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A GEOMETRIC APPROACH TO DISEQUILIBRIUM EXCHANGE RATE FLUCTUATIONS

The Case of Switzerland*

Gilbert RITSCHARD and Daniel ROYER

Université de Genève, CH-1211 Genève 4, Switzerland

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This article deals with the effects of exchange rate fluctuations in non-Walrasian macromodels. A demand driven model ('Keynesian Unemployment') and a supply driven model ('Classical Unemployment'), both estimated on Swiss data, are alternatively considered. In each case an exchange rate modification and possible accompanying policy measures are considered. The feasible consequences on employment and the balance of trade are investigated by means of a geometric comparative static technique. For each type of fix-price equilibrium, the favourable conditions for a devaluation and a revaluation are thus emphasised.

1. Introduction

Since the final collapse of exchange rate parities in 1973, exchange rates of most industrial countries have fluctuated widely and, apparently at least, somewhat erratically. This course of action has given rise to the concern of disorderly market behaviour and increased uncertainty among traders and national monetary authorities. Moreover, for the great majority of countries who must totally import their oil, the fluctuations of their own currency vis-à-vis the U.S. dollar can be, at least in the short run, a major cause of happy or unhappy upheavals in their economy.

Our purpose here is not to elucidate the controversies over determinants of the exchange rate,[1] but rather to acknowledge its instability and therefore try and assess the effects of its variations on aggregate supply and aggregate demand, and finally on the equilibrium value of employment, as well as on the balance of trade.

This assessment will take two forms. One is concerned with *accompanying measures*, the other with *counteracting measures*. The accompanying measures

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[1]See Bigman and Taya (1980) and Frenkel and Johnson (1978) for surveys on this topic.

are the ones that would further drive the economy into a favourable direction that is already implied by an exogenously imposed devaluation or revaluation. The counteracting measures, on the contrary, are measures that would tend to offset, and if possible overcome, whatever negative effect this type of fluctuation of the exchange rate might have on the economy.

Our contention is that, at least in the short run, price movements will not take place automatically at the right time, in the right direction and with the proper magnitude to restore (or attain) automatically a Pareto optimal Walrasian equilibrium. Moreover, a devaluation or revaluation is bound to have different effects according to the type of temporary equilibrium characterising the economy.

We therefore adopt the conceptual framework of non-Walrasian equilibrium macromodels, and especially those based on the Clower–Benassy effective behaviour, which is obtained through the maximisation of the agent's preference function, subject to its budget or technological constraint and all quantity constraints except the one relevant for the market for which it is derived.

This approach leads to a polar characterisation of equilibria in, among others, a demand driven economy ('Keynesian Unemployment') and a supply driven economy ('Classical Unemployment').[2]

If the introduction of the foreign sector is quite straightforward in the demand driven case (as long as exports are exogenous with respect to the domestic flow variables), it implies a departure from the standard model in the supply driven case. In this type of equilibrium indeed the consumption of domestic goods by households is residual (government and foreign markets are served first). This situation induces thus a spillover effect on the import of consumption goods. Imports by firms and imports by households will therefore be given a different treatment.

When facing a devaluation or a revaluation, policy actions envisaged are of two kinds: public expenditures on the one hand, price policies of importers and exporters on the other.

To assess the effects of these measures, a geometric method [Ritschard and Rossier (1981) and Rossier (1982a, b)] is used, which gives at once the feasible set of values for the endogenous variables corresponding to all possible continuous combinations of policy measures. A portion of the frontier of this set will thus correspond to all non-dominated policies in a Paretian fashion: No other feasible policy would improve at least one objective while the others remain the same.

In a previous paper [Royer (1981)] this method was applied to a simplified

[2]See, for instance, Barro and Grossman (1976) and Malinvaud (1977). Our concern being with Western market-type economies, we shall not consider the (anyway somewhat ambiguous) case of 'Repressed Inflation'. For extensions to open economies, see Dixit (1978), Steigum (1980) and Fourgeaud et al. (1981).

version of the model, in which key characteristics of the economy's foreign trade and price structure position were allowed to vary, taking into account the more general situations that can be considered in this respect.

In this paper we concentrate on policy actions only, and the intervals of variation retained will correspond to a feasible range for the instruments. All other parameters have been estimated econometrically.

A word of warning should be given here. Both types of models (demand driven and supply driven) have been estimated on Swiss data for the same period. This does not mean that we intend to determine on the basis of empirical evidence whether the economy was, over that period, 'Keynesian' or 'Classical'. On the contrary, if these concepts have any relevance at all (obviously a statement with which we agree), it lies for reasons of aggregation in intermediate situations, more realistic but also more complex.

Nevertheless, a thorough understanding of simple extreme cases proves often essential before tackling more complex situations, and comparing the effects of counteracting the fluctuations of the exchange rate under each of the extreme regimes already provides useful indications about the ability to act within an intermediate situation.

2. The theoretical model

2.1. General features

The basic setup is the usual non-Walrasian macromodel with one aggregate commodity, one energy product, one type of labour and fiat money as the sole asset.

The commodity and the energy product are available in quantity $Q+Im+E$, where Q is the domestic production, Im the non-energy imports, and E the energy product totally imported. They are consumed in quantity C by the households, I by the firms, G by the government and Ex by the rest of the world. Labour is supplied in quantity N by households, who hold an amount M of nominal balances.

The price variables in terms of domestic currency are p for consumption, p_{im} for imports, P_{ex} for exports and p_e for energy. Prices in terms of foreign currency are denoted by starred variables, while the exchange rate is denoted by r. The variable π stands for the ratio of the import price to the domestic price. Finally the nominal wage rate is w and the interest rate (used as a discount factor by households) is called s.

2.2. The demand driven model

The basic features which lead to a demand driven equilibrium (the so-called Keynesian Unemployment regime) is a sales constraint for the firms and a labour constraint for the households. Output is thus demand generated and we have the following behavioural equations:

$$C = g_1(wN, p, s, M_0), \tag{D.1}$$

$$N = g_2(Q), \tag{D.2}$$

$$Im = g_3(TD, \pi), \tag{D.3}$$

$$E = g_4(Q, p_e), \tag{D.4}$$

$$Ex = g_5(WD, p^*_{ex}), \tag{D.5}$$

along with the definitions

$$TD = C + I + G + Ex, \tag{D.6}$$

$$Q = TD - Im - E, \tag{D.7}$$

$$B = p_{ex}Ex - p_{im}Im - p_eE. \tag{D.8}$$

Eq. (D.1) expresses the demand for consumption goods as a function of actual income wN (money wage rate times actual employment), the price level p, the interest rate s and initial cash balance M_0.

Eq. (D.2) is the demand for labour N from the firms supposed to operate under a sales constraint embodied by output Q.

Eq. (D.3) expresses the imports of non-energy products as a function of total demand TD and relative price π, whereas eq. (D.4) states that the imports of energy products depend on the level of domestic economic activity Q and its own price p_e, since the model assumes no possible substitution with domestic energy.

Finally, exports are given by eq. (D.5) as a function of the foreign demand WD, and the price of traded goods in foreign currency p^*_{ex}.

Eqs. (D.6) and (D.7) are self-contained whereas eq. (D.8) defines the balance of trade B.

2.3. The supply driven model

The main characteristics of a supply driven equilibrium (the so-called Classical Unemployment regime) are that employment, and hence output, respond only to profitability considerations. Households thus face a labour (or income) constraint, and are likely to face a constraint on their consumption of domestic goods,[3] inducing a sequential spillover effect on

[3] It is indeed the case if the government's behaviour is exogenous, implying it is served first.

their demand for imported consumption goods. This can easily be seen by writing their programme as

$$\max U(Cd, Cim, M),$$

$$pCd + p_{im}Cim + M = wN + (1+s)M_0,$$

$$Cd \leqq Cd^*,$$

where Cd is their consumption of domestic goods (bounded by Cd^*), and Cim their consumption of imported goods.

By denoting by Yim that part of their income which exceeds the fraction allotted to domestic consumption,

$$Yim = wN - pCd,$$

their demand for imported goods can be written

$$Cim = f_5(Yim, p_{im}, s, M_0).$$

The whole model is composed of the following equations:

$$N = f_1(w/p), \tag{S.1}$$

$$Q = f_2(N), \tag{S.2}$$

$$Imf = f_3(Q, \pi), \tag{S.3}$$

$$E = f_4(Q, p_e), \tag{S.4}$$

$$Cim = f_5(Yim, p_{im}, s, M_0), \tag{S.5}$$

$$Ex = f_6(WD, p^*_{ex}), \tag{S.6}$$

$$Cd = Q - G - I - Ex + Imf + E, \tag{S.7}$$

$$Yim = wN - pCd, \tag{S.8}$$

$$B = p_{ex}Ex - p_{im}Imf - p_{im}Cim - p_eE. \tag{S.9}$$

Apart from the households' consumption function of imported goods, distinctive features from the demand driven model are the links between profitability w/p, the demand for labour N and output Q [eqs. (S.1) and

(S.2)] and the residual aspect of the consumption of domestic goods [eq. (S.7)]. This latter characteristic implies that firms will serve foreign markets first, which can be justified on the ground of preserving market shares for the economy as a whole. On the households' side, its abruptness is tempered by the possibility of importing consumption goods.

2.4. The price sector

The price variables are assumed to be strongly separable from the real core of the economy in the short run, but react of course instantaneously to a variation in the exchange rate.

Assuming a relative variation $\mathring{r}=\Delta r/r$ of the exchange rate, we posit the following relations for prices:

$$\mathring{p}_{ex}=\gamma_{ex}\mathring{r}, \qquad 0\leqq\gamma_{ex}\leqq 1, \tag{P.1}$$

$$\mathring{p}_{im}=\gamma_{im}\mathring{r}, \qquad 0\leqq\gamma_{im}\leqq 1, \tag{P.2}$$

$$\mathring{p}_{e}=\mathring{r}, \tag{P.3}$$

$$\mathring{p}=\delta_{im}\mathring{p}_{im}+\delta_{e}\mathring{p}_{e}, \tag{P.4}$$

$$\mathring{\pi}=\mathring{p}_{im}-\mathring{p}, \tag{P.5}$$

$$\mathring{p}^*_{ex}=\mathring{p}_{ex}-\mathring{r}. \tag{P.6}$$

A difference of status among these parameters should be noted, as it will prove important in the sequel: Important price elasticity (γ_{im}) and export price elasticity (γ_{ex}) depend to some extent on the willingness and financial capabilities of importers and exporters to pass the effect of an exchange rate variation on to their customers. They can therefore be considered of a somewhat controllable nature. The elasticities of the GNP price index on the contrary are deeply rooted in the structural characteristics of the economy, and therefore largely uncontrollable. In the sequel they will be treated in an ad hoc way, by using ratios of relevant values.

Parameter γ_{ex} is of special interest and can best be interpreted by looking at the relations

$$\mathring{p}_{ex}=\gamma_{ex}\mathring{r}, \qquad \mathring{p}^*_{ex}=(\gamma_{ex}-1)\mathring{r}.$$

Whence,

$$\gamma_{ex}=0 \Rightarrow \mathring{p}_{ex}=0, \quad \mathring{p}^*_{ex}=-\mathring{r},$$

$$\gamma_{ex}=1 \Rightarrow \mathring{p}_{ex}=\mathring{r}, \quad \mathring{p}^*_{ex}=0.$$

When γ_{ex} is at its lowest value, a devaluation ($\mathring{r}>0$) increases the competitiveness of the economy ($\mathring{p}^*_{ex}<0$) but has no effect on the profitability of the firms ($\mathring{p}_{ex}=0$). When it is at its highest value, the full effect of the devaluation bears on the profitability ($\mathring{p}_{ex}>0$), but has no impact on the competitiveness ($\mathring{p}^*_{ex}=0$). The size of γ_{ex} reflects thus the trade-off between profitability ($\gamma_{ex}=1$) and competitiveness ($\gamma_{ex}=0$). Considering now a revaluation ($\mathring{r}<0$), we see that a low value of γ_{ex} does not affect profitability, but weakens the competitiveness ($\mathring{p}^*_{ex}>0$). A high value of γ_{ex} on the other hand does not affect competitiveness but harms the profitability ($p_{ex}<0$).

The price of non-energy imports and the price of energy products (totally imported) are given a distinct treatment. A change in p_e incurred by a variation of r is total, whereas, owing to competitivity considerations on the domestic market, γ_{im} can be given a value lower than one.

3. The empirical model and its causal outline

The parameters of the model have been estimated on Swiss data, for the period 1960–1980, with one exception for the export function, which has been estimated on the 1964–1980 period because of data availability. The model has then been written in rates of variation, except the balance of trade, which appears in absolute variation.[4] Econometric results and the transformation of identities are discussed in the appendix. The only two exogenous variables assumed to vary are the rate of exchange r and public expenditures G. The other exogenous variables are therefore dropped from the model written in rates of variation.

3.1. The demand driven empirical model

It is formed of the eight equations defining the flow variables and employment, plus the six equations referring to prices. Unless otherwise stated, all variables are now rates of variation. We thus have

$$
\begin{aligned}
C &= 0.74\,N - 0.65\,p,\\
N &= 0.82\,Q,\\
Im &= 1.37\,TD - 0.30\,\pi,\\
E &= 1.21\,Q - 0.09\,P_e,\\
Ex &= -0.27\,p^*_{ex},\\
TD &= 0.424\,C + 0.08\,G + 0.29\,Ex, \qquad -0.05 \leqq G \leqq 0.1,\\
Q &= 1.49\,TD - 0.47\,Im - 0.014\,E,\\
\Delta B &= 62580(Ex + p_{ex}) - 62094.5(Im + p_{im}) - 6495.5(E + p_e),
\end{aligned}
$$

[4] This is due to the fact that the initial point is negative. Working with the rate of variation of the balance of trade would have implied counter-intuitive results with respect to the signs.

$$
\begin{aligned}
\pi &= p_{im} - p, \\
p &= 0.26\, p_{im} + 0.03\, p_e, \\
p_{ex} &= \gamma_{ex} r, \qquad 0 \leqq \gamma_{ex} \leqq 1, \\
p_{im} &= \gamma_{im} r, \qquad 0 \leqq \gamma_{im} \leqq 1, \\
p_e &= r, \\
p^*_{ex} &= p_{ex} - r.
\end{aligned}
$$

The causal outline for the whole model can then be represented by the graph given in fig. 1.

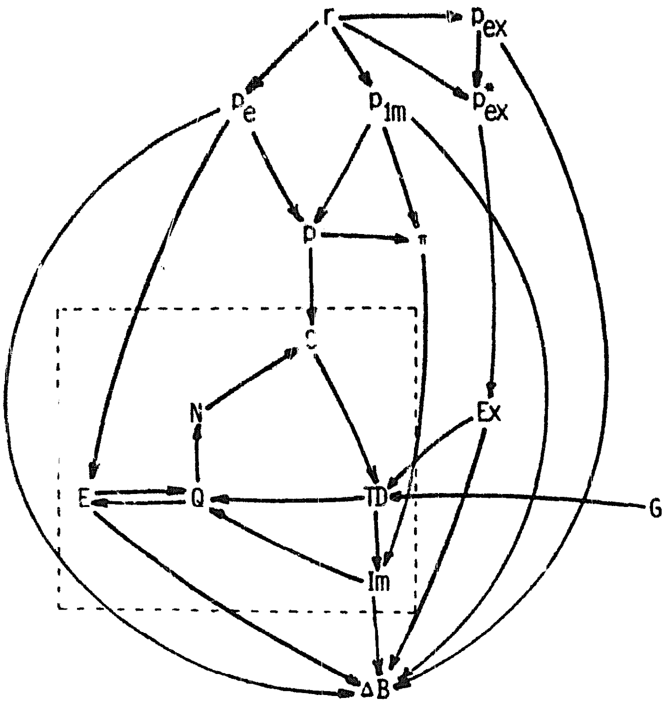

Fig. 1. Graph of the demand driven empirical model.

As expected, the various prices and exports appear in the first three levels, before the strong component corresponding to the real sector of the economy, while the balance of trade is a terminal point for all causal influences. The strong component exhibits typical Keynesian circuits linking the various components of domestic demand to output and employment.

A variation in public expenditures does not affect prices and exports, and has the usual open multiplier effect on the flow variables.

A variation in the exchange rate will affect employment and the balance of trade through the channels of export and import prices. On the export side, it induces a change in the volume of effective demand qualitatively identical to that of public expenditures, this effect being progressively annihilated as γ_{ex} tends to one. On the import side, it has a joint effect through a change in the volume of imports and households' consumption.

As to the effects of a variation of the exchange rate on the balance of trade, they pertain to both the value and the volume side.

The value effect depends straightforwardly on the respective magnitudes of γ_{im} and γ_{ex}.

The volume effect is more complex. An induced change in the price of exports has a direct positive effect on the balance of trade and an indirect negative one through a boost in effective demand. Import prices have at their turn a similar dual effect through the volume of imports, as well as an induced effect through households' consumption.

3.2. The supply driven empirical model

The supply driven model is also composed of the nine equations defining the flow variables, plus the six equations referring to prices. The link v between the demand for labour and the real wage rate has not been estimated, partly because of the lack of reliable data, partly because of its sensitivity to the firms' expectations. Besides, it embodies the effect of a tax incentive to hire labour. It was therefore decided to let this parameter vary over the closed interval [0.1, 0.7], whose bounds were set by cross examination of the relevant series.[5]

Written in rates of variation, the equations are as follows:

$$
\begin{aligned}
N &= vp, \qquad 0.1 \leqq v \leqq 0.7,\\
Q &= 0.99\,N,\\
Imf &= 1.29\,Q - 0.56\,\pi,\\
E &= 1.21\,Q - 0.09\,p_e\\
Cim &= 0.60\,Yim - 0.30\,p_{im},\\
Ex &= -0.27\,p^*_{ex},\\
Cd &= 2.03\,Q - 0.24\,G - 0.89\,Ex + 0.68\,Imf + 0.03\,E, \qquad -0.05 \leqq G \leqq 0.1,\\
Yim &= 5.07(N+w) - 4.07(Cd+p),\\
\Delta B &= 62580(Ex + p_{ex}) - 43743.5\,Imf - 18351\,Cim, - 62094.5\,p_{im} - 6495.5\,(E + p_e),\\
\pi &= p_{im} - p,\\
p &= 0.26\,p_{im} + 0.03\,p_e,\\
p_{ex} &= \gamma_{ex} r, \qquad 0 \leqq \gamma_{ex} \leqq 1,\\
p_{im} &= \gamma_{im} r, \qquad 0 \leqq \gamma_{im} \leqq 1,\\
p_e &= r,\\
p^*_{ex} &= p_{ex} - r.
\end{aligned}
$$

The graph is given in fig. 2. It can be seen immediately that the structure of the model is fully recursive, even the part pertaining to the flow variables.

[5]Let us notice that dealing with a model not fully quantified is possible in the framework of the geometric approach retained in this paper.

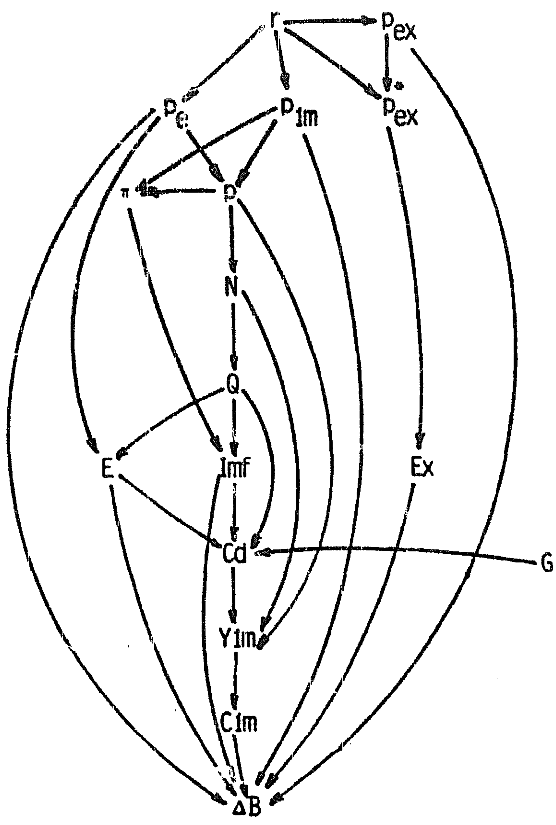

Fig. 2. Graph of the supply driven empirical model.

The flows of causality are unidirectional from the price level to employment, output and the various demands.

The only impact of public expenditures on the balance of trade is therefore a negative one, through the crowding out of private consumption of domestic goods and the resulting boost given to the consumption of imported goods.

A variation of the exchange rate will, on the contrary, affect every variable in the model. Its effect on employment is straightforward through both import prices and their positive effect on the GNP price level. A devaluation will thus enhance employment, to a degree depending on the firms' reaction to an increase in profitability. A revaluation, on the other hand, will lower employment through the same channels.

Its effect on the balance of trade is much less straightforward. Looking at its repercussion on the export side, one sees immediately an unambiguous positive effect due to an increase in the *value* of exports. The *volume* effect only appears when γ_{ex} is strictly inferior to one. It generates a net positive impact on exports (the magnitude of which depends on the actual size of γ_{ex}) which in turn has a direct positive effect on the balance of trade and an indirect negative one through the crowding out of private consumption of domestic goods, and the resulting boost given to the import of consumption goods.

On the import side, the channels through which γ_{im} exerts an influence over the balance of trade is basically twofold. First, there is a joint direct and indirect effect of opposite signs on relative prices of imports, which induces a change in the imports of the firms. In turn those have a negative impact on the imports of consumption goods through the residual income. Second, there is an indirect effect on the GNP price level which induces a change in both categories of imports through the channels of disposable and residual income. Similar effects can be noted for the price of energy.

4. The analytical tool: The geometry of comparative statics

4.1. An outline

Most of the studies concerned with non-Walrasian macromodels rely heavily on geometric illustrations, based on the partitioning of the plane of a selected pair of *exogenous* variables.[6] In the case of a closed economy for instance, each sub-region of the plane considered — corresponding to subsets of pairs of value of the exogenous variables — will characterise one of the possible extreme states of the economy (Keynesian or Classical Unemployment, Repressed Inflation). Even though it is not free of criticisms,[7] such an approach has proven useful in giving a broad overview of the situations considered.

Its extension to open economies on the other hand might prove cumbersome, as more parameters (or exogenous variables) must be taken into account.

In this study we shall make an extensive use of a different geometric approach due to Rossier (1982a, b). Broadly speaking, this method consists in studying the projection in selected planes of relevant *endogenous* variables of a geometric figure, defined in an n-dimensional space, generated by all possible combinations of values of the variable parameters (or exogenous variables). Thus, in our case, we shall study in the (Employment–Balance of Trade) plane the feasible points for these two variables, each extreme point being characterised by different combinations of values of various price elasticities and public expenditures.

4.2. A brief description of the method[8]

The point of departure is an econometric model of m relations linking m

[6] For instance the (p, w) plane for Malinvaud (1977).

[7] See Hildenbrand and Hildenbrand (1978).

[8] A full description including all relevant proofs and algorithmic remarks can be found in Ritschard and Rossier (1981) and Rossier (1982a, b).

endogenous variables y and k exogenous variables z,

$$h(y; z) = 0,$$

which is linearised around the point $(y_0; z_0)$,

$$A\Delta y + B\Delta z = 0,$$

with $A = \partial h/\partial y'$, $B = \partial h/\partial z'$ and $\Delta y = y - y_0$, $\Delta z = z - z_0$. By denoting

$$x = \begin{bmatrix} \Delta y \\ \Delta z \\ v \end{bmatrix}, \qquad D = \begin{bmatrix} A & B & 0 \\ 0 & I & -\Delta z \\ 0 & 0 & 1 \end{bmatrix}, \qquad b = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix},$$

where v is an auxiliary variable equal to 1, the original system can be written in the compact form

$$Dx = b,$$

which permits the exogenous variables and the parameters to be given a symmetrical treatment (they are both elements d_{ij} of matrix D).

Now, the crux of the matter is to consider that the d_{ij}'s can be allowed to take their value over a set of closed intervals, $d_{ij}^0 \leqq d_{ij} \leqq d_{ij}^*$, with the special cases $d_{ij}^0 = d_{ij}^*$ corresponding to parameters (or exogenous variables) we want to keep fixed.

For our problems involving exchange rate variations (part of Δz), we shall mainly consider as variable parameters elasticities of prices with respect to the exchange rate (the γ's), and public expenditures (G).

Having thus defined in the space of parameters a compact parallelotope,[9]

$$\mathscr{D} = \{D / D^0 \leqq D \leqq D^*\},$$

we now want to study the properties of the multi-dimensional figure P,

$$P = \{x \in R^n / Dx = b, D \in \mathscr{D}\},$$

called a *polytope*.

P is a geometric figure of the polyhedric type whose dimension is given by the number of equations containing variable elements. It is totally defined when its *characteristic points*, i.e., the points $x^{(q)} = D^{(q)-1}b$, where $D^{(q)}$ is an extreme point of $\mathscr{D}$, as well as the *edges* linking these points, are known.

[9]The inequality relation $D^0 \leqq D$ reads: None of the elements of D is smaller than the corresponding element of D^0. The interpretation of $D \leqq D^*$ is obviously symmetric.

Moreover, these edges correspond, in the x space, to segments linking pairs of characteristic points $(x^{(q)}, x^{(k)})$ obtained from extreme points $D^{(q)}$ and $D^{(k)}$ which differ only by one element d_{ij}.

It appears of course hardly tractable to apprehend P directly in the n-dimensional space where it is defined. An approach in terms of simulation over $\mathscr{D}$ would certainly be very costly and is bound to miss part of the frontier of P, especially in the presence of non-convexities.

The method we shall use here consists of studying the projection of P on selected axes or planes. We will concentrate on the projection of P in the (Employment–Balance of Trade) plane, analysing the characteristic points of the two-dimensional figure thus obtained, and the edges linking these points. It must be stressed that in this way conclusions on the endogenous variables are obtained at once, taking into account all the relevant hypotheses about parameter values.

5. Feasible consequences of exchange rate fluctuations

5.1. Introductory remarks

The terms 'devaluation' and 'revaluation' used in the sequel are not fully appropriate in a world of flexible exchange rates, or, if one prefers, repressed flexible exchange rates.

An attempt at assessing what external or internal forces cause the rate of exchange of a given currency to go up (devaluation) or down (revaluation) are beyond the scope of this paper. The fact is that, at various degrees and in different places and times, they do exist, independently of decisions made by relevant authorities.[10] Another fact is that, within certain limits, these forces can be counteracted and somehow annihilated by various policy measures, at a somewhat very high cost though.

The consequences of an exogenously determined 10% devaluation ($r=0.10$) and an exogenously determined 10% revaluation ($r=-0.10$) are investigated alternatively under each of the two extreme regimes considered. More precisely, we provide and analyse in each case the set of pairs $(N, \Delta B)$ which are feasible according to three possible ways of counteracting the exchange rate fluctuation effects. The three intervention measures are characterised by the parameters γ_{im}, γ_{ex} and G, the magnitude of which is given by the intervals

$$0 \leqq \gamma_{im} \leqq 1, \qquad 0 \leqq \gamma_{ex} \leqq 1, \qquad -0.05 \leqq G \leqq 0.10.$$

[10] For instance, the Swiss franc was depreciated by 15% with respect to the U.S. dollar during the first six months of 1981. A revaluation of 15% then took place during the next six months.

General implications of exchange rate fluctuations are emphasized by the location of the feasible sets in the $(N, \Delta B)$ plane, i.e., of the projection of the polytopes generated by the variations admitted for γ_{im}, γ_{ex} and G.[11] Then the study of the boundary of the polytope permits to emphasize what we could call the Pareto optimal combinations of intervention measures.

We shall evaluate the results with the help of two reference points. The first point (NE) corresponds to $N=0$ and $\Delta B=0$. It characterises a *neutral intervention* in the sense that, if it is feasible, the corresponding policy measures would fully counteract the effects of the fluctuation of the exchange rate. The second point (NO) corresponds to the *absence of intervention*, and is characterised by $\gamma_{ex}=0$ $(p^*_{ex}=-r)$, $\gamma_{im}=1$ $(p_{im}=r)$ and $G=0$.

5.2. Polytopes for the demand driven model

5.2.1. The devaluation

We posit a 10% devaluation $(r=0.10)$ and consider the polytope generated by the variations, within the demand driven model, of the policy parameters specified above. The polytope is a three-dimensional geometric figure in the $\mathbb{R}^{17}$ space. Its projection in the $(N, \Delta B)$ plane is given in fig. 3.

The location of this set of feasible points shows that in any case a 10% devaluation would increase at least one of the two objectives considered. In other words, this means that the neutral intervention situation (NE) is unfeasible. Moreover, a great part of the set lies in the positive orthant. This indicates that a large proportion of the possible combinations of accompanying measures is compatible with an increase in both objectives.

The form of the projection shows that the two objectives are conflicting. Indeed, the maximum increase (+6182 million francs) in the balance of trade is reached in D_1 where we also have the worst effect on employment (−0.4%). This maximum for ΔB is approximately equal to the 1980 Swiss trade deficit (6010 million francs)[12] while the 0.4% deterioration of employment corresponds for Switzerland to a loss of 12,000 work places.[13] On the other hand, the maximum increase in employment (+1.7%) is reached in D_7 together with the greatest negative effect on the balance of trade (−5082 millions).

The point D_1 (max ΔB and min N) is reached when γ_{ex} is at its upper bound, and γ_{im} and G at their lower bounds. In other words, D_1 corresponds to the case where: (i) the exporters do not reflect the devaluation on their

[11] The polytopes were obtained with the Fortran programme Inmain [Rossier (1982a)].

[12] This amount is of course not stable. For instance, for 1979 the deficit amounted to 815 millions and in 1978 the balance was in excess of 3700 million Swiss francs.

[13] This exceeds somewhat the actual forecasts (0.3%) for unemployment in 1982.

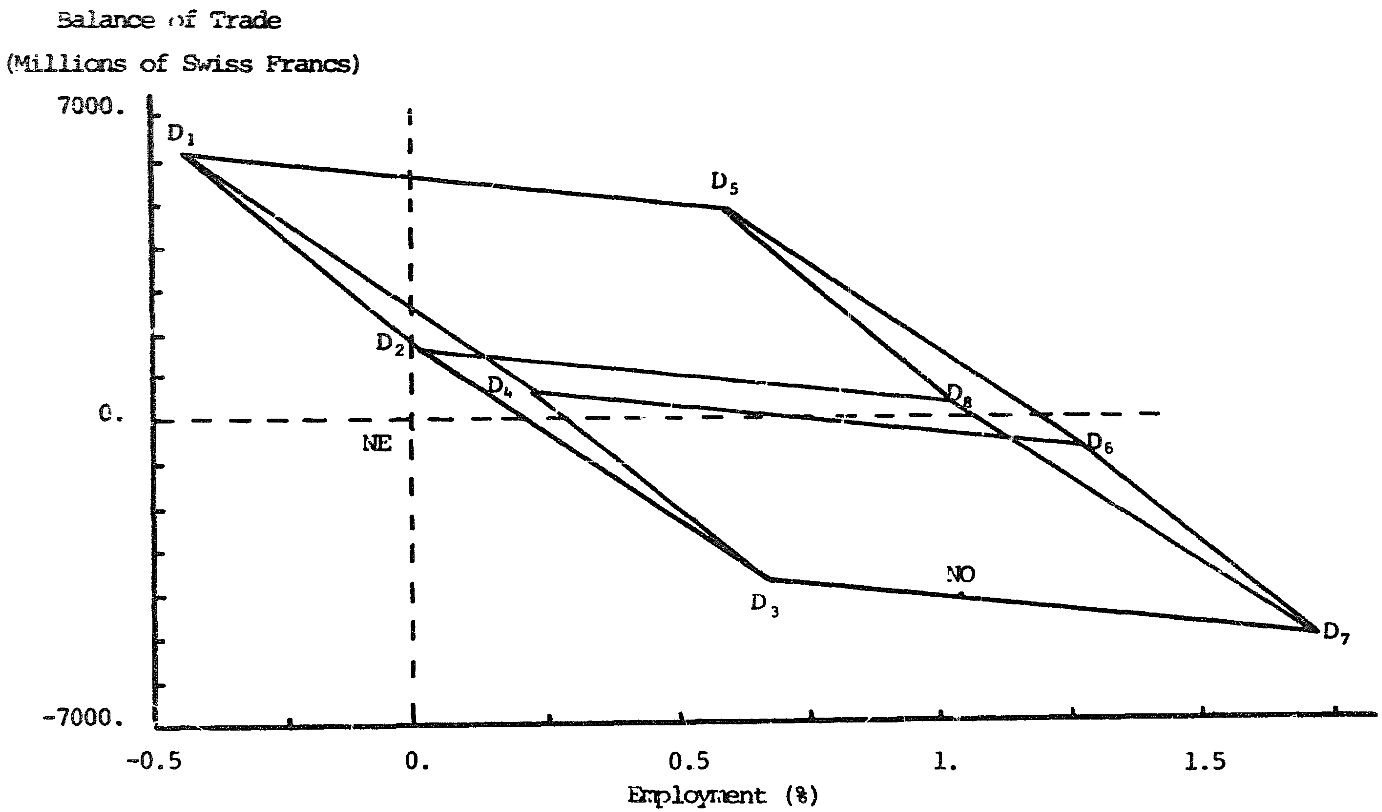

Fig. 3. Devaluation in the demand driven model.

	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB
D_1	1	0	−5%	−0.4%	6182
D_2	1	1	−5%	0.0%	1792
D_3	0	1	−5%	0.7%	−3687
D_4	0	0	−5%	0.2%	704
D_5	1	0	10%	0.6%	4787
D_6	0	0	10%	1.3%	−692
D_7	0	1	10%	1.7%	−5082
D_8	1	1	10%	1.0%	397

foreign currency export prices ($p^*_{ex}=0$); (ii) the importers do not reflect the devaluation on their import prices ($p_{im}=0$); and (iii) the government reduces its spending by 5%. Symmetrically D_7 ($\gamma_{ex}=0$, $\gamma_{im}=1, G=0.1$) corresponds to the case where the variation rate of p^*_{ex} and p_{im} is equal to the rate of devaluation and the increase in G is at its upper bound.

Let us now look more closely at the link between the shape of the polytope and the assumptions made on the policy parameters. We consider first the government spending which, as shown in 3.1, has here the usual open multiplier effect. A ceteris paribus variation from -5% to $+10\%$ of G induces a translation corresponding to an increase of 1% of the employment variation rate and a deterioration of 1395 millions of the balance of trade. Among the three policy measures G appears to be the most appropriate to correct the effects on employment and the least efficient for what concerns the balance of trade. This is characterized by the relatively low slope of the edges D_1–D_5, D_2-D_8, D_4–D_6 or D_3–D_7. Note that this slope can be interpreted as the cost, in terms of balance of trade deterioration, which has to be paid in order to increase N by 1%.[14] The relative efficiency of G for stabilising employment is indeed a natural consequence of the Keynesian structure considered here.

Turning now to the correction ability of the exchange rate elasticity γ_{ex} of the export price, we can examine for example the edge D_2–D_3 (or equivalently D_5-D_6). When γ_{ex} moves from 1 to 0, i.e., when an increased competitiveness is preferred to an increased profitability, N increases by 0.7% while the induced deterioration of the balance of trade amounts to 5479 millions.

As for the effect of the exchange rate elasticity γ_{im} of the import price, it is characterised for example by the edge D_1–D_2 (or equivalently by D_6–D_7). The slope of this edge (-10975 millions for a 1% increase in N) is slightly greater (1.4 times) than the one associated to γ_{ex}. It appears thus to be the fundamental measure which should be activated in order to stabilise the balance of trade. The magnitude of its possible effects is, however, smaller than for γ_{ex}. Indeed, a movement from $\gamma_{im}=1$ towards $\gamma_{im}=0$ induces only a 4390 million increase of the balance of trade at the cost of a 0.4% decrease of N.

Looking now at the frontier of the polytope, we see that the most favourable consequences of the devaluation lie on the edges D_1–D_5–D_6–D_7. This portion of the frontier corresponds thus to the set of non-dominated policies, i.e., policies which are such that no other feasible policy would be more favourable for one of the objectives considered without deteriorating the other.

[14]Indeed, it can also be interpreted as the marginal rate of substitution between the objectives for the policy parameters considered.

Between D_1 and D_5 the non-dominated combinations of intervention measures correspond to cases where γ_{ex} is at its upper bound ($p^*_{ex}=0$) and γ_{im} at its lower bound ($p_{im}=0$). The set of the so-called Pareto optimal points is here obtained by varying G, the public expenditure variation rate. On the edge D_5–D_6, γ_{im} is at its lower bound ($p_{im}=0$) and G at its upper bound. The non-dominated points are generated here by acting upon the elasticity of the export price. Finally, between D_6 and D_7, the two measures which have to be kept fixed are γ_{ex} at its lower bound ($p^*_{ex}=-r$) and G at its upper bound. The optimal points correspond then to various levels of γ_{im}, the elasticity of the import price.

To summarize the findings, let us consider as reference what we have called the 'no-intervention' situation, i.e., the point NO corresponding to $\gamma_{ex}=0$ ($p^*_{ex}=-r$), $\gamma_{im}=1$ ($p_{im}=r$) and $G=0$. Starting from this point NO it comes that the only way to improve employment is by increasing G. On the other hand, the balance of trade deficit could be stabilised by acting either upon γ_{im} or upon γ_{ex}, the former being the less expensive in terms of employment deterioration. To reach the compromise edge D_1–D_5 would require acting both on γ_{im} and γ_{ex}. A joint intervention upon γ_{im} and G would permit to achieve the compromise situations on the edge D_6-D_7, while all three policy measures have to be activated in order to attain a point upon the D_5–D_6 edge.

5.2.2. *The revaluation*

We now consider an exogenously determined 10% revaluation ($r=-0.10$) together with the same feasible accompanying policy measures. The polytope obtained is again a three dimensional geometric figure. Its projection on the ($N, \Delta B$) plane is shown in fig. 4.

Looking first at its location with respect to the two objectives considered we note that the neutral intervention point NE is here feasible. Moreover, since NE is an interior point of the polytope, the 10% revaluation can, depending on the combination of the possible accompanying measures, lead to a joint improvement as well as to a joint deterioration of both objectives. The domain of feasible joint improvements is, however, very confined: In the triangle NE–A–B the maximum increase in the balance of trade amounts to 483 millions while the maximum increase in N is 0.05%.

The form of the polytope is quite similar to that obtained in the devaluation case. Again, the maximum in ΔB (+4617 millions) requires the intervention combination which has the worst consequence on employment (−1.4%). Conversely, the most favourable effect on employment (+0.8%), if it is reached, would be accompanied by the greatest deterioration in the balance of trade (−6647 millions).

The point R_3 (min N and max ΔB) is reached when γ_{ex} is at its lower

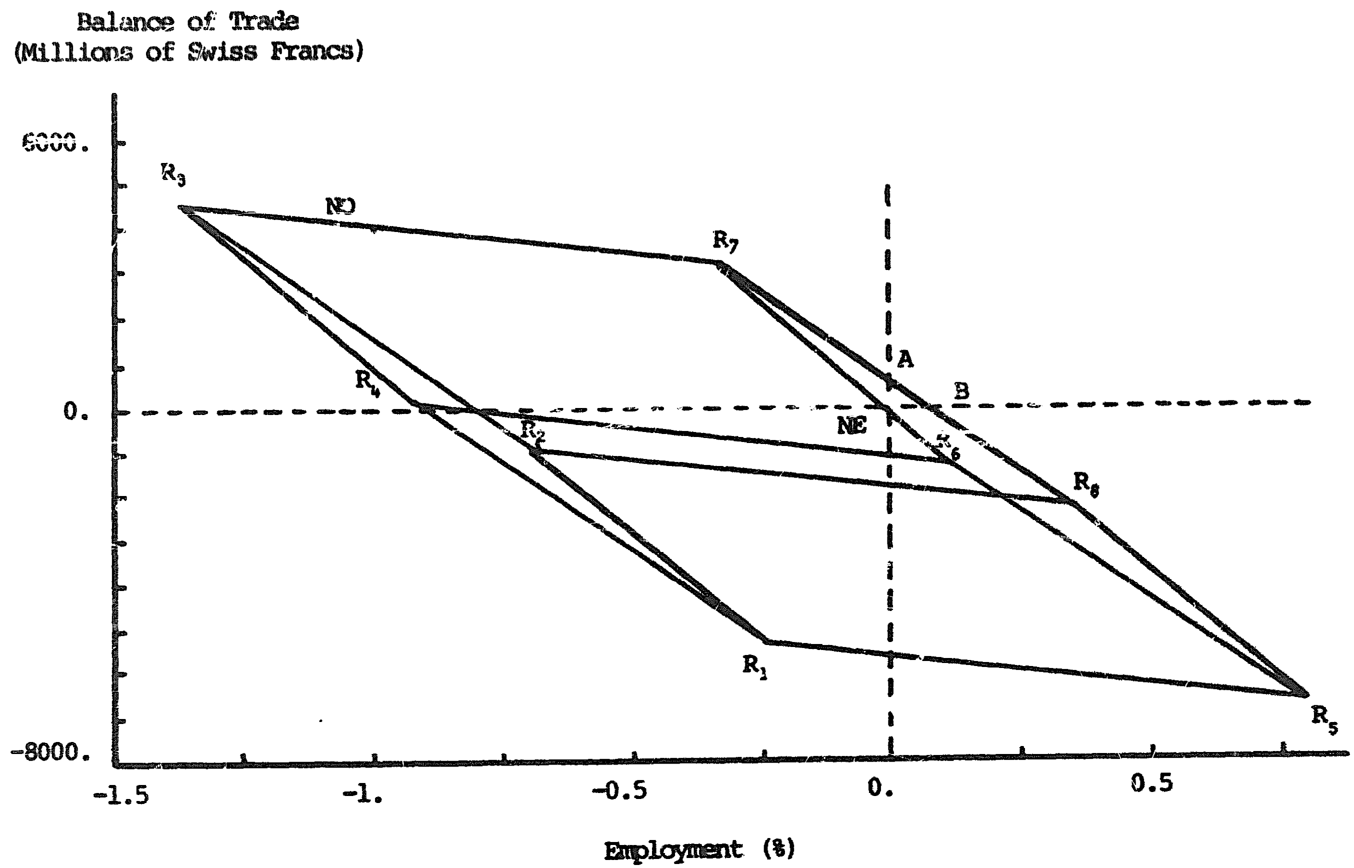

Fig. 4. Revaluation in the demand driven model.

	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB
R_1	1	0	−5%	−0.2%	−5252
R_2	1	1	−5%	−0.7%	−862
R_3	0	1	−5%	−1.4%	4617
R_4	0	0	−5%	−0.9%	227
R_5	1	0	10%	0.8%	−6647
R_6	0	0	10%	0.1%	−1169
R_7	0	1	10%	−0.3%	3222
R_8	1	1	10%	0.3%	−2257

bound ($p^*_{ex} = -r$), γ_{im} at its upper bound ($p_{im} = r$) and G at its lower bound (-5%). The symmetric situation leads to the point R_5 (max N and min ΔB). The difference with the devaluation case comes from the effect of γ_{ex} and γ_{im} which is qualitatively reversed because of the change in the sign of r.

As to the range of effects and efficiency of each policy parameter one can see that they remain the same as in the devaluation case. The role of G is characterised for example by the edge R_3–R_7, while the edges R_7–R_8 and R_8–R_5 illustrate, respectively, the consequences of a change in γ_{ex} and γ_{im}.

Let us now examine the upper portion of the frontier of the polytope which corresponds to the non-dominated policies. Points on the edge R_3–R_7 will be achieved with $\gamma_{ex} = 0$ ($p^*_{ex} = -r$) and $\gamma_{im} = 1$ ($p_{im} = r$). Between R_7 and R_8 the two parameters which have to be kept fixed are γ_{im} and G, both at their upper bounds. The situations which involve consequences on the R_8–R_5 edge are those where γ_{ex} and G are both at their upper bounds.

Note that these Pareto optimal combinations of intervention measures would lead to the less favourable consequences (lower portion of the frontier of the polytope) in the devaluation case. Thus, for instance, the no-intervention point NO, which lies on this portion in fig. 3, is one of the non-dominated policies in the revaluation case.

Starting from this no-intervention point NO we see that the only way to improve slightly the balance of trade is by decreasing G. This small increase in ΔB (+465 millions) would be obtained at a relatively high cost in terms of employment deterioration (-0.33%). Non-dominated situations avoiding a deterioration in any objective (the segment A–B) would be reached by acting on G and γ_{ex}. This is indeed an interesting result since γ_{im}, the third parameter not sollicited here, is certainly the less controllable among the three considered.

5.3. Polytopes for the supply driven model

The analysis of the polytopes is here somewhat more complex since, in addition to the three policy measures, we have a fourth varying parameter, i.e. v, the price elasticity of the labour demand. It is, of course, difficult to interpret v as a policy instrument even though it could be linked with some fiscal policy measures. A different treatment should then be given to this parameter. Practically, its variation over the interval.

$$0.1 \leqq v \leqq 0.7$$

generates a family of subpolytopes. We shall therefore focus on how the subpolytopes are transformed as v varies. Then, the analysis will be carried out by considering the two extreme subpolytopes corresponding, respectively, to $v = 0.1$ and $v = 0.7$.

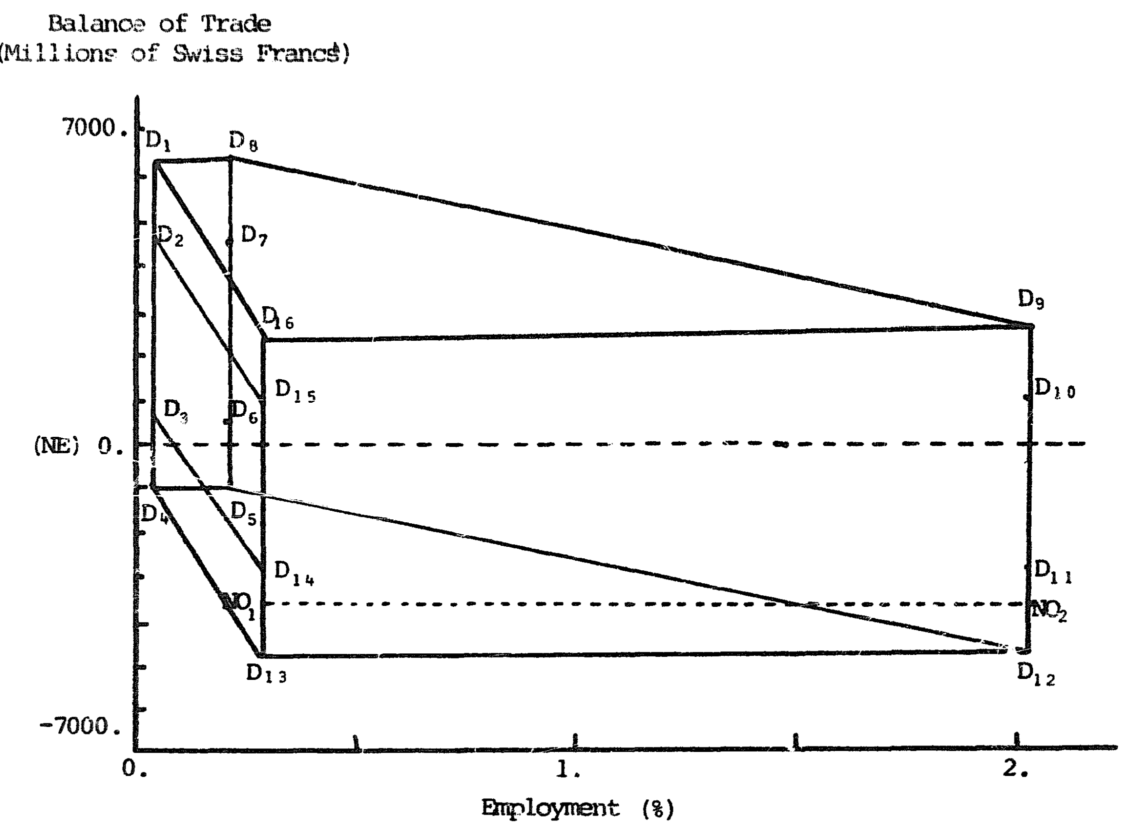

Fig. 5. Devaluation in the supply driven model.

	v	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB		v	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB
D_1	0.1	1	0	−5%	0.03%	6308	D_9	0.7	1	1	−5%	2.0%	2587
D_2	0.1	1	0	10%	0.03%	4695	D_{10}	0.7	1	1	10%	2.0%	973
D_3	0.1	0	0	−5%	0.03%	663	D_{11}	0.7	0	1	−5%	2.0%	−3058
D_4	0.1	0	0	10%	0.03%	−950	D_{12}	0.7	0	1	10%	2.0%	−4671
D_5	0.7	0	0	10%	0.2%	−930	D_{13}	0.1	0	1	10%	0.3%	−4865
D_6	0.7	0	0	−5%	0.2%	683	D_{14}	0.1	0	1	−5%	0.3%	−3252
D_7	0.7	1	0	10%	0.2%	4715	D_{15}	0.1	1	1	10%	0.3%	780
D_8	0.7	1	0	−5%	0.2%	6328	D_{16}	0.1	1	1	−5%	0.3%	2393

5.3.1. The devaluation

We consider the supply driven model with its four varying parameters and posit again a 10% devaluation. The polytope to be studied is a four-dimensional figure in the R^{18} space. Its projection on the $(N, \Delta B)$ plane is given in fig. 5. One dimension is not detectable on this figure since, as will be shown, there are two policy measures which do not influence employment at all.

The neutral intervention point NE does not belong to the set of feasible situations, but is very close to it. This means that a 'quasi-neutral' situation ($N=0.03\%, \Delta B=0$) is feasible.[15] Since the polytope lies entirely East of the $N=0$ axis, it comes that the devaluation shall in any case improve employment. This improvement can be accompanied by either a positive or a negative effect on the balance of trade, depending on the combination of intervention measures. We note also that a great proportion of the policy combinations would lead to an increase in both objectives.

Let us begin the analysis of the form of the polytope by emphasising the role of the parameter v. When v is at its lower bound ($v=0.1$) the feasible situations are given by the sub-polytope D_1–D_4–D_{13}–D_{16}. For v at its upper bound ($v=0.7$), the points compatible with the range of variations of γ_{ex}, γ_{im} and G are given by the sub-polytope D_8–D_9–D_{12}–D_5. Considering the movement, induced by v, from one sub-polytope to the other, we see that v has two effects: a magnitude effect in the N space and a translation effect. Except for these two differences, the form of the figure to be analysed remains the same for various values of v. We shall thus from hereon concentrate on the two extreme sub-polytopes just mentioned.

Contrarily to the demand driven case the two objectives are here not necessarily conflicting. Indeed, the maximum increase in employment (0.3% when $v=0.1$ and 2% when $v=0.7$) can be achieved together with different changes in the balance of trade. These changes in ΔB range from +2393 millions to −4865 millions when $v=0.1$ and from +2587 millions to −4671 millions when $v=0.7$. On the other hand, however, the most favourable impact on ΔB (+6308 millions or +6328 millions) can be reached only in D_1 (or D_8) where the increase in employment is at its minimum.

This point D_1, or D_8, (max ΔB) corresponds to the case where γ_{ex} is at its upper bound ($p_{ex}^*=0$), and γ_{im} and G are at their lower bounds ($p_{im}=0$, $G=-5\%$). It is thus similar to what has been found with the demand driven model. As for the policies leading to D_{13}, or D_{12}, (max N) it can be shown that they only require γ_{im} to be at its upper bound. Indeed, the whole segment D_{13}–D_{16}, or D_9–D_{12}, is defined by $\gamma_{im}=1$ ($p_{im}=r$).

[15]The minimum increase in N comes from the energy price elasticity of the domestic price, which is kept fixed.

This last remark leads us to discuss the role of the parameter γ_{im}. It appears to be the only accompanying measure which can influence employment. Its associated slope, i.e., the cost in terms of balance of trade deterioration which has to be paid for a 1% increase in N, varies with v from -14500 millions for $v=0.1$ to -3515 millions for $v=0.7$. Thus the greater v is the more efficient γ_{im} is for acting on employment.

Concerning the two other policy parameters, it is shown that they have no impact on employment. They can therefore only be used to correct or amplify the consequences of the devaluation on the balance of trade. The range of control which can be achieved through γ_{ex} is characterised by the edge D_1-D_3 (or equivalently D_{16}–D_{14}). This range is shown to be greater (ΔB can be changed by 5645 millions) than for G (1613 millions; see, for instance, the edge D_1–D_2 or D_{16}–D_{15}).

If we consider now the no-intervention situation corresponding to $\gamma_{ex}=0$ ($p^*_{ex}=-r$), $\gamma_{im}=1$ ($p_{im}=r$) and $G=0$, we note that it generates the segment NO_1–NO_2 when v varies. Whatever the value of v, the point NO never belongs to the portion of the frontier of the polytope which defines the Pareto optimal policy combinations. These non-dominated policies are given by the edge D_1–D_{16} when $v=0.1$ and by the edge D_8–D_9 when $v=0.7$.

Starting from a NO point, it is not possible to improve employment. Favourable measures with respect to the balance of trade can be obtained by acting either on γ_{ex} or on G. Both these measures would be costless in terms of employment deterioration. To reach the set of non-dominated situations both γ_{ex} and G have to be activated. It will be reached when γ_{ex} is at its upper bound ($p^*_{ex}=0$) and G at its lower bound ($G=-5\%$). The Pareto optimal set is then generated by the variation of γ_{im}. This parameter is thus the only degree of freedom which allows us to choose between the non-dominated situations.

To conclude, let us notice that the Pareto optimal set lies entirely in the positive orthant. This means that the corresponding policies would induce a joint increase in both objectives, which would not be the case, for instance, for the no-intervention policy.

5.3.2. *The revaluation*

We posit a 10% revaluation ($r=-0.10$) and consider the same four intervals for the varying parameters. The polytope to be studied is again a four-dimensional geometric figure in the $\boldsymbol{R}^{18}$ space. Its projection in the ($N, \Delta B$) plane is given in fig. 6.

As in the devaluation case, the neutral intervention situation NE is unfeasible, the closest feasible point being ($N=-0.03\%$, $\Delta B=0$). As opposed to the devaluation case, the polytope now lies entirely West of the $N=0$ axis.

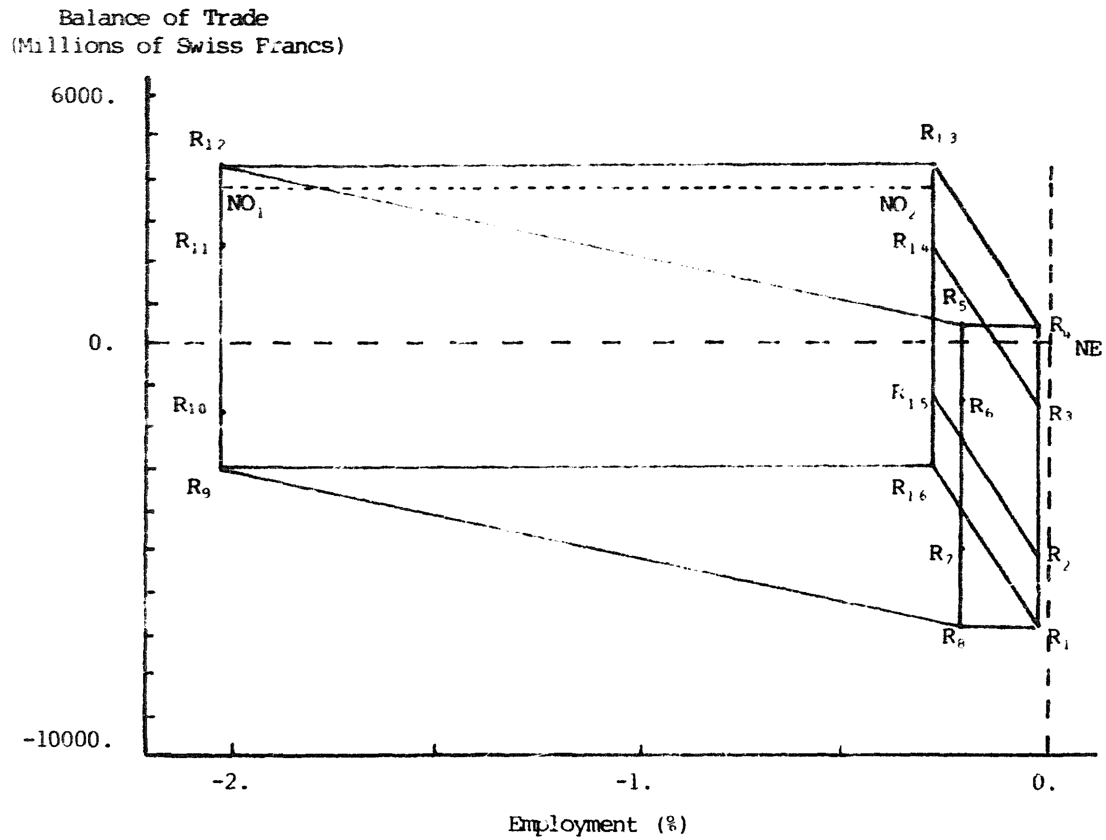

Fig. 6. Revaluation in the supply driven model.

	v	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB		v	γ_{ex}	γ_{im}	$\mathring{G}$	$\mathring{N}$	ΔB
R_1	0.1	1	0	10%	−0.03%	−6846	R_9	0.7	1	1	10%	−2.0%	−3124
R_2	0.1	1	0	−5%	−0.03%	−5233	R_{10}	0.7	1	1	−5%	−2.0%	−1511
R_3	0.1	0	0	10%	−0.03%	−1201	R_{11}	0.7	0	1	10%	−2.0%	2521
R_4	0.1	0	0	−5%	−0.03%	413	R_{12}	0.7	0	1	−5%	−2.0%	4134
R_5	0.7	0	0	−5%	−0.2%	393	R_{13}	0.1	0	1	−5%	−0.3%	4328
R_6	0.7	0	0	10%	−0.2%	−1221	R_{14}	0.1	0	1	10%	−0.3%	2714
R_7	0.7	1	0	−5%	0.2%	5253	R_{15}	0.1	1	1	−5%	−0.3%	−1318
R_8	0.7	1	0	10%	−0.2%	−6866	R_{16}	0.1	1	1	10%	−0.3%	−2931

A revaluation will thus deteriorate employment whatever feasible correction measure is used. As for the proportion of policy combinations which are compatible with an improvement of the balance of trade, we note that it is slightly smaller than in the devaluation case.

Turning now to the shape of the polytope, we see that the role of the parameter v is analogous to what has been seen in the devaluation case. The sub-polytopes associated to the extreme values of v are R_1–R_4–R_{13}–R_{16} when v is at its lower bound, and R_8–R_5–R_{12}–R_9 when v is at its upper bound. This, when v moves from $v=0.1$ to $v=0.7$ it induces a movement from the first extreme sub-polytope to the second.

The results concerning the conflict between the two objectives remain qualitatively the same. Indeed, the minimal deterioration of employment (-0.03% when $v=0.1$ or -0.2% when $v=0.7$) can be achieved together with different consequences on the balance of trade (edge R_1–R_4 when $v=0.1$ and edge R_8–R_5 when $v=0.7$). It corresponds to the situations where γ_{im} is at its lower bound ($p_{im}=0$). The most favourable effect on ΔB ($+4328$ millions when $v=0.1$ and $+4134$ millions when $v=0.7$) can be attained only in R_{13} (or R_{12}) where we also have the worst impact on employment. This maximum in ΔB requires γ_{im} to be at its upper bound ($p_{im}=r$) and γ_{ex} and G to be at their lower bounds ($p_{ex}^{*}=-r, G=-5\%$). This is just the opposite of the devaluation case in what concerns γ_{ex} and γ_{im}. Indeed, as shown for the demand driven model, the effect of γ_{ex} and γ_{im} is here reversed because of the negative sign of r.

As a characteristic of the supply driven model γ_{im} is again the only policy parameter which can modify the effect of the revaluation on employment. Its relative efficiency to control employment increases with v together, however, with the minimum level of employment deterioration. Its associated slope is the same as in the devaluation case.

As far as γ_{ex} and G are concerned, they can only be used to modify the effect on the balance of trade. The range of control for each parameter remains the same as for the devaluation case, i.e., greater corrections on ΔB can be achieved through γ_{ex} than through G. As noted before γ_{ex} works here in the opposite direction.

Looking now at the no-intervention situations given by the segment NO_1-NO_2, we note that they would lead to an improvement of the balance of trade and to the maximum deterioration of employment. Moreover, they are dominated situations which means that it would always be possible to obtain a more favourable effect on ΔB without further deteriorating employment.

The Pareto optimal combinations of intervention measures are characterised here by the surface generated when the R_4–R_{13} edge moves towards the edge R_5–R_{12}. To be reached, these situations require both γ_{ex} and G to be at their lower bounds. Again, when compared with the devaluation case, this result is reversed in what concerns γ_{ex}.

Reaching a non-dominated situation from a *NO* point requires at least a reduction in government spending. A decrease in the employment deterioration can however by obtained only by reducing the elasticity of the import prices.

5.4. Regime comparison and mixed regimes

At the aggregate macro level considered here it would be a strong statement to postulate that any economy is entirely under one of the two regimes studied. It is certainly more realistic to assume that some sectors are demand driven and others supply driven. As a consequence, the aggregate macro regime would correspond to some intermediate situation between the two cases investigated. Our purpose here is to emphasize conclusions about mixed regimes by comparing the findings obtained for each extreme case.

We shall not discuss here the effects in absolute terms since these are largely dependent of the non-controllable parameter v in the supply driven case. The comparison focuses thus on the relative efficiency of the policy measures with respect to the objectives considered. The results obtained for each parameter are summarised in table 1.

Table 1

Demand driven				Supply driven		
Range of effect				Range of effect		
$\Delta\mathring{N}$	$\Delta(\Delta B)$	$\Delta(\Delta B)/\Delta\mathring{N}$		$\Delta\mathring{N}$	$\Delta(\Delta B)$	$\Delta(\Delta B)/\Delta\mathring{N}$
1%	1395	−1395	$\mathring{G}$	0%	1613	∞
0.7%	5479	−7827	γ_{ex}	0%	5645	∞
				0.27%	3741	−3515 ($v=0.1$)
0.4%	4390	−10975	γ_{im}	1.8%		−14500 ($v=0.7$)

The ability of each policy measure to counteract or amplify, in a mixed regime, the consequences of an exchange rate variation will correspond to some combination of these effects. This combination will certainly depend on the relative importance of the demand driven sectors as opposed to the supply driven ones. But it will also heavily rely on the participation in the foreign trade of each demand or supply driven part of the economy.

Bearing this in mind, let us now point out some conclusions which follow from the comparison of the extreme case results. Concerning first the public expenditures G, we see that a decrease in G will in any case improve the balance of trade. As soon as this variation in G affects a demand driven sector it will, however, also deteriorate employment. The same is true for the elasticity of the export prices. In the absence of better knowledge on the sectors touched by each of these two measures it would be hazardous to say something about their relative efficiency to control employment under a mixed regime.

The relative importance of the elasticity of import prices γ_{im} is quite different in each regime: It is the more efficient for acting on ΔB in the demand driven case and the only efficient in what concerns employment in the supply driven case. In absolute terms, however, γ_{im} appears to be the policy measure whose effects are the less sensitive to the regime.

Finally, let us note that only one combination of intervention measures remains Pareto optimal under each regime. It is in both cases (devaluation and revaluation) the intervention which leads to the best result concerning the balance of trade and the worst in what concerns employment.

6. Concluding remarks

This paper obviously calls for two types of comments.

Concerning the model, it is obvious that it shares most of the shortcomings of the first generation non-Walrasian macromodels: mainly the absence of a satisfactory (non-trivial) explanation of endogenous price movements *between* periods, and the lack of inventory considerations, which hinder a smoother and richer characterisation of regimes. In this respect, all we can achieve with this tool is a short term comparative static analysis.

Our contention, however, is that, within the range of time and action considered, basic characteristics driving the economy are not significantly modified by the exogenous variations considered. Conclusions derived from these models are thus meaningful when considering the frequency of occurrence of fluctuations in the exchange rate.

The second comment bears on the method used and is closely related to the choice made with respect to the models. When one leaves the realm of point results (numbers!), one must embrace more global considerations, the looseness of which must be balanced against their relevance. Considering a more or less clear-cut model is in this sense a necessary step before tackling more complex representations.

Further attention should now bear on two points: an endogenous characterisation of gradually evolving mixed regimes, and the links between the financial sector, the interest rate and the rate of exchange.

Appendix: Estimation and other empirical considerations

The equations which were econometrically estimated are discussed first.

The transformation of the identities together with other empirical considerations are presented in a second section. The sources are:

(1) Séries révisées de la comptabilité nationale suisse, 1948–1976, Bureau Fédéral de Statistique, Berne, 1977.
(2) La vie économique, 1977–1981, Revue mensuelle du Département Fédéral de l'Économie Publique, Berne.
(3) Annuaire statistique suisse, 1960–1981, Bureau Fédéral de Statistique, Berne.
(4) Bulletin mensuel de la Banque Nationale Suisse, 1960–1981, Banque Nationale Suisse, Service d'Études et de Statistique, Berne.
(5) Perspectives économiques de l'OCDE, Paris.

A.1. Econometric estimation

A.1.1. The demand driven model

(i) *The consumption function*

The data used are:

C = private consumption expenditures at 1970 prices (1, 2);
wN = disposable income at current prices (1, 2);
p = consumption price index (1, 2);
s = interest rate on Swiss Federal Bonds (4);
H = number of households (3).

The equation was estimated by OLS over the 1960–1980 period; the absolute value of the t-statistic is given between parentheses below each estimate.

$$\underset{(9.17)}{\log(C) = 3.98} + \underset{(17.65)}{0.74} \log(wN) - \underset{(13.64)}{0.65} \log(p) - \underset{(2.4)}{0.03} \log(s) + \underset{(2.63)}{0.24} \log(H),$$

$$\bar{R}^2 = 0.99, \quad DW = 1.95.$$

It can be noted that the estimated income elasticity leads, when the 1980 data are considered, to a marginal propensity to consume of 0.7. $\log(C_{-1})$ as well as indicators of the money balances $[\log(M_0)]$ turned highly unsignificant throughout all specification considered.

(ii) *The labour demand function*

The equation was estimated in values with the following data:

wN = disposable income at current prices (1, 2);
pQ = GDP at current prices (1, 2).

The estimates obtained by OLS over the 1960–1980 period are

$$\log(wN) = -0.483 + 0.82\log(pQ) + 0.19\log(pQ)_{-1}, \qquad \bar{R}^2 = 0.99,$$
$$(11.87)\ (17.48) \qquad (4.10) \qquad DW = 2.03.$$

Assuming $\mathring{w} = 0.82\mathring{p} + 0.19\mathring{p}_{-1}$ (a circle over a variable denotes its rate of variation), the above specification leads to the following labour demand function:

$$N = AQ^{0.82}Q_{-1}^{0.19}.$$

The assumption made implies that the wage rate growth is, after two years, 1% higher than the price increase. This can be considered as low, but one must bear in mind that the wage rate considered is net of taxes. Since the tax rate increases with the wages, the 1% considered leads indeed to a higher increase in the actual wage rate.

(iii) *The non-energy import function*

The data used are:

Im = total imports at 1970 prices minus imports of energy at 1970 prices (1, 2, 3);
TD = GDP at 1970 prices (1, 2) + imports (Im);
π = p_{im}/p, where p_{im} is the price index of Im and p the GNP price index (1, 2, 3).

OLS over the 1960–1980 period gives

$$\log(Im) = -2.59 + 1.37\log(TD) - 0.3\log(\pi), \qquad \bar{R}^2 = 0.99,$$
$$(4.95)(13.2) \qquad (2.39) \qquad DW = 1.06.$$

(iv) *The energy import function*

The data used are:

E = imports of energy at 1970 prices (3);
Q = GNP at 1970 prices (1, 2);
p_e = price index of energy imports (3).

The estimates were obtained by OLS over the 1960–1980 period,

$$\log(E) = -2.84 + 1.21\log(Q) - 0.09\log(p_e), \qquad \bar{R}^2 = 0.93,$$
$$(6.35)(13.25) \qquad (2.9) \qquad DW = 2.06.$$

(v) *The export function*

The data used are:

Ex = total exports at 1970 prices (1, 2);
WD = GDP growth rate of the OECD countries (5);
p^*_{ex} = index of average relative value of the exports (5).

Since the data on the GDP of the OECD are growth rates, the equation is estimated in variation rate form. As in the log–log form the parameters are elasticities. The equation was estimated by OLS over the 1960–1980 period,

$$\overset{\circ}{Ex} = \underset{(9.7)}{1.6}\, \overset{\circ}{WD} - \underset{(1.8)}{0.27}\, \overset{\circ}{p}{}^*_{ex}, \qquad \bar{R}^2 = 0.65, \quad DW = 1.5.$$

The price elasticity is significant only at the 10% level. It was withheld, however, because of its correct sign and its relevance for the model.

A.1.2. The supply driven model

(i) *The production function*

The data used are the same as for the labour demand function in the demand driven model. OLS applied over the 1960–1980 period leads to the equation

$$\log(pQ) = \underset{(13.44)}{0.57} + \underset{(253.83)}{0.99} \log(wN), \qquad \bar{R}^2 = 0.99, \quad DW = 1.29.$$

Assuming the relationship $\overset{\circ}{p} = 0.99\overset{\circ}{w}$, between the growth rates of w and p, we obtain for the production function

$$Q = AN^{0.99}.$$

(ii) *The firm import function*

The data used are:

Imf = total imports, minus imports of consumption goods, minus energy imports, 1970 prices (1, 2, 3, 4);
Q = GDP at 1970 prices (1, 2);
π = p_{im}/p where p_{im} is the price index of Imf and p the GNP price index (1, 2, 3).

The estimates obtained by OLS over the 1960–1980 period are

$$\log(Imf) = -2.2 + \underset{(2.46)(7.05)}{1.29}\log(Q) - \underset{(2.89)}{0.56}\log(\pi), \qquad \bar{R}^2 = 0.95, \quad DW = 1.25.$$

(iii) *The energy import function*

Same as for the demand driven model.

(iv) *The household import function*

The data used are:

Cim = imports of consumption goods at 1970 prices (3, 4);
Yim = disposable income at current prices, minus consumption expenditures on domestic goods at current prices ($wN - pCd$) (1, 2, 3, 4);
p_{im} = price index of imports of consumption goods (4);
s = interest rate on Swiss Federal Bonds (4);
M_0 = property income of households, current prices (1,2);
H = number of households (3).

The parameters were estimated by OLS over the 1960–1980 period,

$$\log(Cim) = \underset{(7.56)}{0.6}\log(Yim) - \underset{(1.43)}{0.3}\log(p_{im}) - \underset{(7.26)}{0.3}\log(s)$$

$$+ \underset{(3.02)}{0.21}\log(M_0) + \underset{(3.4)}{0.28}\log(H), \qquad \bar{R}^2 = 0.99, \quad DW = 1.84.$$

The price elasticity is significant only at the 20% level. It was retained, however, since its sign is as expected and because of its relevance in the model.

(v) *The export function*

Same as for the demand driven model.

A.2. Other empirical considerations

Dealing with the variables in their relative variation form requires a transformation of the identities.

A.2.1. The demand driven model

The identities

$$TD = C + I + G + Ex, \quad Q = TD - Im - E, \quad B = p_{ex}Ex - p_{im}Im - p_e E,$$

were transformed, respectively, into

$$\mathring{TD} = (C_0/TD_0)\mathring{C} + (Ex_0/TD_0)\mathring{Ex} + (G_0/TD_0)\mathring{G},$$

$$\mathring{Q} = (TD_0/Q_0)\mathring{TD} - (Im_0/Q_0)\mathring{Im} - (E_0/TD_0)\mathring{E},$$

$$\Delta B = (p_{ex}Ex)_0(\mathring{Ex} + \mathring{p}_{ex}) - (p_{im}Im)_0(\mathring{Im} + \mathring{p}_{im}) - (p_e E)_0(\mathring{E} + \mathring{p}_e),$$

and the 1980 figures were used as reference values.

Concerning the consumption price responsiveness to the import prices, the two elasticities $\mathscr{E}(p/p_{im})$ and $\mathscr{E}(p/p_e)$ were set, respectively, equal to the ratios

$$p_{im}Im/(pQ + p_{im}Im + p_e E) \quad \text{and} \quad p_e E/(pQ + p_{im}Im + p_e E).$$

The values obtained with the 1980 data are thus

$$\mathscr{E}(p/p_{im}) = 0.26 \quad \text{and} \quad \mathscr{E}(p/p_e) = 0.03.$$

A.2.2. The supply driven model

The identities

$$Cd = Q - I - G - Ex + Imf + E,$$

$$Yim = wN - pCd,$$

$$B = p_{ex}Ex - p_{im}Imf - p_{im}Cim - p_e E,$$

were transformed into

$$\mathring{Cd} = (Q_0/Cd_0)\mathring{Q} - (G_0/Cd_0)\mathring{G} - (Ex_0/Cd_0)\mathring{Ex}$$
$$+ (Imf_0/Cd_0)\mathring{Imf} + (E_0/Cd_0)\mathring{E},$$

$$\mathring{Yim} = (wN_0/Yim_0)(\mathring{N} + \mathring{w}) + ((pCd)_0/Yim_0)(\mathring{Cd} + \mathring{p}),$$

$$\Delta B = (p_{ex}Ex)_0(\mathring{Ex} + \mathring{p}_{ex}) - (p_{im}Imf)_0(\mathring{Imf} + \mathring{p}_{im})$$
$$- (p_{im}Cim)_0(\mathring{Cim} + \mathring{p}_{im}) - (p_e E)_0(\mathring{E} + \mathring{p}_e),$$

and the 1980 figures were used as reference values.

The same assumption as in the demand driven model was made about the consumption price responsiveness to import prices.

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