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Recent Developments in OECD's International Macroeconomic Model

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by

Pete Richardson

Econometric Unit

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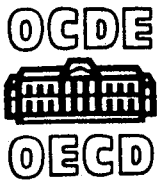

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RECENT DEVELOPMENTS IN OECD'S INTERNATIONAL MACROECONOMIC MODEL

by

Pete Richardson (Ed.)(1)

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1. The principal author of this paper is Head of the Econometric Unit, Economics and Statistics Department. The work reported is largely that of his colleagues in the Department -- Dave Coe, Martine Durand, Mitsuhiro Fukao, Richard Herd, Gerry Holtham, Peter Jarrett, Menahem Prywes, Ulrich Stiehler and Raymond Torres -- who also provided much of the original material. Thanks also go to Andrew Dean, Mike Feiner and Stephen Potter for their comments on an earlier draft.

This paper summarizes recent empirical studies contributing towards the OECD Secretariat INTERLINK world macroeconomic model. For a number of topics, it reviews work which is described in more detail in recent Economics and Statistics Department Working Papers. It also covers a number of areas where recent changes have been relatively less substantial in terms of changes in model structure, but nonetheless influential in the evolution of model properties. A final section reviews current Secretariat macroeconometric modelling work which is yet to be implemented in the model and also discusses possible future developments. A separate companion paper, ESD Working Paper No. 47, analyses the single- and multi-country simulation properties of a recent version of the model, one which includes most of the research reported here.

* * * * * * *

Cet article résume les études empiriques récentes contributant au développement du modèle macro-économique mondial du Secrétariat de l'OCDE INTERLINK. Il passe en revue un certain nombre de sujets traités d'une manière plus détaillée dans des Documents de Travail récents du Département des Affaires Economiques et Statistiques. Il traite également d'un certain nombre de domaines qui ont peu changé la structure du modèle mais qui ont néanmoins des influences sur ses propriétés. La dernière section passe en revue les travaux actuellement poursuivis par le Secrétariat sur la modélisation macro-économique mais qui n'ont pas encore été intégrés au modèle. Elle envisage aussi les perfectionnements ultérieurs possibles. Une autre note, Document de Travail No. 47 du D.A.E.S., analyse les propriétés en simulation d'une version récente du modèle, incorporant la plupart des recherches décrites ici.

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RECENT DEVELOPMENTS IN OECD'S INTERNATIONAL MACROECONOMIC MODEL

INTRODUCTION

1. This paper summarizes recent empirical studies contributing towards the OECD Secretariat INTERLINK world macroeconomic model. It reviews for a number of topics -- business supply, prices, investment income, non-oil commodity and manufactures trade prices -- recent studies which are also described in a series of separate Working Papers. It also covers a number of areas -- consumption, wages and the demand for money -- where recent changes have been less substantial, in terms of revisions to model structure, but nonetheless influential in the evolution of model properties. A final section reviews work in progress but yet to be implemented in the model and also discusses possible future developments. A separate companion paper [Richardson (1987b)] analyses the single- and multi-country simulation properties of a recent version of the model, one which includes most of the research reported here (1).

2. The work presented here is that of a team of economists and much of the material discussed was originally designed to address specific macroeconomic questions of analytic and policy interest for the OECD Economic Policy Committee and its Working Parties, and also the requirements of the Secretariat's regular country surveys carried out for the Economic and Development Review Committee. In this respect, the INTERLINK model serves as a repository for the ongoing macroeconomic-related empirical work carried out in the Economics and Statistics Department, rather than a research vehicle. As in the past, policy concern remains an important criterion in model development (2).

I. RECENT REVISIONS TO INTERLINK

Consumption

3. With regard to the consumption function, earlier versions of the INTERLINK model have incorporated fairly simple equations relating consumption to real disposable income and ex post long-term real interest rates, giving little or no weight to the role of wealth and inflation expectations in the consumer decision-making process. The recent estimation of more comprehensive specifications is described in Holtham and Kato (1986) and this work has been subsequently adapted for use in INTERLINK.

4. Inflation changes the real value of wealth stocks denominated in money terms. As the nominal interest rate is often slow to adjust when inflation rises, there will be a period in which creditors unexpectedly lose to debtors.

A period of higher saving may then ensue as wealth holders restore the real value of their wealth. If inflation rises and the nominal interest rate rises to compensate, preserving the same real interest rate, measured income will increase because the higher money interest payments on outside assets will be counted towards income while the faster erosion of money wealth will not be debited. In this situation real consumption will not change in the absence of money illusion, so that saving will be higher.

5. The objective of specifying the consumption function to take account of these phenomena in a comparable way for a number of countries provides a strong incentive to avoid the use of explicit data for household wealth. These data are generally difficult to identify for most countries and, where obtainable, they are frequently difficult to "endogenise" satisfactorily in a model. The general strategy, in the absence of relevant data, has therefore aimed at reducing the problem by considering different functional forms rather than by manufacturing proxy data.

6. The general class of consumption functions considered in Holtham and Kato (1986) assumes that households in the aggregate wish to maintain a stable relation between wealth and income and that both the desired ratio of wealth to income and the desired proportion of total wealth held in indexed form can be expressed as functions of the real interest rate. This led to the derivation of a general form of equation in which the consumption-income ratio is expressed as a function of the interest rate, the expected inflation rate, and two interaction terms: the product of the expected inflation rate and the interest rate, and the product of the expected inflation rate and the square of the interest rate. For nine OECD economies the empirical results however did not suggest that such interaction terms were statistically important; excluding them led to the estimation of a simpler equation of the following form:

$$\Delta \ln C_t = a_0 + a_1 p_t + a_2 r_t + a_3 \Delta \ln Y_t + a_4 \ln (Y_{t-1}/C_{t-1}) \qquad [1]$$

where:

C = real personal consumption expenditures

Y = real disposable income

p = the rate of change of consumer prices

r = the inflation-adjusted long-term real interest rate

Coefficient estimates for equation [1] were generally right-signed and well-determined, except for France and Japan where the estimated coefficients for the real interest rates were insignificant. Lags on the inflation term were tested over a range of alternatives and, generally speaking, a three-period average of inflation was preferred as the measure of expected inflation. Only for France did an unlagged inflation term give better results.

7. For Japan, where the standard specification failed to give plausible results, an alternative equation assuming that the marginal propensity to consume depends on inflation and real interest rates was tested in the following form:

$$C_t/Y_t = a_0 + a_1 p_t + a_2 r + a_3 C_{t-1}/Y_t \qquad [2]$$

8. The final choice of the aggregate consumption function for each country was based upon both the tracking performance of the equations and the plausibility of their simulation properties. Given these tests, equation [1] was implemented for all countries except Japan where equation [2] was preferred (3). The final equation estimates are summarised in Table 1. For comparative purposes, Table 2 also provides a summary of the corresponding semi-elasticity estimates with respect to inflation and real interest rates and the long-run average propensities to consume, evaluated at sample average values.

9. Comparing the various estimates for individual countries in Tables 1 and 2, there is a fairly wide range of values for the short- and long-run semi-elasticities with respect to inflation and real interest rates. For inflation, moderately large short-run response coefficients were obtained for Japan, Germany, Canada and the United Kingdom, with relatively small coefficients for France and the United States. Allowing for lags, the largest long-run elasticities are those for Canada, Australia, Germany and Japan, with the lowest values again those for the United States and France. The ranking of real interest rate responses are almost identical to those for inflation, with an extreme near-zero value obtained for France. In terms of associated lags, the shortest mean lags are for Japan, Germany and Italy, the longest are for Canada and Australia.

10. With respect to income responses, the largest short-term elasticities are for Germany, Japan, Canada, the United Kingdom and the United States, with elasticities in the approximate range of 0.5 to 0.6, and the smallest for France, Italy and the Netherlands, in the range of 0.15 to 0.20. Mean adjustment lags for income range from one half-year for Germany, the United Kingdom, Italy and Japan to three to four half-years for France, Canada and Australia.

11. Overall, the introduction of these equations into INTERLINK has had quite significant effects on model properties. Fiscal multipliers are generally smaller for all countries, chiefly because of the introduction of inflation effects, significantly so for the United States, Canada, Germany, Italy, Japan and Australia (4). The inflation effect is also important to other areas of analysis. In the case of currency depreciation, the impact of higher prices on consumption now acts as an important offset to the influence of competitiveness changes on net exports and GNP. In the analysis of disinflation, real-side effects are now quantitatively more significant.

Supply

12. The Secretariat's study of aggregate supply in the major economies, summarised in Helliwell et al. (1986), represented a major revision to the theoretical structure of INTERLINK in 1985. This work has subsequently been revised in the light of experience in the use of the blocks in model-based simulation and forecasting analyses. A detailed report of recent supply block re-estimation is given in Jarrett and Torres (1987). While the underlying philosophy of the supply block has not changed, each of the block's behavioural equations as well as the parameters of the production function have been substantially modified.

Table 1

THE AGGREGATE CONSUMPTION FUNCTION

$$\Delta \ln C = a_0 + a_1 \sum_0^2 p + a_2 \left(IRL - \sum_0^2 p\right) + a_3 \Delta \ln Y + a_4 \ln (Y-1/C-1)$$

	a_0	a_1	a_2	a_3	a_4	D_1	D_2	R^2	H	SEE	ApC	RMSE %
United States	-0.00864 (1.1)	-0.00118 (3.4)	-0.000656 —	0.4776 (6.2)	0.3371 (3.7)	-0.01618 (4.7)	0.009964 (3.7)	0.763	3.3	0.005	0.951	0.45
Germany	-0.0183 (2.9)	-0.00437 (6.9)	-0.00218 —	0.601 (11.9)	0.373 (6.3)			0.862	-0.1	0.005	0.889	0.56
France	-0.0271 (1.9)	-0.00104 (3.1)	-0.0000662 (0.1)	0.222 (3.0)	0.290 (4.0)	D -0.0293 (6.6)		0.785	1.5	0.005	0.885	0.50
United Kingdom	-0.00848 (0.9)	-0.00284 (3.0)	-0.00255 (2.0)	0.550 (0.5)	0.361 (2.8)			0.540	-2.2	0.010	0.902	1.19
Italy	-0.134 (3.1)	-0.00138 (2.4)	-0.000545 (0.7)	0.198 (1.8)	0.553 (3.8)			0.456	1.7	0.011	0.756	1.15
Canada	0.0157 (3.2)	-0.00305 (5.9)	-0.00209 —	0.566 (6.2)	0.167 (3.2)			0.668	0.7	0.008	0.953	0.88
Australia	0.00693 (0.7)	-0.00195 (2.7)	-0.000592 (1.3)	0.318 (4.1)	0.160 (1.8)			0.546	-0.3	0.007	0.927	0.84
Netherlands	0.000190 (0.1)	-0.0017 —	-0.0010 —	0.147 (1.6)	0.374 (7.7)	D 0.0193 (6.5)		0.838	0.2	0.006	0.965	0.59

$$C/Y = a_0 + a_1 \sum_0^2 p + a_2 \left(IRL - \sum_0^1 p\right) + a_3 \, C-1/Y$$

Japan	0.384 (5.4)	-0.00398 (7.5)	-0.00177 —	0.581 (6.9)				0.908	1.3	0.0090	0.842	0.50

Notes: 1. For the United States: D1: 73II to 75I = 1.0, otherwise 0
D2: after 83I = 1.0, otherwise 0
For France: D: 68I = 1.0, 68II = -1.0, otherwise 0
For the Netherlands: D: 75II to 78I = 1.0, otherwise 0.

2. For France the current inflation rate is used; for other countries a three-period moving average is used.

3. Estimation sample is 62I to 85I, RMSE statistics relate to the per cent dynamic tracking errors for the period 80II to 85I, (—) denotes a constrained estimate.

Table 2

THE AGGREGATE CONSUMPTION FUNCTION: COMPARATIVE PARAMETERS

	Semi-elasticities with respect to a one-point change in:				Mean lag (in half years)	Income response		
	Inflation rate		Real interest rate			Average propensities (sample mean values)	Impact elasticity (1)	Mean lag
	Impact	Long run	Impact	Long run				
United States	-.0012	-.0035	-.0007	-.0019	2	0.951	.48	2
Germany	-.0044	-.0117	-.0022	-.0058	1	0.889	.60	1
France	-.0010	-.0036	0.0	0.0	2	0.885	.22	3
United Kingdom	-.0028	-.0079	-.0026	-.0071	2	0.902	.55	1
Italy	-.0014	-.0025	-.0005	-.0010	1	0.756	.20	1
Canada	-.0030	-.0182	-.0021	-.0125	5	0.953	.57	3
Australia	-.0019	-.0122	-.0006	-.0037	5	0.927	.32	4
Netherlands	-.0017	-.0045	-.0010	-.0027	2	0.965	.15	2
Japan (2)	-.0047	-.0113	-.0026	-.0050	1	0.842	.58	1

1. By construction, the long-run income elasticities are unity.

2. Evaluated at the mean consumption/income ratio.

A. The production function

13. The production functions have been re-estimated to take account of new and revised historical data and rebasing for some countries. The estimation procedure for the inner production function, in which capital and energy are bundled together, has been slightly modified to permit a more consistent treatment of energy demand.

14. Three main results emerge from the re-estimation. First, the estimated proportion of the capital stock which is re-optimised with respect to the energy-capital price ratio in each semester, i.e. the "retrofitting" parameter, has been reduced on average from 29 per cent to 14 per cent. Secondly, the inner function elasticities (capital/energy) are almost unchanged at an average of about 0.6, while the outer function elasticity (labour/capital-energy bundle) has declined from 0.84 to 0.65. In contrast to other country estimates, that for the U.K. outer elasticity of substitution has increased. Thirdly, in the Japanese and Italian models, capital and energy are now substitutes, in contrast with the other country models.

B. Output supply

15. The output supply equations have been respecified partly to allow for more flexible dynamics by the inclusion of lags in independent variables. The sales variable has also been redefined to allow for normal inventory growth, defined so as to give a constant balanced growth stock-output ratio. In earlier versions of the model, deviations of actual inventory changes from their normal values did not influence the sales demand variable. In the revised version, it is assumed that when firms face an unexpected increase in demand, they can respond, in part, by reducing stocks -- rather than increasing output. Thereafter, stock output ratios gradually return to their equilibrium values. Finally, instead of being constant, equilibrium stock/output ratios are now explicit functions of expected real interest rates, the level of output and trend factors in some cases.

16. The estimation results show little change in demand effects for the U.S. and German equations, weaker effects for Japan and France, and larger effects in the remaining countries. The stock-output ratio equilibration effect is now larger in all cases and the speed of adjustment of actual to desired stock/output ratios, and consequently the adjustment of business sector output to its normal level, is faster.

C. Factor demands

17. A revised dynamic adjustment mechanism for factor demands has been used which is more general than the previous error-correction form. In order to estimate rather than impose the weight of actual output in expected output, the demands for labour and capital are estimated simultaneously. Long-run homogeneity constraints and factor utilisation and profitability rates modify the adjustment process. Expected output is important in the factor demand equations, since the desired levels of inputs are assumed to be determined through the cost-minimising behaviour of firms and thus depend on expected output and relative factor prices. Finally, the investment equation has been respecified as a capital stock equation, with investment defined by the appropriate identity. This latter change provides a more consistent basis for joint factor demand and a more coherent treatment of long-run capital stock equilibrium. The energy demand equation is of similar form but is specified in terms of rates of change.

18. In estimation, the weight attached to actual output in the determination of expected output has been substantially reduced in all country models; in the previous version of the supply block, expected output and desired factor demands were considered to be too dependent on actual output movements. This, together with the allowance for more gradual adjustment, has resulted in a decline in median and mean lags in the labour demand equations: the speed of adjustment of actual to desired employment is now relatively fast for the Canadian and U.S. models, intermediate for European countries and slowest in the Japanese model. Except for Japan, mean lags for the capital stock are longer than those for employment. For energy demand, the speed of adjustment of actual to desired rates of growth is quickest for Japan and the United Kingdom, with full adjustment achieved in the first half-year. For other countries, the adjustment rate is also quite rapid, with the impact effect ranging from 0.6 for France to 0.9 for Italy.

D. Energy prices

19. The business energy price equation in earlier versions of the model posed serious data problems, since one of the explanatory variables -- the price of domestically produced and consumed energy -- could not be updated regularly. The earlier equation also imposed an unduly large effect of foreign on domestic energy prices and neglected the role of taxes and domestic value-added. To overcome these weaknesses, a more general form of the equation has been specified, allowing for the separate influences of imported energy prices, domestic prices and taxes, subject to a unit homogeneity constraint.

20. The estimation results show an average long-run effect for the imported energy price of about one-third. This result is consistent with those obtained independently in the price blocks for the business value-added deflator for energy.

E. Relative price effects and factor demands

21. Comparison of old and new model properties with respect to simulated changes in factor prices show the following general results:

(i) Substitution effects are weaker than in the previous version of the model, except in the case of the United Kingdom.

(ii) Changes in factor demands are less pronounced given the general reduction in substitution effects; once again the U.K. model is an exception in this respect.

(iii) Capital and energy are now substitutes in the Japanese and Italian models and complements elsewhere.

(iv) A nominal wage increase has the biggest negative real output growth effect in the Japanese model as a result of a decline in capital stock.

(v) The revised specification of the energy price equation has reduced the impact of energy price shocks on factor demands.

(vi) Interest rate shocks have similar real output effects in both versions of the model.

F. Potential output

22. As discussed in the section below on price determination [paras. 31-38], the former use of the supply-based "normal output" measure as a proxy for potential was problematic because "normal" tended to be relatively responsive to actual output. The associated measure of factor utilisation was therefore a weak indicator of demand pressure because it was relatively insensitive to a wide range of simulated shocks, both real and nominal. Recent work on supply has therefore involved the specification of an alternative measure of potential consistent with the estimated production function. The preferred measure is based on the actual capital-energy bundle combined with the cost-minimising level of employment, subject to the rate of unemployment being prevented from falling below given minimum levels.

23. On this basis, relatively smooth measures of potential output growth were obtained. The 1986-88 average potential output growth ranges from 4 per cent for Japan to 2 per cent for the United Kingdom, with values around 2 3/4 per cent for the other three European countries, and a 3 per cent rate for the United States and Canada.

Wages

24. The most recent Secretariat estimates of private sector nominal wage equations, summarised for 13 countries in Tables 3 and 4 are broadly similar to those previously reported in Coe (1985) [recent estimates are also presented in Chan-Lee, Coe and Prywes (1987)]. For the United States, Japan and Australia, a more comprehensive wage concept (private sector earnings per employee) is now used. The most important changes in specification are for the United States, where the proxy for inflation expectations has been simplified and the influence of cyclical productivity changes added; and for Japan, where both cyclical productivity growth and changes in the terms of trade are additional determinants. These changes reflect, inter alia, the more comprehensive wage concept and the inclusion of more recent observations where shifts in the terms of trade have been particularly large. In the course of re-estimation, most of the specification tests reported in Coe (1985) were repeated.

25. The unemployment rate is used as a proxy for the excess demand for labour and enters the equations linearly except for Japan, Germany, Austria, the Netherlands and Spain. For these countries, the estimated semi-elasticity of wages with respect to the unemployment rate is given in Table 3 in square brackets, evaluated at the mean unemployment rate for the sample period. On this basis, the equation for Japan has by far the largest estimated elasticity (-1.78), followed by those for the United States, Italy and Austria (-0.6 to -0.7); the estimated elasticities for France, Canada, Australia and Finland are in the -0.3 to -0.5 range; for Germany, the Netherlands and Spain the estimated elasticity is between -0.15 and -0.25.

26. For the United Kingdom, two equations are shown which differ only in the specification of the unemployment term: in the first equation the level of the unemployment rate is used, while in the second the unemployment rate is entered as the difference from its lagged four-year average. This latter specification implies that the inflationary or disinflationary impact on wages from a given level of unemployment disappears over time. A specification with changes in, rather than the level of, the unemployment rate has become

Table 3

AGGREGATE WAGE EQUATIONS (a)

	Constant	Unemployment rate (U)			Inflation (c)	Productivity growth (d)	Other (e)	SEE	DW	$\bar{R}^2$
		U [elasticity] (b)	lnU	1/U						
United States 1964II-85II	4.19 (0.32)	-0.60 (0.07)			1.00 (0.13)	0.27 (0.09)		0.51	2.04	0.76
Japan 1970II-85II	-2.91 (0.83)	[-1.78]		7.13 (1.43)	1.00 (--)	0.60 (0.20)	-0.80 (0.30)	1.00	2.12	0.81
Germany 1964I-85II	0.32 (0.64)	[-0.14]	-0.42 (0.16)		0.99 (0.19)	0.65 (0.14)		0.84	2.30	0.79
France 1964II-84II	2.64 (0.20)	-0.29 (0.04)			1.00 (--)		0.12 (0.03)	0.70	1.47	0.71
United Kingdom (f) 1964I-84II	2.28 (0.56)	-0.15 (0.07)			0.94 (0.10)			1.50	2.14	0.74
	1.85 (0.48)	-0.44 (0.17)			0.98 (0.09)			1.43	2.32	0.77
Italy 1971II-83II	5.58 (2.67)	-0.60 (0.31)			0.96 (0.21)			2.02	2.03	0.59
Canada 1966II-85I	4.77 (0.70)	-0.51 (0.10)			0.89 (0.18)			1.29	2.07	0.58
Australia 1970II-85II	2.87 (0.80)	-0.39 (0.14)			1.00 (--)			1.78	1.92	0.51
Austria 1970II-85I	2.66 (1.02)	[-0.74]	-1.67 (0.47)		0.84 (0.29)		-0.79 (0.37)	1.02	2.38	0.73
Finland 1971II-85I	2.12 (1.22)	-0.49 (0.20)			1.00 (--)	0.91 (0.45)		1.84	2.40	0.29
Netherlands 1971II-85II	3.91 (0.77)	[-0.22]	-1.70 (0.34)		1.00 (--)			1.17	1.79	0.53
Spain 1965I-84I	2.98 (1.76)	[-0.23]	-1.61 (0.51)		0.99 (0.16)	0.82 (0.44)	0.09 (0.06)	1.74	2.15	0.60
Switzerland (g) 1969II-84II	-29.52 (12.67)	0.45 (0.19)			1.00 (0.15)	0.26 (0.11)	-0.41 (0.28)	0.96	2.50	0.71

a) The dependent variable is the growth of the wage rate. The equations were estimated with growth minus the inflation term as the dependent variable. All equations are estimated by two-stage least squares on seasonally-adjusted semi-annual data, except for the constrained equations, which were estimated by ordinary least squares; per cent changes refer to semi-annual changes. The standard error of the estimate (SEE), the Durbin-Watson statistic (DW) and the adjusted proportion of explained variation ($\bar{R}^2$) are calculated using the actual values of the independent variables; $\bar{R}^2$ is based on the error sum of squares. Standard errors appear in parentheses below the coefficient estimates. Dummy variables are reported in Table 4.

b) For those countries where a non-linear specification of the unemployment rate is used, the figures in square brackets give the elasticity of wages with respect to the unemployment rate evaluated at the mean unemployment rate for the sample period. These bracketed figures are comparable to the coefficient estimates in the countries with a linear specification.

c) Inflation is defined as a moving average of current and past growth of the personal consumption deflator for all countries. For Japan, France, Australia, the Netherlands and Finland the coefficient of inflation was constrained to one. A two-period weighted moving average is used for Japan (weights of 0.67, 0.33), Germany (0.75, 0.25) and Italy (0.6, 0.4). For the other countries, the inflation term is a simple moving average of either two semesters (France, Australia, the Netherlands, Switzerland), three semesters (the U.K., Austria, Finland), four semesters (Spain), five semesters (Canada) or seven semesters (the U.S.).

d) Productivity growth is specified as a two-period moving average for the U.S. (weights 0.67, 0.33), Japan (0.67, 0.33) and Germany (0.5, 0.5); for Finland and Spain, it is a simple three-period moving average; for Switzerland it is unlagged.

e) The equations for France and Spain include the growth of the minimum wage relative to the lagged growth of aggregate wages. The difference between the growth of the private consumption deflator and the growth of the GDP deflator, as a proxy for shifts in the terms of trade, is included in the equations for Japan, Austria and Switzerland.

f) In the second U.K. equation the unemployment rate is entered as the difference from a lagged eight-period moving average of unemployment.

g) The activity variable for Switzerland is a measure of the employment rate defined as total employment divided by a lagged two-period moving average of the labour force, multiplied by 100.

Table 4

COUNTRY-SPECIFIC VARIABLES

	Description	Non-zero values for dummy variables	Estimated coefficient	Standard error
United States	Dummy variable for wage/price controls	1.0 from 70I to 72I	-1.00	(0.26)
	Dummy variable for the effect of an increase in the military or civilian wages	1.0 in 67I and 67II	-2.01	(0.40)
Japan	Dummy variable for unusual seasonal pattern	1.0 in 74I and 75I, and -1.0 in 74II and 75II	-3.65	(0.55)
Germany	Dummy variable for the events of 1969 and 1970	1.0 from 69II to 70II	3.51	(0.54)
	Dummy variable for an unusual seasonal variable	Alternates from 1 to -1 from 71I to 74II	0.99	(0.30)
France	Dummy variable for the events of 1968	1.0 in 68II and -1.0 in 69I	1.74	(0.67)
United Kingdom	Dummy variable for unusually large wage increases, perhaps in anticipation of the imposition of wage controls	1.0 in 70I	2.83	(1.53)
	Dummy variable for unusually large wage increases, perhaps associated with the newly-elected Labour government and the contract policy	1.0 from 74II to 75I, and -1.0 from 75II to 77II	3.93	(0.60)
Italy	Dummy variable for unusually large wage increases	1.0 from 73I to 73II	5.07	(1.54)
Canada	Dummy variable for unusually small wage increases	1.0 in 70I	-4.87	(1.33)
	Dummy variable representing possible effects of the Anti-Inflation Board policies	1.0 from 77II to 78II	-1.62	(0.79)
Australia	Dummy for unusually large wage increases, possibly reflecting an award in the National Wage Case by the Arbitration Commission	1.0 from 74I to 74II	5.81	(2.24)
Austria	Dummy variable for unusually large wage increase, perhaps reflecting buoyant profits and unusually strong demand	1.0 in 71I	3.50	(1.40)
	Dummy variable for an unusually large wage increase, perhaps reflecting an unusually large price increase	1.0 in 73II	3.10	(1.08)
Netherlands	Dummy variable for a reduction in indexing and bonuses	1.0 in 80II to 81I	-2.04	(0.50)
Spain	Dummy variable for an unusual seasonal	-1.0 in 81I and 1.0 in 81II	-4.07	(1.23)
Switzerland	Dummy variable for exceptionally large wage increases in the construction sector during a period of strong excess demand for labour, which spread rapidly to other sectors of the economy	1.0 in 70II	2.72	(1.01)

Note: These are the estimated coefficients on dummy variables which are included in the equations reported in Table 3.

associated with the hypothesis of hysteresis in the natural rate [Blanchard and Summers (1986) and Coe (1985)]. This hypothesis appears to receive the strongest support from the U.K. data; and the second equation, incorporating the hypothesis of hysteresis, has been incorporated into the U.K. model in INTERLINK.

27. Short-term productivity growth, which represents an additional cyclical impact on wage growth, is included in the equations for the United States, Japan, Germany, Finland, Spain and Switzerland. Shifts in the terms of trade, proxied by the difference in the growth of the private consumption deflator and the growth of the GDP deflator, enter the equations for Japan, Austria and Switzerland. Although both of these variables are related to the ability of firms to pay, direct measures of aggregate profits or profitability have not been found to be significant. The relative growth of minimum wages are included in the equations for France and Spain.

28. Inflation expectations are assumed to be adaptive, usually with a two- to three-semester distributed lag on current and past inflation, except in North America where the lags are found to be longer, reflecting the prevalence of multi-year contracts. The long-run estimated coefficients on inflation expectations are not significantly different from unity. For Japan, France, Australia and the Netherlands the unconstrained estimates exceeded, but were not significantly different from, unity. Although this might reflect extrapolative expectations or an otherwise incorrect proxy for inflation price expectations, the estimated coefficients on inflation expectations have been constrained not to exceed unity.

29. In the course of re-estimation, a range of stability tests were carried out to assess the extent to which the estimated coefficients might have changed. The results of these are summarised in Table 5. Most of the tests focus on the possibility of a break in wage behaviour in mid-1979, the most likely candidate for a change in policy regime, and also at end-1982, near the end of the severe and prolonged recession of the early 1980s. The general conclusion is that although the wage equations have shown some tendency to overpredict in the 1980s, there is little or no evidence of statistically significant changes in any of the estimated parameters or of structural instability. Further information on these tests, including the calculated test statistics, is given in Chan-Lee, Coe and Prywes (1987).

30. Equations for government sector wages have also been estimated for the Major Seven economies, the Netherlands and Switzerland. These equations relate the growth in compensation per employee in the government sector to current and lagged growth in private sector compensation and an error-correction term which imposes a unit long-run elasticity between government and private sector wages.

Prices

31. The design of the price system for the Major Seven country models was radically revised in 1985 to be consistent with the logic of the supply blocks. This entailed the linking of individual expenditure deflators to a single business value-added deflator, determined in the business supply block on the basis of the production-function-based measures of factor mix and factor costs, and relevant import prices.

Table 5

SUMMARY OF STABILITY TESTS

X indicates that the null hypothesis of equation stability is rejected at the 5 per cent significance level

	United States	Japan	Germany	France	United Kingdom (a)	Italy	Canada	Australia	Austria	Finland	Nether-lands	Spain	Switzer-land
Chow tests													
1979I/1981I break													
1982II/1983I break													
Recursive regression tests													
Forward: CUSUM			X				X						X
CUSUM squared	X	X	X		X		X			X		X	X
Backward: CUSUM	X												
CUSUM squared	X	X	X	X			X	X	X	X		X	X
Tests of parameter shifts													
Constant: 1979I/1981I break													
1982II/1983I break													
Unemployment: 1979I/1981I break					X								
1982II/1983I break													
Inflation: 1979I/1981I break					X X			X					
1982II/1983I break													
Tests of parameters which begin to trend with time after 1979I													
Unemployment		X											
Inflation					X X								
Time trending parameter tests													
F-tests: Test 1				X									
Test 2				X									
Hendry Chi-squared tests													
1979I/1981I break					X X	X			X	X		X	
1982II/1983I break									X	X		X	
Forecast error t-tests for last observation													
1979I/1981I break													
1982II/1983I break													

a) The first column is for the first U.K. wage equation reported in Table 3, the second column is for the second equation.

32. The respecification of domestic price formation in INTERLINK, described in Stiehler (1987), was carried out in the light of experience with this earlier version of the price block. The scope for perverse interaction for some countries between the price, monetary and supply blocks was a particular cause of concern. Many of the basic features of the earlier price block are, however, maintained and the gross value-added deflator of the business sector continues to be the central price measure. As before, prices are modelled as a mark-up on costs, assuming imperfect competition in product markets. The mark-up factor itself varies with changes in excess demand and international competitiveness.

33. There are, however, a number of important new features. The link with the cost dual of the production function has been loosened somewhat. One of the motives here has been to make aggregate inflation less responsive to short-lived or minor changes in the factor mix and costs. For the same reason, capital costs have been given a much smaller weight than before. As discussed in the section above on supply, a new measure of potential output has also been developed, using the production function and cost-minimizing employment (subject to a labour force constraint) as potential labour input, which serves as the excess demand influence on price inflation. This excess demand measure is considerably more responsive to movements in actual output than the previous measure based on normal output. Finally, a value-added deflator for the domestic energy sector has been explicitly incorporated into the system, opening a second channel (in addition to that of input costs) through which changes in energy prices affect inflation. This is found to be particularly important for energy-producing economies, such as the United Kingdom, the United States and Canada.

34. Although the short-run movements in domestic output prices are largely determined by domestic costs, a twofold error-correction ensures long-run homogeneity of the domestic output price level with respect to a weighted average of domestic costs and world prices. A relatively large weight of world prices, which represents a competitiveness effect, combined with overall system properties introduces a strong long-run tendency towards a "proportionate law of one price". In the short run, changes in prices are largely determined by changes in costs and excess demand pressures. As before, the value-added deflator serves as the main domestic determinant of expenditure deflators, with the deflator for inventory changes treated as the implicit residual. The direct impact of energy and non-energy import prices on expenditure deflators operate with variable weights reflecting the current value shares of imports in expenditures.

35. In order to cope with serious problems of multi-collinearity the estimation procedure departed somewhat from classical statistical analysis. A key feature was to allocate the joint variation of various disequilibrium influences alternatively to individual variables and to use the coefficients thereby obtained as priors in a mixed regression.

36. The overall results tend to reveal different degrees of product market competition across countries. Profit margins turn out to be relatively flexible in the equations for the United States, Germany, the United Kingdom and Canada but relatively invariant for Japan, France and Italy. The results are also consistent with an inverse correlation between economy size and the impact of foreign competition.

37. The full-model and partial block simulation properties change somewhat with the revised price system. Generally, inflation is more responsive than before to real-side shocks, which is mainly attributable to the respecification of the excess demand measure. The inflation response to monetary shocks is much now plausible. For some countries, the former version of the model tended to give weak or perverse responses to interest rate reductions, under fixed exchange rate assumptions, with the effects of reduced capital costs and improved productivity tending to offset the positive influence of higher pressure of demand in goods and labour markets. This is no longer the case. The adjustment to energy price shocks also now reflects much better the weight of the domestic energy sector.

38. A notable simulation feature of the new price block is the dynamic interaction of nominal and real influences under an exchange rate shock, reducing the degree of exchange-rate illusion embedded in the model. For a number of countries, this involves both a significantly faster erosion of trade competitiveness gains given by currency depreciation, and, through quicker price adjustments, larger domestic demand offsets to improved net exports, reflecting also the strengthened real-side effects of inflation and interest rates on consumption and investment behaviour.

Demand for Money

39. The money demand equations for each of the major 7 countries have also been re-estimated in the light of deficiencies which emerged in the use of the equations reported in previous Secretariat studies [Blundell-Wignall et al. (1984a,b)]. The former equations for Japan and the United Kingdom were not well supported by the data and a number of parameters had to be imposed in order to achieve acceptable simulation properties (5). Data revisions and redefinitions of monetary aggregates have also contributed to the obsolescence of the former equations.

40. The specification of money demand equations in previous Secretariat work reflected two important considerations. The statistical stability of equation estimates was given a high priority in the choice of monetary aggregates even though they were not necessarily those most relevant to the conduct of policy. The conflict between stability and policy relevance was previously dealt with by the use of bridging equations between the policy-relevant monetary aggregates and the estimated equations. For some countries, notably Italy and Canada, this has proved to be cumbersome. A second consideration concerns the manner in which money demand equations are used in INTERLINK simulations. With the money demand functions routinely inverted in simulation to determine interest rates, under the assumption of a fixed money supply, the response of interest rates to various shocks has also been an important factor in the choice of preferred equations (6).

41. The former specifications were of the following form:

$$\ln(M/P) = a_o + a_1 \ln(Y/P) + a_2 r + a_3 \ln(M/P)_{-1} + a_4 \ln(P/P_{-1})^2 \qquad [3]$$

where:

M = nominal money supply

P = GNP/GDP price deflator

Y = nominal GNP/GDP

r = short-term nominal interest rate

$(P/P_{-1})^2$ = annual rate of inflation (half yearly data)

with only the equations for the United States and the United Kingdom including the inflation term as a proxy for the opportunity cost of holding money. In simulation, this specification caused a number of problems. The use of identical dynamics in equation [3] for income and interest rate terms often gave rise to implausibly sharp movements in short-term interest rates for shocks under a fixed money supply assumption. In respecifying the equation, a degree of smoothing has been introduced for the income term, providing more plausible structure and simulation response. The inclusion of an inflation term also caused perverse movements in interest rates in some simulations. Under a rapid disinflation, the demand for money tends to increase via the inflation term. Since the coefficient on the inflation term was relatively large, the induced increase in demand for money tends to raise the short-term interest rate in order to meet a fixed money supply target.

42. The following alternative equations were estimated with quarterly data, generally for the period 1973Q2 to 1985Q2:

$$\ln(M/P) = a_o + a_1 \ln[(Y/P + (Y/P)_{-1} + (Y/P)_{-2} + (Y/P)_{-3})/4] + a_2 \ln(1+r) + a_3 \ln(M/P)_{-1}) + e \qquad [4]$$

$$\ln(M) = a_o + a_1 \ln[(Y + Y_{-1} + Y_{-2} + Y_{-3})/4] + a_2 \ln(1 + r) + a_3 \ln(M_{-1}) + e \qquad [5]$$

Equation [4], which relates real money demand to real income, guarantees the long-run homogeneity with respect to a change in price level. However, the equation separates the effects of a change in nominal income into a change in the price level, which has no lagged effects, and a change in real income, which has lagged effects. Equation [5] does not impose this restriction on the lag structure, and long-run homogeneity with respect to the price level is achieved if the estimated long-run elasticity of nominal income is equal to one. The choice between these forms was made taking account of the performance of the equation and the homogeneity condition. Money demand equations were first estimated using quarterly data and then transformed into semi-annual form, while preserving long-run income and interest elasticities and mean lags. Preferred estimated equations and transformed analogues are shown in Tables 6 and 7, respectively.

Table 6

ESTIMATED MONEY DEMAND EQUATIONS (a)

$$Ln(M) = a_0 + a_1 \ln(Y + Y_{-1} + Y_{-2} + Y_{-3})/4 + a_2 \ln(1+r) + a_3 \ln(M)_{-1}$$

Dependent variables specification (b)		a_0	a_1	a_2	a_3	R^2	h	S.E.	Long-run (semi) elasticities (d) EY	EP	ER
United States											
M1 73.II-85.II	N	-.001082 (.0447)	.05339 (1.88)	-.1475 (2.58)	.9441 (24.9)	.999	-.448	.00781	.955	.955	2.64
M2 73.II-85.II	N	-.2652 (2.62)	.1482 (3.05)	-.2934 (4.26)	.8602 (17.9)	.999	1.76	.00669	1.06	1.06	2.10
Japan											
M2+CD 73.II-85.II	R	-3.267 (3.88)	.3026 (3.76)	-.2817 (4.18)	.7961 (14.0)	.998	4.50	.00991	1.48	1.0*	1.38
Germany											
M3 73.II-85.II	R	-1.709 (.933)	.1616 (1.12)	-.1808 (3.07)	.8974 (10.8)	.994	.204	.00918	1.57	1.0*	1.76
France											
M2 (new) 78.II-85.III	R	-.8916 (.556)	.2904 (2.60)	-.2792 (3.00)	.7364 (6.96)	.921	2.87	.00859	1.10	1.0*	1.06
M3 (new) 78.II-85.III	R	2.906 (1.17)	.1584 (2.21)	-.1920 (2.73)	.7337 (6.40)	.772	1.87	.00851	.595	1.0*	.721
United Kingdom											
£M3 75.IV-85.II	N(c)	-.3408 (2.55)	.1611 (5.10)	-.1159 (-)	.8467 (27.3)	.999	-	.0102	1.05	1.05	.756*
Italy											
M2 73.II-85.II	R	-.1306 (.113)	.1403 (3.75)	-.5880 (7.16)	.8656 (26.2)	.956	.325	.0123	1.04	1.0*	4.37
Canada (Not used in the INTERLINK system)											
M2+ 73.II-85.II	R(c)	-3.557 (3.67)	.2349 (3.60)	-.1635 (-)	.9030 (31.3)	.999	-	.00740	2.42	1.0*	1.69*

a. OLS estimates. Figures in parentheses are t-statistics.

b. In equations with "N", nominal money supplies and nominal incomes are used. In equations with "R", real money supplies and real incomes are used.

c. In £M3 equations for the U.K. and in M2+ equation for Canada, the coefficients of the nominal interest rate are raised in absolute value by one standard error of an unconstrained equation.

d. EY: real income elasticity

EP: price level elasticity

ER: nominal interest rate semi-elasticity

* Imposed elasticities either by using real "R" specification or using constrained estimation "(c)".

Table 7

TRANSFORMED SEMI-ANNUAL EQUATIONS PRESERVING LONG-RUN ELASTICITIES AND MEAN LAGS (a)

$$\ln(M) = A_0 + A_1 \ln(Y + Y_{-1})/2+ + A_2 \ln(1+R) + A_3 \ln(M)_{-1}$$

Specification (b)		A_0	A_1	A_2	A_3	Mean lags (semesters)	Long-run (semi) elasticities(d) EY	EP	ER
United States									
M1	N	-.002049	.1011	-.2794	.8941	8.44	.955	.955	2.64
M2	N	-.4653	.2600	-.5148	.7547	3.08	1.06	1.06	2.10
Japan									
M2+CD	R	-5.427	.5027	-.4680	.6613	1.95	1.48	1.0*	1.38
Germany									
M3	R	-3.100	.2931	-.3280	.8139	4.37	1.57	1.0*	1.76
France									
M2 (new)	R	-1.411	.4596	-.4419	.5828	1.40	1.10	1.0*	1.06
M3 (new)	R	4.590	.2502	-.3032	.5794	1.38	.595	1.0*	.721
United Kingdom									
£M3	N(c)	-.5910	.2794	-.2010	.7342	2.76	1.05	1.05	.756*
Italy									
M2	R	-.2303	.2474	-1.037	.7630	3.22	1.04	1.0*	4.37
Canada (Imposed equation)									
M2	R	-0.21419	.25	-.45	.75	3.00	1.0*	1.0*	1.8*

a. Transformation of quarterly equations into semi-annual equations is done using the following equations:

$A_0 = 2a_0/2-a_3$ $\quad A_2 = 2a_2/2-a_3$

$A_1 = 2a_1/2-a_3$ $\quad A_3 = a_3/2-a_3$

A_i: coefficients of semi-annual equations.

a_i: coefficients of quarterly equations.

b. In equations with "N", nominal money supply and nominal income are used. In equations with "R", real money supply and real income are used.

c. The coefficient on the interest rate is constrained in the estimation (see Table 1).

d. EY: real income elasticity, EP: price level elasticity, ER: nominal interest rate semi-elasticity, *: imposed elasticities.

43. Given the shifts of emphasis between alternative monetary aggregates, equations for both M1 and M2 were estimated for the United States (7). As with the former equations, the inclusion of an inflation term as a proxy for the opportunity cost of holding money poses a problem in simulation. Whilst there have been historical episodes in which lower U.S. inflation rates have coincided with faster money growth (8), a simulated rise in interest rates caused by a fall in the inflation rate would seem to be generally perverse. Excluding the inflation term with averaged income (equation [4]), the estimated long-run income elasticity became very large (1.5 for M1 and 2.3 for M2), too large in view of the increasing trend of M1 velocity and the steady trend of M2 velocity. The alternative equation [5] has reasonable estimated parameters that broadly satisfy the homogeneity condition and was therefore preferred.

44. For Japan, real M2+CD is used as the dependent variable. The estimated real income elasticity is broadly consistent with the corresponding estimates of the former equation. This is also the case for Germany, where real M3 was used as the dependent variable. For France, where there is a lack of historical time series for the recently-revised monetary aggregates, the equations were re-estimated using a sample starting in 1978. Money demand functions were, in line with targets set for 1987, estimated both for new M2 and M3.

45. For the United Kingdom, £M3 was chosen as the dependent variable given its frequent use as a primary target of monetary policy (9). It is difficult, however, to identify a stable function for £M3. The most "reasonable" estimate was obtained in nominal form. While the estimated long-run income elasticity of 1.05 seems reasonable, the freely-estimated long-run interest elasticity of 0.27 is both statistically insignificant and small as compared with other countries (see Table 7), implying implausibly large movements of interest rates in simulation. Given the large standard error (0.0729 compared with a coefficient of -0.0430), the equation was re-estimated with a constraint setting the interest rate coefficient at one standard error below the unconstrained estimate (-0.1159). The other coefficients of this constrained equation were similar to those of the unconstrained equation, and although the tracking ability of the constrained equation does deteriorate somewhat, its overall performance was judged to be more acceptable.

46. For Italy, in addition to equations for M2 and M3, a private credit demand equation was also estimated. The estimated M3 function had an unreasonably high long-term income elasticity (2.2) and the credit demand function had a negative income elasticity, so that the M2 equation was preferred. This choice appears to be consistent with the increased emphasis of the Bank of Italy on the M2 target relative to the credit aggregate.

47. Canada has not had a monetary target since it stopped targetting M1 in 1982. M1 and M1A have been distorted by the rapid increase in daily interest-bearing chequing accounts, and M2 is perversely correlated with the interest rate. However, M2+ is said to be currently the most reliable aggregate [Bank of Canada (1986)] and was therefore used as the dependent variable. Original estimates of the equation showed implausibly low interest rate elasticities, yielding implausibly large simulated movements in the interest rate under fixed money supply assumptions (10). To maintain reasonable simulation properties, an elasticity broadly in line with U.S. results was therefore imposed. In the normal course of forecasting and simulation analyses, however, Canadian interest rates are generally set in relation to U.S. rates, with due allowance for differential movements in exchange rates.

48. From the point of view of model simulation properties and cross-country comparisons, the most relevant feature of these estimates concerns the relative degrees of pressure on interest rates which they imply, under a fixed monetary rule, for given changes in activity and price levels. The relevant indicators based on the estimated parameters are summarised in Table 8. Excluding Canada, where the relevant parameters are imposed, the main features are relatively low partial responses for Italy and the United States (0.2 and 0.5, respectively), and a relatively high response for U.K. £M3 (1.4).

Investment Income

49. The emergence of large current-account surpluses and deficits at a time of high interest rates and fluctuating exchange rates has increased the importance of international investment income flows, particularly those related to interest on portfolio holdings. In earlier versions of INTERLINK, investment income flows were treated in the model as exogenous items and hence the full effects of cumulating external debt were not properly captured in simulation analyses. Priority was given, therefore, to the development of an international investment income block and the final estimated version of this system, described in Coe et al. (1987), is now fully incorporated into the model.

50. Although this system was estimated on the basis of total investment income data, its design is based primarily on considerations related to portfolio investment and therefore does not take explicit account of the influence of profitability on the returns to foreign direct investment. In the context of Secretariat forecasts and related analyses, the effects of these factors are assessed judgementally.

51. In general, the investment income block relates separate credit and debit flows in nominal terms to the relevant stocks, appropriately valued by currency of denomination, and the corresponding effective rates of return on assets and liabilities. Asset and liability stocks are computed from given starting point assumptions using a series for gross flows of capital, and revaluation effects. Data for gross assets and liabilities are only available for a limited number of countries; for the other countries and regions, the investment income block is based on net flows and asset stocks.

52. For valuation purposes, it is assumed that each country invests in two currency baskets: one consisting of dollar assets, the other a weighted average of other currencies. For each country, the importance of non-dollar currencies in relation to each other is assumed to be given by constant share matrices. The relative importance of dollar-denominated assets and liabilities, however, changes with the dollar exchange rate. Thus the nominal dollar valuations of the outstanding assets and liabilities change with movements in the exchange rates, as well as being affected by capital flows.

53. The central behavioural equations in the system are those for the effective rates of return on assets and liabilities. These are related to weighted short- and long-term interest rates in the currencies relevant to individual countries' asset and liability portfolios. Generally, these rates of return react with a lag to current interest rates, reflecting inter alia the tendency for portfolios to be valued at historic costs adjusted for exchange rate movements, rather than at current market values and the fact that part of the portfolio consists of long-term fixed-rate bonds and loans which do not vary

Table 8

COMPARISON OF PARTIAL SHORT-RATE RESPONSES
UNDER A FIXED MONEY RULE

		Partial impact on short-term rates (pts.) for a 1 per cent increase (1) in:	
	Equation	Real GNP level	Price level
United States	M1	0.4	0.4
	M2	0.5	0.5
Japan	M2 + CD	1.1	0.7
Germany	M3	0.9	0.6
France	M2	1.0	0.9
	M3	0.8	1.4
United Kingdom	£M3	1.4	1.4
Italy	M2	0.2	0.2
Canada (2)	M2+	0.6	0.6
Average for broadest measure (3)		0.8	0.8

1. Full-year effects, calculated as the ratio of the corresponding long-run elasticities to the interest rate semi-elasticity. Reponses in the first half-year are exactly one-half of those shown above.

2. Imposed

3. Excluding Canada

with current interest rates. The estimated parameters and lag distributions in the rate of return equations can, therefore, be thought of as summarising the heterogenous composition of the outstanding stock of assets and liabilities.

54. Given portfolio data based on currency denomination rather than on a geographic distribution, the current version of the block as a whole does not match assets and liabilities and there is not therefore a double-entry system to ensure that one country's credit or asset is another country's debit or liability. The data for the net stocks of assets and liabilities moreover do not in general sum to zero across countries, although the net changes in these stocks, aside from revaluation effects and the world current-account discrepancy, do. In simulation, therefore, global consistency of movements in interest flows depend both upon cross-country compatibility of the rate of return equations and the consistency of global stocks of assets and liabilities held in different currencies. Available tests suggest that for relatively modest changes in interest rates and currencies, consistency is not a problem within the system. However, as long as the basic data contain large differences between credits and debits, simulations do have a tendency to change the world current account discrepancy. A further problem is that there are imbalances in the currency denomination of assets and liabilities and, in the context of major interest-rates changes, secondary consistency adjustments on the basis of gross flows have been found to be necessary.

55. The investment income block has had a significant impact on the channels through which movements in the exchange rate and other variables affect the current account. In the revised system, the effects of simulated improvements in the balance on trade and non-factor services are now amplified by corresponding improvements in the stock of net foreign assets, which in turn generate further improvements in the balance on investment income. In the context of exchange rate simulations, the combination of this effect with those of income revaluations are quantitatively quite significant; for example, for the United States the simulated improvement in the current account, given after three years by a 10 per cent dollar depreciation, increases from $10 billion, with the previous model, to $15 billion with the addition of the investment income block.

Non-Oil Commodity Prices

56. The most recent Secretariat work in the modelling of non-oil commodity prices is an extension of the empirical study presented in Holtham et al. (1985) and is described in Holtham and Durand (1987). Because these equations play only a minor role in the preparation of regular Secretariat short-term forecasts, the failure of earlier equations to track developments in 1984 and 1985 was not the primary motivation for respecification and re-estimation. In medium-term analyses, however, the combination of cyclical dynamics and poor short-term performance posed a number of serious problems.

57. From the point of view of simulation properties, two important features emerged from use of the former system. First, to the extent that the equations relied significantly on lagged dependent variables, often for a number of periods, the adjustment of real commodity prices to simulated shocks proved to be extremely oscillatory. Whilst such behaviour might be rationalised in terms of differential production/inventory and investment cycles, the lack of a clear "explanation" within the structure of the model

was felt to be a weakness. The instability of reduced forms estimated across different data sets also suggested a failure to distinguish correctly between intrinsic cyclical features of commodity markets and the "noise" characteristics of the data set. A second problem related to the extent to which equations based on two parallel sets of price indices -- those from UNCTAD and Hamburg Institute (HWWA) sources -- which are used in the model to determine, respectively, non-OECD and OECD export unit values, implied significantly different movements in the terms of trade for OECD and non-OECD exporters. Whilst such differences may not be inappropriate given the different composition of exports, it was felt that the significance of differing responses should as a matter of course be tested at the estimation stage.

58. The re-estimation work has therefore attempted to resolve as far as possible the above problems. Two important features have been the testing of the trade-off between the complexity of equation dynamics and tracking performance, and the testing of the statistical acceptability of coefficient constraints between equations for the UNCTAD and HWWA indices of similar composition. At the same time, a more flexible nominal dollar as opposed to real price approach has been adopted, with other prices and exchange rates appearing as determining variables. Cointegration analysis has been carried out specifically with respect to the form of the OECD real GNP influence and, at the final stage, a system-wide estimation method was used to provide more efficient coefficient estimates.

59. In estimation, there was little overall difficulty in achieving a general simplification of equation dynamics without loss of predictive power. Preliminary estimates gave long-run elasticity estimates with respect to the OECD dollar GNP prices which were not significantly different from unity and such a constraint was therefore built into later specifications by means of an error-correction term.

60. For some categories there was evidence of a structural break in the relationship in the late 1960s. With respect to the influence of real GNP, cointegration analysis and related parameter estimates failed to identify any long-run relationship between commodity prices in real terms and the level of OECD real GNP, implying an elastic long-run supply. In estimation, the GNP growth rate was found to be significant, though in a number of cases polynomial time trends were also found to be significant. In the context of forecasting analysis, the latter are necessarily treated as judgmental exogenous factors. The level of oil prices was found to be significant in most cases, but, in contrast to previous estimates, only weak interest-rate effects were found, primarily for agricultural raw materials.

61. With regard to cross-equation restrictions, the null hypothesis of identical coefficients could not be rejected for UNCTAD and HWWA indices for agricultural raw materials, in spite of composition differences. For minerals full identity was rejected, although restrictions on identical impact parameters for the OECD dollar price and long-run GNP growth elasticities were accepted. The idiosyncratic classification of the relatively volatile sugar price, as between food and tropical beverage categories for the UNCTAD and HWWA indices, makes corresponding parameter constraints inappropriate. For these categories, the relative instability of individual estimates provides little support for continued disaggregation between the two categories in future work.

62. In simulation testing, the overall results suggest a generally more well-behaved system with little evidence of oscillatory reactions to exogenous shocks and, by comparison with the former system, only limited terms of trade differentials between OECD and non-OECD exporters. In simulation, an important feature of the revised system is that although exchange rate terms are not directly included, the effects of movements in the U.S. dollar are transmitted through movements in the dollar GNP deflator for OECD. With the exception of food prices, the average pass-through of changes in the dollar is of the order of two-thirds. For food a fuller pass-through is present with some evidence of overshooting in the case of the UNCTAD index.

Country-Specific Model Developments

63. In addition to the clearly identified subject block topics, outlined in the previous sections, a number of other important changes have been made to the system in the last year or so. These have been largely country-specific and designed to assist the Secretariat country specialists in their use of the model for forecasts and EDRC-related analyses. The largest single change has been the introduction of separate Federal and State and Local accounts in the government sector of the U.S. country model. These were introduced in a way which leaves overall model properties unchanged but endogenises the most significant elements of the disaggregated accounts.

64. For the Netherlands and Australian country models the household, business and government appropriation accounts have been extended to permit a more detailed analysis of country-specific sub-sectors. For the Netherlands, the gas sector is now separately identified as is the agricultural sector for Australia. For both of these countries, a number of specific equations have been revised in the light of Secretariat and available country-based evidence.

II. WORK IN PROGRESS AND FUTURE DEVELOPMENTS

65. This section describes Secretariat model-related work in progress which is expected to contribute to future versions of INTERLINK (11). It also considers a number of areas of possible future developments related to the Secretariat's current work programme.

Trade Prices and Volumes

66. The determination of import prices on a consistent international basis poses a number of problems for a world linkage model such as INTERLINK, particularly with respect to manufactured goods. In the absence of detailed bilateral price data for 23 Member countries and six non-OECD zones, the current version of the system adopts a two-stage approach, with export prices determined by commodity group at the national level, taking account of domestic costs and competitor prices, and with import prices determined for each country and commodity group in relation to a "shadow price" obtained from import market-weighted averages of corresponding exporter prices. Allowance is made in the "shadow price" for transportation lags and, in the case of

manufactures and non-factor services, some weight is given to the level of domestic GNP prices in the importing country in relation to the world price level. In order to achieve global consistency in export and import price evolution, without ad hoc adjustments, the domestic price weight is constrained to be equal across countries, currently with a value of 10 per cent.

67. There is, however, abundant evidence of price discrimination between export markets, particularly under conditions of uncertainty and major currency movements. To the extent that such discrimination might vary with established market shares and openness, it is unlikely to imply a uniform weight for domestic price influences across countries. Secretariat forecasting experience, notably in the context of U.S. dollar movements during the 1980s, tends to confirm the inadequacy of such an approach (12). Recent Secretariat work on manufactures trade prices, described in Herd (1987), has therefore examined the scope for consistent export and import price determination whilst permitting a variable degree of domestic price influence across markets.

68. The basic approach adopted is that utilised in the French Atlas model (1983). Beginning with a fairly general specification of bilateral pricing in which an exporter's price to a given market is determined by the exporter's costs and the prices of competing goods, both those of the importing country and other exporters, manageable aggregate expressions are derived for average import and export prices for each country. This is achieved through simplifying assumptions relating to overall price and cost homogeneity and the consistency of cost influences across markets and the relative importance of competitors in a given market. The final estimation form for import prices uses a specification involving terms in the importing country's domestic price and weighted exporter costs, with coefficients summing to unity. The corresponding specification for export prices for a given country involves the exporter's costs and a market-weighted average of domestic and import prices, again subject to a homogeneity constraint. Parameters specific to the weighting procedures are, however, common to the full set of export and import price equations, necessitating an iterative estimation procedure.

69. For manufactures export prices, the overall estimation results are generally acceptable and suggest a relatively high average weight, of 35 per cent, given to competitor prices in export price setting. Such a result is not inconsistent with present INTERLINK parameters. The dispersion across countries is relatively wide, however, with relatively low competitor weights (in the range 0.1 to 0.2) obtained for the United States, Canada, Germany, and the United Kingdom compared with relatively high weights for Japan, France and Italy (in the range 0.4 to 0.6) Estimates of the domestic cost weights for a number of smaller countries are also found to be relatively high (in the range of 0.4 to 0.8), suggesting that they too can be significant price makers rather than price takers.

70. For manufactures import prices, the average coefficient on domestic prices is high in relation to the current imposed model parameter, at 0.25, consistent with an average 75 per cent pass-through of exchange-rate and foreign cost movements to import prices. The range of domestic price coefficients is nonetheless wide, with the estimates as high as 0.4 for the United States, Germany and Canada and near zero for Japan, Italy, Finland and New Zealand. Although there is some evidence of large residuals between 1973 to 1975, possibly reflecting the absence of a demand pressure term, the

overall goodness-of-fit excluding this period is reasonable, and out-of-sample predictive accuracy since 1983 is a clear improvement over the existing system.

71. A manufactures trade price system based on these results is currently being tested in an experimental version of the model and, subject to the results of further simulation tests, is likely to be incorporated in the next standard version.

72. As with trade prices, the foreign trade volumes block has not been re-estimated for a number of years. While in general the relevant coefficients continue to be representative of findings in research undertaken by national authorities and present in other international models, there are some cases where the dynamic tracking properties of the equations for manufactured import and export volumes suggest that the underlying parameters may have changed since the current version of the trade block was implemented. In addition, there are currently no price elasticities in the import and export volume equations for food and raw materials. The Secretariat research effort in this area will be focused initially on manufactures imports, followed by raw material and food imports and exports and, finally, manufactures export volumes. Particular attention will be paid to the dynamics of adjustment to relative price changes. In the initial phases, the analysis will remain within the context of the existing demand-related structure, but will later consider the introduction of more long-run supply-side effects on a consistent international basis.

Monetary sector developments

73. In addition to the work on money demand for the major economies outlined earlier, two further aspects of the monetary sectors are currently under review. The first concerns the interest rate yield curve, which in the existing monetary blocks is represented in terms of the equation linking long-term to short-term interest rates, subject to the influence of inflation expectations (in the form of an inflation acceleration term) and, for some economies, government debt, which has fairly recently been endogenised in the fiscal blocks for most Member country models. These equations are being re-estimated on the basis of longer data series, and the role of additional pressure variables, such as those reflecting current-account positions, is also being examined. Results to date, however, fail to identify for a number of major economies plausible inflation terms, but do give limited support to the influence of the external account, notably for Japan and Germany. For a number of countries also, recent estimates tend not to support a long-term unit response to short-term rates, which is currently imposed through an error-correction term. Given the importance of this particular response to the size and speed of the transmission of monetary effects to the real side, more detailed testing is under way in this area.

74. A second area being reviewed concerns the monetary blocks of the smaller country models. At present, these comprise short-term interest rate equations -- essentially reaction functions relating domestic short rates to weighted foreign rates -- and the yield curve, determining long-term rates in relation to short rates. For a number of non-Major Seven countries, there is growing interest also in the introduction of demand for money functions, as for the major economy models, and the re-examination of independent velocity and exchange pressure influences on short-term rates.

Expectations

75. The role and influence of expectations on the macroeconomy continues to be an area of major concern in the Secretariat's empirical and model-based analyses. Significant progress has already been made in opening up the channels in the model through which expectations work, for example with respect to output supply, real interest rates and exchange rates, although further scope remains, for example, with respect to inflation, for a more explicit and consistent treatment.

76. With regard to expectations formation, past versions of the model have tended to rely more on adaptive than forward-looking mechanisms. This in part reflects technical limitations but in a number of areas, for example wage determination, also reflects the weight of empirical evidence in support of an adaptive process. One area of particular interest to future work is the possible development of model-consistent expectations, in effect experimenting with model-based forms of rational expectations. The feasibility of such a study is however seriously limited by model size and the computational burden of performing multiple model solutions over even a limited time horizon. Partly to facilitate work in this area, the data configuration and model solution techniques used in the INTERLINK system are currently being reviewed. At the same time, further work, as described below (para. 86), is being carried out on the construction of a small condensed version of the model specifically for use with the dynamic solution techniques required for the derivation and analysis of model-consistent expectations.

77. An alternative approach is that of incorporating explicit quasi-reduced form relationships for expected variables based on equations relating actual values to current and past values of related variables and also future values of exogenous policy variables, which by definition would be predetermined at the starting point of the simulation period. In the case of wages, estimation results along these lines were reported in Coe (1985). Although such an approach overcomes a number of the computational problems, it seems unlikely to avoid the question of consistency with respect to overall model properties.

Appropriation Accounts

78. The appropriation accounts in INTERLINK have not been subject to major revisions for some time and there are a number of anomalies which need to be addressed. Over the coming year it is hoped to reassess their structure although this may not in fact imply any major changes to overall variable coverage.

79. As regards the general government account, the most important part of the agenda is on the tax side. The personal direct tax equations need to be re-examined in terms of both the elasticities and the lags. It may prove possible to generalise the idea, already adopted for the Netherlands country model, of breaking down increases in the tax base between increases in the number of taxpayers and increases in per capita revenue. It may also be appropriate to incorporate an endogenous response to changes in the inflation rate for countries with some form of indexation. The indirect tax sector will also be reviewed and it may no longer be necessary to keep either the links to input-output weighted expenditures or the direct tie with the subsidies equations.

80. On the spending side, the priorities concern the possible separation between unemployment benefits and other social transfers, and an updating of the coefficients in the debt interest equations. With regard to direct expenditures the current practice of using real government wages and nominal non-wage spending the exogenous or policy variables in simulation seems appropriate for relatively short-term analyses but may need to be reviewed in the context of medium- and longer-term scenarios.

81. The most important prospective change in the households appropriation account concerns the treatment of property income. The current model assumes government net interest payments to be fully counted in business sector income. Household property income, in turn, is defined as a constant share of after-tax business income. An alternative approach would be to allocate net government interest payments between the household and business sectors, with business dividend payments to households modelled separately. This would in turn imply revisions to the modelling of business sector income.

Smaller Country Model Developments

82. A continuing effort is being made to develop and improve the smaller OECD country model blocks within INTERLINK in ways which are useful in the regular construction of forecasts and projections and related simulation analyses. Specific topics currently being reviewed on a cross-country basis include factor demand and wage and price determination.

83. Country specialist interest has perhaps been greatest in the area of wage determination and the relevant empirical work has been included in special chapters on the labour market for a number of recent OECD Country Surveys (13). As far as possible, this work has been carried out in a manner which facilitates cross-country comparisons and permits the relevant equations to be readily incorporated into the model. Wage equations have recentlty been re-estimated and incorporated into the model for Australia, Austria, Finland, the Netherlands, Spain and Switzerland; revised estimates for a number of smaller OECD countries, including Denmark, Sweden, and Ireland, are expected to be incorporated into the next version of the model.

84. With regard to specific country model developments, a relatively ambitious project is nearing completion concerning the Danish model where a systematic review and re-estimation of the relevant country block has been carried out. This has involved a major extension of the existing model structure and re-estimation to include revised tax and household appropriation accounts, a revised consumption equation and a three-factor production function-based supply block (in line with the major country models), with corresponding links to prices. The relevant changes have been incorporated in an experimental version of the model for use in the annual survey of Denmark for the Economic and Development Review Committee.

Non-OECD Regional Blocks

85. With regard to the non-OECD regional blocks of the model, Secretariat work is largely concerned with improving the trade sector relationships linking the North and South. Following the study of commodity prices, described earlier, future plans centre on the possible incorporation of structural features based on a summary representation of the IBRD debt model.

This would permit the introduction of debt and debt service payment considerations in the determination of non-OECD imports and hence allow further for the important feedbacks from OECD activity, inflation and financial influences (14). The main areas of work identified so far in this collaborative project concern the alignment of the relevant data bases and the analysis of aggregation procedures associated with the IBRD model, which is relatively non-linear.

A Condensed Version of INTERLINK

86. The INTERLINK model, like those used by a number of national authorities, is multifunctional and, in terms of size and complexity, its scale represents a compromise between what is necessary for the Secretariat's regular production of detailed country and world trade forecasts and projections and the requirements for related simulation and macroeconomic analyses. Given its multi-country dimension, the system is nonetheless too large to permit a range of more advanced applications (in particular those involving aspects of dynamic optimisation and the use of forward-looking or model-consistent expectation mechanisms). Perhaps more importantly, it is also sufficiently complex in a number of areas to obscure the importance of key features and parameters in the determination of overall model properties. The latter is a major focus of interest in the analysis of longer-term model properties.

87. For these reasons, a study is currently under way to design and produce a condensed or "maquette" version of the model. Such a project, building on the earlier work of Masson and Richardson (1983) with MINILINK, seeks to construct through partial simulation of the main INTERLINK system a reduced-scale structural representation of the model. This will involve the collapsing and aggregation of detailed relationships in the existing model blocks in such a way as to preserve the main features of the structural relationships and the overall single-country and linkage properties of the system.

88. This work is in its early stages but preliminary plans are for the calibration of a linked set of five country/region blocks, separately identifying the United States, Japan, Europe, an aggregate other OECD economy block and a non-OECD regional block. These would vary in specification and size, reflecting specific features of the parent model. Once the relevant model-reduction procedures are in place, it would be the Secretariat's intention to calibrate a new version of such a condensed system from time to time, in line with the evolution of the main system.

NOTES

1. The version of the INTERLINK model considered is the standard version of February 1987. With regard to model releases and testing procedures, see also note (11).

2. A discussion of the role of policy issues in the evolution of earlier versions of the INTERLINK model is given in Llewellyn and Richardson (1985).

3. The final equations, shown in Table 1, differ somewhat from the estimation results reported in Holtham and Kato (1986). For the United States and Japan, differences primarily reflect the recent rebasing of National Accounts. Inflation expectations have also been modelled in the final version with a three-period moving average as against a one-period lag.

4. Whereas the net contributions of the inflation terms are relatively small in the context of a specification which also features nominal interest rates, they are nonetheless quantitatively significant in relation to the previous version of INTERLINK which featured terms in real interest rates.

5. For the United Kingdom, the combination of a relatively high interest elasticity and low income elasticity gave implausibly low interest rate movements with a fixed money supply target. For Japan, the reverse was the case, with the long-term real income elasticity arbitrarily reduced and the interest rate semi-elasticity increased in order to avoid an extreme degree of crowding out. See also note (10).

6. Although earlier versions of the model have included estimated "reaction function" equations for the Major 7 country interest rates, these have not in general been used since they are not clearly associated with an explicit choice of monetary policy. It is considered more useful to specify interest rate determination in the context of explicit simulation and forecasting rules; commonly used alternatives are for short-term rates to be fixed in nominal or real terms or used as instruments to achieve fixed supply or exchange rate targets.

7. No target was set for M1 in 1987 with more emphasis placed on broader aggregates.

8. In 1982 and 1985, for example, the velocity of money declined sharply under rapid disinflation. The Fed accommodated the increased money demand by overshooting M1 targets in these periods.

9. More recently this aggregate has been downgraded with more emphasis placed on the narrow M0 aggregate.

10. The changes in interest rates required to offset unit changes in real GNP and prices for a fixed money target, are given on inverting the demand for money function by the ratio of the income and price elasticities to the interest rate semi-elasticity:

$$dM/M = ey\ dY/Y - eRdR + eP\ dP/P$$

so that for fixed nominal money:

$$dM/M = 0 \text{ and}$$

$$dR = (eY/eR)\ .\ dY/Y + (eP/eR)\ .\ dP/P$$

11. Secretariat procedures with respect to the testing, implementation and release of revised versions of INTERLINK are now well-established. Empirical research and related proposals for revisions to country and

subject blocks are discussed by a Technical Working Group, within the Economics and Statistics Department, along with preliminary assessments of the impact of individual changes on model properties. The latter assessments are carried out in the context of a relatively standardised set of simulation shocks. Where major restructuring is involved, testing is often carried out in the context of experimental reprogrammed versions of the system. Approved model revisions are then incorporated in the coding of finalised standard versions of the model for release twice yearly, at the start of each Economic Outlook forecasting Round.

12. See, for example, Richardson (1987a).

13. See, for example, the OECD Economic Surveys for: Switzerland, December 1985; Spain, April 1986; Finland, June 1986; and Italy, July 1986.

14. Secretariat analyses of the debt aspects of the linkages between the developing countries and the OECD are currently carried out by means of an off-model debt accounting system, as described in Saunders and Dean (1986).

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