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AN ECONOMETRIC DISEQUILIBRIUM MACROMODEL OF THE FINNISH ECONOMY

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ABSTRACT

In this paper a model of the Finnish economy with disequilibrium in the goods and financial markets is specified and estimated by single equation methods. The transmission mechanisms of the model are studied in the framework of various devaluation simulations. The model is very sensitive, especially with respect to the prevailing credit market regime and possible regime changes. Policy effects are not affected so much by conditions in the goods market, assuming moderate policy shocks. These considerations suggest the importance in policy planning of identifying the regimes prevailing in the markets.

CONTENTS

1 INTRODUCTION

With the recent interest in theoretical disequilibrium models, there has also been extensive econometric work on these models. In the disequilibrium models short-run price and wage rigidities prevent instantaneous attainment of an equilibrium leading instead to temporary equilibrium with markets clearing by quantity rather than price adjustments.[1] Estimation of fix-price disequilibrium models for a single market with a demand function, supply function and a min condition, mostly by maximum likelihood method, has been accomplished in several studies since the derivation of the density function for the model by Maddala and Nelson (1974).[2] The main econometric complication is the possibility of unboundedness of the likelihood functions.

The estimation problems are more complex in the case of multimarket disequilibrium models. In these models the multiplicity of the integrals in the likelihood functions depends on the number of interrelated markets, thus creating difficult computational problems in estimation.[3] Despite these pitfalls there have been several attempts to estimate multimarket disequilibrium models. The most notable are by Artus et al. (1982), Kooiman and Kloek (1980), Sneessens (1981) and Vilares (1981) [for a recent survey, see Laffont (1983)]. The first and second models, both two market disequilibrium models, are estimated by the maximum likelihood method, while the other two models, being basically recursive, are estimated using single equation estimation techniques.

Besides estimation problems, this first wave of econometric work on multimarket disequilibrium models has been confined to the goods and labor

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[1]Disequilibrium models were first specified for a closed economy [Barro and Grossman (1976) and Malinvaud (1977)] and subsequently extended to an open economy framework [Dixit (1978), Steigum (1980) and Cuddington (1980)].

[2]For a review of the models and econometric methods, see Quandt (1982).

[3]Besides computational problems in the numerical optimization of the likelihood function there is also a possibility of multiple maxima.

markets. For some small countries with underdeveloped financial markets, such as Finland, an explicit treatment of disequilibrium in these markets would be highly desirable.[4] Since the spillover effect in such models from the goods market to the financial market is relatively weak, the model is approximately recursive and can be estimated by single equation methods, thus avoiding difficulties still encountered in full-information methods.

The aim of this paper is, first, to specify and estimate a disequilibrium macromodel of the Finnish economy and, secondly, to examine the transmission mechanisms of the model in the light of various devaluation simulations. In Section 2 the institutional characteristics of the Finnish economy and the specification of the model are discussed. Estimation results are presented in Section 3. The properties of the model in the different disequilibrium regimes are examined in Section 4 in the framework of devaluation simulations.

2 SPECIFICATION OF THE MODEL[5]

Most of the literature on disequilibrium models assumes highly developed financial markets with normally money as the only asset. However, this specification is not particularly appropriate in the case of a large group of smaller industrialized countries, such as Finland, which lack well functioning financial markets. In Finland domestic interest rates are set institutionally, which, in the absence of other equilibrating non-price loan terms mechanisms, has resulted from time to time in credit rationing.[6] Since other financial institutions and the securities market are relatively unimportant, the financial markets have been dominated by deposit banks, and firms have had to resort mainly to domestic and foreign bank lending

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[4]Theoretical disequilibrium models with an emphasis on financial markets are developed in Kähkönen (1982), Aurikko (1982b) and Cuddington (1983).

[5]The model is discussed in detail in Aurikko (1982b).

[6]Rigidity of non-price loan terms can also be rationalized by existing agreements, costs of changing the terms [see Koskela (1976) and Baltensperger (1978)] and adverse changes in the banks' loan portfolios [see Stiglitz and Weiss (1981)].

for investment finance. Moreover, foreign capital movements have been controlled fairly effectively by the central bank. With relatively low domestic interest rates during the past years, excess demand, and thus credit rationing in the domestic credit market, has occurred.

The model distinguishes between nontraded and traded goods in the domestic commodity markets and between different kinds of assets in in the asset markets. Altogether, there are five commodities in the model: nontraded goods(Q1), traded goods exported and used domestically for consumption or investment (Q2), imported final goods (MF) substitutable for the domestic traded goods in consumption (MFH) and investment (MFI), intermediate imports (MRF) used as inputs in domestic production in a proportion depending on relative prices, and labor (L). The assets in the model are currency (S), deposits (D), loans (LO), central bank credit (H), foreign capital (KF) and the foreign exchange reserves of the central bank (GCB). The sectoral aggregation of the model consists of households, banks, the central bank, the government sector, the foreign sector and two sets of firms producing nontraded and traded goods, respectively.

Households demand the domestic nontraded (C1) and traded goods (C2) as well as imported final goods (MFH). They supply labor, which is assumed to be determined exogenously. This implies that unemployment has only income effects with no substitution effects. Firms supply nontraded and traded goods to households, the government sector and the foreign sector. Firms demand labor, intermediate imports, investment goods, and domestic and foreign finance.

The domestic economy is connected with the foreign sector (rest of the world) through imports of intermediate and final goods, exports of traded goods and capital movements. Thus, the overall balance of the balance of payments (change in the foreign exchange reserves of the central bank, GCB) is $\Delta GCB = BC + \Delta eKFP + \Delta eKFG$, where BC is the current account and KFP (KFG) is the net stock of the foreign debt of the firms (government) in terms of foreign currency and e is the exchange rate.

With the balance sheet of the central bank defined as $S = H + GCB$, the supply of central bank credit to the private banks H^S is determined residually because the foreign exchange reserves of the central bank GCB are determined endogenously and it is assumed that the supply of currency S^S is determined by the demands of households.

Banks grant loans (LO) to households and firms that are financed by deposits from households (DH) and central bank credit (H), i.e. $LOH + LO1 + LO2 = LO = DH + H$, where all items are denominated in domestic currency because it is assumed that the banks' foreign exchange position is closed. The banks are assumed to behave[7] so that the supply of loans is $LO^S = LO^S(\overset{+}{RL},\overset{-}{R})$, where R is the marginal cost of central bank credit determined as $R = R(\overset{+}{H})$.

Real government absorption (G) is composed of purchases of traded and nontraded goods, which, together with taxes (T), are exogenous in the model. Also, since the main interest is with exchange rate policies, the model abstracts from government bonds and bank lending. Finally, the supply of deposits is derived residually from the balance sheet of the private banks.

Because the model describes a small open economy with underdeveloped financial markets it is assumed that of the eleven markets in the model only four are rationed and of them the labor and nontraded goods markets are always in excess supply. Thus, depending on the prevailing level of prices, wages and interest rates, the model generates four kinds of unemployment disequilibria, which can be classified as a Keynesian unemployment regime with excess supply and a classical unemployment regime with excess demand in the traded goods market. Both regimes contain two regimes, one with and one without credit rationing. To discuss the effective demands and supplies it is illuminating to consider the budget constraints facing the various sectors in the model.

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[7]See Aurikko (1982a). The signs above the variables refer to the assumed signs of the partial effects.

TABLE 1. Budget constraints of the model

Households	$C1^d + C2^d + MFH^d + \Delta SH^d + \Delta DH^d =$
	$L1^s + L2^s + \Pi - T + \Delta LOH^d - R \cdot H$
Firms	$I2D^d + MFI^d = \Delta LO1^d + \Delta LO2^d + \Delta KFP^d$
Central bank	$\Delta H^s + \Delta GCB^d = \Delta S^s$
Banks	$\Delta LO^s = \Delta DH^s + \Delta H^d$
Government	$G1^d + G2^d + RF \cdot KFG = \Delta KFG^d + T + R \cdot H$
Foreign sector	$X^d - M^s - RF \cdot KF + \Delta KF^s = \Delta GCB^s.$
Total	$(C1^d + G1^d - Q1^s) + (C2^d + X^d + G2^d + I2D^d - Q2^s)$
	$+ (L1^d + L2^d - L1^s - L2^s) + (LO^s - LOH^d - LO1^d - LO2^d) = 0.$

In Table 1 subscripts d and s indicate demand and supply and all prices and exchange rates are, for simplicity, normalised to be equal to one. Uses of finance are written on the left-hand side and sources on the right-hand side. In the household budget constraint Π stands for the aggregated contemporary dividends of firms, which are assumed to be distributed to the households. It is also assumed that the banks' profits accrue to the households and the central bank's profits to the government. Summing the sectoral budget constraints gives the aggregate budget constraint.

The transactions in the four disequilibrium markets are determined by the short side of the market, which by assumption is always the demand side in the nontraded goods market and labor market. With the markets clearing by quantity rather than price adjustment, there will be spillover effects from demand or supply failures to the other markets. These effects arise from demand failure in the labor and nontraded goods markets as well as from possible rationing in the traded goods and credit markets. The spillover effects of unemployment appear only in household income since the labor supply is fixed. Excess supply of nontraded goods influences the demands of firms producing nontraded goods. Rationing of traded goods demand in the classical regime has spillover effects on the trade offers of households. By assumption, firms are never rationed in the labor market. However, they are constrained in the traded goods market in the Keynesian regime. Moreover, possible credit rationing has spillover effects on the to the behavior of both households and firms.

3 ESTIMATION

The model estimated in this section is specified on the basis of the theoretical model discussed in the previous section. Annual data for the years 1960 - 80 are mainly adapted and aggregated from the data base of the quarterly econometric model constructed at the Bank of Finland (BOF3 model).[8]

Of the four disequilibrium markets in the model, in only two, i.e. the loan and traded goods markets, are transactions assumed to be determined either by demand or supply, whereas the nontraded goods market and the labor market are always demand-determined. In view of the size of the whole model and anticipating insurmountable computational problems as discussed in Section 1, the statistical model of the loan and traded goods markets is written as an approximation in the form

(1) $$Z_1 = \min(Z_1^d, Z_1^s) + \varepsilon_1$$

(2) $$Z_2 = \min[Z_2^d - \alpha_2(Z_1^d - Z_1), Z_2^s] + \varepsilon_2,$$

where Z_i, Z_i^d and Z_i^s are the observed quantities, unobserved demands and supplies in the loan (i=1) and traded goods markets (i=2), respectively, α_2 is a parameter and ε_1 and ε_2 are normally and independently distributed error terms with zero means.[9] In the credit rationing regime the spillover

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[8] Bank of Finland (1983) and Tarkka and Willman (1981). The nontraded and traded sectors correspond to the aggregated closed and open sectors in the BOF3 model. The specification of some equations also resembles that of the BOF3 model, except for the spillover terms. The variables are listed in the Appendix. The data and list of equations of the model are available from the author upon request.

[9] For the conceptual and econometric issues connected with specifying error terms in the min condition, see Quandt (1982) and Laffont (1983).

term $Z_1^d - Z_1$ is positive and it can be shown [Ito (1980)] that in the case of Cobb-Douglas utility functions the deviation of the rationed agents' effective demand from their notional unconstrained demand is a linear function of the degree of excess demand. In the regime without credit rationing (excess loan supply) $Z_1^d - Z_1 = 0$ and the spillover effect is absent. The system (1) - (2) is recursive and can be estimated sequentially by single equation estimation methods. Although the system is nonlinear because of the additive error specification, maximum likelihood estimation and nonlinear least squares estimation are equivalent. Thus (1) is estimated with a nonlinear algorithm as

$$(3) \qquad \log(LO^s/LO_{-1}) = \underset{(188.7)}{.302} - \underset{(1.7)}{.006}\,TIME + \sum_{0}^{2} a_i (R-RL)_{-i}$$

$$(4) \qquad \log(LO^d/ LO_{-1}) = \underset{(5.9)}{-.455} + \underset{(12.2)}{.611}\,\log(QV/LO_{-1}) + \underset{(3.8)}{.382}\,\log(W/P) - \underset{(1.2)}{.009}\,TIME$$

$$a_0 = \underset{(1.7)}{-.002} \qquad a_1 = \underset{(1.7)}{-.005} \qquad a_2 = \underset{(1.7)}{-.004} \qquad \Sigma a_i = -.011$$

$$(5) \qquad LO = \min(LO^s, LO^d)$$

$$\bar{R}^2 = .754 \qquad DW = 1.871 \qquad SE = .021$$

Equation (3) is specified according to the discussion in Section 2 and equation (4) is a simple version of loan demand determined by the value of aggregate income (QV), Walrasian real wages (W/P) and a time trend (TIME).[10] Nonsignificant interest rates are omitted. Models (3) and (4) resemble those of the BOF3 model and, as can be seen from Figure 1, indicate the existence

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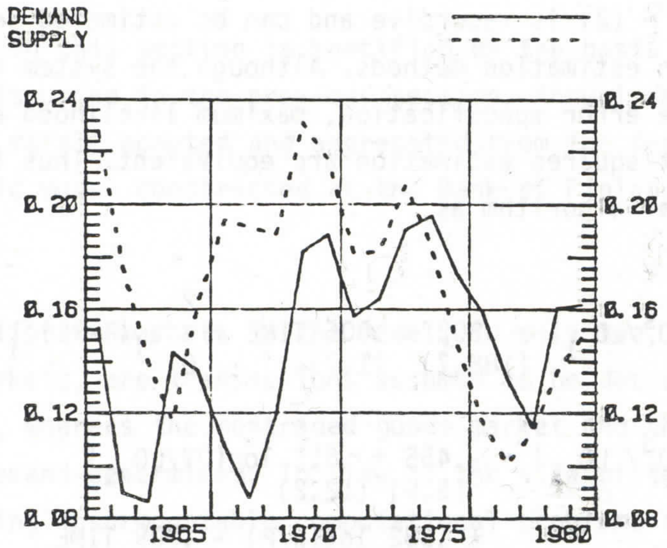
[10]In the estimated equations the t-statistics are written in parentheses below the coefficients, $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom, DW is the Durbin-Watson statistic and SE is the standard error of estimate.

of credit rationing in 1964 and in 1974 - 80.[11]

FIGURE 1. LOAN MARKET



In the estimation of the disequilibrium model (2) for traded goods, credit rationing effects are captured in the relevant equations by the variable RHOE defined as

(6) $$RHOE = \max[\log(LO^d/LO^s),0].$$

Because of the relatively low number of degrees of freedom, the components of $Q2^d$ were first estimated separately with the fitted values inserted in (2):

(7) $$\log Q2^s = \underset{(120.8)}{-6.040} + \underset{(23.3)}{1.420} \log K - \underset{(2.9)}{.468} \log(PMRF/P2)$$

(8) $$\log Q2^d = \underset{(.17)}{.071} + \underset{(36.7)}{.993} \log[\tilde{C}2+\tilde{X}+(PI/P2)\widetilde{IM} - (PMF/P2)\widetilde{MFI}+G2]$$

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[11]In the quarterly BOF3 model credit rationing is observed in 1962 - 64 and in 1974 - 78.

(9) $Q2 = \min(Q2^s, Q2^d)$

$\bar{R}^2 = .992 \quad DW = 1.552 \quad SE = .026.$

In the traded goods supply model (7) it is assumed in a traditional way that in the short-run the capital stock (K) is a fixed factor and consequently enters (7) as an explanatory variable together with relative prices.[12] In the equation (8) PI is the price index of total investment IM, G2 is exogenous while $\tilde{C2}$, $\tilde{X}$, $\tilde{IM}$ and $\tilde{MFI}$ are the computed values from

(10) $$\log C2 = \underset{(5.0)}{-4.035} + \underset{(16.0)}{1.022}\log(YD_{-1}/P2_{-1}) + \underset{(3.0)}{.484}\log(PMF/P2) + \underset{(2.3)}{.499}\log(P2_{-1}/P2_{-2}) - \underset{(1.8)}{1.166}\,RHOE_{-1} - \underset{(1.2)}{.768}\,RHOE_{-2}$$

$\bar{R}^2 = .950 \quad DW = 1.728 \quad SE = .058$

(11) $$\log X = \underset{(15.8)}{5.016} + \underset{(18.8)}{.895}\log MFO - \underset{(2.0)}{.648}\log[P2/(FXUS\cdot PMFO)]$$

$\bar{R}^2 = .973 \quad DW = 1.169 \quad SE = .055$

(12) $$IM/K_{-1} = \underset{(.04)}{.110} - \underset{(2.8)}{.064}\log(W/P2) - \underset{(3.2)}{.029}\log(RF/RL) + \underset{(7.9)}{.434}\log Q1 - \underset{(7.8)}{.395}\log K_{-1} + \sum_{3}^{5} a_i RHOE_{-i}$$

$$a_3 = \underset{(1.10)}{-.089} \quad a_4 = \underset{(1.10)}{-.119} \quad a_5 = \underset{(1.10)}{-.089} \quad \Sigma a_i = -.297$$

$\bar{R}^2 = .863 \quad DW = 1.752 \quad SE = .006$

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[12] In (7) and subsequently import prices are given in terms of domestic currency. In (7) PMRF is the price index of intermediate imports MRF.

(13) $$\log MFI = \underset{(3.2)}{2.649} + \underset{(1.5)}{2.008}\, DS63 + \underset{(6.8)}{.588} \log IM - \underset{(2.2)}{.880} \log(PMF/P2)$$
$$- \underset{(1.1)}{.402} \log(PMF_{-1}/P2_{-1})$$

$\bar{R}^2 = .858$ DW = 1.181 SE = .075

In (10) the lag in real disposable income (YD/P2) was chosen to reduce simultaneity and ensure convergence of the model. The credit rationing variable is also included in (10). To capture the effects of inflation on the consumption variable, $\log(P2_{-1}/P2_{-2})$ has been added. In the aggregated exports (X) model in (11) the explanatory variables are foreign imports MFO and a ratio of traded goods prices to prices of foreign imports, both in USD. The model of total investment in (12) includes an adjustment mechanism and is log-linear and aggregated, i.e. $K/K_{-1} = (K^d/K_{-1})^{\alpha} RHOE^{\beta}$, where the approximation $\log(K/K_{-1}) \approx IM/K_{-1}$ is used. Furthermore, production Q1 is used rather than Q on empirical grounds.[13] According to the model the years 1963 - 64 and 1969 - 74 are fairly plausibly supply-determined and the years 1975 - 79 demand-determined. In the other years, the supply of and demand for traded goods are approximately in balance (Figure 2).

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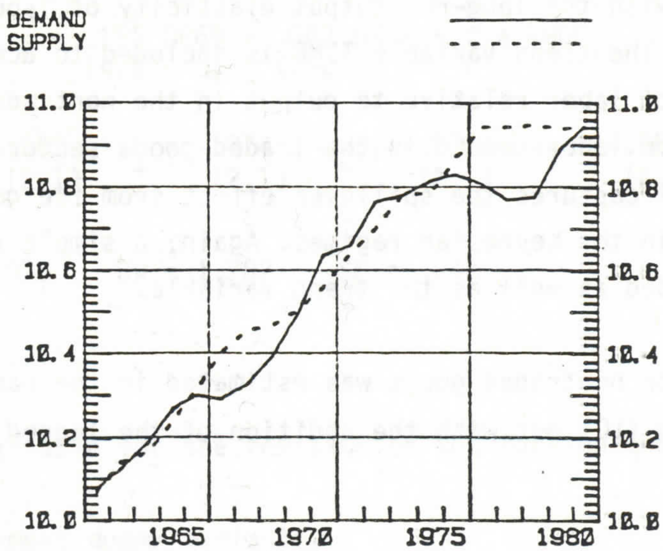
[13]The correct variable should have been PII as defined in (14).

FIGURE 2. TRADED GOODS MARKET



A spillover variable similar to that in the loan market is defined in the traded goods market as

(14) $PII = \max[\log(Q2^s/Q2^d), 0]$.

Separate equations for effective labor demands in the nontraded and traded sectors were estimated:

(15) $$\log(L1/Q1) = \underset{(3.8)}{-1.531} - \underset{(2.6)}{.469} \log(W/P1) - \underset{(1.7)}{.075} \log(PMRF/P1) + \underset{(5.3)}{.564} \log(L1_{-1}/Q1) - \underset{(3.1)}{.008}\ TIME$$

$\bar{R}^2 = .999$ DW = 1.660 SE = .008.

(16) $$\log L2 = \underset{(3.3)}{3.984} - \underset{(1.0)}{.082} \log(W/P2) - \underset{(1.5)}{.176}\ PII - \underset{(1.6)}{.286}\ PII_{-1} + \underset{(1.9)}{.364} \log L2_{-1} + \underset{(2.5)}{.007}\ TIME$$

$\bar{R}^2 = .858$ DW = 1.942 SE = .017.

In (15) the lagged dependent variable represents an adjustment process in the labor markets with the long-run output elasticity of labor demand constrained to unity. The trend variable TIME is included to account for the diminished amount of labor relative to output in the nontraded goods sector. In equation (16) for labor demand in the traded goods sector, the variable PII defined in (14) captures the spillover effect from the goods markets to the labor markets in the Keynesian regimes. Again, a simple adjustment mechanism is included as well as the trend variable.

Effective demand for nontraded goods was estimated in the same way as for traded goods in (10) but with the addition of the lagged stock of assets[14]

$$(17)\quad \log C1 = \underset{(.5)}{.437} + \underset{(8.8)}{.910}\log(YD_{-1}/P1_{-1}) + \underset{(1.8)}{.237}\log[(DH_{-1}+S_{-1}+B_{-1})/YD_{-1}]$$
$$+ \underset{(2.8)}{.058}\log(FCGH/P1) - \underset{(3.9)}{.325}\,DTR66 + \underset{(2.6)}{.264}\log(P1_{-1}/P1_{-2})$$
$$- \underset{(1.7)}{.922}\,RHOE_{-1}.$$

$$\bar{R}^2 = .989 \qquad DW = 1.989 \qquad SE = .023.$$

The models of the two remaining import components were estimated as

$$(18)\quad \log MRF = \underset{(6.3)}{-7.164} - \underset{(4.0)}{.442}\log(PMRF/P2) + \underset{(14.8)}{1.524}\log Q1 + \underset{(2.2)}{1.397}\,DS63$$
$$- \underset{(4.0)}{.155}\,DF69 - \underset{(14.8)}{.829}\,PII$$

$$\bar{R}^2 = .993 \qquad DW = 2.068 \qquad SE = .035$$

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[14]Since C1 includes investment in housing, variables FCGH (exogenous state loans for housing) and DTR66 (a dummy variable for tax reliefs in housing in 1966) were used.

$$\text{(19)} \quad \log MFH = \underset{(8.5)}{-11.45} + \underset{(14.5)}{1.804} \log(YD/P2) - \underset{(5.8)}{1.165} \log(PMF/P2) + \underset{(1.3)}{.926}\, DS63$$

$$+ \underset{(4.5)}{.185}\, DF69 - \underset{(2.2)}{.062}\, DMCP + \sum_{0}^{3} a_i RHOE_{-i}$$

$$a_0 = \underset{(2.1)}{-.582} \quad a_1 = \underset{(2.1)}{-.874} \quad a_2 = \underset{(2.1)}{-.874} \quad a_3 = \underset{(2.1)}{-.582} \quad \Sigma a_i = -2.912$$

$$\bar{R}^2 = .978 \qquad DW = 1.782 \qquad SE = .042$$

where

DF69 = dummy variable for the revision of the foreign trade statistics in 1969

DMCP = cash payment dummy variable.

Model (18) for intermediate imports (MRF) and model (19) for households' final imports (MFH) are fairly standard with plausible demand and price elasticities, except that spillover effects from the disequilibrium markets are present.

Demand for currency (S) was simply estimated as

$$\text{(20)} \quad \log S = \underset{(2.9)}{3.669} - \underset{(2.9)}{.517} \log[(DH_{-1}+S_{-1}+B_{-1})/P_{-1}] + \underset{(14.9)}{.834} \log QV$$

$$+ \underset{(1.3)}{1.699}\, RHOE$$

$$\bar{R}^2 = .987 \qquad DW = 1.163 \qquad SE = .062$$

and net imports of private foreign capital (FFP) as

$$\text{(21)} \quad FFP = \underset{(.6)}{305.7} - \underset{(5.1)}{629.0}\, \Delta(RF-RL) + \underset{(3.6)}{.202}\, \Delta Q1V - \underset{(1.8)}{.105}\, \Delta(Q \cdot PII)_{-1}$$

$$\bar{R}^2 = .728 \qquad DW = 1.475 \qquad SE = 1190.1$$

The marginal cost of central bank credit (R) to the private banks as an increasing function of the amount of the credit (H) is determined from

(22) $R = RDI + (HV/HQ)\cdot H\cdot IND(H-HQ)$,

where

RDI = exogenous basic discount rate on the central bank credit

HV = exogenous sensitivity parameter of the cost of central bank credit with respect to the amount of the credit (H)

HQ = exogenous quota of central bank credit.

In (22) $IND(H-HQ) = 1$, if $H > HQ$ and $= 0$ otherwise, so that the marginal cost of central bank credit to the private banks equals the basic discount rate when actual central bank credit is lower than the quota. The marginal cost increases according to the sensitivity parameter when $H > HQ$. The sensitivity parameter was calculated using the marginal cost data in Tarkka (1981).

Non-Walrasian models have been studied mostly by assuming rigid prices. This has restricted the analysis to the short-run. In the longer run the assumption of fixed prices is clearly not tenable. There exist some theoretical attempts to endogenize prices in non-Walrasian models. In these models the prices are assumed to be either set by the agents or determined by some auctioneer mechanisms.[15] In this study it is assumed that prices and wages respond at least partly to the latter, somewhat ad hoc, mechanism, i.e. prices and wages react to excess demands. However, the reaction is not assumed to be complete in the sense of equilibrating the markets in the short-run. Thus quantities adjust in the first place resulting in an equilibrium with rationing, while prices and wages respond only gradually and in the longer run to excess demands or supplies.

The endogenous prices in the model are nontraded (P1) and traded goods prices (P2) and aggregate wages (W). All import prices in terms of foreign currency and world market prices are assumed exogenous. The specification of the price-wage block includes the determination of domestic prices, a

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[15] See e.g. Honkapohja (1979) and Green and Laffont (1981). Stability in dynamic disequilibrium models is analysed in Honkapohja and Ito (1983).

Phillips curve and an expectations formation mechanism. In the case of a small open economy like Finland, domestic prices are strongly influenced by world market prices although costs and demand pressures have some influence too.[16]

As the model is disaggregated into nontraded and traded goods, the wage-price model is formulated along the lines of the Scandinavian inflation model[17] and the nontradeable-tradeable approach.[18] According to these approaches nontraded goods prices are determined by unit labor costs and traded goods prices as well as by demand pressures in the traded goods sector, which are assumed to be symmetric and temporary. Traded goods prices depend on world market prices and permanently on demand pressures with a fairly long lag.

$$(23) \quad \Delta \log P1 = \underset{(2.7)}{.013} + \underset{(8.4)}{.616}\ \Delta \log[(W \cdot L1)/Q1] + \underset{(8.0)}{.381}\ \Delta \log P2 + \underset{(2.8)}{.118}\ \Delta \log(Q2^d/Q2^s)$$

$$\bar{R}^2 = .950 \quad DW = 2.808 \quad SE = .010$$

$$(24) \quad \Delta \log P2 = \underset{(9.8)}{.673}\ \Delta \log(FXUS \cdot PMFO) - \underset{(.4)}{.007}\ DINP + \underset{(1.5)}{.123}\ \log(Q2^d_{-2}/Q2^s_{-2}) + \underset{(2.7)}{.243}\ \Delta \log P2_{-1}$$

$$\bar{R}^2 = .874 \quad DW = 2.407 \quad SE = .026$$

In accordance with the expectations-augmented Phillips curve, wages are postulated to depend on price expectations formed with perfect foresight and on unemployment. However, the latter dependence is assumed to be of a

[16] Empirical evidence is given in Vartia and Salmi (1981) and Aurikko (1984).

[17] Edgren, Faxén and Odhner (1969).

[18] See e.g. Dornbusch (1973).

transitory nature only so as to maintain long-run parity with domestic and foreign inflation.[19] Moreover, since it is assumed that the wage share is constant in the long-run the coefficients of traded goods prices and productivity are constrained to be equal, i.e. the variable (P2·Q2)/L2 was used.[20] Thus

$$(25)\quad \Delta\log W = +\underset{(3.9)}{.314}\ \Delta\log[(P2\cdot Q2)/L2] + \underset{(4.6)}{.427}\ \Delta\log[(P2\cdot Q2)_{-1}/L2_{-1}]$$
$$-\ \underset{(4.1)}{.091}\ \Delta\log U_{-2} - \underset{(.9)}{.014}\ DINP + \underset{(1.7)}{.225}\ \Delta\log W_{-1}$$

$$\bar{R}^2 = .760 \qquad DW = 2.451 \qquad SE = .019$$

where

U = unemployment rate

DINP = dummy variable for incomes policies in 1969 - 70

The dynamics of the wage-price submodel behaves in accordance with the Scandinavian inflation model of the small open economy. International inflation and changes in the exchange rate are transmitted in full to domestic prices and wages in the long-run. Thus domestic inflation can be kept lower than international inflation only by continuous revaluation.

4 SIMULATIONS

Since the effects of economic policies in a disequilibrium model are highly dependent on the regimes prevailing in the economy, this issue is studied in the framework of various exchange rate policy simulations. Other illustrative policies in this context would have been demand management, monetary or price (wage) policies. An additional motivation for the examination of policy simulations is that this issue has not yet been adequately explored in the multimarket econometric disequilibrium

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[19] Ettlin (1979).

[20] For simplicity, the number of persons employed, L1 or L2, has been used in (23) and (24) instead of hours worked, which would have been a more correct variable.

models. In the simulations, use is made of the control solution of the model, which is a simultaneous solution of the model utilizing actual values of lagged endogenous variables at the start of the simulation period and actual values of the exogenous variables throughout the simulation period.[21] The results of the simulation experiments are expressed as dynamic multipliers of the form $100 \cdot (ZD_t - ZC_t)/ZC_t$ or $(ZD_t - ZC_t)$, where ZC is the control solution and ZD the disturbed (simulated) solution of variables Z.

In the simulations a 10 per cent permanent devaluation is assumed to be carried out at the beginning of, alternatively, 1965, 1971 or 1975. The timing of the devaluations is set so as to coincide with the different regimes in the economy. According to Figures 1 and 2 the economy was in the Keynesian regime without credit rationing in 1965-69 in the classical regime without credit rationing in 1970-73 and in the Keynesian regime with credit rationing in 1975-79. In this context, assumptions about accommodating domestic economic policy measures and other exogenous changes in the model must be made. The former are simply assumed away.[22] As regards the latter, changes in exogenous import prices in terms of domestic currency are of importance. It is assumed that import prices of final goods (consumption and investment goods) in terms of domestic currency increase by only 80 per cent of the devaluation and that the devaluation is entirely and instantly passed through to the import prices of intermediate imports (raw materials and fuels) in terms of domestic currency, i.e. the pass-through rate is 100 per cent.[23]

Results of the devaluation simulations are presented in Figures 3 - 12. For ease of comparison the 1965 and 1971 devaluation runs are set to

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[21]According to the dynamic ex post solution (not reported here) the model works satisfactorily.

[22]In the case of monetary policy this simply means that the discount policy of the central bank is passive, implying that the monetary effects of the balance of payments are not neutralized.

[23]See the discussion in Aurikko (1982a). Exogenous imports and exports of services, investment income, nominal taxes and other incomes were also increased in the simulations by the same percentage as the devaluation.

coincide with the 1975 devaluation. According to the adopted Scandinavian inflation model the domestic price level rises quite rapidly in all simulations. In the third year after the devaluation it has risen by the full amount of the devaluation and actually overshoots in two cases mainly because the credit markets stays in the no credit rationing regime with demand for traded goods increasing relatively fast. Subsequently, the price level multiplier diminishes, reflecting tightening of credit market conditions.

FIGURE 3. DOMESTIC PRICE LEVEL (%)

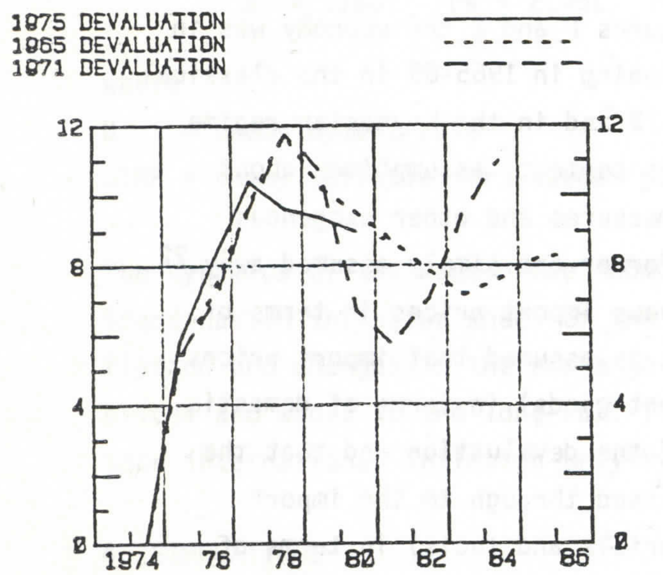
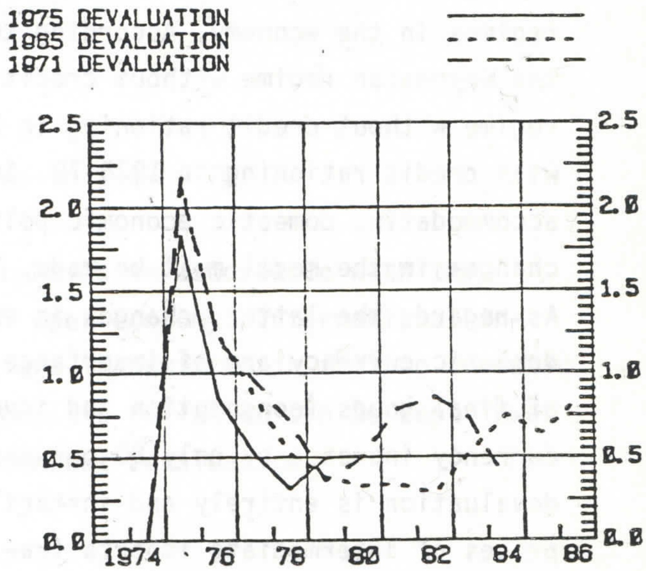


FIGURE 4. EXPORTS (%)



Because of the rapid increase in domestic prices, the volume of exports responds markedly only for 2 to 3 years after the devaluation. In later years, the export multiplier is about 0.5 per cent.

There are considerable differences in GDP (Q) developments in the three cases. In the 1965 devaluation the GDP effect is mostly positive, reflecting easy credit market conditions, while in the other two cases there is a contractive effect shortly after the devaluation as the credit market switches into the credit rationing regime. Because of the strong and subsequently positive effect on exports, developments in the traded goods sector are on balance more favorable than in the nontraded goods sector (Figures 6 - 7).

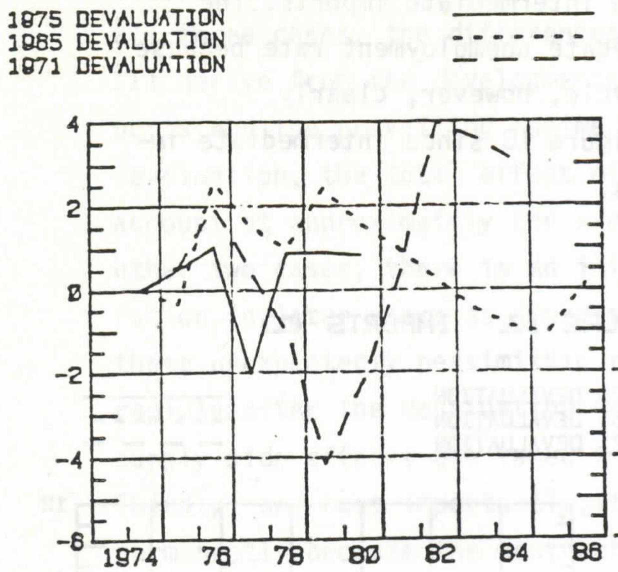


FIGURE 5. GDP (%)

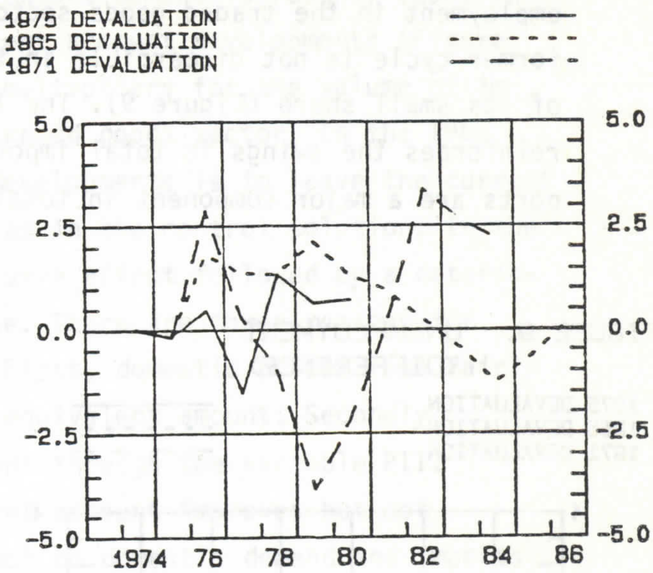


FIGURE 6. NONTRADED GOODS, Q1 (%)

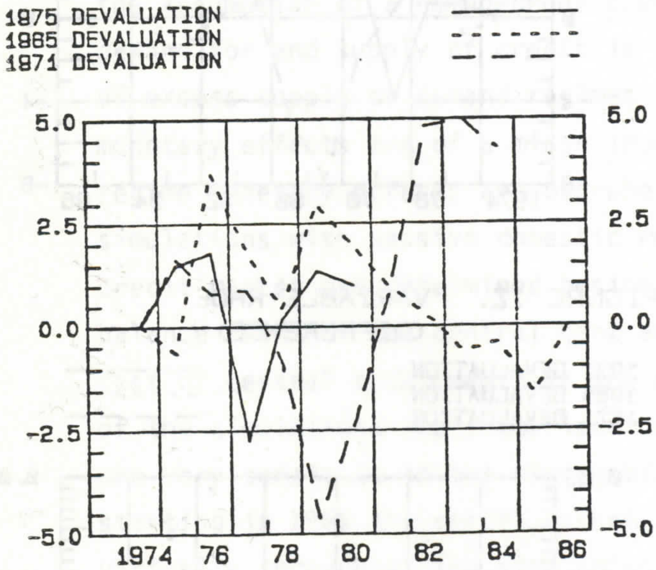


FIGURE 7. TRADED GOODS, Q2 (%)

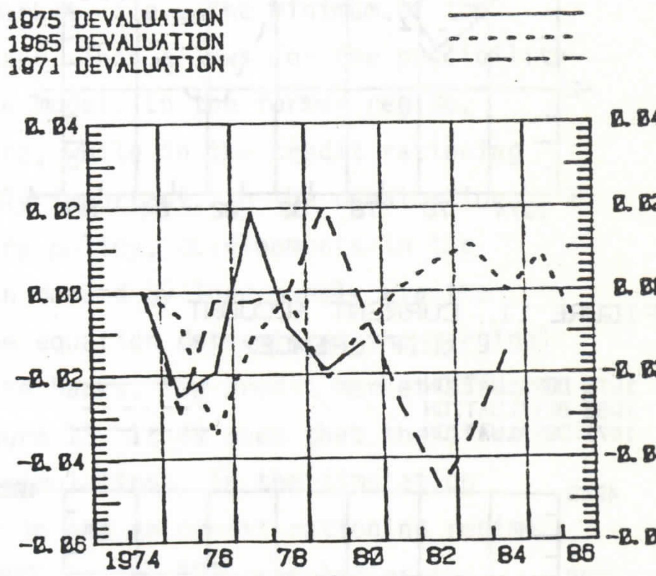


FIGURE 8. VARIABLE PII (DIFFERENCE)

The devaluation responses in the traded goods market are summarized in the variable PII in Figure 8. In the case of the 1965 devaluation in the Keynesian unemployment regime without credit rationing, PII is mostly at a lower level than in the control solution, thus implying higher employment and imports. In the other two cases, the response oscillates around the control solution, giving rise to cycles of about five years duration in employment in the traded goods sector and in intermediate imports. The former cycle is not discernible in the aggregate unemployment rate because of its small share (Figure 9). The latter cycle, however, clearly reinforces the swings in total imports in Figure 10 since intermediate imports are a major component in total imports.

FIGURE 9. UNEMPLOYMENT (DIFFERENCE)

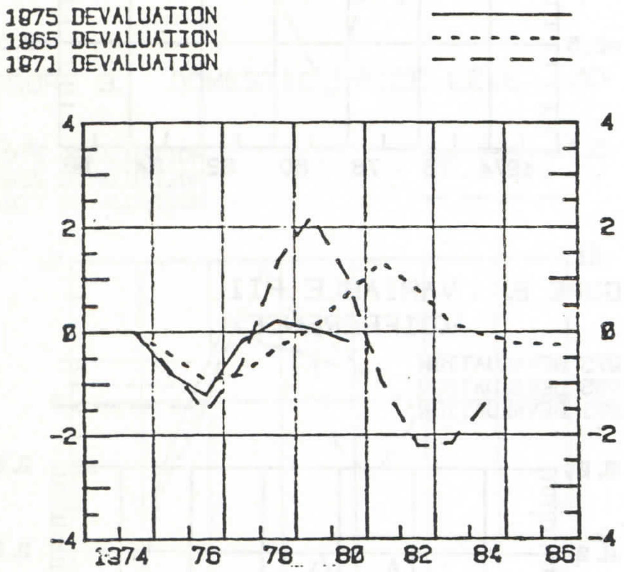


FIGURE 10. IMPORTS (%)

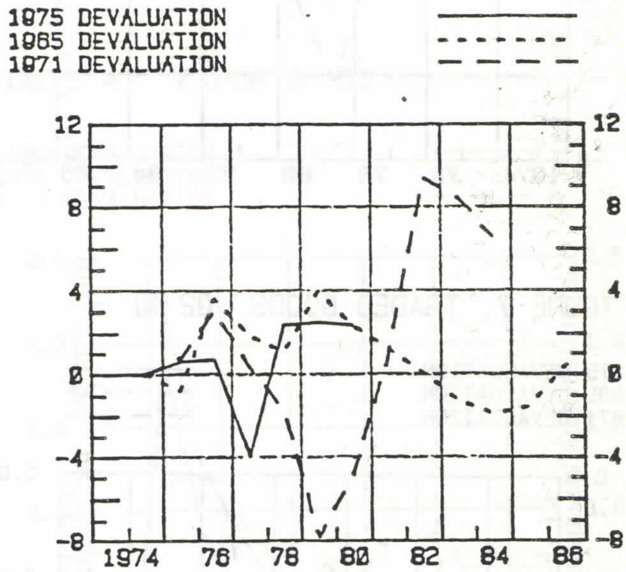


FIGURE 11. CURRENT ACCOUNT (DIFFERENCE)

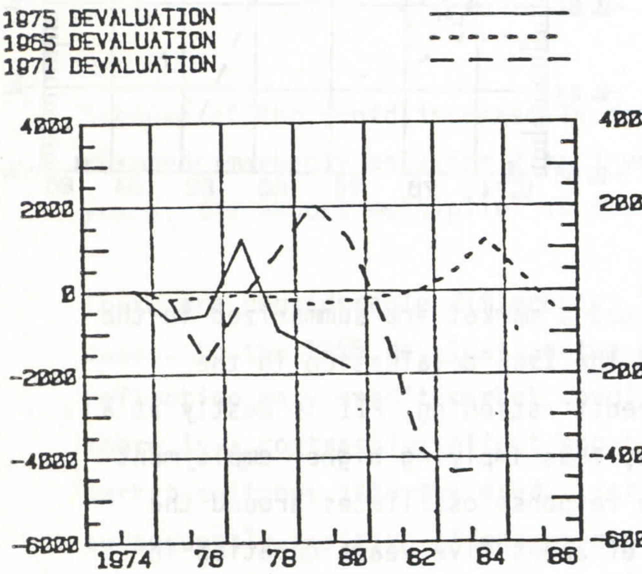
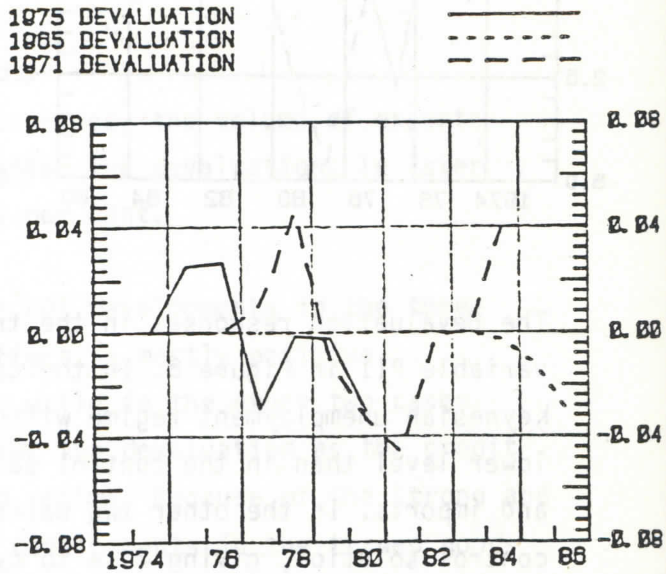


FIGURE 12. VARIABLE RHOE (DIFFERENCE)



Because the multiplier for the value of export demand is roughly equal in all three cases, the differences in current account developments (Figure 11) derive from the developments in the multipliers for the volume of imports and the prevailing regime in the traded goods sector. In the 1965 devaluation, the total effect of these developments is to leave the current account at approximately the same level as in the control solution. In the other two cases, there is an initial J-curve effect followed by a deterioration in later years as imports increase. There are three reasons for these unexpectedly pessimistic results. First, domestic prices rise fairly rapidly after the devaluation and by an equivalent amount. Secondly, supply-side effects are taken into account through the variable PII. Thirdly, and most importantly, the current account improves but not permanently because the contractive effect on domestic demand and imports of possible credit rationing is only temporary.

Credit rationing is thus a vital element in the model. The model is based on the assumption of a homogeneous credit market, i.e., the minimum of the demand for and supply of credit is realized. This allows for the possibility of excess supply or demand regimes in the model. In the former regime, monetary effects are of a minor importance, while in the credit rationing regime monetary effects are overwhelmingly important. In the devaluation simulations with passive domestic monetary policy, developments in the credit market are determined besides loan demand by loan supply via the balance sheet of the central bank and the equation determining the marginal cost of central bank credit to the private banks. The credit market effects of the simulations are summarized in Figure 12. It is seen that the effects are very sensitive to the timing of the simulations. In the simulation starting in 1965 the credit market stays in the no credit rationing regime virtually throughout the simulation period. In the 1971 simulation the credit market switches into the credit rationing regime during the third year after the devaluation, while in the case of the simulation for the devaluation in 1975, when credit rationing already prevails, there is an immediate increase in credit rationing. In both the two last-mentioned cases, there is a sharp swing in the opposite direction in the credit market shortly after the tightening.

Summarizing the devaluation simulations in the different regimes, it can be concluded that the beneficial effects of devaluation are best secured by implementing the policy in the Keynesian unemployment regime with no credit rationing or easing the credit market with appropriate monetary policies to ensure a rapid expansion in exports with relatively minor economic fluctuations. An implication of the model is that model devaluation would not be the ideal policy to restore lost international price competitiveness.[24]

5 SUMMARY AND CONCLUSIONS

In this paper a disequilibrium model of the Finnish economy is specified and estimated with annual data. The estimation method is fairly simple, thus avoiding the complexities inherent with more sophisticated methods. Nevertheless, the results are plausible and satisfactory. As the transmission mechanisms of economic policy measures are more varied in disequilibrium models than in equilibrium models, the properties of the model were examined in the framework of exchange rate policy simulations. According to the simulations, the policy effects are very sensitive, especially to the credit market conditions prevailing at the time the policies are implemented and to a possible change in the credit market regime or excess demand for credit in the credit rationing regime. The policy effects are not affected so much by the conditions prevailing in the goods market, assuming moderate policy shocks, although some cyclical oscillations are discernible. In summary it can be concluded that the beneficial effects of devaluation are best obtained by implementing the policy measure in the Keynesian unemployment regime with no credit rationing in order to ensure fast export expansion with relatively minor economic fluctuations. Moreover, disequilibria in the credit and goods markets seem to have clear implications both for the timing of the policy measures and for the supporting monetary and fiscal policies undertaken in order to dampen possible cyclical movements in domestic demand.

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[24]According to a revaluation simulation starting in 1971, revaluation would be successful in curbing domestic inflation and would have no adverse balance of payments effect. On the other hand, revaluation would depress domestic demand and increase unemployment considerably.

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APPENDIX

Variables of the model

Endogenous variables:

CA	=	Current account
C1	=	Volume of consumption of nontraded goods
C2	=	Volume of consumption of traded goods
DH	=	Deposits of the public in the banks
FFP	=	Net imports of private foreign capital
GCP	=	Foreign exchange reserves of the central bank
H	=	Central bank debt of the banks
IM	=	Volume of investment of firms
K	=	Net stock of capital of firms
LE	=	Total employment
LO	=	Loans of the banks to the public
LO^d	=	Demand for bank loans
LO^s	=	Supply of bank loans
L1	=	Employment in the nontraded goods sector
L2	=	Employment in the traded goods sector
MFH	=	Volume of imports of final goods (consumer goods)
MFI	=	Volume of imports of final goods (investment goods)
MRF	=	Volume of imports of intermediate goods (raw materials and fuels)
P	=	Price index of total output
PII	=	Excess supply of traded goods
P1	=	Price index of nontraded goods output
P2	=	Price index of traded goods output
Q	=	Volume of gross output
Q1	=	Volume of gross output of nontraded goods
Q2	=	Volume of gross output of traded goods
$Q2^d$	=	Demand for traded goods
$Q2^s$	=	Supply of traded goods
R	=	Marginal cost of central bank credit
RHOE	=	Excess demand for bank loans
S	=	Currency (notes and coin in circulation)

TB = Trade balance
U = Unemployment rate
X = Volume of exports
YD = Real disposable income
W = Wage rate

Exogenous variables:

B = Government bonds
DF69 = Dummy variable for the revision of foreign trade statistics in 1969
DMCP = Cash payment dummy variable
DINP = Dummy variable for incomes policies in 1969 - 70
DTR66 = Dummy variable for tax reliefs in housing in 1966
FCGH = State loans for housing
FFG = Net imports of foreign capital by the government sector
FXUS = FIM/USD exchange rate
G1 = Government sector expenditure on nontraded goods
G2 = Government sector expenditure on traded goods
HQ = Quotas of central bank credit
HV = Sensitivity parameter of the cost of central bank with respect to the amount of credit
L = Supply of labour
MFO = Weighted volume of imports in the countries most important for Finland's exports
MSV = Value of imports of services
PMF = Unit value index of imported final goods
PMFO = Price index of MFO
PMRF = Unit value index of imported intermediate goods
RDI = Basic discount rate on the central bank credit
RF = Foreign interest rate level (3 month eurodollar rate in London)
RL = Interest rate level of domestic bank loans
TIME = Time trend
XSV = Value of exports of services
YFTF = Net investment income and transfers in the balance of payments