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EFFECTS OF EXCHANGE RATE POLICY AND IMPORTED INFLATION IN A CREDIT RATIONING ECONOMY

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This paper is a preliminary version of an ongoing research project.

CONTENTS

Abstract

EFFECTS OF EXCHANGE RATE POLICY AND IMPORTED INFLATION IN A CREDIT RATIONING ECONOMY

In the paper effects of exchange rate policies and imported inflation are assessed in the case of Finland which is a small open economy with undeveloped financial markets. Under these circumstances interest rates do not equilibrate the credit market so that a simplified theoretical macromodel with credit rationing is first presented. In the second part of the paper the Bank of Finland quarterly econometric model for the Finnish economy is simulated. The most important conclusion to emerge from the simulations with the quarterly model is that the results are highly dependent on the credit market conditions.

I. INTRODUCTION

The aim of this paper is to simulate effects of exchange rate policies and imported inflation in the case of Finland which is a small open economy with undeveloped financial markets. In the Finnish financial markets domestic interest rates have institutionally been kept at a relatively low and stable level which has resulted to credit rationing. As the markets have been dominated by deposit banks, other financial institutions and the security market playing a minor role firms have had to resort mainly to bank lending in investment finance. Moreover foreign capital movements have at the same time been controlled fairly effectively by the central bank, so that excess demand in the domestic credit market has been an almost permanent phenomenon. In this framework independent monetary policy has been largely possible and as the banks have continuously resorted to central bank borrowing the main monetary instruments have been the terms and cost of the central bank credit.

To study the channels through which exchange rate policies and imported inflation affect the economy a simplified theoretical macromodel with credit rationing is first specifies in Section II. The credit rationing elements are formulated in the model by assuming that the credit market is heterogenous, thus implying that credit rationing is a permanent phenomenon. Section III is devoted to simulations using the Bank of Finland quarterly econometric model for the Finnish economy. Finally there is a brief concluding section.

Helpful discussions with the Bank of Finland Model Project team are gratefully acknowledged. The views expressed in the paper are preliminary in nature and not necessarily those of the Bank of Finland.

II. THE CHANNELS OF EXCHANGE RATE POLICY EFFECTS IN A SIMPLIFIED MACROECONOMIC MODEL WITH CREDIT RATIONING

1. Introduction

In simulating effects of economic policy with a large macro-econometric model it is instructive first to study these effects with the aid of a simplified theoretical model containing the most important elements and economic policy channels of the econometric model. The simplified model is used for an analysis of the direct and indirect channels of foreign exchange policy and imported inflation in order to be able to interpret the simulation results of the macroeconometric model and to assess their plausibility and logical consistency.

Table 1. Simplified Flow-of-Funds Framework

	Foreign sector	Private sector	Private banks	Central bank	Government	Total
Gross income	YF	YPB			YGB	YV^s
- taxes		-TA			TA	
+ transfers		TR			-TR	
= Disposable income	YF	YP			YG	YV^s
- absorption		-EPV			-EGV	$-EV^d$
+ imports	MV					MV^s
- exports	-XV					$-XV^d$
= Financial deficit	-BC	BCP			BCG	0
Δ currency		$-\Delta S^d$		ΔS^s		0
Δ deposits		$-\Delta D^d$	ΔD^s			0
Δ central bank debt			ΔH^d	$-\Delta H^s$		0
Δ loans		ΔL^d	$-\Delta L^s$			0
Δ bonds		$-\Delta B^d$			ΔB^s	0
Δ foreign capital	$-\Delta KF^s$	ΔKFP^d			ΔKFG^d	0
Δ foreign exchange (central bank)	ΔGCB^s			$-\Delta GCB^d$		0
	0	0	0	0	0	

For an overall view of the model, Table 1 presents a simplified flow-of-funds framework with a foreign sector, private sector, private banks, central bank and government sector. Summing horizontally and vertically gives market and budget constraints, respectively. Subscripts d and s indicate demand and supply, respectively. Positive entries denote sources of finance and negative entries uses of finance.

2. The Model

The model examined in this section is based on a short-run open economy extension of the traditional Keynesian model (Meade, 1952 and Mundell, 1962)[1]. It is assumed that the economy produces a single homogenous commodity either for domestic demand or for export. Two commodities are imported: a final good and a intermediate good (cf. Korkman, 1980). The former is substitutable for the domestic commodity while the latter is used as an input in domestic production in a proportion depending on relative prices. The equilibrium condition for the goods market is[2]

$$(2.1)\qquad Y = \frac{P}{PD}\, EP(\overset{+}{Y}, \overset{-}{T}, \overset{-}{RL}, \overset{-}{\frac{Z}{P}}, \frac{\overset{+}{V}-1}{P}) + \frac{PP}{PD}\, G + \frac{PP}{PD}\, X(\overset{-}{\frac{PP}{ePF}})$$

$$- \frac{ePMF}{PD}\, MF(\overset{+}{E}, \overset{-}{\frac{ePMF}{PP}}) - \frac{ePMR}{PD}\, MR\,(\overset{+}{Y}, \overset{-}{\frac{ePMF}{PD}}),$$

where

Y = real domestic output (income)
EP = real private domestic consumption and investment demand (private absorption)
G = exogenous real government demand (government absorption)
Z = rate of credit rationing
X = volume of exports
MF = volume of final imports
MR = volume of intermediate imports
PD = domestic output deflator
PP = price level of domestic commodity
P = overall domestic price level

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1. To explore longer-run implications, the model incorporates dynamics stemming from changes in stocks of financial assets working through the balance of payments and the government budget constraint together with price adjustment. However, exchange rate expectations and, in the long-run, important changes in stocks of real assets are ignored in the model.

2. To simplify the specification of demand and import functions, the demand variables are written so as to include imports. In particular, because of their minor importance, terms-of-trade effects (see Laursen and Metzler, 1950) on EP are assumed away. These variables also have their natural empirical counterparts in the econometric model.

PF = exogenous foreign price level in foreign currency
PMF = exogenous price level of final imports in foreign currency
PMR = exogenous price level of intermediate imports in foreign currency
e = exchange rate.

In (2.1) private absorption depends conventionally on real income Y, exogenous real taxes T, the loan rate RL and lagged real wealth V_{-1}/P. The signs above the variables refer to the assumed signs of the partial effects. In addition spill-over effects from credit rationing are captured by the inclusion of the variable Z/P in (2.1). This is justified by assuming that the crediit market is an aggregate of heterogenous submarkets with the simultaneous occurence of both rationed and unrationed customers, so that $Z \geq 0$. It can be shown (Ito, 1980) that in the case of Cobb-Douglas utility functions the deviation of the rationed customers' effective demand from their notional unconstrained demand is a linear function of the degree of excess demand. Aggregating over submarkets gives (2.1) (see Muellbauer, 1978) assuming that there is no direct spill-over effects from private demand to the credit market.

Export demand X depends on relative prices foreign demand being not explicitly included because it can be assumed to be given exogenously in the case of a small country. According to the import demand function MF, total domestic absorption is allocated between domestic and foreign sources depending on relative prices. Similarly, the proportion of imported intermediate inputs used in production is based on relative prices.

The current account in terms of domestic prices is

$$(2.2) \qquad BC = PP \cdot X - ePMF \cdot MF - ePMR \cdot MR - YF$$

where

YF = $RF_{-1} \cdot e\,(KFP_{-1} + KFG_{-1})$, i.e. net interest payments abroad
RF = exogenous foreign interest rate level
KFP = net stock of the short- and long-term foreign debt of the private sector in terms of foreign currency
KFG = net stock of the foreign debt of the government in terms of foreign currency.

In the short-run KFP is the only endogenous component of total foreign debt and it is written simply

$$(2.3) \qquad eKFP = KFP^{d} = KFP^{d}\,(\overset{-}{RF},\overset{+}{RL},\overset{+}{Z}).$$

This specification is essentially portfolio theoretical containing, however, no wealth variables (see Aurikko 1976). The credit rationing variable Z captures the spill-over effect from the credit market as capital movements, and especially short-term capital flows, are not totally controlled by the central bank. In the equilibrium condition (2.3), foreign supply is assumed perfectly elastic and demand-determined. This implies that exchange rate changes lead to proportional changes in the net stock of foreign debt expressed in terms of foreign currency.

From the central bank balance sheet (see Table 1)

$$(2.4) \qquad S = H + GCB$$

the supply of central bank credit to the private banks H^{s} is derived residually, as the foreign exchange reserves of the central bank GCB are obtained from the overall balance of the balance of payments

$$(2.5) \qquad \Delta GCB = BC + \Delta KFP^{d} + \Delta eKFG$$

and the supply of currency S^{s} is assumed to be determined by demand given as

$$(2.6) \qquad S^{s} = S^{d}(\overset{+}{PD \cdot Y},\overset{-}{RD},\overset{+}{V_{-1}}).$$ [1]

The specification of the remaining assets and liabilities of the model starts from the balance sheet of the private banks (see Table 1).

$$(2.7) \qquad L = D + H,$$

where L is loans granted to the private sector, D domestic deposits and H central bank credit. All items in (2.7) are denominated in domestic currency, because it is assumed that

1. In (2.6) RD is the exogenous deposit rate.

the banks only act as intermediaries for loans denominated in foreign currency, i.e. their foreign exchange position is closed.

The banks are assumed to determine individually their supply of loans by maximising their profit and regarding deposits as well as interest rates exogenously given. The supply of loans is thus

$$(2.8) \qquad L^S = L^S(\overset{+}{RL},\overset{-}{R}),$$

where R is the marginal cost of central bank credit defined as

$$(2.9) \qquad R = R(\overset{+}{H}).$$ [1]

Finally, the stock of government bonds in the portfolio of the private sector is determined by supply because it is assumed that the government fixes their terms so as to make them sufficiently attractive. The supply of government bonds follows from the government budget constraint[2]

$$(2.10) \qquad \Delta eKFG + \Delta B = PP(G-T) + RF_{-1} \cdot eKFG_{-1} + RB_{-1} \cdot B_{-1}.$$

The price and wage block of the model contains equations and definitions for domestic prices, a Phillips curve and a simple 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 as well.[3] A hat over a variable denotes proportionate change, e.g. $\hat{PD} = \Delta PD/PD_{-1}$. Assuming all prices and the exchange rate in the previous period to be equal to one, we get $PD = PD_{-1}(1 + \hat{PD}) = 1 + \hat{PD}$. Thus

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1. The equation should also include the exogenous basic discount rate together with monetary policy parameters determinig the marginal cost for central bank credit. Although being the most important monetary instruments of the central bank they are not included in (2.9) because they are subsequently treated as constants.

2. In the constraint, RB is the exogenous tax-free bond rate.

3. For empirical evidence, see Aurikko (1980) and Vartia and Salmi (1981).

(2.11) $\hat{PD} = a_1 + a_2\hat{W} + a_3(Y - \bar{Y}) + a_4 \left[e(1 + \hat{PF}) - 1\right]$

$0 < a_2 < 1,\ a_3,\ 0 < a_4 \leq 1,$

where $\bar{Y}$ is capacity output.

Wages are determined as

(2.12) $\hat{W} = b_1 + b_2\hat{P} + b_3(Y - \bar{Y}),\ 0 < b_2 \leq 1,\ b_3 > 0.$

Equation (2.12) is a conventional expectations-augmented Phillips curve for wages with price expectations formed according to the perfect foresight hypothesis being equivalent to rational expectations in a deterministic model and the unemployment level approximated according to "Okuns's law" by the capacity output gap $Y - \bar{Y}$.[1]

Prices PP and P are defined as[2]

(2.13) $\hat{PP} = k_1\hat{PD} + (1 - k_1) \left[e(1 + \hat{PMR}) - 1\right],\ 0 < k_1 < 1$

(2.14) $\hat{P} = k_2\hat{PP} + (1 - k_2) \left[e(1 + \hat{PMF}) - 1\right],\ 0 < k_2 < 1.$

Equations (2.11)-(2.14) can be reduced to

(2.15) $\hat{P} = c_1 + c_2(Y - \bar{Y}) + c_3 \left[e(1 + \hat{PMR}) - 1\right]$

$+ c_4 \left[e(1 + \hat{PMF}) - 1\right] + c_5 \left[e(1 + \hat{PF}) - 1\right].$

With above restrictions $c_2, c_3, c_4, c_5 > 0$.[3]

1. Possible direct credit rationing effects on the supply side of the model are assumed negligible and are thus ignored.

2. The price levels are geometric averages with fixed weights. In the short-run this is not a serious limitation.

3. It is easily seen that in the long-run when $Y = \bar{Y}$ a sufficient condition for the domestic inflation rate to equal world inflation or exchange rate depreciation is that (2.11) and (2.12) are linearly homogenous with $a_2 + a_4 = 1$ and $b_2 = 1$.

3. Effects of Exchange Rate Policy and Imported Inflation

In this section short-run effects of exchange rate policy and imported inflation are briefly summarized.[1] According to the model the effect of devaluation is channelled through the positive direct effect on domestic output, credit rationing, the current account and domestic inflation. The indirect effects (see Appendix, Table A.1) are also plausible but somewhat ambiguous the credit rationing variable having essentially an analoguous role to the domestic interest rate in IS-LM models. The total effect of devaluation on credit rationing is positive while with respect to the current account, domestic demand and prices it is ambiguous, but probably positive.

As a conclusion it can be noted that even a relatively simple macroeconomic model with qualitative assumptions about the partial responses cannot yield unambiguous short-run total effects for devaluation. This applies especially to the domestic demand and current account effects. Moreover, the quantitative properties of the responses, such as their magnitude and dynamic path, are outside the sphere of a static equilibrium model. Therefore it is desirable to study them in the framework of an econometric model.

III. EFFECTS OF EXCHANGE RATE POLICY IN A MACROECONOMIC MODEL OF THE FINNISH ECONOMY

1. A Partial Approach

Traditionally, effects of exchange rate policies have often been assessed with in the framework of various partial approaches. A short empirical discussion of the elasticities approach is particularly useful here as an introduction to the empirical properties of the foreign trade block of the model.

In the elasticity approach the direct substitution effects of foreign exchange policy on the trade balance are considered

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1. See Appendix for a more detailed analysis.

in the case where domestic incomes, wages and prices are taken as constants. In order to assess the substitution effects implied by the elasticities approach, it is useful to briefly review the foreign trade equations of the Bank of Finland quarterly model containing disaggregated equations for export prices, export demand and import demand.[1]

The specification for export prices in the case of relatively homogenous products is

$$(3.1) \qquad PXUS = aPCOUS^{b}(CDUS/CFUS)^{c},$$

where PXUS is export prices, PCOUS world market prices and CDUS/CFUS relative costs in the home country and competitor countries, all measured in US dollars. The specification implies that exchange rate changes are fully passed through to the prices expressed in domestic currency. Export prices of more heterogenous, imperfectly substitutable products also reflect the effects of prices of other inputs and capacity utilization pressures.

As Finnish export prices are highly dependent on world market prices, export volumes are also assumed to be determined from the supply side as well as by relative prices and demand, so that exporters adjust deliveries according to profitability developments: i.e., exports are determined as

$$(3.2) \qquad X = a'MFO^{b'}(PXUS/PCOUS)^{c'}K^{d'}, \quad c' < 0,\ d' > 0,$$

1. These are discussed in Aurikko (1975) and Aurikko (1980).

where MFO is the volume of imports of the most important export markets and K is a profitability variable (gross profits). It is postulated that when profitability is above (below) the average level exports increase (decrease). This influence is stronger the more homogenous exports are.

Import prices are exogenous in the model. It is also assumed that the supply of Finnish imports is very elastic at exogenously determined world market prices. Disaggregated import demand equations are specified in the standard way as

$$(3.3) \qquad M = a_1 D^{a_2} (PM/PD)^{a_3} Q^{a_4}, \; a_2 > 0, \; a_3 < 0$$

where D is the relevant demand variable, PM/PD relative prices of imports and demand D in domestic currency and Q other variables.

The long-run price elasticity for total imports of goods aggregated by 1978 shares was -0.68 and that for exports -1.24.[1] As the foreign trade equations approximately fulfil the requirements for application of the Marshall-Lerner condition,[2] it is conceivable that devaluation would, according to this criterion, improve the Finnish trade balance. However, for a preliminary appraisal of the workings and dynamics of the foreign trade block of the model, the following simulation is presented.

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1. The absolute values of the short-run price elasticities are considerable smaller, as distributed lag schemes are extensively used in the foreign trade equations.

2. As Finland is to a large extent a price-taker in her export markets, export prices in terms of foreign currency remain practically unchanges after devaluation. Exports tend to increase through the profitability channel after devaluation.

Table 2. Partial substitution (elasticities) effects of devaluation[1]

	1971	1972	1973	1974	1978
Export prices	8.0	8.3	8.1	8.0	8.0
Volume of exports	1.1	1.2	2.1	2.3	2.3
Value of exports	9.2	9.9	10.4	10.5	10.4
Import prices	9.0	9.0	9.0	9.5	9.3
Volume of imports	-4.0	-5.2	-5.2	-5.4	-5.2
Value of imports	4.6	3.3	3.3	3.7	3.6
Trade balance	0.3	0.7	0.9	1.2	2.4

1. A 10 per cent devaluation of the Finnish mark from 1971.I onwards. Except for the trade balance, which is in billions of marks, multipliers are expressed as $100(XD_t - XC_t)/XC_t$ where

XC = control solution of variable X
XD = disturbed solution of variable X (only exchange rates are increased 10 per cent permanently from 1971.I).

As no domestic repercussions of the devaluation are taken account, aggregate export prices expressed in foreign currency fall somewhat. This causes growth in the aggregate export volume even disregarding the positive effects from increased profitability. Exogenous import prices in domestic currency are assumed to increase over 9 per cent immediately after devaluation so that import volumes decrease quite sharply. As a consequence of these developments the trade balance improves markedly.

In the partial analysis of the effects of devaluation discussed so far in this section, domestic prices, wages and for the most part monetary influences were assumed to be constants throughout. The rest of the paper deals with the quantitative effects of devaluation based on simulations of the macroeconomic model of the Finnish economy.

2. The Model

The macroeconometric model used in simulations is a quarterly model constructed at the Bank of Finland (BOF model).[1] It is basically Keynesian demand determined model in which production, income, labour, price and wage blocks have been disaggregated into two open sector industries (forestry and manufacturing) and two closed sector industries (services and agriculture). This disaggregation utilizes the basic framework and ideas of the Scandinavian model of inflation[2] implying that in the long-run inflation will be equal to the rate of change in the foreign prices and the exchange rate of the Finnish mark.

As there is no equilibrating interest rate mechanism in the Finnish loan market, equations for the demand for and supply of loans have been included in the financial sector of the BOF model estimated by means of a disequilibrium method. The minimum of the logarithmic ratio between these and zero is used as a credit rationing variable which is the main channel of transmission of monetary effects in the model. Thus, unlike the theoretical model, the BOF model assumes a homogenous credit market in which either excess demand (credit rationing) or excess supply (no credit rationing) is possible.

3. The Simulations

In this section the BOF model is simulated for the effects of exchange rate policy and imported inflation. 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. The results of the simulation

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1. For details, see Tarkka and Willman (1981).

2. See Edgren, Faxén and Odhner (1969).

experiments are expressed as dynamic multipliers of the form $100 \cdot (XD_t - XC_t)/XC_t$, where XC is the control solution of variable X and XD the disturbed (simulated) solution of variable X.[1]

In the exchange rate policy simulation a 10 per cent permanent devaluation is assumed to be carried out at the beginning of 1971. The devaluation is timed to coincide with a downturn of the business cycle. This is to avoid excessive overheating of the economy in the form of capacity constraints and accelerated inflation, thus providing scope in the model for export expansion via increased profitability and import substitution.

In connection with the devaluation simulation, assumptions about accommodating domestic economic policy measures and other exogenous changes in the model must be made. The former are simply assumed away.[2] Of the latter, changes in exogenous import prices in terms of domestic currency are of importance. They can be shown to increase by the full amount of the devaluation as long as no other countries alter they exchange rates, the price elasticity of the supply of imports is infinite and foreign exporters do not alter their supply prices in terms of dollars (Goldstein, 1974). In the case of a small open economy the first two conditions are obviously met. However, using evidence from empirical estimates of past Finnish devaluations[3], it is assumed here that 20 per cent of the devaluation is absorbed by

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1. In Figures 3 and 4 absolute differences $XD_t - XC_t$ are used.

2. In the case of monetary policy this simply means that the discount policy of the central bank is passive as in the theoretical model, implying that the monetary effects of the balance of payments are not neutralized.

3. These results are available from the author upon request.

foreign exporters so that imports prices of final goods (consumer and investment goods) in terms of domestic currency increase by only 80 per cent of the devaluation. While this assumption is based on competitive considerations, it is clear 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.

In the other two simulations experiments - international inflation and an increase in the prices of imported energy - the relevant prices are increased permanently by 10 per cent as from the beginning of 1971. In the former simulation foreign interest rates are also increased by 10 percentage points in the first quarter of 1971.

Results of the devaluation simulations are presented in Figures 1 - 4. According to the BOF model the volume of imports decreases immediately after the devaluation but less than in the partial simulation in Table 2. This is because the solution also includes the effects of the devaluation on domestic prices, production and credit markets. Later on, imports stay at a lower level than in the control solution, mainly in response to developments in domestic consumption and investment.

FIGURE 1. EFFECTS OF DEVALUATION

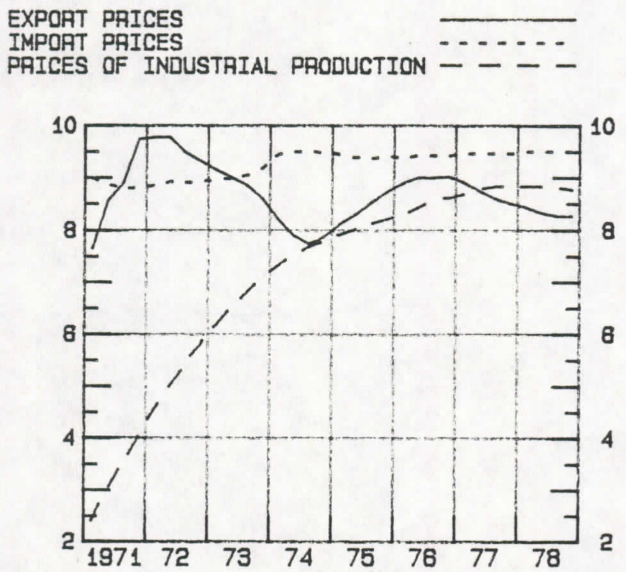


FIGURE 2. EFFECTS OF DEVALUATION

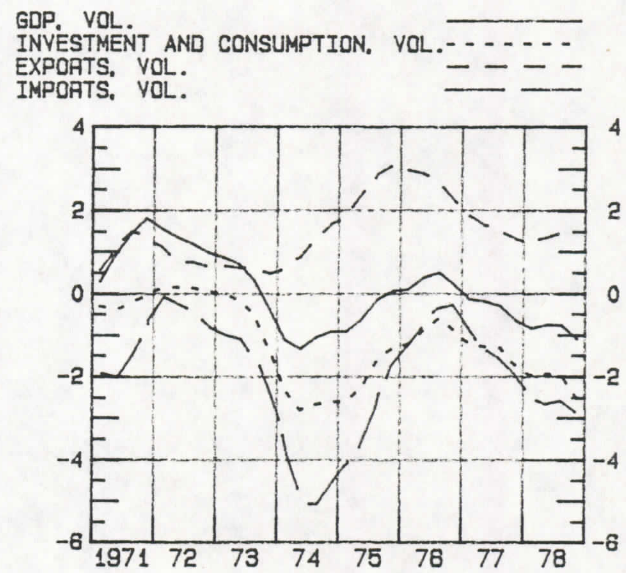


FIGURE 3. EFFECTS OF DEVALUATION

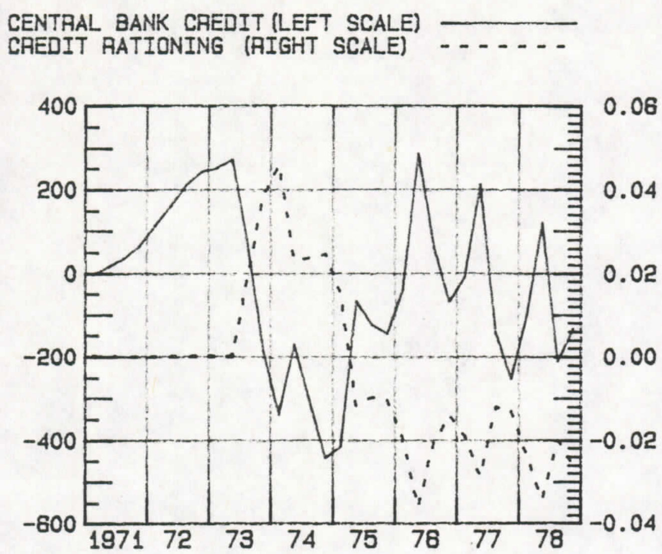
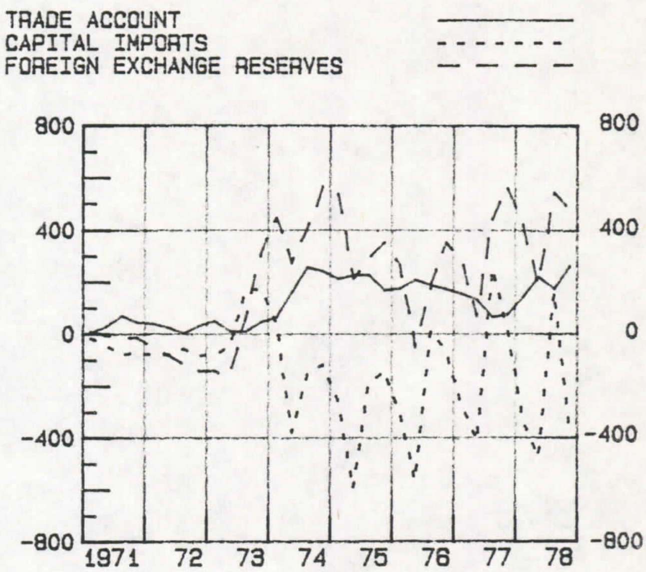


FIGURE 4. EFFECTS OF DEVALUATION



Export prices rise rapidly by nearly the full amount of the devaluation, but stabilize subsequently at a level about 8 per cent higher. In spite of increased domestic costs, the volume of exports responds positively to the devaluation throughout the simulation period because of favourable profitability developments. Accordingly, the trade account does not improve markedly until three years after the devaluation. This prolonged J-curve effect derives from terms-of-trade changes and the different dynamics of export and import volumes.

The current account improves approximately in line with the trade account because the changes in exchange rates has relatively little effect on imports and exports of services and investment income. Imports of long-term capital increase slightly throughout almost the entire simulation period while short-term capital imports are for the most part markedly lower than in the control solution, a reflection mainly of the improvement in the current account. All in all, these changes result in an increase in the foreign exchange reserves of the central bank.

The effects of foreign exchange policy on domestic demand are expansive immediately after the devaluation, but soon both investment and consumption begin to contract, the former mainly because of the credit rationing effect and the latter because of slower growth in disposable income. However, at the beginning of the fifth year following the devaluation, tightness in the credit market eases and this has a positive effect on domestic demand.[1]

Credit rationing is thus an important element in the BOF model. In contrast to the assumption of a heterogenous credit market in the theoretical model of Section II, where excess demand was a persistent phenomenon, the BOF model is based on the assumption of a homogenous 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 case of the devaluation simulation with passive domestic monetary policy, the credit market switches into an excess demand (credit rationing) regime in the third year after the devaluation, while in the control solution the excess supply (no credit

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1. Some implications for the long-run effects of devaluation can be inferred from Figures 1-4. The dynamic multipliers at the end of the simulation period suggest that the model is approximately neutral with respect to price developments while the real variables oscillate, although the amplitude of the oscillations are dampened over time mainly because of changes in the credit market conditions and profitability. The simulation results together with rough estimations of the effects of stabilization measures possibly undertaken in connection with the devaluation do not contradict with the so-called devaluation cycle hypothesis based on theoretical and empirical findings on Finnish devaluations carried out at intervals of ten years (see Korkman, 1978). According to the hypothesis during the first years after devaluation domestic demand increases, unemployment falls and relative share of profits increases. This process is reversed in the latter part of the cycle until a new devaluation is undertaken.

rationing) regime prevails until the beginning of 1974 exerting a contractive effect on domestic demand.[1]

Because of this feature of the model, the effects of policy simulations are somewhat sensitive to the timing of the simulations. A similar devaluation simulation starting from the beginning of 1974 with credit rationing prevailing shows that the initial contractive effect of the tightening of the credit markets on domestic demand is stronger and faster than in the devaluation simulation in Figures 1-4.

Although based on different credit market assumptions, the results of the devaluation simulation are in line with the qualitative conclusions made with the simplified theoretical model of Section II. In particular the credit market effects of devaluation on domestic investment demand are dominant and apart from an initial expansive effect aggregate domestic demand contracts for a large part of the simulation period according to the econometric model. As policy simulations with the BOF model depend crucially upon the prevailing credit market regime and upon switching between the two regimes it would be desirable to develop a version of the model based on heterogenous credit markets, which would permit smoother switching between the two regimes. Devaluation simulations associated with various domestic monetary measures are also important as a means of determining the sensitivity of the model with respect to these policies and in order to find optimal policy measures.

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1. In Figure 3 the credit rationing effect is measured as the difference between the simulated and control values of the credit rationing variable. The control solution is zero (no credit rationing) until the first quarter of 1974 and positive (credit rationing) thereafter. The simulated solution is zero in the first nine quarters of the simulation period and positive therafter. During the period 1973-1975, it is greater than the control solution and in 1976-1978 smaller, implying tighter credit market conditions in 1973-1975 and easier conditions later on.

FIGURE 5. EFFECTS OF INTERNATIONAL INFLATION

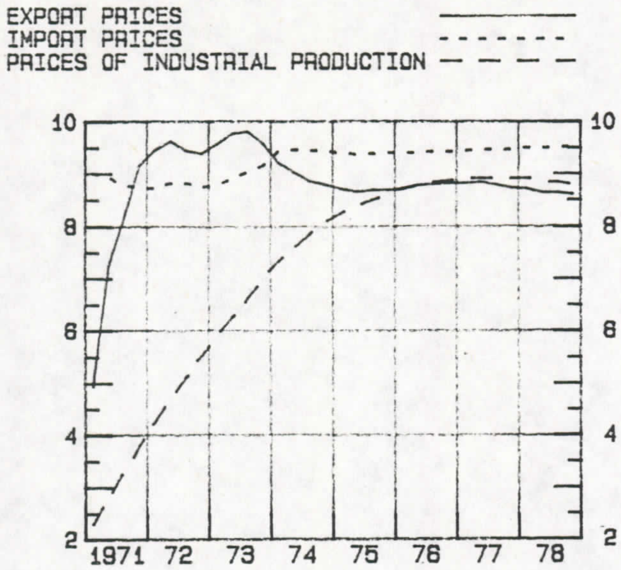
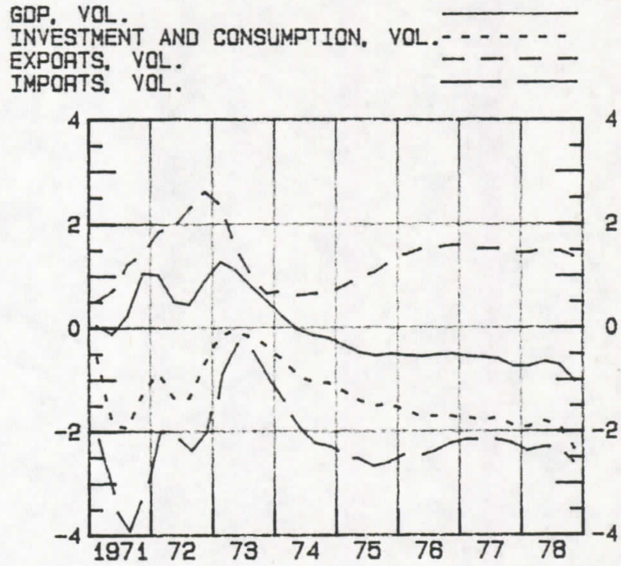


FIGURE 6. EFFECTS OF INTERNATIONAL INFLATION



In Figures 5 and 6 the effects of international inflation on prices and demand are roughly comparable to those of foreign exchange policy. This follows from the fact that exchange rates and foreign prices enter the model almost symmetrically. However, because of lags, export prices react more slowly than in the devaluation simulation causing only modest export and domestic demand expansion immediately after the price shock. Even with a considerable drop in the volume of imports, the current account deteriorates, demonstrating the J-curve effect in the first half of 1971. With foreign interest rates temporarily increased, capital imports are depressed and the foreign exchange reserves of the central bank are lower during the first two quarters as compared with the control solution. Because of the assumption of unchanged monetary policy, the credit market switches into a credit rationing regime during 1971-1972. In 1973 there is no credit rationing and domestic demand increases.

Thus differences in the effects of international inflation and devaluation in the BOF model stem mainly from different lag schemes in the foreign trade equations with respect to exchange rates and foreign prices and from the assumption about foreign interest rates.

FIGURE 7. EFFECTS OF INCREASE IN THE PRICES OF IMPORTED ENERGY

EXPORT PRICES ————
IMPORT PRICES - - - - - - -
PRICES OF INDUSTRIAL PRODUCTION — — — —

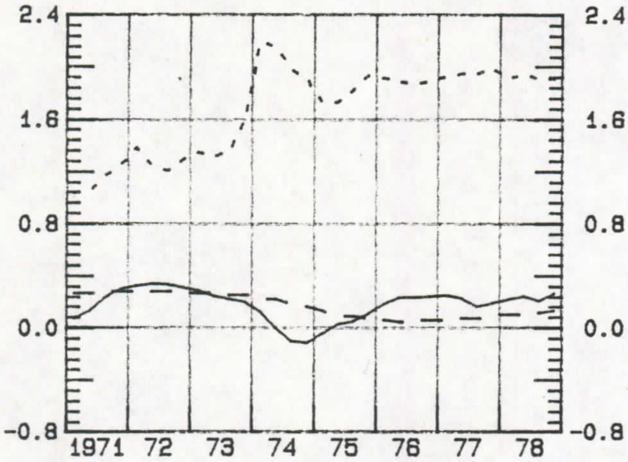
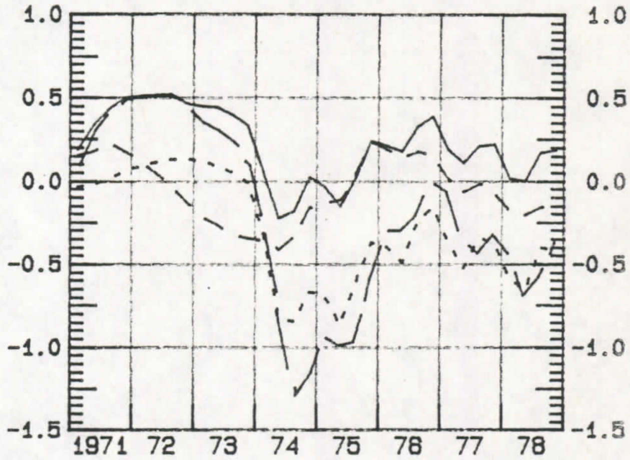


FIGURE 8. EFFECTS OF INCREASE IN THE PRICES OF IMPORTED ENERGY

GDP, VOL. ————
INVESTMENT AND CONSUMPTION, VOL. - - - - - - -
EXPORTS, VOL. — — — —
IMPORTS, VOL. —— ——



Finally, the effects of a 10 per cent increase in the prices of imported energy are presented in Figures 7 and 8. The effects are inflationary and expansive. The current account effect is negative and the credit rationing effect marginally positive throughout the simulation period.[1]

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1. The effect on domestic demand in contractive only temporarily mainly because a shock of only 10 per cent does not trigger any fundamental change in the credit market conditions. Experiment with a corresponding 100 per cent shock showed a highly contractive response with considerable tightening in the credit market. However, in this case a complicating factor is that with a sizeable increase in energy prices some increase in other international prices should also be assumed.

IV. CONCLUSIONS

In this paper the effects of devaluation and imported inflation are studied in the framework of a macroeconometric model specified for a small open economy with undeveloped financial markets. The policy effects and their channels are first analyzed with the aid of a simplified macroeconomic model containing credit rationing elements. According to the simulations the present version of the BOF model is fairly sensitive to the credit market conditions prevailing at the time the policies are implemented and to a possible change in credit market regime or tightness in the credit rationing regime. This has implications both for the timing of the policy measures and for the supporting monetary policy undertaken in order to dampen possible cyclical movements in domestic demand. An additional complicating factor is that the model is not linear with respect to the magnitude of the shock.

APPENDIX

This appendix builds and analyses short-run effects and longer-run implications of exchange rate policy and imported inflation on domestic output, credit rationing, the current account and domestic inflation in a macromodel outlined in Section II.

The model is as follows:

$$(A.1) \qquad Y = \frac{1+\hat{P}}{1+\hat{PD}} E\left[Y,T,RL,RF,\frac{Z}{1+\hat{P}}, \frac{(L^s+GCB+B)_{-1}}{1+\hat{P}}\right] + \frac{1+\hat{PP}}{1+\hat{PD}} G$$

$$+ \frac{1+\hat{PP}}{1+\hat{PD}} X\left[\frac{1+\hat{PP}}{e(1+\hat{PF})}\right]$$

$$\frac{e(1+\hat{PMF})}{1+\hat{PD}} MF\left[E, \frac{e(1+\hat{PMF})}{1+\hat{PP}}\right] - \frac{e(1+\hat{PMR})}{1+\hat{PD}} MR\left[Y, \frac{e(1+\hat{PMR})}{1+\hat{PD}}\right]$$

$$(A.2) \qquad Z = L^d\left[(1+\hat{PD})Y,RL\right] - L^s\left[(1+\hat{PD})Y,RL,RD,(L^s+GCB+B)_{-1}, GCB\right]$$

$$(A.3) \qquad BC = (1+\hat{PP})X-e(1+\hat{PMF})MF-e(1+\hat{PMR})MR-eRF_{-1}(KFP^d_{-1}+KFG_{-1})$$

$$(A.4) \qquad \hat{P} = c_1+c_2(Y-\bar{Y})+c_3\left[e(1+\hat{PMR})-1\right]+c_4\left[e(1+\hat{PMF})-1\right]+c_5\left[e(1+\hat{PF})-1\right]$$

$$(A.5) \qquad \Delta GCB = BC + \Delta KFP^d + \Delta eKFG$$

$$(A.6) \qquad \Delta eKFG + \Delta B = (1+\hat{PP})(G-T) + RF_{-1}\cdot eKFG_{-1} + RB_{-1}\cdot B_{-1} .$$

The first four equations of the model determine the short-run static flow equilibrium and the last two equations the intermediate-run dynamic stock equilibrium. The distinctive feature of the model as compared with IS-LM models is that the conventional equilibrating endogenous interest rate mechanism of IS-LM models is replaced by credit rationing and its spill-over effects to other markets.[1] The crucial monetary policy instruments are the terms and cost of the private banks' central bank credit. In the present model the equilibrium condition (A.1) defines the IS curve of the commodity market and equation (A.2) the LM curve of the loan market with respect to Y and Z.

Before analyzing the model by comparative statics it is first necessary to see whether the static part of the model can be solved uniquely. The Jacobian (J) of the static part of the model (A.1)-(A.6), where $F^i = (A,i)$, i= 1,...,6, is

$$\text{(A.7)} \quad F^1_Y - F^1_Z F^2_Y + F^1_Z F^2_{\hat{P}} F^4_Y - F^1_{\hat{P}} F^4_Y \, .$$

Sufficient conditions for (A.7) to be positive follow from the assumptions about the signs of the partial derivatives of the model. In addition it is required that F^1_Y, F^1_Z and $F^1_{\hat{P}}$ are all positive. The first is true if $E_1 < 1$, the second if $MF_1 < 1$ and the third if the partial price effect on demand is negative. Thus a unique solution for the model exists locally with respect to the endogenous variables as a function of the exogenous variables and parameters.

In studying the comparative statics properties of the model it is illuminating to treat the direct and indirect channels of causation separately.[2] In the case of exchange rate policy there are four direct channels, i.e. $\partial Y(e)/\partial e$, $\partial Z(e)/\partial e$, $\partial BC(e)/\partial e$ and $\partial \hat{P}(e)/\partial e$, which are positive according to the assumptions made above. In particular, $\partial BC(e)/\partial e = - F^3_e > 0$ provided the Marshall-Lerner condition is met.[3] Thus, for example, devaluation according to the model directly increases domestic demand and credit rationing, i.e. tightens the domestic credit market, improves the current account in terms of domestic currency and raises the domestic rate of inflation.

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1. Earlier attempts at specifying an IS-LM analogy for the Finnish economy have been made by Koskela (1979), Oksanen (1980) and Willman (1981).

2. A similar approach is used in Turnovsky (1977).

3. In fact, the Marshall-Lerner condition is possibly more stringent than necessary in the present model, because export prices in domestic currency rise according to equations (2.11) and (2.13). However, net interest payments also increase with unitary elasticity.

The total effect of devaluation can be obtained from equations

$$\begin{pmatrix} \partial Y/\partial e \\ \partial Z/\partial e \\ \partial BC/\partial e \\ \partial \hat{P}/\partial e \end{pmatrix} \begin{pmatrix} J_{11} & J_{21} & J_{31} & J_{41} \\ J_{12} & J_{22} & J_{32} & J_{42} \\ J_{13} & J_{23} & J_{33} & J_{43} \\ J_{14} & J_{24} & J_{34} & J_{44} \end{pmatrix} \begin{pmatrix} \partial Y(e)/\partial e \\ \partial Z(e)/\partial e \\ \partial BC(e)/\partial e \\ \partial \hat{P}(e)/\partial e \end{pmatrix}$$

where the indirect multiplier terms J_{ij} are cofactors of the Jacobian matrix with signs

Table A.l. Indirect effects of devaluation originating from

	Direct demand effect effect	Direct credit rationing effect	Direct current account effect	Direct domestic price effect
Y	+	-	0	-
Z	+	+	0	(+)
BC	(-)	+	+	(-)
$\hat{P}$	+	-	0	+

It can be seen from the first column of Table A.l that, according to the model, devaluation also increases domestic demand indirectly. Similarly, it tightens credit markets and accelerates inflation. However, the indirect demand effect on current account is ambiguous, but possibly negative provided that the partial price and demand effects on credit rationing and the credit rationing effects on the current account are dominated by the partial price and demand effects on the current account, implying that the Marshall-Lerner condition is met.

The second column shows that a direct increase in credit rationing tends to reinforce itself indirectly, but reduce demand and inflation; the current account is improved indirectly. According to the third column the initial current account improvement is magnified indirectly. There are no other indirect effects because the variable BC in the model does not appear in equations (A.1), (A.2) and (A.4). The last column shows that domestic inflation reinforces itself indirectly. On the other hand, the indirect credit rationing effect is ambiguous but presumably positive. The indirect negative effect of inflation on the current account presupposes similar conditions as in the case of the indirect demand effect on the current account.

The sign of the overall effect of devaluation on the endogenous variables of the model is ambiguous, with the exception of the positive credit rationing effect, because according to Table A.1 the indirect effects, the sum of which gives the total effect, are different in sign and therefore offsetting. For example, of the four channels making up the overall effect of devaluation on the current account two are positive and two negative: the indirect current account and credit rationing effects are positive while the demand and price effects are assumed to be negative. If the negative effects are relatively small, then the short-run impact of devaluation on the current account is positive. The total effect of devaluation on domestic demand and prices is also ambiguous, but probably positive. For this to be so requires, in particular, that the credit market effects of devaluation on demand and prices are rather small.

Using the above results, the effects of imported inflation in the form of an increase in the prices of intermediate imports and overall foreign inflation are briefly discussed. The direct effects of an increase in the prices of intermediate imports (e.g. energy) are positive, exept that $\partial Z(\hat{PMR})/\partial \hat{PMR} = 0$. The positive direct demand and current account responses presuppose that the absolute value of the price elasticity of intermediate imports is large enough to compensate for the offsetting effects in final imports and exports caused by rising domestic prices. According to Table A.1, the total effect is positive on inflation and possibly negative on the current account. Demand and credit market affects are uncertain.[1]

As foreign prices and the exchange rate enter the model almost symmetrically, the effects of an increase in international inflation ($d\hat{PMR} = d\hat{PMF} = d\hat{PF}$) are almost identical to those of exchange rate policy. Because, in addition, e is in net interest payments in equation (A.3), the total short-run effect of devaluation on the current account is weaker than the effect of a corresponding increase in international inflation. Thus, provided the Marshall-Lerner condition holds, international inflation has more favourable balance of payments effects than devaluation.

To simplify the dynamic analysis of the model, it is assumed that V_{-1} does not enter in equation (A.2). It is also assumed that B is an exogenous policy parameter of the government and that $\Delta B = 0$. Moreover, the exogenous foreign prices and exchange rate are set equal to one and the dynamics of domestic prices and wages are assumed to be stable with stationary values equal to one.

The dynamics of the model are determined by equations

$$\text{(A.8)} \qquad Y - E\left[\overset{+}{Y}, \overset{-}{Y_{-1}}, \overset{+}{GCP}, \overset{+}{GCB_{-1}}\right] + MF(E) + MR(Y) = 0$$

$$\text{(A.9)} \qquad \Delta\, GCB + MF(E) + MR(Y) - KFP^d + (1 + RF_{-1})\, KFP^d_{-1} = 0$$

---

1. The above price elasticity assumption might be unrealistic as substitution of raw material imports in domestic production is difficult, at least in the short-run. Consequently, the absolute value of price elasticity could be small so that the direct demand and current account effects may be negative. In this case the total effect on demand and credit markets is also negative, while that on the current account and inflation is ambiguous, but presumably negative on the former and positive on the latter.

obtained by inserting equation (A.2) into (A.1) and (A.6) into (A.5). Linearization of the system gives

$$\text{(A.10)} \quad Y + \overset{+}{a}Y_{-1} + \overset{-}{b}GCB + \overset{-}{c}GCB_{-1} = K$$

$$\text{(A.11)} \quad Y + \overset{?}{d}Y_{-1} + \overset{+}{e}GCB + \overset{-}{f}GCB_{-1} = K'$$

where K and K' are constants and the signs above the parameters have been derived using previous results and assumptions.

The stability conditions for (A.10) and (A.11) (see Gandolfo, 1980) suggest that the system might be stable provided that $d > 0$, i.e. the wealth effects of Y_{-1} via L^{s}_{-1} on E are dominated by the credit rationing effects of Y_{-1} on KFP^{d}_{-1}. Thus the stability of (A.10) and (A.11), and hence local stability of (A.8) and (A.9), is not easily determined. However, assuming that the system is dynamically stable in the sense that all prices, wages and nominal variables grow at the rate determined by international inflation and all real variables are constant, suggests that devaluation is transmitted in full to domestic prices in the long-run. Domestic inflation can be kept lower than international inflation only by continuous revaluation.

The existence of a long-run dynamic equilibrium characterised by constant inflation implies the conventional result of monetary analysis that the real equations of the model are homogenous of degree zero and mininal equations of degree one. A once-and-for-all devaluation or international inflation shock does not affect the stationary real variables of the model. So there are no current account effects except during a temporary adjustment period.

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