employment, 1000 persons	-1.09	-4.32	-7.78	-11.04	-13.10	-5.15
Labour force, 1000 persons	-0.37	-2.50	-4.73	-6.90	-8.32	-3.11
Unemployment rate, percentage points	0.03	0.07	0.13	0.18	0.21	0.09
Balance of payments:						
Current account, FIM billion	0.41	0.37	0.64	0.97	1.20	1.68
Private capital imports, FIM billion	0.41	-0.09	-0.09	-0.08	-0.06	0.06
Foreign exchange reserves, FIM billion	0.82	1.10	1.64	2.53	3.67	11.25
Central bank domestic credit, FIM billion	-0.75	-0.96	-1.51	-2.45	-3.65	-11.18
Demand for money:						
Monetary base, per cent	0.18	0.35	0.32	0.18	0.05	0.12
Broad money, per cent	0.07	0.26	0.25	0.12	0.00	0.13

SIMULATION RESULTS 2: INCREASE IN PUBLIC EMPLOYMENT

Public production and central government consumption increased permanently by 4 billion 1985 FIM per annum (about 1 per cent of GDP in 1990). Interest rates fixed.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	1.00	0.99	1.01	0.92	0.72	-0.39
Imports, total, %	1.50	1.36	1.42	1.45	1.38	0.28
Exports, total, %	0.05	-0.01	-0.13	-0.43	-0.83	-2.17
Multilateral (West) %	-0.03	-0.11	-0.29	-0.64	-1.10	-2.58
Bilateral (East), %	0.20	0.60	0.88	0.99	0.95	-0.17
Services, %	0.30	-0.01	-0.16	-0.41	-0.80	-1.53
Private consumption, %	0.32	0.86	1.02	1.08	1.05	0.23
Public consumption, %	5.99	4.57	4.29	4.06	3.74	2.76
Private fixed investment, %	0.01	0.28	0.36	0.29	0.13	-1.46
Residential, %	0.26	1.05	1.21	1.31	1.22	-0.41
Non-residential, %	-0.08	0.01	0.07	-0.05	-0.24	-1.84
Domestic demand, %	1.40	1.37	1.45	1.47	1.36	0.33
GDP deflator, %	-0.13	0.53	0.70	0.95	1.24	1.45
Private consumption deflator, %	0.09	0.30	0.39	0.59	0.82	0.88
Private investment deflator, %	0.07	0.25	0.33	0.51	0.73	0.83
Export goods deflator, %	0.01	0.05	0.13	0.28	0.45	0.53
Wage rate, %	0.18	0.36	0.56	0.90	1.21	1.26
Performed working hours, %	0.91	1.40	1.40	1.36	1.23	0.07
Employment, 1000 persons	7.25	27.76	30.88	31.23	29.98	5.62
Labour force, 1000 persons	4.63	18.12	20.23	20.54	19.81	3.76
Unemployment rate, percentage points	-0.11	-0.40	-0.45	-0.46	-0.44	-0.08
Balance of payments:						
Current account, FIM billion	-1.84	-1.71	-1.94	-2.33	-2.72	-4.28
Private capital imports, FIM billion	0.25	0.23	0.25	0.35	0.35	0.18
Foreign exchange reserves, FIM billion	-1.59	-3.08	-4.77	-6.75	-9.13	-26.25
Central bank domestic credit, FIM billion	1.72	3.41	5.25	7.35	9.84	26.96
Demand for money:						
Monetary base, per cent	0.35	0.87	1.17	1.39	1.54	1.13
Broad money, per cent	0.43	1.04	1.40	1.61	1.74	1.20
Sectoral financial balances:						
Current account, % of GDP	-0.32	-0.25	-0.27	-0.31	-0.34	-0.42
Net lending, % of GDP						
Private sector	0.22	0.28	0.27	0.20	0.18	0.53
Public sector	-0.53	-0.53	-0.54	-0.51	-0.52	-0.95
of which Central government	-0.66	-0.70	-0.71	-0.70	-0.70	-1.03

SIMULATION RESULTS 3: INCREASE IN PUBLIC EMPLOYMENT

Public production and central government consumption increased permanently by 4 billion 1985 FIM per annum (roughly 1 per cent of GDP in 1990).

Money market rate endogenous, domestic credit extended by the central bank fixed.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	0.98	0.89	0.79	0.58	0.28	-1.12
Imports, total, %	1.47	1.20	1.07	0.89	0.63	-1.06
Exports, total, %	0.05	-0.01	-0.11	-0.37	-0.73	-1.94
Private consumption, %	0.31	0.77	0.80	0.71	0.52	-0.81
Public consumption, %	5.99	4.56	4.28	4.04	3.73	2.84
Private fixed investment, %	-0.02	0.02	-0.29	-0.83	-1.44	-4.71
Residential, %	0.19	0.62	0.33	-0.01	-0.44	-3.32
Non-residential, %	-0.10	-0.18	-0.50	-1.10	-1.78	-5.21
Domestic demand, %	1.38	1.23	1.12	0.95	0.67	-0.86
GDP deflator, %	-0.13	0.52	0.66	0.87	1.11	1.07
Private consumption deflator, %	0.09	0.29	0.36	0.51	0.69	0.55
Private investment deflator, %	0.07	0.24	0.30	0.43	0.61	0.53
Export goods deflator, %	0.01	0.04	0.11	0.24	0.38	0.46
Wage rate, %	0.18	0.35	0.51	0.80	1.05	0.66
Performed working hours, %	0.90	1.35	1.27	1.12	0.90	-0.48
Employment, 1000 persons	7.21	27.16	28.83	27.11	23.59	-7.05
Labour force, 1000 persons	4.61	17.78	19.02	18.04	15.86	-4.29
Unemployment rate, percentage points	-0.11	-0.39	-0.42	-0.39	-0.34	0.12
Interest rates, percentage points:						
Money market rate	0.31	0.73	1.07	1.33	1.57	2.40
Taxable bond rate	0.16	0.37	0.55	0.69	0.81	1.23
Taxfree bond rate	0.08	0.23	0.34	0.47	0.58	0.83
Balance of payments:						
Current account, FIM billion	-1.81	-1.49	-1.42	-1.43	-1.43	-1.00
Private capital imports, FIM billion	1.89	1.60	1.42	1.39	1.36	0.76
Foreign exchange reserves, FIM billion	0.08	0.19	0.19	0.15	0.08	-0.92
Central bank domestic credit, FIM billion	0.00	0.00	0.00	0.00	0.00	0.00
Demand for money:						
Monetary base, per cent	0.23	0.49	0.48	0.35	0.17	-1.52
Broad money, per cent	0.25	0.49	0.40	0.14	-0.18	-2.36
Sectoral financial balances:						
Current account, % of GDP	-0.31	-0.22	-0.19	-0.19	-0.17	-0.11
Net lending, % of GDP						
Private sector	0.23	0.34	0.41	0.44	0.52	1.27
Public sector	-0.54	-0.55	-0.60	-0.63	-0.69	-1.38
of which Central government	-0.67	-0.72	-0.76	-0.79	-0.84	-1.39

SIMULATION RESULTS 4: INCREASE IN EXPORT MARKETS

Volume of imports of goods of Finland's major western export countries increased permanently by one per cent. Interest rates fixed.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	0.17	0.28	0.29	0.24	0.15	-0.05
Imports, total, %	0.26	0.42	0.45	0.41	0.32	0.03
Goods, %	0.26	0.40	0.43	0.38	0.29	0.04
Services, %	0.23	0.48	0.59	0.58	0.47	0.02
Exports, total, %	0.81	0.73	0.61	0.48	0.36	0.19
Multilateral (West) %	0.95	0.83	0.67	0.51	0.37	0.16
Bilateral (East), %	0.03	0.11	0.18	0.20	0.17	-0.07
Services, %	0.79	0.75	0.65	0.54	0.46	0.50
Private consumption, %	0.07	0.19	0.24	0.23	0.17	-0.04
Public consumption, %	0.01	0.01	0.01	-0.01	-0.03	-0.06
Private fixed investment, %	0.14	0.27	0.33	0.29	0.17	-0.16
Domestic demand, %	0.03	0.20	0.25	0.22	0.14	-0.09
GDP deflator, %	0.02	0.09	0.16	0.23	0.26	0.12
Private consumption deflator, %	0.01	0.07	0.14	0.20	0.23	0.10
Private investment deflator, %	0.01	0.06	0.12	0.17	0.19	0.08
Export goods deflator, %	0.03	0.08	0.14	0.19	0.21	0.10
Wage rate, %	0.02	0.08	0.16	0.22	0.25	0.12
Performed working hours, %	0.10	0.21	0.28	0.29	0.25	-0.01
Employment, 1000 persons	0.86	3.39	5.46	6.44	6.19	0.27
Labour force, 1000 persons	0.53	2.16	3.54	4.24	4.13	0.22
Unemployment rate, percentage points	-0.01	-0.05	-0.08	-0.09	-0.09	0.00
Balance of payments:						
Current account, FIM billion	0.70	0.52	0.44	0.43	0.43	0.60
Private capital imports, FIM billion	0.05	0.08	0.08	0.07	0.05	0.01
Foreign exchange reserves, FIM billion	0.75	1.34	1.86	2.36	2.84	5.75
Central bank domestic credit, FIM billion	-0.72	-1.27	-1.74	-2.20	-2.68	-5.68
Demand for money:						
Monetary base, per cent	0.08	0.20	0.30	0.35	0.35	0.10
Broad money, per cent	0.10	0.24	0.35	0.40	0.39	0.11

SIMULATION RESULTS 5: INCREASE IN WORLD MARKET PRICES

World market prices (import prices and competitors'prices on export markets) increased permanently by one per cent. Interest rates fixed.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	0.24	0.46	0.45	0.33	0.16	-0.18
Imports, total, %	-0.10	0.29	0.38	0.33	0.21	-0.18
Goods, %	-0.06	0.30	0.35	0.30	0.18	-0.15
Services, %	-0.36	0.25	0.51	0.51	0.35	-0.33
Exports, total, %	0.62	0.74	0.61	0.44	0.30	0.25
Multilateral (West) %	0.66	0.77	0.63	0.46	0.32	0.33
Bilateral (East), %	0.17	0.45	0.61	0.60	0.50	-0.02
Services, %	0.80	0.81	0.51	0.25	0.07	0.07
Private consumption, %	0.01	0.26	0.34	0.29	0.18	-0.20
Public consumption, %	-0.11	-0.19	-0.24	-0.31	-0.38	-0.48
Private fixed investment, %	0.29	0.75	0.88	0.71	0.43	-0.25
Domestic demand, %	0.03	0.33	0.38	0.30	0.13	-0.30
GDP deflator, %	0.17	0.48	0.73	0.93	1.04	0.94
Private consumption deflator, %	0.25	0.54	0.78	0.95	1.05	0.95
Private investment deflator, %	0.34	0.61	0.81	0.95	1.04	0.95
Export goods deflator, %	0.59	0.67	0.82	0.96	1.04	0.98
Price competitiveness (relat. export prices), %	0.36	0.30	0.15	0.03	-0.05	0.02
Wage rate, %	0.24	0.54	0.79	0.98	1.09	1.01
Performed working hours, %	0.13	0.32	0.41	0.40	0.30	-0.20
Employment, 1000 persons	1.06	5.05	8.15	9.23	8.13	-3.81
Labour force, 1000 persons	0.70	3.22	5.30	6.10	5.46	-2.49
Unemployment rate, percentage points	-0.01	-0.08	-0.12	-0.13	-0.12	0.06
Balance of payments:						
Current account, FIM billion	0.34	0.15	0.14	0.21	0.31	1.07
Private capital imports, FIM billion	0.23	0.19	0.18	0.17	0.15	0.16
Foreign exchange reserves, FIM billion	0.57	0.90	1.22	1.61	2.06	6.86
Central bank domestic credit, FIM billion	-0.51	-0.70	-0.89	-1.17	-1.57	-6.35
Demand for money:						
Monetary base, per cent	0.16	0.52	0.82	1.00	1.07	0.81
Broad money, per cent	0.14	0.53	0.84	1.03	1.09	0.80

SIMULATION RESULTS 6: REDUCTION IN THE SHORT TERM INTEREST RATE

Money market rate permanently reduced by 2 percentage points.

Difference from baseline case.

Year	1	2	3	4	5	10
GDP, %	0.16	0.46	0.65	0.72	0.72	0.58
Imports, total, %	0.24	0.75	1.05	1.21	1.25	1.17
Exports, total, %	0.00	-0.03	-0.09	-0.17	-0.24	-0.24
Multilateral (West) %	-0.01	-0.09	-0.19	-0.31	-0.41	-0.37
Bilateral (East), %	0.02	0.15	0.36	0.56	0.70	0.86
Services, %	0.05	0.10	0.04	-0.05	-0.15	-0.36
Private consumption, %	0.12	0.46	0.72	0.87	0.93	0.92
Private fixed investment, %	0.35	1.22	2.05	2.52	2.73	2.94
Residential, %	0.69	1.79	2.30	2.52	2.52	2.37
Non-residential, %	0.23	1.03	1.97	2.52	2.81	3.13
Domestic demand, %	0.22	0.68	0.98	1.13	1.16	1.00
GDP deflator, %	0.01	0.07	0.16	0.25	0.32	0.45
Private consumption deflator, %	0.00	0.06	0.14	0.23	0.29	0.36
Private investment deflator, %	0.01	0.07	0.13	0.20	0.26	0.36
Export goods deflator, %	0.01	0.04	0.09	0.12	0.14	0.00
Wage rate, %	0.01	0.07	0.17	0.28	0.40	0.81
Performed working hours, %	0.07	0.28	0.47	0.60	0.64	0.34
Employment, 1000 persons	0.52	3.84	8.17	11.77	13.84	9.39
Labour force, 1000 persons	0.26	2.24	5.01	7.40	8.81	5.85
Unemployment rate, percentage points	-0.01	-0.07	-0.13	-0.19	-0.22	-0.15
Interest rates, percentage points:						
Money market rate	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00
Taxable bond rate	-1.03	-1.03	-1.03	-1.03	-1.03	-1.03
Taxfree bond rate	-0.35	-0.59	-0.66	-0.68	-0.69	-0.72
Balance of payments:						
Current account, FIM billion	-0.31	-1.03	-1.55	-1.93	-2.19	-3.04
Private capital imports, FIM billion	-8.82	-1.99	-1.85	-1.97	-2.23	-3.17
Foreign exchange reserves, FIM billion	-9.12	-12.14	-15.54	-19.44	-23.86	-51.43
Central bank domestic credit, FIM billion	9.40	12.68	16.28	20.33	24.88	52.94
Demand for money:						
Monetary base, per cent	0.77	1.37	1.78	2.05	2.21	2.41
Broad money, per cent	1.16	1.99	2.51	2.82	3.00	3.18

APPENDIX 2

EX POST FORECAST 1986 - 1988

Ex Post simulation 1986 - 1988: Forecast vs. actual figures.
Actual in parentheses after forecast.

Supply and Demand (volume changes, per cent):

Year	1986	1987	1988
Real GDP	2.7 (2.1)	3.0 (4.0)	2.8 (5.0)
Private consumption	4.8 (4.1)	6.3 (5.7)	2.9 (5.0)
Private fixed investment	-1.6 (-0.4)	4.8 (5.0)	5.1 (11.7)
Total exports	1.8 (1.3)	-1.2 (2.6)	-0.6 (3.9)
Total imports	4.4 (3.1)	8.0 (9.0)	6.8 (11.5)

Other indicators:

Year	1986	1987	1988
Inflation (CPI, per cent)	2.5 (3.1)	1.0 (3.8)	4.2 (4.6)
Real wage rate, per cent	2.5 (3.1)	5.9 (3.1)	3.4 (4.2)
Unemployment rate, per cent	5.5 (5.4)	5.8 (5.1)	6.0 (4.5)
Broad money (M3), per cent	18.3 (8.7)	9.2 (13.5)	8.2 (23.6)
Current account, FIM bill.	-0.4 (-3.8)	-5.1 (-7.9)	-5.8(-12.6)
Money market rate, per cent	5.4 (11.8)	6.6 (10.0)	8.1 (10.0)

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II EXPORTS AND IMPORTS

Abstract

This chapter on the modelling of foreign trade in the Bank of Finland's BOF4 quarterly macroeconometric model first appeared in the Bank of Finland Discussion Paper Series in May 1988, series no. 3/88.

Specification of the volume and price equation of Finland's multilateral exports of goods is based on the assumption that Finnish products enjoy only temporary monopoly power. In the context of the whole model this implies that the price of exports of goods as well as short-run marginal costs converge towards a level determined solely by competing foreign prices.

The modelling of Finland's bilateral trade is based on the assumption that the value of bilateral exports adjusts to the value of bilateral imports, which, in turn, is determined by Finnish demand for imports from eastern markets.

Modelling of the trade in services and imports, excluding imports of oil, fuels and lubricants, is quite conventional: the volume of exports of services and the volumes of imports depend on relevant relative price and activity variables. The modelling of imports of crude oil, fuel and lubricants is based on the assumption that imports of energy are a residual determined by the demand for and the domestic supply of energy.

II.1 Introduction

For the purposes of the present report on exports and imports, it is useful to note two key characteristics of the BOF4 model. As regards technology, a CES value-added production function is assumed throughout, embedded in a simple input-output framework describing the use of inputs other than labour and capital. The market structure assumption is basically one of monopolistic competition in all sectors in the short run, but in manufacturing and forestry perfect competition on worldwide markets is considered to be a relevant long-run assumption. This is clearly reflected in the export equations.

II.2 Exports

Exports are divided into three categories in BOF4. Exports of services are distinguished from exports of goods, and exports of goods are divided into multilateral and bilateral exports; the latter group consists mainly of Finland's exports to the U.S.S.R., whereas other exports belong mostly to the former category. The special attention paid to bilateral trade in the model stems from the fact that the importance of this trade in the Finnish business cycle far exceeds its relative size as an item of aggregate demand.

II.2.1 Multilateral Exports of Goods

Multilateral, or "western", exports make up about 80 per cent of Finland's exports of goods. The export equation is shown as equation X.1 in the equation list (see appendix). The specification is almost identical to the one included in the previous BOF3 version of the model (see Tarkka & Willman, 1985). This equation is based on the idea that domestic and foreign productive capacity are fully substitutable for each other, at least in the long run. According to this view, Finland enjoys only temporary monopoly power in any field of production, and in the long run the equilibrium price of exports will, because of foreign competition, be determined quite independently of domestic factors. Another way of putting this is to say that foreign demand for Finnish products is dynamic: the demand curve is downward sloping in the short run but horizontal in the long run. This implies a Phelps & Winter (1971) type of demand equation for multilateral exports: a change in the market share of Finnish exports depends on the relative price level.

We measure the size of the market by the volume index of imports of Finland's 14 most important trading partners. As the relative price variable we have used the unit value index of Finland's exports of goods to western markets relative to the competing foreign prices. The index for the foreign competing prices was constructed as a weighted unit value index of imports of the same 14 countries used in measuring the growth of export markets and adjusted for the import price of fuels and lubricants. The energy adjustment is intended to take into account the fact that Finland is not an oil exporter.

The indices of import volumes and import prices of the 14 trading partners are Divisia-Törnqvist indices with moving annual weights. In table 1 the weights of different countries are given for a sample of years.

Our approach implies much stronger effects of domestic costs on export volumes than the conventional "large-country" model used by Aurikko (1985a) and many other authors. However, the differences from the conventional approach are not very important in the short run.

TABLE 1. THE SHARES OF THE 14 MOST IMPORTANT COUNTRIES IN FINLAND'S MULTILATERAL EXPORTS OF GOODS, PER CENT

	1960	1965	1970	1975	1980	1985
Sweden	6.5	10.5	21.0	28.1	25.2	21.0
United Kingdom	35.7	29.9	24.2	22.5	17.3	17.0
Germany, F.R.	17.4	16.7	14.6	12.4	16.2	15.0
France	7.0	6.7	5.2	5.5	6.9	6.0
Netherlands	8.9	8.8	6.4	4.1	6.6	5.0
Norway	1.9	1.7	5.1	7.3	6.4	7.0
Denmark	5.2	5.6	5.7	5.6	5.3	6.0
United States	7.4	8.9	6.5	5.0	4.9	10.0
Italy	3.2	4.6	3.4	2.1	3.7	3.0
Switzerland	0.8	0.9	2.4	2.2	2.4	2.0
Belgium	5.5	4.9	2.6	2.2	2.1	2.0
Austria	0.2	0.4	1.1	1.3	1.1	1.0
Japan	0.1	0.2	0.4	0.8	1.1	2.0
Canada	0.1	0.3	0.1	0.8	0.8	2.0

The percentages may not sum exactly to 100 due to rounding.

The dynamic form of the equation is obtained as a result of a search procedure. The dependent variable is the change in the market share of Finland's multilateral exports. The estimation was started with a general loglinear specification in which a large number of lags on all relevant variables were included. Statistically insignificant terms were then eliminated one by one until a parsimonious specification with only significant explanatory variables was obtained. The problem of endogeneity of export prices was treated by using the two-stage least squares method of estimation.

The dynamic elasticities of the demand for multilateral exports of goods are reported in the following table.

TABLE 2. DYNAMIC DEMAND ELASTICITIES OF THE DEMAND FOR FINNISH MULTILATERAL EXPORTS OF GOODS

variable	immediate elasticity	one-year elasticity	five-year elasticity	long-run elasticity
foreign imports	1.00	1.00	1.00	1.00
relative prices	-1.34	-1.85	-3.80	$-\infty$

As a result of the a priori constraint, the elasticity of export demand with respect to market growth is unity regardless of the time span of analysis. On the other hand, the price elasticity is clearly dynamic, increasing almost three-fold in five years from its first-quarter value. It is observed, however, that the increase in price elasticity towards infinity is rather slow.

II.2.2 Prices of Multilateral Exports of Goods

The theoretical foundations of the estimated equation for the price of multilateral exports of goods are defined by the following profit maximization problem of a representative firm:

$$(1)\qquad \max_{Y} \sum_{t=0}^{\infty} \emptyset^{t} \cdot PROFIT_{t}$$

$$PROFIT = P \cdot Y - W \cdot L - P^{m} \cdot M - P^{k} \cdot K$$

s.t.

$$Y/Y_{-1} = (P^{f}/P)^{\alpha}(D/D_{-1}) \qquad \text{(firm level demand for output)}$$

$$L = CES^{-1}[(1-a) \cdot Y, K, TIME] \qquad \text{(inverted CES-production function)}$$

$$M = a \cdot Y \qquad \text{(demand for material inputs)}$$

where Y is output, P is the price of output, W is the nominal wage rate, L is the required labour input, P^m is the price and M the volume of material inputs, P^k is the implicit rent of capital, K the stock of capital, P^f is the competing price, and D is the demand shift variable. Variables W, P^m, P^f, P^k and K are here treated as exogenous, although they are of course endogenous in the full model.

We see that the specification of the demand function corresponds to that of the estimated equation for Finland's multilateral exports of goods: the price elasticity is finite in the short-run but becomes infinite in the long run.

Profit maximization implies the following first order condition:

$$(2)\qquad (1-1/\alpha)P_{t} - SMC_{t} = -(\emptyset/\alpha)(P_{t+1}Y_{t+1}/Y_{t})$$

where

$$SMC = a \cdot P^{m} + (1-a) \cdot W \cdot (\delta L/\delta Y) \qquad \text{(short-run marginal costs of production)}$$

Dividing both sides of equation (2) by the term $[(\alpha - 1 + \emptyset)/\alpha] \cdot P_t$, we can write the following Euler equation

$$(3) \qquad \log(P_t/SMC_t) = -\beta \log(P_{t+1}Y_{t+1}/P_tY_t) + m$$

where $\beta = \emptyset/(\alpha - 1 + \emptyset) > 0$ and $m = \log[\alpha/(\alpha - 1 + \emptyset)] > 0$

Assuming adaptive expectations in P and Y and denoting the logs of the corresponding capital letters with small letters equation (3) reduces to

$$(4) \qquad \Delta p = b_0\Delta smc + b_1\Delta p^f + b_2(smc_{-1} - p_{-1}) + b_3\Delta(y_{-1} - d_{-1}) + b_4$$

where Δ denotes a difference operator and

$b_0 = 1/[1 + \beta(1-\mu)(\alpha-1)]$; $b_1 = \beta\alpha(1-\mu)b_0$;

$b_2 = \mu b_0$; $b_3 = \beta(1-\mu)b_0$; $b_4 = m\mu b_0$

and μ is the adaptation coefficient of the expectations mechanism.

Equation (4) shows that in the long-run equilibrium output price equals marginal costs. However, the form of the demand equation guarantees that in full equilibrium the price of output must also equal the competing world market price: as long as these two prices deviate from each other there are continuous changes in the market share of Finland's exports. As marginal costs are endogenous in the whole model this mechanism also forces them to adjust towards the competing world market price. Hence, in the long run equilibrium the equality $P = SMC = P^f$ prevails. The quantity produced by the manufacturing sector will then be determined solely by supply factors, and it will settle on the level where marginal costs have adapted to world market prices.

As operational counterparts for the size of the market for Finland's multilateral exports and for the competing world market price, we use the same variables as in the estimated equation for the volume of multilateral exports. The marginal cost variable is constructed with the aid of the nested Leontief-CES-production function estimated for manufacturing (see eq. X6).

The estimated price equation for Finland's multilateral exports of goods is given as X.5 in the list. Besides the variables included on the right hand side of equation (4), the estimated equation includes the lagged change in the relative price as an additional explanatory variable. This term captures the empirical fact that the short-run dynamics of the estimated export equation is more complicated than in equation (4).

The dynamic partial elasticities of the price of multilateral exports of goods with respect to marginal costs and to the foreign competing price is presented in the following table.

TABLE 3. PARTIAL ELASTICITIES OF FINLAND'S MULTILATERAL EXPORT PRICE OF GOODS WHEN MARGINAL COSTS ARE EXOGENOUS

variable	immediate elasticity	one-year elasticity	long-run elasticity
marginal cost	0.29	0.50	1.00
competing foreign price	0.60	0.39	0.00

Due to the endogeneity of marginal costs the long-run elasticities in table 3 are not particularly interesting. The elasticity of marginal costs of exports with respect to the volume of exports is determined by the technology assumptions of the model and by the share of exports in manufacturing output. Evaluated for 1985, and for given nominal wages and a given capital stock, the long-run elasticity of marginal costs in manufacturing with respect to western exports is about 0.20. This implies an elasticity of -5 of export volume with respect to wages/world market prices after all price and volume adjustments have been carried out.

II.2.3 Bilateral Exports

The modelling of Finland's bilateral exports starts from the assumption that the value of bilateral exports is determined by the value of Finland's bilateral imports. Finland's imports from the Soviet Union consist mainly of crude oil and other energy, and the experience from the "oil shock" periods and from the oil price collapse of 1986 seems to support the conclusion that it is the volume of Finnish exports which ultimately adjusts to balance the bilateral trade account. For a closer examination of the Finnish-Soviet trade, see Rautava & Tervonen (1987) and Holopainen (1981).

Although the modelling of bilateral trade in goods is based on the adjustment of exports over time to equate exports and imports, this is only an approximation. In reality it is the clearing account which must be balanced, not trade in goods. Since the invisible items (services and capital movements) are also considerable, there may at times be a significant difference between the balance of trade and the balance on clearing account payments.

The equation for the volume of Finland's bilateral exports is shown as X.2 in the list of equations. It is essentially an estimated partial adjustment mechanism to the balance-of-trade condition. The speed of adjustment in response to changes in relative prices and in the volume of bilateral imports is restricted to be the same. This is also apparent from table 4, where the dynamic elasticities of the equation are reported.

TABLE 4. DYNAMIC ELASTICITIES OF FINLAND'S BILATERAL EXPORTS OF GOODS

variable	immediate elasticity	one-year elasticity	long-run elasticity
bilat. imports	0.07	0.23	1.0
export price	-0.07	-0.23	-1.0

The modelling of the main determinant of bilateral exports, i.e. the value of bilateral imports, is discussed in connection with the other import items.

The price of bilateral exports depends - as stipulated in trade agreements - on the prices of corresponding products in western markets. Let us assume that bilateral trade contracts are concluded at the same price at which industrial products are sold in the domestic market. If the time span between contracts and deliveries is geometrically distributed, the prices will follow domestic industrial product prices with a geometric lag. As most export contracts are made in clearing roubles, changes in the FIM rate of the rouble during the lag will have to be taken into account. Despite the fact that bilateral trade prices are tied to prices elsewhere, prices have nevertheless increased clearly faster than domestic prices in Finland or foreign trade prices generally. This may be due to increased technological sophistication in bilateral exports, which will have to be taken into account by a time trend if we wish to restrict the elasticity of bilateral export prices with respect to domestic prices of industrial products to one. The estimated equation is shown an X.4 in the list of equations.

According to the equation, the convergence of prices of bilateral exports towards the domestic price level of industrial products is fairly fast: as much as 42 per cent of the price gap is eliminated in a quarter. Because of the trend variable, the rise in prices of bilateral exports is approximately 2.1 per cent faster than the rise in P4.

II.2.4 Exports of Services

Exports of services relate partly to the transportation of Finland's foreign trade. The share of transportation in total exports of services was 41.8 per cent in 1980, while the remaining 58.2 per cent consisted of tourism and exports of other services. The scale, or income, variable of the equation is a geometric weighted average of the volume of Finnish foreign trade and of the volume of imports of Finland's major trading partners. The latter is intended to measure the general level of economic activity abroad. The weights correspond to the above-mentioned shares in 1980 of transportation revenue and other revenue in exports of services. The long-run elasticity of the composite scale variable is restricted to unity.

The equation for exports of services is shown as X.3 in the equation list. Because of data problems involved in deflating the nominal export figures, relative prices (competitiveness) are measured by the ratio of prices of private services etc. to import prices of consumer goods. Here we assume that the import prices of consumer goods also reflect the general level of prices of services abroad.

The dynamic properties of the equation are as indicated in table 5.

TABLE 5. THE DYNAMIC ELASTICITIES OF EXPORTS OF SERVICES

variable	immediate elasticity	one-year elasticity	long-run elasticity
foreign trade	0.42	0.42	0.42
activity abroad	0.58	0.58	0.58
relative prices	0.00	-0.80	-1.07

For more econometrics on Finnish exports of services, see Moilanen (1981). The price of exports of services is determined as a weighted average of the prices of domestic private services and imports of services (see equation X.8).

II.3 Imports

In BOF4, five categories of imports are distinguished: 1) raw materials excl. crude oil; 2) crude oil, fuels and lubricants; 3) consumer goods; 4) investment goods and 5) services. In addition there is an equation for the determination of the nominal value of bilateral (mainly Soviet) imports.

The economic content of the import equations has not changed much since the BOF3 version of the model. The dynamic specifications are, however, now obtained as a result of a systematic search method. This has also been used by Aurikko (1985), whose results are mostly vindicated by our findings.

The equations are loglinear demand functions with an empirically determined lag structure. The determinants for each category of imports are 1) an activity variable, and 2) a relative price variable. These are defined as follows.

For imports of raw materials, real GDP is used as the activity variable and the import prices of raw materials relative to the price of domestically produced manufactures is used as the relative price.

For imports of consumer goods, private consumption less consumption of services by households and government is used as the activity variable. The relative price is the import price adjusted by the sales tax rate and divided by the private consumption deflator.

For imports of investment goods, the volume of total fixed investment is used as the activity variable and the import price relative to the price of domestically produced manufactured goods measures the relative price.

For imports of services, the activity variable is a geometric average of real GDP and the volume of private consumption of services. The weights correspond to the shares in imports of services other than travel, and travel, respectively. The relative price is the import price of services divided by the deflator of private consumption of services.

The modelling of imports of crude oil, fuels and lubricants is a little more complicated. The approach used here is to view imports of energy as a residual determined by the demand for energy, on the one hand, and by the domestic supply of energy, on the other. In the equation we have used real GDP as the activity variable with long-run elasticity constrained to unity and the tax-adjusted import price of fuels relative to the private consumption deflator as the price variable. The long-run propertes of the equation have been restricted so that any increase in domestically produced energy will eventually crowd out a corresponding amount of energy imports. In the equation a fixed coefficient of 0.9421 is used to make the energy figures (which are in 1000 toe) commensurable with the import figures (which are millions of FIM in 1985 prices).

The actual import volume equations are shown as M.1, M.2, M.3, and M.5 in the equation list. The properties of the import equations may be characterized by dynamic price and activity elasticities. These are reported in the following tables. The activity elasticites are calculated in two different ways: first, holding the domestic energy supply constant, and second, changing the domestic energy supply proportionately with the other activity variables.

TABLE 6. DYNAMIC ACTIVITY ELASTICITIES OF IMPORTS (DOMESTIC ENERGY SUPPLY CONSTANT)

import category	immediate elasticity	one-year elasticity	long-run elasticity
raw materials	1.86	2.24	0.78
oil, fuels etc.	0.69	0.81	1.36
consumer goods	1.22	1.48	1.60
investment goods	0.52	0.73	1.01
total goods	1.24	1.51	0.97
services	1.16	1.42	1.54
total imports	1.28	1.56	1.14

TABLE 7. DYNAMIC ACTIVITY ELASTICITIES OF IMPORTS (DOMESTIC ENERGY SUPPLY PROPORTIONAL TO ACTIVITY)

import category	immediate elasticity	one-year elasticity	long-run elasticity
raw materials	1.86	2.24	0.78
oil, fuels etc.	0.69	0.61	1.00
consumer goods	1.22	1.48	1.60
investment goods	0.52	0.73	1.01
total goods	1.24	1.47	0.90
services	1.16	1.42	1.54
total imports	1.28	1.52	1.07

An interesting feature of imports of raw materials is the high short-run elasticity with respect to GDP. However, the elasticity declines in the long run. We believe that this behaviour is associated with an inventory cycle in raw materials. This finding has also been confirmed by other Finnish studies (see e.g. Vajanne (1983)).

TABLE 8. DYNAMIC PRICE ELASTICITIES OF IMPORTS

import category	immediate elasticity	one-year elasticity	long-run elasticity
raw materials	-0.68	-0.68	-0.79
oil, fuels etc.	0.00	-0.19	-0.71
consumer goods	-0.47	-0.57	-0.61
investment goods	-0.97	-0.99	-1.14
total goods	-0.53	-0.57	-0.77
services	-0.63	-0.76	-0.83
total imports	-0.55	-0.60	-0.78

Apart from the system of import demand functions now described, the BOF4 model includes a very simple equation for forecasting the value of Finland's bilateral imports (eq. M6 in the equation list). It is based on the assumption of constant marginal propensities to import from multilateral sources: according to the equation, 76.9 per cent of imports of oil, fuels and lubricants come (at the margin) from the Soviet Union and other bilateral sources; the corresponding propensity for other categories of imports is 4.3 per cent.

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III PRODUCTION AND EMPLOYMENT

Abstract

This paper contains a description of the production and labour demand sections of the BOF4 model. It first appeared in the Bank of Finland Discussion Paper Series in July 1988, series no. 14/88.

CES value added production functions are developed and estimated for the five sectors of the economy. From these the marginal product of labour and capital functions are derived which are important factors in determining investments and the prices of gross outputs in each of the sectors. The demand for labour hours is defined as a gradual adjustment process towards the level determined by the inverted production functions. An input-output model is used to determine output and value-added deflators by sectors as well as the prices of the different demand components.

III.1 Introduction

This report describes a part of the supply side of the BOF4 model, namely the production functions and technology, the determination of sectoral outputs and labour demand.

First, the technological assumptions of the model and the estimation of the sectoral CES-production functions are described. Production functions are used to calculate the marginal costs of production and the marginal products of fixed capital, which drive the price and investment equations of the model. Second, we describe the use of an input-output model to determine the relation between production prices and value-added deflators on the other hand and output by sectors on the other. Inverted production functions are used to solve for required labour inputs. The modelling of the demand for work hours and the determination of employment consists the third part of the paper.

III.2 Production Functions and Technology

III.2.1 The General Modelling Strategy

In BOF4, production is disaggregated into the following five sectors:

TABLE 1.

Sector	Code in BOF4	1985 share in GDP
- Agriculture	1	4.4 %
- Forestry	3	3.7 %
- Manufacturing	4	25.4 %
- Private services etc.	2	49.8 %
- Government services	G	16.8 %

Manufacturing includes mining, and the private services sector includes construction, electricity, gas and water sectors. Fishing is included in agriculture.

For each sector we have estimated a production function. These production functions are not directly parts of the model, but they are used in the derivation of the factor demand equations (i.e. investment and work hours equations) and in estimating marginal costs of production; the marginal costs in turn enter the pricing equations. This two-stage strategy of modelling the supply side helps to ensure the consistency of the the equations in the model with each other and with the chosen technology assumptions.

III.2.2 The CES Value Added Production Functions

The production functions are assumed to be "nested" in the sense that labour and capital are separable from the other inputs. This allows us to model the production of real value added in the different sectors as functions of labour and capital inputs only. The value added production functions are of the "CES" type with Hicks-neutral technical progress and constant returns to scale:

(1) $$Q = A \cdot \exp(\gamma \cdot TREND) \cdot (a \cdot K^{-\rho} + (1-a) \cdot L^{-\rho})^{-1/\rho}$$

Here Q is the real value added originating from the sector in question, K is the stock of fixed capital and L is the labour input (measured in hours worked). The impact of technical progress is captured by the inclusion of the linear time trend TREND. A, γ, a and ρ are parameters; of these, γ measures the rate at which technical progress increases the efficiency of production and ρ governs the elasticity of substitution between labour and capital, a indicates the weighting of capital and labour and A is a factor reflecting the scale of operation.

Although the functional form is assumed to be the same for each of the five sectors of the model, separate parameter values are estimated for each of them. For the agricultural sector the CES function was estimated directly by nonlinear least squares (in a form solved for the labour/capital ratio). For the other sectors, we have used a two-step procedure broadly similar to that described in Klein and Bodkin (1967). This method circumvents the problem of multicollinearity by assuming that the observed labour share in the value added is consistent with the cost-minimizing optimum. This allows us to write the following loglinear regression equation for each sector:

(2) $$\log((PQ-WL)/WL) = \log(a/(1-a)) - \rho \cdot \log(K/L)$$

Here WL denotes labour costs (wage bill plus employers' social security payments) and PQ-WL is the gross operating surplus of the sector in question (total value added at factor cost minus labour costs).

From the regression coefficients of the above equation we can solve for parameters a, ρ and, further, the elasticity of substitution $s = 1/(1+\rho)$. If ρ, the coefficient of the capital-labour ratio in equation (2) were zero, the factor shares explained by the equation would be independent of the capital-labour ratio and the technology would be of the Cobb-Douglas type (with unit elasticity of substitution). The regression (2) is hence a kind of test of the CES specification against the more restrictive Cobb-Douglas specification.

After solving for the estimates of a and ρ, these are substituted into the original production function (1) and the scale parameter A and the rate of technical progress γ are estimated by loglinear least squares. After this second step, we have obtained all of the required parameter estimates.

The estimation was carried out using annual data for the period 1960 - 1985. The factor share data was adjusted for the labour input of the self-employed persons so that the wage bill was multiplied by the ratio of total hours worked to the hours worked by employees. In estimating the CES production function for the private services sector, the housing sector (letting and operating of dwellings and use of owner-occupied dwellings) was deducted from both the value added and the capital stock concept.

A comprehensive account of the estimation results is given in appendix 1. The most important characteristics of the estimated production functions are the elasticities of substitution and the rates of technical progress. These are given in the following table:

TABLE 2.

Sector	elasticity of substitution $s = \frac{1}{1+\rho}$	rate of technical progress (% p.a.) γ
- Agriculture	0.97	0
- Forestry	1.48	0.3
- Manufacturing	0.88	3.0
- Private services etc.	0.62	3.2
- Government services	0.51	0.7

The production functions which are actually used in BOF4 are quarterly versions of the estimated annual production functions. The conversion of annual CES functions into quartely ones is done by multiplying the capital stock by four in the estimation of the annual functions. The finally obtained quarterly functions are:

Agriculture:

(3) $$GDP1 = 0.424 \cdot (0.6663 \cdot KF1^{-.028} + 0.3337 \cdot LH^{-.028})^{(-1/.028)}$$

Forestry:

(4) $$GDP3 = 9.042 \cdot e^{.003 \cdot TREND}(0.1611 \cdot KF3^{.326} + 0.8389 \cdot LH3^{.326})^{(1/.326)}$$

Manufacturing:

(5) $$GDP4 = 2.268 \cdot e^{.031 \cdot TREND}(0.5535 \cdot KF4^{-.143} + 0.4465 \cdot LH4^{-.143})^{(-1/.143)}$$

Private services etc. (excl. housing):

(6) $$GDP2 = 1.073 \cdot e^{.032 \cdot TREND}(0.8882 \cdot KF2^{-.605} + 0.1118 \cdot LH2^{-.605})^{(-1/.605)}$$

Government services:

(7) $$GDPG = 0.807 \cdot e^{.007 \cdot TREND}(0.9864 \cdot (KFCG + KFLG)^{-.978} + 0.0136 \cdot LHG^{-.978})^{(-1/.978)}$$

See appendix 3 for a list of symbols.

From these functions it is straightforward to derive the inverted production functions (the labour requirement (LH_i) functions), the marginal product of labour (MPL_i), the marginal product of capital (MPK_i), and the marginal cost of production (SMC_i) functions used in BOF4.

The marginal product of labour implied by the equation (1), can be written as

(8) $\partial Q/\partial L = (1-a)\cdot A\cdot \exp(\gamma\cdot TREND)\cdot[a\cdot(K/L)^{-\rho} + (1-a)]^{-(\rho+1)/\rho}$

This formula is used in developing the sectoral short-run marginal cost of production functions. These are of the form

(9) $SMC = (1-a_Q)\cdot P^m + (a_Q)\cdot W/(\partial Q/\partial L)$,

where P^m is the weighted sum of input prices from other sectors and raw materials and the parameter a_Q describes the division of costs between material inputs and value added. The marginal product of labour (8) could also be expressed in terms of Q/L on the right hand side. This form was actually used in the earlier versions of the SMC functions. (See BOF4: Equations, TU 6/87). Having production in the denominator of the SMC function reduces costs (and prices) in the short run when GDP rises because labour hours react slowly to changes in production. This feature was regarded as undesirable in simulations and so the MPL_i functions were written in the form (8).

The marginal product of capital derived from equation (1) is

(10) $(\partial Q/\partial K) = a\cdot A^{-\rho}\cdot \exp(-\rho\cdot\gamma\cdot TREND)\cdot\left(\frac{GDP}{KF_{-1}}\right)^{\rho+1}$.

Using the parameters estimated from the production functions we can calculate time series for (10) to be used in the investment equations.

III.2.3 The Leontief Outer Production Functions

In the technology assumption used in the BOF4 model, the CES value added production functions are nested in a Leontief outer or "gross" production function in each sector of production. This means that the proportions of real value added in real output are assumed to be fixed, as are the proportions of non-primary inputs - meaning imports and purchases from other sectors used in production. These assumptions make it possible to use an input-output table to evaluate the cost structure of the different sectors in the model.

Since gross outputs and intersectoral flows of goods are not explicitly included in the model as variables, the outer production functions are not needed as such. Rather, the Leontief functions assigned for each sector are used in the actual model structure in two ways.

First, the cost functions implied by the outer production functions are used to determine the relationships between producer prices and value added deflators. This is possible because the knowledge of input coefficients enables us to compute the share of the producer price needed to cover costs of non-primary inputs and so the value added deflator is "residually" determined. This is explained more closely in the chapter in this book describing the modelling of prices and wages in BOF4 (see also Tarkka & Willman (1985)).

Second, the information on input coefficients is used in the determination of the value added by sectors. This is explained in more detail in the next section. The idea is familiar from input-output models: assume that the structure of aggregate demand is known, and also that each component of aggregate demand uses gross output of the different sectors in fixed proportions. This makes it possible to calculate the gross outputs of different sectors used to satisfy final demand. However, since gross outputs are also used as intermediate inputs in production, information on the input coefficients is needed before the gross output and the real value added produced in each sector can be solved for.

In estimating the input coefficients the Finnish input-output table of 1982 is used. The results are shown in the following table, where

a_1 is the coefficient of	inputs from agriculture,
a_3	inputs from forestry,
a_4	inputs from manufacturing,
a_2	inputs from the private service sector,
a_G	inputs from the govt. services sector,
a_{MR}	imported raw materials (excl. fuels),
a_{MF}	imported fuels,
a_Q	capital and labour (i.e. value added).

TABLE 3. THE INPUT COEFFICIENTS IN 1982

	Sector: Agric. (1)	Forestry (3)	Manufact. (4)	Priv.serv. (2)	Govt. (G)
a_1	0.0648	0.0096	0.0652	0.0014	0.0000
a_3	0.0079	0.0307	0.0393	0.0013	0.0000
a_4	0.2684	0.0223	0.3004	0.1413	0.0000
a_2	0.1132	0.0307	0.1082	0.2582	0.0000
a_G	0.0000	0.0000	0.0000	0.0000	0.0000
a_{MR}	0.0359	0.0074	0.1115	0.0495	0.0000
a_{MF}	0.0095	0.0148	0.0700	0.0148	0.0000
a_Q	0.5003	0.9200	0.3054	0.5335	1.0000
Sum	1.0000	1.0000	1.0000	1.0000	1.0000

The cost functions in the different sectors have the following form:

$$C = X\cdot(a_1\cdot P1 + a_3\cdot P3 + a_4\cdot P4 + a_2\cdot P2 + a_G\cdot PG + a_{MR}\cdot PMR + a_{MF}\cdot PMF + a_Q\cdot PGDP), \tag{11}$$

where C is the total cost of production, X is gross output, a_i:s are input-output coefficients, P1, P3, P4, P2, PG, PMR and PMF are the prices of respective inputs and PGDP is the value added deflator. This is the form of the total cost functions. It is useful mainly because it can be inverted to a formula for the value added deflator.

When evaluating the relevant marginal cost of production, a short-run variable cost concept is needed instead of the total cost given by (11). If the stock of fixed capital is treated as predetermined at each instant, the short-run marginal costs do not include gross operating surplus. Hence the short-run marginal costs can be expressed by eq. (9). These matters are discussed in more detail in a later report of the modelling of prices.

III.3 The Supply Side: Production and Employment

The supply side in BOF4 consists of two types of equations. On the one hand, the production and employment equations determine how a given aggregate demand is satisfied by production taking place in the different sectors of the economy. On the other hand, the labour supply, wage and price equations describe the behavioural aspects of supply, namely the decisions of workers, unions and firms. The first, technological aspect of the supply side in BOF4 is discussed in the present chapter.

III.3.1 The Determination of Output by Sectors

The determination of the sectoral composition of real value added starts from the composition of aggregate demand given by the equations on the demand side of the model. The structure of demand is converted to the corresponding structure of output and indirect taxes (less subsidies) by means of an input-output model.[1] Estimates of this conversion matrix (except for inventories) are based on the input-output coefficient matrix presented in table 4.

Note that general government is a peculiar production sector in that its output is used only for public consumption. This implies that no other demand component but public consumption affect, directly or indirectly, general government production. Equation Q.6 (in appendix 2), which defines the production of general government sector (equalling its value-added), states that 67 per cent of the the increase in public consumption is directed at the production of general government sector.

Equations Q.1 - Q.5 convert the rest of the final demand and imports of inputs into value-added of four private sectors and into indirect taxes less subsidies. Denote the conversion matrix contained by these

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[1]A more profound description of such a model can be found in Tarkka & Willman (1985), pp. 156 - 158.

equations by B. Now, after cancelling the row of general government production and the column of public consumption originating from the government sector in table 4, the matrix B can be expressed in terms of coefficients presented in table 4 as follows:

$$B = \begin{bmatrix} F^d(I_4-A)^{-1}D(I_{10}+\gamma^d)^{-1} \\ \\ [\pi(I_4-A)^{-1}D+\gamma](I_{10}+\gamma^d)^{-1} \end{bmatrix}$$

where F is the row vector of value added coefficients
A is the matrix of inter industry input coefficients
D is the matrix of the coefficients of imported inputs and final demand components
γ is the row vector of idirect tax coefficients levied on production
π is the row vector of indirect tax coefficients levied on imported inputs and final demand
I_4 is the four by four identity matrix
I_{10} is the ten by ten identity matrix

and superscript d is used to denote diagonal matrixes formed by row vectors F and γ.

However, as to the conversion of the change in inventories into sectoral production and indirect taxes, the input-output estimates obtained by this way were not accepted. Estimates based on the input-output study are point estimates of a single year (in this case 1982), and can deviate, especially in the case of inventories, quite considerably from their longer-run averages. That is why the parameters of this row were estimated by using the OLS method.

TABLE 4.

THE MATRIX OF INPUT-OUTPUT COEFFICIENTS IN 1982

Selling Industries	Bying Industries					Final Demand										
	agric. (1)	priv. services (2)	forest. (3)	manuf. (4)	govt. (G)	imported inputs	priv. consumption			public consumpt.		investment		exports		Change in inven-tories
							durabl.	non-dur.	services	priv. origin	govt. origin	prod. inv.	housing inv.	goods	services	
agriculture (1)	.0766	.0016	.0095	.0769	.0000	-.0478	.0000	.0626	.0002	.0038	.0000	.0000	.0000	.0192	.0000	2.5554
priv. services (2)	.1096	.2730	.0306	.1141	.0000	-.1191	.4427	.4178	.9938	.5956	.0000	.8738	1.0000	.0000	1.0000	2.0997
forestry (3)	.0076	.0013	.0056	.0439	.0000	-.0151	.0000	.0160	.0003	.0104	.0000	.0087	.0000	.0017	.0000	.6156
manufacturing (4)	.2901	.1740	.0340	.4710	.0000	-.8180	.5573	.5035	.0057	.3902	.0000	.1175	.0000	.9791	.0000	-4.2707
government (G)	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	.0000	.0000	.0000
indirect taxes minus subsidies	.0316	.0357	.0039	-.0162	.0000	.0000	.1370	.2513	-.0036	.0486	.0000	.0423	.0197	-.0228	.0197	-.4715
value added	.4845	.5144	.9164	.3103	1.0000	-	-	-	-	-	-	-	-	-	-	-
sum	1.0000	1.0000	1.0000	1.0000	1.0000	-1.0000	1.1370	1.2513	.9964	1.0486	1.0000	1.0423	1.0197	.9772	1.0197	.5285

In calculating the conversion estimates for the imported final goods the following additional assumptions were needed:

- The tax content of imported and domestically produced services is the same.
- Indirect taxes are levied 23.22 per cent and 9.71 per cent of the imports of consumption goods and investment goods, respectively.
- Of the imports of consumption goods 34 per cent is included in the private consumption of durables, 49 per cent in the private consumption of non- and semi-durables and 17 per cent in public consumption.
- All imports of investment goods are included in the private nonresidential investment and public investment.

III.3.2 The Demand for Labour Hours

In BOF4, two measures of labour input are used: work hours (LH_i) and paid labour inputs (LW_i). The latter are defined as the wage bill at constant (base-year) wages.

$$(12) \qquad LW_i = 100 \cdot \frac{YW_i}{WR_i},$$

where LW_i is paid labour inputs, YW_i is the wage bill and WR_i is the wage rate all referring to the sector in question. Since the wage rate indices do not reflect changes in paid holidays nor changes in overtime compensation, paid labour inputs overestimate the real hours worked. Furthermore, work hours include the effort of self-employed persons, whereas paid labour input depends only on "bought" labour. On the other hand, by using the concept of paid labour input the sectoral wage bill can be expressed as the product of the paid labour input and the wage rate, which is more consistent from the point of view of the whole model.

The demand for hours in each production sector is explained by the inverted CES production functions. Thus, the effects of capital deepening and technical progress on the demand for labour are captured in a way consistent with the technological assumptions of the whole BOF4 model. However, the inverted production function approach is incapable of taking into account the dynamics of labour demand. In particular, the observed procyclical movement of productivity cannot be explained by the inverted production function approach alone. (For a survey of labour demand equations see Fair (1969), also Intriligator (1978) ch. 8.5.)

To overcome this notorious problem, we have allowed a slow adjustment in the demand for work hours towards the equilibrium dictated by the inverted production functions. The adjustment mechanisms are obtained as results of an iterative specification search method, starting form unconstrained dynamics and dropping one by one, those lags of the explanatory variables which were statistically insignificant. The conformity of the equations in the long run with the inverted production function is ensured by the so-called error correction terms.

The dynamic properties of the demand for hours equations are described in the following tables, in which the elasticities of work hours with respect to output and the capital stock are presented. In table 6 the elasticity of labour demand is expressed in terms of the elasticity of productivity holding output constant.

TABLE 5. THE DYNAMIC ELASTICITIES OF WORK HOURS WITH RESPECT TO CHANGES IN OUTPUT IN THE BOF4 MODEL

sector	immediate elasticity	one-year elasticity	fifth-year elasticity
agriculture	0.11	0.20	1.05
forestry	0.56	0.66	1.97
manufacturing	0.45	0.64	1.36
priv. services etc.	0.45	0.51	1.04
general government	0.00	0.70	1.08
total economy	0.33	0.54	1.13

TABLE 6. THE DYNAMIC ELASTICITIES OF PRODUCTIVITY WITH RESPECT TO CHANGES IN THE STOCK OF FIXED CAPITAL IN THE BOF4 MODEL

sector	immediate elasticity	one-year elasticity	fifth-year elasticity
agriculture	0.00	0.06	0.61
forestry	0.00	0.16	1.16
manufacturing	0.00	0.07	0.42
priv. services etc.	0.00	0.03	0.13
general government	0.00	0.05	0.07
total economy	0.00	0.05	0.26

Changes in the sectoral composition of the value added also have an effect on the average labour productivity, since the productivities differ across sectors, as indicated by the following table:

TABLE 7. THE PRODUCTIVITY OF LABOUR IN DIFFERENT SECTORS OF THE BOF4 MODEL IN 1985, (AVERAGE FOR THE ECONOMY = 100)

agriculture	34
forestry	169
manufacturing	116
priv. services etc.	108
general government	100

After the demand for labour hours is determined in the model, these are used to solve for paid labour inputs. This is done by simple linkage equations (L.6 to L.10 in the list of equations).

III.3.3 Employment

The equation for employment (see L.12 in appendix 2) determines the number of employed persons on the basis of the total demand for work hours. The elasticity of employment with respect to the demand for hours is given in the following table.

TABLE 8. THE DYNAMIC ELASTICITY OF EMPLOYMENT WITH RESPECT TO CHANGES IN THE DEMAND FOR WORK HOURS

	immediate elasticity	one-year elasticity	fifth-year elasticity
total economy	0.14	0.45	0.95

In the long run the elasticity is constrained to unity. In addition, the equation contains a trend variable which causes a decrease in hours per per person at a rate of 0.86 per cent per annum.

A simple linear relationship (L.11) is used to convert the Labour Force Survey statistics to correspond to the SNA concept of employment.

APPENDIX 1

THE ESTIMATION OF THE CES VALUE ADDED PRODUCTION FUNCTIONS

For sectors 2, 3, 4 and G the following loglinear equation is estimated with annual data. The capital stock is multiplied by four to get parameter estimates equivalent to quarterly equations. (A list of variables is in appendix 3).

(A1) $\log((PQ - WL \cdot Z)/WL \cdot Z) = \log(a/(1-a)) - \rho \cdot \log((4 \cdot K/L)$

Where Z is the correction term to account for the self-employed in sectors 2, 3 and 4.[2] From this the value for a (the distribution parameter) and ρ (the parameter which governs the elasticity of substitution between labour and capital: $s = 1/(1+\rho)$) are solved for and substituted into:

(A2) $Q = A \cdot \exp(\gamma \cdot TREND) \cdot [a \cdot (4 \cdot K)^{-\rho} + (1-a) \cdot L^{-\rho}]^{-1/\rho}$.

Dividing by $[a \cdot (4 \cdot K)^{-\rho} + (1-a) \cdot L^{-\rho}]^{-1/\rho}$ and taking logs gives

(A3) $\log(Q/[a \cdot (4K)^{-\rho} + (1-a) \cdot L^{-\rho}]^{-1/\rho}) = \log A + \gamma \cdot TREND$

From this second stage equation we get estimates for A and γ. Using the estimated parameters for a, ρ, A and γ the final production functions can be written as equations (3) - (7) in the main text. See tables A1 and A3 below.

For the agricultural sector where no technical progress could be identified ($\gamma = 0$ in equation A2) the CES value added production function (A2) was estimated directly by nonlinear least squares in a form solved for the labour/capital - ratio:

[2] See the list of variables in appendix 3 for a more accurate explanation.

(A4) $$L/K = \left[\frac{A^{\rho}}{(1-a)} \cdot \left(\frac{Q}{K}\right)^{-\rho} - \frac{a}{1-a} \right]^{-\frac{1}{\rho}}$$

The estimation results are

$$\frac{LH1}{KF1} = \left[\underset{(19.91)}{2.9253} \left(\frac{GDP1}{KF1}\right)^{\underset{(-2.69)}{-.0281}} - \underset{(28.01)}{1.9967} \right]^{\underset{(2.69)}{(1/-.0281)}}$$

$\bar{R}^2 = 0.444$ DW = 0.430 SE = 0.00129

Estimation period 1960 - 1985. The solved parameters are A = .4242, ρ = 0.0281 and a = 0.6663. Numbers in brackets are standard deviations.

Note that here the stock of capital is not multiplied by four since it appears on the both sides of the equation.

PRODUCTION FUNCTION ESTIMATION RESULTS FOR SECTORS 2, 3, 4 and G

TABLE A1 EQUATION A1 (First stage)

	Equation	$\bar{R}^2$	DW	SE	estimation period	Solved from the equation a	ρ	s
Private services etc. (excl. housing)	$\log\left(\frac{GDPV2 - Q1V83}{(1+SOCCR2)\cdot YW2\cdot ZL2} - 1\right) = \underset{(0.4034)}{2.0726} - \underset{(0.0682)}{0.6050}\log\left(4\cdot\frac{KF2}{LH2}\right)$	0.756	1.129	0.118	1960 - 1985	0.8882	-0.605	0.623
Forestry	$\log\left(\frac{GDPV3}{(1+SOCCR3)\cdot YW3\cdot ZL3} - 1\right) = \underset{(0.1970)}{-1.6501} + \underset{(0.0336)}{0.3261}\log\left(4\cdot\frac{KF3}{LH3}\right)$	0.789	1.170	0.138	1960 - 1985	0.1611	0.326	1.484
Manufacturing	$\log\left(\frac{GDPV4}{(1+SOCCR4)\cdot YW4\cdot ZL4} - 1\right) = \underset{(0.5755)}{0.2148} - \underset{(0.0977)}{0.1429}\log\left(4\cdot\frac{KF4}{LH4}\right)$	0.044	1.042	0.148	1960 - 1985	0.5535	-0.143	0.875
Government services	$\log\left(\frac{GDPVG}{(1+SOCCRG)\cdot YWG} - 1\right) = \underset{(0.8955)}{4.2834} - \underset{(0.1281)}{0.9781}\log\left(4\cdot\frac{(KFCG+KFLG)}{LHG}\right)$	0.696	0.905	0.043	1960 - 1985	0.9864	-0.978	0.506

TABLE A3 EQUATION A3 (Second stage)

	Equation	$\bar{R}^2$	DW	SE	estimation period	Solved from the equation A	γ
Private services etc. (excl. housing)	$\log\left[\frac{GDP2 - QIV83/(.01\cdot PGDP2)}{(.8882(4\cdot KF2)^{-.605}+.1118LH^{-.605})^{(-1/.605)}}\right] = \underset{(0.0104)}{0.0702} + \underset{(0.0007)}{0.0316}\cdot TREND$	0.988	0.390	0.026	1960 - 1985	1.073	0.032
Forestry	$\log\left[\frac{GDP3}{(.1611(4\cdot KF3)^{.3261}+.8389LH3^{.3261})^{(-1/.3261)}}\right] = \underset{(0.0299)}{2.2019} + \underset{(.0020)}{0.0029}\cdot TREND$	0.041	0.842	0.076	1960 - 1985	9.042	0.003
Manufacturing	$\log\left[\frac{GDP4}{(.5535(4\cdot KF4)^{-.143}+.4465LH4^{-.143})^{(-1/.143)}}\right] = \underset{(0.0145)}{0.8191} + \underset{(0.0010)}{0.0306}\cdot TREND$	0.976	0.557	0.037	1960 - 1985	2.268	0.031
Government services	$\log\left[\frac{GDPG}{(.9864(4\cdot(KFCG+KFLG))^{-.978}+.0136LHG^{-.978})^{(-1/.978)}}\right] = \underset{(0.0056)}{-0.2147} + \underset{(0.0004)}{0.0071}\cdot TREND$	0.937	0.834	0.014	1960 - 1985	0.807	0.007

List of symbols, see appendix 3.
Standard deviations are given in brackets under the parameters.

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IV LABOUR SUPPLY, WAGES AND PRICES

Abstract

This paper describes the supply of labour and the determination of wages and prices in the BOF4 model. It first appeared in the Bank of Finland Discussion Paper series in January 1989, series no. 6/89.

Labour supply is modelled as a function of real wage, income and discouraged worker effects.

Wages are a function of the unemployment rate. Besides that they respond to the deviation of actual wages from equilibrium wages dictated by nominal marginal productivity. Expected inflation and taxation are entered through the separate treatment of negotiated wages. Manufacturing is assumed to be the wage leader in the economy so that developments in other sectors are affected by the wage drift in manufacturing and are tied to manufacturing wages also in the long-run.

In sectors open to foreign competition the prices of the products as well as the marginal costs are taken to be determined solely by competitors' prices in the long-run. In the short-run, however, Finnish firms are assumed to possess certain monopoly power over their prices. Pricing in the closed sectors is supposed to be more monopolistic, so that prices are based only on domestic costs including the prices of imported inputs. The cost structure of the different sectors as well as prices of the final demand components are evaluated by the help of input-output tables.

IV.1 Introduction

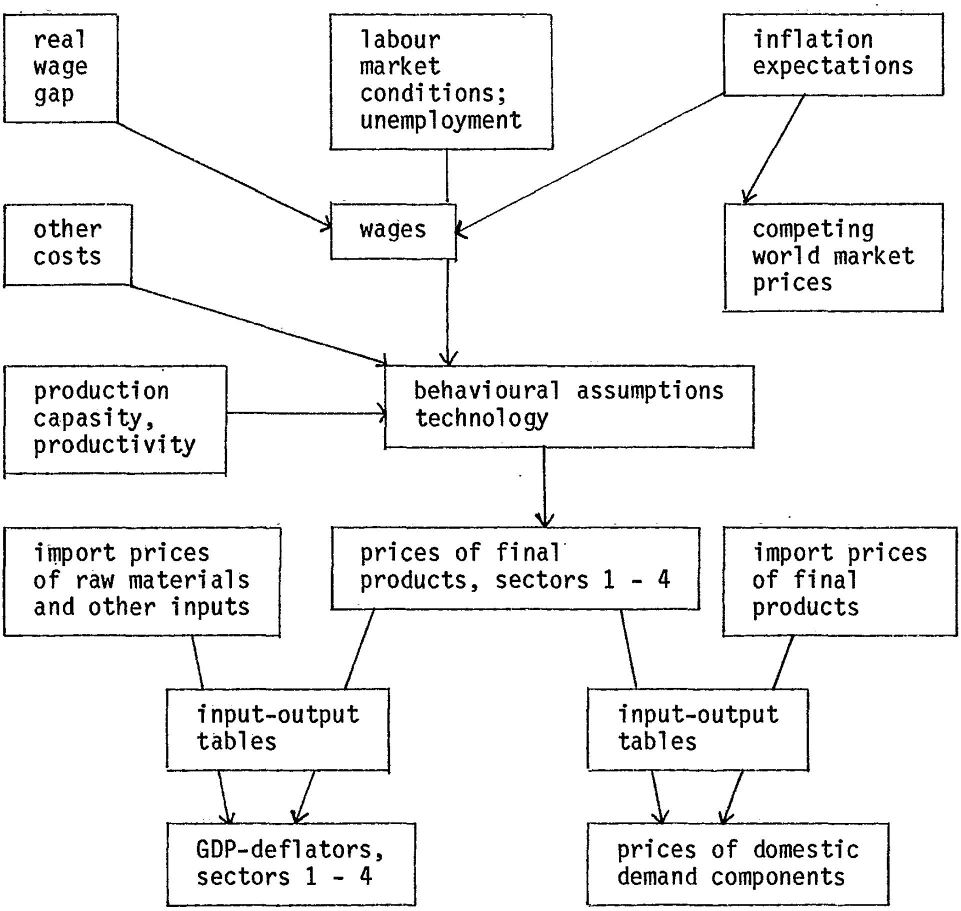
This chapter turns to the "behavioural" aspects of supply side modelling. The exposition follows the approximate order of causation in the model structure. First the labour supply is described as one of the determinants of the labour market situation. This is an important factor in the determination of wages and prices, along with productivity import prices, and competitors' prices in the export markets. These determine wages and domestic prices in three phases.

First, wages are determined on the basis of the labour market situation, productivity, relative prices and inflation expectations. The wages block of the model resembles the Scandinavian inflation model in that the open sector (manufacturing) is the wage leader, and that income distribution (sometimes called the real wage gap) influences wages also directly, not only through the unemployment rate as in the basic Phillips curve model.

In the second phase, prices of final output of the different production sectors are determined on the basis of marginal costs of production and the prices prevailing on foreign markets. In this phase the technology assumptions of the model play a key role.

In the third phase of the price determination, the model uses input-output coefficients to solve for sectoral value added deflators and the deflators of the different demand components. These are based on the prices of output of the different sectors. Most of the impact of indirect taxes on prices occurs in this phase, although some price effects of commodity taxes and subsidies are imputed in the previous phase of price determination, too.

FIGURE 1. THE STRUCTURE OF THE WAGE-PRICE BLOCK.



IV.2 Labour Supply

The labour force equation in BOF4 explains the changes in the participation rate. The participation equation has not changed much from the BOF3 version of the model (see Tarkka & Willman, 1985 pp. 205 - 212). The equation is based on the idea that consumption of goods and leisure[1] are substitutes in households' utility functions.[2] Thus, the after-tax real wage rate, which is the relative price of leisure, is one of the main determinants of the labour force participation decision.

Another relevant factor is the overall level of consumption and ultimately real income: if leisure is a normal good, labour supply is negatively affected by an increase in consumption. Conversely, if leisure is an inferior good, then an increase in consumption should, ceteris paribus, increase the labour supply.

A third factor is the "discouraged worker effect" which is caused by the fixed costs of entering the labour force such as costs of searching a job, getting a suitable training and making other necessary arrangements. In the presence of such costs, the demand for labour has a positive effect on the supply of labour, since the higher is the probability of actually getting a job after the participation decision has been made, the less do the mentioned fixed costs hinder labour force participation (see Abbot & Ashenfelter (1976) and Eaton & Quandt (1983)).

In addition to these arguments, a trend is included in the determinants of labour supply equation captured by the constant term in the estimated difference form. This measures the secular effects of increased education, better pensions and other institutional factors.

According to the estimated equation (see L.13 in appendix 1), leisure is a indeed normal good, so that a general rise in real incomes and consumption will decrease labour supply albeit the elasticity with respect to consumption is very small. The compensated real wage

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[1]Actually the substitution is between consumption of goods on the other hand and leisure combined with homework on the other when the participation decision is made.

[2]See e.g. Deaton and Muellbauer (1980) ch. 4 and 11 for a review of the microeconomics of labour supply equations.

elasticity of labour supply (holding real consumption constant) is positive but even smaller in absolute terms, so that if the rise in real incomes happens as a result of an increase in after-tax wages, the total effect of an increase in real wages on labour supply is a small negative figure, as shown in the following table of labour supply elasticities:

TABLE 1. ELASTICITIES OF THE SUPPLY OF LABOUR (LABOUR FORCE)

variable	elasticity
working-age population	0.382
employment	0.648
consumption	-0.030
real wage rate (the substitution effect)	0.005
real wage rate (the income and substitution effect)	-0.005

The total real wage effect, i.e. the uncompensated real wage elasticity is computed from the 1985 share of net wage income in households' disposable income and assuming that the marginal elasticity of consumption with respect to real disposable income is unity. It is seen that the labour supply curve, if drawn on the basis of these estimates, is slightly backward-bending.

The properties of the equation are such that if working-age population is increased while holding per capita consumption and the unemployment rate constant, then the elasticity of labour supply with respect to working-age population is unity and the participation rate also stays constant.

It must be pointed out that because labour supply is estimated in the form of the participation rate, it does not measure that part of changes in the supply of labour which is due to movements from full-time work to part-time work and vice versa.

From the point of view of the full macroeconomics model, the significance of the labour force participation equation is that it constitutes one of the determinants of the unemployment rate. Unemployment rate in turn affects wage rates through the wage equations. As aggregate demand is price elastic in the model, the labour force participation equation is thus an important link in the neoclassical adjustment mechanisms which work to balance the goods and labour markets in the long run.

IV.3 Wages

IV.3.1 Union Behaviour, Negotiated Wage Rates and Expected Inflation

Finnish labour markets are characterized by a high degree of unionization and, also, a high degree of synchronization in making the economy-wide wage contracts which result from collective bargaining between labour unions and organizations of employers. The unionization rate in Finland was 86 per cent in 1985.

The equation for the negotiated wage rate (in fact for the private sector), shown as W.6 in appendix 1, is based on the idea that trade unions are concerned with real disposable (after tax) wages even if bargaining in practice is over nominal wages. The estimated function is of the form

$$(1) \qquad \hat{wn} = (1-\lambda)a + \lambda\hat{wn}_{-1} + (1-\lambda)c\,\pi^{e} + b[\log(1-\hat{tax}) - \lambda\log(1-\hat{tax}_{-1})]$$

where wn is the log of negotiated wages, π^e is the expected increase of consumer prices over four quarters (in logs) and tax is the average personal tax rate. ˆ over a variable refers to differences over four quarters. The steady state equilibrium implied by (1) is

$$(2) \qquad \hat{wn} = a + c\pi^{e} + b\log(1-\hat{tax})$$

In the long-run the price expectations are not completely passed on into negotiated wages the parameter c being 0.67 (calculated from equation W.6). If parameter c were restricted to unity it would imply that price increases were overcompensated in the final behavioral wage equation (see equation W.4 in appendix 1). Because this was not desirable the parameter of the expected inflation was freely estimated as in equation W.6.

Expected inflation (see eq. W.7) is operationalized not only by recent price increases and the constant term, but also a relative price variable, measuring deviations from purchasing power parity between domestic and foreign currencies. This is reasonable since the policy of a pegged exchange rate creates a tendency of the domestic price level to converge over time towards a level dictated by the "law of one price", at least in tradeable goods. If, for example, there is a sudden change in foreign prices domestic prices are also expected to rise. This effect works directly trough the relative price variable in W.7 as well through lagged changes in PCP and P4.

Inflation expectations affect wage behaviour only through their effect on negotiated wages which are left permanently on a higher level after a temporary rise in expected inflation. In the very long-run the effect on actual wages through negotiated wages fades out altogether via the equilibrating mechanism of the wage drift. This can be seen from tables 2 and 3a - 3c. Increasing the average personal tax rate by one percentage point raises negotiated wages immediately by 1.1 per cent and is passed on into actual wages as governed by the specifications of the equations (see the next paragraph and tables 3a - 3c).

Negotiated wages influence the rest of the model only through their influence on actual wages. For forecasting purposes the negotiated wage rate can be exogenised for the near future when the outcome of the wage bargaining is known. In the long-run "market forces" dominate also centralized wage settlements as part of the process of determining actually paid wages.

TABLE 2. ELASTICITIES OF ACTUAL WAGES WITH RESPECT TO NEGOTIATED WAGES IN THE BOF4 MODEL

	immediate elasticity	one-year elasticity	five-year elasticity	ten-year elasticity
agriculture	1	0.91	0.34	0.08
priv. services etc.	1	1.98	0.42	0.10
forestry	1	0.93	0.36	0.09
manufacturing	1	0.91	0.35	0.08
government	1	1.00	0.71	0.34
wage rate, total	1	0.96	0.46	0.15

IV.3.2 Actual Wage Rates

Actually applied wage rates are not completely dictated by collective agreements. A so-called "wage drift" exists between the negotiated wage rate increases and those actually recorded in different industries. In the BOF4 model, the actual wage rates depend on the negotiated wage rates, on the one hand, and on other "economic factors", on the other. The changes in the wages block of the model since the BOF3 version raported in Tarkka & Willman (1985) are not very great.

The economic aspects of wage determination are mainly included in the wage equation for manufacturing. Other sectors are assumed to be "wage followers" adjusting rather passively to the development of wages in the manufacturing sector. This is in accordance with the so-called scandinavian model of inflation (see e.g. Edgren, Faxen & Odhner, (1969)). The equality - or proportionality - of wages in the long run would follow by necessity if labour were homogenous and perfectly mobile.

The most important wage equation of the model, that for manufacturing wages, is shown as W.4 in the list. The equation was first estimated with private sector negotiated wages as an unrestricted explanatory variable allowing the coefficient of negotiated wages to change in 1975, because of a definitional change in statistics. This gave a parameter close to 1 to negotiated wages in the latter period. After this the equation was estimated in the restricted form so that an increase in negotiated wages is fully passed on into actual wages.

The second explanator is the rate of unemployment. This Phillips curve effect is not very strong in the model and it is also rather slow due to the fact that the rate of unemployment affects the wage drift only after a one-year lag. For example, an increase in the rate of unemployment from 5 to 6 per cent would deccelerate the annual increase of wages by about one half percentage point. This effect would be somewhat stronger on lower levels of unemployment. The effect is also strenghtened by the wage/price linkages of the full BOF4 model as lower wages work through the price mechanism which again feed back on wages etc.

Perhaps the most unconventional part of the specification is the direct effect of "equilibrium wages" on actually paid wages. The deviation of equilibrium wages from actual wages measures the excess demand for labour. Equilibrium wages are operationalized by the nominal marginal product of labour in manufacturing, which in turn depends on the physical marginal product of labour and on the value added deflator. The effect of equilibrium wages is entered through two terms in the equation: the log-change of the value added deflator less indirect labour costs, and an error correction term measuring the "real wage gap", that is the lagged deviation of actually paid wages and indirect labour costs from the marginal productivity of labour.

The presence of marginal productivity in the wage equation might be given an expectations-based interpretation. However, we prefer to think that inflation expectations enter mainly through the negotiated wage rate and that the convergence of wages towards equilibrium wages operationalized by the marginal product of labour are an indication of the influence of excess demand for labour on the price of labour. As argued by Dreze (1987), wage equations should take into account the simultaneous existence of unemployment and excess demand for labour. It should be noted, moreover, that the marginal productivity hypothesis is the mechanism of wage determination in manufacturing also according to the Scandinavian model of inflation.

TABLES 3a - 3c. PARTIAL ELASTICITIES OF THE WAGE BLOCK WITH RESPECT TO THE MAIN EXPLANATORY VARIABLES INFLATION EXPECTATIONS ARE EXOGENOUS IN COLUMNS 1 - 6.

explanatory variable / endogenous variable	1 unemployment UR	2 real wage gap GDP4	3 employers social sec. contrib. rate SOCCR4	4 average personal tax rate ATAX	5 inflation expectations[1] INF	6 prices PGDP4	7 prices when inflation expectations are endogenous PGDP4, PCP
3a. one-year elasticity							
negotiated wages	0.00	0.00	0.00	1.13	0.56	0.00	0.47
agriculture	0.00	0.10	-0.23	1.02	0.52	0.27	0.70
priv. services etc.	-0.82	0.02	-0.08	1.10	0.55	0.10	0.56
forestry	0.00	0.08	-0.19	1.04	0.53	0.23	0.67
manufacturing	0.00	0.10	-0.21	1.03	0.52	0.26	0.69
government	-0.74	0.00	-0.01	1.12	0.56	0.01	0.48
wage rate, total	-0.54	0.04	-0.11	1.08	0.54	0.13	0.59
3b. five-year elasticity							
negotiated wages	0.00	0.00	0.00	1.09	0.67	0.00	0.56
agriculture	-2.18	0.76	-0.58	0.36	0.24	0.73	0.93
priv. services etc.	-2.43	0.66	-0.53	0.45	0.30	0.66	0.90
forestry	-2.14	0.73	-0.57	0.38	0.25	0.71	0.92
manufacturing	-2.14	0.74	-0.57	0.37	0.25	0.72	0.92
government	-2.98	0.33	-0.29	0.76	0.48	0.35	0.76
wage rate, total	-2.46	0.61	-0.49	0.50	0.32	0.61	0.88
3c. ten-year elasticity							
negotiated wages	0.00	0.00	0.00	1.10	0.67	0.00	0.56
agriculture	-2.80	1.05	-0.75	0.10	0.05	0.94	0.98
priv. services etc.	-3.17	1.03	-0.74	0.12	0.07	0.92	0.98
forestry	-2.79	1.05	-0.75	0.11	0.06	0.93	0.98
manufacturing	-2.79	1.05	-0.75	0.10	0.06	0.93	0.98
government	-4.80	0.75	-0.56	0.38	0.23	0.69	0.89
wage rate, total	-3.45	0.97	-0.70	0.18	0.11	0.87	0.96

[1]Inflation expectations increased by one per cent during the first year.

The coefficient of the "real wage gap" is 0.058 implying that about 25 per cent of the "real wage gap" tends to be eliminated through wage adjustments within one year. In addition to these variables some seasonal dummies and a dummy measuring a change in the size of the constant term were included in the manufacturing wage equation.

In the equations determining wages in other sectors (see equations W.1, W.2, W.3 and W.5) the private sector negotiated wage rate enters with coefficient one just as in manufacturing. The wage drift in manufacturing drives up wages in other sectors the effect being strongest in agriculture but not identifiable in private services. There both the two-period lag of the level and of the change of unemployment showed up as significant explanators. In the government sector the wage drift variable is lagged by four periods which possibly reflects the fact that public sector wages are often adjusted to observed wage drift in manufacturing after a delay. An error correction mechanism constrains the long-run elasticities of the wages of the other sectors with respect to manufacturing to unity. This adjustment process is slowest in the government sector. The relations between the variables in the wage block can be summarized in tables 3a - 3c.

IV.4 Prices

IV.4.1 Marginal Costs and the Pricing of Output

Of the five sectors included in the BOF4 model, four produce goods which are sold in the market. Actually, manufactured goods are sold in three different markets, i.e. domestically, as western exports and as eastern (bilateral) exports. Government sector produces public goods for which no market prices exist. (There is, however, a definitional unity between the government sector value added deflator and the producer price of the government sector output.)

Theoretical foundations of the estimated pricing equations of the model are based on the solution of the following profit maximization problem of the firm:

(1) $$\max_{Y} \sum_{t=0}^{\infty} \emptyset^{t} \cdot PROFIT_t$$

$$PROFIT = P \cdot Y - w \cdot L - P^{m} \cdot M - P^{k} \cdot K$$

s.t.

$$Y = (P^{c}/P)^{\alpha} \cdot D \cdot (Y_{-1}/D_{-1})^{\mu} \quad \text{(firm-level demand for output)}$$

$$L = CES^{-1}[(1-a) \cdot Y,\ K,\ TIME] \quad \text{(inverted CES-production function)}$$

$$M = a*Y \quad \text{(demand for material imputs)}$$

where Y is output, P is the price of output, w is the nominal wage rate, L is the required labour input, P^m is the price and M the volume of material inputs, P^k is the implicit rent of capital, K the stock of capital, P^c is the price of competing products, D is the demand shift variable, $\emptyset$ is a discount factor, α governs the price elasticity of demand and μ is used to specify the dynamics of the firm-level demand function. Variables w, P^m, P^k and K are here treated as predetermined.

The specification of dynamics in the demand function is quite general. With the parameter value $\mu = 0$ it collapses to the conventional static demand function $Y = (P^c/P)^{\alpha}D$ and with $\mu = 1$ to the function of infinite long-run price elasticity à la Phelps & Winter (1970)

(2) $$Y/Y_{-1} = (P^{c}/P)^{\alpha}(D/D_{-1}).$$

In this latter case firms possess monopoly power over their products only in the short-run. If they permanently keep the price level of their products above that of their competitors, they will lose all of their customers.

Maximization of profits implies the following first order condition for any period t (The Euler equation):

(3) $[1-1/\alpha]P_t - SMC_t = -(\phi\mu/\alpha)(P_{t+1}Y_{t+1}/Y_t)$

where

$SMC = a \cdot P^m + (1-a)w \cdot (MPL)$ (short-run marginal costs of production)

MPL is marginal product of labour $\delta L/\delta Y$. One can easily see that in the case of a static demand curve ($\mu = 0$) the right hand term in equation (3) equals zero implying the following conventional mark-up price equation:

(4) $P_t = [\alpha/(\alpha-1)]*SMC_t$

Estimated equations in the closed sectors 1 and 2 of the model are based on relation (4) interpreted, however, as a definition of only the long-run dependence of prices on marginal costs.

In the open sectors of the economy, however, the firms are assumed to possess monopoly power only in the short run, i.e. $\mu = 1$ and, hence, the demand function (2) is faced by the firms. In this case the equilibrium price relation is determined by the transversality condition,[3] corresponding to equation (3):

(5) $\lim_{T\to\infty} \phi^T[P_T(1-1/\alpha) - SMC_T + (\phi/\alpha)P_T] = 0$

Equations (2) and (5) imply the following long-run relationships between prices, marginal costs and competing foreign prices

(6a) $P = [\alpha/(\phi-1+\alpha)]*SMC$

(6b) $P = P^C$

---

[3]The transversality condition of the infinite horizon problem is obtained as a limit of the Euler equation solved for the last period T of the corresponding finite horizon problem, when T approaches infinity. (See Sargent (1979) p. 195 - 197.)

The mark-up factor in (6a) is the closer to unity the smaller is the rate of time preference (i.e. the closer to 1 is ϕ).

What equations (6a) and (6b) actually state is that it is the price of the competing products, which in the long run determines the development of the price of output as well as the development of the marginal cost variable SMC. This is an argument, which entitles us to use the price of competing foreign products as an explanatory variable, along with the variable SMC, in the price equations of the open sectors and exports to the western markets. The derivation of the excact form of the estimated export price equations is presented in Tarkka and Willman (1988) p. 8 - 9.

Estimated behavioral equations for the prices of gross outputs in sectors 1 - 3 and for the prices of manufactured goods sold in the domestic market and in the western export market, respectively, are presented by equations P.1, P.4, P.7, P.10 and X.5. The corresponding marginal cost variables, the SMC:s are given in equations P.2, P.5, P.8, P.11 and X.6. They are based on the sectoral production functions presented in Tarkka, Willman and Rasi ((1988), p. 11) The marginal cost variables include also indirect taxes contained in production of goods (see definitional equations P.3, P.6, P.9 and P.13).

TABLE 4. PARTIAL ELASTICITIES OF OUTPUT PRICES WITH RESPECT TO SHORT-RUN MARGINAL COSTS OF PRODUCTION

Prices in	immediate elasticity	one-year elasticity	long-run elasticity
Agriculture	0.04	0.49	0.97
Priv. services etc.	0.29	0.65	0.99
Forestry	0.12[1]	0.10	0.00
Manufactured goods sold in domestic market	0.24	0.43	1.00
Exports to the western market	0.29	0.49	1.00

[1]The effect with the lag of one quarter.

Partial, single equation simulations in table 4 show that, in the long-run, an increase in the short-run marginal costs raises the corresponding prices approximately proportionately in all sectors except forestry. There the marginal costs have an direct effect on prices only in the short-run. As can be seen from table 5 only in forestry the link from competing foreign prices to the equilibrium output price works directly through the price equation. The long-run elasticity of prices in forestry with respect to world-market prices of wood products is unity even if marginal costs were treated as exogenous.

TABLE 5. PARTIAL ELASTICITIES OF OUTPUT PRICES AND WITH RESPECT TO FOREIGN COMPETITORS' PRICE

Prices in	immediate elasticity	one-year elasticity	long-run elasticity
Agriculture	-	-	-
Priv. services etc.	-	-	-
Forestry	0.13	0.31	1.00
Manufactured goods sold in domestic market	0.18[1]	0.10	0.00
Exports to the western market	0.60	0.39	0.00

[1]The effect with the lag of one period.

Due to the exogeneity of marginal costs the partial long-run elasticities in table 5 do not give the full picture of the dependencies of the model. Simulated with the whole model an increase of one per cent in competitors' prices is passed on into the prices and marginal costs of exports and domestically sold manufactured goods within 5 - 6 years. In forestry there is an overshooting of marginal costs but in the very long-run the parity of eq. (6) is approached. (See figures 2 and 3).

FIGURE 2. DYNAMIC ELASTICITIES OF PRICES OF MANUFACTURED GOODS WITH RESPECT TO ONE PERCENT INCREASE IN COMPETITORS' PRICES

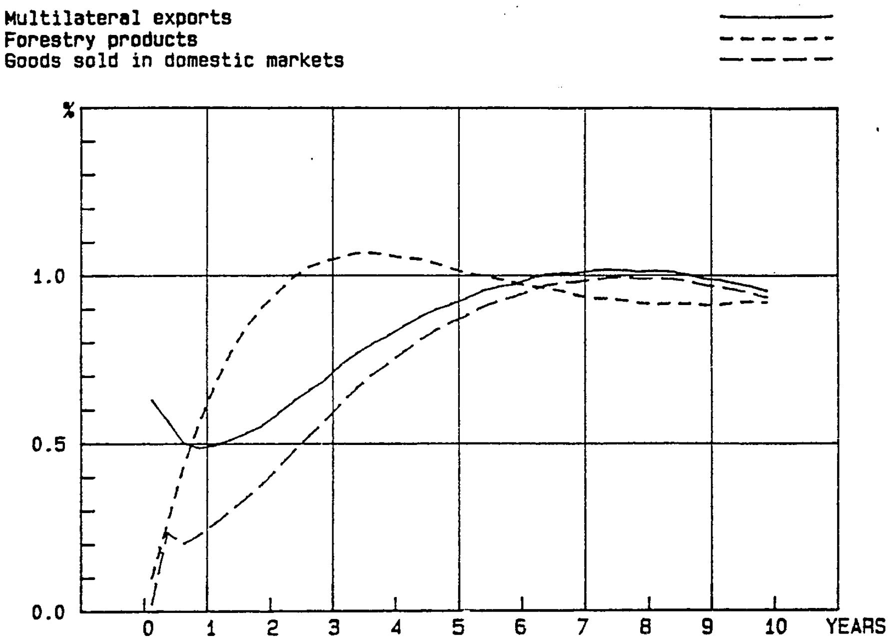
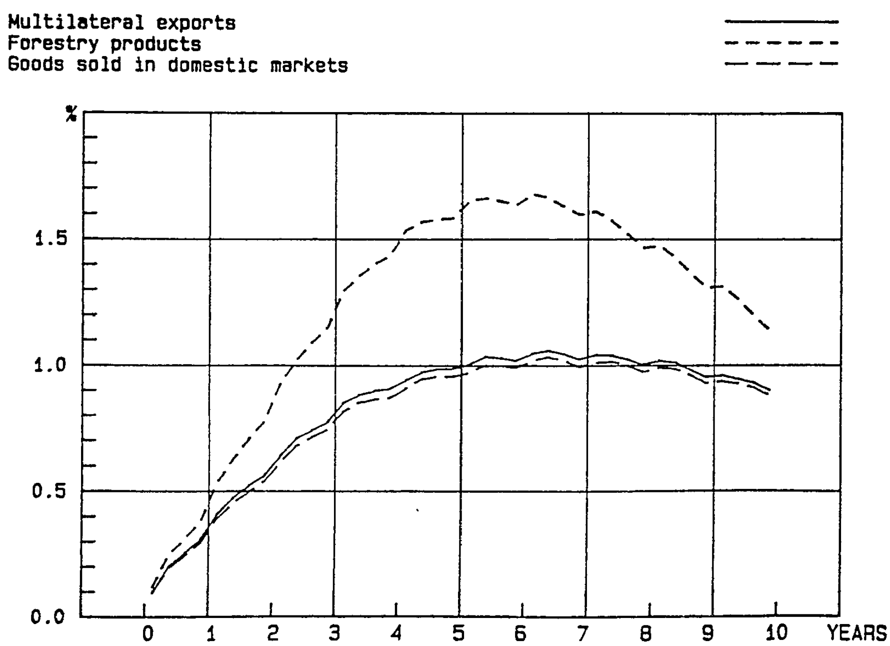


FIGURE 3. DYNAMIC ELASTICITIES OF SHORT-RUN MARGINAL COSTS OF MANUFACTURED GOODS WITH RESPECT TO ONE PER CENT INCREASE IN COMPETITORS' PRICES



In the long-run the prices in the open sector depend only on the competing foreign prices. (See also figure 2). This implies a horizontal demand curve in the long-run. This is in accordance with the infinite price elasticity of the multilateral exports equation given in table 2 of the chapter on foreign trade in this book.

Equation P.12 determines the aggregate price index of output in manufacturing. It is solved from the identity (expressed at current prices) defining that the output in manufacturing equals the sum of exports and domestic absorbtion of domestically produced manufactured goods.

The prices of bilateral exports are determined by equation X.4. It is based on the assumption that bilateral trade contracts are concluded at the same price at which industrial products are sold in the domestic market. A geometric lag from the domestic manufacturing price to the price of bilateral exports measures the time span between contracts and deliveries. As export contracts are usually made in clearing rubles, changes in the FIM rate of the rouble during the lag has also been taken into account.

IV.4.2 Value Added Deflators

The GDP deflators for the four private sectors of the model is obtained in two stages. In the first stage input-output estimates for the GDP deflators are solved from the sectoral cost functions (see equation 11 in Tarkka, Willman and Rasi (1988)). These estimates are determined by equations P.14 - P.17. In the second stage identifies between the GDP deflators and corresponding input-output deflators are used (see equations P.23 - P.26).

In the government service sector the GDP deflator is determined as a mark-up over labour costs and indirect taxes (see equation P.27).

IV.4.3 Deflators of Demand Components

Besides exports and inventories, the demand in BOF4-model is disaggregated into twelve sub-components for which also price equations are needed. The similar two-stage approach as in the case of the GDP deflator was used. At the first stage input-output estimates are obtained as weighted averages of the prices of sectoral outputs and import prices (these are equations P.18 - P.22 in the list). At the second stage actual prices are explaned by corresponding input-output price estimates and effective indirect tax rates. For example the price of durables in private consumption is given as the result of two equations:

(P.18) $$\log PCDIO = .3183 \cdot \log P2 + .4007 \cdot \log PD4 + .2810 \cdot \log PMC$$

and

(P.31) $$\Delta \log PCD = \Delta \log (1 + TIRCD) + \Delta \log PCDIO$$

In the list of equations the prices of demand components and effective indirect tax rates are determined by equations P.29 - P.50. Price indexes of aggregate demand components and the price of GDP deflator at factor cost are solved from identities P.51 - P.56.

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V PRIVATE CONSUMPTION AND INVESTMENT

Abstract

This report describes the determination of private consumption and investment in the BOF4 model. It first appeared in the Bank of Finland Discussion Paper series in January 1989, series no. 9/89.

The consumption function of the model is loosely based on the permanent income hypothesis. Relative prices and the level of aggregate consumption determine the shares of the three consumption subgroups included in the aggregate. The non-residential investment equations are derived from the capital owners' intertemporal profit maximization problem in accordance with the neoclassical investment theory. Modelling of residential investment is based on Tobin's q approach and that of inventories on the buffer stock-accelerator approach. The properties of the equations are illustrated by means of tables of dynamic elasticities throughout the paper.

V.1 Introduction

This paper describes the modelling of private consumption and investment, which are of course the most crucial components of aggregate demand. The paper is set out as follows.

First, the breakdown of aggregate demand and the relative size of the different components is described. Second, the aggregate private consumption function is derived and the disaggregation of private consumption into subgroups using a simple expenditure system is described.

Equations for non-residential private fixed investment, housing investment and inventory investment are derived in the third part of the paper. The properties of the estimated equations listed in the appendix are described by means of partial elasticities throughout the paper.

V.2 The Structure of Aggregate Demand

The relative significance of the private demand components dealt with in the present paper is set forth in the following table.

TABLE 1. THE STRUCTURE OF AGGREGATE DEMAND LESS IMPORTS IN 1985 ACCORDING TO THE CLASSIFICATION USED IN BOF4

```
 73.3 % total consumption
        72.7 % private consumption
               11.0 % durables
               35.4 % services
               53.6 % non-durables
        27.3 % public consumption
               33.6 % central govt.
               66.4 % local govt.
  1.3 % inventory investment
 23.3 % total fixed investment
        86.8 % private fixed investment
               70.0 % non-residential investment
                       9.7 % agriculture
                       3.2 % forestry
                      27.6 % manufacturing
                      59.5 % private services etc.
               30.0 % residential construction
        13.2 % public fixed investment
               36.0 % central govt. investment
               64.0 % local govt. investment
 28.8 % exports
        84.0 % exports of goods
               75.8 % multilateral (west)
               24.2 % bilateral (east)
        16.0 % exports of services
-27.8 % imports
        85.1 % imports of goods
               47.5 % raw materials excl. crude oil
               21.9 % crude oil, fuels & lubricants
               16.1 % consumption goods
               14.5 % investment goods
        14.9 % imports of services
```

In the first column of percentages, the relative sizes of the different components are given as per cent of GDP in purchasers' values (incl. the statistical discrepancy). In the other columns, the percentages indicate relative shares in the next higher aggregate.

Altogether, there are 16 categories of aggregate demand and 5 categories of imports. Of these, only three are exogenous, namely central government consumption and both categories of public fixed investment (central and local government). All other items have their own behavioural equations in the model.

V.3 Private Consumption

Three categories of private consumption are distinguished in BOF4: durable goods, services and a residual category consisting of nondurable and semidurable goods. This disaggregation is useful mainly because different consumption categories have different import propensities and different treatment in indirect taxation. Furthermore, the structure of consumption has of course, an effect on how aggregate demand is allocated among the different production sectors of the economy.

The model has an aggregate consumption function determining private consumption as a whole. Its disaggregation into the three subgroups is achieved by three equations forming a highly simplified "expenditure system".

V.3.1 The Consumption Function

The consumption function is shown as equation C.1 (page 31) in the equation list. The specification is close to that included in the previous BOF3 version of the model (see Tarkka & Willman (1985)). According to the equation, consumption is a loglinear function of real disposable income, liquid assets, inflation, the interest rate on tax-free bonds and past consumption. The specification is perhaps best understood in the light of the permanent income hypothesis originally developed by Friedman (1957). In the following we briefly review the theoretical foundations of the equation. For a more thorough survey of the subject, see e.g. King (1985) and the literature cited therein.

The permanent income hypothesis is based on the notion that if consumers have access to a well-functioning capital market, the timing of their lifetime earnings is irrelevant to their consumption decisions. Only the discounted present value of consumers' present and future income matters for optimal consumption decisions.

The concept of permanent income is a way of summarizing households' expectations concerning their future disposable income as a single number. Permanent income may be defined as the constant income level which has the same discounted present value as the expected future incomes of currently living households. According to the permanent income theory of consumption, private consumption is determined by permanent income:

(1) $$\log C = \log k + \log Y^p$$

where C is (real) consumption and Y^p is (real) permanent income and k is a factor of proportionality which depends at least on the real rate of interest and the subjective rate of time preference (impatience). If the rate of time preference is independent of the level of consumption, k is independent of Y^p. Otherwise, unit elasticity of consumption with respect to permanent income as implied by (1) does not hold.

To make the permanent income model operational, assumptions must be made on how expectations concerning future incomes and real interest rates are formed. In BOF4 we make the following assumptions:

1. Income expectations are adaptive:

(2) $$\log Y^p = a \cdot \log Y + (1-a) \cdot \log Y^p_{-1} + b$$

See, e.g., Muth (1960). The constant term adjusts permanent income for a possible trend in actual income. Without a constant term and with growing actual income, the adaptive scheme (2) would lead to permanent income being systematically lower than actual income.

2. Expectations concerning the long-run average level of the real rate of interest are adaptive with the same adaptation parameter a as in (2):

$$(3) \qquad r^e = a \cdot (i - inf^e) + (1 - a) \cdot r^e_{-1},$$

where i is the after-tax bond rate, r^e is the expected real interest rate, and inf^e is the expected 12-month rise in consumer prices.

To obtain a proxy for expected inflation, we estimated a loglinear function of actual inflation and the divergence of prices in manufacturing from competitors' prices on foreign markets. The estimated equation is presented as equation C.15 in the appendix. In the private consumption equation, expected inflation is measured by a moving average of the model's inflation expectations proxy.

Still assuming that the effect of the expected real interest rate on k in equation (1) can be linearized, the above assumptions allow us to write the following "permanent income-adaptive expectations" model:

$$(4) \qquad \log C = c_1 \cdot \log Y - c_2 \cdot (i - inf^e) + c_3 \cdot \log C_{-1} + c_4$$

This served as a basis for the consumption equation of the BOF4 model. However, the actual equation contains some (three) additional elements which are found to be empirically important and which seem to take into account effects neglected by the basic permanent income theory.

These added terms are the following:

- A liquidity variable (the ratio of currency and deposits to disposable income) may capture liquidity effects which are assumed away by the assumption of perfect capital markets in the simplest permanent income theory.

- A variable measuring unexpected inflation, which was originally proposed by Deaton (1977). This affects consumption negatively. Deaton attributed this empirically rather robust effect to the informational difficulty of separating inflation from relative price changes. It is also possible that what is observed is in fact the real balance effect of unexpected inflation on the real value of household assets denominated in nominal terms.

- In the adaptive income expectations mechanism, the observed actual income was operationalized by including both lagged and current income in the equation, as if real income were in fact observed with a mean lag of half a quarter.

The properties of the consumption function of the BOF4 model can be characterized by the dynamic elasticities of consumption with respect to changes in real income, the rate of interest, liquidity and the general level of prices (incl. nominal incomes and money balances). These elasticities are summarized in table 2.

TABLE 2. DYNAMIC ELASTICITIES OF PRIVATE CONSUMPTION ACCORDING TO EQUATION C.1

Variable	Immediate Elasticity	One-year Elasticity	Long-run Elasticity
1. Real income	0.27	0.60	0.81
2. Real liquid assets	0.00	0.08	0.14
3. Both above	0.27	0.68	0.94
4. Real interest rate	0.00	-0.05	-0.09
5. Inflation surprise	-0.31	-0.12	0.00

Line 3 shows an income elasticity computed on the assumption that the ratio of liquid assets to income is constant. The one-year elasticities in the table are average effects during the first year. The elasticity with respect to the interest rate is a "semi-elasticity": the percentage effect on consumption of a one percentage point change in the relevant rate.

As regards the results presented in the table, the following observations should be made. First, the long-run income elasticity is somewhat less than one, which points to non-homotheticity of households' preferences, so that the rate of time preference - or "impatience" - would be greater at lower levels of consumption. Second, the effect of the real rate of interest on consumption is weak. (In the estimated equation it is also statistically insignificant.) Third, inflation has negative short-run effects on consumption, which disappear only slowly over a period of two years or so. The equation has, however, been constructed so that in the long run pure inflation has no effects on consumption (or saving).

V.3.2 Division of Consumption into Subgroups

The starting point for the specification of the demand functions for the three consumption subgroups are static, constant-elasticity demand functions of the form

$$(5) \qquad \log C^i = a + b \cdot \log C - \log (P^i/PCP)$$

where C^i is consumption of goods in category i, C is total private consumption, P^i is the price index for goods in category i and PCP is the price index for total private consumption.

A well-known problem with demand systems consisting of equations like (5) is that they do not satisfy "the adding-up criterion", according to which the sum of C^i's must be equal to C. To remedy this problem one has to resort either to the so-called Rotterdam approximation or to compute one of the categories as a residual, thus forgoing the constant-elasticity assumption for that category. The latter approach was followed in BOF4. Thus, the largest of the consumption categories, semi-durables and non-durables, is residually determined by subtracting from total private consumption the consumption of durables and services.

In the model the division of consumption into subgroups is achieved by equations C.2, C.3 and C.4. The income and price elasticities of the simple "expenditure system" of the BOF4 model are presented in table 3. "Income elasticities" refer to elasticities of demand for different consumption categories with respect to changes in total private consumption. There are two different concepts of own-price elasticity of demand: compensated price elasticity measures the effect of a change in the price of a good on the demand for it when real income (or real total consumption) is held constant; uncompensated elasticity, which is the other concept of price elasticity, measures the effect on demand when nominal income (nominal total consumption) is held constant. Both compensated and uncompensated elasticities are reported in the table.

TABLE 3. DEMAND ELASTICITIES OF CONSUMPTION SUBGROUPS

Category of goods	Income elasticity	Compensated price el.	Uncompensated price el.
Services	1.25	-0.36	-0.80
Durables	1.40	-1.19	-1.31
Other goods	0.75	-0.26	-0.66

For a comprehensive discussion on expenditure systems and elasticities of demand, see, e.g., Deaton and Muellbauer (1980).

V.4 Fixed Investment

There are five categories of private fixed investment in BOF4. Non-residential investment is modelled separately for each of the four privately-operated production sectors and residential construction constitutes the fifth category.

V.4.1 Non-residential Private Fixed Investment

The productive, or non-residential, investment functions are reported as equations I.1, I.3, I.5 and I.7 for agriculture, private services, forestry and manufacturing, respectively. The theoretical foundation of these equations is the neoclassical investment theory as developed by Jorgenson (1963), Lucas (1967), Gould (1968) and Abel (1980).

Investment is viewed as a result of demand for fixed capital in production. The crucial parts of the analysis of the demand for capital are: (1) the prevailing production technology; (2) the form of adjustment costs arising from changing the stock of capital; (3) the price elasticity of the demand curve faced by firms in the market where they sell their output; (4) the corporate tax system.

The investment equations of BOF4 are derived from the capital owners' intertemporal profit maximization problem. Firms are assumed to maximize the discounted present value of their profits. The maximization problem may be written as follows:

$$(6) \qquad \max \sum_{t=0}^{\infty} (1+i-\Delta\log P^k)^{-t} \cdot \mathrm{PROFIT}_t$$

$$\mathrm{PROFIT} = (P^y/P^k) \cdot Y - (W/P^k) \cdot L - UC \cdot K - A(K, K_{-1})$$

$$Y = \mathrm{CES}(K, L, \mathrm{TIME}) \qquad \text{(production function)}$$

$$Y = D(P^y, P^c, Z) \qquad \text{(firm-level demand for output)}$$

where $A(K, K_{-1})$ is the real adjustment cost function and $D(P^y, P^c, Z)$ is the firm-level demand for output, which is a function of the selling price, the average price in the market and other factors, respectively. A first-order condition for the profit-maximizing capital accumulation program is now given by the following Euler equation:

$$(7) \qquad \partial A/\partial K = (P^y/P^k) \cdot (1+1/E) \cdot MPK - UC - (1+i-\Delta\log P^k_{+1})^{-1} \cdot \partial A_{+1}/\partial K$$

Here E is the price elasticity of the firm-level demand for output, which is infinite in the case of perfect competition. MPK is the marginal product of capital function through which the production technology affects the investment program. UC is the real user cost of capital, which includes the effects of the expected real rate of interest and the corporate tax system. $\partial A/\partial K$ and $\partial A_{+1}/\partial K$ are the marginal adjustment costs incurred in the current and next period, respectively, of increasing the stock of capital in this period. We now discuss each of these terms of the Euler equation in turn.

The technology assumptions employed in BOF4 are specified by the production functions reported in volume 14/88 of this series. The CES "putty-putty" production functions of the four private sectors of production imply real marginal product of capital functions of the type

$$(8) \qquad MPK^{i} = C \cdot (GDP^{i}/KF^{i}_{-1})^{r} \cdot \exp(0.01 \cdot g \cdot TIME)$$

where MPK^{i} is the marginal product of capital in sector i, GDP^{i} is the real value added produced in sector i and KF^{i} is the stock of fixed capital in sector i (lagged one quarter in the MPK function). The parameter values of this function applicable to the different sectors are indicated in the following table. The marginal and average products of capital in 1985 are also presented in the table (in annualized rates).

TABLE 4. THE PARAMETERS OF THE MARGINAL PRODUCT OF CAPITAL FUNCTION IN THE DIFFERENT PRODUCTION SECTORS AND ESTIMATED REAL MARGINAL AND AVERAGE PRODUCTS IN 1985

Sector	C	r	g	MPK	APK
Agriculture	0.68	1.03	0.00	0.17	0.26
Forestry	0.33	0.67	0.10	0.24	0.62
Manufacturing	0.49	1.14	-0.44	0.28	0.59
Private services etc.	0.85	1.61	-1.94	0.32	0.54

The fixed capital stock concept used in BOF4 corresponds fairly closely to the "net fixed capital stock" of the Finnish Central Statistical Office. Further, it should be noted that the linear time trend variable TIME, which captures the effect of technical progress, increases by 0.25 units per quarter and thus by one unit yearly. In calculating the marginal product of capital for the private services sector, the stock of residential capital is excluded from the capital stock and the value added originating from the ownership of dwellings is also excluded from the GDP concept.

The real user cost of fixed capital is defined by equations I.2, I.4, I.6 and I.8 for the different sectors. User costs are calculated using the standard "Jorgensonian" formula (for a review of the concept and estimation of the user cost of capital, see Koskenkylä (1985)).

(9) $$UC = (i - inf^{e} + d) \cdot (1 - tc \cdot td/(i+td))/(1-tc)$$

where i is the nominal rate of interest (market yield on tax-free bonds), inf^{e} is expected inflation, d is the rate of depreciation of capital, tc is the corporate income tax rate and td is the tax depreciation coefficient, which is infinite in the case of free tax depreciation. For the agricultural sector, in which the owners of fixed capital are typically private households, the marginal personal tax rate was used in the user cost formula instead of the corporate tax rate. BOF4 includes two tax depreciation allowance parameters (td in the formula): one for manufacturing and another for the other sectors.

"Adjustment costs" are a broad category of costs arising from planning, installment and gestation of new structures and equipment. In the neoclassical capital theory adjustment costs are needed to ensure that the flow of new investment is finite even when the marginal product of capital differs from the marginal cost of capital. The form of the adjustment cost function is one of the main determinants of the form of the investment function. Particularly elegant results are obtained in the case of translog adjustment costs:

$$A = (a/2)\cdot\Delta K\cdot\Delta\log K \tag{10}$$

This specification, which is also used in BOF4, yields the following partial derivatives $\partial A/\partial K$ and $\partial A_{+1}/\partial K$ for the Euler equation:

$$\partial A/\partial K = (a/2)\cdot(\Delta\log K + (K-K_{-1})/K) \simeq a\cdot\Delta\log K \tag{11}$$

$$\partial A_{+1}/\partial K = -(a/2)\cdot(\Delta\log K + (K-K_{-1})/K_{-1}) \simeq -a\cdot\Delta\log K \tag{12}$$

So the Euler equation may be written as:

$$a\cdot\Delta\log K = a\cdot(1/(1+r^e))\cdot\Delta\log K_{+1} + (P^y/P^k)\cdot(1+1/E)\cdot MPK - UC \tag{13}$$

Here the optimal current increase in the capital stock is given as a function of the present difference of the marginal product and user cost of capital, as well as the optimal increase in capital in the next period. By successive substitutions, the Euler equation (13) may be solved to yield

$$\Delta\log K = 1/a\cdot\sum_{t=0}^{\infty} (1+r^e)^{-t}\cdot((P^y/P^k)\cdot(1+1/E)\cdot MPK - UC) \tag{14}$$

Of course, (14) is not yet a complete solution since the marginal product of capital variable MPK is still a function of K. The right-hand side of the equation is the present value of the expected marginal quasi-rent on fixed capital. Denoting this by QR^e, the Euler equation may be written as

$$\Delta\log K = 1/a\cdot(QR^e) \tag{15}$$

With adaptive expectations of the quasi-rent, as in the presentation of the permanent income model, this gives

$$\Delta\log K = g/a\cdot((P^y/P^k)\cdot(1+1/E)\cdot MPK - UC) + g\cdot\Delta\log K_{-1} \tag{16}$$

This is the basis of the investment equations of the model (see appendix). The dependent variable of the equations is $I/K_{-1}+d = \Delta\log K$. In developing the actual functional forms of the estimated equations, perfect competition was assumed to prevail in manufacturing and forestry, implying $(1+1/E)=1$. In services and agriculture, a finite firm-level price elasticity of demand was allowed. This means that the coefficients of $(P^y/P^k).MPK$ and $-UC$ can not be restricted to be equal and have to be estimated separately.

The dynamics of the equations in the model are a little more general than in (16). In particular, it turned out that in the services sector the data favoured the inclusion of a yearly difference in UC as an additional explanatory variable. This makes the impact of capital costs on investment emerge somewhat slower than in the basic specification (16). In manufacturing, the inclusion of a two-quarter lag of investment and an accelerator term (log change of output) in the equation was found to improve the stochastic properties of the equation significantly. These additions do not alter the long-run properties of the equations.

The dynamic properties of the investment equations can be analyzed with the help of price and output elasticities. The elasticities of demand can be computed for the flow of gross investment and for the stock of fixed capital; of these, the former has perhaps more practical interest from the demand management angle whereas the latter is probably more meaningful from the analytical point of view. The elasticities for the flows are reported in the following tables, while the elasticitics for the stocks are reported in Appendix 1. It should be borne in mind that these elasticities are strictly partial in the sense that prices and output volumes are kept exogenous. The only feedback which is taken into account is that due to the capital accumulation equations $\Delta K = I - d \cdot K_{-1}$ (these are equations I.24 to I.31 in the list).

TABLE 5. DYNAMIC OUTPUT ELASTICITIES OF GROSS FIXED INVESTMENT

	Time span of the elasticity (years)			
Sector	0	1	5	10
Agriculture	0.11	0.17	0.25	0.29
Forestry	0.07	0.15	0.58	0.69
Manufacturing	1.10	1.03	1.60	1.28
Private services etc.	0.42	0.73	1.28	1.16
Total	0.60	0.75	1.21	1.08

To summarize table 5, the average long-run output elasticity of private gross fixed investment is about one. As can be expected, the lowest elasticity is in agriculture and the highest in manufacturing.

The cost of capital has two components, the user cost of financial capital and the price of capital goods. These have different effects on investment in the model, as shown in the following tables.

TABLE 6. DYNAMIC PRICE ELASTICITIES OF GROSS FIXED INVESTMENT WITH RESPECT TO THE REAL USER COST OF FINANCIAL CAPITAL

	Time span of the elasticity (years)			
Sector	0	1	5	10
Agriculture	0.00	-0.00	-0.23	-0.22
Forestry	0.01	-0.01	-0.49	-0.46
Manufacturing	-0.02	-0.08	-1.20	-0.90
Private services etc.	0.00	0.00	-0.38	-0.21
Total	-0.01	-0.02	-0.57	-0.38

TABLE 7. DYNAMIC PRICE ELASTICITIES OF GROSS FIXED INVESTMENT WITH RESPECT TO THE REAL PRICE OF CAPITAL GOODS

	Time span of the elasticity (years)			
Sector	0	1	5	10
Agriculture	-0.11	-0.16	-0.22	-0.28
Forestry	-0.11	-0.22	-0.75	-1.01
Manufacturing	-0.08	-0.16	-0.76	-1.11
Private services etc.	-0.23	-0.40	-0.61	-0.63
Total	-0.17	-0.30	-0.62	-0.73

As can be seen from tables 6 and 7, the investment in the open sectors of the economy, manufacturing and forestry, is much more price-elastic than in the closed sectors. The figures in table 7 can also be interpreted as elasticities with respect to the value added deflator, omitting only the minus signs.

The elasticities are not quite independent of the levels and growth rates of the variables involved, since the equations are not loglinear in variables. The above tables are based on data for the period 1975 - 1985. The capital depreciation coefficients also have an influence on the results. Capital depreciation (consumption) rates are exogenous variables in BOF4. In 1985 the annual rates were as shown in the following table.

TABLE 8. DEPRECIATION RATES OF FIXED CAPITAL IN 1985 (ANNUAL RATES)

Agriculture	8.43 %
Forestry	8.41 %
Manufacturing	8.08 %
Private services etc.	7.88 %

The 1985 figures in the depreciation rate table give a fairly good idea of the situation in other years too, since in the estimates of the Central Statistical Office (on which the above numbers are based) the depreciation rates do not change much over time.

A much discussed property of the investment functions is the elasticity with respect to changes in the rate of interest. In a way this is captured by the elasticity with respect to the real user cost of capital (table 6), but in practice the conversion from the user cost elasticity to interest rate elasticity is not straightforward owing to the complexity of the formula for user cost. To facilitate interpretation, we present the semi-elasticities of the sectoral user costs with respect to the rate of interest in table 9. One can easily obtain the semi-elasticities of investment with respect to the interest rate by multiplying the user cost elasticities in table 6 by the figures in table 9.

TABLE 9. SEMI-ELASTICITIES OF THE SECTORAL USER COSTS OF CAPITAL WITH RESPECT TO THE AFTER-TAX RATE OF INTEREST. 1980 - 1985 AVERAGES

Agriculture	12.0
Forestry	12.2
Manufacturing	12.2
Private services etc.	12.7

V.4.2 Housing Investment

The specification of the equation for housing investment has not been changed much from the previous version of the model (see Tarkka & Willman, 1985).

Housing investment is implicitly divided into two parts, state--financed and freely-financed production of dwellings. The former is assumed to to be directly proportional to the amount of central government finance used, while the latter is based on the Tobin's "q" approach to investment, i.e the construction of new dwellings is a function of the market price of dwellings relative to their production costs (Tobin (1969)). Hence the following relation for housing investment IH can be written:

$$IH = a\cdot(FH/PIH) + b\cdot[\log(PH/PIH)]\cdot KH \tag{17}$$

where FH is the flow of government housing loans, PIH the index of housing construction costs, PH the index of the market price of dwellings and KH the stock of dwellings. In (17) KH is used as a proxy for housing construction capacity.

In the estimated equation (I.9) the market price of dwellings has been reduced to its determinants as follows. First, the market price of dwellings, including of course newly produced dwellings, is equal to the discounted present value of the price of housing services (an imputed rent or user cost concept) as

$$(18) \qquad PH = PCH/r^e$$

where PCH is the price of housing services and r^e refers to an expected long-term real after-tax rate of interest faced by households. In the model this is assumed to be a linear function of the present real after-tax rate on bank loans (note that the Finnish housing loan system has traditionally been based mainly on variable-rate contracts).

Secondly, the interaction of the demand for housing and the existing stock of housing units determines the price of housing services PCH. The households demand housing services provided by the stock of residential capital. In the consumption block of BOF4, the demands for different subcategories of consumption were specified to be loglinear functions of total private consumption and the price of the particular consumption category relative to the overall private consumption deflator. In deriving the housing investment equation we have not estimated the price and income elasticities of the demand for housing services. Instead, we have utilized estimates published by Virén (1983). He presents an income elasticity of 1.0213 and an uncompensated price elasticity of -0.7373. These imply a compensated price elasticity of -0.5538 (the buget share of housing costs being 18 % on average). If the supply of housing services is proportional to the stock of residential capital, these elasticities imply the following equation for the price of housing services:

(19) $\log PCH = \log PCP + 1.844 \cdot \log C - 1.806 \cdot \log KH + \text{constant}$

where PCP is the deflator of private consumption and C is the volume of private consumption.

The estimated equation (I.9) was obtained after substituting equations (18) and (19) into (17) and including a partial adjustment mechanism in the reactions of construction to changes in the housing market.

Possible credit rationing effects are captured by an ad hoc varible defined as the difference between the bank loan rate and the short-term money market rate.

The properties of the residential construction equation are described in the following table with the help of "income" (consumption), price and interest rate elasticities of housing investment. The interest rate elaticities are semi-elasticities with respect to a one percentage point change in all interest rates.

TABLE 13. ELASTICITIES OF RESIDENTIAL CONSTRUCTION

Variable	Immediate elasticity	One-year elasticity	Long-run elasticity
Consumption	0.29	0.45	0.95
Building costs	-0.25	-0.44	-0.67
Interest rate	0.00	-0.22	-0.67

The elasticities are evaluated from data for the period 1975 - 1985, and the dependence of the stock of residential capital on investment is taken into account.

V.5 Inventory Investment

Inventory investment is treated as a single aggregate in BOF4. No disaggregation into, say, raw materials and finished goods or by production sectors is attempted. The equation is almost exactly the same as in BOF3 (see Tarkka & Willman, 1985).

The inventory investment equation is based on the buffer stock-accelerator approach. Firms are seen to operate under demand uncertainty. Both production and storage costs are assumed to be convex functions of output and the level of inventories, repectively. In these circumstances it is optimal for firms to absorb part of the demand shocks by selling from inventories (in the case of a positive demand surprise) or by accumulating them (in the case of a negative demand surprise). This allows the firm to produce more economically by smoothing the time profile of output.

Application of dynamic optimization to the problem sketched out above (see Tarkka & Willman, 1985, pp. 148 - 152 and 175 - 177 for details) yields the following inventory equation:

$$(20) \qquad \Delta KI = s \cdot KI^{*} + s \cdot KI_{-1} + s \cdot (SALE^{*} - SALE)$$

where KI is the stock of inventories, KI^{*} is the optimal long-run stock of inventories (in the sense that the cost of holding and managing inventories is minimized), SALE is sales of storable goods (which is equal to the production of storables less inventory change) and $SALE^{*}$ is the expected long-run normal level of sales.

The optimal level of inventories is specified as:

$$(21) \qquad K^{*} = (a + a \cdot r^{e}) \cdot SALE^{*}$$

Where r^{e} is the expected real rate of interest. Equation (21) implies that in equilibrium, when sales are at their normal level and all inventory adjustments in response to past demand shocks have been completed, the turnover time of inventories ($K^{*}/SALE^{*}$) is a linear function of the real rate of interest. Assuming that the expected long-run normal level of sales and the expected real rate of interest are adjusted adaptively, inventory investment can be written as a function of current and lagged sales, the real rate of interest scaled by the sales variable, the inherited (lagged) level of inventories and the lagged inventory change (see equation I.10 of the model).

In the equation, the sales variable is calculated from the final demand components by subtracting from the total final demand the consumption of services, government consumption and imports of goods. Adjustment is also made for the difference between production and final demand figures caused by net indirect taxes and the national accounts statistical discrepancy.

In other investment equations of the BOF4 model, inflation expectations were operationalized using a special variable related to consumer prices. In inventory investment, however, better results were obtained with a lagged rise in import prices.

According to the equation, 64 per cent of changes in sales are absorbed by inventory changes in the quarter when they occur. This means that the immediate reaction of production to demand changes is only 36 per cent. Inventory adjustments are, however, only temporary, and in the longer run the production of storables must respond fully to permanent changes in sales. It takes three quarters of a year before production grows to the level corresponding to increased demand. Thereafter production slightly exceeds the level of sales until inventories have grown to the new target level. In all, this adjustment process takes about 7 years before being completed. Thus inventories partly neutralize the transmission of random variations in the demand for storable goods to production.

The estimated interest rate sensitivity of inventory demand is modest from the macroeconomic point of view: an increase of one percentage point in the real rate of interest causes an immediate reduction in inventory investment of only 0.08 per cent of sales (150 millions of 1985 FIM). The response is somewhat larger in the medium run and decreases again in the long run as the adjustment of the inventory stock to the change in the real rate of interest approaches completion.

APPENDIX 1

TABLE 1. DYNAMIC OUTPUT ELASTICITIES OF THE STOCK OF CAPITAL

	Time span of the elasticity (years)		
Sector	1	5	10
Agriculture	0.01	0.07	0.16
Forestry	0.01	0.13	0.35
Manufacturing	0.03	0.49	0.86
Private services etc.	0.05	0.42	0.77
Total	0.04	0.38	0.70

TABLE 2. DYNAMIC PRICE ELASTICITIES OF THE STOCK OF CAPITAL WITH RESPECT TO THE REAL USER COST OF FINANCIAL CAPITAL

	Time span of the elasticity (years)		
Sector	1	5	10
Agriculture	0.00	-0.04	-0.10
Forestry	0.00	-0.10	-0.23
Manufacturing	0.00	-0.24	-0.51
Private services etc.	0.00	-0.07	-0.12
Total	0.00	-0.12	-0.22

TABLE 3. DYNAMIC PRICE ELASTICITIES OF THE STOCK OF CAPITAL WITH RESPECT TO THE REAL PRICE OF CAPITAL GOODS

	Time span of the elasticity (years)		
Sector	1	5	10
Agriculture	-0.01	-0.07	-0.15
Forestry	-0.01	-0.20	-0.50
Manufacturing	-0.01	-0.21	-0.57
Private services etc.	-0.03	-0.22	-0.41
Total	-0.02	-0.20	-0.43

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Juha Tarkka and Alpo Willman

VI INCOME DISTRIBUTION AND GOVERNMENT FINANCES

Abstract

This paper describes how income distribution and government finances are modelled in BOF4, a quarterly econometric model of the Bank of Finland.

The equations comprising the income distribution and government finances block in the model consist of tax equations, behavioural equations for the local government sector and a large number of accounting identities linking production and prices to incomes of households and other sectors of the economy.

VI.1 Introduction

The BOF4 model of the Finnish economy is a quarterly econometric model developed at the Bank of Finland for forecasting and policy analysis. The model consists of about 270 equations, 100 of which are estimated behavioural or otherwise approximate relationships. The model may be characterized as an empirical application of the basic "neoclassical synthesis" approach to macroeconomics. Thus, the model can be seen as consisting of aggregate demand (IS), aggregate supply (AS) and monetary (LM) submodels or "blocks".

The present paper describes the determination of income distribution and government incomes and outlays in BOF4, and completes a series covering all sectors of the model. Reports have previously been published on exports and imports (Tarkka and Willman (1988)), production and employment (Tarkka, Willman and Rasi (1988)), wages and prices (Tarkka, Willman and Rasi (1989)), consumption and investment (Tarkka, Willman and Männistö (1989)) financial markets (Tarkka and Willman (1990)) and the macroeconomic foundations and simulation properties of the model (Tarkka, Männistö and Willman (1990)).

The analysis of taxes and government finances in BOF4 is very similar to the earlier generation of the model, reported in detail in Tarkka and Willman (1985). However, the modelling of income distribution - although still very aggregated - is somewhat more detailed than in BOF3. The analysis of income distribution is carried out to the extent required by the determination of sectoral disposable income, sectoral net saving and the incidence of indirect taxation.

The public finances block comprises the central government, the Social Insurance Institution and local government (municipalities). The exogenous variables and parameters connected with the revenues and expenditures of the central government and the Social Insurance Institution are the fiscal policy instruments of the model. The municipalities, in turn, are treated as endogenous decision-making units comparable to those of the private sector. The behavioural equations pertaining to local government incomes and outlays are based on the assumption that municipalities - given their budget constraint - seek to maximize the welfare of local inhabitants. The central government's control of local government finances is limited mainly to decisions relating to central government transfers to municipalities.

VI.2 The Accounting Framework

VI.2.1 National Income

The starting point in the modelling of incomes is, of course, the value-added at factor cost originating in the five production sectors of the model. These are calculated by multiplying real value-added (see determination of output by sectors in Tarkka, Willman and Rasi (1988)) by sectoral value-added deflators. For each sector, the value-added is divided in to wages, employers' social security payments and gross operating surplus. Income redistribution starts from these basic income flows.

The sum of sectoral value-added in production (at current prices) gives gross domestic product. By adding investment income from abroad (determined in the balance-of-payments block of the model) to and by subtracting consumption of fixed capital (determined in the investment block of the model) from gross domestic product we end up with national income (see equation Y.1 in the list of equations in the appendix). By adding net transfers from abroad to national income we obtain national disposable income, which in the BOF4 model is disaggregated into the disposable income of households (including non-profit institutions), the corporate sector and the government sector (including central and local government and social security funds) (see equations Y.3 - Y.6). Sectoral net lending is obtained by subtracting net investment from disposable income (see equations Y.7 - Y.8). Investment by the household sector is approximated by the sum of residential construction and fixed investment in agriculture and forestry. In calculating the corporate sector's net lending the fact that the sum of sectoral net lending equals the current account balance is utilized. The national income framework is illustrated by the following table.

TABLE 1. THE NATIONAL INCOME FRAMEWORK IN THE BOF4 MODEL. FIGURES FOR 1985 IN MILLIONS OF FIM

Domestic wages and salaries	150138
Employers' social security contributions	33923
Wages and salaries from abroad, net (exog.)	255
Property income and entrepreneurial income, net	57307
of which: corporations and general government	14039
households and non-profit institutions	43268
Indirect taxes less subsidies	37456
National income	279079
Transfers from abroad, net	-1509
National disposable income	277570
of which: households and non-profit institutions	189109
corporations	11576
general government	77140
Consumption of fixed capital	49620
Property income from abroad, net	-6287
Gross domestic product (in purchasers' values)	334986
Commodity taxes less commodity subsidies	38152
Gross domestic product (in basic values)	296834

Investment income and net transfers from abroad are taken from the balance-of-payments statistics. They deviate slightly from the corresponding SNA figures, and hence also the figures for national and corporate sector disposable income and capital consumption in BOF4 are not exactly same as those published in SNA. The advantages of using the balance-of-payments figures are that they are quarterly and the publishing lag is substantially shorter than for the SNA figures. Moreover, the balance-of-payments figures have in any event to be used in the balance-of-payments block.

VI.2.2 Households' Disposable Income

Besides actual households, the household sector in BOF4 includes non-profit institutions. The determination and components of households' disposable income in BOF4 are summarized in table 2:

TABLE 2. COMPONENTS OF HOUSEHOLD DISPOSABLE INCOME IN THE BOF4 MODEL IN 1985. MILLIONS OF FIM

wages and salaries	150138
+ employers' soc.sec. contributions	33923
+ entrepreneurial income	45472
+ other household income, net	-2204
- transfers to other sectors, net	38220
= households' disposable income	189109

Wages and salaries are computed for each of the five production sectors of the model by multiplying paid labour inputs by the wage rates of the relevant sectors (see equations Y.10 to Y.15).

Employers' social security contributions are likewise computed by production sectors, on the basis of wage bills and statutory social security contribution rates (see equations Y.16 to Y.26). Social security contributions are divided by recipient in the model into central government, the Social Security Institution and private social security schemes.

The model includes three equations for the determination of households' entrepreneurial income (equations Y.27 to Y.30). For agriculture and forestry, entrepreneurial income is determined by the gross operating surplus less capital consumption in these sectors. In agriculture, subsidies (other than those reflected in prices and hence in value-added) are also taken into account. Entrepreneurial income from the sectors other than agriculture and forestry is simply assumed to grow proportionally to value-added.

Other household income consists mainly of interest, dividends and rent (equation Y.31). This item has a very simplistic equation which explains "other household income" on the basis of the stocks of bank loans and the bank lending rate, the stocks of bank deposits and government bonds and the time deposit rate.

Household net transfers to other sectors (equation Y.34) are determined within the following framework:

TABLE 3. COMPOSITION OF HOUSEHOLDS' NET TRANSFERS TO OTHER SECTORS IN BOF4 IN 1985, MILLIONS OF FIM

+ direct taxes (of households)	51214
+ national pensions and sickness insurance contributions	5960
+ employers' soc.sec. contributions	33923
- transfers from central government	12026
- benefits from the Soc.Sec. Institution	18525
- other transfers to households, net	22326
= net tranfers to other sectors	38220

The discussion of the determination of households' direct taxes and pensions and sickness insurance contributions to the Social Security Institution is deferred to a later section.

Note that employers' social security contributions, which were included in the definition of households' disposable income, are deducted in net transfers so that the net effect on household income vanishes.

Transfers from central government and benefits from the Social Security Institution are exogenous either in nominal terms (central government transfers and sickness insurance compensation of the Social Security Institution) or in real terms (pensions paid by the Social Security Institution).

Other transfers to households consist mainly of income transfers to households from the rest of the private sector (however, transfers from local government are also included here). The item is dominated by pensions and insurance benefits from private insurance companies and unemployment insurance funds.

The equation for other transfers to households (see Y.33 in the list of equations) is based on the assumption that in the long run benefits paid by the various private schemes match the corresponding insurance payments. The financial position (surplus or deficit) of the private insurance schemes is approximated by the social security payments accruing to private social security funds, less transfers to households, excluding unemployment benefits. An improvement in the financial position of the private social security funds would accelerate the real growth of transfers to households, and vice versa. Changes in unemployment and in the real wage rate have an independent effect on the growth of transfers through unemployment insurance benefits.

VI.3 Taxes

VI.3.1 Direct Taxes

In BOF4, direct taxes are determined by two equations: one for direct taxes paid by households and another for direct taxes on corporations. The taxes determined by these equations include both central and local government taxes. There is a third, separate equation for the determination of the tax revenue of the local government sector and the part of direct taxes remaining with the central government is then residually determined.

VI.3.1.1 Households

In Finland, the household income tax is a combination of a progressive central government income tax and a proportional local government tax. The household income tax equation (G.1 in the list) determines the total revenue from both of these taxes. We consider the progressive central government tax first.

In BOF4, the central government tax rate is endogenous. It is modelled as a function of taxpayers' average income and of the parameters which describe the prevailing income tax schedule.

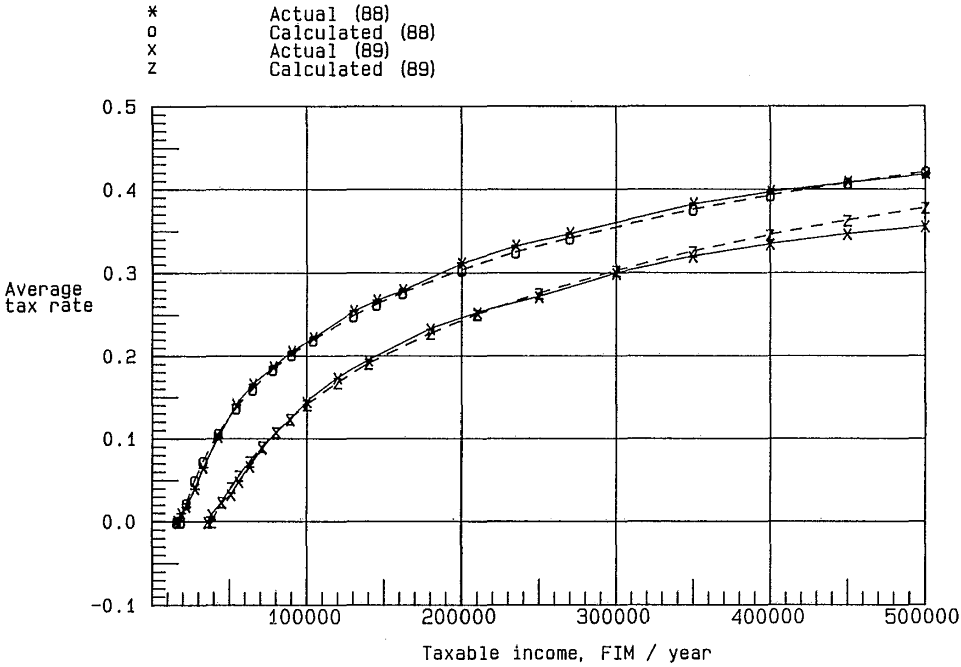
At the individual level, the Finnish progressive income tax schedule may be closely approximated by the following loglinear function:

(1) $t/y = A + B\log y$, if $y > \exp(-A/B)$
$t/y = 0$, if $y < \exp(-A/B)$

where t/y is the average tax rate of an individual with a taxable income y. The parameters A and B summarize the tax schedule and are in principle changed each year. The parameter B increases with the progressivity of the schedule (B = 0 for a proportional system). The average tax rate is equal to zero when $y = \exp(-A/B) = y_0$. This is the lower limit of taxable income of the tax schedule in question.

The time series for parameters of the tax schedule are included as exogenous variables in the BOF4 model. They are estimated separately for each year by fitting the equation (1) by OLS to the statutory income tax schedule for each year. Figure 1 shows the actual tax schedules and estimated tax schedules based on equation (1) for the years 1988 and 1989.

FIGURE 1. AVERAGE INCOME TAX RATE AS A FUNCTION OF INCOME, ACCORDING TO THE 1988 AND THE 1989 INCOME TAX SCALES



It may be noted that according to this type of tax schedule, the marginal tax rate is determined as follows:

$$(2) \qquad dt/dy = A + B(1 + \log y) = t/y + B$$

and the elasticity of tax revenue with respect to income is

$$(3) \qquad (dt/dy)(y/t) = B/(t/y) + 1$$

At the aggregate level, tax revenue depends on income distribution across individual taxpayers. Let income distribution be characterized by the density function f(y), the integral of which is equal to unity. Then aggregate tax revenue is

$$(4) \qquad T/N = \int_{y_0}^{\infty} (Ay + By\log y)f(y)dy$$

where T is total tax revenue and N is the number of taxpayers. As shown in Tarkka and Willman (1985, pp. 282 - 292), the expression (4) can further be developed to yield

$$(5) \qquad T/(N\bar{y}) = A + B\log \bar{y} + Bk$$

where $k = \int_{y_0}^{\infty} (y/\bar{y})\log(y/\bar{y})f(y)dy$ and $N\bar{y}$ equals aggregate taxable income

The distribution of income about its mean $\bar{y}$ is summarized by the function k. If the distribution of income is constant and if the share of individuals below the lower limit of taxable income is also constant, k is constant over time. This assumption is made in BOF4, and a value of 8.25 is estimated for k.

The above discussion applies to the progressive central government income tax. The equation for total taxes levied on households is obtained from the specification (5) by adding to it the average local government tax rate.

Finally, account must be taken of the fact that a rather complicated deduction system links the tax base (or income liable to taxation) to the actually taxable income. Moreover, this deduction system is different for central and local government taxes. In the actual household income tax equation of BOF4 the deduction systems are taken into account in the following way. The terms of the equation pertinent to the central government tax are multiplied by a parameter measuring the share of taxable income in central government taxation and the local government tax rate is multiplied by a similar parameter for local government taxation.

The tax base is approximated by the sum of wage income, households' entrepreneurial income and transfers from the Social Security

Institution. Summarizing the above discussion, it can be noted that altogether five tax parameters interact in the determination of direct taxes paid by households: two parameters measuring the origin and progressivity of the central government income tax schedule; the local government tax rate; and two parameters describing the deduction systems in central and local government taxation.

In the 1980s there were two major reforms of personal income taxation in Finland. The tax reform of 1982 widened the tax base to include certain transfers from the Social Security Institution. This change is taken into account in defining the tax base variable. The tax reform of 1989 lowered progressive income tax rates in different income brackets (see figure 1) and reduced deductions. These changes are straightforwardly taken into account by the policy parameters of the personal income tax equation. In addition the tax reform of 1989 tightened the taxation of interest income and capital gains and reduced tax allowances for interest expenses. However, the income classification in the BOF4 model is too aggregated to allow proper treatment of these changes.

The model also includes an equation (G.2) from which an estimate of the "representative" marginal tax rate is computed. This is based on the formula (2), including the local government tax rate and employees' social security contribution rate. The estimate for the "representative" marginal tax rate may be interpreted as the marginal tax rate faced by a taxpayer with an average income.

VI.3.1.2 Corporations

Like households, corporate entities also pay both central and local government income tax. Corporate income tax is proportional (with minor exceptions) and in this sense it is simpler than household income tax. The major difficulties in modelling corporate income tax lie in the determination of taxable income and in the dynamics of tax collection and tax reimbursements.

The taxable income of corporations in central and local government taxation is determined by equations Y.42 and Y.43, respectively. In both of these equations, taxable income is determined on the basis of an approximate measure of corporate profits: gross operating surplus less entrepreneurial income and transfers to households, as defined by equation Y.41. Dummies are included to take into account the reform of business taxation in 1969.

Apart form rather intricate dynamics, the corporate income tax equation (G.4 in the list) is a simple function of taxable incomes and tax rates. The dynamic form of the equation is due to the fact that the collected taxes are determined on the basis of taxable income of two years ago and the difference between collected taxes and taxes payable is settled in the two years following the tax year in question. The dependent variable of the equation includes the property tax paid by corporations until 1967; on the right-hand side of the equation a dummy variable takes the property tax into account.

VI.3.2 Indirect Taxes

Indirect taxes are disaggregated into three types of commodity taxes and other indirect taxes. All of these have their own equation in the model. The commodity taxes are the sales tax, the excise tax on liquid fuels and other commodity taxes. The item "other indirect taxes" includes fees, duties etc. paid by business units to the central government.

The sales tax is levied in Finland as a fixed percentage of the sales price. Most transactions in goods, including imports, are subject to the tax, while services and part of manufacturing investments are not. Since the seller may deduct purchases of goods on which tax is already paid, the system resembles a value-added tax. However, some compounding takes place due to the system of calculating the tax on the basis of the sales price, not the before-tax price. The feature that most services are tax-free also constitutes a significant departure from the pure value-added tax.

On the basis of the 1982 input-output study, the following estimate of the tax base is constructed for the BOF4 model:

93.3 % of private consumption of durables
74.3 % of private consumption of non- and semi-durables
6.3 % of private consumption of services
9.7 % of government consumption
29.1 % of fixed investment, excluding manufacturing
6.6 % of exports of goods and services
32.0 % of value-added in agriculture
15.4 % of value-added in forestry
28.6 % of value-added in private services etc.
9.3 % of value-added in manufacturing
a variable proportion of fixed investment in manufacturing

The variable proportion of manufacturing fixed investment which is subject to the sales tax takes into account the fact that the sales tax rates applied to manufacturing investment in machinery and equipment and to investment in construction deviate from each other as well as from the general sales tax rate.

The equation (see G.5 in the list) determines tax revenue by multiplying the tax base by the tax rate. Two dummies are included to take into account the period before 1963 when the present tax system was adopted and a third dummy takes into account the changes in the tax treatment of liquid fuels and electricity in 1974 and in 1986.

The equation for the excise tax on liquid fuels (eq. G.6) determines the revenue from this tax on the basis of the (ad quantum) tax rates for liquid fuels and variables which reflect the factors affecting the demand for liquid fuels (real GDP and the real after-tax price of these fuels).

Other commodity taxes include taxes on alcohol, tobacco, cars and some less important items. In the equation for other commodity taxes (see G.7 in the list) tax revenue is assumed to be proportional to the estimated tax base. The estimates of effective tax rates are based on information for the year 1982, and are assumed to be constant in the ordinary use of the model.

Finally, other indirect taxes are simply assumed to be proportional to nominal GDP (see equation G.8).

VI.4 Central Government Finances

In BOF4 the income, expenditure and capital account items of the central government are analyzed within the following framework, which corresponds closely to the SNA data:

TABLE 4. CENTRAL GOVERNMENT ACCOUNTS IN BOF4, MILLIONS OF FIM. (FIGURES FOR THE YEAR 1985)

Income:

direct taxes	25384
indirect taxes	47803
commodity taxes	45358
sales tax	24811
excise tax on liquid fuels	4465
other commodity taxes	16082
other indirect taxes	2445
employers' child allowance payments	671
other revenue	6953
total income	80811

Expenditure:

consumption	22901
subsidies	9878
commodity subsidies	7206
other subsidies	2672
transfers to households	12026
transfers to local government	21153
transfers to the Soc. Sec. Institution	4022
transfers abroad	1060
investment, total	4024
investment, public administration	3766
investment in government enterprises	258
interest on government debt	4575
other expenditure	782
total expenditure	80421

Capital Balance:

total expediture	80421
total income	80811
net financial deficit	-390
less net increase in housing loans	-1003
net foreign borrowing	1608
net central bank borrowing	-953
net borrowing from deposit banks	-2250
net change in bonds held by the public	4346
other net borrowing	-2138

On the income side, the modelling of taxes has been explained above. The direct tax revenue of the central government is solved in the model by deducting from total direct taxes the part payable to local government. "Other revenue" consists mainly of the operating surplus of various government enterprises and interest and dividend income of the central government (see equation G.12). In the equation determining this revenue item in the BOF4 model, the change in "other revenue" is explained by the change in the wage bill of the general government sector (proxying the operating surplus of this sector) and by the change in housing loans and other net borrowing by the state.

On the expenditure side, consumption and investment are exogenous in real terms, while transfers are exogenous in nominal terms. Only the interest on government debt is endogenized, and the change in this expenditure item is a function of current interest rates and changes in the net foreign and domestic (bond) debt of the state (see equation G.13).

The financial transactions of central government are all exogenous in the normal use of the BOF4 model, with the exception of the net change in bonds held by the public. This item is residually determined on the basis of the net financial surplus or deficit of the state and the net flows in the exogenous financing items.

VI.5 Local Government Finances

The most important part of local government finances is endogenously explained in the BOF4 model. The modelling strategy is based on the approach presented by Gramlich (1969) and is essentially the same as in the BOF3 version of the model (see Tarkka and Willman, 1985, pp. 303 - 308). (This approach is also used in the DRI model of the U.S. economy (see Eckstein, 1983)).

The central idea in this approach is that municipalities have a special motive to balance their operating budget, i.e. saving is associated with positive, although decreasing, marginal utility (or equally utility in a negative function of the future interest burden caused by the operating deficit). The municipalities are assumed to decide the local government tax rate and part of local government consumption expenditure. Another part of local government consumption is constrained to be proportional to transfers received by municipalities from the central government. Central government transfers to municipalities are a fiscal policy parameter which is outside the control of municipalities themselves. The preferences of local policy makers are described by a Cobb-Douglas utility function, which includes the following arguments:

- the income of taxpayers after the local government tax
- the voluntary part of local government consumption, financed entirely out of local taxes
- the part of local government consumption which is proportional to transfers from central government
- current saving, equalling investment outlays less net borrowing

The form of the utility function is then:

$$U = \alpha \log(C-s\cdot TR) + \beta \log(s\cdot TR) + \gamma \log(Y-t\cdot Y) + \rho \log(I-B) \tag{6}$$

where C is local government consumption, TR is transfers received form the central government, 1/s is the proportion of government financing in that part of consumption which is partly financed with transfers, Y is taxable income, t is the tax rate, I is investment and B is net borrowing. I is treated as a predetermined variable, as the planning horizon for investment is assumed to be longer than one period. Utility U is maximized with respect to current policy variables C, t and B subject to the following budget constraint:

(7) $$t \cdot Y + TR + B = C + I$$

where SUB is local government subsidices to the private sector. The solution of this optimization problem is given by the following equations for the tax rate t and consumption C:

(8) $$t = b_0 + b_1(C + SUB - TR)/Y$$

(9) $$C = c_0 TR + c_1(t \cdot Y - SUB)$$

where $b_0 = \rho/(1 + \gamma)$: $\qquad b_1 = \gamma/(\rho + \gamma)$

$$c_0 = \alpha/[\alpha + (1 - k)\rho]$$

$$c_1 = [\alpha + (1 - k)\rho s]/[\alpha + (1 - k)\rho]$$

and k is partial derivate of the tax base Y with respect to a change in local government consumption. The equations actually estimated in the model are derived from the optimality conditions (8) and (9) by allowing a partial adjustment mechanism in the local government tax rate and consumption (see G.14 and G.16 in the list of equations). Tax revenue actually accruing to the local government is determined by the technical relation G.15.

The tax rate setting of the municipalities is characterized by the following elasticities with respect to the tax base and transfers received from the central government:

TABLE 5. ELASTICITIES OF THE AVERAGE LOCAL TAX RATE IN THE BOF4 MODEL, EVALUATED IN 1980

variable	first-year elasticity	second-year elasticity	long-run elasticity
consumption	0	0.09	0.79
transfer revenue	0	-0.04	-0.37
tax base	0	-0.34	-3.05

Consumption behaviour, in contrast, is described by the following propensities to consume:

TABLE 6. CONSUMPTION PROPENSITIES OF THE LOCAL GOVERNMENT SECTOR OUT OF DIFFERENT TYPES OF INCOME IN THE BOF4 MODEL

income type	immediate propensity	one-year propensity	long-run propensity
tax revenue	0.24	.41	0.61
transfer revenue	0.54	.91	1.38

Since the model does not include all income and expenditure items of the local government sector, the budget constraint and the net financial surplus concept of that sector in BOF4 are not fully compatible with the SNA.

VI.6 The Social Security Institution

What was noted above about the incompatibility of the BOF4 model data with the SNA in the treatment of the local government sector also holds for social security funds belonging to general government. Their small real activities (consumption, investment, value-added etc.) are abstracted away and merged with the central and local government real-side items in the model. On the financial side, only the most important items of the largest government-operated fund, the

Social Security Institution, are included. Other transactions are implicitly assumed to take place within the private non-banking sector.

The revenue items of the Social Security Institution included in the model are the following. 1) contributions from the insured, i.e. households; 2) contributions from employers; and 3) transfers form the central government. Of these, the first two are endogenized on the basis of the aggregate wage bill and the prevailing exogenous contribution rates. In the normal use of the model, transfers from the central government are exogenous. On the expenditure side, the benefits paid by the Social Security Institution are disaggregated in to pensions and sickness insurance compensation.

The significance of variables having to do with the Social Security Institution is that they help to determine the disposable income of households. It should be noted that although the financial repercussions of possible financial surpluses or deficits of the Social Security Institution (or those of the other parts of government, for that matter) are not directly visible in the equations of the model, they are in fact traced in an internally consistent way in the system. This is due to Walras' Law of markets under the assumption of perfect substitutability of domestic non-monetary assets.

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VII FINANCIAL MARKETS AND THE BALANCE OF PAYMENTS

Abstract

This chapter describes the modelling of financial markets and the balance of payments in the BOF4 model. It first appeared in the Bank of Finland Discussion Paper series in January 1990, series no. 1/90. A preliminary version was presented at the Nordic symposium on economic modelling in Oslo, September 12 - 14, 1989.

In BOF4, the short-term interest rate is determined as a result of the interaction of the demand for money and money supply, as in the conventional IS-LM approach. Alternatively, the model may be solved under the assumption that monetary policy is based on pegging interest rates. In that case, the domestic credit of the Central Bank is the equilibrating variable.

The model includes term structure and tax structure equations for determining three market-determined longer-term interest rates: the taxable bond yield, the yield on tax-free bonds and the average bank lending rate. The short-term money market rate is, however, the main underlying determinant for all of these.

Foreign assets are assumed to be less than perfect substitutes for domestic assets. With fixed exchange rates, this is of course a necessary condition for the independent determination of the domestic interest rates. Capital movements are modelled using the Kouri-Porter (1975) approach. This means estimating a form of the portfolio equation for net foreign assets in which the domestic interest rate is reduced to its determinants. The monetary autonomy of the Finnish economy is estimated to be rather limited.

The behaviour of the financial block of equations in the model and the transmission of financial influences to the real side of the model are illustrated by three simulation experiments.

VII.1 Introduction

The BOF4 model may be characterized as an empirical application of the basic "neoclassical synthesis" approach to macroeconomics. Thus, the model can be seen as consisting of aggregate demand (IS), aggregate supply (AS), and monetary (LM) submodels or "blocks".

The model is, to our knowledge, the first comprehensive application of this modelling tradition to the Finnish economy after the deregulation of financial markets in Finland in the mid-1980's.

The basic approaches of financial modelling employed in BOF4 are discussed in chapter 2 below. The demand for and supply of money equations are presented in chapter 3. These equations determine the short-term market rate of interest in the model, when the model is used in the flexible interest rate models. The determination of other interest rates is described in chapter 4, which concentrates on two essential questions, the term structure of interest rates and the influence of capital income taxation on the interest rate mechanism. The modelling of capital flows in the balance of payments is described in chapter 5.

Chapter 6 presents preliminary results on forward currency markets. The operation of the financial/monetary relationships is illustrated in chapter 7 by means of simulation experiments. Some results on the financial behaviour according to the BOF4 model have previously been presented in Willman (1989).

Throughout the paper, reference is made to the list of equations included as appendix 1. Another appendix is devoted to a brief description of how the recent deregulation of the Finnish financial markets and the ensuing structural changes have influenced our modelling effort.

VII.2 The General Approach

VII.2.1 The Extended Monetary Approach to Financial Modelling

The strategy of modelling the financial markets in BOF4 may be described as the "monetary" or, perhaps more informatively, "residual-asset" approach. This is characterized by the following basic assumptions:

1. All assets which are denominated in domestic currency and are not classified as money are very close substitutes. If there are risk (or term) premia between them, the premia are assumed to remain constant in time.

2. There is a single "leading" market rate of interest, which is sufficient to measure the intertemporal opportunity costs of investment, consumption and holding money. This is a consequence of the first assumption. Long-run interest rates are linked to the "leading" or "benchmark" short-term interest rate by means of relationships like term structure are tax structure equations.

3. Unlike other assets, money is treated like a durable good and stable demand functions exist for the kinds of money included in the model (in BOF4, there are two: currency and broad money).

4. Assets denominated in foreign currency may be treated as imperfect substitutes for domestic assets. If this is not done, a "Mundell-Fleming model" is obtained in which uncovered interest rate parity holds between domestic and foreign financial markets. With imperfect substitutability, as in BOF4, partial independence of the domestic rate of interest is retained.

The term "residual-asset approach" refers to the fact that in this type of model the demand and supply functions for assets bearing the "leading" market rate of interest are not explicitly included. Rather, the demands for and supplies of "bonds" (and other similar instruments) are obtained as residuals for the agents' or sectors' budget constraints and the consistency of the whole model with a market equilibrium in this omitted market is ensured by Walras' law.

The residual asset approach can also be called "monetary". This does not imply any necessary association with the "monetarist" doctrines of economic policy, but is simply due to the fact that in this framework the working of the financial markets can be studied by focusing only on the demand for and supply of money. This is especially obvious in a closed-economy context and is familiar from the common IS-LM framework from which the whole approach originates.

The residual-asset approach has been by far the most common way of modelling financial markets in practical models, because it allows for some degree of flexibility and independence in designing expenditure, money demand and other equations in the model while retaining consistency with budget constraints. The approach should be contrasted with the comprehensive portfolio approach of financial modelling, which aims at treating all assets - even tangibles - in a symmetrical way. This much more demanding strategy was proposed by Brainard and Tobin (1968) and has lately gained increasing popularity in model building (see e.g. Keating (1985)). However, a drawback of this approach is that, besides requiring a major research effort, a lot of subjective judgement concerning parameter restrictions, exogeneity specifications etc. is required to obtain a tractable model. These difficulties would, we think, be especially severe in the context of structural changes such as have occurred in the financial markets in Finland in the 1980s as a result of financial liberalization.

VII.2.2 Overview of the Financial Block

The financial block of BOF4 is built around the balance-of-payments identity and the balance sheets of the central bank and the deposit banks. In this framework, the model includes behavioural equations for external capital movements, demand for currency and the demand for broad money. The concept of broad money includes currency and all bank deposits which do not bear market rates of interest. Thus, the money market liabilities of the banks in the form of CDs etc. are excluded from the concept of money.

The determination of the money supply is governed by the balance sheet identities and a technical equation determining the banks' required reserve deposits at the central bank. These suffice to link the quantity of broad money to the net central bank position of the banks. In the case where the central bank pegs the market rate of interest, the quantity of money is demand-determined and the money supply identities determine the amount of central bank credit; in the case where the central bank fixes its domestic credit the money supply identities determine the quantity of money and the demand for money function in turn determines the rate of interest consistent with it.

BOF4 includes three interest rates which are entirely market-determined. These are the short-term money market rate, the taxable bond (debenture) rate and the yield on tax-free bonds. (At present, the short-term money market rate is measured by the 3-month "HELIBOR" rate, but the data include slightly different definitions for earlier periods.) The banks' average lending rate is partly market-determined and partly exogenously determined; the interest rate on new bank loans is market-determined whereas changes in the interest rates on the outstanding loan stock is closely related to changes in the (exogenous) discount rate. Thus the economics of the average lending rate become rather complicated.

The model also deals with the call money (overnight) rate, but in the normal use of the model this is directly linked to the money market rate. The banks' most common time deposit rate is directly tied to the exogenous discount rate of interest.

The influence of the domestic money supply on the market rate of interest is limited by capital mobility. This is because under the fixed exchange rate regime (assumed in the basic version of the BOF4 model) capital outflows decrease the supply of money and tighten the money market. Capital inflows do, of course, have an effect in the opposite direction. Technically speaking, only short-term foreign capital flows are endogenous in the model, but since the exogenous long-term part has a complete crowding-out effect on the short-term capital account, the model works as if total private capital flows were modelled.

The financial block of the model also contains a few "post-recursive" equations which have no feedback to the rest of the model. On the balance-of-payments side, there are three tentative equations describing the operation of the forward exchange markets and the determination of the forward premium on the markka vis-à-vis the US dollar. On the domestic side, there is the equation for bank loans to the public. In the standard use of the model, autonomous changes in bank loans are completely absorbed by money market deposits at the banks (CDs) and for this reason the bank lending equation is not very important. However, the model may be used to describe the pre-1980's regime, in which the banks did not deal with the public in the short-term money market. In that case, the bank lending equation becomes important from the point of view of the money supply process.

VII.3 The Demand for and Supply of Money

VII.3.1 The Demand for Money: Currency

The demand for currency equation (see equation R.1 in the attached list of equations) is another of the money demand functions of the BOF4 model. It determines the amount of currency in circulation as a function of consumption, consumer prices and the interest rate on bank deposits.

The theoretical idea behind the equation is simply that currency holdings yield liquidity services which are complementary to private consumption - the only category of transactions in which currency is used to a significant degree. The interest rate on bank deposits represents the opportunity cost of holding currency, since bank deposits are obviously the nearest substitute for currency among the different available assets. (Note that in Finland payment services such as small-denomination cheques and a giro system are traditionally provided by banks to holders of interest-bearing time deposits.)

The dynamic form of the equation corresponds to the "nominal adjustment mechanism" of Goldfeld (1976). Accordingly, it takes time to adjust the currency holdings in response to changes in real consumption, the price level and the deposit rate of interest. The functional form is loglinear with the exception of the deposit rate which is included linearly with a lag of one quarter. The dynamic properties of the equation are described in the following table.

TABLE 1. THE DYNAMIC ELASTICITIES OF THE DEMAND FOR CURRENCY (SEMI-ELASTICITY IN THE CASE OF THE INTEREST RATE)

Variable	Immediate elasticity	One-year elasticity	Long-run elasticity
Consumption	0.13	0.15	0.46
Price level	0.27	0.34	1.00
Deposit rate	0.00	-.47	-1.69

The interest rate elasticity is expressed in the form of a "semi-elasticity", i.e. the percentage effect on the demand for currency of a change of one percentage point in the deposit rate. The proper interest rate elasticities are -0.03 in the first year and -0.11 in the long run (evaluated according to the deposit rate in 1985). It may be noted that the long-run consumption elasticity is not too far from 0.5 implied by the well-known square root rule discovered by Baumol (1952).

VII.3.2 The Demand for Money: Broad Money

As mentioned above, the concept of broad money used in BOF4 includes:

- domestic currency in circulation
- cheque and postal giro deposits of the domestic non-bank public denominated in markkas
- all time deposits of the domestic non-bank public denominated in markkas.

Wholesale deposits bearing the market rate of interest (sometimes called "unregulated deposits", which include large-denomination CDs and similar instruments) are excluded.

The functional form of the demand for broad money equation is the following:

$$(1) \qquad M3/Y_{-1} = a_0 - a_1[(1-tm)i - i_D] + a_2\Delta Y/Y_{-1} + a_3 M3_{-1}/Y_{-1}$$

Here M3 is the stock of broad money, Y is nominal GDP, i is the short-term market rate of interest, i_D is the tax-free time deposit rate and tm is the capital market tax rate calculated from the interest rate differential between taxable and tax-free bonds (its determination is presented below in section 5.3).

According to this specification, the inverse of the velocity of circulation of broad money is a linear function of the opportunity cost of holding money, where the opportunity cost is measured by the difference between the after-tax market rate of interest and the own (deposit) rate of money. Dynamically, the equation is in the same nominal-adjustment tradition as the demand for currency equation.

As can be seen from section 6.2 of this paper below, parameters of the demand for money equation (1) (solved for the money market rate of interest) are also contained in the capital flow equation. To capture parameter constraints across these two equations, they were estimated as a system using the nonlinear estimation method MINDIS (minimum distance estimation) (see Berndt, Hall, Hall and Hansman (1975) and Amemiya (1977)). We also studied whether, as a result of structural changes in the Finnish financial markets, the estimates of the parameters of the model changed within the estimation period. We found a break in the data generating process in the second quarter of 1984. At that time, the banks' cartel agreement on rates on money market instruments was broken as a result of action taken by the Bank of Finland. In the estimated equations R.11 and B.7 (see the appendix), the emergence of a competitive money market was taken into account by a dummy variable, which allowed the parameter estimates of the interest sensitivity of the demand for money and the demand for net foreign debt to change in the second quarter of 1984. According to the estimated equation, the interest sensitivities of the demand for money and the demand for net foreign debt increased more than four fold in the quarter.

The elasticities of the demand for broad money equation in the latter part of the estimation period are reported in the following table. Again, the interest rate elasticities are given in the form of semi-elasticities. The elasticities are computed from the 1985 levels of the variables concerned.

TABLE 2. THE DYNAMIC ELASTICITIES OF THE DEMAND FOR BROAD MONEY (INTEREST RATE ELASTICITIES ARE SEMI-ELASTICITIES)

Variable	Immediate elasticity	One-year elasticity	Long-run elasticity
Nominal GDP	0.08	0.69	1.00
Interest rate	-0.31	-0.94	-1.24
Deposit rate	0.40	1.18	1.54

The proper interest rate elasticities may be obtained by multiplying the semi-elasticities by the relevant interest rates in decimal form. For example, the long-run interest rate elasticity of the demand for broad money is -0.12 evaluated at the 1985 level of the interest rates.

VII.3.3 The Supply of Money

The balance sheet framework which determines the supply of money in BOF4 consists of the balance sheets of the central bank and the consolidated deposit bank sector. In addition to these identities, a technical equation determining the banks' required reserves is needed.

Let us adopt the following notation for the purposes of the present exposition:

THE BALANCE SHEETS

The Central Bank:

  foreign reserves, R
\+ central bank credit to the government, DG
\+ central bank credit to the public, DP
\+ central bank credit to the deposit banks, DB
\- own capital and other items of the central bank, net OCB
\- required reserves of the deposit banks, Q
= currency in circulation, S

Deposit Banks:

\+ bank credit to the government, net LG
\+ bank loans to the public, LP
\+ required reserves of the deposit banks, Q
\- own capital and other items of the banks, net OB
\- money market deposits at the banks, CD
\- central bank credit to the banks, DB
= bank deposits of the public, MD

required reserves:

$$Q = r \cdot MD$$

Broad money, M3, is defined as MD + S.

In the case of pegged interest rates, the demand for bank deposits and the demand for currency are determined from outside the money supply framework. In this case, the money supply framework determines central bank credit to the deposit banks in the following way:

$$DB = S + r \cdot MD - DG - DP - R + OCB$$

Or, expressed with the help of the demand function for broad money,

$$DB = (1-r) \cdot S + r \cdot M3 - DG - DP - R + OCB.$$

On the other hand, if the central bank fixes its domestic credit DB+DG+DP-OCB, it is the supply of money which is determined by the money supply identities:

$$M3 = 1/[(r + (1-r) \cdot S/M3)] \cdot (DB + DG + DB + R - OCB)$$

It can be seen that the model traces the influences on money supply of all components of domestic central bank credit as well as of the foreign currency reserves. Since BOF4 does not contain a demand for free reserves equation, the reactions of money supply to these monetary policy instruments are quick (immediate, in fact) and very powerful.

The money multiplier $1/(r + (1-r) \cdot S/M3)$ was 8.4 in 1985 and varies as the reserve requirement r and the ratio of the demand for currency to the demand for broad money S/M3 change. Note that the supply of money is sensitive to the market rate of interest since the "cash ratio" S/M depends (positively) on the market rate of interest according to the demand for money functions of BOF4.

There is a practical modelling problem in that the statutory cash reserve base, or the definition of bank liabilities which are subject to the reserve requirement, does not exactly correspond to the bank deposits included in BOF4's definition of money. This has been dealt with by means of rewriting the demand for cash reserve deposits equation in difference form (see equation R.2 in the equation list).

This is equivalent to assuming that the share of bank deposits in the cash reserve base remains constant.

VII.3.4 Bank Lending

The role of bank credit in the money supply framework deserves further comment. As can be seen from the above presentation of the money supply framework, required reserves, net central bank debt and deposits of the public are the only items in the banks' balance sheets which have a direct bearing on the money supply process in the model. Changes in bank credit to the public, or to the government, for example, are completely sterilized in this framework by changes in money market deposits with banks (CDs). A necessary condition for this to happen is, however, that the banks participate in the money market.

Things are different, however, if banks do not accept money market deposits (CD = 0 in the notation of this chapter) and if bank lending is rationed. Broadly speaking, these conditions prevailed in Finland in the 1960's and 1970's. In this case the supply of money must be calculated by "credit counterparts":

$$M3 = LP + DP + LG + DG + F - OB - OCB$$

In this money supply regime, the equation determining bank loans to the public LP becomes crucial for the determination of the money stock and the determination of the market rates of interest. This is because it is now the only endogenous domestic component of the money supply and because in the BOF4 model the foreign component does not completely offset the changes in liquidity originating from domestic sources.

The bank lending equation (R.10 in the list) is a supply function designed to be useful in a regime of institutionally controlled lending rates and monetary policy operating through the marginal cost of central bank credit to the banks (for the derivation and estimation of the equation, see Tarkka, 1986). The equation has no particular significance outside the regime of excess demand for credit and non-participation of banks in the market for short-term money market deposits.

The bank loan supply equation determines the flow supply of loans. The explanatory variables in the equation are the difference between the average lending rate and the marginal cost of funds for the banks, and the rate of inflation. According to the equation, an increase in the spread between the lending rate and the marginal cost of funds will eventually accelerate the annual rate of growth of bank loans by 0.9 per cent. An increase in the rate of inflation by one per cent will, ceteris paribus, accelerate the rate of growth of bank loans by 0.6 per cent.

The operation of the model in the "repressed markets" regime, i.e. without the money market deposits, is described in Tarkka (1985).

VII.4 The Term Structure of Interest Rates and the Miller Equilibrium

At any point of time there are many prevailing interest rates, which differ from each other with respect to the maturity, risks and tax treatment associated with them. The central bank cannot control all of them at once. Typically, the operations of the central bank directly affect a short-term interest rate, which is closely related to the equilibrium in the money market. This is also so in Finland. Real economic activity, on the other hand, is more closely linked to the after-tax real returns on claims with longer maturities. Hence, to be able to study the transmission of monetary policy in a macro model, the short-term money market rate must be linked to bond rates and the after-tax returns must be estimated.

In the BOF4 model, the interest rate structure is determined as follows: It is the expectations hypothesis which first, via a simple term structure equation, links the taxable short-term money market interest rate to the market yield on debentures. This yield represents the long-term taxable interest rate in BOF4. Another term-structure relation is estimated for the average interest rate on outstanding bank loans, which in the BOF4 model is important in the housing market and in calculating net interest payments by the household sector.

Further, the taxable long-term interest rate is connected with the long-term tax-free interest rate by the Miller equilibrium relationship, which in an economy with taxes is the counterpart of the well-known Modigliani-Miller equilibrium in a tax-free economy.

VII.4.1 The Term Structure Equation for the Long-Term Interest Rate

Under efficient arbitrage, the market equilibrium implies the following relation between long-term and short-term interest rates:

$$(2) \qquad R(t) = (1/m) \cdot \sum_{i=0}^{m-1} E(t)r(t+i) + k(t)$$

where R denotes the interest rate on loans with a maturity of m periods, r is the one-period rate, k is term premium and E denotes the expectation operator. Equation (2) asserts that, after taking into account transaction costs and risk considerations, the yield on an m period bond has to equal the expected cumulative yield on investment in a series of one-period bonds for m periods.

The equilibrium condition (2) is transformed into the expectations model of the term structure of interest rates, if the term premium k(t) is assumed to be constant. The implication of this assumption is that the yield on long-term bonds can be affected by monetary policy only by influencing the expected path of the yield on short-term assets. If the term premium could vary, then monetary policy could also affect long-term rates through other channels, such as "debt management".

The next step is to specify the formation of interest rate expectations. From many alternative hypotheses we adopted the regressive hypothesis:

$$(3) \qquad E_t\, r(t+1) = r(t) + (1-e)(r^* - r(t)) = e \cdot r(t) + g$$

Equation (3) states that, over time, the short-term interest rate is expected to converge to a long-run "normal" level r*. The benefit of the regressive hypothesis, besides being simple, is that it has worked quite well in earlier empirical studies (see Dobson et al. (1976)). This expectations hypothesis is also the rational one if the short-term interest rate follows a linear first order stochastic process such as that formulated by Cox, Ingersoll and Ross (1985).

After subsequent substitution of (3) into (2), we end up with the following term structure equation for the long-term interest rate:

$$(4) \qquad R(t) = c + b \cdot r(t),$$

where $c = (1/m) \cdot g \sum_{i=1}^{m-1} \sum_{j=1}^{i} e^{i} + k$ and $b = (1/m) \sum_{i=0}^{m-1} e^{i}$.

In estimating (4), the Cochrane-Orcutt autocorrelation correction was used. Equation R.2 in the list of equations is the resulting empirical term structure model. According to it, changes in the short-term interest rate are transmitted to the long-term taxable interest rate with the weight 0.51. This is the parameter b. From the estimated equation we can calculate the short-term interest rate level, which is forecast to produce a horizontal yield curve (i.e. R(t) = r(t)); this interest rate level is 12.1 per cent. (If the term premium were zero, this would also be the estimate of the expected long-term equilibrium level of the short-term interest rate.) If the actual short-term interest rate is below 12.1 per cent, then, according to the estimated equation, the long-term interest rate is above the short-term interest rate. The situation is reversed if the short-term interest rate is above 12.1 per cent.

VII.4.2 The Banks' Average Lending Rate

Until the middle of the 1980's the average bank lending rate was regulated by the Bank of Finland and very closely linked to the base rate (discount rate). Between 1983 - 1986, however, as part of the liberalisation process in the Finnish financial markets, interest rates on new bank loans were gradually deregulated and allowed to be freely determined by market forces.

As the substitutability between bank loans and debt issued by firms must be very close, the bank lending rate on new loans is assumed to be determined by the short-term interest rate via a term structure relation similar to equation (4). However, typically bank loans are not granted as fixed rate loans. Rather, interest rates levied on them are linked to some reference interest rate. As the discount rate is used as the reference interest rate for the major part of bank loans, changes in the discount rate are reflected in the average bank lending rate quite strongly.

The estimated equation for the average rate on outstanding bank loans takes these features into account (equation R.4 in the list of equations). The dynamic properties of the estimated equation are described in the following table.

TABLE 3. THE DYNAMIC RESPONSE EFFECTS ON THE AVERAGE BANK LENDING RATE

Variable	Immediate effect	One-year effect	Long-run effect
Discount rate	.98	.82	0
Short-term interest rate	.10	.14	.34

We see that although in the long run the average bank lending rate is independent of the discount rate, short-run variations in the RLB are dominated by changes in the discount rate. Changes in the short-term money market rate, in turn, have quite small immediate effects on the bank lending rate. The steady state form of equation R.4 states, however, that in the long run the bank lending rate is determined solely by the short-term interest rate and the term premia. The yield curve implied by the steady state relation is horizontal if RS is 9.8 per cent; with values of short-term interest rate above (below) 9.8, the bank lending rate is below (above) the short-term interest rate.

VII.4.3 The Determination of the Tax-Free Long-Term Interest Rate: The Miller Equilibrium

In making portfolio choices, rational agents allocate their available resources with reference to the after-tax returns of alternative investments. Therefore in the BOF4 model it is the after-tax long-term interest rate which is used as the argument of private consumption and, via user cost variables, as the argument of private investment. In financial markets, the after-tax short-term interest rate equilibrates the money market and changes in the after-tax short-term interest rate differential between domestic and foreign interest rates determine net capital imports.

Quite often there are difficulties in obtaining data on yields on tax-free assets. In Finland, however, a major part of central government bonds are tax-free and secondary market data on the yields of these bonds are available (see Alhonsuo et al. (1989)). Since domestic assets with the same maturity are assumed to be perfect substitutes in the BOF model, it is legitimate to use the government bond rate as an indicator for all after-tax long-term yields.

The effects of changes in the tax-free long-term interest rate are transmitted to fixed investments through the sectoral user cost variables. User costs are calculated using the standard "Jorgensonian" formula (for a review of the concept and estimation of the user cost of capital, see Koskenkylä (1985)).

(5) $UC = (RB - inf^e + d) \cdot (1 - ts \cdot td/(RB+td))/(1-ts)$

where inf^e is expected inflation, d is the rate of depreciation of capital and s is the statutory corporate tax rate. td is the tax depreciation coefficient, which is infinite in the case of free tax depreciation.

In a more general form the user cost formula also includes the effect of the capital structure. This formula, however, collapses to the one presented above, if the after-tax financing costs from different sources are equal, as is the case in Miller equilibrium.

We now turn to the determination of the tax structure of interest rates. It is clear that, if two assets are similar in all other respects except tax treatment, the interest rate on the taxable asset must be above that on the tax-free asset. Otherwise, no one with a positive income tax rate would be willing to hold the taxable asset.

Assume for simplicity that there are two tax-free assets (government bonds and equities) and one taxable asset (bonds issued by firms). Now the following identity between the expected returns on these assets can be written:

(6) $RB = RE = (1 - tm) \cdot RT$,

where RB and RE are the rates of return on tax-free bonds and equities, respectively, RT is the taxable bond rate and tm is the marginal tax rate of the marginal investor. Among investors with different marginal tax rates on interest income, the marginal investor is defined as someone who is indifferent between buying taxable or tax-free claims because he obtains equal after-tax yields on both types of securities. Investors with a lower marginal tax rate than tm demand only taxable claims and investors with a higher marginal tax rates buy only tax-free claims.

The problem is, then, what determines the marginal investor's marginal tax-rate, or who is the marginal (representative) investor.

Miller's proposition gives an answer to this question (Miller (1977); see also DeAngelo and Masulis (1980) and Aivazian and Callen (1987)). According to the Miller proposition, the marginal investor's marginal tax rate must in equilibrium (with negligible taxation of equity appreciation) be equal to the effective corporate tax rate. Important implications of this proposition are: (i) capital structure is irrelevant for any single firm; (ii) there is a unique debt-equity ratio for the aggregate corporate sector; (iii) the tax structure of interest rates is determined by the corporate tax parameters.

In a dynamic framework Miller's proposition can be derived as follows. We specify the following demand and supply functions for taxable corporate debt:

(7) $B^d = A \cdot (RT/RE)^a$; A, a > 0 (demand)

(8) $d \log(B^s)/dt = m \cdot \log[RE/(1-tc) \cdot RT]$; m > 0 (supply)

where tc is the effective corporate tax rate. Equation (7) defines aggregate demand for taxable bonds. It can be interpreted as follows: the greater is the interest rate differential between taxable and tax-free securities, the higher is the marginal income tax rate of the marginal investor (see identity (6)). Hence, the widening of the interest rate differential between taxable and tax-free securities increases the demand for taxable bonds, because the number of investors whose marginal income tax rate is below the marginal investor's tax rate becomes greater. As mentioned above, investors in this group hold only taxable bonds. The share of taxable bonds in the portfolios of marginal investors, who under progressive tax scales hold both taxable and tax-free securities, also increases. In this way they maximize their after-tax incomes.

Equation (8), which defines firms' flow supply of taxable bonds, is based on the assumptions that firms maximize their value, debt charges are deductible in calculating the corporate tax bill and that a firm cannot change its capital structure costlessly. Under the first two assumptions the optimal financing solution of a firm would be to issue only bonds, if $RE > (1-tc)\cdot RT$. In the opposite case the optimal solution would be to issue only equity. Only with equality would the capital structure be irrelevant from the point of view of the value of the firm (see DeAngelo and Masulis (1980)). The inclusion of adjustment costs implies that changes in the capital structure of firms do not occur instantaneously but gradually. This is what equation (8) states.

By differentiating the log of equation (7) with respect to time and then equating the result with (8), we obtain the following relation between the tax-free and taxable interest rates:

$$(9) \qquad d\log(RE)/dt = d\log(RT)/dt + (m/a)\cdot\log[(1-tc)RT/RE]$$

According to equation (9), with the effective corporate tax rate given, all changes in the taxable interest rate are immediately transmitted to the tax-free interest rate. The speed at which the monetary policy is transmitted from short-term interest rates to taxable and tax-free long-term interest rates is the same.

Hence, all changes in the interest rate differential between taxable and tax-free interest rates result from changes in the effective corporate tax rate. According to equation (9), there is a partial adjustment process by which the interest rate differential between taxable and tax-free securities follows the effective corporate tax rate. We see that in the long-run equilibrium $RE = (1-tc)RT$ and, on the basis of identity (6), $tm = tc$. Hence, it is the effective corporate tax rate which determines the marginal investor's marginal rate. (It is worth noting that equation (9) could be written as a partial adjustment equation for the marginal income tax rate of marginal investors, i.e. $d\log(1-tm)/dt = (m/a)\cdot\log[(1-tm)/(1-tc)]$.)

Before estimating (9) there is still one problem to be solved; corporate income tax rules do not specify the effective tax rate, only the statutory rate, which, owing to various allowances and deductions, can be quite considerably above the effective tax rate. Consequently, we assumed the following relation between the effective and statutory corporate tax rates:

(10) $tc = (b_0 \cdot ts + b_1 \cdot \Delta P/P_{-1})/(1 + RT)^2$

where ts indicates the statutory corporate tax rate and p the price level. Parameter $b_0 < 1$ and parameter $b_1 \gtrless 0$. This simple relation takes into account the possibility that corporate income taxation is not neutral with respect to the inflation rate. The discount factor $(1+RT)^2$, in turn, takes into account the fact that there is about two years lag from the accrual of tax liabilities to the collection of taxes.

According to Miller's proposition, t_m equals tc in the long-run equilibrium. This allows us to use 1-RB/RT as the dependent variable in estimating parameters b_0 and b_1 using simple regression analysis. For the sample period 1977 - 1988, the estimate for b_0 was .82 and for b_1 11.4. The latter parameter estimate implies that the corporate tax rules are quite unneutral with respect to inflation. The coefficient of the inflation variable may also include some effects of the (relatively light) equity taxation.

TABLE 4. THE DETERMINATION OF THE IMPLICIT EFFECTIVE CORPORATE TAX RATE (PERCENTAGE POINTS)

Variable	Effect
Statutory tax rate	0.67
Inflation rate (per cent)	-0.93

As equation (9) was not estimated for the yield on equities but for the yield on tax-free government bonds, we allowed the short-run dynamics to be determined more freely than implied by equation (9); the short-run effects of changes in the long-run taxable interest rate on the government bond rate were not constrained to equal unity. Hence, the government bond market and the equity market are not assumed to be so closely integrated to each other that at each instant of time RB would equal RE. Rather, we assume it to be the long-run equilibrium relation.

According to the estimated equation for the government bond rate, the speeds at which the effects from the effective corporate tax rate and from the taxable long-term interest rate are transmitted to the government bond rate are equal (see equation R3 in the list of equations).

TABLE 5. THE DYNAMIC RESPONSE EFFECTS ON THE TAX-FREE BOND RATE (PERCENTAGE POINTS)

Variable	Immediate effect	One-year effect	Long-run effect
Long-term taxable rate	0.19	0.47	0.73
Effective tax rate	0.03	0.06	0.10

VII.5 The Balance of Payments

In the above discussion of money supply the determination of the foreign reserves of the central bank was not explained. Actually the foreign reserves are endogenous in the basic version of BOF4. The assumption of a fixed exchange rate implies that the foreign reserves are determined by the current and capital accounts of the balance of payments.

In BOF4, the balance of payments is analyzed within the following framework:

TABLE 6. THE BREAKDOWN OF THE BALANCE OF PAYMENTS IN BOF4

Exports of goods (multilateral)
Imports of goods (multilateral)
Surplus on the multilateral trade account

Exports of goods (bilateral)
Imports of goods (bilateral)
Surplus on the bilateral trade account

Trade balance

Exports of services
Imports of services

Balance of goods and services

Investment income from abroad, net
Transfers from abroad, net

Current account

Private long-term capital inflow, net
Government long-term capital inflow, net
Central bank long-term capital inflow, net

Current and long-term capital account

Short-term capital account

Change in central bank's foreign reserves

VII.5.1 The Current Account

All main components of the current account are endogenous in BOF4. The trade account and the services account are determined from the foreign trade equations by means of the relevant identities. Net investment income from abroad depends on net long-term foreign debt and the average of the ratio of net investment income to foreign debt in the two previous quarters (see equation B.3).

Net foreign transfers are a sum of the government's foreign transfers (mostly development assistance) and private transfers, which are assumed to be proportional to the value of the GDP (see equation B.4).

VII.5.2 Capital Movements

Net long-term borrowing by the government (and the central bank) are exogenous in BOF4. So, too, are, in a technical sense, movements in long-term private capital. However, as foreign long-term and foreign short-term private capital are assumed to be perfect substitutes for each other, the though model operates as if it were the sum of all private capital movements which are explained by the capital movement equation.

The theoretical starting point in the modelling of capital movements is the portfolio approach. According to this theory, private capital movements in the balance of payments reflect portfolio shifts and are caused by changes in relative returns on domestic and foreign assets. In addition, mere accumulation of wealth by investors may also lead to changes in net foreign investment. The portfolio approach to the balance of payments was originally developed by Branson (1968).

The portfolio equations are, however, very difficult to estimate directly. Partly this is is due to simultaneity in the determination of the domestic rate of interest and capital movements. On the other hand, the problems are caused by measurement errors in relative returns, particularly exchange rate expectations. Both of these factors tend to bias the estimates of interest rate sensitivity of capital movements downward. The problems become virtually insurmountable in the limiting case of perfect substitutability of domestic and foreign assets. In that case an attempt to explain capital flows in terms of relative returns would be impossible since arbitrage would by necessity keep the expected returns of domestic and foreign assets equal (allowing for exchange rate expectations). Hence, a zero estimate of interest elasticity would be obtained although the true elasticity would be infinite.

Kouri and Porter (1974) developed a partially reduced form of the capital flow equation which overcomes these problems. The idea, also followed in BOF4, is to substitute the inverted money demand function and the money supply identity for the rate of interest in the capital flow equation. The starting point is the following linearized version of the capital flow equation:

$$(11) \qquad \frac{FP^{uc}}{Y_{-1}} = b\{\Delta[(1-tm)i] - \Delta[(1-tm)i^f]\} + v$$

Here the private uncovered capital inflow FP^{uc} is a function of the change in the relative expected yield differential between domestic and foreign assets: $\Delta[(1-tm)i]$ and $\Delta[(1-tm)i^f]$ are changes in the domestic and foreign after-tax interest rate, respectively.[1] The interest rate effect is scaled by lagged nominal GDP, Y_{-1}, which serves as a surrogate for wealth. Exchange rate expectations are omitted from the equation although they are certainly important in practice. The obvious reason for neglecting exchange rate expectations in the model is the difficulty of measuring them. However, for most of the data the expected change in the effective exchange rate of the markka is probably small due to the fixed rate regime, which is institutionalized in Finland. The role of the constant term in equation (11) is to take into account the average effect of the growth of wealth (which is an unobservable variable) on net capital flows.

In our formulation of the portfolio equation in a world with taxes, we have implicitly assumed that exchange rate gains and losses are not taxable. This is evident in (11) in that the risk premium is not a function of tax rates.

Note that the uncovered and total private capital flows are different only if the authorities participate in the forward currency market, purchasing a part of the private sector's exchange rate position. In the case where the central bank participates in the forward market,

[1] It is assumed in (11) that capital gains on foreign assets are not taxable. If capital gains were taxable, the government would share the foreign exchange risk with private investors and, hence, instead of being multiplied, the interest rates in (11) should be divided by 1-tm.

the private sector's uncovered and total capital flows are linked by the following identity:

$$FP^{uc} = FP + FF \text{ (change in the net forward currency position of the central bank)}$$

For the purposes of the Kouri-Porter reduction of the capital flow model, we need the inverted money demand function in its difference form. By solving equation (1) for the after-tax money market interest rate we obtain:

$$(12) \qquad \Delta[(1-tm)i] = \Delta i_d - \frac{1}{a_1}\,\Delta(\frac{M3}{Y_{-1}}) + \frac{a_2}{a_1}\,\Delta(\frac{\Delta Y}{Y_{-1}}) + \frac{a_3}{a_1}\,\Delta(\frac{M3_{-1}}{Y_{-1}})$$

We also need the money supply identity of the model in its difference form:

$$(13) \qquad \Delta M3 = FP + FG + CA + \Delta DP + \Delta DG + \Delta LP + \Delta LG - \Delta CD - \Delta OCB - \Delta OB$$

Substituting (13) in (12) and the resulting expression in (11) and solving for FP^{uc} we obtain

$$(14) \qquad \frac{FP^{uc}}{Y_{-1}} = k_1 \cdot \{\Delta i_d - \Delta[(1-tm)i^f]\} + k_2 \cdot \Delta(\frac{M3_{-1}}{Y_{-1}})$$

$$+ k_3(\frac{\Delta Y}{Y_{-1}} - \frac{\Delta Y_{-1}}{Y_{-2}})$$

$$- k_4 \cdot \{FG + CA + \Delta DP + \Delta DG + \Delta LP + \Delta LG - \Delta CD$$

$$- \Delta OCB - \Delta OB - FF - M3_{-1} \cdot \frac{\Delta Y_{-1}}{Y_{-2}}\}/Y_{-1}$$

$$+ k_5$$

where $k_1 = \frac{b}{1+b/a_1}$; $k_2 = \frac{a_2 b/a_1}{1+b/a_1}$; $k_3 = \frac{a_3 b/a_1}{1+b/a_1}$; $k_4 = \frac{b/a_1}{1+b/a_1}$; $k_5 = \frac{v}{1+b/a_1}$

This is the Kouri-Porter equation. The coefficients have the following structural interpretation:

- the coefficient k_1 of the foreign interest rate (and the domestic deposit rate) indicates the response of the capital flow to these variables when the domestic component of money supply is held constant. This is not the same concept as the interest sensitivity of the original portfolio equation, which can, however, be recovered from the coefficients of the Kouri-Porter equation, since $b = k_1/(1-k_4)$.

- the parameter k_4 is the famous "offset coefficient" measuring the proportion of changes in domestic credit which is offset by changes in induced private capital flows.

The capital flow equation of BOF4 (see B.7 in the list of equations) corresponds to the basic Kouri-Porter equation (14). The equation has been divided throughout by the lagged broad money stock to eliminate heteroskedasticity. In section 4 it was already mentioned that because of parameter constraints across equations the demand for money equation and the capital flow equation were estimated as a system. In addition a dummy variable was included, allowing the interest sensitivities of the demand for money and the demand for net foreign debt to change in 1984Q2. In that quarter these interest sensitivities became 4.3 times greater compared to the preceding period. It is worth noting that these parameter changes did not affect the estimate of the "offset coefficient" k_4, because relative changes in structural parameters a_1 and b are equal.

According to the estimated capital flow equation, the offset coefficient is 0.86, which means that this proportion of changes in the domestic credit of the banking sector is immediately reflected in capital movements; similarly, current account surpluses and the government's foreign borrowing crowd out private foreign borrowing by

86 per cent. An increase in the foreign rate of interest by one percentage point would lead to a capital outflow of FIM 367 million (computed from the 1985 levels of variables; in 1988 the effect would have been FIM 417 million).

These effects cited above summarize capital mobility if monetary policy operates through fixing domestic credit. If monetary policy pegs the domestic rate of interest, we may calculate from the coefficients of the equation that an increase of one percentage point in the rate of interest would have caused an immediate capital inflow of FIM 2560 million in 1985 (or FIM 3014 million in 1988). This is the common definition of interest sensitivity of demand for foreign capital.

VII.6 Forward Currency Markets

The BOF4 includes three tentative equations for the forward currency markets. The behaviour of the corporate sector is captured by a supply equation for forward currency. An identity determines the amount of forward cover needed by banks who buy the net forward currency supplied by firms, taking into account the forward currency operations of the central bank. Finally, the behaviour of banks is summarized by the equation determining the forward premium.

The net supply of forward currency by firms (equation B.8) depends on the deviation of the forward premium from covered interest rate parity, as well as on the trade balance and the overall open position of the private sector. The equation is estimated in difference form.

The net forward position of the banks is equal to the net supply of forward currency by firms and the central bank. This is also equal to the amount of spot cover needed by the banks in order to avoid exchange rate risk. The amount of spot cover needed by banks determines how much banks are willing to pay for forward currency (US dollars). If interest arbitrage were perfect, the forward premium would exactly correspond to the interest rate differential between currencies. As it is costly for the banks to obtain spot cover for their forward position, the forward premium is a slightly decreasing function of the banks' net forward position. For example, an increase in the banks' forward position by FIM 10 billion in 1988 would have caused a reduction of 0.23 per cent in the price of USD sold 3 months forward.

VII.7 Simulation Experiments

To illustrate the interaction of the financial and real sectors of the BOF4 model the following three simulation experiments were run:

1. Central bank credit was increased by FIM 5 billion (about one percent of nominal GDP in 1989) in the flexible interest rate regime.

2. The statutory corporate tax rate was increased by 10 percentage points in the pegged interest rate regime.

3. The statutory corporate tax rate was increased by 10 percentage points in the flexible interest rate regime.

All the simulations were run with exogenous nominal transfers from the central government to the other sectors of the economy. Personal income tax schedules, however, were endogenized to prevent bracket creep despite gradual inflation.

Simulation 1: Central bank credit increased by 1 % of nominal GDP

In this experiment the central bank increases the domestic credit component of the monetary base through an open market operation of FIM 5 billion. The results are summarized in table 7.

Because of the induced capital outflow, the effect on the monetary base is, however, much smaller; only about 1.5 per cent of the increase in central bank credit ultimately shows up in the monetary base, whereas the rest of the shock is offset by a decrease in the foreign currency reserves of the central bank (fig. 1a). On the broad money level, the money multiplier process translates the increase in the monetary base into a FIM 585 million expansion in M3 in the period the money market intervention is implemented.

As a response to the increase in the money supply, the money market interest rate decreases immediately by 1.6 percentage points (fig. 1b). The effect on the tax-free long-term interest rate, which is the most important interest rate from the point of view of investment behaviour, is about half of this. In the later periods the interest rate effects gradually converge towards zero. During the first few years this is mainly due to increased economic - especially investment - activity, which increases the demand for money (fig. 1c). However, increased activity also results in a deeper current account deficit, which cumulatively decreases the money supply and over time nullifies the original expansive effect (fig. 1d).

All in all, monetary policy is neutral in the long run in the flexible interest rate regime. After about eight years, the GDP effect has vanished. Although prices also react in the medium term, the long-run neutrality of money does not result from price level adjustment, but rather from the leak of money abroad through the current account. This is, of course, a general result implied by the assumption of fixed exchange rates.

FIGURE 1. CENTRAL BANK CREDIT INCREASED BY FIM 5 BILLION. DIFFERENCES FROM BASELINE CASE

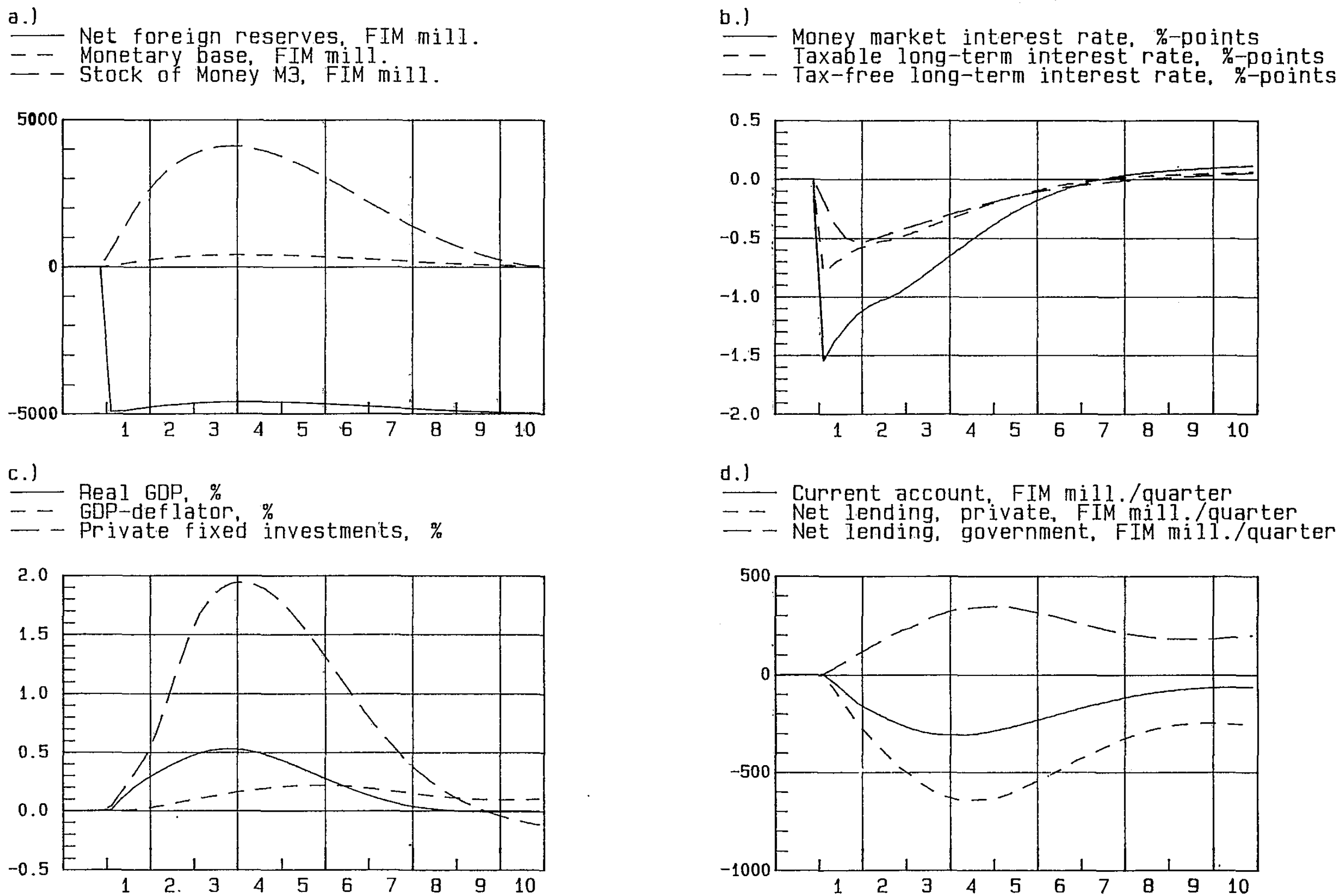


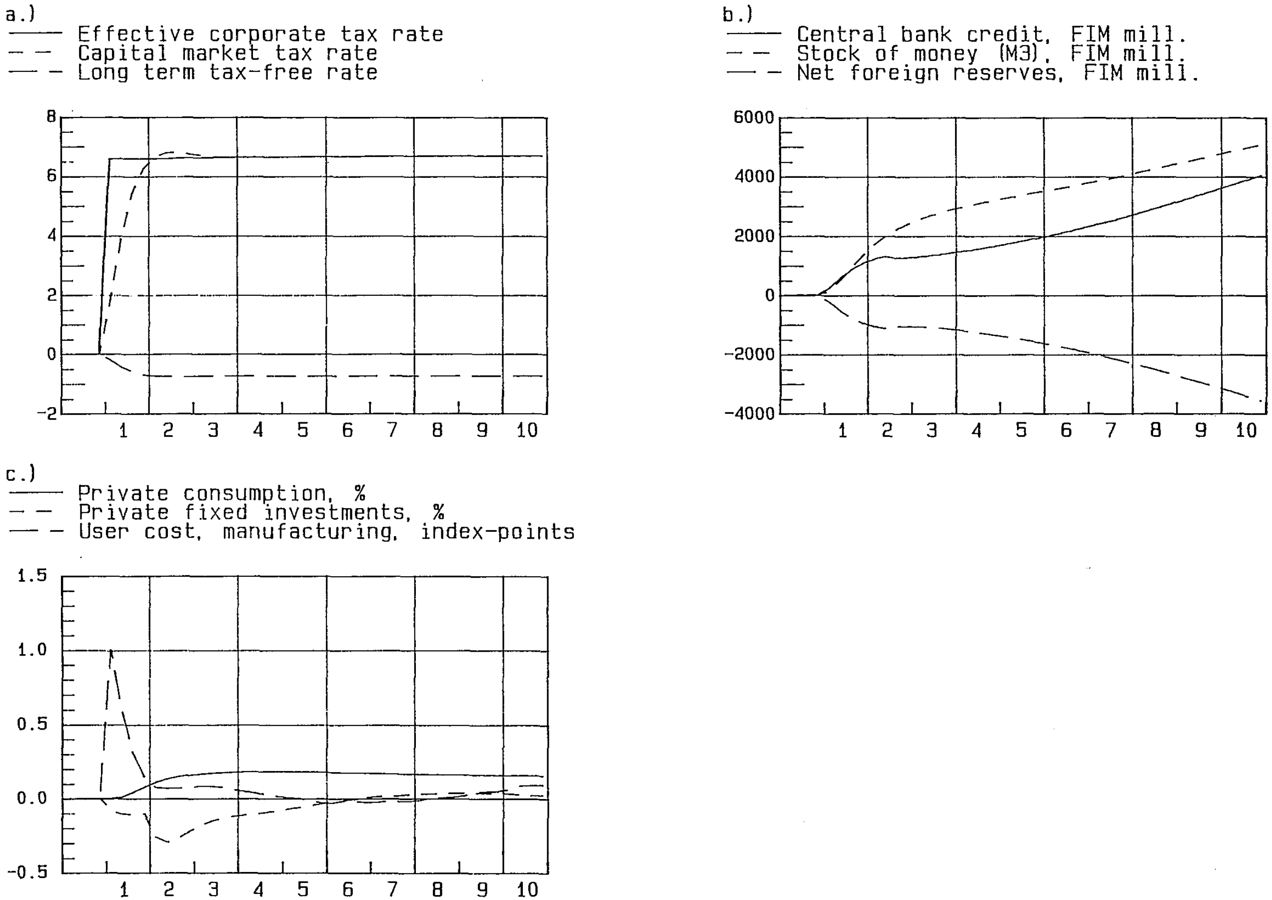
TABLE 7. SIMULATION RESULTS

Central bank credit increased by FIM 5 billion (corresponds to one per cent of GDP in year 1)

Difference from baseline case.

years	1	2	3	4	5	6	7
GDP, %	0.1	0.4	0.5	0.5	0.4	0.2	0.1
Imports, total, %	0.2	0.7	0.9	0.8	0.6	0.4	0.2
Exports, total, %	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2
Private consumption, %	0.2	0.5	0.7	0.7	0.6	0.5	0.3
Private fixed investment, %	0.3	1.1	1.8	1.8	1.5	1.0	0.5
Residential, %	0.6	1.4	1.7	1.7	1.2	0.7	0.4
Non-residential, %	0.2	1.1	1.8	1.9	1.6	1.1	0.6
Domestic demand, %	0.2	0.6	0.8	0.8	0.6	0.4	0.2
GDP deflator, %	0.0	0.1	0.1	0.2	0.2	0.2	0.2
Private consumption deflator, %	0.0	0.1	0.1	0.2	0.2	0.2	0.1
Wage rate, %	0.0	0.1	0.1	0.2	0.3	0.3	0.3
Actual hours worked, %	0.1	0.2	0.4	0.4	0.4	0.2	0.1
Employment, 1000 persons	0.5	3.3	6.5	8.5	8.5	6.8	4.3
Interest rates, percentage points							
Money market rate	-1.3	-1.0	-0.8	-0.5	-0.3	-0.1	0.0
Taxable bond rate	-0.7	-0.5	-0.4	-0.3	-0.1	-0.1	0.0
Tax-free bond rate	-0.4	-0.5	-0.4	-0.2	-0.1	-0.1	0.0
Bank lending rate (av. stock)	-0.2	-0.2	-0.3	-0.2	-0.2	-0.1	-0.1
Balance of payments							
Current account, FIM billion	-0.3	-0.9	-1.2	-1.2	-1.0	-0.8	-0.6
Private capital imports, FIM billion	-4.5	1.0	1.3	1.2	1.0	0.7	0.5
Foreign exhange reserves, FIM billion	-4.8	-4.6	-4.6	-4.6	-4.6	-4.7	-4.8
Central bank domestic credit, FIM billion	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Demand for money							
Monetary base, per cent	0.6	1.0	1.1	1.1	0.9	0.6	0.4
Broad money, per cent	1.0	1.5	1.6	1.4	1.1	0.8	0.5

FIGURE 2. CORPORATE TAX RATE INCREASED BY 10 PERCENTAGE POINTS; FIXED MONEY MARKET RATE. DIFFERENCES FROM BASELINE CASE



<u>Simulation 2</u>: Corporate tax rate increased by 10 percentage points in the pegged interest rate regime

In this simulation the overall effects on the real economic variables are small. From the point of view of understanding the implications of the Miller equilibrium the results are, however, interesting and illustrative.

The ten percentage point increase in the statutory corporate tax rate increases the effective corporate tax rate by about 7 percentage points (fig. 2a). This increase in the effective tax rate is further gradually transmitted transmitted to the capital market tax rate (the marginal investor's marginal tax rate) through a partial adjustment mechanism. The adjustment process is practically completed within a period of one year.

The spread between the interest rates on taxable and tax-free securities has to widen to preserve the equality of after-tax yields of the different domestic assets. However, as the money market interest rate is pegged in this experiment, the widening of the interest rate spread is possible only through a decrease in tax-free interest rates. In the present simulation the tax-free long-term interest rate decreases by about 0.7 percentage point.

An interesting result is that the increase in the corporate tax rate causes a capital outflow and a decrease in the stock of foreign reserves (fig. 2b). The reason is that the after-tax interest rate differential between domestic and foreign finance is decreased from the point of view of domestic borrowers. This discourages foreign borrowing and makes domestic finance relatively more competitive. The capital outflow is, however, financed by the central bank in the interest rate pegging regime, and it thus has no further repercussions in the domestic economy.

The real effects of the tax rate increase are modest (fig. 2c). The most important channel through which the effects of a change in the corporate tax rate are transmitted to the real economy is the user cost of fixed capital investments. The increase in the corporate tax rate should, ceteris paribus, raise the user cost and, hence, decrease investment. However, as the tax increase also causes the tax-free long-term interest rate to fall, one cannot, on a priori grounds, even be sure about the direction of the total effect of the increase in the corporate tax rate on the user cost of fixed capital.

In the present simulation user costs, e.g. in the manufacturing and private services sectors, rise by 5.9 and 7.3 per cent, respectively, during the period of implementation of the tax increase. During the following quarters, however, most of the user cost effect vanishes. This kind of time path follows from the slow adjustment of the tax-free long-term interest rate to the change in the corporate rate. Therefore at first the change in the corporate tax rate dominates the interest rate effect in the user cost. Later, the decrease in the tax-free long-term interest rate almost completely neutralizes the original tax effect on the user cost estimates.

As the fixed investments react to the changes in the user cost variables, there is a slight temporary decrease in non-residential fixed investments. There is also a small but permanent positive effect on private consumption. This results from the increased liquidity of households; the fall in the after-tax interest rates increases the demand for money, which the central bank has to finance so as to be able to peg the taxable money market rate.

<u>Simulation 3</u>: Corporate income tax rate increased by 10 percentage points in the flexible interest rate regime

In the flexible interest rate regime, the effects of a change in the corporate tax rate are stronger than in the pegged interest rate regime. This is due to the fact that the widening of the interest rate spread between the taxable and tax-free rates is now transmitted to both rates; the taxable rates increase and the tax-free rates decrease and, consequently, the tax-free bond rate decreases less than in the case of the pegged money market rate (fig. 3b). This weakens the interest rate effect, which in the previous experiment virtually neutralized the direct user cost effect of tighter corporate taxation.

The multiplier-accelerator process, which is set in motion by the increase in the user costs of capital, is strong enough to overcome the increase in the propensity to consume which dominated in the previous simulation and is also visible in the present case (fig. 3c).

In the case of flexible interest rates, the central bank does not accommodate demand for money through its open market operations. Thus, the increased demand for money is financed through an increase in the foreign component of the monetary base i.e. the net foreign reserves of the central bank (fig. 3d). This results from a positive current account effect, which is slightly greater than the capital outflow caused by the increased taxation in the Finnish capital market.

FIGURE 3. CORPORATE TAX RATE INCREASED BY 10 PERCENTAGE POINTS; FLEXIBLE MONEY MARKET RATE. DIFFERENCES FROM BASELINE CASE

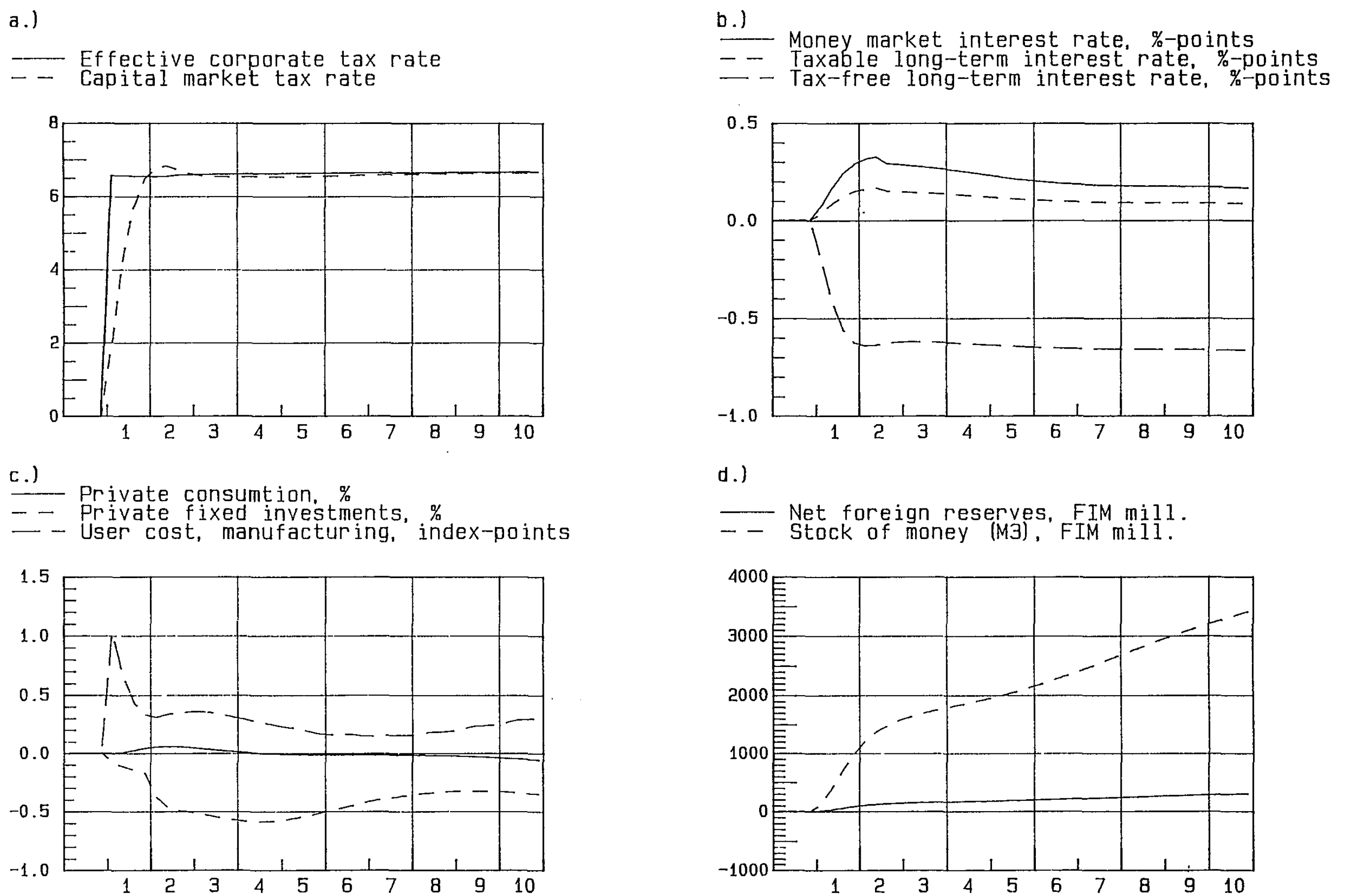


TABLE 8. SIMULATION RESULTS

Corporate tax rate increased by 10 percentage points.

Difference from baseline case.

years	1	2	3	4	5	6	7
GDP, %	0.0	-0.2	-0.4	-0.5	-0.5	-0.4	-0.4
Imports, total, %	-0.1	-0.3	-0.6	-0.7	-0.7	-0.6	-0.5
Exports, total, %	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2
Private consumption, %	0.0	0.0	-0.2	-0.3	-0.4	-0.4	-0.3
Private fixed investment, %	-0.2	-1.0	-1.8	-2.4	-2.5	-2.2	-1.8
Residential, %	-0.1	-0.5	-1.0	-1.2	-1.1	-0.8	-0.6
Non-residential, %	-0.3	-1.1	-2.0	-2.7	-3.0	-2.7	-2.2
Domestic demand, %	-0.1	-0.3	-0.5	-0.7	-0.7	-0.6	-0.5
GDP deflator, %	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1
Private consumption deflator, %	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1
Wage rate, %	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2
Actual hours worked, %	0.0	-0.1	-0.2	-0.4	-0.4	-0.4	-0.3
Employment, 1000 persons	-0.1	-1.2	-3.5	-6.1	-7.9	-8.4	-7.8
Interest rates, percentage points							
Money market rate	0.5	0.8	0.8	0.7	0.5	0.3	0.1
Taxable bond rate	0.2	0.4	0.4	0.4	0.2	0.1	0.1
Tax-free bond rate	-0.4	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9
Capital market tax rate, percentage points	4.6	6.1	5.8	5.7	5.8	5.9	6.0
Bank lending rate (av. stock)	0.1	0.2	0.2	0.2	0.2	0.2	0.1
Central government borrowing, net, FIM billion	-0.9	-0.8	-0.7	-0.6	-0.6	-0.8	-1.0
Balance of payments							
Current account, FIM billion	0.1	0.4	0.7	0.9	0.9	0.8	0.5
Private capital imports, FIM billion	0.0	-0.3	-0.7	-0.9	-0.9	-0.7	-0.5
Foreign exhange reserves, FIM billion	0.1	0.1	0.1	0.1	0.1	0.2	0.3
Central bank domestic credit, FIM billion	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Demand for money							
Monetary base, per cent	0.2	0.3	0.3	0.3	0.4	0.5	0.7
Broad money, per cent	0.4	0.5	0.5	0.6	0.7	1.0	1.2

APPENDIX 1

INSTITUTIONAL CHANGE AND THE MODELLING OF FINNISH FINANCIAL MARKETS

We believe that BOF4 is the first model of the Finnish economy in which the financial sector is constructed entirely in the mainstream tradition of macroeconomic modelling, assuming that market-clearing interest rates link the financial and real sectors of the economy. The reason for this lies in the institutional development of the Finnish financial markets.

Until recently, Finnish financial markets were dominated by banks and tightly regulated. An organized money market has emerged only in the 1980's, and the long-term capital market was also largely dormant prior to this decade, with the exception of a thin secondary market for tax-exempt government bonds.

As the interest rates applied by banks were traditionally regulated by either the central bank (on the lending side) or by cartel agreements (on the deposit side), data on market-determined interest rates have been virtually nonexistent. Furthermore, since interest rate regulation made credit rationing possible, economists were reluctant to use the controlled interest rates in financial modelling. For example, in BOF3, the predecessor of the present BOF4 model, the regulated bank lending rate was supplemented by a variable measuring excess demand for bank loans in the equations where market rates of interest would have been required. As an alternative to this approach, some researchers have used the Bank of Finland's call money rate as a measure of financial market conditions. However, this method may be criticized on the grounds that only banks had access to the call money market.

In the 1980's, a money market has emerged, at first in the form of special wholesale deposits with banks. Simultaneously, the forward currency market, which has been active since the beginning of 1970's, has grown rapidly and assumed many of the functions which money markets perform in other countries as firms have learned to use covered foreign assets as a subsitute for domestic money market instruments. In the course of 1980's the previously thin market for taxable corporate bonds (debentures) has become much more active.

The short history of organized money markets in Finland means that data on the money market rate of interest is available only for the 1980's. For 1960's and 1970's we have been forced to construct estimates for it. For the period 1972 - 1979, the market rate of interest is operationalized with the covered 3-month eurodollar rate, sometimes called the "euromarkka rate". This is computed on the basis of forward premiums on the US dollar quoted in the Finnish forward market. For the period 1961 - 1971, a proxy for the market rate has been constructed from the regulated bank lending rate and the estimate of excess demand for bank loans provided in Tarkka (1986). The construction of the proxy is based on the following regression for the period 72.1 - 83.4:

$$RS - RLB = \underset{(24.6)}{183.8} \cdot (RHO + RHO_{-1})$$

$$R^2 = 0.269 \qquad SE = 3.91 \qquad DW = 0.711$$

Here RS is the short-term money market rate, RLB is the average bank lending rate (both in per cent) and RHO is the estimate for the relative excess demand for bank loans from Tarkka's study. The regression equation provides a formula for computing RS for the period before the forward premium on USD became available.

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APPENDIX 1

LIST OF EQUATIONS

List of equations for the BOF4 quarterly model of the Finnish economy, August 1989 version.

Notation used:

Values of parameter estimates are ordinary least squares estimates.

Standard errors of parameter estimates are in parentheses below the coefficients.

When standard error is not shown, the parameter in question is fixed a priori e.g. on the basis of input-output studies.

Weights of Almon lags are denoted by a_i, b_i, etc.

Variables with a subscript are lagged. Subscripts refer to number of lags in quarters.

Δ	is the difference operator.
Δ^n	denotes difference over n quarters.
log	denotes natural logarithms.

Units:
Values are in millions of FIM.
Volumes are in millions of FIM at 1985 prices.
Price indices take the value 100 in 1985.
Interest rates are in per cent.
Energy is in 1000 toe.
Labour force figures are in 1000 persons.

$\bar{R}^2$	= corrected coefficient of determination
DW	= Durbin - Watson statistic
SE	= standard error of estimate
rho	= coefficient of first-order autocorrelation correction

The estimation period is given after the summary statistics

C. CONSUMPTION

C.1 Total Private Consumption, Volume

$$
\begin{aligned}
\log C = {} & \underset{(0.4034)}{3.05838} \\
& + \underset{(0.0668)}{0.35939} \cdot \Delta\log(YD/PCP) \\
& + \underset{(0.0817)}{0.60266} \cdot \log(YD_{-1}/PCP_{-1}) \\
& + \underset{(0.0849)}{0.36032} \cdot \log C_{-1} \\
& - \underset{(0.1476)}{0.40031} \cdot (\log(PCP/PCP_{-1}) - INFL/4) \\
& - \underset{(0.0430)}{0.05606} \cdot (RB_{-1}/100 - INFL) \\
& + \underset{(0.0333)}{0.08695} \cdot \log[(CUR_{-1} + KDP_{-1})/YD]
\end{aligned}
$$

where $INFL = 0.4 \cdot INF_{-1} + 0.3 \cdot INF_{-2} + 0.2 \cdot INF_{-3} + 0.1 \cdot INF_{-4}$

$\bar{R}^2 = 0.997$ DW = 2.127 SE = 0.0129 63.1 - 85.4

C	Total private consumption, millions of 1985 FIM
CUR	Currency in circulation, FIM million
INF	Expected inflation over four periods, per cent
KDP	Bank deposits by the public, FIM million
PCP	Private consumption prices, 1985 = 100
RB	Market yield on tax-free bonds, per cent
YD	Household disposable income, FIM million

C.2 Private Consumption, Serices, Volume

$$\log CS = -\underset{(0.1924)}{3.68074} + \underset{(0.0185)}{1.24514} \cdot \log C - \underset{(0.1989)}{0.36430} \cdot \log(PCS/PCP)$$

$\bar{R}^2 = 0.997$ RHO = 0.610 SE = 0.0187 61.1 - 85.4

C.3 Private Consumption, Durables, Volume

$$\log CD = -\underset{(0.7850)}{6.46462} + \underset{(0.0737)}{1.39808} \cdot \log C - \underset{(0.1894)}{1.19498} \cdot \log(PCD/PCP)$$

$\bar{R}^2 = 0.952$ DW = 1.538 SE = 0.1059 61.1 - 85.4

C.4 Private Consumption, Non-Durables and Semi-Durables, Volume

$$CND = C - CD - CS$$

C	Total private consumption, millions of 1985 FIM
CD	Private consumption, durables, millions of 1985 FIM
CND	Private consumption, non-durables and semi-durables, millions of 1985 FIM
CS	Private consumption, services, millions of 1985 FIM
PCD	Private consumption prices, durables, 1985 = 100
PCP	Private consumption prices, 1985 = 100
PCS	Private consumption prices, services, 1985 = 100

C.5 Total Public Consumption, Volume

$$CG = CCG + CLG$$

C.6 Total Consumption, Volume

$$CTOT = C + CG$$

C.7 Total Private Consumption, Value

$$CV = CSV + CDV + CNDV$$

C.8 Private Consumption, Services, Value

$$CSV = CS \cdot PCS/100$$

C.9 Private Consumption, Durables, Value

$$CDV = CD \cdot PCD/100$$

C.10 Private Consumption, Non-Durables and Semi-Durables, Value

$$CNDV = CND \cdot PCND/100$$

C	Total private consumption, millions of 1985 FIM
CCG	Central government consumption, millions of 1985 FIM
CD	Private consumption, durables, millions of 1985 FIM
CDV	Private consumption, durables, FIM million
CG	Total public consumption, millions of 1985 FIM
CLG	Local government consumption, millions of 1985 FIM
CND	Private consumption, non-durables and semi-durables, millions of 1985 FIM
CNDV	Private consumption, non-durables and semi-durables, FIM million
CS	Private consumption, services, millions of 1985 FIM
CSV	Private consumption, services, FIM million
CTOT	Total consumption, millions of 1985 FIM
CV	Total private consumption, FIM million
PCD	Private consumption prices, durables, 1985 = 100
PCND	Private consumption prices, non-durables and semi-durables, 1985 = 100
PCS	Private consumption prices, services, 1985 = 100

C.11 Central Government Consumption, Value

$$CCGV = CCG \cdot PCCG/100$$

C.12 Local Government Consumption, Value

$$CLGV = CLG \cdot PCLG/100$$

C.13 Total Public Consumption, Value

$$CGV = CCGV + CLGV$$

C.14 Total Consumption, Value

$$CTOTV = CV + CGV$$

CCG	Central government consumption, millions of 1985 FIM
CCGV	Central government consumption, FIM million
CGV	Total public consumption, FIM million
CLG	Local government consumption, millions of 1985 FIM
CLGV	Local government consumption, FIM million
CTOTV	Total consumption, FIM million
CV	Total private consumption, FIM million
PCCG	Central government consumption prices, 1985 = 100
PCLG	Local government consumption prices, 1985 = 100

I. INVESTMENT AND CAPITAL COSTS

I.1 Private Fixed Investment, Agriculture, Volume

$$
\begin{aligned}
IF1/KF1_{-1} - CCR1 = & - \underset{(0.0023)}{0.00367} \\
& + \underset{(0.0103)}{0.01216} \cdot (4 \cdot MPK1 \cdot PGDP1/PIF1) \\
& - \underset{(0.0047)}{0.00990} \cdot (UC1_{-4}/PIF1_{-4}) \\
& + \underset{(0.1093)}{0.48181} \cdot (IF1_{-1}/KF1_{-2} - CCR1_{-1}) \\
& + \underset{(0.0001)}{0.00020} \cdot (TREND + TREND74)
\end{aligned}
$$

where $MPK1 = 0.6826 \cdot (GDP1/KF1_{-1})^{1.0281}$

$\bar{R}^2 = 0.437$ DW = 2.043 SE = 0.0013 70.1 - 85.4

I.2 User Cost of Fixed Capital, Agriculture

$$
\begin{aligned}
UC1 = & PIF1 \cdot (RB/100 + 4 \cdot CCR1 - INF) \cdot \\
& ((1 - MTAX \cdot ALFA/(RB/100 + ALFA))/(1 - MTAX))
\end{aligned}
$$

ALFA	Tax Depreciation coefficient
CCR1	Capital consumption rate, agriculture
GDP1	Production at factor cost, agriculture, millions of 1985 FIM
IF1	Private fixed investment, agriculture, millions of 1985 FIM
INF	Expected inflation, per cent
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
MTAX	Personal marginal tax rate, estimate
PGDP1	Value added deflator in agriculture, 1985 = 100
PIF1	Fixed investment prices, agriculture, 1985 = 100
RB	Market yield on tax-free bonds, per cent
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TREND74	Breaking trend: 60.1 = 15, 60.2 = 14.75, ..., 74.4 = .25, zero thereafter
UC1	User cost of fixed capital, agriculture

I.3 Private Fixed Investment, Services, Volume

$$
\begin{aligned}
IF2/KF2_{-1} - CCR2 = &- \underset{(0.0011)}{0.00182} \\
&+ \underset{(0.0183)}{0.08283} \cdot (4 \cdot MPK2 \cdot PGDP2/PIF2) \\
&- \underset{(0.0050)}{0.01155} \cdot (UC2_{-4}/PIF2_{-4}) \\
&+ \underset{(0.0832)}{0.61308} \cdot (IF2_{-1}/KF2_{-2} - CCR2_{-1})
\end{aligned}
$$

where $MPK2 = 0.8513 \cdot e^{-0.0191 \cdot TREND} \cdot [(GDP2 - 0.049 \cdot KH_{-1}/4)/KF2_{-1}]^{1.6050}$

$\bar{R}^2 = 0.895$ DW = 2.204 SE = 0.0016 70.1 - 85.4

I.4 User Cost of Fixed Capital, Services

$$
UC2 = PIF2 \cdot (RB/100 + 4 \cdot CCR2 - INF) \cdot ((1 - (TYCR + TLGR) \cdot ALFA/(RB/100 + ALFA))/(1 - TYCR - TLGR))
$$

ALFA	Tax Depreciation coefficient
CCR2	Capital consumption rate, services
GDP2	Production at factor cost, services etc., millions of 1985 FIM
IF2	Private fixed investment, services etc., millions of 1985 FIM
INF	Expected inflation, per cent
KF2	Net stock of fixed capital, service etc., millions of 1985 FIM
KH	Net stock of private residential capital, net, millions of 1985 FIM
PGDP2	Value added deflator in services etc., 1985 = 100
PIF2	Fixed investment prices, services, 1985 = 100
RB	Market yield on tax-free bonds, per cent
TLGR	Average local government tax rate
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TYCR	Corporate tax rate in central government taxation
UC2	User cost of fixed capital, services etc.

I.5 Private Fixed Investment, Forestry, Volume

$$IF3/KF3_{-1} - CCR3 = \underset{(0.0005)}{-\ 0.00105}$$

$$+ \underset{(0.0019)}{0.00539} \cdot (4 \cdot MPK3 \cdot PGDP3 - UC3)/PIF3$$

$$+ \underset{(0.0429)}{0.86780} \cdot (IF3_{-1}/KF3_{-2} - CCR3_{-1})$$

where $MPK3 = 0.3303 \cdot (GDP3/KF3_{-1})^{0.6739} \cdot e^{0.0009 \cdot TREND}$

$\bar{R}^2 = 0.951$ DW = 2.698 SE = 0.0012 70.1 - 85.4

I.6 User Cost of Fixed Capital, Forestry

$$UC3 = PIF3 \cdot (RB/100 + 4 \cdot CCR3 - INF) \cdot ((1 - (TYCR + TLGR) \cdot ALFA/(RB/100 + ALFA))/(1 - TYCR - TLGR))$$

ALFA	Tax Depreciation coefficient
CCR3	Capital consumption rate, forestry
GDP3	Production at factor cost, forestry, millions of 1985 FIM
IF3	Private fixed investment, forestry, millions of 1985 FIM
INF	Expected inflation, per cent
KF3	Net stock of fixed capital, forestry, millions of 1985 FIM
PGDP3	Value added deflator in forestry, 1985 = 100
PIF3	Fixed investment prices, forestry, 1985 = 100
RB	Market yield on tax-free bonds, per cent
TLGR	Average local government tax rate
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TYCR	Corporate tax rate in central government taxation
UC3	User cost of fixed capital, forestry

I.7 Private Fixed Investment, Manufacturing, Volume

$$
\begin{aligned}
IF4/KF4_{-1} - CCR4 = {} & \underset{(0.0007)}{0.00081} \\
& + \underset{(0.0066)}{0.01428} \cdot (4 \cdot MPK4 \cdot PGDP4 - UC4)/PIF4 \\
& + \underset{(0.0107)}{0.03761} \cdot \Delta \log GDP4 \\
& + \underset{(0.1157)}{0.64340} \cdot (IF4_{-1}/KF4_{-2} - CCR4_{-1}) \\
& + \underset{(0.1123)}{0.24778} \cdot (IF4_{-2}/KF4_{-3} - CCR4_{-2})
\end{aligned}
$$

where $MPK4 = 0.4924 \cdot (GDP4/KF4_{-1})^{1.1429} \cdot e^{-0.0044 \cdot TREND}$

$\bar{R}^2 = 0.837$ DW = 1.454 SE = 0.0025 70.1 - 85.4

I.8 User Cost of Fixed Capital, Manufacturing

$$
\begin{aligned}
UC4 = {} & PIF4 \cdot (RB/100 + 4 \cdot CCR4 - INF) \cdot \\
& ((1 - (TYCR + TLGR) \cdot ALFA4/(RB/100 + ALFA4))/(1 - TYCR - \\
& TLGR))
\end{aligned}
$$

ALFA4	Tax depreciation coefficient, manufacturing
CCR4	Capital consumption rate, manufacturing
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
IF4	Private fixed investment, manufacturing, millions of 1985 FIM
INF	Expected inflation, per cent
KF4	Net stock of fixed capital, manufacturing, millions of 1985 FIM
PGDP4	Value added deflator in manufacturing, 1985 = 100
PIF4	Fixed investment prices, manufacturing, 1985 = 100
RB	Market yield on tax-free bonds, per cent
TLGR	Average local government tax rate
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TYCR	Corporate tax rate in central government taxation
UC4	User cost of fixed capital, manufacturing

I.9 Residential Construction, Volume

$$
\begin{aligned}
IH/KH_{-1} = {} & \underset{(0.0035)}{0.01550} \\
& + \underset{(0.0008)}{0.00311} \cdot (\log(PCP/PIH) + 1.844 \cdot \log C - 1.806 \cdot \log KH_{-1}) \\
& - \underset{(0.0047)}{0.00951} \cdot (RLB_{-1} \cdot (1-MTAX)/100 - INF) \\
& + \underset{(17.9641)}{66.51898} \cdot FCGH/(PIH \cdot KH_{-1}) \\
& - \underset{(0.0036)}{0.00365} \cdot (RS_{-1} - RLB_{-1})/100 \\
& + \underset{(0.0863)}{0.57309} + IH_{-1}/KH_{-1} \\
& + \underset{(0.0021)}{0.00530} \cdot DTR66
\end{aligned}
$$

$\bar{R}^2 = 0.851$ DW = 1.847 SE = 0.0010 64.1 - 85.4

DTR66	Dummy for tax exemption of rent income
C	Total private consumption, millions of 1985 FIM
FCGH	Central government housing loans, drawing, FIM million
IH	Residential construction, millions of 1985 FIM
INF	Expected inflation, per cent
KH	Net stock of private residential capital, net, millions of 1985 FIM
MTAX	Personal marginal tax rate, estimate
PCP	Private consumption prices, 1985 = 100
PIH	Residential construction prices, 1985 = 100
RLB	Bank lending rate, per cent
RS	Money market rate, per cent

I.10 Change in Inventories, Volume

$$
\begin{aligned}
II = & - \underset{(560.2019)}{1069.17233} \\
& - \underset{(0.0702)}{0.63583} \cdot \Delta SALE \\
& + \underset{(0.0399)}{0.10154} \cdot SALE_{-1} \\
& + \underset{(0.0003)}{0.00078} \cdot (100 \cdot (PMG_{-1} - PMG_{-5})/PMG_{-5} - RS_{-1}) \cdot SALE_{-1} \\
& + \underset{(0.0634)}{0.72461} \cdot II_{-1} \\
& - \underset{(0.0141)}{0.03185} \cdot KII_{-2}
\end{aligned}
$$

where $SALE = CTOT - CS + ITOT + XG - MG + STD - TIN - GDPG$

$\bar{R}^2 = 0.754$ DW = 2.390 SE = 670.7911 62.1 - 85.4

I.11 Private Non-Residential Investment, Volume

$IF = IF1 + IF2 + IF3 + IF4$

I.12 Private Fixed Investment, Volume

$I = IF + IH$

CS	Private consumption, services, millions of 1985 FIM
CTOT	Total consumption, millions of 1985 FIM
GDPG	Production at factor cost, general government, millions of 1985 FIM
I	Private fixed investment, millions of 1985 FIM
IF	Private non residential investment, millions of 1985 FIM
IF1	Private fixed investment, agriculture, millions of 1985 FIM
IF2	Private fixed investment, services etc., millions of 1985 FIM
IF3	Private fixed investment, forestry, millions of 1985 FIM
IF4	Private fixed investment, manufacturing, millions of 1985 FIM
IH	Residential construction, millions of 1985 FIM
II	Change in inventories, millions of 1985 FIM
ITOT	Total fixed investment, millions of 1985 FIM
KII	Stock of inventories, millions of 1985 FIM
MG	Imports of goods, total, millions of 1985 FIM
PMG	Import prices of goods, 1985 = 100
RS	Money market rate, per cent
STD	Statistical discrepancy, millions of 1985 FIM
TIN	Indirect taxes less subsidies, millions of 1985 FIM
XG	Exports of goods, millions of 1985 FIM

I.13 Total Public Investment, Volume

$$IG = ICG + ILG$$

I.14 Total Investment, Volume

$$ITOT = I + IG$$

I.15 Private Fixed Investment, Agriculture, Value

$$IFV1 = IF1 \cdot PIF1/100$$

I.16 Private Fixed Investment, Services, Value

$$IFV2 = IF2 \cdot PIF2/100$$

I.17 Private Fixed Investment, Forestry, Value

$$IFV3 = IF3 \cdot PIF3/100$$

I.18 Private Fixed Investment, Manufacturing, Value

$$IFV4 = IF4 \cdot PIF4/100$$

I	Private fixed investment, millions of 1985 FIM
ICG	Central government investment, millions of 1985 FIM
IF1	Private fixed investment, agriculture, millions of 1985 FIM
IF2	Private fixed investment, services etc., millions of 1985 FIM
IF3	Private fixed investment, forestry, millions of 1985 FIM
IF4	Private fixed investment, manufacturing, millions of 1985 FIM
IFV1	Private fixed investment, agriculture, FIM million
IFV2	Private fixed investment, services, FIM million
IFV3	Private fixed investment, forestry, FIM million
IFV4	Private fixed investment, manufacturing, FIM million
IG	Total public investment, millions of 1985 FIM
ILG	Local government investment, millions of 1985 FIM
ITOT	Total fixed investment, millions of 1985 FIM
PIF1	Fixed investment prices, agriculture, 1985 = 100
PIF2	Fixed investment prices, services, 1985 = 100
PIF3	Fixed investment prices, forestry, 1985 = 100
PIF4	Fixed investment prices, manufacturing, 1985 = 100

I.19 Residental Construction, Value

$$IHV = IH \cdot PIH/100$$

I.20 Private Non-Residential Investment, Value

$$IFV = IFV1 + IFV2 + IFV3 + IFV4$$

I.21 Private Fixed Investment, Value

$$IV = IFV + IHV$$

I.22 Total Public Investment, Value

$$IGV = ILGV + ICGV$$

I.23 Total Investment, Value

$$ITOTV = IV + IGV$$

I.24 Net Stock of Fixed Capital, Agriculture, Volume

$$KF1 = IF1 + (1 - CCR1) \cdot KF1_{-1}$$

CCR1	Capital consumption rate, agriculture
ICGV	Central government investment, FIM million
IF1	Private fixed investment, agriculture, millions of 1985 FIM
IFV	Private non-residential investment, FIM million
IFV1	Private fixed investment, agriculture, FIM million
IFV2	Private fixed investment, services, FIM million
IFV3	Private fixed investment, forestry, FIM million
IFV4	Private fixed investment, manufacturing, FIM million
IGV	Total public investment, FIM million
IH	Residential construction, millions of 1985 FIM
IHV	Residential construction, FIM million
ILGV	Local government investment, FIM million
ITOTV	Total fixed investment, FIM million
IV	Private fixed investment, FIM million
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
PIH	Residential construction prices, 1985 = 100

I.25 Net Stock of Fixed Capital, Services, Volume

$$KF2 = IF2 + (1 - CCR2) \cdot KF2_{-1}$$

I.26 Net Stock of Fixed Capital, Forestry, Volume

$$KF3 = IF3 + (1 - CCR3) \cdot KF3_{-1}$$

I.27 Net Stock of Fixed Capital, Manufacturing, Volume

$$KF4 = IF4 + (1 - CCR4) \cdot KF4_{-1}$$

I.28 Net Stock of Fixed Capital, Central Government, Volume

$$KFCG = ICG + (1 - CCRG) \cdot KFCG_{-1}$$

I.29 Net Stock of Fixed Capital, Local Government, Volume

$$KFLG = ILG + (1 - CCRG) \cdot KFLG_{-1}$$

I.30 Net Stock of Private Residential Capital, Volume

$$KH = IH + (1 - CCRH) \cdot KH_{-1}$$

CCR2	Capital consumption rate, services
CCR3	Capital consumption rate, forestry
CCR4	Capital consumption rate, manufacturing
CCRG	Capital consumption rate, general government
CCRH	Capital consumption rate, residential construction
ICG	Central government investment, millions of 1985 FIM
IF2	Private fixed investment, services etc., millions of 1985 FIM
IF3	Private fixed investment, forestry, millions of 1985 FIM
IF4	Private fixed investment, manufacturing, millions of 1985 FIM
IH	Residential construction, millions of 1985 FIM
ILG	Local government investment, millions of 1985 FIM
KF2	Net stock of fixed capital, service etc., millions of 1985 FIM
KF3	Net stock of fixed capital, forestry, millions of 1985 FIM
KF4	Net stock of fixed capital, manufacturing, millions of 1985 FIM
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
KH	Net stock of private residential capital, net, millions of 1985 FIM

I.31 Stock of Inventories, Volume

$$KII = II + KII_{-1}$$

I.32 Inventory Investment and Statistical Discrepancy, Volume

$$IIS = II + STD$$

I.33 Inventory Investment and Statistical Discrepancy, Value

$$IISV = GDPV + MV - CTOTV - ITOTV - XV$$

I.34 Consumption of Fixed Capital

$$CCTV = \underset{(0.00003)}{0.00948} \cdot PIF \cdot [CCR1 \cdot KF1_{-1} + CCR2 \cdot KF2_{-1} + CCR3 \cdot KF3_{-1}$$

$$+ CCR4 \cdot KF4_{-1} + CCRG \cdot (KFLG_{-1} + KFCG_{-1}) + CCRH \cdot KH_{-1}]$$

$\bar{R}^2 = 0.997$ RHO = 0.45 SE = 111.6741 61.1 - 85.4

CCR1	Capital consumption rate, agriculture
CCR2	Capital consumption rate, services
CCR3	Capital consumption rate, forestry
CCR4	Capital consumption rate, manufacturing
CCRG	Capital consumption rate, general government
CCRH	Capital consumption rate, residential construction
CCTV	Consumption of fixed capital, FIM million
CTOTV	Total consumption, FIM million
GDPV	GDP in Purchasers' Values, FIM million
II	Change in inventories, millions of 1985 FIM
IIS	Inventory investment and statistical discrepancy, millions of 1985 FIM
IISV	Inventory investment and statistical discrepancy, millions of FIM
ITOTV	Total fixed investment, FIM million
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
KF2	Net stock of fixed capital, service etc., millions of 1985 FIM
KF3	Net stock of fixed capital, forestry, millions of 1985 FIM
KF4	Net stock of fixed capital, manufacturing, millions of 1985 FIM
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
KII	Stock of inventories, millions of 1985 FIM
KH	Net stock of private residential capital, net, millions of 1985 FIM
MV	Imports of goods and services, FIM million
PIF	Private non-residential investment prices, 1985 = 100
STD	Statistical discrepancy, millions of 1985 FIM
XV	Exports of goods and services, FIM million

X. EXPORTS AND EXPORT PRICES

X.1 Exports of Goods, Multilateral, Volume

$$
\begin{aligned}
\Delta \log (XGW/MFOR) = & - \underset{(0.0135)}{0.01009} \\
& - \underset{(0.1181)}{0.48086} \cdot \Delta \log(XGW_{-1}/MFOR_{-1}) \\
& + \underset{(0.3979)}{1.35315} \cdot \log(PFXG/PXGW) \\
& - \underset{(0.3511)}{1.17166} \cdot \log(PFXG_{-2}/PXGW_{-2})
\end{aligned}
$$

$\bar{R}^2 = 0.266$ DW = 2.108 SE = 0.07031 70.1 - 85.4

(estimated with two-stage least squares)

MFOR	Imports of Finland's major export countries, 1985 = 100
PFXG	Index of competing foreign prices
PXGW	Export prices of goods, multilateral, 1985 = 100
XGW	Exports of goods, multilateral, millions of 1985 FIM

X.2 Exports of Goods, Bilateral, Volume

$$XGE = \underset{(0.0757)}{0.45142} \cdot \sum_{i=0}^{10} a_i \, (MGEV/(0.01 \cdot PXGE))_{-i}$$

$$+ \underset{(0.0826)}{0.51576} \cdot XGE_{-1}$$

lag i	0	1	2	3	4	5	6	7	8
weight a_i	0.17	0.15	0.14	0.12	0.11	0.09	0.08	0.06	0.05

lag i	9	10	$\sum$
weight a_i	0.03	0.02	1

$\bar{R}^2 = 0.937$ DW = 2.019 SE = 311.1023 64.1 - 85.4

X.3 Exports of Services, Volume

$$\Delta(\log XS - var1) = \underset{(0.5272)}{-1.06860} \cdot \Delta\log(P2_{-1}/PMC_{-1})$$

where $var1 = 0.418 \cdot \log(XG + MG) + 0.582 \cdot \log MFOR$

$\bar{R}^2 = 0.076$ DW = 1.905 SE = 0.10969 71.1 - 85.4

MFOR Imports of Finland's major export countries, 1985 = 100
MG Imports of goods, total, millions of 1985 FIM
MGEV Imports of goods, bilateral, FIM million
P2 Prices in services, 1985 = 100
PMC Import prices of consumer goods, 1985 = 100
PXGE Export prices of goods, bilateral, 1985 = 100
XG Exports of goods, millions of 1985 FIM
XGE Exports of goods, bilateral, millions of 1985 FIM
XS Exports of services, millions of 1985 FIM

X.4 Export Prices of Goods, Bilateral

$$\log(PXGE/P4) = \underset{(0.02759)}{-\,0.18544} + \underset{(0.05455)}{0.57920} \cdot var1 + \underset{(0.00128)}{0.00882} \cdot TREND$$

where $var1 = \log[(PXGE_{-1}/P4)\cdot(FXSUSD/FXSUSD_{-1})\cdot(FXSSUR/FXSSUR_{-1})]$

$\bar{R}^2 = 0.937$ DW = 2.056 SE = 0.0359 64.1 - 85.4

X.5 Export Prices of Goods, Multilateral

$$\begin{aligned}\Delta\log PXGW = {} & \underset{(0.00481)}{0.00006} \\ & + \underset{(0.1751)}{0.29595} \cdot \Delta\log SMCXG \\ & + \underset{(0.1611)}{0.60307} \cdot \Delta\log PFXG \\ & + \underset{(0.0620)}{0.10396} \cdot \log(SMCXG_{-1}/PXGW_{-1}) \\ & - \underset{(0.1002)}{0.20733} \cdot \Delta^2\log(PFXG_{-1}/PXGW_{-1}) \\ & + \underset{(0.0457)}{0.07804} \cdot \Delta\log(XGW_{-1}/MFOR_{-1}) \\ & + \underset{(0.0229)}{0.03902} \cdot \Delta\log(XGW_{-2}/MFOR_{-2}) \\ & - \underset{(0.0303)}{0.05964} \cdot \Delta\, D75 \\ & + \underset{(0.0325)}{0.07364} \cdot \Delta\, D75_{-1}\end{aligned}$$

$\bar{R}^2 = 0.491$ DW = 1.981 SE = 0.02313 70.1 - 85.4

D75	Dummy: 60.1 - 74.4 = 1, 75.1 → = 0
FXSSUR	Exchange rate, USD/SUR
FXSUSD	Exchange rate, FIM/USD
MFOR	Imports of Finland's major export countries, 1985 = 100
P4	Prices in manufacturing, 1985 = 100
PFXG	Index of competing foreign prices
PXGE	Export prices of goods, bilateral, 1985 = 100
PXGW	Export prices of goods, multilateral, 1985 = 100
SMCXG	Marginal costs in exports
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
XGW	Exports of goods, multilateral, FIM million

X.6 Marginal Costs in Exports

$$\begin{aligned} SMCXG = {} & 1.00866 \cdot (1 + TIRXG) \cdot \\ & 1.01434 \cdot (1 + TIR4) \cdot \\ & [.437 \cdot 102.83176 \cdot (1 + SOCCR4) \cdot YW4/ \\ & \quad [LH4 \cdot e^{.03063 \cdot TREND} \cdot \\ & \quad (.55349 \cdot (KF4/LH4)^{-.14291} + .44651)^{(-1/.14291 - 1)}] + \\ & .563 \cdot (.1654 \cdot P1 + .2745 \cdot P2 + .0997 \cdot P3 + \\ & \quad .2829 \cdot PMR + .1775 \cdot PMFL)] \end{aligned}$$

X.7 Indirect Tax Rate on Exports, Goods

$$\begin{aligned} TIRXG = {} & (1 - 0.9509 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.0771 \cdot \\ & 0.01 \cdot TSR \cdot D5863) - 1 \end{aligned}$$

X.8 Export Prices of Services

$$\Delta \log(PXS/PMS) = \underset{(0.09195)}{0.90721} \cdot \Delta \log(P2/PMS)$$

$\bar{R}^2 = 0.7392$ DW = 1.7781 SE = 0.1003 77.1 - 85.4

X.9 Exports of Goods, Multilateral, Value

$$XGWV = PXGW \cdot XGW/100$$

X.10 Exports of Goods, Bilateral, Value

$$XGEV = PXGE \cdot XGE/100$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, FIM million
LW4	Paid labour input, manufacturing, millions of 1985 FIM
MGV	Imports of goods, total, FIM million
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
PMS	Import prices of services, 1985 = 100
PXGE	Export prices of goods, bilateral, 1985 = 100
PXGW	Export prices of goods, multilateral, 1985 = 100
PXS	Export prices of services, 1985 = 100
SMCXG	Marginal costs in exports
SOCCR4	Employers' social security contribution rate, manufacturing
SUB	Subsidies, millions of 1985 FIM
TIR4	Indirect tax rate on production, manufacturing
TIRXG	Indirect tax rate on exports, goods
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TSR	Sales tax rate
XGE	Exports of goods, bilateral, millions of 1985 FIM
XGEV	Exports of goods, bilateral, FIM million
XGW	Exports of goods, multilateral, millions of 1985 FIM
XGWV	Exports of goods, multilateral, FIM million
YW4	Wages and salaries, manufacturing, millions of FIM

X.11 Exports of Goods, Volume

$$XG = XGW + XGE$$

X.12 Exports of Goods, Value

$$XGV = XGWV + XGEV$$

X.13 Exports of Services, Value

$$XSV = 0.01 \cdot PXS \cdot XS$$

X.14 Export Prices of Goods

$$PXG = 100 \cdot XGV/XG$$

X.15 Exports of Goods and Services, Volume

$$X = XG + XS$$

X.16 Exports of Goods and Services, Value

$$XV = XGV + XSV$$

PXG	Export prices of goods, 1985 = 100
PXS	Export prices of services, 1985 = 100
X	Exports of goods and services, millions of 1985 FIM
XG	Exports of goods, millions of 1985 FIM
XGE	Exports of goods, bilateral, millions of 1985 FIM
XGEV	Exports of goods, bilateral, FIM million
XGV	Exports of goods, FIM million
XGW	Exports of goods, multilateral, millions of 1985 FIM
XGWV	Exports of goods, multilateral, FIM million
XS	Exports of services, millions of 1985 FIM
XSV	Exports of services, FIM million
XV	Exports of goods and services, FIM million

M. IMPORTS

M.1 Imports of Raw Materials, Volume

$$
\begin{aligned}
\log MR = &+ \underset{(0.50838)}{0.16243} \\
&+ \underset{(0.07422)}{0.30548} \cdot \log MR_{-1} \\
&+ \underset{(0.05763)}{0.18540} \cdot \log MR_{-2} \\
&+ \underset{(0.32836)}{1.84867} \cdot \log GDPF \\
&- \underset{(0.32597)}{1.45062} \cdot \log GDPF_{-3} \\
&- \underset{(0.08576)}{0.68435} \cdot \log(PMR/P4) \\
&+ \underset{(0.10072)}{0.28035} \cdot \log(PMR_{-1}/P4_{-1}) \\
&+ \underset{(0.05431)}{0.29022} \cdot DS63 \\
&- \underset{(0.03947)}{0.29960} \cdot DFT69
\end{aligned}
$$

$\bar{R}^2 = 0.9854$ $DW = 1.8937$ $SE = 0.0616$ 62.1 - 85.4

DFT69	Dummy for revision of foreign trade statistics in 1969
DS63	Dummy for dock strike in 1963
GDPF	GDP at factor cost, millions of 1985 FIM
MR	Imports of raw materials, millions of 1985 FIM
P4	Prices in manufacturing, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100

M.2 Imports of Fuels and Lubricants, Volume

$$
\begin{aligned}
\Delta\log MFL = & + \underset{(0.8145)}{0.57025} \\
& - \underset{(0.1538)}{0.41318} \cdot \Delta\log MFL_{-1} \\
& - \underset{(0.1301)}{0.56142} \cdot \Delta\log MFL_{-2} \\
& - \underset{(0.2488)}{0.68779} \cdot [\log(MFL_{-1} + 0.9421 \cdot CEND_{-1}) - \log GDPF] \\
& - \underset{(0.1358)}{0.36092} \cdot \log(POIL_{-2}/PCP_{-2})
\end{aligned}
$$

where $POIL = (2.2052 \cdot PMFL + 100 \cdot (0.5494 \cdot TEBR + 0.4506 \cdot TEDR)) \cdot (100 + DTO \cdot TSR \cdot D5863)$

$\bar{R}^2 = 0.604$ DW = 1.859 SE = 0.12253 76.2 - 85.4

CEND	Domestic energy (incl. nuclear power) consumption, 1000 toe
D5863	Dummy replacing sales tax rate in 1958 - 1963
DTO	Dummy for removal of sales tax on fuels in 1974
GDPF	GDP at factor cost, millions of 1985 FIM
MFL	Imports of fuels and lubricants, millions of 1985 FIM
PCP	Private consumption prices, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
TEBR	Excise tax rate on petrol
TEDR	Excise tax rate on diesel oil
TSR	Sales tax rate

M.3 Imports of Investment Goods, Volume

$$
\begin{aligned}
\log MI = & - \underset{(0.47875)}{1.04731} \\
& + \underset{(0.09099)}{0.31301} \cdot \log MI_{-1} \\
& + \underset{(0.07221)}{0.17298} \cdot \log MI_{-2} \\
& + \underset{(0.10144)}{0.51928} \cdot \log ITOT \\
& - \underset{(0.12394)}{0.98158} \cdot \log(PMI/P4) \\
& + \underset{(0.15407)}{0.38932} \cdot \log(PMI_{-1}/P4_{-1}) \\
& + \underset{(0.07785)}{0.32788} \cdot DS63
\end{aligned}
$$

$\bar{R}^2 = 0.859$ DW = 2.0181 SE = 0.0879 63.1 - 85.4

DS63	Dummy for dock strike in 1963
ITOT	Total fixed investment, millions of 1985 FIM
MI	Imports of investment goods, millions of 1985 FIM
P4	Prices in manufacturing, 1985 = 100
PMI	Import prices of investment goods, 1985 = 100

M.4 Imports of Consumer Goods, Volume

$$\begin{aligned}
\log MC = & - \underset{(1.79027)}{4.23859} \\
& + \underset{(0.07988)}{0.23228} \cdot \log MC_{-1} \\
& + \underset{(0.16841)}{1.22264} \cdot \log(CTOT - CS - 0.82 \cdot CG) \\
& - \underset{(0.15444)}{0.47372} \cdot \log(100 + TSR \cdot D5863) \cdot PMC/PCP \\
& + \underset{(0.06084)}{0.36588} \cdot DS63 \\
& + \underset{(0.04362)}{0.15240} \cdot DFT69 \\
& - \underset{(0.01574)}{0.04631} \cdot DMCP
\end{aligned}$$

$\bar{R}^2 = 0.965$ DW = 1.899 SE = 0.0647 62.1 - 85.4

CG	Total public consumption, millions of 1985 FIM
CS	Private consumption, services, millions of 1985 FIM
CTOT	Total consumption, millions of 1985 FIM
D5863	Dummy replacing sales tax rate in 1958 - 1963
DFT69	Dummy for revision of foreign trade statistics in 1969
DMCP	Dummy for cash payment requirement for imports
DS63	Dummy for dock strike in 1968
MC	Imports of consumer goods, millions of 1985 FIM
PCP	Private consumption prices, 1985 = 100
PMC	Import prices of consumer goods, 1985 = 100
TSR	Sales tax rate

M.5 Imports of Services, Volume

$$\log MS = -\underset{(1.37160)}{6.36627}$$

$$+ \underset{(0.08460)}{0.24332} \cdot \log MS_{-1}$$

$$+ \underset{(0.16309)}{1.16111} \cdot (0.28 \cdot \log CS + 0.72 \cdot \log GDPF)$$

$$- \underset{(0.07526)}{0.63080} \cdot \log(PMS/PCS)$$

$\bar{R}^2 = 0.8496$ DW = 2.513   SE = 0.0655   77.1 - 85.4

M.6 Imports of Goods, Bilateral, Value

$$MGEV/MGEV_{-1} = \underset{(0.02939)}{0.76917} \cdot MFLV/MGEV_{-1}$$

$$+ \underset{(0.01071)}{0.04333} \cdot (MGV - MFLV)/MGEV_{-1}$$

$$+ \underset{(59.93944)}{557.85216} \cdot (MGV - MFLV)/((MG - MFL) \cdot MGEV_{-1})$$

$\bar{R}^2 = 0.6829$ DW = 1.1595   SE = 0.0899   62.1 - 85.4

CS	Private consumption, services, millions of 1985 FIM
GDPF	GDP at factor cost, millions of 1985 FIM
MFLV	Imports of fuels and lubricants, FIM million
MG	Imports of goods, total, millions of 1985 FIM
MGEV	Imports of goods, bilateral, FIM million
MGV	Imports of goods, total, FIM million
MFL	Imports of fuels and lubricants, millions of 1985 FIM
MFLV	Imports of fuels and lubricants, FIM million
MS	Imports of services, millions of 1985 FIM
PCS	Private consumption prices, services, 1985 = 100
PMC	Import prices of consumer goods, 1985 = 100

M.7 Imports of Raw Materials, Value

$$MRV = 0.01 \cdot PMR \cdot MR$$

M.8 Imports of Fuels and Lubricants, Value

$$MFLV = 0.01 \cdot PMFL \cdot MFL$$

M.9 Imports of Investment Goods, Value

$$MIV = 0.01 \cdot PMI \cdot MI$$

M.10 Imports of Consumer Goods, Value

$$MCV = 0.01 \cdot PMC \cdot MC$$

M.11 Imports of Services, Value

$$MSV = 0.01 \cdot PMS \cdot MS$$

M.12 Imports of Goods, Total, Volume

$$MG = MR + MFL + MC + MI$$

MC	Imports of consumer goods, millions of 1985 FIM
MCV	Imports of consumer goods, FIM million
MFL	Imports of fuels and lubricants, millions of 1985 FIM
MFLV	Imports of fuels and lubricants, FIM million
MG	Imports of goods, total, millions of 1985 FIM
MI	Imports of investment goods, millions of 1985 FIM
MIV	Imports of investment goods, FIM million
MR	Imports of raw materials, millions of 1985 FIM
MRV	Imports of raw materials, FIM million
MS	Imports of services, millions of 1985 FIM
MSV	Imports of services, FIM million
PMC	Import prices of consumer goods, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMI	Import prices of investment goods, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
PMS	Import prices of services, 1985 = 100

M.13 Imports of Goods, Total, Value

$$MGV = MRV + MFLV + MCV + MIV$$

M.14 Import Prices of Goods

$$PMG = 100 \cdot MGV/MG$$

M.15 Imports of Goods and Services, Volume

$$M = MG + MS$$

M.16 Imports of Goods and Services, Value

$$MV = MGV + MSV$$

M	Imports of goods and services, millions of 1985 FIM
MCV	Imports of consumer goods, FIM million
MFLV	Imports of fuels and lubricants, FIM million
MG	Imports of goods, total, millions of 1985 FIM
MGV	Imports of goods, total, FIM million
MIV	Imports of investment goods, FIM million
MRV	Imports of raw materials, FIM million
MS	Imports of services, millions of 1985 FIM
MSV	Imports of services, FIM million
MV	Imports of goods and services, FIM million
PMG	Import prices of goods, 1985 = 100

Q. PRODUCTION

Q.1 - Q.5 Production at Factor Cost by Sectors

	ΔCD	ΔCND	ΔCS	ΔCG-ΔGDPG	ΔIF+ΔIG	ΔIH	ΔXG	ΔXS	ΔMC	ΔMS	ΔMI	ΔMR+ΔMFL	ΔIIS
ΔGDP1	+.0507	+.0698	+.0224	+.0465	+.0281	+.0214	+.0971	+.0214	-.0773	-.0224	-.0311	-.0996	+.1134 (0.02173)
ΔGDP2	+.3844	+.3341	+.7517	+.4977	+.6522	+.7380	+.1898	+.7380	-.4937	-.7517	-.7224	-.2497	+.3275 (0.03804)
ΔGDP3	+.0515	+.0563	+.0233	+.0546	+.0365	+.02220	+.0897	+.02220	-.0708	-.0233	-.0404	-.0898	+.1278 (0.01919)
ΔGDP4	+.3827	+.3281	+.1609	+.3345	+.2062	+.1544	+.6614	+.1544	-.4529	-.1609	-.2284	-.5663	+.3841 (0.03774)
ΔTIN	+.1307	+.2117	+.0417	+.0667	+.0770	+.0640	-.0380	+.0640	+.0947	-.0417	+.0223	+.0054	+.0439 (0.02215)

	R^2	DW	SE	period
GDP1 Production at Factor Cost, Agriculture, Volume	0.2246	2.888	240.2729	62.1 - 85.4
GDP2 Production at Factor Cost, Services etc., Volume	0.4382	2.811	420.6088	62.1 - 85.4
GDP3 Production at Factor Cost, Forestry, Volume	0.3219	2.489	212.1714	62.1 - 85.4
GDP4 Production at Factor Cost, Manufacturing, Volume	0.5216	3.1411	417.2685	62.1 - 85.4
TIN Indirect Taxes Less Subsidies, Volume	0.0392	2.996	244.9243	62.1 - 85.4

CD	Private consumption, durables, millions of 1985 FIM
CG	Total public consumption, millions of 1985 FIM
CND	Private consumption, non-durables and semi-durables, millions of 1985 FIM
CS	Private consumption, services, millions of 1985 FIM
GDPG	Production at factor cost, general government, millions of 1985 FIM
IF	Private non residential investment, millions of 1985 FIM
IG	Total public investment, millions of 1985 FIM
IH	Residential construction, millions of 1985 FIM
IIS	Inventory investment and statistical discrepancy
MC	Imports of consumer goods, millions of 1985 FIM
MFL	Imports of fuels and lubricants, millions of 1985 FIM
MI	Imports of investment goods, millions of 1985 FIM
MR	Imports of raw materials, millions of 1985 FIM
MS	Imports of services, millions of 1985 FIM
XG	Exports of goods, millions of 1985 FIM
XS	Exports of services, millions of 1985 FIM

Q.6 Production at Factor Cost, General Government, Volume

$$\Delta GDPG = \underset{(0.02210)}{0.66225} \cdot \Delta CG$$

Q.7 Gross Domestic Product at Factor Cost, Volume

$$GDPF = GDP1 + GDP2 + GDP3 + GDP4 + GDPG$$

Q.8 Production at Factor Cost, Agriculture, Value

$$GDPV1 = GDP1 \cdot PGDP1/100$$

Q.9 Production at Factor Cost, Services etc., Value

$$GDPV2 = GDP2 \cdot PGDP2/100$$

Q.10 Production at Factor Cost, Forestry, Value

$$GDPV3 = GDP3 \cdot PGDP3/100$$

Q.11 Production at Factor Cost, Manufacturing, Value

$$GDPV4 = GDP4 \cdot PGDP4/100$$

CG	Total public consumption, millions of 1985 FIM
GDP1	Production at factor cost, agriculture, millions of 1985 FIM
GDP2	Production at factor cost, services etc., millions of 1985 FIM
GDP3	Production at factor cost, forestry, millions of 1985 FIM
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
GDPF	GDP at factor cost, millions of 1985 FIM
GDPG	Production at factor cost, general government, millions of 1985 FIM
GDPV	GDP in Purchasers' Values, FIM million
GDPV1	Production at factor cost, agriculture, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
PGDP1	Value added deflator in agriculture, 1985 = 100
PGDP2	Value added deflator in services etc., 1985 = 100
PGDP3	Value added deflator in forestry, 1985 = 100
PGDP4	Value added deflator in manufacturing, 1985 = 100

Q.12 Production at Factor Cost, General Government, Value

$$GDPVG = GDPG \cdot PGDPG/100$$

Q.13 Gross Domestic Product at Factor Cost, Value

$$GDPFV = GDPV1 + GDPV2 + GDPV3 + GDPV4 + GDPVG$$

Q.14 Gross Domestic Product in Purchasers' Values, Volume

$$GDP = GDPF + TIN$$

Q.15 Gross Domestic Product in Purchasers' Values, Value

$$GDPV = GDPFV + TIV - SUB$$

GDP	GDP in Purchasers' Values, millions of 1985 FIM
GDPF	GDP at factor cost, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPG	Production at factor cost, general government, millions of 1985 FIM
GDPV1	Production at factor cost, agriculture, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
GDPVG	Production at factor cost, FIM million
PGDPG	Value added deflator in general government, 1985 = 100
SUB	Subsidies, millions of 1985 FIM
TIN	Indirect taxes less subsidies, millions of 1985 FIM
TIV	Central government revenue from commodity taxes, FIM million

L. EMPLOYMENT

L.1 Performed Working Hours, Agriculture

$$\Delta \log LH1 = \underset{(0.0073)}{-\ 0.00817} \underset{(0.0868)}{+\ 0.10695} \cdot \Delta \log GDP1 \underset{(0.0638)}{-\ 0.06912} \cdot \log(GDP1T_{-1}/GDP1_{-1})$$

where $GDP1T = 0.4242 \cdot (0.6663 \cdot KF1^{-.0281} + 0.3337\ LH1^{-0.0281})^{35.6}$

$\bar{R}^2 = 0.000$ DW = 2.334 SE = 0.07112 62.1 - 85.4

L.2 Performed Working Hours, Services etc.

$$\Delta \log LH2 = \underset{(0.0057)}{0.01131} \underset{(0.0783)}{-\ 0.20657} \cdot \Delta \log LH2_{-1} \underset{(0.1760)}{+\ 0.44686} \cdot \Delta \log(GDP2 - 0.04885 \cdot KH/4) \underset{(0.0677)}{-\ 0.15057} \cdot \log(GDP2T_{-1}/GDP2_{-1} - 0.04885KH_{-1}/4) \underset{(0.0071)}{-\ 0.02853DQ1} \underset{(0.0070)}{-\ 0.05755DQ2}$$

where $GDP2T = 1.07269 \cdot e^{0.0316 \cdot TREND} \cdot (0.88821 \cdot KF2^{-0.605} + 0.1118 \cdot LH2^{-0.605})^{-1.65}$

$\bar{R}^2 = 0.506$ DW = 2.155 SE = 0.02739 62.1 - 85.4

GDP1	Production at factor cost, agriculture, millions of 1985 FIM
GDP2	Production at factor cost, services etc., millions of 1985 FIM
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
KF2	Net stock of fixed capital, service etc., millions of 1985 FIM
KH	Net stock of private residential capital, net, millions of 1985 FIM
LH1	Performed working hours, agriculture, millions of hours
LH2	Performed working hours, services etc., millions of hours
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
DQ1	Seasonal dummy, the first quarter
DQ2	Seasonal dummy, the second quarter

L.3 Performed Working Hours, Forestry

$$
\begin{aligned}
\Delta\log LH3 = & - \underset{(0.0083)}{0.01816} \\
& - \underset{(0.0838)}{0.30126} \cdot \Delta\log LH3_{-1} \\
& + \underset{(0.0930)}{0.56133} \cdot \Delta\log GDP3 \\
& - \underset{(0.0901)}{0.20716} \cdot \log(GDP3T_{-1}/GDP3_{-1})
\end{aligned}
$$

where $GDP3T = 9.04218 \cdot e^{0.00285 \cdot TREND} \cdot (0.161 \cdot KF3^{0.326} + 0.839 \cdot LH3^{0.326})^{3.07}$

$\bar{R}^2 = 0.340$ DW = 2.310 SE = 0.08015 62.1 - 85.4

GDP3	Production at factor cost, forestry, millions of 1985 FIM
KF3	Net stock of fixed capital, forestry, millions of 1985 FIM
LH3	Performed working hours, forestry, millions of hours
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.

L.4 Performed Working Hours, Manufacturing

$$
\begin{aligned}
\Delta \log LH4 = & - \underset{(0.0024)}{0.00572} \\
& + \underset{(0.0643)}{0.15119} \cdot \Delta \log LH4_{-1} \\
& + \underset{(0.0821)}{0.44859} \cdot \Delta \log GDP4 \\
& - \underset{(0.0539)}{0.13498} \cdot \log(GDP4T_{-1}/GDP4_{-1}) \\
& - \underset{(0.0210)}{0.20787} \cdot \Delta D75 \\
& + \underset{(0.0262)}{0.21837} \cdot \Delta D75_{-1}
\end{aligned}
$$

where $GDP4T = 2.2685 \cdot e^{0.0306 \cdot TREND} \cdot (0.553 \cdot KF4^{-0.143} + 0.447 \cdot LH4^{-0.143})^{-6.997}$

$\bar{R}^2 = 0.721$ DW = 2.347 SE = 0.0207 62.1 - 85.4

GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
KF4	Net stock of fixed capital, manufacturing, millions of 1985 FIM
LH4	Performed working hours, manufacturing, millions of hours
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
D75	Dummy 60.1 - 74.4 = 1, 75.1 - 85.4 = 0

L.5 Performed Working Hours, General Government

$$\Delta \log LHG = + \underset{(0.0127)}{0.00267} - \underset{(0.1035)}{0.76273} \cdot \log(GDPGT_{-1}/GDPG_{-1})$$

where $GDPGT = 0.80682 \cdot e^{0.0071 \cdot TREND} \cdot (0.986 \cdot (KFCG + KFLG)^{-0.978} + 0.014 \cdot LHG^{-0.978})^{-1.022}$

$\bar{R}^2 = 0.359$ DW = 1.916 SE = 0.12424 62.1 - 85.4

L.6 Paid Labour Input, Argiculture

$$\Delta \log LW1 = + \underset{(0.00182)}{0.00093} + \underset{(0.09196)}{0.73582} \cdot \Delta \log LW1_{-1} + \underset{(0.03987)}{0.80796} \cdot \Delta \log LH1 - \underset{(0.07661)}{0.72775} \cdot \Delta \log LH1_{-1}$$

$\bar{R}^2 = 0.930$ DW = 1.437 SE = 0.0113 76.1 - 85.4

GDPG	Production at factor cost, general government, millions of 1985 FIM
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
LH1	Performed working hours, agriculture, millions of hours
LHG	Performed working hours, general government, millions of hours
LW1	Paid labour input, agriculture, millions of 1985 FIM
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.

L.7 Paid Labour Input, Services etc.

$$\Delta \log LW2 = \underset{(0.00102)}{+\ 0.00118}$$

$$\underset{(0.11294)}{+\ 0.67917} \cdot \Delta \log LW2_{-1}$$

$$\underset{(0.02964)}{+\ 0.95488} \cdot \Delta \log LH2$$

$$\underset{(0.10979)}{-\ 0.70972} \cdot \Delta \log LH2_{-1}$$

$\bar{R}^2 = 0.970$ DW = 0.527 SE = 0.0061 76.1 - 85.4

L.8 Paid Labour Input, Forestry

$$\Delta \log LW3 = \underset{(0.00201)}{-\ 0.00166}$$

$$\underset{(0.10022)}{+\ 0.79961} \cdot \Delta \log LW3_{-1}$$

$$\underset{(0.02836)}{+\ 0.98501} \cdot \Delta \log LH3$$

$$\underset{(0.10031)}{-\ 0.80135} \cdot \Delta \log LH3_{-1}$$

$\bar{R}^2 = 0.976$ DW = 0.452 SE = 0.0123 76.1 - 85.4

LH2	Performed working hours, services etc., millions of hours
LH3	Performed working hours, forestry, millions of hours
LW2	Paid labour input, services etc., millions of 1985 FIM
LW3	Paid labour input, forestry, millions of 1985 FIM

L.9 Paid Labour Input, Manufacturing

$$\Delta\log LW4 = \underset{(0.00195)}{-\,0.00084} + \underset{(0.14376)}{0.39085} \cdot \Delta\log LW4_{-1} + \underset{(0.07261)}{0.74732} \cdot \Delta\log LH4 - \underset{(0.11698)}{0.47563} \cdot \Delta\log LH4_{-1}$$

$\bar{R}^2 = 0.742$ DW = 0.818 SE = 0.0123 76.1 - 85.4

L.10 Paid Labour Input, General Government

$$\log LWG = \underset{(0.28325)}{+\,3.67023} + \underset{(0.05632)}{1.05517} \cdot \log LHG$$

$\bar{R}^2 = 0.900$ DW = 1.476 SE = 0.0347 76.1 - 85.4

LH4	Performed working hours, manufacturing, millions of hours
LHG	Performed working hours, general government, millions of hours
LW4	Paid labour input, manufacturing, millions of 1985 FIM
LWG	Paid labour input, general government, millions of 1985 FIM

L.11 Employment (SNA)

$$LE = +\underset{(89.22924)}{273.611124} + \underset{(0.03744)}{0.84219} \cdot LES$$

$\bar{R}^2 = 0.998$ RHO = 0.980 SE = 3.1261 76.1 - 85.4

L.12 Employment (Labour Force Survey)

$$\Delta \log LES = \underset{(0.02786)}{0.05141} + \underset{(0.04247)}{0.07800} \cdot \log(LH_{-1}/LES_{-1}) + \underset{(0.03588)}{0.14397} \cdot \Delta \log LH + \underset{(0.04364)}{0.13635} \cdot \Delta \log LH_{-1} + \underset{(0.03963)}{0.15048} \cdot \Delta \log LH_{-2} + \underset{(0.03558)}{0.18175} \cdot \Delta \log LH_{-3} + \underset{(0.03499)}{0.07713} \cdot \Delta \log LH_{-4} + \underset{(0.00033)}{0.00067} \cdot TREND$$

$\bar{R}^2 = 0.3007$ DW = 1.7749 SE = 0.0048 62.1 - 85.4

LE	Employment (SNA), 1000 persons
LES	Employment (Labour Force Survey), 1000 persons
LH	Performed working hours total, millions of hours
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.

L.13 Labour Force (Labour Force Survey)

$$\Delta\log(LFS/N) = \underset{(0.00030)}{+\ 0.00026}\ (+\ .0003) \underset{(0.04672)}{+\ 0.64817} \cdot \Delta\log(LES/N) \underset{(0.00336)}{+\ 0.00520} \cdot \Delta\log((1 - MTAX) \cdot WR/PCP) \underset{(0.01609)}{-\ 0.03026} \cdot \Delta\log(C/N)$$

$\bar{R}^2 = 0.6871$ DW = 2.0315 SE = 0.0027 63.1 - 85.4

L.14 Performed Working Hours, Total

$$LH = LH1 + LH2 + LH3 + LH4 + LHG$$

L.15 Paid Labour Input, Total

$$LW = LW1 + LW2 + LW3 + LW4 + LWG$$

L.16 Unemployment (Labour Force Survey)

$$LUS = LFS - LES$$

L.17 Unemployment Rate (Labour Force Survey)

$$UR = 100 \cdot LUS/LFS$$

C	Total private consumption, millions of 1985 FIM
LES	Employment (Labour Force Survey), 1000 persons
LFS	Labour force (Labour Force Survey), 1000 persons
LH	Performed working hours total, millions of hours
LH1	Performed working hours, agriculture, millions of hours
LH2	Performed working hours, services etc., millions of hours
LH3	Performed working hours, forestry, millions of hours
LH4	Performed working hours, manufacturing, millions of hours
LHG	Performed working hours, general government, millions of hours
LUS	Unemployment (Labour Force Survey), 1000 persons
LW	Paid labour input, total, millions of 1985 FIM
LW1	Paid labour input, agriculture, millions of 1985 FIM
LW2	Paid labour input, services etc., millions of 1985 FIM
LW3	Paid labour input, forestry, millions of 1985 FIM
LW4	Paid labour input, manufacturing, millions of 1985 FIM
LWG	Paid labour input, general government, millions of 1985 FIM
MTAX	Personal marginal tax rate, estimate
N	Population of working age (15-74 years), 1000 persons
PCP	Private consumption prices, 1985 = 100
UR	Unemployment rate, per cent
WR	Wage rate, total, 1985 = 100

W. WAGES

W.1 Wage Rate, Agriculture

$$\begin{aligned}\Delta\log(WR1/WNRP) = & - \underset{(0.0033)}{0.00018} \\ & + \underset{(0.1620)}{1.05674} \cdot \Delta\log(WR4/WNRP) \\ & + \underset{(0.0391)}{0.11443} \cdot \log(WR4_{-1}/WR1_{-1}) \\ & - \underset{(0.0017)}{0.00447} \cdot TREND74\end{aligned}$$

$\bar{R}^2 = 0.404$ DW = 2.478 SE = 0.0201 65.1 - 85.4

WNRP	Negotiated wage rate, private sector, 1985 = 100
WR1	Wage rate, agriculture, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
TREND74	Linear trend: 60.1 = 15, 60.2 = 14.75, ..., 74.4 = .25, zero thereafter

W.2 Wage Rate, Services etc.

$$\begin{aligned}\Delta\log(WR2/WNRP) = &+ \underset{(0.0033)}{0.01289}\\ &+ \underset{(0.0627)}{0.34396} \cdot \log(WR4_{-1}/WR2_{-1})\\ &- \underset{(0.0073)}{0.01338} \cdot \Delta^2\log UR\\ &- \underset{(0.0028)}{0.0083} \cdot \log UR_{-2}\end{aligned}$$

$\bar{R}^2 = 0.264$ DW = 2.092 SE = 0.01197 65.1 - 85.4

W.3 Wage Rate, Forestry

$$\begin{aligned}\Delta\log(WR3/WNRP) = &+ \underset{(0.0086)}{0.02949}\\ &+ \underset{(0.3436)}{0.74445} \cdot \Delta\log(WR4/WNRP)\\ &+ \underset{(0.0961)}{0.50486} \cdot \log(WR4_{-1}/WR3_{-1})\\ &- \underset{(0.0029)}{0.01234} \cdot TREND74\end{aligned}$$

$\bar{R}^2 = 0.292$ DW = 2.139 SE = 0.04262 65.1 - 85.4

WNRP	Negotiated wage rate, private sector, 1985 = 100
WR2	Wage rate, services and other, 1985 = 100
WR3	Wage rate, forestry, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
TREND74	Linear trend: 60.1 = 15, 60.2 = 14.75, ..., 74.4 = .25, zero thereafter
UR	Unemployment rate, per cent

W.4 Wage Rate, Manufacturing

$$
\begin{aligned}
\Delta\log(WR4/WNRP) = &- \underset{(0.0631)}{0.24900} \\
&- \underset{(0.0589)}{0.61823} \cdot D75 \cdot \Delta\log WNRP \\
&- \underset{(0.0029)}{0.01019} \cdot \log UR_{-4} \\
&+ \underset{(0.0491)}{0.19045} \cdot \Delta\log(PGDP4/(1 + SOCCR4)) \\
&+ \underset{(0.0141)}{0.05823} \cdot var1 \\
&+ \underset{(0.0029)}{0.01377} \cdot D75 \\
&- \underset{(0.0023)}{0.00450} \cdot DQ1 \\
&- \underset{(0.0023)}{0.00520} \cdot DQ3
\end{aligned}
$$

where $var1 = \log(PGDP4_{-1}/(WR4_{-1} \cdot (1 + SOCCR4_{-1}))) + (1/.87496) \cdot \log(GDP4_{-1}/LH4_{-1}) - 0.004377 \cdot TREND$

$\bar{R}^2 = 0.618$ DW = 2.110 SE = 0.0085 65.1 - 85.4

GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
LH4	Performed working hours, manufacturing, millions of hours
PGDP4	Value added deflator in manufacturing, 1985 = 100
SOCCR4	Employers' social security contribution rate, manufacturing
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
UR	Unemployment rate, per cent
WNRP	Negotiated wage rate, private sector, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
D75	Dummy: 60.1 - 74.4 = 1, 75.1 - = 0
DQ1	Seasonal dummy, the first quarter
DQ3	Seasonal dummy, the third quarter

W.5 Wage Rate, Central and Local Government

$$\Delta \log(WRG/WNRP) = \underset{(0.0052)}{+\,0.01575}$$

$$+ \underset{(0.0898)}{0.23479} \cdot \Delta \log(WR_{-4}/WNRP_{-4})$$

$$+ \underset{(0.0169)}{0.03686} \cdot \log(WR4_{-1}/WRG_{-1})$$

$$- \underset{(0.0032)}{0.00714} \cdot \log UR$$

$\bar{R}^2 = 0.120$ DW = 1.896 SE = 0.0112 65.1 - 85.4

UR	Unemployment rate, per cent
WNRP	Negotiated wage rate, private sector, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
WRG	Wage rate, general government, 1985 = 100

W.6 Negotiated Wage Rate

$$\Delta^4 \log WNRP = \underset{(0.0047)}{+\ 0.00575}$$

$$\underset{(0.0750)}{+\ 0.41236} \cdot \Delta^4 \log(WNRP_{-1})$$

$$\underset{(0.0642)}{+\ 0.39346} \cdot INF$$

$$\underset{(0.1463)}{-\ 0.73575} \cdot \Delta^4[\log(1-ATAX) - .41 \cdot \log(1-ATAX_{-1})]$$

$\bar{R}^2 = 0.765$ DW = 1.907 SE = 0.0134 66.1 - 85.4

W.7 Expected inflation

$$INF = \underset{(0.01150)}{+\ 0.00217}$$

$$\underset{(0.03116)}{+\ 0.83559} \cdot \Delta^4 \log(PCP)$$

$$\underset{(0.07353)}{+\ 0.23150} \cdot \log(PFXG/P4)$$

Regressand INF in estimation was log (PCP_{+4}/PCP)

$\bar{R}^2 = 0.557$ DW = 0.3711 SE = 0.0276 69.1 - 85.4

W.8 Wage Rate, Total

$$WR = 100 \cdot YW/LW$$

ATAX	Personal tax rate, estimate
LW	Paid labour input, total, millions of 1985 FIM
P4	Prices in manufacturing, 1985 = 100
PCP	Private consumer prices, 1985 = 100
PFOR	Import prices of Finland's major export countries, FIM, 1985 = 100
WNR	Negotiated wage rate, private sector, 1985 = 100
WR	Wage rate, total, 1985 = 100
YW	Wages and salaries, total, FIM million
INF	Expected inflation for private consumption prices

P. PRICES AND COSTS

P.1 Prices in Agriculture

$$\Delta(P1 - SMC1) = \underset{(0.04752)}{0.27921} \cdot \Delta(SMC1_{-1} - SMC1) + \underset{(0.04475)}{0.41178} \cdot \Delta(SMC1_{-2} - SMC1) + \underset{(0.05266)}{0.17635} \cdot \Delta(SMC1_{-3} - SMC1) + \underset{(0.05887)}{0.09186} \cdot \Delta(SMC1_{-4} - SMC1)$$

$\bar{R}^2 = 0.8185$ DW = 1.9449 SE = 0.8648 62.1 - 85.4

P.2 Marginal Costs in Agriculture

$$SMC1 = 1.03027 \cdot (1 + TIR1) \cdot \{.535 \cdot 45.1661 \cdot (1+SOCCR1-.87 \cdot (SOCSR+SOCGR)) \cdot WR1/ ((.6663 \cdot (KF1/LH1)^{-.02813} + .3337)^{-1/.02813-1}) + .465 \cdot (.2603 \cdot P2+.0182 \cdot P3+.6172 \cdot PD4+.0825 \cdot PMR+.0218 \cdot PMFL)\}$$

P.3 Indirect Tax Rate on Production, Agriculture

$$TIR1 = [1 + 0.1737 \cdot TSR \cdot D5863/100 + 0.1040 \cdot (TIV - TSCG)/(GDPFV - GDPVG) - 0.0161 \cdot SUB/(GDPFV - GDPVG) - 0.2726 \cdot (SUBT - SUB)/GDPV1] - 1$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDP1	Production at factor cost, agriculture, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPV1	Production at factor cost, agriculture, FIM million
GDPVG	Production at factor cost, FIM million
LH1	Performed working hours, agriculture, millions of hours
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
SMCD4	Marginal costs of manufacturing goods sold on the domestic market
SMC1	Marginal costs in agriculture
SOCCR1	Employers' social security contribution rate, agriculture
SOCGR	Employers' child allowance contribution rate
SOCSR	Employers' national pensions and sickness insurance contribution rate
SUB	Subsidies, millions of 1985 FIM
SUBT	Subsidies, total, FIM million
TIR1	Indirect tax rate on production, agriculture
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
WR1	Wage rate, agriculture, 1985 = 100

P.4 Prices in Services etc.

$$
\begin{aligned}
\Delta(P2 - SMC2) = &+ \underset{(0.1085)}{0.22987} \cdot \Delta(SMC2_{-1} - SMC2) \\
&+ \underset{(0.1106)}{0.24906} \cdot \Delta(SMC2_{-2} - SMC2) \\
&+ \underset{(0.1007)}{0.2504} \cdot \Delta(SMC2_{-3} - SMC2)
\end{aligned}
$$

$\bar{R}^2 = 0.398$ RHO = -0.37 SE = 0.913 62.1 - 85.4

P.5 Marginal Costs in Services etc.

$$
\begin{aligned}
SMC2 = {} & .95248 \cdot (1 + TIR2) \cdot \\
& \{.719 \cdot 1084.187 \cdot (1+SOCCR2) \cdot YW2/ \\
& \quad [LH2 \cdot EXP(.0316 \cdot TREND) \cdot \\
& \quad (.88821 \cdot (KF2/LH2)^{-.60502} + .11179)^{-1/.60605-1}] + \\
& .281 \cdot (.0067 \cdot P1 + .0062 \cdot P3 + .6783 \cdot PD4 + .2376 \cdot PMR + .0711 \cdot PMFL)\}
\end{aligned}
$$

P.6 Indirect Tax Rate on Production, Services etc.

$$
\begin{aligned}
TIR2 = {} & [1 + 0.1439 \cdot TSR \cdot D5863/100 + 0.2103 \cdot (TIV - TSCG)/ \\
& (GDPFV - GDPVG) - 0.0298 \cdot SUB/(GDPFV - GDPVG) + \\
& 0.9125 \cdot TIOCG/GDPV2 + 0.2224 \cdot (SUBT - SUB)/GDPV2] - 1
\end{aligned}
$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDP2	Production at factor cost, services etc., millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPVG	Production at factor cost, general government, FIM million
LH2	Performed working hours, services etc., millions of hours
LW2	Paid labour input, services etc., millions of 1985 FIM
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
SMC2	Marginal costs in services etc.
SOCCR2	Employers' social security contribution rate, services etc.
SUB	Subsidies, millions of 1985 FIM
SUBT	Subsidies, total, FIM million
TIOCG	Central government revenue from other indirect taxes, FIM million
TIR2	Indirect tax rate on production, services
TIV	Central government revenue from commodity taxes, FIM million
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
WR2	Wage rate, services and other, 1985 = 100

P.7 Prices in Forestry

$$\begin{aligned}\Delta\log P3 = &- \underset{(0.0515)}{0.20016}\\ &+ \underset{(0.0863)}{0.31891} \cdot \Delta\log P3_{-1}\\ &+ \underset{(0.0589)}{0.12945} \cdot \Delta\log(PWW \cdot FXSUSD)\\ &+ \underset{(0.0668)}{0.12149} \cdot \Delta\log SMC3_{-1}\\ &+ \underset{(0.0261)}{0.10201} \cdot \log(PWW_{-1} \cdot FXSUSD_{-1}/P3_{-1})\\ &+ \underset{(0.1474)}{0.21642} \cdot \Delta\log GDP4_{-1}\end{aligned}$$

$\bar{R}^2 = 0.353$ DW = 1.939 SE = 0.036 62.1 - 85.4

P.8 Marginal Costs in Forestry

$$\begin{aligned}SMC3 = .99664 \cdot (1+TIR3) \cdot \{&.925 \cdot 19.22742 \cdot (1+SOCCR3) \cdot YW3/\\ &[LH3 \cdot EXP(.00285 \cdot TREND) \cdot\\ &(.16109 \cdot (KF3/LH3)^{.32612} + .83891)^{1/.32612-1}] +\\ &.075 \cdot (.1289 \cdot P1 + .4121 \cdot P2 + .2993 \cdot PD4 + .0993 \cdot PMR + .0604 \cdot PMFL)\}\end{aligned}$$

P.9 Indirect Tax Rate on Production, Forestry

$$\begin{aligned}TIR3 = [&1 + 0.013 \cdot TSR \cdot D5863/100 + 0.0266 \cdot (TIV - TSCG)/\\ &(GDPFV - GDPVG) - 0.0026 \cdot SUB/(GDPFV - GDPVG) -\\ &0.0029 \cdot (SUBT - SUB)/GDPV3] - 1\end{aligned}$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
FXSUSD	Exchange rate, FIM/USD
GDP3	Production at factor cost, forestry, millions of 1985 FIM
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPVG	Production at factor cost, general government, FIM million
LH3	Performed working hours, forestry, millions of hours
LW3	Paid labour input, forestry, millions of 1985 FIM
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
PWW	World-market prices of wood products (HWWA), 1985 = 100
SMC3	Marginal costs in forestry
SOCCR3	Employers' social security contribution rate, forestry
SUB	Subsidies, millions of 1985 FIM
SUBT	Subsidies, total, FIM million
TIR3	Indirect tax rate on production, forestry
TIV	Central government revenue from commodity taxes, FIM million
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
WR3	Wage rate, forestry, 1985 = 100

P.10 Price Index of Manufactured Goods Sold on the Domestic Market

$$\log(PD4/PD4_{-1}) = \underset{(0.0069)}{+\ 0.01074} \underset{(0.0436)}{+\ 0.18256} \cdot \Delta\log(PFXG_{-1}/PD4_{-1}) \underset{(0.0704)}{+\ 0.23535} \cdot \log(SMCD4/PD4_{-1}) \underset{(0.0146)}{-\ 0.04556} \cdot DP75 \underset{(0.0161)}{+\ 0.03823} \cdot DP75_{-1} \underset{(0.0143)}{+\ 0.02256} \cdot DP75_{-2}$$

$\bar{R}^2 = 0.420$ RHO = 0.67 SE = 0.01482 64.1 - 85.4

P.11 Marginal Costs of Manufactured Goods sold on the Domestic Market

$$SMCD4 = 1.01434 \cdot (1+TIR4) \cdot \{.437 \cdot 102.83176 \cdot (1+SOCCR4) \cdot YW4/ [LH4 \cdot EXP(.03063 \cdot TREND) \cdot (.55349 \cdot (KF4/LH4)^{-.14291}+.44651)^{-1/.14291-1}] + .563 \cdot (.1654 \cdot P1+.2745 \cdot P2+.0997 \cdot P3+.2829 \cdot PMR+.1775 \cdot PMFL)\}$$

DP75	Dummy for change in manufacturing pricing in 1975
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
LH4	Performed working hours, manufacturing, millions of hours
LW4	Paid labour input, manufacturing, millions of 1985 FIM
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
SMCD4	Marginal costs of manufacturing goods sold on the domestic market
SOCCR4	Employers' social security contribution rate, manufacturing
TIR4	Indirect tax rate on production, manufacturing
TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
WR4	Wage rate, manufacturing, 1985 = 100

P.12 Prices in Manufacturing

$$P4 = PD4 + 0.307 \cdot (PXG - PD4) \cdot XG/GDP4$$

P.13 Indirect Tax Rate on Production, Industry

$$TIR4 = [1 - 0.0634 \cdot TSR \cdot D5863/100 + 0.0589 \cdot (TIV - TSCG)/(GDPFV - GDPVG) - 0.2886 \cdot SUB/(GDPFV - GDPVG) - 0.0115 \cdot (SUBT-SUB)/GDPV4] - 1$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
GDPVG	Production at factor cost, general government, FIM million
P4	Prices in manufacturing, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PXG	Export prices of goods, 1985 = 100
SUB	Subsidies, millions of 1985 FIM
SUBT	Subsidies, total, FIM million
TIR4	Indirect tax rate on production, manufacturing
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
XG	Exports of goods, millions of 1985 FIM

P.14 - P.17

	P1/ (1+TIR1)	P2/ (1+TIR2)	P3/ (1+TIR3)	P4/ (1+TIR4)	P1	P2	P3	PD4	PMR	PMFL
PGDP1IO	2.0777	0	0	0	0	-.2338	-.0163	-.5543	-.0741	-.019
PGDP2IO	0	1.4641	0	0	-.0026	0	-.0024	-.2649	-.0927	-.027
PGDP3IO	0	0	1.0867	0	-.0104	-.0334	0	-.0243	-.0080	-.004
PGDP4IO	0	0	0	2.2021	-.2041	-.3387	-.1230	0	-.3490	-.219

PGDP1IO = Input-Output Estimate for PGDP1
PGDP2IO = Input-Output Estimate for PGDP2
PGDP3IO = Input-Output Estimate for PGDP3
PGDP4IO = Input-Output Estimate for PGDP4

P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
P4	Prices in manufacturing, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
PMR	Import prices of raw materials, 1985 = 100
TIR1	Indirect tax rate on production, agriculture
TIR2	Indirect tax rate on production, services
TIR3	Indirect tax rate on production, forestry
TIR4	Indirect tax rate on production, manufacturing

P.18 - P.22

	log P1	log P2	log P3	log PD4	log PGDPG	log PMC	log PMI	∑
log PCDIO	0	0.3183	0	0.4007	0	0.2810	0	1
log PCNDIO	0.0562	0.3749	0.0144	0.4518	0	0.1027	0	1
log PCSIO	0.0002	0.9913	0.0003	0.0057	0	0.0025	0	1
log PCGIO	0.0009	0.1340	0.0023	0.0878	0.7422	0.0328	0	1
log PIFIO	0	0.5956	0.0099	0.1340	0	0	0.2605	1

PCDIO = Input-Output Estimate for PCD
PCNDIO = Input-Output Estimate for PCND
PCSIO = Input-Output Estimate for PCS
PCGIO = Input-Output Estimate for PCLG and PCCG
PIFIO = Input-Output Estimate for PIF1, PIF2, PIF3, PICG and PILG

P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
PGDPG	Value added deflator in general government, 1985 = 100
PMC	Import prices of consumer goods, 1985 = 100
PMI	Import prices of investment goods, 1985 = 100

P.23 Value Added Deflator in Agriculture

$$\Delta \log PGDP1 = \Delta \log PGDP1IO$$

P.24 Value Added Deflator in Services etc.

$$PGDP2 = PGDP2IO$$

P.25 Value Added Deflator in Forestry

$$\Delta \log PGDP3 = \Delta \log PGDP3IO$$

P.26 Value Added Deflator in Manufacturing

$$\Delta \log PGDP4 = \Delta \log PGDP4IO$$

PGDP1	Value added deflator in agriculture, 1985 = 100
PGDP1IO	Value added deflator in agriculture, input-output estimate, 1985 = 100
PGDP2	Value added deflator in services etc., 1985 = 100
PGDP2IO	Value added deflator in services etc., input-output estimate, 1985 = 100
PGDP3	Value added deflator in forestry, 1985 = 100
PGDP3IO	Value added deflator in forestry, input-output estimate, 1985 = 100
PGDP4	Value added deflator in manufacturing, 1985 = 100
PGDP4IO	Value added deflator in manufacturing, input-output estimate, 1985 = 100

P.27 Value Added Deflator in General Government

$$\Delta\log[PGDPG/(1 + TIRG)] = \underset{(0.46605)}{+\ 3.32444}$$

$$\underset{(0.09185)}{+\ 0.46480} \cdot \Delta\log[(1 + SOCCRG) \cdot YWG/GDPG]$$

$$\underset{(0.09984)}{+\ 0.70772} \cdot \log VAR1_{-1}$$

where $VAR1 = (1 + TIRG) \cdot [(1 + SOCCRG) \cdot YWG/GDPG]/PGDPG$

$\bar{R}^2 = 0.3546$ DW = 2.038 SE = 0.0189 62.1 - 85.4

P.28 Indirect Tax Rate, General Government

$$TIRG = (1 + 0.0082 \cdot TIOCG/GDPVG) - 1$$

P.29 Private Consumption Prices, Non-Durables and Semi-Durables

$$\Delta\log PCND = \Delta\log(1 + TIRCND) + \Delta\log PCNDIO$$

P.30 Indirect Tax Rate on Consumption, Non-Durables and Semi-Durables

$$TIRCND = (1 + 3.5532 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 1.3886 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.7431 \cdot 0.01 \cdot TSR \cdot D5863) - 1$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDPG	Production at factor cost, general government, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, general government, FIM million
MGV	Imports of goods, total, FIM million
PCND	Private consumption prices, non-durables and semi-durables, 1985 = 100
PCNDIO	Private consumption prices, non-durables and semi-durables, input-output estimate, 1985 = 100
PGDPG	Value added deflator in general government, 1985 = 100
SOCCRG	Employers' social security contribution rate, general government, FIM million
SUB	Subsidies, millions of 1985 FIM
TIOCG	Central government revenue from other indirect taxes, FIM million
TIRCND	Indirect tax rate on consumption, non-durables and semi-durables
TIRG	Indirect tax rate on production, general government
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
YWG	Wages and salaries, general government, FIM million

P.31 Private Consumption Prices, Durables

$$\Delta \log PCD = \Delta \log(1 + TIRCD) + \Delta \log PCDIO$$

P.32 Indirect Tax Rate on Consumption, Durables

$$TIRCD = (1 + 0.8562 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG))/(1 - 0.9334 \cdot 0.01 \cdot TSR \cdot D5863) -1$$

P.33 Private Consumption Prices, Services

$$\Delta \log PCS = \Delta \log(1 + TIRCS) + \Delta \log PCSIO$$

P.34 Indirect Tax Rate, Services etc.

$$TIRCS = (1 + 0.08455 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.5738 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.06299 \cdot 0.01 \cdot TSR \cdot D5863) -1$$

P.35 Central Government Consumption Prices

$$\Delta \log PCCG = \Delta \log(1 + TIRCG) + \Delta \log PCGIO$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, general government, FIM million
MGV	Imports of goods, total, FIM million
PCCG	Central government consumption prices, 1985 = 100
PCD	Private consumption prices, durables, 1985 = 100
PCDIO	Private consumption prices, durables, input-output estimate, 1985 = 100
PCGIO	Public consumption prices, input-output estimate, 1985 = 100
PCS	Private consumption prices, services, 1985 = 100
PCSIO	Private consumption prices, services, input-output estimate, 1985 = 100
SUB	Commodity subsidies, millions of 1985 FIM
TIRCD	Indirect tax rate on consumption, durables
TIRCG	Indirect tax rate on consumption, general government
TIRCS	Indirect tax rate on consumption, services
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate

P.36 Local Government Consumption Prices

$$\Delta \log PCLG = \Delta \log(1 + TIRCG) + \Delta \log PCGIO$$

P.37 Indirect Tax Rate on Consumption, General Covernment

$$TIRCG = [(1 + 0.1879 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.3282 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3807 \cdot 0.01 \cdot TSR \cdot D5863)]^{0.2578} - 1$$

P.38 Fixed Investment Prices, Agriculture

$$\Delta \log PIF1 = \Delta \log(1 + TIRIF1) + \Delta \log PIFIO$$

P.39 Indirect Tax Rate on Investment, Agriculture

$$TIRIF1 = (1 + 0.1331 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.005 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3298 \cdot 0.01 \cdot TSR \cdot D5863) -1$$

P.40 Fixed Investment Prices, Services etc.

$$\Delta \log PIF2 = \Delta \log(1 + TIRIF2) + \Delta \log PIFIO$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, general government, FIM million
MGV	Imports of goods, total, FIM million
PCGIO	Public consumption prices, input-output estimate, 1985 = 100
PCLG	Local government consumption prices, 1985 = 100
PIF1	Fixed investment prices, agriculture, 1985 = 100
PIF1IO	Fixed investment prices, input-output estimate, 1985 = 100
PIF2	Fixed investment prices, services, 1985 = 100
SUB	Subsidies, millions of 1985 FIM
TIRCG	Indirect tax rate on consumption, general government
TIRIF1	Indirect tax rate on investment, agriculture
TIRIF2	Indirect tax rate on investment, services
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate

P.41 Indirect Tax Rate on Investment, Services etc.

$$TIRIF2 = (1 + 0.1331 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.005 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3298 \cdot 0.01 \cdot TSR \cdot D5863) - 1$$

P.42 Fixed Investment Prices, Forestry

$$\Delta \log PIF3 = \Delta \log(1 + TIRIF3) + \Delta \log PIFIO$$

P.43 Indirect Tax Rate on Investment, Forestry

$$TIRIF3 = (1 + 0.1331 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.005 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3298 \cdot 0.01 \cdot TSR \cdot D5863) -1$$

P.44 Fixed Investment Prices, Manufacturing

$$\Delta \log PIF4 = \Delta \log(1 + TIRIF4) + \Delta \log PIFIO$$

P.45 Indirect Tax Rate on Investment, Industry

$$TIRIF4 = (1 + 0.1331 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.005 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3916 \cdot 0.01 \cdot (0.7432 \cdot TSR7 + (1 - 0.7432) \cdot TSR8) \cdot D5863) -1$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, general government, FIM million
MGV	Imports of goods, total, FIM million
PIF3	Fixed investment prices, forestry, 1985 = 100
PIFIO	Fixed investment prices, input-output estimate, 1985 = 100
PIF4	Fixed investment prices, manufacturing, 1985 = 100
SUB	Commodity subsidies, millions of 1985 FIM
TIRCG	Indirect tax rate on consumption, general government
TIRIF2	Indirect tax rate on investment, services
TIRIF3	Indirect tax rate on investment, forestry
TIRIF4	Indirect tax rate on investment, manufacturing
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
TSR7	Sales tax rate, industrial machinery and equipment
TSR8	Sales tax rate, industrial buildings

P.46 Residential Construction Prices

$$\Delta\log PIH = \Delta\log(1 + TIRIH) + \Delta\log P2$$

P.47 Indirect Tax Rate on Investment, Residential Construction

$$TIRIH = 1/(1 - 0.2669 \cdot 0.01 \cdot TSR \cdot D5863) - 1$$

P.48 Central Government Investment Prices

$$\Delta\log PICG = \Delta\log(1 + TIRIG) + \Delta\log PIFIO$$

P.49 Local Government Investment Prices

$$\Delta\log PILG = \Delta\log(1 + TIRIG) + \Delta\log PIFIO$$

P.50 Indirect Tax Rate on Investment, General Covernment

$$TIRIG = (1 + 0.1331 \cdot (TIV - TSCG)/(GDPFV + MGV - GDPVG) - 0.005 \cdot SUB/(GDPFV + MGV - GDPVG))/(1 - 0.3298 \cdot 0.01 \cdot TSR \cdot D5863) - 1$$

P.51 Value Added Deflator at Factor Cost

$$PGDPF = 100 \cdot GDPFV/GDPF$$

D5863	Dummy replacing sales tax rate in 1958 - 1963
GDPF	GDP at factor cost, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPVG	Production at factor cost, general government, FIM million
MGV	Imports of goods, total, FIM million
P2	Prices in services etc., 1985 = 100
PGDPF	Value added deflator at factor cost, 1985 = 100
PICG	Central government investment prices, 1985 = 100
PIFIO	Fixed investment prices, input-output estimate, 1985 = 100
PIH	Residential construction prices, 1985 = 100
PILG	Local government investment prices, 1985 = 100
SUB	Commodity subsidies, millions of 1985 FIM
TIRIG	Indirect tax rate on investment, general goverment
TIRIH	Indirect tax rate on investment, residential construction
TIV	Central government revenue from commodity taxes, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate

P.52 Private Investment Prices

$$PI = 100 \cdot IV/I$$

P.53 Private Non-Residential Investment Prices

$$PIF = 100 \cdot IFV/IF$$

P.54 Public Investment Prices

$$PIG = 100 \cdot IGV/IG$$

P.55 Investment Prices

$$PITOT = 100 \cdot ITOTV/ITOT$$

P.56 Public Consumption Prices

$$PCG = 100 \cdot CGV/CG$$

P.57 Private Consumption Prices

$$PCP = 100 \cdot CV/C$$

C	Total private consumption, millions of 1985 FIM
CG	Total public consumption, millions of 1985 FIM
CGV	Total public consumption, FIM million
CV	Total private consumption, FIM million
I	Private fixed investment, millions of 1985 FIM
IF	Private non residential investment, millions of 1985 FIM
IFV	Private non-residential investment, FIM million
IG	Total public investment, millions of 1985 FIM
IGV	Total public investment, FIM million
ITOT	Total fixed investment, millions of 1985 FIM
ITOTV	Total fixed investment, FIM million
IV	Private fixed investment, FIM million
PCG	Public consumption prices, 1985 = 100
PCP	Private consumption prices, 1985 = 100
PI	Private investment prices, 1985 = 100
PIF	Private non-residential investment prices, 1985 = 100
PIG	Public investment prices, 1985 = 100
PITOT	Investment prices, 1985 = 100

Y. INCOMES

Y.1 National Income

$$Y = GDPV + YFIN - CCTV$$

Y.2 Net Property and Entrepreneurial Income

$$YNWN = Y - YW - SOCC - YWF - (TICG - SUBT)$$

Y.3 National Disposable Income

$$YDTOT = Y + YFTR$$

Y.4 Household Disposable Income

$$YD = YW + YSE + YOH - TRHGN + SOCC$$

Y.5 General Government Disposable Income

$$\begin{aligned} YDG = 1.02104 \cdot (&CGV + ICGTV + ILGV - \\ &.01 \cdot CCRG \cdot (PICG \cdot KFCG_{-1} + PILG \cdot KFLG_{-1}) - \\ &FCGN + (TYLG + TRCGL - CLGV - ILGV) + (SOCLS + SOCCS + \\ &TRCGS - TRSHV)) \end{aligned}$$

CCTV	Consumption of fixed capital
CGV	Total public consumption, FIM million
CLGV	Local government consumption, FIM million
FCGN	Central government borrowing, net, FIM million
GDPV	GDP in Purchasers' Values, FIM million
ICGTV	Central government investment (incl. enterprises), FIM million
ILGV	Local government investment, FIM million
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
PICG	Central government investment prices, 1985 = 100
PILG	Local government investment prices, 1985 = 100
SOCC	Employers' social security contributions, total, FIM million
SOCCS	Employers' national pension and sickness insurance contributions, FIM million
SOCLS	Insured persons' national pension and sickness insurance contributions, FIM million
SUBT	Subsidies, total, FIM million
TICG	Central government revenue from indirect taxes, FIM million
TRCGL	Central government transfers to local government, FIM million
TRCGS	Central government transfers to the Social Security institution, FIM million
TRHGN	Households' transfers to other sectors, net FIM million
TRSHV	Benefits paid by the social Insurance Institution, FIM million
TYLG	Local government revenue from direct taxes, FIM million
Y	National Income, FIM million
YD	Household disposable income, FIM million
YDG	General government disposable income, FIM million
YDTOT	National disposable income, FIM million
YFIN	Investment income from abroad, net, FIM million
YFTR	Income transfers from abroad, net, FIM million
YNWN	Net property and entrepreneurial income, FIM million
YOH	Other household income, FIM million
YSE	Households' entrepreneurial income, total, FIM million
YW	Wages and salaries, total FIM million
YWF	Compensation of employees receivable from the rest of the world, net, FIM million

Y.6 Corporate Sector Disposable Income

$$YDC = YDTOT + YWF - YDG - YD$$

Y.7 Household Net Lending

$$FH = YD - CV + .01 \cdot CCRH \cdot PIH \cdot KH_{-1} - IHV + .01 \cdot CCR1 \cdot PIF1 \cdot KF1_{-1} - IFV1 + .01 \cdot CCR3 \cdot PIF3 \cdot KF3_{-1} - IFV3$$

Y.8 General Government Net Lending

$$FG = YDG - CGV + .01 \cdot CCRG \cdot (PICG \cdot KFCG_{-1} + PILG \cdot KFLG_{-1}) - ICGTV - ILGV$$

Y.9 Corporate Sector Net Lending

$$FB = BPCV - FH - FG$$

Y.10 Wages and Salaries, Total

$$YW = YW1 + YW2 + YW3 + YW4 + YWG$$

Y.11 Wages and Salaries, Agriculture

$$YW1 = LW1 \cdot WR1/100$$

BPCV	Current account, FIM million
CCRG	Capital consumption rate, general government
CCRH	Capital consumption, residential construction, FIM million
CCR1	Capital consumption rate, agriculture
CCR3	Capital consumption rate, forestry
CV	Total private consumption, FIM million
FB	Corporate sector net lending, FIM million
FG	General government net lending, FIM million
FH	Household net lending, FIM million
ICGTV	Central government investment (incl. enterprises), FIM million
IFV1	Private fixed investment, agriculture, FIM million
IFV3	Private fixed investment, forestry, FIM million
IHV	Residential contruction, FIM million
ILGV	Local government investment, FIM million
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
KF3	Net stock of fixed capital, forestry, million of 1985 FIM
KH	Net stock of private residential capital, millions of 1985 FIM
LW1	Paid labour input, agriculture, millions of 1985 FIM
PICG	Central government investment prices, 1985 = 100
PIF1	Fixed investment prices, agriculture, 1985 = 100
PIF3	Fixed investment prices, forestry
PIH	Residential construction prices, 1985 = 100
PILG	Local government investment prices, 1985 = 100
WR1	Wage rate, agriculture, 1985 = 100
YD	Household disposable income, FIM million
YDC	Corporate sector's disposable income, FIM million
YDG	General government disposable income, FIM million
YDTOT	National disposable income, FIM million
YW	Wages and salaries, total FIM million
YWF	Compensation of employees receivable from the rest of the world, net, FIM million
YWG	Wages and salaries, general government, FIM million
YW1	Wages and salaries, agriculture, FIM million
YW2	Wages and salaries, services etc., FIM million
YW3	Wages and salaries, forestry, FIM million
YW4	Wages and salaries, manufacturing, FIM million

Y.12 Wages and Salaries, Services etc.

$$YW2 = LW2 \cdot WR2/100$$

Y.13 Wages and Salaries, Forestry

$$YW3 = LW3 \cdot WR3/100$$

Y.14 Wages and Salaries, Manufacturing

$$YW4 = LW4 \cdot WR4/100$$

Y.15 Wages and Salaries, General Government

$$YWG = LWG \cdot WRG/100$$

Y.16 Employers' Social Security Contributions, Total

$$SOCC = SOCC1 + SOCC2 + SOCC3 + SOCC4 + SOCCG$$

Y.17 Employers' Social Security Contributions, Agriculture

$$SOCC1 = SOCCR1 \cdot YW1$$

LWG	Paid labour input, government, millions of 1985 FIM
LW2	Paid labour input, services etc., millions of 1985 FIM
LW3	Paid labour input, forestry, millions of 1985 FIM
LW4	Paid labour input, manufacturing, millions of 1985 FIM
SOCC	Employers' social security contributions, total, FIM million
SOCCG	Employers' social security contributions, general government, FIM million
SOCCR1	Employers' social security contributions rate, agriculture
SOCC1	Employers' social security contributions, agriculture, FIM million
SOCC2	Employers' social security contributions, services etc., FIM million
SOCC3	Employers' social security contributions, forestry, FIM million
SOCC4	Employers' social security contributions, manufacturing, FIM million
WRG	Wage rate, general government, 1985 = 100
WR2	Wage rate, services and other, 1985 = 100
WR3	Wage rate, forestry, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
YWG	Wages and salaries, general government, FIM million
YW1	Wages and salaries, agriculture, FIM million
YW2	Wages and salaries, services etc., FIM million
YW3	Wages and salaries, forestry, FIM million
YW4	Wages and salaries, manufacturing, FIM million

Y.18 Employers' Social Security Contributions, Services etc.

$$SOCC2 = SOCCR2 \cdot YW2$$

Y.19 Employers' Social Security Contributions, Forestry

$$SOCC3 = SOCCR3 \cdot YW3$$

Y.20 Employers' Social Security Contributions, Manufacturing

$$SOCC4 = SOCCR4 \cdot YW4$$

Y.21 Employers' Social Security Contributions, General Government

$$SOCCG = SOCCRG \cdot YWG$$

Y.22 Employers' Social Security Contribution Rate, Agriculture

$$\begin{aligned} SOCCR1 - SOCSR - SOCGR = & + \underset{(0.00283)}{0.03550} \\ & + \underset{(0.03137)}{0.91941} \cdot SOCLELR \end{aligned}$$

$\bar{R}^2 = 0.957$ DW = 0.951 SE = 0.0049 70.1 - 79.4

SOCCG	Employers' social security contributions, general government, FIM million
SOCCRG	Employers' social security contributions rate, general government, FIM million
SOCCR1	Employers' social security contributions rate, agriculture
SOCCR2	Employers' social security contribution rate, services etc.
SOCCR3	Employers' social security contribution rate, forestry
SOCCR4	Employers' social security contribution rate, manufacturing
SOCC2	Employers' social security contributions, services etc., FIM million
SOCC3	Employers' social security contributions, forestry, FIM million
SOCC4	Employers' social security contributions, manufacturing, FIM million
SOCGR	Employers' child allowance contribution rate
SOCLELR	Employers' contribution rate for temporary employee pension scheme
SOCSR	Employers' national pensions and sickness insurance contribution rate
YWG	Wages and salaries, general government, FIM million
YW2	Wages and salaries, services etc., FIM million
YW3	Wages and salaries, forestry, FIM million
YW4	Wages and salaries, manufacturing, FIM million

Y.23 Employers' Social Security Contribution Rate, Services etc.

$$SOCCR2 - SOCSR - SOCGR = \underset{(0.00388)}{+\ 0.01745} \underset{(0.04516)}{+\ 0.98524} \cdot (0.76 \cdot SOCTELR + 0.24 \cdot SOCLELR)$$

$\bar{R}^2 = 0.924$ DW = 0.418   SE = 0.0068   70.1 - 79.4

Y.24 Employers' Social Security Contribution Rate, Forestry

$$SOCCR3 - SOCSR - SOCGR = \underset{(0.00294)}{+\ 0.03083} \underset{(0.03266)}{+\ 0.87228} \cdot SOCLELR$$

$\bar{R}^2 = 0.948$ DW = 0.800   SE = 0.0051   70.1 - 79.4

Y.25 Employers' Social Security Contribution Rate, Manufacturing

$$SOCCR4 - SOCSR - SOCGR = \underset{(0.00494)}{+\ 0.04576} \underset{(0.05830)}{+\ 1.04788} \cdot SOCTELR$$

$\bar{R}^2 = 0.892$ DW = 0.297   SE = 0.0087   70.1 - 79.4

SOCCR2	Employers' social security contribution rate, services etc.
SOCCR3	Employers' social security contribution rate, forestry
SOCCR4	Employers' social security contribution rate, manufacturing
SOCGR	Employers' child allowance contribution rate
SOCLELR	Employers' contribution rate for temporary employee pension scheme
SOCSR	Employers' national pensions and sickness insurance contribution rate
SOCTELR	Employers' contribution rate for employee pension schemes

Y.26 Employers' Social Security Contribution Rate, General Government

$$SOCCRG - SOCSR - SOCGR = \underset{(0.01958)}{+\ 0.06081} \underset{(0.12477)}{+\ 0.61297} \cdot (SOCCRG_{-1} - SOCSR_{-1} - SOCGR_{-1})$$

$\bar{R}^2 = 0.372$ DW = 1.888 SE = 0.0037 70.1 - 79.4

Y.27 Households' Entrepreneurial Income, Total

$$YSE = YSE1 + YSE3 + YSEO$$

Y.28 Entrepreneurial Income, Agriculture

$$YSE1 = \underset{(0.02830)}{1.02694} \cdot (YNW1 - PIF1 \cdot KF1_{-1} \cdot CCR1/100) \underset{(0.08117)}{+\ 0.51851} \cdot (SUBCG + SUBLG - SUB)$$

$\bar{R}^2 = 0.9701$ DW = 2.319 SE = 109.8429 62.1 - 85.4

CCR1	Capital consumption rate, agriculture
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
PIF1	Fixed investment prices, agriculture, 1985 = 100
SOCCRG	Employers' social security contributions rate, general government, FIM million
SOCGR	Employers' child allowance contribution rate
SOCSR	Employers' national pensions and sickness insurance contribution rate
SUB	Commodity subsidies, millions of 1985 FIM
SUBCG	Central government subsidies, FIM million
SUBLG	Local government subsidies, FIM million
YNW1	Gross operating surplus, agriculture, FIM million
YSE	Households' entrepreneurial income, total, FIM million
YSEO	Other entrepreneurial income, FIM million
YSE1	Entrepreneurial income, agriculture, FIM million
YSE3	Entrepreneurial income, forestry, FIM million

Y.29 Entrepreneurial Income, Forestry

$$YSE3 = \underset{(0.01370)}{0.97901} \cdot (YNW3 - PIF3 \cdot KF3_{-1} \cdot CCR3/100)$$

$\bar{R}^2 = 0.943$ DW = 1.4372 SE = 117.6334 62.1 - 85.4

Y.30 Other Enterpreneurial Income

$$\Delta(100 \cdot YSEO/PIH - 0.04885 \cdot KH_{-1}/4) =$$

$$- \underset{(27.67100)}{38.82150}$$

$$+ \underset{(0.01291)}{0.12805} \cdot \Delta[100 \cdot (GDPV2 + GDPV4)/PIH - 0.04885 \cdot KH_{-1}/4]$$

$$+ \underset{(0.08656)}{0.28573} \cdot \Delta(100 \cdot YSEO_{-1}/PIH_{-1} - 0.04885 \cdot KH_{-2}/4)$$

$\bar{R}^2 = 0.694$ DW = 2.006 SE = 182.594 75.1 - 85.4

Y.31 Other Household Income

$$YOH = - \underset{(0.00011)}{0.00124} \cdot (RLB \cdot LBP_{-1})$$

$$+ \underset{(0.00016)}{0.00119} \cdot RDT \cdot (KDP_{-1} + SECPCG_{-1})$$

$\bar{R}^2 = 0.964$ DW = 0.210 SE = 36.3580 62.1 - 85.4

CCR3	Capital consumption rate, forestry
GDPV2	Production at factor cost, services and other, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
KDP	Banks' deposits by the public, FIM million
KF3	Net stock of fixed capital, forestry, million of 1985 FIM
KH	Net stock of private residential capital, millions of 1985 FIM
LBP	Bank loans to the public, FIM million
PIF3	Fixed investment prices, forestry
PIH	Residential contruction prices, 1985 = 100
RDT	Interest rate, time deposits, per cent
RLB	Bank lending rate, per cent
SECPCG	Central government bonds held by the public, FIM million
YNW3	Gross operating surplus, forestry, FIM million
YOH	Other household income, FIM million
YSEO	Other entrepreneurial income, FIM million
YSE3	Entrepreneurial income, forestry, FIM million

Y.32 Other Transfers to Households, Net, Value

$$TRHOV = TRHO \cdot PCP/100$$

Y.33 Other Transfers to Households, Net, Volume

$$\begin{aligned}\Delta TRHO = {} & \underset{(5.86218)}{13.56406} \\ & + \underset{(0.03625)}{0.03007} \cdot \Delta[100 \cdot (SOCC - SOCG - SOCCS)/PCP] \\ & + \underset{(0.58087)}{1.66438} \cdot \Delta(LU \cdot WR/PCP) \\ & + \underset{(0.09512)}{0.69397} \cdot \Delta[TRHO_{-1} - 1.6 \cdot LU_{-1} \cdot WR_{-1}/PCP_{-1}]\end{aligned}$$

$\bar{R}^2 = 0.479$ DW = 1.623 SE = 33.3389 63.1 - 84.4

Y.34 Households' Transfers to Other Sectors

$$TRHGN = TYP + SOCLS + SOCC - TRCGH - TRSHV - TRHOV$$

Y.35 Gross Operating Surplus, Total

$$YNW = YNW1 + YNW2 + YNW3 + YNW4 + YNWG$$

LU	Unemployment, 1000 persons
PCP	Private consumption prices, 1985 = 100
SOCC	Employers' social security contributions, total, FIM million
SOCCS	Employers' national pensions and sickness insurance contributions, FIM million
SOCG	Central government revenue from employers' child allowance contributions, FIM million
SOCLS	Insured persons national pensions and sickness insurance contributions, FIM million
TRCGH	Central government transfers to households, FIM million
TRHGN	Households' transfers to other sectors, net, FIM million
TRHO	Other transfers to households, net, millions of 1985 FIM
TRHOV	Other transfers to households, net, FIM million
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
TYP	Central and local government revenue from direct taxes on households, FIM million
WR	Wage rate, total, 1985 = 100
YNW	Gross operating surplus, total, FIM million
YNWG	Gross operating surplus, general government, FIM million
YNW1	Gross operating surplus, agriculture, FIM million
YNW2	Gross operating surplus, services and other, FIM million
YNW3	Gross operating surplus, forestry, FIM million
YNW4	Gross operating surplus, manufacturing, FIM million

Y.36 Gross Operating Surplus, Agriculture

YNW1 = GDPV1 - SOCC1 - YW1

Y.37 Gross Operating Surplus, Services etc.

YNW2 = GDPV2 - SOCC2 - YW2

Y.38 Gross Operating Surplus, Forestry

YNW3 = GDPV3 - SOCC3 - YW3

Y.39 Gross Operating Surplus, Manufacturing

YNW4 = GDPV4 - SOCC4 - YW4

Y.40 Gross Operating Surplus, General Government

YNWG = GDPVG - SOCCG - YWG

Y.41 Profits of Corporate Entities Before Taxation

YC = YNW - YSE - YOH - TRHOV

GDPVG	Production at factor cost, FIM million
GDPV1	Production at factor cost, agriculture, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
SOCCG	Employers' social security contributions, general government, FIM million
SOCC1	Employers' social security contributions, agriculture, FIM million
SOCC2	Employers' social security contributions, services etc., FIM million
SOCC3	Employers' social security contributions, forestry, FIM million
SOCC4	Employers' social security contributions, manufacturing, FIM million
TRHOV	Other transfers to households, net, FIM million
YC	Profits of corporate entities before taxation, FIM million
YNW	Gross operating surplus, total, FIM million
YNWG	Gross operating surplus, general government, FIM million
YNW1	Gross operating surplus, agriculture, FIM million
YNW2	Gross operating surplus, services and other, FIM million
YNW3	Gross operating surplus, forestry, FIM million
YNW4	Gross operating surplus, manufacturing, FIM million
YOH	Other household income, FIM million
YSE	Households' entrepreneurial income, total, FIM million
YWG	Wages and salaries, general government, FIM million
YW1	Wages and salaries, agriculture, FIM million
YW2	Wages and salaries, services etc., FIM million
YW3	Wages and salaries, forestry, FIM million
YW4	Wages and salaries, manufacturing, FIM million

Y.42 Taxable Corporate Income in Central Government Taxation

$$\sum_{i=0}^{3} YCCG_{-i} = \underset{(0.00111)}{0.12938} \cdot \sum_{i=0}^{3} YC_{-i}$$

$$+ \underset{(0.00985)}{0.06945} \cdot \sum_{i=0}^{3} (YC \cdot DEVL)_{-i}$$

$\bar{R}^2 = 0.9815$ DW = 0.205 SE = 244.7754 62.1 - 85.4

Y.43 Taxable Corporate Income in Local Government Taxation

$$\sum_{i=0}^{3} YCLG_{-i} = \underset{(0.00280)}{0.31040} \cdot \sum_{i=0}^{3} YC_{-i}$$

$$+ \underset{(0.02493)}{0.04726} \cdot \sum_{i=0}^{3} (YC \cdot DEVL)_{-i}$$

$\bar{R}^2 = 0.981$ DW = 0.185 SE = 619.4579 62.1 - 85.4

DEVL	Dummy for corporate tax reform in 1969
YC	Profits of corporate entities before taxation, FIM million
YCCG	Taxable corporate income in central government taxation, FIM million
YCLG	Taxable corporate income in local government taxation, FIM million

G. PUBLIC SECTOR

G.1 Central and Local Government Revenue from Taxes on Households

$$
\begin{aligned}
TYP/var1 = {} & \underset{(0.0174)}{0.06973} + \underset{(0.0684)}{.99288} \cdot (DTLG \cdot TLGR/DTCG) \\
& + TYU + TYS \cdot \log(var1/LE)) \\
& + \underset{(0.3789)}{8.25404}\, TYS \\
& + \underset{(0.0089)}{0.03341}\, DTYP
\end{aligned}
$$

where $var1 = DTCG \cdot (YW + 0.4\ YSE_{-8} + DSOC \cdot TRSHV)$

$\bar{R}^2 = 0.877$ DW = 1.990 SE = 0.025 62.1 - 85.4

G.2 Personal Marginal Tax Rate, estimate

$$
\begin{aligned}
MTAX = {} & 0.99288 \cdot (DTLG \cdot TLGR/DTCG + TYU + TYS \cdot \log(var1/LE) \\
& + 9.24692\ TYS + 0.06973 + SOCLR
\end{aligned}
$$

where $var1 = DTCG \cdot (YW + 0.4\ YSE_{-8} + DSOC \cdot TRSHV)$

DSOC	Dummy for inclusion of transfers in tax base in 1982
DTCG	Dummy for the deduction system in central government taxation
DTLG	Dummy for the decuction system in local government taxation
DTYP	Dummy for change in timing of tax reimbursement in 1976
LE	Employment, 1000 persons
MTAX	Personal marginal tax rate, estimate
SOCLR	Insured persons' national pensions and sickness insurance contribution rate
TLGR	Average local government tax rate
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
TYP	Central and local government revenue from direct taxes on households, FIM million
TYS	Slope of the progressive income tax schedule
TYU	Intercept of the progressive income tax schedule
YSE	Households' entrepreneurial income, total, FIM million
YW	Wages and salaries, total, FIM million

G.3 Household Average Income Tax Rate, estimate

$$ATAX = DTCG \cdot (MTAX - SOCLR - .99288 \cdot TYS) + SOCLR$$

G.4 Central and Local Government Revenue from Direct Taxes on Corporate Entities

$$TYC - DPROP = \underset{(0.01214)}{0.86258} \cdot [ET + .3 \cdot (MT_{-4} - ET_{-4}) + .7 \cdot (MT_{-8} - ET_{-8})]$$

where $ET = TYCR \cdot TER \cdot YCCG_{-8} + TLGR \cdot TER \cdot YCLG_{-8}$
and $MT = TYCR \cdot YCCG + TLGR \cdot YCLG$

$\bar{R}^2 = 0.9573$ DW = 0.2782 SE = 76.4721 64.1 - 85.4

ATAX	Household average income tax rate, estimate
DPROP	Dummy for property tax reduction
DTCG	Dummy for the deduction system in central government taxation
MTAX	Personal marginal tax rate, estimate
SOCLR	Insured persons' national pensions and sickness insurance contribution rate
TER	Increase in the tax base
TLGR	Average local government tax rate
TYC	Central and local government revenue from direct taxes on corporate entities, FIM million
TYCR	Corporate tax rate in central government taxation
YCCG	Taxable corporate income in central government taxation, FIM million
YCLG	Taxable corporate income in local government taxation, FIM million

G.5 Central Government Revenue from Sales Tax

$$\log(TSCG/TSR) = \underset{(0.39243)}{-\ 4.84506}$$

$$+ \underset{(0.03897)}{1.01914} \cdot \log SLVV$$

$$+ \underset{(0.02111)}{1.01707} \cdot \log D5863$$

$$- \underset{(0.00794)}{0.03748} \cdot D6263$$

$$+ \underset{(0.06342)}{0.10554} \cdot DTO$$

where $SLVV = 0.933 \cdot CDV + 0.743 \cdot CNDV + 0.063 \cdot CSV + 0.097 \cdot CGV + 0.291 \cdot (ITOTV - IFV4) + 0.066 \cdot XV + 0.320 \cdot GDPV1 + 0.286 \cdot GDPV2 + 0.154 \cdot GDPV3 - 0.093 \cdot GDPV4 + (0.3916(0.7432\ TSR7 + 0.2568\ TSR8) \cdot D5863)/TSR) \cdot IFV4$

$\bar{R}^2 = 0.979$ RHO = 0.58 SE = 0.0663 61.1 - 85.4

CDV	Private consumption, durables, FIM million
CGV	Total public consumption, FIM million
CNDV	Private consumption, non-durables and semi-durables, FIM million
CSV	Private consumption, services, FIM million
D5863	Dummy replacing sales tax rate in 1958 - 1963
D6263	Dummy for sales tax avoidance in 1962 - 1963
DTO	Dummy for removal of sales tax on fuels and lubricants in 1974
GDPV1	Production at factor cost, agriculture, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
IFV4	Private fixed investment, manufacturing, FIM million
ITOTV	Total fixed investment, FIM million
TSCG	Central government revenue from sales tax, FIM million
TSR	Sales tax rate
TSR7	Sales tax rate, industrial machinery and equipment
TSR8	Sales tax rate, industrial buildings
XV	Exports of goods and services, FIM million

G.6 Central Government Revenue from Excise Tax on Liquid Fuels

$$\log(TECG/(0.5494 \cdot TEBR + 0.4506 \cdot TEDR)) = \underset{(0.76486)}{-\,9.01982} + \underset{(0.12940)}{1.50127} \cdot \sum_{i=0}^{3} a_i \log GDPF - \underset{(0.14508)}{0.14610} \cdot \log(POIL/PCP)$$

where $POIL = (1.6133 \cdot PMFL + 100 \cdot (0.5494 \cdot TEBR + 0.4506 \cdot TEDR)) \cdot (100 + DTO \cdot TSR \cdot D5863)$

lag i	0	1	2	3	$\sum$
weight a_i	.4	.3	.2	.1	1

$\bar{R}^2 = 0.871$ DW = 2.003 SE = 0.1382 62.1 - 85.4

G.7 Other Commodity Taxes

$$TIOV = \underset{(0.00432)}{0.84855} \cdot var1$$

where $var1 = (0.0134 + 0.0006 \cdot TSR \cdot D5863) \cdot MV + 0.138 \cdot CNDV + 0.1341 \cdot CDV + 0.0023 \cdot GDPV$

$\bar{R}^2 = 0.9938$ DW = 1.722 SE = 93.2269 62.1 - 85.4

CDV	Private consumption, durables, FIM million
CNDV	Private consumption, non-durables and semi-durables, FIM millions
D5863	Dummy replacing sales tax rate in 1958 - 1963
DTO	Dummy for removal of sales tax on fuels and lubricants in 1974
GDPF	GDP at factor cost, millions of 1985 FIM
GDPV	GDP in Purchasers' Values, FIM million
MV	Imports of goods and services, FIM million
PCP	Private consumption prices, 1985 = 100
PMFL	Import prices of fuels and lubricants, 1985 = 100
TEBR	Excise tax rate on petrol
TECG	Central government revenue from excise tax on liquid fuels, FIM million
TEDR	Excise tax rate on diesel oil
TIOCG	Central government revenue from other indirect taxes, FIM million
TIOV	Other commodity taxes, FIM million
TSR	Sales tax rate

G.8 Central Government Revenue from Other Indirect Taxes

$$TIOCG = \underset{(0.00057)}{0.00774} \cdot GDPV$$

$\bar{R}^2 = 0.540$ RHO = 0.980 SE = 10.3996 62.1 - 85.4

G.9 Central Government Revenue from Employers' Child Allowance Contributions

$$SOCG = \underset{(0.00855)}{0.98594} \cdot SOCGR \cdot YW$$

$\bar{R}^2 = 0.978$ DW = 1.683 SE = 13.4516 62.1 - 85.4

G.10 Employers' National Pensions and Sickness Insurance Contributions

$$SOCCS = \underset{(0.00751)}{1.01636} \cdot SOCSR \cdot YW$$

$\bar{R}^2 = 0.990$ DW = 0.120 SE = 78.3569 62.1 - 85.4

GDPV	GDP in Purchasers' Values, FIM million
SOCCS	Employers' national pensions ans sickness insurance contributions, FIM million
SOCG	Central government revenue from employers' child allowance contributions, FIM million
SOCGR	Employers' child allowance contribution rate
SOCSR	Employers' national pensions and sickness insurance contribution rate
TIOCG	Central government revenue from other indirect taxes, FIM million
YW	Wages and salaries, total, FIM million

G.11 Insured Persons National Pensions and Sickness Insurance Contributions

$$SOCLS/SOCLR = \underset{(0.00487)}{1.04580} \cdot (1 - DTYLG) \cdot YW + \underset{(0.00428)}{0.42085} \cdot DTYLG \cdot \sum_{i=6}^{8} YW_{-i}$$

$\bar{R}^2 = 0.996$ DW = 0.249 SE = 727.7781 62.1 - 85.4

G.12 Central Government Other Revenue

$$YOCG - YOCG_{-3} = \underset{(0.04049)}{0.17447} \cdot (YWG - YWG_{-3}) + \underset{(0.01922)}{0.00938} \cdot \sum_{i=0}^{2} FCGHN_i - \underset{(0.00732)}{0.01435} \cdot \sum_{i=0}^{2} FCGON_i$$

$\bar{R}^2 = 0.444$ DW = 1.239 SE = 61.1019 62.1 - 85.4

DTYLG	Dummy for change in the system of advance dispursement of tax receipts to local government
FCGHN	Central government housing loans, net change, FIM million
FCGON	Central government other borrowing, net, FIM million
SOCLR	Insured persons' national pensions and sickness insurance contribution rate
SOCLS	Insured persons national pensions and sickness insurance contributions, FIM million
YOCG	Central government other revenue, FIM million
YW	Wages and salaries, total, FIM million
YWG	Wages and salaries, general government, FIM million

G.13 Central Government Interest Expenditure

$$GCGI - GCGI_{-1} = \underset{(0.00019)}{0.00341} \cdot (RFOR \cdot FMCGN + RDT \cdot FPCGN)$$

$\bar{R}^2 = 0.672$ DW = 0.969 SE = 10.4539 62.1 - 85.4

G.14 Average Local Government Tax Rate

$$TLGR - TLGR_{-4} = \underset{(0.0001)}{0.00029} + \underset{(0.0493)}{0.82526}(TLGR_{-1} - TLGR_{-5})$$

$$+ \underset{(0.0155)}{0.05296}(TLGRE_{-4} - TLGR_{-4})$$

where $TLGRE = 0.09422 - 0.00884 \cdot DTYLG + 0.48837\left(\frac{CLGV + SUBLG - TRCGL}{VP}\right)$

$$VP = DTLG \cdot [DTYLG \cdot YW_{-6} + (1 - DTYLG)YW + TER \cdot (YCLG_{-6} + .715\ YSE_{-6}) + DSOC \cdot TRSHV]$$

$\bar{R}^2 = 0.758$ DW = 1.882 SE = 0.0008 63.1 - 88.4

CLGV	Local government consumption, FIM million
DSOC	Dummy for inclusion of transfers in tax base in 1982
DTLG	Dummy for share of income taxes in local government taxation
DTYLG	Dummy for change in the system of advance dispursement of tax receipts to local government
FMCGN	Foreign borrowing by the central government, net, FIM million
FPCGN	Change in holdings of central government bonds by the public, FIM million
GCGI	Central government interest expenditure, FIM million
RDT	Interest rate, time deposits, per cent
RFOR	Average 3 month euromarket interest rate for USD, GBP, DEM and CHF, per cent
SUBLG	Local government subsidies, FIM million
TER	Increase in the tax base
TLGR	Average local government tax rate
TRCGL	Central government transfers to local government, FIM million
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
YCLG	Taxable corporate income in local government taxation, FIM million
YSE	Households' entrepreneurial income, total, FIM million
YW	Wages and salaries, total, FIM million

G.15 Local Government Revenue from Direct Taxes

$$\log(TYLG/TLGR) = \underset{(0.06850)}{-\,1.02961} + \underset{(0.00657)}{1.10234} \cdot \log VP + \underset{(0.01344)}{0.24194} \cdot DTYLG$$

where $VP = DTLG \cdot [DTYLG \cdot YW_{-6} + (1 - DTYLG) \cdot YW + TER \cdot (YCLG_{-6} + 0.715 \cdot YSE_{-6}) + DSOC \cdot TRSHV)]$

$\bar{R}^2 = 0.999$ DW = 0.443 SE = 0.0343 62.1 - 85.4

G.16 Local Government Consumption, Volume

$$CLG \cdot PCLG \cdot 0.01/(TYLG \cdot SUBLG) = \underset{(0.0395)}{0.23981} + \underset{(0.1029)}{0.53809} \cdot TRCGL/(TYLG - SUBLG) + \underset{(0.0740)}{0.60794} \cdot CLG_{-1} \cdot PCLG_{-1} \cdot 0.01/(TYLG - SUBLG)$$

$\bar{R}^2 = 0.973$ DW = 2.023 SE = 0.0268 64.1 - 88.4

G.17 Central Government Revenue from Direct Taxes

$$TYCG = TYP + TYC - TYLG$$

CLG	Local government consumption, millions of 1985 FIM
DSOC	Dummy for inclusion of transfers in tax base in 1982
DTLG	Dummy for share of income taxes in local government taxation
DTYLG	Dummy for change in the system of advance dispursement of tax receipts to local government
PCLG	Local government consumption prices, 1985 = 100
SUBLG	Local government subsidies, FIM million
TER	Increase in the tax base
TLGR	Average local government tax rate
TRCGL	Central government transfers to local government, FIM million
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
TYC	Central and local government revenue from direct taxes on corporate entities, FIM million
TYCG	Central government revenue from direct taxes, FIM million
TYLG	Local government revenue from direct taxes, FIM million
TYP	Central and local government revenue from direct taxes on households, FIM million
YCLG	Taxable corporate income in local government taxation, FIM million
YSE	Households' entrepreneurial income, total, FIM million
YW	Wages and salaries, total, FIM million

G.18 Central Government Revenue from Commodity Taxes

TIV = TSCG + TECG + TIOV

G.19 Central Government Revenue from Indirect Taxes

TICG = TIV + TIOCG

G.20 Central Government Revenue, Total

YCGTOT = TYCG + TICG + SOCG + YOCG

G.21 Central Government Investment, Value

ICGV = ICG • PICG/100

G.22 Central Government Investment (including enterprises), Value

ICGTV = ICGV + ICGEV

G.23 Subsidies

SUBT = SUBCG + SUBLG

ICG	Central government investment, millions of 1985 FIM
ICGEV	Central government investment in government enterprises, FIM million
ICGTV	Central government investment (including enterprises), FIM million
ICGV	Central government investment, FIM million
PICG	Central government investment prices, 1985 = 100
SOCG	Central government revenue from employers' child allowance contributions, FIM million
SUBCG	Central government subsidies, FIM million
SUBLG	Local government subsidies, FIM million
SUBT	Subsidies, total, FIM million
TECG	Central government revenue from excise tax on liquid fuels, FIM million
TICG	Central government revenue from indirect taxes, FIM millionn
TIOCG	Central government revenue from other indirect taxes, FIM million
TIOV	Other commodity taxes, FIM million
TIV	Central government revenue from commodity taxes, FIM millio
TSCG	Central government revenue from sales tax, FIM million
TYCG	Central government revenue from direct taxes, FIM million
YCGTOT	Central government revenue, total, FIM million
YOCG	Central government other revenue, FIM million

G.24 Central Government Expenditure, Value

$$GCGTOTV = CCGV + ICGTV + SUBCG + TRCGH + TRCGL + TRCGS + TRCGF + GCGI + GOCGV$$

G.25 Benefits paid by the Social Insurance Institution, Value

$$TRSHV = TRSH \cdot PCP/100$$

G.26 Central Government Borrowing, Net

$$FCGN = GCGTOTV - YCGTOT$$

G.27 Central Government Housing Loans, Net Change

$$FCGHN = FCGH - FCGHB$$

G.28 Change in Holdings of Central Government Bonds by the Public

$$FPCGN = FCGN - FMCGN - (LBFGN - LBFGN_{-1}) + (LCGBN - LCGBN_{-1}) + FCGHN - FCGON$$

G.29 Local Government Investment, Value

$$ILGV = ILG \cdot PILG/100$$

G.30 Local Government Other Expenditures, Net, Value

$$GLGOV = TYLG + TRCGL - CLGV - ILGV$$

CCGV	Central government consumption, FIM million
CLGV	Local government consumption, FIM million
FCGH	Central government housing loans, drawing, FIM million
FCGHB	Central government housing loans, redemptions, FIM million
FCGHN	Central government housing loans, net change, FIM million
FCGN	Central government borrowing, net, FIM million
FCGON	Central government other borrowing, net, FIM million
FMCGN	Foreign borrowing by the central government, net, FIM million
FPCGN	Change in holdings of central government bonds by the public, FIM million
GCGI	Central government interest expenditure, FIM million
GCGTOTV	Central government expenditure, FIM million
GLGOV	Other expenditure, local government, FIM million
GOCGV	Other expenditure, central government, FIM million
ICGTV	Central government investment (including enterprises), FIM million
ILG	Local government investment, millions of 1985 FIM
ILGV	Local government investment, FIM million
LBFGN	Central government debt to the Bank of Finland, net, FIM million
PCP	Private consumption prices, 1985 = 100
PILG	Local government investment prices, 1985 = 100
SUBCG	Central government subsidies, FIM million
TRCGF	Central government transfers abroad, FIM million
TRCGH	Central government transfers to households, FIM million
TRCGL	Central government transfers to local government, FIM million
TRCGS	Central government transfers to the social insurance institution, FIM million
TRSH	Benefits paid by the Social Insurance Institution, millions of 1985 FIM
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
TYLG	Local government revenue from direct taxes, FIM million
YCGTOT	Central government revenue, total, FIM million

B. BALANCE OF PAYMENTS

B.1 Trade Balance

$$BPTV = XGV - MGV$$

B.2 Balance of Goods and Services

$$BPTSV = BPTV + XSV - MSV$$

B.3 Investment Income from Abroad, Net

$$YFIN = 0.5 \cdot KLMN_{-1} \cdot (YFIN_{-1}/KLMN_{-2} + YFIN_{-2}/KLMN_{-3})$$

B.4 Income Transfers from Abroad, Net

$$- YFTR - TRCGF = \underset{(0.00006)}{0.00038} \cdot GDPV$$

$\bar{R}^2 = 0.2993$ DW = 1.660 SE = 21.6383 62.1 - 85.4

B.5 Current Account

$$BPCV = BPTSV + YFIN + YFTR$$

BPCV	Current account, FIM million
BPTSV	Balance of goods and services, FIM million
BPTV	Trade balance, FIM million
GDPV	GDP in purchasers' values, FIM million
KLMN	Long-term foreign debt, net, FIM million
MGV	Imports of goods, total, FIM million
MSV	Imports of services, FIM million
TRCGF	Central government transfers abroad, FIM million
YFIN	Investment income from abroad, net, FIM million
YFTR	Income transfers from abroad, net, FIM million
XGV	Exports of goods, FIM million
XSV	Exports of services, FIM million

B.6 Current and Long-Term Capital Account

$$BPBV = BPCV + FLMN + FMCGN + \Delta KFBFO$$

B.7 Short-Term Capital Account

$$(FSMN + FLMN - \Delta FPBBF)/(KDP_{-1} + CUR_{-1}) =$$

$$\underset{(0.04735)}{-\ 0.85583} \cdot VVV$$

$$-\ [\underset{(.00067)}{0.00128} \cdot DMM + \underset{(0.00160)}{0.00551} \cdot (1-DMM)] \cdot$$

$$[\Delta((RB/RDEB)RFOR) - \Delta RDT] \cdot GDPV_{-1}/(KDP_{-1} + CUR_{-1})$$

$$+\ \underset{(0.06150)}{0.67186} \cdot \left(\frac{GDPV_{-1}}{KDP_{-1} + CUR_{-1}}\right)\Delta\left(\frac{KDP_{-1} + CUR_{-1}}{GDPV_{-1}}\right)$$

$$+\ \underset{(0.05892)}{0.11388} \cdot \left(\frac{GDPV_{-1}}{KDP_{-1} + CUR_{-1}}\right)\left(\frac{\Delta GDPV}{GDPV_{-1}} - \frac{\Delta GDPV_{-1}}{GDPV_{-2}}\right)$$

$$+\ \underset{(0.00193)}{0.00251} \cdot GDPV_{-1}/(KDP_{-1} + CUR_{-1})$$

$$-\ \underset{(0.01017)}{0.01934} \cdot (DMM - DMM_{-1})$$

where $VVV = (\Delta KDP + \Delta CUR - FSMN - FLMN + \Delta FPBBF)/(KDP_{-1} + CUR_{-1}) - \Delta GDPV_{-1}/GDPV_{-1}$

$\bar{R}^2 = 0.859$ SE = 0.0061 72.1 - 86.4

Estimated jointly with equation R.8

BPBV	Current and long-term capital account (basic balance), FIM million
BPCV	Current account, FIM million
CUR	Currency in circulation, FIM million
DMM	Dummy for the emergence of the CD market
FLMN	Long-term private capital inflows, net, FIM million
FMCGN	Foreign borrowing by the central government, net, FIM million
FPBBF	Banks' forward purchases of foreign exchange from the Bank of Finland, FIM million
FSMN	Short-term capital account, FIM million
GDPFV	GDP at factor cost, FIM million
GDPV	GDP in purchasers' values, FIM million
KDP	Bank deposits by the public, FIM million
KFBFO	Bank of Finland's other foreign assets, net, FIM million
RDT	Interest rate, time deposits, per cent
RFOR	Weighted average 3-month euromarket interest rate for USD, GBP, DEM and CHF, per cent

B.8 Banks' Forward Purchases of Foreign Exchange from the Public, Net

$$\Delta FPBP = \underset{(0.0601)}{0.5425} \cdot (FSMN + FLMN - FPBBF + FPBBF_{-1})$$

$$+ \underset{(0.2206)}{0.1314} \cdot \Delta BPTV$$

$$+ \underset{(0.0124)}{0.0205} \cdot KATPAR$$

where $KATPAR = (\Delta RS - \Delta REUD - \Delta FXFUS) \cdot (XV_{-1} + MV_{-1})$

$\bar{R}^2 = 0.758$ DW = 2.330 SE = 1466.17 80.3 - 88.4

B.9 Forward Premium on USD

$$FXFUS - RS + REUD = + \underset{(0.14898)}{0.7779}$$

$$- \underset{(1.3424)}{5.4211} \cdot (FPBT/KDP + FPBT_{-1}/KDP_{-1})$$

$\bar{R}^2 = 0.317$ DW = 1.158 SE = 0.5730 80.3 - 88.4

B.10 Long-Term Foreign Debt, Net

$$KLMN = KLMN_{-1} + FLMN + FMCGN + KFBFO - KFBFO_{-1} + ((FXSD - FXSD_{-1})/FXSD_{-1}) \cdot (KLMN_{-1} + 0.5 \cdot (FLMN + FMCGN + KFBFO - KFBFO_{-1}))$$

BPTV	Trade balance, FIM million
FLMN	Long-term private capital inflows, net, FIM million
FMCGN	Foreign borrowing by the central government, net, FIM million
FPBBF	Banks' forward purchases of foreign exchange from the Bank of Finland, FIM million
FPBP	Banks' forward purchases of foreign exchange from the public, net, FIM million
FPBT	Banks' overall forward position
FSMN	Short-term capital account, FIM million
FXFUS	Three-month forward premium on USD, % pa
FXSD	Exchange rate index for long-term foreign debt, 1960 = 1.00
KFBFO	Bank of Finland's other foreign assets, net, FIM million
KDP	Bank deposits by the public, FIM million
KLMN	Long-term foreign debt, net, FIM million
MIV	Imports of investment goods, FIM million
REUD	Interest rate, 3-month eurodollar deposits, per cent
RS	Money market rate, per cent

B.11 Bank of Finland's Foreign Claims, Net

$$GFXN = GFXT + KFBFO + GFXC$$

B.12 Banks' Overall Forward Position

$$FPBT = FPBP + FPBBF$$

B.13 Bank of Finland's Tied Foreign Exchange Reserves

$$\Delta GFXT = XGEV - MGEV$$

B.14 Bank of Finland's Convertible Foreign Exchange Reserves

$$\Delta GFXC = BPBV + FSMN - \Delta GFXT$$

BPBV	Current and long-term capital account (basic balance), FIM million
FPBBF	Banks' forward purchases of foreign exchange from the Bank of Finland, FIM million
FPBT	Banks' net forward position in foreign exchange, FIM million
FSMN	Short-term capital account, FIM million
GFXC	Bank of Finland's convertible foreign exchange reserves, FIM million
GFXN	Bank of Finland's foreign claims, net, FIM million
GFXT	Bank of Finland's tied foreign exchange reserves, FIM million
KFBFO	Bank of Finland's other assets, net, FIM million
MGEV	Imports of goods, bilateral, FIM million
XGEV	Exports of goods, bilateral, FIM million

R. FINANCIAL MARKETS

R.1 Currency in Circulation

$$\log(CUR/PCP) = \underset{(0.14518)}{-\,0.12178} + \underset{(0.02941)}{0.12590} \cdot \log C - \underset{(0.00483)}{0.00523} \cdot RDT_{-1} + \underset{(0.06812)}{0.72629} \cdot \log(CUR_{-1}/PCP)$$

$\bar{R}^2 = 0.913$ DW = 2.457 SE = 0.0321 61.1 - 85.4

R.2 Market Yield on Debentures

$$RDEB = \underset{(0.65617)}{5.88100} + \underset{(0.05061)}{0.51258} \cdot RS$$

$\bar{R}^2 = 0.790$ RHO = 0.23 SE = 0.3265 62.1 - 86.4

C	Total private consumption, millions of 1985 FIM
CUR	Currency in circulation, FIM million
PCP	Private consumption prices, 1985 = 100
RDEB	Market yield on debentures, per cent
RDT	Interest rate, time deposits, per cent
RS	Money market rate, per cent

R.3 Yield on Tax-Free Bonds

$$\Delta \log RB = \underset{(0.11509)}{0.30993} \cdot \Delta \log RB_{-1}$$

$$+ \underset{(0.08697)}{0.26554} \cdot \Delta \log[(1 - TEFFR)RDEB]$$

$$+ \underset{(0.07438)}{0.30763} \cdot \log[(1 - TEFFR_{-1})RDEB_{-1}/RB_{-1}]$$

where $TEFFR = [0.82266 \cdot (TYCR + TLGR) - 11.393 \cdot \Delta PCP/PCP_{-1}]/(1 + 0.01 \cdot RDEB)^2$

$\bar{R}^2 = 0.4027$ DW = 1.8644 SE = 0.035 77.1 - 88.4

R.4 Banks' Average Interest Rate on Outstanding Loans

$$\Delta RLB = \underset{(0.02671)}{0.10291} \cdot \Delta RS + \underset{(0.05341)}{0.98182} \cdot \Delta RD$$

$$+ \underset{(0.01363)}{0.04033} \cdot RS_{-1} - \underset{(0.02849)}{0.11846} \cdot RLB_{-1}$$

$$+ \underset{(0.23831)}{0.76826}$$

$\bar{R}^2 = 0.965$ RHO = -0.61 SE = 0.099 85.1 - 88.4

R.5 Overnight (Call Money) Rate

$$\Delta RCALL = \Delta RS$$

R.6 Time Deposit Rate

$$\Delta RDT = \Delta RD$$

R.7 Cash Reserve Deposits by Banks

$$\Delta(CR/KDP) = \underset{(0.00045)}{0.00990} \cdot \Delta CRR$$

$\bar{R}^2 = 0.830$ DW = 1.670 SE = 0.0015 62.1 - 85.4

CR	Cash reserve deposits by banks, FIM million
CRR	Cash reserve requirement, per cent
KDP	Bank deposits by the public, FIM million
PCP	Private consumption prices, 1985 = 100
RB	Market yield on tax-free bonds, per cent
RCALL	Overnight (Call Money) rate, per cent
RD	Bank of Finland's base rate, per cent
RDEB	Market yield on debentures, per cent
RDT	Interest rate, time deposits, per cent
RLB	Bank lending rate, per cent
RS	Money market rate, per cent
TLGR	Average local government tax rate
TYCR	Corporate tax rate in central government taxation

R.8 Banks' Net Debt to the Bank of Finland

$$LBFBN = CUR - GFXN - LBFGN - LBFPN + KOBFN$$

R.9 Banks' Gross Debt to the Bank of Finland

$$LBFBT = LBFBN + CR - LBFCUR$$

R.10 Bank Loans to the Public

$$\begin{aligned} DID \cdot (LBP - LBP_{-1})/LBP_{-1} = {} & \underset{(0.00210)}{0.03679} \cdot DID \\ & - \underset{(0.00033)}{0.00229} \cdot DID \cdot \sum_{i=0}^{7} a_i (RCALL - RLB)_{-i} \\ & + \underset{(0.01571)}{0.12047} \cdot DID \cdot (PGDPF - PGDPF_{-4})/PGDPF_{-4} \end{aligned}$$

lag	i	0	1	2	3	4	5	6	7	$\sum$
weight	a_i	22	.19	.17	.14	.11	.08	.06	.03	1

$\bar{R}^2 = 0.889$ DW = 1.659 SE = 0.0062 62.1 - 85.4

R.11 Bank Deposits by the Public

$$\begin{aligned} \Delta\left(\frac{KDP + CUR}{GDPV_{-1}}\right) = {} & \frac{A4 + DMM \cdot (A5 - A4)}{A2} \cdot \left(\Delta RDT - \Delta\left(\frac{RB}{RDEB} \cdot RS\right)\right) \\ & - \frac{A7}{A2} \cdot \left[\frac{(KDP + CUR)}{GDPV_{-1}} - \frac{(KDP_{-1} + CUR_{-1})}{GDPV_{-1}}\right] \\ & - \frac{A6}{A2} \cdot \left(\frac{\Delta GDPV}{GDPV_{-1}} - \frac{\Delta GDPV_{-1}}{GDPV_{-2}}\right) \end{aligned}$$

where $A2 = \underset{(0.04735)}{-.85583}$ $A4 = \underset{(.00160)}{-.00551}$ $A5 = \underset{(.00067)}{-.00128}$

$A6 = \underset{(.05892)}{.11388}$ $A7 = \underset{(.06150)}{.67186}$

$\bar{R}^2 = .748$ SE = .0186 72.1 - 86.4

Estimated jointly with equation B.7

CR	Cash reserve deposits by banks, FIM million
CUR	Currency in circulation, FIM million
DID	Dummy: credit rationing periods
DMM	Dummy for the emergence of the CD market
GFXN	Bank of Finland's foreign claims, net, FIM million
GDPV	GDP in purchasers' values, FIM million
KDP	Banks' deposits by the public, FIM million
KOBFN	Bank of Finland's capital and other items, FIM million
LBFBN	Banks' net debt to the Bank of Finland, FIM million
LBFBT	Gross central bank debt of the banks, FIM million
LBFCUR	Till money credits to the banks, FIM million
LBFGN	Central government debt to the Bank of Finland, net, FIM million
LBP	Bank loans to the public, FIM million
PGDPF	GDP deflator at factor cost, 1985 = 100
RB	Market yield on tax-free bonds, per cent
RCALL	Overnight (call money) rate, per cent
RDEB	Market yield on debentures, per cent
RDT	Interest rate, time deposits, per cent
RLB	Bank lending rate, per cent
RS	Money market rate, per cent

R.12 Banks' Other Liabilities

$$KDOB = LBP - KDP - LCGBN - LBFBN - KOBN$$

R.13 Central Government Bonds Held by the Public

$$SECPCG = FPCGN + SECPCG_{-1}$$

FPCGN	Change in holdings of central government bonds by the public, FIM million
KDOP	Banks' other liabilities, FIM million
KDP	Bank deposits by the public, FIM million
KDOB	Balance sheet of the banks, other items, net, FIM million
LBFBN	Banks' net debt to the Bank of Finland, FIM million
LBP	Bank loans to the public, FIM million
LCGBN	Banks' debt to the central government, net, FIM million
SECPCG	Central government bonds held by the public, FIM million

APPENDIX 2
LIST OF VARIABLES

Exogenous variables are denoted by *, excluding short-term interest rates RS and RCALL and Banks' Gross debt to the Central Bank LBFBT which is either endogenous or exogenous depending on the model version.

*ALFA	Tax Depreciation coefficient
*ALFA4	Tax Depreciation coefficient, manufacturing
ATAX	Personal tax rate, estimate
BPBV	Current and long-term capital account (basic balance), FIM million
BPCV	Current account, FIM million
BPTSV	Balance of goods and services, FIM million
BPTV	Trade balance, FIM million
C	Total private consumption, millions of 1985 FIM
*CCG	Central government consumption, millions of 1985 FIM
CCGV	Central government consumption, FIM million
*CCRG	Capital consumption rate, general government
*CCRH	Capital consumption rate, residential construction
*CCR1	Capital consumption rate, agriculture
*CCR2	Capital consumption rate, services
*CCR3	Capital consumption rate, forestry
*CCR4	Capital consumption rate, manufacturing
CCTV	Consumption of fixed capital, FIM million
CD	Private consumption, durables, millions of 1985 FIM
CDV	Private consumption, durables, FIM million
*CEND	Domestic energy (incl. nuclear power) consumption, 1000 toe
CG	Total public consumption, millions of 1985 FIM
CGV	Total public consumption, FIM million
CLG	Local government consumption, millions of 1985 FIM
CLGV	Local government consumption, FIM million
CND	Private consumption, non-durables and semi-durables, millions of 1985 FIM
CNDV	Private consumption, non-durables and semi-durables, FIM million
CR	Cash reserve deposits by banks, FIM million
*CRR	Cash reserve requirement
CS	Private consumption, services, millions of 1985 FIM

CSV	Private consumption, services, FIM million
CTOT	Total consumption, millions of 1985 FIM
CTOTV	Total consumption, FIM million
CUR	Currency in circulation, FIM million
CV	Total private consumption, FIM million
FB	Net lending by the corporate sector, incl. financial institutions, FIM million
*FCGH	Central government housing loans, drawing, FIM million
*FCGHB	Central government housing loans, redemptions, FIM million
FCGHN	Central government housing loans, net change, FIM million
FCGN	Central government borrowing, net, FIM million
*FCGON	Central government other borrowing, net, FIM million
FG	Net lending by the public sector, FIM million
FH	Net lending by households, FIM million
*FLMN	Long-term private capital inflows, net, FIM million
*FMCGN	Foreign borrowing by the central government, net, FIM million
*FPBBF	Banksä forward purchases of foreign exchange from the Bank of Finland, FIM million
FPBP	Banks' forward purchases of foreign exchange from the public, net, FIM million
FPBT	Banks' overall forward position, FIM million
FPCGN	Change in holdings of central government bonds by the public, FIM million
FSMN	Short-term capital account, FIM million
FXFUS	Forward Premium on USD, % pa
*FXSD	Exchange rate index for long-term foreign debt, 1960 = 1.00
*FXSUSD	Exchange rate, FIM/USD
GCGI	Central government interest expenditure, FIM million
GCGTOTV	Central government expenditure, FIM million
GDP	GDP in Purchasers' Values, millions of 1985 FIM
GDP1	Production at factor cost, agriculture, millions of 1985 FIM
GDP2	Production at factor cost, services etc., millions of 1985 FIM
GDP3	Production at factor cost, forestry, millions of 1985 FIM
GDP4	Production at factor cost, manufacturing, millions of 1985 FIM
GDPF	GDP at factor cost, millions of 1985 FIM
GDPFV	GDP at factor cost, FIM million
GDPG	Production at factor cost, general government, millions of 1985 FIM
GDPV	GDP in Purchasers' Values, FIM million
GDPVG	Production at factor cost, general government, FIM million

GDPV1	Production at factor cost, agriculture, FIM million
GDPV2	Production at factor cost, services and other, FIM million
GDPV3	Production at factor cost, forestry, FIM million
GDPV4	Production at factor cost, manufacturing, FIM million
GFXC	Bank of Finland's convertible foreign exchange reserves, FIM million
GFXN	Bank of Finland's foreign claims, net, FIM million
GFXT	Bank of Finland's tied foreign exchange reserves, FIM million
GLGOV	Other expenditure, local government, FIM million
*GOCGV	Other expenditure, central government, FIM million
I	Private fixed investment, millions of 1985 FIM
*ICG	Central government investment, millions of 1985 FIM
*ICGEV	Central government investment in government enterprises, FIM million
ICGTV	Central government investment (including enterprises), FIM million
ICGV	Central government investment, FIM million
IF	Private non residential investment, millions of 1985 FIM
IF1	Private fixed investment, agriculture, millions of 1985 FIM
IF2	Private fixed investment, services etc., millions of 1985 FIM
IF3	Private fixed investment, forestry, millions of 1985 FIM
IF4	Private fixed investment, manufacturing, millions of 1985 FIM
IFV	Private non-residential investment, FIM million
IFV1	Private fixed investment, agriculture, FIM million
IFV2	Private fixed investment, services, FIM million
IFV3	Private fixed investment, forestry, FIM million
IFV4	Private fixed investment, manufacturing, FIM million
IG	Total public investment, millions of 1985 FIM
IGV	Total public investment, FIM million
IH	Residential construction, millions of 1985 FIM
IHV	Residential construction, FIM million
II	Change in inventories, millions of 1985 FIM
IIS	Inventory investment and statistical discrepancy, millions of 1985 FIM
IISV	Inventory investment and statistical discrepancy, millions of FIM
*ILG	Local government investment, millions of 1985 FIM
ILGV	Local government investment, FIM million
INF	Expected inflation, per cent
ITOT	Total fixed investment, millions of 1985 FIM

ITOTV	Total fixed investment, FIM million
IV	Private fixed investment, FIM million
KDOB	Banks' other liabilities, FIM million
KDP	Banks' deposits by the public, FIM million
*KFBFO	Bank of Finland other foreign liabilities, net, FIM million
KFCG	Net stock of fixed capital, central government, millions of 1985 FIM
KFLG	Net stock of fixed capital, local government, millions of 1985 FIM
KF1	Net stock of fixed capital, agriculture, millions of 1985 FIM
KF2	Net stock of fixed capital, service etc., millions of 1985 FIM
KF3	Net stock of fixed capital, forestry, millions of 1985 FIM
KF4	Net stock of fixed capital, manufacturing, millions of 1985 FIM
KH	Net stock of private residential capital, millions of 1985 FIM
KII	Stock of inventories, millions of 1985 FIM
KLMN	Long-term foreign debt, net, FIM million
*KOBFN	Bank of Finland other balance sheet items, net, FIM million
KOBN	Balance sheet of the banks, other items, net, FIM million
LBFBN	Banks' net debt to the Bank of Finland, FIM million
LBFBT	Gross Central Bank Debt of the Banks, FIM million
*LBFCUR	Till-money credits, FIM million
*LBFGN	Central government debt to the Bank of Finland, net, FIM million
*LBFPN	Bank of Finland lending to the public, FIM million
LBP	Bank loans to the public, FIM million
*LCGBN	Banks' debt to the central government, net, FIM million
LE	Employment, 1000 persons
LES	Employment (Labour Force Survey), 1000 persons
LFS	Labour force, (Labour Force Survey), 1000 persons
LH	Performed working hours total, millions of hours
LHG	Performed working hours, general government, millions of hours
LH1	Performed working hours, agriculture, millions of hours
LH2	Performed working hours, services etc., millions of hours
LH3	Performed working hours, forestry, millions of hours
LH4	Performed working hours, manufacturing, millions of hours
LUS	Unemployment (Labour Force Survey), 1000 persons
LW	Paid labour input, total, millions of 1985 FIM
LWG	Paid labour input, general government, millions of 1985 FIM
LW1	Paid labour input, agriculture, millions of 1985 FIM
LW2	Paid labour input, services etc., millions of 1985 FIM
LW3	Paid labour input, forestry, millions of 1985 FIM

LW4	Paid labour input, manufacturing, millions of 1985 FIM
M	Imports of goods and services, millions of 1985 FIM
MC	Imports of consumer goods, millions of 1985 FIM
MCV	Imports of consumer goods, FIM million
MFL	Imports of fuels and lubricants, millions of 1985 FIM
MFLV	Imports of fuels and lubricants, FIM million
*MFOR	Imports of Finland's major export countries, 1985 = 100
MG	Imports of goods, total, millions of 1985 FIM
MGEV	Imports of goods, bilateral, FIM million
MGV	Imports of goods, total, FIM million
MI	Imports of investment goods, millions of 1985 FIM
MIV	Imports of investment goods, FIM million
MR	Imports of raw materials, millions of 1985 FIM
MRV	Imports of raw materials, FIM million
MS	Imports of services, millions of 1985 FIM
MSV	Imports of services, FIM million
MTAX	Personal marginal tax rate, estimate
MV	Imports of goods and services, FIM million
*N	Population of working age (15-74 years), 1000 persons
P1	Prices in agriculture, 1985 = 100
P2	Prices in services etc., 1985 = 100
P3	Prices in forestry, 1985 = 100
P4	Prices in manufacturing, 1985 = 100
PCCG	Central government consumption prices, 1985 = 100
PCD	Private consumption prices, durables, 1985 = 100
PCDIO	Private consumption prices, durables, input-output estimate 1985 = 100
PCG	Public consumption prices, 1985 = 100
PCGIO	Public consumption prices, input-output estimate, 1985 = 100
PCLG	Local government consumption prices, 1985 = 100
PCND	Private consumption prices, non-durables and semi-durables, 1985 = 100
PCNDIO	Private consumption prices, non-durables and semi-durables, input-output estimate, 1985 = 100
PCP	Private consumption prices, 1985 = 100
PCS	Private consumption prices, services, 1985 = 100
PCSIO	Private consumption prices, services, input-output estimate, 1985 = 100

PD4	Price index of manufacturing goods sold on the domestic market, 1985 = 100
*PFOR	Import prices of Finland's major export countries, FIM, 1985 = 100
PFXG	Competitors' prices on foreign markets, 1985 = 100
PGDP1	Value added deflator in agriculture, 1985 = 100
PGDP1IO	Value added deflator in agriculture, input-output estimate, 1985 = 100
PGDP2	Value added deflator in services etc., 1985 = 100
PGDP3	Value added deflator in forestry, 1985 = 100
PGDP3IO	Value added deflator in forestry, input-output estimate, 1985 = 100
PGDP4	Value added deflator in manufacturing, 1985 = 100
PGDP4IO	Value added deflator in manufacturing, input-output estimate, 1985 = 100
PGDPF	Value added deflator at factor cost, 1985 = 100
PGDPG	Value added deflator in general government, 1985 = 100
PI	Private investment prices, 1985 = 100
PICG	Central government investment prices, 1985 = 100
PIF	Private non-residential investment prices, 1985 = 100
PIFIO	Fixed investment prices, input-output estimate, 1985 = 100
PIF1	Fixed investment prices, agriculture, 1985 = 100
PIF2	Fixed investment prices, services, 1985 = 100
PIF3	Fixed investment prices, forestry, 1985 = 100
PIF4	Fixed investment prices, manufacturing, 1985 = 100
PIG	Public investment prices, 1985 = 100
PIH	Residential construction prices, 1985 = 100
PILG	Local government investment prices, 1985 = 100
PITOT	Investment prices, 1985 = 100
*PMC	Import prices of consumer goods, 1985 = 100
*PMFL	Import prices of fuels and lubricants, 1985 = 100
PMG	Import prices of goods, 1985 = 100
*PMI	Import prices of investment goods, 1985 = 100
*PMR	Import prices of raw materials, 1985 = 100
*PMS	Import prices of services, 1985 = 100
*PWW	World-market prices of wood products (HWWA), 1985 = 100
PXG	Export prices of goods, 1985 = 100
PXGE	Export prices of goods, bilateral, 1985 = 100
PXGW	Export prices of goods, multilateral, 1985 = 100
PXS	Export prices of services, 1985 = 100

RB	Market yield on tax-free bonds, per cent
RCALL	Overnight (call money) rate, per cent
*RD	Base rate on central bank debt, per cent
RDEB	Market yield on debentures, per cent
RDT	Interest rate, time deposits, per cent
*REUD	Interest rate, 3-month eurodollar deposits, per cent
*RFOR	Average 3 month euromarket interest rate for USD, GBP, DEM and CHF, per cent
RLB	Banks' average interest rate on outstanding loans, per cent
RLBN	Average rate on deposit banks' new lending, per cent
RS	Money market rate, per cent
RSV	Estimate for after-tax short term interest rate, per cent
SECPCG	Central government bonds held by the public, FIM million
SMCD4	Marginal costs of manufacturing goods sold on the domestic market, 1985 = 100
SMCXG	Marginal costs in exports, 1985 = 100
SMC1	Marginal costs in agriculture, 1985 = 100
SMC2	Marginal costs in services etc., 1985 = 100
SMC3	Marginal costs in forestry, 1985 = 100
SOCC	Employers' social security contributions, total, FIM million
SOCCG	Employers' social security contributions, general government, FIM million
SOCC1	Employers' social security contributions, agriculture, FIM million
SOCC2	Employers' social security contributions, services etc., FIM million
SOCC3	Employers' social security contributions, forestry, FIM million
SOCC4	Employers' social security contributions, manufacturing, FIM million
SOCCRG	Employers' social security contribution rate, general government
SOCCR1	Employers' social security contribution rate, agriculture
SOCCR2	Employers' social security contribution rate, services etc.
SOCCR3	Employers' social security contribution rate, forestry
SOCCR4	Employers' social security contribution rate, manufacturing
SOCCS	Employers' national pensions ans sickness insurance contributions, FIM million
SOCG	Central government revenue from employers' child allowance contributions, FIM million
*SOCGR	Employers' child allowance contribution rate

*SOCLELR	Employers' contribution rate for temporary employee pension scheme
*SOCLR	Insured persons' national pensions and sickness insurance contribution rate
SOCLS	Insured persons national pensions and sickness insurance contributions, FIM million
*SOCSR	Employers' national pensions and sickness insurance contribution rate
*SOCTELR	Employers' contribution rate for employee pension schemes
*STD	Statistical discrepancy, millions of 1985 FIM
*SUB	Commodity subsidies, millions of 1985 FIM
*SUBCG	Central government subsidies, FIM million
*SUBLG	Local government subsidies, FIM million
SUBT	Subsidies, total, FIM million
*TEBR	Excise tax rate on petrol
TECG	Central government revenue from excise tax on liquid fuels, FIM million
*TEDR	Excise tax rate on diesel oil
TEFFR	Effective corporate tax rate, per cent
*TER	Increase in the tax base
TICG	Central government revenue from indirect taxes, FIM million
TIN	Indirect taxes less subsidies, millions of 1985 FIM
TIOCG	Central government revenue from other indirect taxes, FIM million
TIOV	Other commodity taxes, FIM million
TIRG	Indirect tax rate on production, general government
TIR1	Indirect tax rate on production, agriculture
TIR2	Indirect tax rate on production, services
TIR3	Indirect tax rate on production, forestry
TIR4	Indirect tax rate on production, manufacturing
TIRCD	Indirect tax rate on consumption, durables
TIRCND	Indirect tax rate on consumption, non-durables and semi-durables
TIRCS	Indirect tax rate on consumption, services
TIRCG	Indirect tax rate on consumption, general government
TIRIH	Indirect tax rate on investment, residential construction
TIRIG	Indirect tax rate on investment, general goverment
TIRIF1	Indirect tax rate on investment, agriculture
TIRIF2	Indirect tax rate on investment, services
TIRIF3	Indirect tax rate on investment, forestry
TIRIF4	Indirect tax rate on investment, manufacturing

TIRXG	Indirect tax rate on exports, goods
TIV	Central government revenue from commodity taxes, FIM million
TLGR	Average local government tax rate
*TOCG	Compulsory fees, fines and penalties, FIM million
*TRCGF	Central government transfers abroad, FIM million
*TRCGH	Central government transfers to households, FIM million
*TRCGS	Central government transfers to the social insurance institution, FIM million
*TREND	Linear trend: 60.1 = .25, 60.2 = .50 etc.
*TREND74	Breaking trend: 60.1 = 15, 60.2 = 14.75, ..., 74.4 = .25, zero thereafter
*TRCGL	Central government transfers to local government, FIM million
TRHGN	Households' transfers to other sectors, net, FIM million
TRHO	Other transfers to households, net, millions of 1985 FIM
TRHOV	Other transfers to households, net, FIM million
*TRSH	Benefits paid by the Social Insurance Institution, millions of 1985 FIM
TRSHV	Benefits paid by the Social Insurance Institution, FIM million
*TRSP	Pensions paid by the Social Insurance Institution, millions of 1985 FIM
*TRSSV	Sickness insurance compensation, FIM million
TSCG	Central government revenue from sales tax, FIM million
*TSR	Sales tax rate
*TSR7	Sales tax rate, industrial machinery and equipment
*TSR8	Sales tax rate, industrial buildings
TYC	Central and local government revenue from direct taxes on corporate entities, FIM million
TYCG	Central government revenue from direct taxes, FIM million
*TYCR	Corporate tax rate in central government taxation
TYLG	Local government revenue from direct taxes, FIM million
TYP	Central and local government revenue from direct taxes on households, FIM million
*TYS	Slope of the progressive income tax schedule
(*)TYU	Intercept of the progressive income tax schedule
UC1	User cost of fixed capital, agriculture
UC2	User cost of fixed capital, services etc.
UC3	User cost of fixed capital, forestry
UC4	User cost of fixed capital, manufacturing
UR	Unemployment rate, per cent
WNRP	Negotiated wage rate, private sector 1985 = 100

WR	Wage rate, total, 1985 = 100
WRG	Wage rate, general government, 1985 = 100
WR1	Wage rate, agriculture, 1985 = 100
WR2	Wage rate, services and other, 1985 = 100
WR3	Wage rate, forestry, 1985 = 100
WR4	Wage rate, manufacturing, 1985 = 100
X	Exports of goods and services, millions of 1985 FIM
XG	Exports of goods, millions of 1985 FIM
XGE	Exports of goods, bilateral, millions of 1985 FIM
XGEV	Exports of goods, bilateral, FIM million
XGV	Exports of goods, FIM million
XGW	Exports of goods, multilateral, millions of 1985 FIM
XGWV	Exports of goods, multilateral, FIM million
XS	Exports of services, millions of 1985 FIM
XSV	Exports of services, FIM million
XV	Exports of goods and services, FIM million
Y	National Income, FIM million
YC	Profits of corporate entities before taxation, FIM million
YCCG	Taxable corporate income in central government taxation, FIM million
YCGTOT	Central government revenue, total, FIM million
YCLG	Taxable corporate income in local government taxation, FIM million
YD	Household disposable income, FIM million
YDC	Disposable income of the corporate sector incl. financial institutions, FIM million
YDG	Disposable income of the public sector, FIM million
YDTOT	National disposable income, FIM million
YFIN	Investment income from abroad, net, FIM million
YFTR	Income transfers from abroad, net, FIM million
YNW	Gross operating surplus, total, FIM million
YNWG	Gross operating surplus, general government, FIM million
YNW1	Gross operating surplus, agriculture, FIM million
YNW2	Gross operating surplus, services and other, FIM million
YNW3	Gross operating surplus, forestry, FIM million
YNW4	Gross operating surplus, manufacturing, FIM million
YNWN	Net property and entrepreneurial income, FIM million
YOCG	Central government other revenue, FIM million
YOH	Other household income, FIM million
YSE	Households' entrepreneurial income, total, FIM million

YSE1	Entrepreneurial income, agriculture, FIM million
YSE3	Entrepreneurial income, forestry, FIM million
YSEO	Other entrepreneurial income, FIM million
YW	Wages and salaries, total, FIM million
*YWF	Wages, salaries, empl. social secur. contr., from abroad, net, FIM million
YWG	Wages and salaries, general government, FIM million
YW1	Wages and salaries, agriculture, FIM million
YW2	Wages and salaries, services etc., FIM million
YW3	Wages and salaries, forestry, FIM million
YW4	Wages and salaries, manufacturing, FIM million

DUMMY VARIABLES

D5863	Dummy replacing sales tax rate in 1958 - 1963
D6263	Dummy for sales tax avoidance in 1962 - 1963
DEVL	Dummy for change in corporate taxation in 1969
DFT69	Dummy for revision of foreign trade statistics in 1969
DMM	Dummy for money markets
DQ1	Seasonal dummy, the first quarter
DQ2	Seasonal dummy, the second quarter
DQ3	Seasonal dummy, the third quarter
D75	Dummy, 60.1 - 74.1 = 1, 75.1 - = 0
DMCP	Dummy for cash payment requirement for imports
DP75	Dummy for change in manufacturing pricing in 1975
DPROP	Dummy for property tax reduction
DS63	Dummy for dock strike in 1963
DS71	Dummy for strike in the metal and engineering industry in 1971
DSOC	Dummy for inclusion of transfers in tax base in 1982
DTCG	Dummy for share of income taxes in central government taxation
DTLG	Dummy for share of income taxes in local goverment taxation
DTO	Dummy for removal of sales tax on fuel and lubricants in 1974
DTR66	Dummy for tax exemption of rent income
DTYLG	Dummy for change in the system of advance disbursement of tax receipts to local government
DTYP	Dummy for change in timing of tax reimbursements in 1976
DX66	Dummy for exceptional ice conditions in 1966

APPENDIX 3

PUBLICATIONS CONNECTED WITH THE BOF MODEL

PUBLICATIONS ABOUT THE BOF MODEL IN ORDER OF PUBLICATION

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