Desmos: A Model for the Coordination of Economic Policies in the EEC Countries*

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INTRODUCTION

Since the war the extremely rapid and sustained increase in the volume of international transactions has dramatically increased the economic interdependence of countries. This has resulted in a sharply perceived need for better coordination of economic policies. In spite of the progress of international cooperation it cannot be said that this need has been answered.

Part of the problem, we believe, is its complexity. It is difficult to agree to a set of coordinated measures when the gains achieved through coordination are only dimly perceived. Policy coordination is typically one of the economic problems whose complexity is such that ad hoc reasoning cannot grasp it adequately, so that an econometric model is needed to make sense of the multiple interactions involved.

Perhaps in no region has the need for better coordination of economic policies been as sharply perceived as in the EEC; in no region has the inadequacy of coordination attempts been so strongly criticized. It was natural therefore to try to construct a model which might help readers to understand the interaction of policies and economic development in the EEC.

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*Desmos = Link in Greek. The Desmos I model, covering the six initial EEC countries, was built by Mrs. M. Grinwis. Desmos II, the work of A. Dramais, is a substantially elaborated version of Desmos I, extended to cover the nine present EEC countries.

Such a model should be simple. Experience shows that policy advisers — surely wisely — disregard totally the results of models unless their mechanisms can be explained in simple terms. Wisely also they are interested only in models which can be handled rapidly and reliably.

The model should therefore have the following characteristics:

(a) Its equations should be specified in a single and readily understandable way;
(b) The economies of different countries should be described by similar equations: no policy adviser will accept that an unexpected result of the model is due to, say, France having a Phillips curve and Germany a Kuh wage function;
(c) The model should use only readily available data, so that it can be run from a single center, and does not depend on special hard-to-get data and information on economic variables and policy measures;
(d) The model should be reliable and useful not only for short-run, but for medium-run projections;
(e) It should have well-documented properties, so that any results produced can be rapidly understood and explained;
(f) It should be capable of reflecting a wide range of economic policies.

These guidelines explain the design of the Desmos model, which describes the interdependence of real and price variables in EEC countries in terms of four blocks of equations:

(a) a factor demand block;
(b) an income and expenditures block;
(c) a wage price block;
(d) a trade linkage block.

In each case the specification used reflects broadly accepted and well-tested ideas about economic causality.

Desmos does not encompass all relevant phenomena. The most glaring omissions are neglect of linkages which operate via international capital movements and labor migrations. The only study which incorporates such linkages is that by Helliwell, using the linked RDX II + MPS system. As indicated by his contribution to this volume, Helliwell finds that these linkages are not important in the short run; they operate rather slowly and have substantial effects only after a few years. The omission therefore affects the usefulness of Desmos mainly as a tool for medium-run forecasts.[1]

Another deficiency of the model is that economic activity outside of the EEC countries is treated as exogenous. This defect will be removed in

[1]These linkages will be introduced in the future. A. Sapir has worked on labor migrations and A. Dramais has obtained results on interest rate linkages via the Eurodollar rate. This preliminary work has revealed however that the data on labor movements and on capital markets in the EEC is extremely deficient; it will be a long time before a specification for EEC countries' capital and labor linkage systems comparable to Helliwell's will become possible.

the near future by introducing very simple equations reflecting the dependence of the rest of the world on economic trends in the EEC. No attempt has been made to describe precisely the institutional linkages between policy measures and the economy. Desmos does not include sets of fiscal equations indicating how, for instance, tax or social security measures affect different variables: public finance instruments are identified only in an aggregate way as public expenditures and the share of taxes in GNP. Neither does it contain detailed monetary sectors, indicating how, for example, discount rate changes or open market policies affect interest rates: governments are supposed to control in some way which the model does not explain "the rate of interest." We feel that although something is lost by this shortcut, especially on the monetary side, construction of adequate fiscal and monetary submodels was not compatible with the goal of constructing an easily manageable policy coordination model.

In spite of this insistence on simplicity of specification, Desmos is far from having a simple causal structure. This complexity reflects the fact that the commonly accepted macro-economic theory which the model quantifies is far from representing economic causality in simple terms. Also, in spite of the moderate size of individual country models, the total system is large. Desmos covers nine countries and includes linkage equations also. This explains why the total size of the model is 258 equations. There are many ways in which the system could be extended and improved; but before considering each step it is necessary to multiply by nine the number of equations to be added, to identify the new exogenous and endogenous variables needed and examine whether the new data required are found in easily available sources as is required if the model and its data bank are to be operationally maintained from a single center.

SALIENT FEATURES OF MODEL'S STRUCTURE

The equations of the model are given in the Appendix; in the following section of the paper we will try to document the features of the model which simulations have shown to be important.

Factor Demand Block

The factor demand block is neo-classical, allowing substitution between labor and capital along a Cobb Douglas function. This implies that demand for capital and labor depends not only on output, but on factor prices.

A well-known problem in estimation of neo-classical factor demand systems is that the labor and capital demand functions obtained are not consistent with a unique production function. This is a serious defect of these equations if the models are meant to produce satisfactory long-run forecasts. Inconsistent labor and investment demand functions are incapable of generating a coherent picture of the future growth of prices, wages, interest rates, capital and labor use, and production.

There are various ways of enforcing consistency in estimation of capital and labor demand functions. We chose to use the procedure proposed by Coen and Hickman[2] which involves using a maximum likelihood procedure to estimate equations of the type[3]

$$EMPi = (PIBCFi)^b \, (CCAPi/Wi)^c \, 10^{-d \, TEMPS} \, EMPi^e_{-1}$$

$$CAPi = (\rho i PIBCFi + (1 - \rho i) \, PIBCFi_{-1})^b \cdot [ki(CCAPi/Wi) + (1 - ki)(CCAPi_{-1}/Wi_{-1})]^c \cdot 10^{-d \, TEMPS} \, CAPi^e_{-1}$$

$$0 \leqslant \rho_i \leqslant 1$$
$$0 \leqslant k_i \leqslant 1$$

where ρ_i and k_i are weights used in forming weighted averages of variables involved.

under appropriate constraints on the coefficient. The method seemed robust. It has so far been used only for the USA, and it seemed interesting to test its applicability to factor demand in the EEC.

This initial judgment about the method's robustness proved on the whole justified. In spite of the poor quality of data it was possible to obtain good results in estimation for Germany, Belgium, Italy and the United Kingdom. For France and Denmark it was necessary to impose as a constraint constant returns to scale of the underlying production function. For the Netherlands it was found necessary to estimate the production function directly so that only the adjustment lags were left to be estimated in capital and labor demand functions. For Ireland capital demand was estimated using a Jorgenson specification, whereas labor demand was estimated as for the Netherlands. Only for that country do the two demand functions fail to achieve consistency with the same production function. The inconsistency is not very severe however as shown by Table 1.

The underlying production functions are broadly similar. They show evidence of increasing returns, except when constant returns were imposed in estimation.

The chief properties of the estimated factor demand functions are summarized in Table 2. The mean capital adjustment lags seem very long. In judging them it must be borne in mind that — because of the desire for simplicity — only one capital demand function is estimated covering the total capital stock and total output. Although it is expected that adjustment of production capital to output and factor prices is rather fast for directly productive investment, the same is not true of housing and infrastructure investment; the very long lags are not entirely unreasonable therefore.

[2]R.M. Coen and B. Hickman, "Constrained Joint Estimation of Factor Demand and Production Functions," *Review of Economics and Statistics*, No. 3, 1970, pp. 287-300.

[3]Definitions of symbols are given in Appendix.

One question raised by the results is whether the Coen-Hickman specification is flexible enough to allow fully for differences in the speed of adjustment of capital demand to the level of GNP and to factor prices. Adjustment to changes in GNP — capital widening — is probably faster than adjustment to factor prices, which necessitates capital deepening and thus an overhaul of existing facilities. The results reveal such a discrepancy for most of the functions estimated, but the Coen-Hickman specification, which does not permit a difference in mean adjustment lag exceeding one year, may not be flexible enough to reflect the full extent of the difference. For labor the problem arises even more acutely, since the specification does not allow for any difference in adjustment speed to the level of activity and to factor prices.

The attention of the reader is drawn to the differences in adjustment speed of labor and capital between countries. These differences have a significant influence on the simulation behavior of the country submodels.

Table 1

Production Functions Underlying the Capital and Labor Demand Functions

Countries	b	c	b + c	d
Germany	0.98	0.30	1.28	0.0248
Belgium	0.86	0.27	1.13	0.0225
Denmark	0.81	0.19	1.00	0.0218
France	0.86	0.14	1.00	0.0235
Ireland 1	0.66	0.34	1.00	n.a.
2	0.71	0.29	1.00	0.0086
Italy	0.88	0.27	1.15	0.0251
The Netherlands	0.85	0.55	1.39	0.0191
United Kingdom	0.90	0.19	1.09	0.0225

Where the specification is $PIBi = aEMPi^b \, CAPi^c \, e^{d \, TEMPS}$

For Ireland specification 1 is derived from the capital demand function; 2 from the labor demand function.

Table 2

Capital and Labor Demand Functions*

	Capital Demand				Labor Demand		
			GDP	Factor Prices			
	b	c	Mean Lag (years)	Mean Lag (years)	b	c	Mean Lag (years)
Germany	0.049	-0.048	15.9	15.9	0.098	0.298	7.9
Belgium	0.122	-0.105	9.0	9.3	0.318	0.086	2.7
Denmark	0.110	-0.090	8.0	9.0	0.156	0.030	6.4
France	0.044	-0.038	21.7	22.7	0.740	0.104	1.3
Ireland	n.a.	n.a.	n.a.	n.a.	0.243	n.a.	4.8
Italy	0.124	-0.109	8.9	9.3	0.522	0.142	1.6
The Netherlands	0.041	-0.035	16.5	17.5	0.118	n.a.	10.0
United Kingdom	0.092	-0.083	9.0	10.0	0.402	0.076	2.3

Where b, c are the short-run elasticities of capital and labor demand with respect to GDP and relative factor prices.

*As explained, the Coen-Hickman approach did not give results for Ireland and the Netherlands. This explains the lack of a relative price term in the labor demand equation for these countries. This does not mean that demand for labor is wholly insensitive to relative prices, for in both countries labor demand depends on capital stock, which depends on factor price, so that an indirect relation exists. But this is weak, and the different specification adopted for these countries does affect the simulation behavior of the corresponding submodels.

The last important remark is that — because capital and labor demand respond to factor prices and to output with a lag — the Coen-Hickman specification permits substantial variation in the degree of utilization of factors of production. Factor utilization is accordingly an important variable of the Desmos model. As will be seen it plays a significant role in explaining exports. Also, the increase in factor utilization in an upswing leads to an Okun's law type response of productivity to demand, which we feel is empirically realistic.

Income Expenditure Block

The *consumption* functions explain the level of consumption as a function of deflated disposable income, with an exponential lag which can be explained in several ways, e.g., by the permanent income hypothesis.

As the table shows, the long-term propensities to consume differ little between countries — Denmark's high propensity being an exception. They are quite close to the average propensities, as is implied by the permanent income hypothesis. Countries differ substantially however in the speed of adjustment of consumption to changes in income, and these differences affect significantly the dynamic simulation properties of the models. The lags are on the whole rather short: in no case does income appreciably influence consumption after the third year.

The *disposable income* equations are a convenient way of side-stepping the complex task of estimating detailed public sector submodels. What is interesting is that the aggregate behavior of the different governments has been so similar; by and large the net levy of governments on incomes has varied proportionately to GNP; the net tax share is quite similar in the different countries.

The reader should note that it is disposable income in value which is related to the current price GNP, whereas the volume of consumption depends on disposable income deflated by the price of private consumption. Consumer behavior is therefore influenced by the relationship between the price index of private consumption and of GNP. The simulation results show, for example, a clear impact of changes in the terms of trade on the level of private consumption expenditures.

Government consumption is considered as exogenous. As taxes net of transfers are a function of GNP, public savings play the role of an automatic stabilizer of the level of activity. Of course, it is doubtful that government expenditures do not to some extent depend on income, and from this point of view the model is not quite realistic.

Gross domestic fixed capital formation is obtained by a quasi-identity involving the capital stock and the rate of amortization. As already noted, Ireland is an exception in that investment is determined by a Jorgenson function.

Data on *changes in inventories* in EEC countries are extremely unreliable. It is the custom of several statistical offices to include most of the errors and omissions adjustments in this item. It was decided not to attempt a refined estimation, and to assume that changes in stocks equal 10 percent of the changes of GNP plus an estimated constant term.

Wage Price Block

Little refinement has so far gone into this block, which links wages to unemployment and prices by Phillips curves, and explains prices by cost-push formulas. Ideally it would be desirable to connect prices and wages to the Coen-Hickman production function. This could be used to construct an indicator of factor costs, which would determine prices along with disequilibrium variables like unemployment or the degree of use of capacity, along the lines of the RDX II model, for instance. We plan to experiment with such a formulation in future.

Table 3

Consumption and Disposable Income Equations

	Consumption Function		Disposable Personal Income
	Marginal Propensity to Consume		
	Short run	Long run	Regression Coefficient
Germany	0.54	0.83	0.65
Belgium	0.67	0.75	0.72
Denmark	0.58	0.96	0.65
France	0.59	0.83	0.68
Ireland	0.81	0.81	0.74
Italy	0.43	0.81	0.78
The Netherlands	0.51	0.81	0.68
United Kingdom	0.46	0.82	0.67
Luxemburg	0.60	0.92	0.70

The estimated equations for wages given in the Appendix are difficult to compare because the definition and statistical coverage of the wage indices vary from country to country and because "normal" unemployment levels differ among countries. We have computed therefore the values of elasticity at the mean of wages with respect to the chief explanatory variables. The elasticities in Table 4 refer to the semi-reduced form equations obtained by eliminating private consumption prices between the wage and private consumption price equations of the model. As the table shows, Phillips curves for different countries imply broadly similar behavior. The reader is cautioned however that, since the wage equations are nonlinear, the sensitivity of wages to changes in employment is apt to differ substantially from year to year; this once again is a very clear feature of the simulation results.

Table 4

Wages: Elasticities at the Mean with Respect to Explanatory Variables

	Elasticities of Wages with Respect to		
	Employment	Active Population	Import Prices
Germany	2.02	-2.06	—
Belgium	2.93	-3.06	0.15
Denmark	1.06	-1.09	0.21
France	2.72	-2.76	—
Ireland	3.26	-3.45	0.45
Italy	2.08	-2.19	—
The Netherlands	2.12	-2.15	0.21
United Kingdom	1.55	-.157	—

For France the Phillips curve failed to give results. It was necessary to use a different specification, in which wages depend on changes in unemployment. This appears to reflect a pattern of labor market behavior where changes in unemployment have a very rapid but noncontinuing effect on the level of wages.

To understand the behavior of the model, it is useful to relate the "supply curves" for labor which the table represents to "demand curves" represented by the labor demand relations of the factor demand block. The latter are given in Table 5. In the Netherlands, since the employment demand function is a reversed Cobb Douglas with a Koyck lag, employment is not directly a function of wages. Thus, in the short run, it depends only on business fluctuations and not on relative prices.

Prices are explained by wages and import prices. The first variable reflects a cost-push influence, the second translates both push and pull effects. Import prices influence domestic prices both directly, because goods sold in domestic markets incorporate imports, and indirectly to the extent that domestic producers adjust selling prices and profit margins to match the prices offered by foreign competitors. It is clear from the estimated coefficient that the second effect is substantial.

Table 5

Elasticities of Labor Demand

	Short-term elasticities with respect to		Long-term elasticities with respect to	
	Production	Wages	Production	Wages
Germany	0.098	-0.030	0.777	-0.238
Belgium	0.318	-0.086	0.878	-0.237
Denmark	0.156	-0.030	1.000	-0.192
France	0.743	-0.104	1.000	-0.140
Italy	0.522	-0.142	0.872	-0.237
The Netherlands	0.118	n.a.	1.180	n.a.
United Kingdom	0.402	-0.076	0.919	-0.174

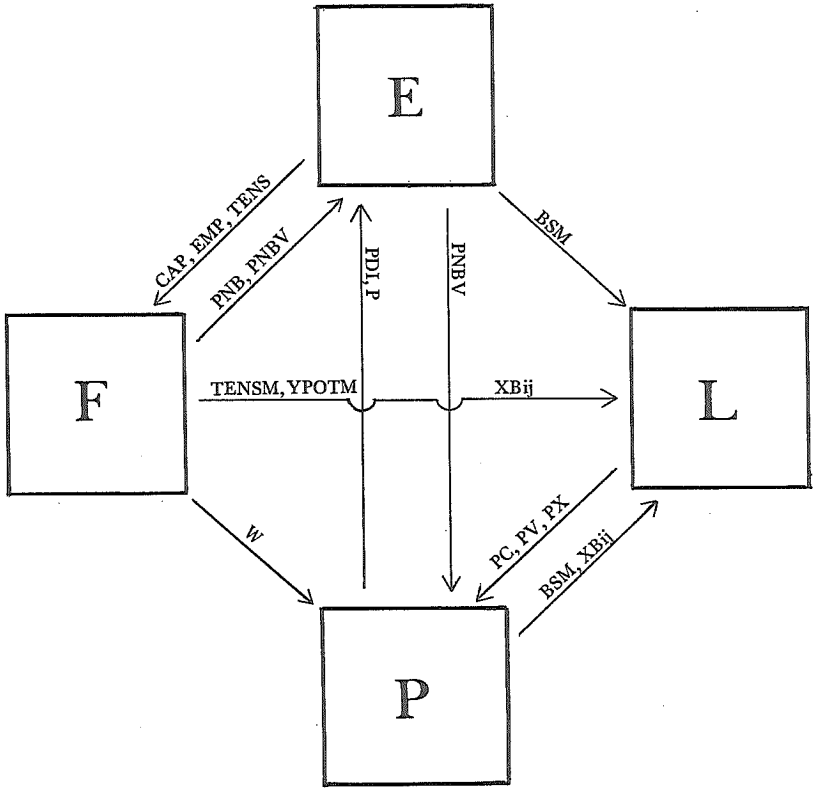
Foreign prices influence consumer prices only in the smaller countries. It was decided not to use a regression for France with a highly significant import price coefficient, to maintain symmetry with the specification for other large countries where domestic consumer prices did not depend significantly on import prices. The table shows that this apparently strong sensitivity of French prices to foreign influences is a general characteristic of the French economy which separates it from those of its Common Market partners.

Another interesting result is the tendency of Italian exporters to behave very competitively and match international prices almost irrespective of changes in their own costs. This is also probably a realistic trait of the Italian economy, which helps to account for the lack of effect of recent devaluations in restoring the balance-of-payments equilibrium.

Structure of the Country Submodels

In spite of our determination to avoid any needless complexity, the structure of the Desmos model is far from simple. The diagram below, which identifies the relation between the blocks of equations in each of the countries' submodels, helps to explain its simulation behavior. In the

diagram the blocks refer to the four categories of endogenous variables identified in the list of notations in the appendix. The variable names above or to the left of each arrow refer to the variables in the block reached by the arrow, which depend on variables in the block from which the arrow originates.



F, E, P, L are respectively the factor demand, expenditure, price and linkage blocks of the model.

The Linkage Block

In Desmos as in other linked models exporters are price setters and quantity takers. Each countries' *imports* are determined by its GNP and by relative prices; these equations are allocated between exports by *bilateral trade flows equations. For export prices* it is exporters who call the tune, their behavior being described by appropriate equations for each country; these prices are averaged to determine *import prices* for each country. Sellers of many manufactured goods are in fact price setters and quantity takers, so that such a system is not unrealistic, at least for developed countries.

As in a recent study by Hickman and Lau,[4] which served as a point of departure, the bilateral flow equations are linearized constant elasticity functions. The underlying functions have the form:

$$\left(\frac{XB_{ij}}{BM^*_j}\right) = \alpha ij \left(\frac{PXC_i}{PMC^*_j}\right)^{\beta_j} \left(\frac{YPOT_i}{YPOTM^*_j}\right)^{\gamma_j} \left(\frac{TENS_i}{TENSM^*_j}\right)^{\delta_j} e^{TIE_{ij}}$$

where BM^*_j, PMC^*_j, $YPOTM^*_j$, and $TENSM^*_j$ are appropriate CES indices of real imports, import prices, supplier capacity output, and supplier capacity utilization in the jth import market.[5] Other variables are defined in the Appendix. We assume $\beta_j = \beta$, $\gamma_j = \gamma$, and $\delta_j = \delta$ for all j, and that $\alpha_{ij} = \alpha_{ij}\,(e^{TIE_{ij}})$ where

$$TIE_{ij} = \alpha^*_1\, BCEEI_{ij} + \alpha^*_2\, BAELE_{ij} + \alpha^*_3\, BCEEX_{ij} + \alpha^*_4\, BAELEX_{ij}$$ [6]

The data are the constant and current price trade matrices built by G. Taplin at the IMF.

The term $e^{TIE_{ij}}$ allows for integration effects, where $BCEEI_{ij}$ and $BAELE_{ij}$ stand for Common Market and EFTA intra-trade dummies and $BCEEX_{ij}$ and $BAELEX_{ij}$ for extra-trade dummies. Of the four coefficients only the first is significant. We plan to experiment with formulations in which the integration effect is represented by a trend. $TENS_i$ is a pressure of demand variable, $TENSM^*_j$ being the weighted pressure of demand of exporters into each market. Pressure of demand is represented by the ratio of GNP to production capacity at full employment, as measured by the models' production functions.

[4]B. Hickman and L. Lau, "Elasticities of Substitution and Export Demand in a World Trade Model," *European Economic Review*, Vol. IV, December 1973.

[5]These indices become trade weighted averages such as PMC_j upon linearization by the Taylor's series expansion around the values of variables for a base year, as is fully described in Hickman and Lau.

[6]The function $\alpha_{ij}\,(e^{TIE_{ij}})$ becomes a simple linear sum as shown in the Appendix upon linearization referred to in footnote 5.

The most novel term of the specification is $(YPOT_i/YPOTM^*_j)$, the ratio of production capacity in the country of origin to a weighted average of its competitors' capacity on each of its markets. This unorthodox term allows for two major misspecifications of export-demand functions of the usual type.

(i) The functions are specified as if countries all exported the same goods, where the manufactures, especially the exports which we measure, are made up of hundreds of thousands of different products. No country exports more than a small fraction of the number of goods exchanged in international trade. The number of products which a country is able to supply should therefore be an argument of the export demand function, for a country which matches its competitors' prices for all products will sell more if it exports many than if it exports only a few products. To the extent that large countries produce a broader range of goods than small ones, because it is uneconomic to produce at a very small scale of output, this factor may be captured by the $(YPOT_i/YPOTM^*_j)$ variable.

(ii) International trade takes place in conditions of very imperfect information, and this makes selling effort perhaps as important as price in the competition for markets. For many products, e.g., machines, importers may know only a few of the potential suppliers of the goods they need. For other goods, e.g., cameras, the final buyer has only a vague understanding of the merits of the goods between which he may choose. Selling effort has a considerable effect on exports and this works to the advantage of the large countries which have larger sales forces than their smaller competitors.

It should be noted that according to both (i) and (ii) it would be expected that exports will depend on the production capacity of the exporter and not on its GNP, and this is reflected in the specification used. The specification differs in this important respect from the so-called "gravity model" in which exports depend on the GNP of the exporter. In the long run, capacity and GNP will move together; but in a short-term model it is essential to distinguish between the two.

It can be shown that if m_j is the share of imports in aggregate expenditures $(PNB_j + M_j)$, the price elasticity of export demand on market j is

$$-\beta + \sum_j a_{ij}\,(\beta - c_j/(1 - m_j\, b_j))$$

where β and c_j are the price elasticities of the bilateral flows and import equations; b_j the income elasticity of import demand, and a_{ij} import shares of country i in market j. Given the import functions estimated, the typical price elasticity of export demand works out to a value of some 1.65. The typical price elasticity of import demand is -0.4. Price adjustment is thus moderately effective as a means of restoring balance-of-payments equilibrium.

Another important part of the bilateral trade equation is the a_{ij} coefficient equal to import shares in the base year. These are the main determinants of the strength of trade linkages between countries. In Table 7 the special relation between the United Kingdom and Ireland is very evident, as are the strong ties between the "DM block" countries (Germany, Belgium, Holland) who have remained in the EEC snake. Another noteworthy feature is the United Kingdom's strong dependence on extra EEC trade.

POLICY RESPONSE OF THE MODEL

Because of the model's complexity it is impossible to predict its behavior from the study of its equations. As explained in the introduction we feel that the properties of a model intended to be used for policy coordination should be thoroughly understood and documented. The best way of doing this, we felt, was to compute a complete set of dynamic policy multipliers.

Examination of computing costs showed that it was possible to produce at low cost tables of dynamic multipliers covering the effect over five years of changes of six policy instruments by each EEC country except Luxemburg, and by all EEC countries together, i.e., a total of 55 simulations. Detailed tables giving some 3,000 dynamic multipliers for all major variables from a 1970-1974 simulation are available; space considerations preclude however a complete reproduction of these results in this volume.

As for the model's structure, the discussion will be confined to highlights. We will discuss in succession:

(a) the mechanisms through which policy instruments affect the economies of the EEC countries;
(b) the "controllability" of the four objective variables of the model;
(c) differences in the response of countries to changes in instruments: does Desmos shed any light on the reason for the strikingly different history of say the German and UK economies in the 1960s and 1970s?
(d) a comparison of the multipliers with the results on international transmission of economic fluctuations presented by Hickman;
(e) in the last section of the paper, finally, we try to indicate how the model's dynamic multipliers might be used to devise a coordinated economic policy which would meet the current economic difficulties of EEC members and reflect their preference as to the choice of instruments used to achieve chosen goals.

Controllability of the EEC Economy

Experience in using models for policy-making indicates that — wisely — policy-makers are not interested in knowing the precise values of policy multipliers; what they are really prepared to discuss and perhaps be persuaded to take into account are signs and orders of magnitude of impacts.

Table 6

Coefficient in Price Equations

	Private Consumption Prices		Public Consumption Prices	Investment Goods Prices		Export Prices	
	Wages	"Import" Prices	Wages	Wages	"Import" Prices	Wages	"Import" Prices
Germany	0.42	—	0.71	0.54	0.18	0.32	0.40
Belgium	0.31	0.29	0.42[x]	0.59	0.23	0.45	0.35
Denmark	0.27	0.19	0.80	0.37	0.31	0.21	0.39
France	0.85	—	0.80	0.60	0.48	0.62	0.62
Ireland	0.44	0.32	0.69	0.36	0.26	0.47	0.49
Italy	0.50	—	0.69	0.37	0.21	0.14	0.76
The Netherlands	0.48	0.19	0.72	0.44	0.29	0.30	0.50
United Kingdom	0.68	—	0.73	0.88	—	0.66	0.51

[x]Long-term coefficient from a Koyck specification; short-run coefficient = 0.22.

They perceive the model not as an exact tool for computation of policies, but as a way of obtaining better qualitative understanding of economic interactions.

It is thus interesting to look at the multipliers in terms of what Lancaster has christened "qualitative economic theory": i.e., theory which takes into account only whether the influence of a variable on another is positive, zero, or negative. Is it possible to decide how instruments should be used to achieve given objectives if all that is known is the signs of their dynamic multipliers? We will call a model with this property strongly controllable. The property is desirable not only because it facilitates discussion of policies with users. But it also implies that the impacts of instruments are sufficiently differentiated to endow policy makers with flexibility in coping with a broad range of possible economic situations.

The sign pattern of policy multipliers is given in Table 9. It is immediately apparent that, since the unemployment and consumer price multipliers have opposite signs for all instruments, they are not separately strongly controllable in the above defined sense. This is of course what

Table 7

Pattern of Interdependence of the EEC Countries; Market Shares in 1963*

Supplier (i) \ Market (j)	G	BLEU	D	F	E	I	N	U	R
G	—	0.2079	0.2277	0.1967	0.0678	0.1840	0.2392	0.0458	0.0808
BLEU	0.0753	—	0.0332	0.0865	0.0237	0.0336	0.1835	0.0230	0.0152
D	0.0266	0.0042	—	0.0070	0.0102	0.0130	0.0070	0.0356	0.0088
F	0.1117	0.1474	0.0412	—	0.0268	0.1002	0.0447	0.0326	0.0448
E	0.0014	0.0008	0.0003	0.0010	—	0.0010	0.0010	0.0337	0.0008
I	0.0771	0.0374	0.0274	0.0653	0.0112	—	0.0314	0.0227	0.0289
N	0.1083	0.1513	0.0478	0.0482	0.0295	0.0309	—	0.0396	0.0168
U	0.0560	0.0604	0.1549	0.0662	0.5597	0.0658	0.0817	—	0.0860
R	0.5436	0.3906	0.4675	0.5291	0.2711	0.5715	0.4115	0.7670	0.7179

*G = Germany, BLEU = Belgium and Luxemburg, D = Denmark, F = France, E = Ireland, I = Italy, N = Netherlands, U = United Kingdom, R = Rest of the world.

Table 8

Effects of Synchronized Changes of Six Policy Instruments on the Main EEC Variables

Measures / Variables		GNP	Consumption	Investment	Export	Import	Employment	Wages	Consumption Prices	Export Prices $	Import Prices $	Balance of Payments
Public Consumption	70	1.56	1.04	0.58	0.51	1.99	0.33	0.49	0.35	0.24	0.13	-0.33
	72	1.92	1.93	1.84	0.16	2.69	0.87	1.70	0.97	0.87	0.41	-0.54
	74	1.91	2.35	2.40	-0.43	3.11	1.21	3.42	1.93	1.91	0.77	-0.71
Taxes	70	-0.71	-1.30	-0.27	-0.36	-1.22	-0.15	-0.22	-0.17	-0.11	-0.07	0.20
	72	-1.23	-2.32	-1.02	-0.42	-2.03	-0.50	-0.64	-0.39	-0.33	-0.17	0.39
	74	-1.35	-2.66	-1.35	-0.30	-2.28	-0.78	-1.07	-0.60	-0.59	-0.27	0.49
Investment	70	1.36	0.84	4.85	0.82	2.45	0.29	0.44	0.33	0.22	0.13	-0.36
	72	3.36	2.76	12.20	1.40	5.67	1.36	1.80	1.22	0.88	0.45	-0.98
	74	4.79	4.56	18.53	0.95	8.21	2.65	4.30	2.96	2.37	0.98	-1.66
Exchange Rate	70	-2.16	-1.06	-0.60	-4.12	0.10	-0.45	-0.78	-0.70	5.90	2.65	-0.36
	72	-2.35	-1.72	-1.36	-3.45	-0.08	-1.12	-1.74	-1.17	5.35	2.40	-0.25
	74	-2.44	-2.02	-1.74	-2.89	-0.28	-1.58	-2.56	-1.59	4.76	2.15	-0.16
Interest Rate	70	-0.28	-0.16	-0.81	-0.37	-0.51	0.07	0.16	0.13	0.11	0.04	0.05
	72	-1.47	-1.11	-4.78	-1.16	-2.33	-0.06	0.21	0.10	0.17	0.04	0.33
	74	-1.65	-1.41	-5.13	-1.21	-2.51	-0.21	0.12	0.04	0.14	0.03	0.39
Immigration of Labor	70	0.44	0.20	0.07	1.50	0.60	0.08	-0.93	-0.57	-0.49	-0.21	0.16
	72	0.46	0.18	-0.14	1.58	0.32	0.17	-1.88	-0.96	-1.00	-0.43	0.20
	74	0.44	0.07	-0.35	1.55	0.10	0.21	-2.39	-1.19	-1.32	-0.55	0.22

economists have in mind when they speak of the "trade-off" between inflation and unemployment. From a mathematical point of view there is no such thing as a trade-off: if there are two instruments, if their dynamic multipliers are not co-linear, and if their values can be changed freely, it is possible to achieve any combination of inflation and unemployment rates. But if, as happens to be the case, the impacts are not strongly differentiated, separate control of unemployment and prices implies very large and politically unacceptable changes of instruments.

If either consumer prices or unemployment are dropped from the list, the remaining objectives are strongly controllable. This is shown in Table 10. The first part of the table shows that — because of the signs of dynamic multipliers — there must be a policy combining demand contraction with revaluation which has no impact on the balance of payments, but decreases both GNP and consumer prices. A drop in the interest rate and a rise in the labor force increase GNP and reduce prices, again with no effect on the balance of payments. As the second part of the table shows, a combination of these four policy measures will reduce inflation without cutting the rate of growth or affecting the balance of payments.

The Phillips curve has become an unfashionable concept, because it does not explain the recent inflation well. It is certainly not as stable a relation as, say, the consumption function. Estimation results suggest that over the sample period, at any rate, it has explained wages reasonably well, with coefficients which are roughly comparable between countries. There is at least historical interest in an examination of the model's inflation/unemployment trade-offs. This is given in Table 11.

Table 9

Sign Pattern of Policy Multipliers

Impact on	Public Consumption, Direct Taxes, Investment	Rate of Exchange	Long-term Interest Rate	Labor Immigration
GNP	+	—	—	+
Unemployment	—	+	0*	+
Consumer prices	+	—	0*	—
Balance of payments	—	—	+	+

*Impacts quite small

Table 10

Impacts of Combinations of Instruments*

Impact on	$\frac{-\Delta EXP}{+\Delta EXCH}$ a	$\frac{-\Delta RL}{+\Delta IMMIG}$ b	$\frac{\Delta EXCH}{-\Delta RL}$ c	$\frac{\Delta EXP}{-\Delta IMMIG}$ d
GNP	—	+	0	0
Consumer prices	—	—	—	+
Balance of payments	0	0	—	—

	$\frac{-\Delta EXP - \Delta RL}{+\Delta EXCH + \Delta IMMIG}$ (a + b)	$\frac{-\Delta EXP - \Delta RL}{+\Delta EXCH + \Delta IMMIG}$ -c — d	$\frac{-\Delta RL + \Delta IMMIG}{-\Delta EXCH + \Delta EXP}$ -(a — b)
GNP	0	0	+
Consumer prices	—	0	0
Balance of payments	0	+	0

* ΔEXP = use of expansionary policies: increases in public consumption, cut in taxes, stimulus to investment

ΔRL = increase in long-term rate of interest

$\Delta EXCH$ = currency revaluation

$\Delta IMMIG$ = import of foreign labor

Because of the nonlinearity of this relation the table distinguishes expansionary measures, which push the economy into the low unemployment zone, and deflationary measures which have an opposite effect. It is wise to avoid comparing dynamic multipliers in the two categories.

What is striking is how unfavorable the trade-off is. It is, roughly speaking, necessary to increase unemployment by 1 percent to reduce prices by 1 percent. It is doubtful whether voters in most countries are willing to pay such a price to combat inflation. The frequent statements that "the Phillips curve does not work any more" to a certain extent reflects the fact that "it does not work as much as we would like." The unemployment price for controlling inflation is so high that after a year of experience with recession political pressure to expand demand becomes overwhelming.

Table 11

Inflation/Unemployment Tradeoffs

(Ratios of private consumption prices to unemployment multipliers of different instruments)

	Expansionary Measures		Deflationary Measures		
Year	Public Consumption	Investment	Direct Taxes	Exchange Rate	Labor Import
1	1.06	1.14	1.13	1.56	0.62
3	1.11	0.90	0.78	1.04	1.10
5	1.60	1.12	0.77	1.01	1.51

The impact profiles in the table are interesting. The trade-off of (expansionary) public consumption increases rises, the trade-offs of (deflationary) tax increases fall, because the first instrument carries unemployment into the steeply rising zone of the Phillips curve, the other into its flat portion. Labor import stands out however for its rising inflation/unemployment tradeoff. Tax increases are the least advantageous method of fighting inflation. In the "expansionary measures" category investment is a way of reducing unemployment which has a lower inflation cost than public consumption.

EFFECT OF SYNCHRONIZED ECONOMIC POLICIES

It is not possible to present in full the close to 3,000 dynamic policy multipliers computed. A useful way of understanding the behavior of the model is however to discuss the impacts of synchronized changes in policy instruments. We will first discuss the impacts on EEC aggregates, shown in Table 8, then the impacts on individual countries. Impacts of public expenditures will be described in some detail, as a device to introduce to the reader the mechanisms of the model.

Impacts on EEC Aggregates

The policy measures considered are sustained changes of six policy instruments:

(a) exogenous changes of aggregate demand components:
  (i) public consumption: increase equal to 1 percent of GNP;
  (ii) direct taxes: increase equal to 1 percent of GNP;
  (iii) investment: increase equal to 1 percent of GNP.

(b) other instruments:
  (i) 10 percent revaluation;
  (ii) 1 percent increase of the long-term interest rate;
  (iii) labor immigration equal to 1 percent of the active population.

Exogenous Changes of Aggregate Demand Components

(i) *Public Consumption*

An increase in public expenditure increases GNP through the multiplier. This influence is somewhat enhanced by the impact of the measure on the terms of trade, which affect consumption through their impact on personal disposable income.

The increase in production sets in motion the accelerator mechanism, causing a rise of investment. Because of the long lags of investment demand, this impact is spread over a fairly long period. As production increases, however, the relative price of labor rises, and this amplifies significantly the increase in investment.

Imports increase both because of the expansion of the economic activity, and because of the increase in domestic prices.

The effect on unemployment is the result of a positive impact of higher GNP, partly offset by factor substitution caused by an increase in the relative price of labor.

The reduction in unemployment causes a sustained increase in wages and prices, which deteriorates the competitive position of the Common Market.

Exports increase at first, because of the rise in intratrade of EEC countries. The unfavorable effect of prices and of increased pressure of demand gradually predominate, and in the fifth year EEC exports have fallen below the level in the control solution.

(ii) *Increase in Direct Taxes*

The effect of higher taxes differs from that of higher public consumption in two ways. The effect of taxes is weaker, because an increase reduces savings and does not lead to an equivalent drop in consumption. The nonlinearity of the wage equation also affects the result: the price repercussions of a cut in expenditures are less than those of an equivalent increase in expenditures. This accounts for the very different time profiles of the GNP and employment multipliers of public consumption and direct taxes.

(iii) *Exogenous Increase of Investment*

This instrument can be used realistically only in countries which have a large and diversified public sector, and systems of investment incentives which are sufficiently powerful to influence productive investments substantially. Only France, Italy, and perhaps Britain fulfill these conditions.

For the sake of comparability, the simulations have been run on the assumption that all countries use this instrument simultaneously.

The impacts are large and suggest that this instrument is a powerful one. Increase in investment has the same impact on demand as increasing public consumption, but it increases production capacity, relieves the pressure of demand and helps exports; increasing the capital stock releases labor and reduces the impact of higher demand on the labor market and on prices.

Other Instruments

(i) *10 Percent Revaluation*

As emphasized by modern balance of payments theory, revaluation has both price and absorption effects.[7] The price effects lead to a deterioration of the balance of payments. This leads to a drop in GNP which sets in motion substantial deflationary forces. The increase in dollar export prices is already in the first year less than is implied by the revaluation; because of the rise in unemployment and its effect on wages, these prices fall even more in the following years. All this explains why the impact of the revaluation on the balance of payments is not lasting.

This result of the model is confirmed by post-war experience.[8]

(ii) *1 Percent Increase in the Long-term Interest Rate*

The main impacts of this instruments are on GNP and on the balance of payments. For employment the impact of a reduction in activity is offset by substitution of labor for capital, induced by the higher price of capital. As unemployment varies little, prices and wages are almost unchanged.

(iii) *Immigration of Foreign Labor*

This is also a measure which cannot be applied in all countries. In the United Kingdom, in particular, strong opposition to labor import makes it impossible to bring in large numbers of workers from developing countries. Most of the continental EEC countries have freely used this instrument to ease inflationary pressures, or to prevent unemployment from increasing in times of recession.

The model confirms that this is an effective and powerful instrument. Import of labor helps the balance of payments through its impact on the pressure of demand; the imported labor force is not absorbed rapidly into production so that the reduction in tightness of labor markets is lasting.

[7]S.S. Alexander, "Effects of Devaluation on a Trade Balance", IMF Staff Papers 2, 1952, pp. 263-276.

[8]The price elasticity in the bilateral export flow equations, which is equal to -1.6, may also be too low. We were not able to experiment with an alternative specification of the bilateral flow equations estimated very recently, which implies a long-term elasticity of approximately -4.

Response of Individual Country Models

Observers of current economic trends tend to speak of countries as though they had unique and very distinct personalities. One hears remarks such as "what else could be the result in Britain," or "of course we must remember that this is happening in Germany." To what extent are such differences captured by models such as ours?

It is convenient to think of personality as being the product of two components, gifts and what a person chooses to do with these gifts. Interpreting the distinction for countries would lead to distinguishing between the countries' structure as they could be described by models, and the preferences of countries as to choice of objectives and instruments.

To what extent do models like Desmos' capture such elusive personality differences between countries? It is clear that for this purpose they are at best imperfect tools. As to structure the models do not cover such an important part of the countries' economies as their financial sectors, the behavior of which is surely an important determinant of economic developments. There are more subtle difficulties, also. For instance it was found necessary to constrain price elasticities of exports and the inventory accelerators to be equal for all countries, and this meant assuming away a possibly important source of inter-country differences. Also, the decision to use as much as possible the same theoretical framework in constructing each model is possibly a limitation: perhaps the very different consumption theories of Keynes and Rueff faithfully reflect very different behavior patterns in the United Kingdom and in France.

What the model does not capture either are the preferences of countries. The German economy's "personality" may be due as much to a distaste for inflation, which leads to ready acceptance of some excess capacity, as to differences in structure. Likewise ready acceptance of immigration by the German and French populations, or the leverage on private investment afforded by the French planning system give policy makers in these countries greater scope in using these instruments than is the case in, say, the United Kingdom.

Since the Desmos concept of constructing similar models offers an exceptional opportunity to compare the behavior of different countries, it has seemed worthwhile to try to extract from the host of estimated dynamic multipliers information which is relevant to this question. We first look at the impacts of changes in a single country on the economy of that country. The most interesting results are those for the investment and revaluation multipliers, presented in Tables 12a and 12b.

The multiplier effects of exogenous changes in investment shed light on what has sometimes been called the "stop-go" feature of UK economic policy. The United Kingdom and also France and Italy are seen to be exceptionally sensitive to cumulative influences caused by shifts in the propensity to invest. This is partly because these countries are large — in the more open economies of the smaller countries inflationary impulses tend to be fairly quickly dissipated. But it is quite interesting that Germany does not share this instability of the three other large countries.

Table 12a

Impact of Autonomous Changes of Investment in One Country on that Country's GNP, Consumer Prices, and Balance of Payments

Impact on		G	B	D	F	E	I	N	U
GNP	1	1.11	0.90	1.00	1.21	0.38	1.23	0.77	1.06
	3	1.51	1.73	2.60	3.96	0.46	3.44	1.08	3.23
	5	1.79	1.91	3.43	6.89	0.41	4.64	1.27	3.87
Consumer Prices	1	0.10	0.07	0.02	0.71	0.04	0.21	0.01	0.06
	3	0.53	0.33	0.15	1.43	0.10	1.27	0.05	1.04
	5	0.85	0.64	0.47	1.61	0.13	2.82	0.10	5.60
Balance of Payments	1	-0.36	-0.72	-0.56	-0.42	-0.74	-0.53	-0.50	-0.39
	3	-0.57	-1.29	-1.30	-1.29	-1.11	-1.64	-0.48	-1.37
	5	-0.72	-1.48	-1.75	-2.24	-1.71	-2.68	-0.49	-2.47

Table12b

Impact of a Revaluation in One Country on the Country's GNP, Consumer Prices, and Balance of Payments

Impact on		G	B	D	F	E	I	N	U
GNP	1	-2.71	-3.70	-2.80	-2.05	-0.84	-1.93	-3.42	-2.38
	3	2.82	-3.43	-2.26	-2.02	-0.72	-2.29	-3.58	-2.64
	5	2.90	-3.06	-2.12	-2.29	-0.66	-2.68	-3.68	-2.28
Consumer Prices	1	-0.23	-3.25	-3.17	-1.55	-4.94	-0.28	-2.58	-0.12
	3	-0.98	-3.81	-3.35	-1.49	-5.35	-1.01	-2.80	-0.80
	5	-1.41	-4.25	-3.62	-1.23	-5.68	-1.68	-3.10	-1.97
Balance of Payments	1	-0.44	1.23	0.32	-0.11	0.11	-0.36	0.11	-0.69
	3	-0.20	1.04	0.10	-0.18	0.07	-0.28	-0.15	-0.40
	5	-0.05	1.21	0.28	-0.23	0.26	-0.08	-0.13	-0.26

Table 13a

Sensitivity of GNP to Policy Instruments in Different EEC Countries

		Germany	Belgium	Denmark	France	Ireland	Italy	The Netherlands	United Kingdom
Public Consumption	70	1.49	1.98	2.20	1.45	1.27	1.76	1.66	1.47
	72	1.89	2.14	3.06	1.67	1.38	2.56	2.12	1.65
	74	2.07	2.13	3.38	1.92	1.36	3.04	2.22	0.79
Taxes	70	-0.69	-1.08	-1.02	-0.78	-0.56	-0.67	-0.73	-0.60
	72	-1.18	-1.40	-1.96	-1.19	-0.69	-1.43	-1.23	-1.11
	74	-1.32	-1.41	-2.26	-1.34	-0.62	-1.76	-1.35	-1.06
Investment	70	1.50	1.44	1.38	1.57	0.64	1.32	1.48	0.96
	72	2.34	3.06	3.56	5.15	1.12	3.24	2.82	2.89
	74	2.97	3.82	5.08	8.84	1.36	4.16	3.88	3.52
Revaluation	70	-2.45	-2.94	-2.51	-1.82	-0.88	-1.68	-2.91	-2.23
	72	-2.59	-2.84	-2.25	-1.97	-0.71	-2.06	-3.26	-2.48
	74	-2.71	-2.63	-2.15	-2.30	-0.53	-2.49	-3.45	-2.15
Long-term Interest Rate	70	-0.11	0.73	-0.07	-0.22	-0.05	-1.01	-0.10	-0.07
	72	-1.26	-1.95	-1.46	-1.24	-0.51	-2.49	-1.10	-1.36
	74	-1.50	-1.96	-1.58	-1.51	-0.29	-2.56	-1.37	-1.45
Labor Immigration	70	0.48	0.48	0.45	0.57	0.42	0.23	0.47	0.36
	72	0.56	0.53	0.39	0.44	0.51	0.14	0.53	0.54
	74	1.51	0.47	0.24	0.39	0.46	0.05	0.57	0.64

Table 13b

Sensitivity of Private Consumption Prices to Policy Instruments in Different EEC Countries

		Germany	Belgium	Denmark	France	Ireland	Italy	The Netherlands	United Kingdom
Public Consumption	70	0.14	0.21	0.07	0.86	0.25	0.34	0.07	0.10
	72	0.76	0.80	0.45	0.89	1.15	1.41	0.36	1.30
	74	1.19	1.38	1.32	0.61	2.58	2.60	0.82	4.75
Taxes	70	-0.06	-0.10	-0.03	-0.46	-0.10	-0.10	-0.03	-0.03
	72	-0.31	-0.34	-0.17	-0.55	-0.41	-0.44	-0.14	-0.33
	74	-0.48	-0.56	-0.41	-0.46	-0.79	-0.82	-0.30	-0.95
Investment	70	0.13	0.16	0.05	0.93	0.12	0.23	0.05	0.06
	72	0.74	0.75	0.37	1.92	0.68	1.18	0.30	0.98
	74	1.18	1.50	1.23	2.12	2.55	2.36	0.77	6.12
Revaluation	70	-0.21	-2.16	-2.18	-1.32	-3.02	-0.25	-1.66	-0.11
	72	-0.89	-2.72	-2.46	-1.30	-3.64	-0.89	-1.98	-0.77
	74	-1.29	-3.17	-2.83	-1.08	-4.32	-1.50	-2.36	-1.90
Long-term Interest Rate	70	0.13	0.08	0.03	0.40	0.03	-0.16	0.02	0.05
	72	0.47	0.12	0.06	0.02	-0.01	-0.41	0.00	0.12
	74	0.58	0.08	0.02	-0.05	-0.11	-0.65	-0.08	-0.01
Labor Immigration	70	-0.62	-0.35	-0.23	-1.08	-0.84	-0.39	-0.23	-0.21
	72	-1.63	-0.76	-0.60	-0.78	-1.82	-0.87	-0.63	-0.74
	74	-2.03	-0.97	-0.92	-0.66	-2.44	-1.17	-0.92	-1.36

The revaluation impacts also correspond roughly with expectations based on historical experience. The German (and Italian) impacts vanish within a few years, whereas in France and in the United Kingdom the impact of exchange rate changes is more lasting. Revaluation has a much stronger impact on prices in smaller than in larger countries; this means that an isolated revaluation imposes much greater strain on producers, say, in the Netherlands than in Germany, even for domestic sales. It is at first sight surprising that revaluation actually improves the balance of payments of the smaller countries. This is both because the absorption effect of revaluation is very strong in their very open economies and hence has a greater effect on imports, and because the drop in consumer prices caused by revaluation limits wage increases and reduces the increase of dollar export prices.

How sensitive are EEC countries to general inflationary and deflationary forces? This may be examined by looking at the impacts on GNP and consumer prices of synchronized changes of policy instruments in all EEC countries. These multipliers are presented in Tables 13a and 13b.

Rather than discussing these figures in detail it has seemed preferable to rank countries on the basis of the sensitivity of their GNP and their consumer prices to different instruments. For each instrument countries were ranked in order of quantity and price impacts in the first and fifth year. The number of times that a country was given ranks 1-2-3, 4-5, or 6-7-8 was then counted. The results are given in Table 14.

Germany seems to have the greatest flexibility in response to policy instruments in that the impact is strongly differentiated, influencing mainly quantities in some cases, mainly prices in others. Belgium is very sensitive in respect to both quantity and price. France reacts strongly in the short run but weakly in the longer run. In Denmark and in the Netherlands the response of quantity variables is strong, that of price variables weak. Ireland, on the other hand, has been weak in quantity, but strong in price response, whereas in the United Kingdom the initial response of both prices and quantities is weak but inflationary forces become strong after a few years.

International Transmission of Economic Fluctuations

What light, finally, does the study shed on the problem of the international transmission of economic fluctuations? Here again we have tried to sift through the lengthy tables of multipliers to extract only the most interesting information.

A detailed examination of multipliers shows that the pattern of interdependence of EEC countries reflects fairly closely the structure of the trade shares matrix underlying the bilateral shares equations (see Table 3). It is thus not necessary to present the full table of cross-impacts between countries. It is more appropriate to concentrate on the important issue of the strength of linkages between countries, also discussed by Helliwell and

Table 14

A Rank Analysis of Sensitivity of GNP and Consumer Prices to Policy Instruments in Different EEC Countries

Country		First Year			Fifth Year		
		Ranks 1 to 3	Ranks 4 and 5	Ranks 6 to 8	Ranks 1 to 3	Ranks 4 and 5	Ranks 6 to 8
Germany	Q	2	4	0	2	2	2
	P	2	3	1	2	1	3
Belgium	Q	5	1	0	3	3	0
	P	2	4	0	1	5	0
Denmark	Q	3	2	1	4	0	2
	P	1	0	5	1	1	4
France	Q	4	0	2	1	3	2
	P	5	1	0	0	1	5
Ireland	Q	0	0	6	0	1	5
	P	4	1	1	6	0	0
Italy	Q	2	0	4	4	1	1
	P	4	1	1	4	1	1
The Netherlands	Q	2	4	0	3	2	1
	P	0	1	5	0	1	5
United Kingdom	Q	0	1	5	1	0	5
	P	0	1	5	4	1	1

Hickman. To what extent are our results comparable to those of Hickman using the LINK model?

Before presenting the results it is necessary to draw attention to differences between the two sets of results. LINK is a world model, whereas in Desmos the rest of the world is exogenous; this means that the latter model will tend to underestimate slightly the strength of linkages. In addition, the LINK results refer to the price index of GNP. This index may be distorted in curious ways by terms of trade changes, and we have preferred to look at consumer prices. The most important difference between the two studies is however that in the LINK system models with a very different structure are used, whereas the Desmos models have been made as comparable as possible. Judgment on the results of the calculation has therefore some bearing on the choice between linking models which reflect very different concepts of economic relationships, and models reflecting a uniform theoretical approach.

For both prices and quantities the Desmos pattern of linkages is much more uniform than implied by the LINK system. The LINK impacts of disturbances in Germany on GNP of other countries are much stronger than those computed using Desmos; for Belgium, France, Italy and the United Kingdom they are weaker. The Desmos multipliers imply a somewhat more strongly dynamic pattern of behavior than those of LINK. For prices the differences between the two sets of results are striking. This time it is the UK and Netherlands LINK models which affect most strongly those of other countries, either positively or negatively.

The Desmos results suggest that it is not true that the transmission of price impulses is weaker than the transmission of quantity impulses. The ratio of the price impact of a disturbance within a country to the average impact in other countries is in fact substantially greater for prices than for quantities. This is of course an important finding for understanding the origins of the present world-wide inflationary trends, and for an assessment of the ease with which individual countries could isolate themselves from world inflation.

THE MODEL AS A TOOL FOR THE COORDINATION OF ECONOMIC POLICIES

Can a model like Desmos, finally, fulfill its aim of clarifying negotiations on the coordination of economic policies? This is a question which can be answered only by an example. Using the dynamic multipliers of Desmos we examine the calculations which negotiators attempting to coordinate policies today might carry out as they seek to work out a balanced package of measures, which improves the situation of all countries and does not require the use of politically unacceptable policy instruments.

As negotiations start, representatives of the different countries might agree to general goals:

Table 15a

Desmos and Link Patterns of GNP Interdependence: A Comparison

(Percentage change of GNP of country in column induced by unit percentage income shock of country in row)

Country	Year	Germany		Belgium		France		Italy		United Kingdom	
		D	L	D	L	D	L	D	L	D	L
Germany	1	1.25	0.98	0.16	0.18	0.08	0.08	0.08	0.19	0.04	0.10
	3	1.56	1.20	0.28	0.66	0.14	0.21	0.16	0.81	0.08	0.53
Belgium	1	0.03	0.01	1.41	1.10	0.01	0.01	0.01	0.01	0.01	0.01
	3	0.03	0.02	1.39	0.86	0.03	0.01	0.02	0.02	0.01	0.02
France	1	0.07	0.04	0.13	0.08	1.46	1.21	0.05	0.07	0.03	0.04
	3	0.09	0.06	0.15	0.08	1.61	1.22	0.08	0.11	0.04	0.04
Italy	1	0.05	0.02	0.05	0.03	0.04	0.02	1.69	1.30	0.03	0.03
	3	0.09	0.05	0.10	0.05	0.08	0.04	2.37	1.80	0.05	0.08
United Kingdom	1	0.02	0.02	0.04	0.03	0.02	0.01	0.02	0.03	1.19	1.24
	3	0.04	0.04	0.07	0.05	0.03	0.02	0.04	0.08	1.29	1.51

(D = Desmos; L = Link)

Table 15b

Desmos and Link Patterns of Price Interdependence: A Comparison

(Percentage price change of country in column induced per unit percentage income shock of country in row. GNP or GDP price for Link results; private consumption prices for Desmos)

Country	Year	Germany D	Germany L	Belgium D	Belgium L	France D	France L	Italy D	Italy L	United Kingdom D	United Kingdom L
Germany	1	0.12	1.10	0.02	-0.02	0.05	0.01	0.01	-0.03	0.00	0.02
	3	0.63	2.38	0.10	-0.29	0.06	0.10	-0.14	0.00	0.03	-0.05
Belgium	1	0.00	0.02	0.11	0.07	0.02	0.00	0.00	0.00	0.00	0.00
	3	0.01	0.03	0.43	0.09	0.02	0.00	0.01	0.00	0.01	0.00
France	1	0.01	0.05	0.05	-0.01	0.87	-0.08	0.01	-0.01	0.00	-0.01
	3	0.03	0.08	0.08	0.03	0.87	-1.73	0.03	0.04	0.02	0.02
Italy	1	0.00	0.03	0.01	0.00	0.02	0.00	0.32	0.08	0.00	-0.01
	3	0.02	0.09	0.03	-0.01	0.03	-0.01	1.29	0.38	0.02	0.01
United Kingdom	1	0.00	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	0.08	-0.36
	3	0.01	0.11	0.04	-0.01	0.01	0.01	0.01	0.01	0.95	0.63

(D = Desmos; L = Link)

(a) an improvement of the French, Italian, and UK balances of payments;
(b) an unchanged basic balance of the EEC as a whole, because it is felt desirable to avoid worsening the position of the dollar and of other currencies;
(c) these goals imply a worsening of the balances of payments of Germany, the Netherlands, and Belgium;
(d) in general it is felt desirable to check demand and prices, but only to a moderate extent because of the danger of causing a grave recession;
(e) the French, Italian, and UK representatives convey the determination of their governments to improve their countries' situation; the representatives of other countries indicate that their governments are willing to go out of their way to facilitate the improvement of these three countries' situation.

Discussions around the table quickly show that the use of available instruments is hampered by institutional factors and taboos, and by some particular countries' dislike of particular types of policies. Thus:

(a) only France and Italy, because of their large public enterprise sectors (and because of the French planning process) are able to change exogenously their level of investment;
(b) in the United Kingdom there is strong prejudice against the import of labor from developing countries; such labor imports are also excluded in Ireland and Italy, which have large surpluses of agricultural labor to absorb;
(c) on the other hand John Bull seems to swallow tax and public expenditures changes with more equanimity than continental tax payers. In Italy the Government is so weak that restrictive fiscal policies cannot be envisaged;
(d) in Belgium revaluation is for obscure reasons blocked by a durable taboo. The French delegate indicates that President Giscard-d'Estaing has decided to use more orthodox policies than his predecessor;
(e) it is not practical to change interest rates by more than 1 percent without disrupting capital markets.

As the discussion proceeds, tentative agreement is gradually reached on a first set of policy measure. The units considered in the Table are:

Public expenditures	: percent of GNP
Taxes	: percent of GNP
Investment	: percent of GNP
Long-term interest rate	: percent
Import of labor	: percent of labor force
Revaluation	: percent

Table 16 gives the combined impact of the measures on targets of economic policy in each EEC country, except Luxemburg.

As the table shows, the result of this first round of policy coordination is obviously unsatisfactory. Belgium is exposed to sharp inflationary pressures. France's and Italy's growth are checked dramatically, and unemployment in these countries rises to politically unacceptable levels. The improvement of the UK balance of payments is felt to be insufficient by this country's negotiators.

This leads to agreement to a change of the initial package of measures. Table 16b documents the new modifications of instrument values, and the forecasts of the impacts on objectives.

As results of the second round are appraised, using the model results, negotiators are pleased to note that the impacts on policy objectives of countries are roughly as desired. The check to French and Italian growth is felt to be the inevitable price of a sounder economic situation; the more favorable UK situation is the reward of extremely austere policies. However, a US Government observer who has been invited to attend the meeting is quick to point out that the large improvement of the EEC balance of payments will be disastrous for his and for other nonmember countries. In fact, as he points out, such an improvement cannot be realized in a world of fluctuating exchange rates: the policies envisaged would lead to a 20 — 30 percent appreciation of EEC currencies versus the dollar.

A third round of modification is then put on the drawing board. Examination of the model's multipliers suggest that the balance-of-payments surplus can be eliminated without undue repercussions on other policy objectives by combining a 10 percent joint revaluation of EEC currencies, with a 1 percent increase in their public expenditures. The result is described in Table 16c.

The prospects suggested by this table are judged generally adequate. They can of course be improved by further refinement of the proposed policies, and I am sure that the dedicated negotiators of this imaginary example would continue to improve the package of measures until a completely satisfactory picture is obtained. In practice also they would not be content with ad hoc computations based on dynamic multipliers, but would want to solve the models for each proposed package of measures. We feel however that the description of these three iterations is enough to suggest how a model like Desmos can assist in working out coherent sets of policies, which reflect widely divergent situations and objectives of a number of countries.

Table 16a

First Round EEC Policy Coordination: Agreed Measures and Computed Effects

Measure	Government Expenditure	Taxes	Investment	Interest Rate	Labor Import	Revaluation %
Germany	+1				+1	+5
Belgium	+1			-1	+1	
Denmark						
France	-1		-1		+1	
Ireland				+1		
Italy			-2			-10
The Netherlands	+1				+1	+5
United Kingdom	-1			+1		-10

Effects in Different Years	GNP			Unemployment			Consumer Prices			Balance of Payments		
	1	3	5	1	3	5	1	3	5	1	3	5
Germany	0.07	0.02	-0.34	-0.08	0.99	0.94	-0.67	-1.63	-2.10	-0.50	-0.56	-0.55
Belgium	2.45	2.81	2.13	0.48	0.16	0.17	-0.17	-0.43	-0.56	-1.14	-1.64	-1.70
Denmark	-0.73	-0.69	-0.98	0.01	0.15	0.22	-0.10	-0.23	-0.44	-0.06	-0.11	-0.15
France	-2.09	-5.23	-8.44	1.24	4.85	8.27	-2.66	-3.17	-2.92	0.11	1.58	-2.76
Ireland	-0.26	-0.76	-0.61	0.04	0.26	0.48	-1.29	-1.59	-2.28	0.04	0.55	-0.24
Italy	-4.48	-4.74	-7.01	0.15	2.13	4.57	-0.14	-1.64	-4.08	1.42	3.53	5.36
The Netherlands	0.10	-0.22	-0.71	1.00	1.10	1.29	-1.44	-1.86	-2.23	-0.26	-0.57	-0.69
United Kingdom	1.10	-0.11	1.66	0.44	0.22	2.59	-0.10	-1.66	-6.18	1.02	0.51	0.88
Common Market	-0.24	-1.88	-3.07	0.16	1.51	2.57	-0.95	-1.73	-2.77	0.54	1.05	1.53

Table 16b

Second Round of EEC Policy Coordination: Modification of Agreed Measures and Computed Effects

Measure	Government Expenditure	Taxes	Investment	Interest Rate	Labor Import
Germany					
Belgium	-1			+0.5	+1
Denmark					
France			+1		-2
Ireland			(years 3 to 5)		
Italy			+1		
The Netherlands			(years 3 to 5)		
United Kingdom		-2			

Effects in Different Years	GNP			Unemployment			Consumer Prices			Balance of Payments		
	1	3	5	1	3	5	1	3	5	1	3	5
Germany	0.01	0.06	-0.04	0.98	0.99	0.94	-0.67	-1.64	-2.06	-0.53	-0.55	-0.45
Belgium	1.17	1.46	1.39	1.60	1.40	1.33	-0.40	-1.28	-1.69	-0.34	-0.68	-0.77
Denmark	-0.85	-0.83	-0.93	0.01	0.19	0.24	-0.07	-0.27	-0.54	-0.10	-0.08	-0.11
France	-3.30	-5.06	-5.42	0.33	3.16	4.54	-1.58	-0.98	-0.21	-0.13	0.92	1.28
Ireland	-0.45	-1.03	-0.78	0.06	0.38	0.68	-1.31	-1.83	-2.84	-0.06	0.45	0.16
Italy	-4.51	-3.57	-3.46	0.15	1.77	2.73	-0.14	-1.45	-2.82	1.42	3.02	3.72
The Netherlands	-0.01	0.02	-0.41	1.00	1.12	1.33	-1.43	-1.93	-2.32	-0.34	-0.56	-0.55
United Kingdom	0.19	-1.72	0.29	0.58	0.79	3.49	0.04	-2.17	-7.68	1.43	1.43	2.12
Common Market	-0.87	-2.08	-2.05	0.49	1.35	1.80	-0.43	-1.26	-2.03	0.55	0.95	1.10

Table 16c

Third Round of EEC Policy Coordination: Modification of Agreed Measures and Computed Effects

Measure	Government Expenditure	Revaluation
Germany	1	10
Belgium	1	10
Denmark	1	10
France	1	10
Ireland	1	10
Italy	1	10
The Netherlands	1	10
United Kingdom	1	

Effects in Different Years	GNP			Unemployment			Consumer Prices			Balance of Payments		
	1	3	5	1	3	5	1	3	5	1	3	5
Germany	-0.95	-0.64	-0.68	1.05	1.15	1.18	-0.74	-1.77	-2.16	-1.34	-1.36	-1.26
Belgium	0.21	0.76	0.89	1.76	1.88	1.91	-2.35	-3.20	-3.48	-1.55	-0.59	-0.53
Denmark	-1.16	-0.02	0.30	0.05	0.18	0.12	-2.18	-2.28	-2.05	-0.55	-0.81	-0.93
France	-3.67	-5.36	-5.80	-0.45	3.79	5.33	-2.04	-1.39	-0.68	-0.60	0.35	0.61
Ireland	-0.06	-0.36	0.05	0.05	0.28	0.39	-4.08	-4.32	-4.58	-0.55	0.00	-0.07
Italy	-4.43	-3.07	-2.86	0.12	1.72	2.62	-0.05	-0.93	-1.72	0.72	1.97	2.35
The Netherlands	-1.26	-1.12	-1.64	1.08	1.33	1.67	-3.02	-3.55	-3.86	-0.85	-1.24	-1.24
United Kingdom	-0.57	-2.55	-1.07	0.68	1.04	4.06	0.03	-1.64	5.01	0.39	1.66	1.06
Common Market	-1.47	-2.51	-2.58	0.61	1.60	2.17	-0.78	-1.46	-1.69	-0.14	0.16	0.23

CONCLUSION

This paper has described a model the aims of which are not so much methodological as practical. The model is meant to represent and quantify commonly accepted beliefs about macroeconomic interrelationships, by using an equation system whose properties are carefully documented. Such a model, it is felt, would be a useful tool in negotiations on the coordination of economic policies. The study does make two methodological contributions. It is the first to apply to a set of countries the Coen-Hickman specification, which ensures consistency of labor and capital demand equations with a single underlying production function. The trade linkage system used also innovates in incorporating the influence of pressure of demand and production capacity effects on exports.

The model, finally, represents a useful point of departure for further research because it has been kept simple and highly manageable. It should prove possible to use it in the future as the centerpiece of a more complex linked system, taking into account financial, labor, and other linkages between countries, or for experiments with alternative explanations of inflation or economic instability.

Appendix I

Factor Demand Block

Demand for Fixed Capital

Germany

$$CAPA = \underset{(0.009)}{10^{0.1086}} \left(PIBCFA_{-1}\right)^{\underset{(0.0062)}{0.0491}} \left(\frac{CCAPA_{-1}}{WA_{-1}}\right)^{\underset{(0.0064)}{-0.0481}}$$

$$\left(10^{\underset{(0.00010)}{-0.00053\ TEMPS}}\right) \cdot \left(CAPA_{-1}\right)^{\underset{(0.018)}{0.937}} + VEXA$$

$$VA = CAPA - 0.935\ CAPA_{-1}$$

$\bar{R}^2 = 0.999$
DW = 1.97

Belgium

$$CAPB = \underset{(0.072)}{10^{0.133}} \cdot \left[0.75\ PIBCFB + 0.25\ PIBCFB_{-1}\right]^{\underset{(0.036)}{0.122}} \cdot$$

$$\left[0.5\left(\frac{CCAPB}{WB}\right) + \left(\frac{0.5\ CCAPB_{-1}}{WB_{-1}}\right)\right]^{\underset{(0.026)}{-0.105}} \cdot \left(10^{\underset{(0.0004)}{-0.0012TEMPS}}\right)$$

$$\cdot \left(CAPB_{-1}\right)^{\underset{(0.138)}{0.872}} + VEXB$$

$$VB = CAPB - 0.916\ CAPB_{-1}$$

$\bar{R}^2 = 0.992$
DW = 2.24

Denmark

$$CAPD = \underset{(0.029)}{10^{0.0824}} \cdot \left(PIBCFD\right)^{\underset{(0.055)}{0.111}} \cdot \left(\frac{CCAPD_{-1}}{WD_{-1}}\right)^{\underset{(0.044)}{-0.090}}$$

$$\left(10^{\underset{(0.0005)}{-0.0011\ TEMPS}}\right) \cdot \left(CAPD_{-1}\right)^{\underset{(0.056)}{0.889}} + VEXD$$

$$VD = CAPD - 0.93\ CAPD_{-1}$$

$\bar{R}^2 = 0.990$
DW = 1.79

France

$$CAPF = \underset{(0.005)}{10^{0.055}}\ (PIBCFF)^{\underset{(0.011)}{0.044}} \left(\frac{CCAPF_{-1}}{WF_{-1}}\right)^{\underset{(0.009)}{-0.038}}$$

$$(\underset{(0.00011)}{10^{-0.00045\ TEMPS}}) \cdot (CAPF_{-1})^{\underset{(0.266)}{0.956}} + VEXF$$

$$VF = CAPF - 0.931\ CAPF_{-1}$$

$\bar{R}^2 = 0.968$
$DW = 1.74$

Ireland

$$CAPE = VE + 0.93\ CAPE_{-1}$$

$$VE = \underset{(17.902)}{-101.677} + \underset{(0.107)}{0.140} \left(\frac{\Delta PIBVE}{CCAPE}\right)_{-1} + \underset{(0.106)}{0.200} \left(\frac{\Delta PIBVE}{CCAPE}\right)_{-2}$$

$$+ \underset{(0.015)}{0.201}\ CAPE_{-1} + VEXE$$

$\bar{R}^2 = 0.947$
$DW = 1.48$

Italy

$$CAPI = \underset{(0.028)}{10^{0.139}} \left[0.75\ PIBCFI + 0.25\ PIBCFI_{-1}\right]^{\underset{(0.034)}{0.124}}$$

$$\left[0.5\ \frac{CCAPI}{WI} + 0.5\ \frac{CCAPI_{-1}}{WI_{-1}}\right]^{\underset{(0.030)}{-0.109}} (\underset{(0.0001)}{10^{-0.0014\ TEMPS}})$$

$$\cdot (CAPI_{-1})^{\underset{(0.019)}{0.857}} + VEXI$$

$\bar{R}^2 = 0.999$
$DW = 1.61$

Luxemburg

$$VL = PNBL - CL - GL - DSTL - XBSL + BSML$$

Netherlands

$$CAPN = \underset{(0.036)}{10^{0.082}}\ (PIBCFN)^{\underset{(0.026)}{0.041}} \left(\frac{CCAPN_{-1}}{WN_{-1}}\right)^{\underset{(0.023)}{-0.035}}$$

$$(\underset{(0.00020)}{10^{-0.00034\ TEMPS}}) \cdot (CAPN_{-1})^{\underset{(0.039)}{0.943}} + VEXN$$

$$VN = CAPN - 0.934\ CAPN_{-1}$$

$\bar{R}^2 = 0.997$
$DW = 1.52$

United Kingdom

$$CAPU = \underset{(0.049)}{10^{0.112}}\ (PIBCFU_{-1})^{\underset{(0.022)}{0.092}} \left(\frac{CCAPU_{-1}}{WU_{-1}}\right)^{\underset{(0.021)}{-0.083}}$$

$$(\underset{(0.0004)}{10^{-0.0009\ TEMPS}}) \cdot (CAPU_{-1})^{\underset{(0.142)}{0.900}} + VEXU$$

$$VU = CAPU - 0.930\ CAPU_{-1}$$

$\bar{R}^2 = 0.986$
$DW = 2.10$

EEC total

$$VT = VA/4.0 + VB/50 + VD/6.90714$$
$$+ VF/4.93706 + VE/357.143 + VI/0.625$$
$$+ VL/50 + VN/3.62 + VU/0.357143$$

Demand for Labor

Germany

$$EMPA = \underset{(0.469)}{10^{0.333}}\ PIBCFA^{\underset{(0.008)}{0.098}} \left(\frac{CCAPA}{WA}\right)^{\underset{(0.006)}{0.030}} \underset{(0.0002)}{10^{-0.0011\ TEMPS}}\ EMPA_{-1}^{\underset{(0.106)}{0.874}}$$

$$CHA = POPACA - EMPA$$

$\bar{R}^2 = 0.94$
$DW = 2.28$

Belgium

$$EMPB = 10^{0.433}\ PIBCFB^{0.318}\left(\frac{CCAPB}{WB}\right)^{0.086}\ 10^{-0.0031\ TEMPS}\ EMPB_{-1}^{0.638}$$
(0.152) (0.052) (0.030) (0.001) (0.119)

$$CHB = POPACB - EMPB$$

$\bar{R}^2 = 0.98$
DW = 2.11

Denmark

$$EMPD = 10^{0.277}\ PIBCFD^{0.156}\left(\frac{CCAPD}{WD}\right)^{0.030}\ 10^{-0.0015\ TEMPS}\ EMPD_{-1}^{0.844}$$
(0.167) (0.096) (0.029) (0.0009) (0.097)

$$CHD = POPACD - EMPD$$

$\bar{R}^2 = 0.93$
DW = 1.69

France

$$EMPF = 10^{1.474}\ PIBCFF^{0.740}\left(\frac{CCAPF}{WF}\right)^{0.104}\ 10^{-0.0076\ TEMPS}\ EMPF_{-1}^{0.257}$$
(0.402) (0.203) (0.028) (0.0004) (0.102)

$$CHF = POPACF - EMPF$$

$\bar{R}^2 = 0.90$
DW = 1.85

Ireland

$$EMPE = 10^{0.077}\ PIBCFE^{0.243}\ CAPE^{-0.071}\ 10^{-0.0021\ TEMPS}\ EMPE_{-1}^{0.828}$$
(0.019) (0.043)

$$CHE = POPACE - EMPE$$

$\bar{R}^2 = 0.93$
DW = 1.88

Italy

$$EMPI = 10^{1.945}\ PIBCFI^{0.522}\left(\frac{CCAPI_{-1}}{WI_{-1}}\right)^{0.142}\ 10^{-0.0056\ TEMPS}\ EMPI_{-1}^{0.402}$$
(1.134) (0.300) (0.099) (0.0007) (0.283)

$$CHI = POPACI - EMPI$$

$\bar{R}^2 = 0.79$
DW = 1.99

The Netherlands

$$EMPN = 10^{0.3279}\ PIBCFN^{0.118}\ CAPN^{-0.066}\ 10^{-0.00098\ TEMPS}\ EMPN_{-1}^{0.90}$$
(0.634) (0.020)

$$CHN = POPACN - EMPN$$

$\bar{R}^2 = 0.93$
DW = 1.83

United Kingdom

$$EMPU = 10^{1.388}\ PIBCFU^{0.402}\left(\frac{CCAPU}{WU}\right)^{0.076}\ 10^{-0.0039\ TEMPS}\ EMPU_{-1}^{0.563}$$
(0.791) (0.125) (0.042) (0.0014) (0.194)

$$CHU = POPACU - EMPU$$

$$EMPT = EMPA + EMPB + EMPD + EMPF + EMPE + EMPI + EMPN + EMPU$$

$\bar{R}^2 = 0.94$
DW = 2.49

Potential GNP, Pressure of Demand

$$YPOTi = (CiPOPACi^{ai}\ CAPi^{bi}\ e^{-giTEMPS}) / VBYi\ 1963$$
$$TENSi = (PIBCFi/VBYi \cdot YPOTi)$$

where VBYi = stochastic term of production function computed as a residual

Income Expenditures Block
Consumption Functions

Germany

$$CA = 8.577 + 0.542\ YDA + 0.344\ CA_{-1}$$
(1.474) (0.070) (0.081)

$\bar{R}^2 = 0.998$
DW = 1.67

Belgium

$$CB = 57.115 + 0.667\ YDB + 0.115\ CB_{-1}$$
(20.229) (0.169) (0.244)

$\bar{R}^2 = 0.995$
DW = 2.24

Denmark $CD = -0.787 + 0.580\ YDD + 0.396\ CD_{-1}$
(0.502) (0.083) (0.098)

$\bar{R}^2 = 0.996$
$DW = 1.84$

France $CF = 16.220 + 0.593\ YDF + 0.286\ CF_{-1}$
(2.169) (0.059) (0.076)

$\bar{R}^2 = 0.999$
$DW = 1.66$

Ireland $CE = 56.472 + 0.711\ YDE + 0.124\ CE_{-1}$
(19.804) (0.114) (0.156)

$\bar{R}^2 = 0.994$
$DW = 2.28$

Italy $CI = 0.706 + 0.431\ YDI + 0.470\ CI_{-1}$
(0.353) (0.127) (0.174)

$\bar{R}^2 = 0.997$
$DW = 1.82$

Luxemburg $CL = -0.132 + 0.595\ YDL + 0.355\ CL_{-1}$
(1.289) (0.217) (0.215)

$\bar{R}^2 = 0.974$
$DW = 1.51$

The Netherlands
$CN = 1.730 + 0.507\ YDN + 0.371\ CN_{-1}$
(0.446) (0.103) (0.140)

$\bar{R}^2 = 0.996$

$DW = 2.06$

United Kingdom
$CU = 1.610 + 0.455\ YDU + 0.443\ CU_{-1}$
(0.322) (0.104) (0.124)

$\bar{R}^2 = 0.997$
$DW = 1.71$

Disposable Income, Current Price

Germany $YDVA = 7.967 + 0.650\ PNBVA - YDEXA$
(1.695) (0.024)

$\bar{R}^2 = 0.979$
$DW = 1.80$

Belgium $YDVB = 22.256 + 0.721\ PNBVB - YDEXB$
(3.470) (0.005)

$\bar{R}^2 = 0.999$
$DW = 2.02$

Denmark $YDVD = 3.660 + 0.648\ PNBVD - YDEXD$
(2.051) (0.009)

$\bar{R}^2 = 0.997$
$DW = 2.25$

France $YDVF = 4.401 + 0.680\ PNBVF - YDEXF$
(1.355) (0.006)

$\bar{R}^2 = 0.997$
$DW = 1.57$

Ireland $YDVE = 49.400 + 0.736\ PNBVE - YDEXE$
(4.146) (0.005)

$\bar{R}^2 = 0.999$
$DW = 1.98$

Italy $YDVI = -0.016 + 0.775\ PNBVI - YDEXI$
(0.160) (0.009)

$\bar{R}^2 = 0.998$
$DW = 1.80$

Luxemburg $YDVL = -1.040 + 0.716\ PNBVL - YDEXL$
(0.923) (0.029)

$\bar{R}^2 = 0.987$
$DW = 1.83$

The Netherlands

$$YDVN = -0.484 + 0.683\ PNBVN - YDEXN$$
$$(0.242)\ \ (0.009)$$

$\bar{R}^2 = 0.997$
DW = 1.61

United Kingdom

$$YDVU = 0.425 + 0.672\ PNBVU - YDEXU$$
$$(0.255)\ \ (0.008)$$

$\bar{R}^2 = 0.998$
DW = 1.90

Disposable Income, Constant Price

$$YDi = 100\ YDVi/PCi$$

Inventory Change

$$DSTi = a + 0.1\ (PNBi - PNBi_{-1})$$

$$DSTT = DSTA/4.0 + (DSTB + DSTL)/50.0 + DSTD/6.90714 + DSTF/4.93706 + DSTE/357.143 + DSTI/0.625 + DSTN/3.62 + DSTU/0.357143$$

Expenditure Identities

$$PNBi = Ci + Gi + Vi + DSTi + XBSi - BSMi$$

$$PNBVi = (PCi.Ci + PGi.Gi + PVi.Vi + Pi.DSTi + PXi.XBSi - PMi.BSMi)/100$$

$$PIBVi = PNBVi + VAEXVi$$

$$PIBCFi = (PIBVi - TinDVi + SUBVi)/(Pi/100)$$

(except Luxemburg)

$$PNBL = (10^{\underset{(0.065)}{0.410}})\ \ PNBT^{\underset{(0.025)}{0.730}}$$

$\bar{R}^2 = 0.986$
DW = 1.80

$$PNBVL = PNBL\ .\ (PL/100)$$

Wage Price Block

Wages

Germany

$$WA = WA_{-1}\ \underset{(0.453)}{(0.390} + \underset{(3.862)}{13.966/CHA} + \underset{(0.443)}{0.606(PCA/PCA_{-1})})$$

$\bar{R}^2 = 0.600$
DW = 1.76

Belgium

$$WB = WB_{-1}\ \underset{(0.262)}{(0.549} + \underset{(1.006)}{6.358/CHB} + \underset{(0.264)}{0.439(PCB/PCB_{-1})})$$

$\bar{R}^2 = 0.861$
DW = 1.85

Denmark

$$WD = WD_{-1}\ \underset{(0.389)}{(0.431} + \underset{(0.521)}{1.137/CHB} + \underset{(0.382)}{0.604(PCD/PCD_{-1})})$$

$\bar{R}^2 = 0.511$
DW = 2.24

France

$$WF = WF_{-1}\ \underset{(0.174)}{(0.494} \underset{(0.020)}{-0.021(CHF/CHF_{-1})} + \underset{(0.168)}{0.581(PCF/PCF_{-1})})$$

$\bar{R}^2 = 0.490$
DW = 1.54

Ireland

$$WE = WE_{-1}\ \underset{(0.307)}{(0.038} + \underset{(3.086)}{7.552/CHE} + \underset{(0.309)}{0.878\ (PCE/PCE_{-1})})$$

$\bar{R}^2 = 0.561$
DW = 2.35

Italy

$$WI = WI_{-1}\ \underset{(0.022)}{(0.933} + \underset{(35.222)}{105.904/CHI})$$

$\bar{R}^2 = 0.424$
DW = 1.77

The Netherlands

$$WN = WN_{-1}\ (0.337 + 1.307/CHN + 0.709(PCN/PCN_{-1}))$$
$$(0.307)\quad (0.288)\qquad (0.288)$$

$\bar{R}^2 = 0.297$
DW = 2.10

United Kingdom

$$WU = WU_{-1}\ (0.274 + 5.306/CHU + 0.733(PCU/PCU_{-1}))$$
$$(0.181)\quad (2.497)\qquad (0.176)$$

$\bar{R}^2 = 0.589$
DW = 1.75

Total EEC

$$WT = (WA.EMPA + WB.EMPB + WD.EMPD + WF.EMPF + WE.EMPE + WI.EMPI + WN.EMPN + WU.EMPU)/EMPT$$

Private Consumption Prices

Germany

$$PCA = PCA_{-1}\ (0.582 + 0.418\ WA/WA_{-1})$$
$$(0.108)\quad (0.093)$$

$\bar{R}^2 = 0.534$
DW = 1.37

Belgium

$$PCB = PCB_{-1}(0.406 + 0.307\ WB/WB_{-1} + 0.287\ PMB/PMB_{-1})$$
$$(0.409)\quad (0.115)\qquad (0.233)$$

$\bar{R}^2 = 0.322$
DW = 1.68

Denmark

$$PCD = PCD_{-1}(0.554 + 0.269\ WD/WD_{-1} + 0.193\ PMD/PMD_{-1})$$
$$(0.117)\quad (0.117)\qquad (0.111)$$

$\bar{R}^2 = 0.465$
DW = 1.84

France

$$PCF = PCF_{-1}(0.151 + 0.849\ WF/WF_{-1})$$
$$(0.254)\quad (0.236)$$

$\bar{R}^2 = 0.470$
DW = 1.86

Ireland

$$PCE = PCE_{-1}(0.250 + 0.436\ WE/WE_{-1} + 0.317\ PME/PME_{-1})$$
$$(0.130)\quad (0.109)\qquad (0.156)$$

$\bar{R}^2 = 0.803$
DW = 2.58

Italy

$$PCI = PCI_{-1}(0.505 + 0.495\ WI/WI_{-1})$$
$$(0.061)\quad (0.070)$$

$\bar{R}^2 = 0.692$
DW = 2.05

Luxemburg

$$PCL = PCL_{-1}(0.164 + 0.901\ PCT/PCT_{-1})$$
$$(0.110)\quad (0.408)$$

$\bar{R}^2 = 0.405$
DW = 1.80

The Netherlands

$$PCN = PCN_{-1}(0.327 + 0.482\ WN/WN_{-1} + 0.191\ PMN/PMN_{-1})$$
$$(0.313)\quad (0.244)\qquad (0.166)$$

$\bar{R}^2 = 0.236$
DW = 1.45

United Kingdom

$$PCU = PCU_{-1}(0.320 + 0.680\ WU/WU_{-1})$$
$$(0.101)\quad (0.184)$$

$\bar{R}^2 = 0.489$
DW = 1.80

Total EEC

$$PCT = [PCA(CA/4) + PCB(CB/50) + PCL(CL/50) + PCD(CD/6.90714) + PCF(CF/4.93706) + PCE(CE/357.143) + PCI(CI/0.625) + PCN(CN/3.62) + PCU(CU/0.357143)]/CT$$

Public Consumption Prices

Germany

$$PGA = PGA_{-1}(0.287 + 0.713\ WA/WA_{-1})$$
$$(0.101)\ \ (0.132)$$

$\bar{R}^2 = 0.225$
DW = 1.32

Belgium

$$PGB = PGB_{-1}(0.301 + 0.219\ WB/WB_{-1} + 0.480\ PGB_{-1}/PGB_{-2})$$
$$(0.061)\qquad\qquad (0.160)$$

$\bar{R}^2 = 0.663$
DW = 2.02

Denmark

$$PGD = PGD_{-1}(0.201 + 0.797\ WD/WD_{-1})$$
$$(0.220)\ \ (0.202)$$

$\bar{R}^2 = 0.491$
DW = 2.17

France

$$PGF = PGF_{-1}(0.197 + 0.802\ WF/WF_{-1})$$
$$(0.276)\ \ (0.339)$$

$\bar{R}^2 = 0.254$
DW = 1.83

Ireland

$$PGE = PGE_{-1}(0.313 + 0.688\ WE/WE_{-1})$$
$$(0.223)\ \ (0.229)$$

$\bar{R}^2 = 0.362$
DW = 1.59

Italy

$$PGI = PGL_{-1}(0.322 + 0.690\ WI/WL_{-1})$$
$$(0.147)\ \ (0.137)$$

$\bar{R}^2 = 0.617$
DW = 1.79

The Netherlands

$$PGN = PGN_{-1}(0.292 + 0.718\ WN/WN_{-1})$$
$$(0.250)\ \ (0.187)$$

$\bar{R}^2 = 0.512$
DW = 1.36

United Kingdom

$$PGU = PGU_{-1}(0.283 + 0.734\ WU/WU_{-1})$$
$$(0.189)\ \ (0.181)$$

$\bar{R}^2 = 0.507$
DW = 2.09

Price of Gross Fixed Capital Formation

Germany

$$PVA = PVA_{-1}(0.264 + 0.538\ WA/WA_{-1} + 0.181\ PMA_{-1}/PMA_{-2})$$
$$(0.120)\ \ (0.106)\qquad\qquad (0.075)$$

$\bar{R}^2 = 0.671$
DW = 2.25

Belgium

$$PVB = PVB_{-1}(0.203 + 0.592\ WB/WB_{-1} + 0.228\ PMB/PMB_{-1})$$
$$(0.107)\ \ (0.191)\qquad\qquad (0.133)$$

$\bar{R}^2 = 0.381$
DW = 1.68

Denmark

$$PVD = PVD_{-1}(0.314 + 0.370\ WD/WD_{-1} + 0.314\ PMD/PMD_{-1})$$
$$(0.088)\ (0.076)\qquad\qquad (0.079)$$

$\bar{R}^2 = 0.810$
DW = 1.97

France

$$PVF = PVF_{-1}\,(-0.073 + 0.595\ WF/WF_{-1} + 0.478\ PMF/PMF_{-1})$$
$$(0.283)\quad (0.238)\qquad\qquad (0.173)$$

$\bar{R}^2 = 0.486$
DW = 1.60

Ireland

$$PVE = PVE_{-1}\,(0.381 + 0.364\ WE/WE_{-1} + 0.257\ PME/PME_{-1})$$
$$(0.197)\quad (0.137)\qquad\qquad (0.170)$$

$\bar{R}^2 = 0.404$
DW = 1.85

Italy

$$PVI = PVI_{-1}(0.415 + 0.373\ WI/WI_{-1} + 0.213\ PMI/PML_{-1})$$
$$(0.085)\quad (0.062)\qquad\qquad (0.091)$$

$\bar{R}^2 = 0.795$
DW = 1.49

The Netherlands

$$PVN = PVN_{-1}(0.270 + 0.435\ WN/WN_{-1} + 0.294\ PMN/PMN_{-1})$$
$$(0.345)\quad (0.209)\qquad\qquad (0.184)$$

$\bar{R}^2 = 0.235$
DW = 1.57

United Kingdom

$$PVU = PVU_{-1}(0.107 + 0.878\ WU/WU_{-1})$$
$$(0.202)\quad (0.197)$$

$\bar{R}^2 = 0.567$
DW = 1.87

Export Prices in National Currency

Germany

$$PXA = PXA_{-1}(0.260 + 0.322\ WA/WA_{-1} + 0.398\ PMA/PMA_{-1})$$
$$(0.071)\quad (0.050)\qquad\qquad (0.063)$$

$\bar{R}^2 = 0.909$
DW = 2.43

Belgium

$$PXB = PXB_{-1}(0.198 + 0.451\ WB/WB_{-1} + 0.351\ PMB/PMB_{-1})$$
$$(0.222)\quad (0.229)\qquad\qquad (0.151)$$

$\bar{R}^2 = 0.516$
DW = 1.54

Denmark

$$PXD = PXD_{-1}(0.385 + 0.213\ WD/WD_{-1} + 0.394\ PMD/PMD_{-1})$$
$$(0.219)\quad (0.187)\qquad\qquad (0.196)$$

$\bar{R}^2 = 0.303$
DW = 2.18

France

$$PXF = PXF_{-1}(-0.267 + 0.615\ WF/WF_{-1} + 0.617\ PMF/PMF_{-1})$$
$$(0.176)\quad (0.189)\qquad\qquad (0.260)$$

$\bar{R}^2 = 0.547$
DW = 1.81

Ireland

$$PXE = PXE_{-1}(0.016 + 0.473\ WE/WE_{-1} + 0.494\ PME/PME_{-1})$$
$$(0.173)\quad (0.142)\qquad\qquad (0.205)$$

$\bar{R}^2 = 0.665$
DW = 1.35

Italy

$$PXI = PXI_{-1}(0.095 + 0.137\ WI/WI_{-1} + 0.756\ PMI/PMI_{-1})$$
$$(0.140)\quad (0.057)\qquad\qquad (0.161)$$

$\bar{R}^2 = 0.830$
DW = 2.13

The Netherlands

$$PXN = PXN_{-1}(0.206 + 0.302\ WN/WN_{-1} + 0.498\ PMN/PMN_{-1})$$
$$(0.131)\quad (0.093)\qquad\qquad (0.107)$$

$\bar{R}^2 = 0.535$
DW = 2.23

United Kingdom

$$PXU = PXU_{-1}(-0.193 + 0.663\ WU/WU_{-1} + 0.511\ PMU/PMU_{-1})$$
$$(0.094)\quad (0.149)\qquad\qquad (0.068)$$

$\bar{R}^2 = 0.911$
DW = 2.04

Dollar Export Prices

$$PXCi = ((PXI/100) \cdot REVALi) \cdot AJPXi$$

Other Prices

$$PDIi = \frac{PCi \cdot Ci + PVi \cdot Vi + PGi \cdot Gi + Pi \cdot DSTi}{(Ci + Gi + Vi + DSTi)}$$

$$Pi = 100(PNBVi/PNBi)$$

Except Luxemburg:

$$PL = \underset{(0.083)}{PL_{-1}}(\underset{}{0.005} + \underset{(0.301)}{0.620}.PCT/PCT_{-1} + \underset{(0.308)}{0.337}PL_{-1}/PL_{-2})$$

$\bar{R}^2 = 0.60$
DW = 2.49

$$CCAPi = PVi\ (RLi + di)/1000$$

$$PXCT = \sum_{i\ (i\ \epsilon\ EEC)} (PXC_i \cdot XBT_i)/(WT - XBTR)$$

$$PMCT = \sum_{i\ (i\ \epsilon\ EEC)} (PMC_i \cdot BM_i)/WT - BMR)$$

Linkage Block

Goods and Services Imports

Germany

$$BSMA = \underset{(0.127)}{10^{-0.594}}\ DMA^{\underset{(0.070)}{1.360}} \left(\frac{PMA}{PDIA}\right)^{\underset{(0.118)}{-0.574}}$$

$\bar{R}^2 = 0.999$
DW = 1.92

Belgium

$$BSMB = \underset{(0.157)}{10^{-0.599}}\ DMB^{\underset{(0.066)}{1.264}} \left(\frac{PMB}{PDIB}\right)^{\underset{(0.171)}{-0.325}}$$

$\bar{R}^2 = 0.996$
DW = 2.28

Denmark

$$BSMD = \underset{(0.129)}{10^{-0.353}}\ DMD^{\underset{(0.097)}{1.211}} \left(\frac{PMD}{PDID}\right)^{\underset{(0.145)}{-0.401}}$$

$\bar{R}^2 = 0.997$
DW = 2.22

France

$$BSMF = \underset{(0.053)}{10^{-0.565}}\ DMF^{\underset{(0.038)}{1.415}} \left(\frac{PMF}{PDIF}\right)^{\underset{(0.302)}{-0.450}}$$

$\bar{R}^2 = 0.993$
DW = 1.90

Ireland

$$BSME = \underset{(0.507)}{10^{-1.588}}\ DME^{\underset{(0.206)}{1.606}} \left(\frac{PME}{PDIE}\right)^{\underset{(0.403)}{-0.316}}$$

$\bar{R}^2 = 0.937$
DW = 1.99

Italy

$$BSMI = \underset{(0.058)}{10^{-0.224}}\ DMI^{\underset{(0.101)}{1.501}} \left(\frac{PMI}{PDII}\right)^{\underset{(0.274)}{-0.550}}$$

$\bar{R}^2 = 0.962$
DW = 1.77

Luxemburg

$$BSML = \underset{(0.043)}{10^{-0.673}}\ (PNBL + BSML)^{\underset{(0.024)}{1.191}}$$

$\bar{R}^2 = 0.994$
DW = 1.82

The Netherlands

$$BSMN = \underset{(0.040)}{10^{-0.158}}\ DMN^{\underset{(0.026)}{1.102}} \left(\frac{PMN}{PDIN}\right)^{\underset{(0.258)}{-0.430}}$$

$\bar{R}^2 = 0.996$
DW = 1.59

United Kingdom

$$BSMU = \underset{(0.161)}{10^{-0.327}}\ \underset{(0.091)}{DMU^{1.431}}\ \underset{(0.357)}{\left(\frac{PMU}{PDIU}\right)^{-0.466}}$$

$\bar{R}^2 = 0.963$
DW = 1.43

Total EEC

$$BSMT = BSMA/4.0 + BSMB/50 + BSMD/6.90714 + BSMF/4.93706 + BSME/357.143 + BSMI/0.625 + BSMN/3.62 + BSMU/0.357143$$

$DMi = a_{1i}\,Ci + a_{2i}\,Gi + a_{3i}\,Vi + a_{4i}\,DSTi + a_{5i}\,XBSi$

where a_{ji} = import content of demand component j, whose numerical values are given in the following table.

Import Contents of Final Demand

	Private Consumption	Public Consumption	Gross Fixed Capital Formation	Change Inventories	Export Goods Services
Germany	0.172	0.134	0.151	0.213	0.156
Belgium	0.289	0.120	0.410	0.460	0.371
Denmark	0.315	0.140	0.430	0.560	0.340
France	0.119	0.060	0.170	0.130	0.125
Ireland	0.340	0.160	0.450	0.660	0.370
Italy	0.141	0.038	0.176	0.295	0.163
The Netherlands	0.337	0.162	0.450	0.662	0.312
United Kingdom	0.170	0.088	0.143	0.200	0.229

Goods Imports

Germany

$$BMA = \underset{(2.370)}{(-1.671} + \underset{(0.025)}{0.736}\ BSMA)/4.0$$

$\bar{R}^2 = 0.989$
DW = 1.41

Belgium

$$BMB = \underset{(5.496)}{(25.621} + \underset{(0.016)}{0.695}\ BSMB)/50$$

$\bar{R}^2 = 0.995$
DW = 1.73

Denmark

$$BMD = \underset{(0.279)}{(2.571} + \underset{(0.012)}{0.680}\ BSMD)/6.90714$$

$\bar{R}^2 = 0.997$
DW = 2.03

France

$$BMF = \underset{(2.284)}{(4.637} + \underset{(0.030)}{0.669}\ BSMF)/4.93706$$

$\bar{R}^2 = 0.982$
DW = 1.56

Ireland

$$BME = \underset{(15.290)}{(11.680} + \underset{(0.034)}{0.797}\ BSME)/357.143$$

$\bar{R}^2 = 0.983$
DW = 2.19

Italy

$$BMI = \underset{(0.108)}{0.508} + \underset{(0.016)}{0.712}\ BSMI)/0.625$$

$\bar{R}^2 = 0.995$
DW = 1.76

Luxemburg

$$BML = (6.259 + 0.654\ BSML)/50$$
$$(0.875)\ (0.032)$$

$\bar{R}^2 = 0.972$
DW = 1.43

The Netherlands

$$BMN = (1.529 + 0.819\ BSMN)/3.62$$
$$(0.693)\ (0.019)$$

$\bar{R}^2 = 0.995$
DW = 1.79

United Kingdom

$$BMU = (-0.492 + 0.756\ BSMU)/0.357143$$
$$(0.254)\ (0.021)$$

$\bar{R}^2 = 0.993$
DW = 1.43

BLEU (Belgium and Luxemburg)

$$BMBL = (BMB + BML)/TUEBL$$

Bilateral Trade Flows

$$(XBij - \overset{\circ}{aij}\ BMj) = -1.584\ \overset{\circ}{XBij}\ (PXCi - PMCj)$$
$$(0.176)$$
$$+ 1.011\ \overset{\circ}{XBij}\ (YPOTi - YPOTMj)$$
$$(0.080)$$
$$- 0.945\ \overset{\circ}{XBij}\ (TENSi - TENSMj)$$
$$(0.322)$$
$$+ 0.082\ \overset{\circ}{XBij}\ .\ BCEEI_{ij}$$
$$(0.020)$$
$$- 0.037\ \overset{\circ}{XBij}\ \cdot\ BAELEI_{ij} + 0.006\ \overset{\circ}{XBij}.BCEEX_{ij}$$
$$(0.023) \qquad (0.009)$$
$$- 0.050\ \overset{\circ}{XBij}.BAELEX_{ij}$$
$$(0.011)$$

$\bar{R}^2 = 0.406$

Exports of Services

Germany

$$XSA = 6.532 + 0.138\ (4.0\ XBTA)$$
$$(0.973)\ (0.010)$$

$\bar{R}^2 = 0.742$
DW = 2.50

Belgium

$$XSB = -1.500 + 0.192\ (.50\ XBTB)$$
$$(4.301)\ (0.012)$$

$\bar{R}^2 = 0.984$
DW = 1.41

Denmark

$$XSD = -0.516 + 0.354\ (.691\ XBTD)$$
$$(0.381)\ (0.023)$$

$\bar{R}^2 = 0.969$
DW = 1.73

France

$$XSF = -12.788 + 0.245\ (4.94\ XBTF)$$
$$(2.570)\ (0.045)$$

$\bar{R}^2 = 0.959$
DW = 1.29

Ireland

$$XSE = 76.034 + 0.389\ (357.1\ XBTE)$$
$$(11.672)\ (0.047)$$

$\bar{R}^2 = 0.924$
DW = 1.47

Italy

$$XSI = 0.356 + 0.387\ (.625\ XBTI)$$
$$(0.104)\ (0.020)$$

$\bar{R}^2 = 0.978$
DW = 1.79

The Netherlands

$$XSN = 4.318 + 0.184\ (3.62\ XBTN)$$
$$(0.195)\ \ (0.016)$$

$\bar{R}^2 = 0.989$
$DW = 2.19$

United Kingdom

$$XSU = -0.075 + 0.401\ (.357\ XBTU)$$
$$(0.352)\ \ (0.068)$$

$\bar{R}^2 = 0.880$
$DW = 1.68$

Averages and World Variables

$$PMCj = \sum_i \overset{\circ}{a}ij\ PXCi$$

$$YPOTMj = \sum_i \overset{\circ}{a}ij\ YPOTi$$

$$TENSMj = \sum_i \overset{\circ}{a}ij\ TENSi$$

$$XBTR = \sum_j XBRj + CIRM$$

$$BMR = \sum_i XBiR + CIRM$$

$$WT = \sum_i XBTi$$

World Prices, Terms of Trade, Current Price Balances on Goods and Services

$$PWT = (\Sigma PXCi \cdot XBTi + PXCR \cdot XBTR)/WT \qquad (i \in EEC)$$

$$TECHi = PXi/PMi$$

$$BGSVi = (PXi/100) \cdot XBSi - (PMi/100) \cdot BSMi$$

Appendix II

Notation

The variable names listed below are the Fortran names used in the solution program. The suffix i = A, I, N, F, B, U, D, L represent countries where

A = Germany (Allemagne)
I = Italy
N = The Netherlands
F = France
B = Belgium
U = United Kingdom
E = Ireland (Eire)
L = Luxemburg
T = Total EEC
R = Rest of world.

The base year for constant price flows and for indices is 1963. The main data source is the OECD National Accounts Statistics and Labour Force Statistics except for wages (UN Monthly Bulletin of Statistics) and for interest rates and rates of exchange (IMF International Financial Statistics). The trade matrices and the "dollar" export price indices were communicated by G. Taplin, IMF, and are the same as those used in Project Link. All monetary data are expressed in billions of national currency except Italy (thousands billion lira) and Ireland (millions of pounds).

Endogenous Variables

Factor Demand Block

CAPi : capital stock at constant prices
Vi : gross fixed capital formation, constant prices
EMPi : total employment (thousands)
CHi : unemployment (thousands)
YPOTi : potential output
TENSi : pressure of demand

Income Expenditure Block

Ci : private consumption, constant prices
DSTi : changes in stocks, constant prices
PNBi : Gross National Product, constant prices
PNBVi : Gross National Product, current prices
PIBVi : Gross Domestic Product, current prices
PIBCFi : Gross Domestic Product at factor cost, constant prices
YDi : Disposable Income, constant prices
YDVi : Disposable Income, current prices

Wage Price Block

Wi : index of hourly earnings in manufacturing (1963 = 100)
PCi : price index of private consumption (1963 = 100)
PVi : price index of Gross Domestic Asset Formation (1963 = 100)
PGi : price index of Government Current Expenditures (1963 = 100)
PXi : price index of Total Exports (1963 = 100) in national currency
PMi : price index of Total Imports (1963 = 100) in national currency
PXCi : dollar price index of Exports (1963 = 100)
PMCi : dollar price index of Imports (1963 = 100)
Pi : deflator of Gross National Product (1963 = 100)
PDIi : deflator of Internal Demand (1963 = 100)
CCAPi : implicit price of capital

Trade Linkage Block

XBij : exports of goods from country i to country j, constant prices i, j = A, I, N, F, B, U, D, E and R (rest of the world)
XBTi : total exports of goods, constant prices
BMi : total imports of goods, constant prices
XSi : exports of services, constant prices
SMi : imports of services, constant prices
XBSi : exports of goods and services, constant prices
BSMi : imports of goods and services, constant prices
BMBL : BLEU imports of goods
DMi : import content of final expenditures
YPOTMi: average production capacity of competitors of country i
TENSMi: average pressure of demand of competitors of country i
BGSVi : balance on goods and services, current account
TECHi : terms of trade
PWT : world prices

Policy Instruments

Gi : government current expenditure, constant prices
TINDVi : indirect taxes, current prices
SUBVi : subsidies, current prices
REVALi : index of rates of exchange, expressed in units of national currency per US dollar
POPACi : available labor force
RLi : long-term rate of interest
YDEXi : exogenous change in taxes
VEXi : exogenous change in investment

Other Exogenous Variables

PXRW : export price of countries other than the EEC (1963 = 1.0)
TEMPS : time (1953 = 0)
AJPXi : adjustment converting export prices for goods to export prices for goods and services
AJPMi : adjustment converting import prices for goods to import prices for goods and services
PXCGR : export prices of goods, rest of world
PXCR : export prices of goods and services, rest of world
CIRM : intratrade, rest of world
YPOTR : production capacity, rest of world
TENSR : pressure of demand, rest of world
UEBL : share of Belgium in goods exports of the BLEU
TUEBL : adjustment of goods imports of BLEU to goods imports of Belgium
VAEXVi : net factor income paid to rest of world, current prices
BCEEI : dummy variable intra EEC trade
BAELE : dummy variable intra EFTA trade
BCEEX : dummy variable EEC-non-EEC trade
BAELEX: dummy variable EFTA-non-EFTA trade

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Discussion

Keith N. Johnson

In this paper, Waelbroeck and Dramais report on yet another internationally linked empirical system, in this case a series of models of economies which make up the European Economic Community. We have heard this morning from the LINK project and will hear next from RDX/MPS. It is apparent that these linked macro-model systems differ in both structure and orientation in comparison to the theoretical papers presented earlier. Only recently has large-scale economic modelling been intensively applied to the international system. The resulting models still tend to rely heavily on fundamental linkages among trade flows and trade prices (as well as the relationships between these and domestic sectors) while the theoretical focus has moved on to other considerations such as monetary and investment linkages. Similarly, nowhere among the empirically oriented studies is there truly a discussion of coordinated policy, that is of linkages among policy instruments or between transmitted economic impulses and policy responses. Instead these models are mainly used to carry out ceteris paribus simulation studies, however complicated they might be. In particular, despite the evident efforts of the authors, the use of "coordination" in the title of this paper represents more their plans than accomplishments. I return to this point later.

Nevertheless, even in the rather restricted context of current international modelling experience, DESMOS is clearly distinguishable. Waelbroeck and Dramais have quite effectively developed a set of small-scale, medium-term models by carefully insuring the integrity of the underlying production relationships. These basic equations are then extended into complete models, but extended only enough to incorporate relevant policy channels, and kept simple otherwise. Finally, the country models are interrelated by means of a new form of linkage equation, where the novel feature is the introduction of capacity effects in export determination.

What is obtained is a set of nine rather modest-scale models which are specified as nearly the same across countries as possible. The self-imposed constraints of moderate size and common specification do not

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appear to be unduly restrictive, judging by the DESMOS experience. However, one feels a certain trepidation in voicing criticism. If the commonality of specification is to be maintained, then each new equation must be implemented for each of the nine countries. If the feasibility of maintaining the system in a single center is to protected, then each data series must be easily available.

Yet, certain scattered criticisms are appropriate. In the estimation of DESMOS, the Coen-Hickman technique is used to insure mutual consistency among the production, labor demand, and investment equations. In the long run, therefore, they are guaranteed that these three variables move sensibly along the frontier of a single production technology. However, in the short run this restriction may be a liability; it is not then reasonable to expect the economy to be at the technological frontier and a more varied pattern of responses is possible. By introducing some adjustment lags, Waelbroeck and Dramais attempt to reflect this fact, but imperfectly to be sure. The mean adjustment lags in Table 2 are often implausibly long. For example, half of the capital response to a change in output consumes over 15 years for Germany and the Netherlands and over 20 years for France. The labor demand mean lags are also too long for Germany (eight years) and for Denmark (six years). As the authors note, this result may follow from a too close tie between the adjustment speeds to a change in factor prices compared to a change in output. They also plan apparently to tie prices directly to unit production costs. In fact, a careful review of the equations for the various price deflators indicates that, for many of the countries, one cannot distinguish statistically between the expenditure prices when the specifications are the same. For example, the Ireland consumption price is determined from wages with an estimated elasticity of 0.44 (standard error of 0.11) and from import prices with an elasticity of 0.32 (0.16). The investment deflator equation has corresponding elasticities of 0.36 (0.14) and 0.26 (0.17). Export prices have elasticities of 0.47 (0.14) and 0.49 (0.20). We do not know the sampling covariances, but based on the sampling errors alone, it is possible these three equations are the same. A similar result appears for Belgium, France, and somewhat for the Netherlands and Denmark. Italy, Germany, and the United Kingdom have more distinctive patterns however. If divergent price movements are important in determining dynamic simulation responses, whether these differences are significant could be crucial.

The extension of the production sectors into compact, sensible models, regardless of the price equations, is nicely accomplished, but the introduction of policy channels seems to be less complete. For example, the only monetary instrument is the long-term interest rate which enters in the definition of the cost of capital. If consumption were disaggregated into durables and non-durables, it might be possible to introduce the term-structure of interest rates to reflect credit rationing in the determination of durable consumption. This would of course require new variables and extra equations. More disturbing is the absence of any income-side relationships or tax rates explicitly considered. The equation determining

disposable income linearly from total income then must be interpreted as reflecting not only tax and transfer policies, but also as implicitly reflecting the distribution of incomes, say, as between wages and profits. It is doubtful whether alternative policies (or particularly policy response functions) may be adequately studied without such distributional information. This qualification would seem to hold particularly where the capital stock is treated in a putty-putty framework. For example, a fairly common feature of certain of the LINK models is that increased wage demands, ceteris paribus, may lead, for a year or two, to increased output despite falling exports and increasing imports because of short-run transfers of income from profits to wages.[1]

In the linkages among real trade flows, Waelbroeck and Dramais have introduced a most interesting new result. Following Hickman-Lau, they explain market shares as a function of relative export prices, but also employ relative capacity utilization and relative production capacity as additional explanatory variables. This extension is a particularly good example of how a set of small models may be useful. The role of and need for a capacity utilization effect in export determination has been recognized in LINK meetings for two years or more (not infrequently by Prof. Waelbroeck), but the present model has accommodated to the need much more quickly. The basic problem in this respect is to develop internationally comparable indices of capacity utilization, a difficulty which is neatly circumvented when, as here, the underlying models are specified identically. The bilateral flow equation which is used, it should be emphasized, is very restrictive. The underlying functions given in the discussion of the Linkage Block are linearized around the base year shares a^0_{ij} and simplified substantially to give the linear functions in the Appendix. Notice that even the underlying functions assume that the elasticity of substitution is constant within each import market. The same assumption applies to elasticities with respect to relative capacity output and with respect to relative capacity utilization. In the pooled time-series and cross-section estimated equation, each of these elasticities is further assumed to be the same across markets. In the Klein-van Peeterssen and Moriguchi versions of the LINK equations, these parameters are assumed to vary across markets but not across exporters to any market.[2] Furthermore, some unpublished calculations made by Moriguchi and myself suggest that even this weaker constraint is not tenable statistically; without some restriction, however, there are serious degrees of freedom problems in estimating all of the parameters. Similarly, the import expenditure elasticities in the DESMOS

[1]See the chapter by Johnson and Klein, this volume.

[2]See L.R. Klein and A. van Peeterssen, "Forecasting World Trade within Project LINK" in J. Ball (ed.), *The International Linkage of National Economic Models*, North-Holland, 1973. Also Moriguchi and K. Johnson, "The Estimation of Import Market Shares, A New Approach," Kyoto Discussion Paper No. 58 presented to the annual LINK world meeting, Vienna 1972.

equation are assumed to be constant across markets and exporters. Numerous published studies have verified the existence of differential effects here.

The preceding comments refer to the traditional parts of the DESMOS import allocation model, but in addition to relative prices, market shares depend on the product of the variables:

$$\left(\frac{Y_i}{Y_j^*}\right)^{\gamma} \cdot \left(\frac{T_i}{T_j^*}\right)^{\delta}$$

where Y_i is capacity output and T_i is the ratio of actual output to capacity output (say Q_i/Y_i) in country i. Assuming adequate equilibration in the models, in the long run, we have $Q_i = Y_i$ so the second term tends to unity. Furthermore, since the estimate of γ and of $-\delta$ are both near unity, market shares will eventually vary with the ratio Q_i/Q_j^*, essentially a gravity model specification. In the short run, capacity should be fairly constant. In this case, market shares can easily be seen to vary with $k(Q_i/Q_j^*)^{-1}$ where k is the constant $(Y_i/Y_j^*)^2$. In a sense, therefore, the model behaves initially *opposite* to that of a gravity model.

The appropriateness of the capacity measure is somewhat questionable however. The traditional justification for defining capacity output by evaluating the production function at full employment is that capital is fixed in the short run. In DESMOS, however, excepting the United Kingdom and Germany, capital is variable as well as malleable within a period of a year. Also, it is not clear that capacity *to export* is being measured. If one believes in the dichotomy of the "Scandanavian" model, and if tradeables were produced mainly from capital and non-tradeables mostly from labor, then a measure which ultimately depends on the unemployment rate might be a poor indicator of under-utilization of export capacity. For short-run forecasting , these considerations are probably not especially important. However, because of the specification of the production sector and simplifications on the demand side, I believe that DESMOS is more reliable for medium-run structural analysis so that the creativity demonstrated in this export specification may not be as useful to DESMOS as to others. Waelbroeck and Dramais have here broken new ground empirically, and, hopefully their efforts will enhance what may be a fruitful path of inquiry.

As it was not possible for Waelbroeck and Dramais to completely report all of their policy simulations, it is not possible for me to pursue detailed comment on all they describe. Nor is it necessary. A few isolated remarks will suffice.

The overall pattern of the dynamic multipliers which appear in this section of the paper are quite sensible and provide testimony to the usefulness of such small models. The impact of direct inducements to investment seems to be notably strong and those operating via interest rates

notably weak in comparison. Also, it is not clear exactly how the immigration of labor calculations are undertaken. If there is an assumed increase, for example, in German "guest workers," is there also a partially countervailing decrease in the active population assumed, say in Italy? The most interesting result would seem to be the price responses to exchange fluctuation in Table 8, which may be approximately interpreted as an analysis of a "typical" E.E.C. economy. Following a 10 percent revaluation, export prices in local currency units fall by almost 4 percent and continue to decline. By the fifth year, more than half of the change in the exchange rate has been absorbed, and, as a consequence, the effect on the balance of payments is temporary and small. The authors note, correctly, that one reason for this effect is the decline in wages which accompanies reduced activity, but this is not the most important reason. The typical export price equation depends on wages, but also on import prices, and the elasticity with respect to the latter is generally equal to or greater than that with respect to wages. In fact, nearly 90 percent of the initial year absorption is attributable to the same source. To a certain extent, where imported materials are used in the production process, this result stems from declining unit costs, but it must largely represent competitive behavior on the part of exporters.

I do not want to comment on the DESMOS multiplier and cross-multiplier calculations in comparison to those of Hickman and the LINK model. It is essential to point out, however, that the most important difference between the two sets of calculations is not the difference in structure or size, but rather the period. The DESMOS multipliers cover the period 1970 — 1975 while Hickman's multipliers are evaluated over the period 1973 — 1975. The initial conditions may substantially influence dynamic multipliers where the models are non-linear, and this accounts for the large differences, for example, in the case of the Netherlands.

The section on "controllability" of the E.E.C. model can be misleading. Where we might agree that policy makers, indeed all of us, are not concerned with precise values of policy multipliers since, after all, they are statistical estimates and subject to sampling error (of generally unspecified magnitudes), the extensive use of only the signs of the multipliers in this section will not even reflect orders of magnitude unless much care is taken.

One assumption which must underly such "qualitative" analysis is that it is possible to determine a set of policy experiments which are, in some sense, comparable, perhaps in terms of political feasibility. Using Table 8, it is possible to construct a new Table 9′ which contains not only the signs but also typical orders of magnitudes of policy responses. Referring to their Table 9, and disregarding the unemployment target, Waelbroeck and Dramais now argue that there must be some combination of demand contraction and revaluation which has no impact on the balance of payments. Unless the system is extremely non-linear, this combination will exist with the (dynamic) weights assigned to each instrument depending on the (dynamic) multipliers in Table 9′. In Table 8, it is seen that the impact on the

balance of payments of a unit increase in public consumption is -0.33 while the impact of a unit revaluation is -0.36. If the units are small enough to assume approximate linearity, then a unit policy variation composed of approximately 1/2 unit fiscal contraction and 1/2 unit revaluation will be close to neutral regarding the balance of payments. By the fifth year, the weights in the policy mix must be approximately 0.22 fiscal contraction and 0.78 revaluation. These calculations then lead Waelbroeck and Dramais to their Table 10 and me to my Table 10′ which gives, in addition to the signs, the unit policy mixes and resulting impacts. The point, of course, is that the numerical entries in Table 10′ and particularly the weights form a significantly different pattern than the signs alone in Table 10. For example, fiscal policy seems to be very unimportant, whatever the target. Importing foreign labor is the most important element in the policy mix to control prices as well as in the policy mix to stimulate real output. Increases in the long-term interest rate are most heavily weighted in a policy mix to improve the balance of payments. These results are not entirely plausible, but do effectively demonstrate the care required in the interpretation of such qualitative analysis.

Table 9′

Sign and Magnitude of Typical Policy Multipliers

Impact on:	Public Consumption	Rate of Exchange	Long-term Interest Rate	Labor Immigration
GNP	+1.9	-2.4	-1.6	+0.4
Unemployment	-1.2	+1.6	+0.2	+0.8
Consumer Prices	+1.9	-1.6	+0.1	-1.2
Balance of Payments	-0.7	-0.2	+0.4	+0.2

Source: Waelbroeck and Dramais, Table 8, five-year multipliers.

Note: Public consumption = increase equal to 1 percent of GNP
Rate of exchange = 10 percent revaluation
Long-term Interest Rate = 100 basis point increase
Labor Immigration = 1 percent increase in active population

Table 10′

Impacts of Combinations of Instruments

	-ΔEXP (0.22) +ΔEXCH (0.78)	-ΔRL (0.33) +ΔIMMIG (0.67)	+ΔEXCH (0.40) -ΔRL (0.60)	+ΔEXP (0.22) -ΔIMMIG (0.78)
	(a)	(b)	(c)	(d)
Impact on:				
GNP	-2.3	+0.8	0.0	0.0
Consumer Prices	-1.5	-0.8	-0.7	+1.4
Balance of Payments	0.0	0.0	+0.3	-0.3

	-ΔEXP (0.07) +ΔEXCH (0.20) -ΔRL (0.24) +ΔIMMIG (0.49)	-ΔEXP (0.07) -ΔEXCH (0.27) +ΔRL (0.40) +ΔIMMIG (0.26)	+EXP (0.08) -ΔEXCH (0.25) -ΔRL (0.22) +ΔIMMIG (0.44)
	(a+b)	(-c — d)	(-a+b)
Impact on:			
GNP	0.0	0.0	+1.3
Consumer Prices	-1.0	0.0	0.0
Balance of Payments	0.0	+0.3	0.0

Source: Table 9′.

Note: +ΔEXP = increase of public consumption equal to 1 percent of GNP
+ΔEXCH = 10 percent revaluation
+ΔRL = 100 basis point increase in long-term interest rate
+ΔIMMIG = 1 percent increase in active population, labor immigration

The paper returns at the end to the question of policy coordination, and so do I. In so doing, I wish to emphasize the importance of this (or some other) econometric model in policy analysis. The premise that it is quite unlikely for a policy maker to fully comprehend the myriad of interactions and dependencies in the economy will lead almost directly to the recommendation that an econometric model will supplement his effectiveness in this respect. Still, as the present authors are careful to point out, the model is just a tool in this process.

Other tools are equally necessary in the E.E.C. coordination exercise they hypothesize. The negotiating forum, that is the ability to communicate policy targets and preferences simultaneously, is one such requirement. The *desire* on the part of E.E.C. member governments to coordinate policy is another. The capability of these governments to then implement faithfully the agreed-upon policies is a third. All are integral parts of the analysis of coordinated policy. A structural econometric model like DESMOS does not, for example, indicate to what extent policy making "should" be decentralized either across countries or within a single economy. A very useful result would be the identification of those policies which can be effectively set by means of response functions as opposed to requiring a negotiated consensus. Suppose, on the other hand, that equally acceptable impacts in the hypothetical E.E.C. negotiation example could be obtained from quite different instrument variations. If the required policies are not unique, what determines the result? Finally, no consideration is given to bargaining power; the participation and compliance of, say, the United Kingdom must be presupposed in the present example when it may be to the British advantage to do neither.

In fact, what DESMOS represents in terms of coordination of economic policy is simply a method by which a diverse but interrelated set of interests may attempt to understand one another. It could equally be used as a policy tool by the administration of some "United States of Europe." However, it is not as easily adapted to the analysis where national identities and goals are quite segregated and distinct, the case which seems to me to reflect the important aspect of coordination.