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The OECD's New Global Model

Karine Hervé,
Nigel Pain,
Pete Richardson,
Franck Sédillot,
Pierre-Olivier Beffy

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ABSTRACT/RÉSUMÉ

The OECD's New Global Model

This paper provides a summary of the OECD's new global macroeconometric model, including an overview of model structure and a selection of simulations illustrating its main properties. Compared with its predecessors, the new model is more compact and regionally aggregated, but gives more weight to the focus of policy interests in global trade and financial linkages. The country model structures typically combine short-term Keynesian-type dynamics with a consistent long-run neo-classical supply-side. While retaining a conventional treatment of international trade and payments linkages, the model has a greater degree of stock-flow consistency, with explicit modelling of domestic and international assets, liabilities and associated income streams. Account is also taken of the influence of financial and housing market developments on asset valuation and domestic expenditures via house and equity prices, interest rates and exchange rates. As a result, the model gives more prominence to wealth and wealth effects in determining longer-term outcomes and the role of asset prices in the transmission of international shocks both to goods and financial markets.

JEL classification codes: E17; F01; F47
Keywords: Global; macroeconomics; econometric modelling; simulation

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Le nouveau modèle global de l'OCDE

Ce document de travail présente un résumé du nouveau modèle macro-économétrique de l'OCDE, incluant une vue d'ensemble de la structure du modèle et une sélection de simulations qui illustrent ses principales propriétés. Comparé aux modèles antérieurs, le nouveau modèle est plus compact et agrégé par région, mais donne plus de poids aux politiques économiques portant sur les interactions entre le commerce mondial et les marchés financiers. Les structures du modèle par pays combinent des dynamiques de court terme de type Keynésien avec un côté de l'offre à long terme néo-classique consistant. Alors qu'il conserve un traitement conventionnel des interactions enter le commerce international et les secteurs financiers, le modèle a un meilleur degré de consistance des stocks et des flux, avec une modélisation explicite des actifs domestiques et internationaux et des flux des actions et des revenus qui en découlent. On tient compte aussi de l'influence du développement des marchés financier et immobilier sur les valorisations d'actifs et les dépenses domestiques à travers les prix des maisons et des titres, des taux d'intérêt et des taux de change. En conséquence, le modèle donne plus d'importance à la richesse et aux effets de richesse dans les résultats à long terme des simulations, ainsi qu'au rôle du prix des actifs dans la transmission des chocs internationaux entre les biens et les marchés financiers.

Classification JEL : E17 ; F01 ; F47
Mots clefs : global ; macro-économiques ; modèle économétrique ; simulation

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TABLE OF CONTENTS

ABSTRACT/RÉSUMÉ 2

THE OECD'S NEW GLOBAL MODEL 5

1. Introduction and summary 5
2. Overview of model structure and key structural equations 7
   - 2.1 The supply sector and factor demand 7
   - 2.2 Wages and prices 10
   - 2.3 Household consumption 13
   - 2.4 International trade volumes 14
   - 2.5 The public sector 15
   - 2.6 Financial markets and monetary policies 16
   - 2.7 International financial flows, assets and liabilities 16
   - 2.8 The form and role of the non-OECD country regions within the model 18
3. Simulation properties of the new global model 18
   - 3.1 Fiscal shocks 19
   - 3.2 Interest rate shocks 23
   - 3.3 Exchange-rate shocks 27
   - 3.4 A sustained increase in non-OECD demand 31

BIBLIOGRAPHY 34

Tables

1. Long-run properties of key equations for OECD countries and regions 8
2. Short-run elasticity responses of key relationships for OECD countries and regions 9
3. Sustained increase in US public expenditures (1% of GDP) 21
4. Sustained increase in Japanese public expenditures (1% of GDP) 22
5. Sustained increase in euro area public expenditures (1% of GDP) 23
6. Sustained increase in US interest rates (100 basis points) 25
7. Sustained increase in Japanese interest rates (100 basis points) 26
8. Sustained increase in euro area interest rates (100 basis points) 27
9. 10% US dollar depreciation 29
10. 10% yen depreciation 30
11. 10% euro depreciation 31
12. Sustained 10% increase in non-OECD domestic demand 32

Figures

1. Interactions in the wage-price system 11
2. The structure of household wealth 14
3. The sectoral decomposition of financial assets and liabilities 17

THE OECD'S NEW GLOBAL MODEL

by

Karine Hervé, Nigel Pain, Pete Richardson, Franck Sédillot and Pierre-Olivier Beffy[1]

1. Introduction and summary

1. Over the past three decades, empirical macroeconomic models have served as important tools of analysis in the OECD Economics Department, for international macroeconomic forecasting and policy assessment. This paper provides an overview of the OECD's most recent work in this area, in the context of a preliminary version of a new global model. It provides general background to the current work, a summary overview of model structure and key parameters and a selection of simulations illustrating its main features and properties.

2. In the context of macroeconomic forecasting and assessment work, empirical models provide a useful framework of analysis that ensures the coherency of model and judgement-based forecasts, through consistent accounting relationships within and between country models and through specific structural features. In particular, structural and parameter restrictions imposed on international trade and finance sectors provide a basis for consistent international trade and payments projections, and a means for assessing the consistency of internal and external imbalances of individual countries and regions within a global framework.[2] At the same time, domestic models based around consistent supply frameworks, including potential output and factor demands, provide a useful means for assessing sustainable growth, the balance between supply and demand in labour and product markets and, thereby, underlying inflation pressures.[3]

3. International macroeconomic models also provide a useful means of tracing the implications of a variety shocks, both exogenous and policy driven, within and between individual economies and regions. Indeed, simulation-based assessments of the implications of new data and changes in key assumptions

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1. The new global model was developed as part of the Economics Department contribution to the recent OECD-wide Globalisation and Structural Adjustment study and was previously described in Hervé *et al.* (2008). Part of the work in the paper was made possible by generous support from the Japanese ESRI and Statistics Norway. At the time of preparation of the material, the authors were all members of the OECD Economics Department Macroeconomic Analysis and Systems Management Division. They are especially grateful to David Turner, Jorgen Elmeskov and Jean-Luc Schneider for comments on previous drafts of the paper. Special thanks go to Robin Choudhury for his expert technical support in maintaining the model and producing simulations, to Diane Scott for assistance in preparing the document and to Ane-Katherine Christensen for general statistical support to the project.

2. For this reason, many of the OECD's international model developments have been rooted in empirical work on international trade and payments, dating from Adams, Eguchi *et al.*, 1969, to Turner *et al.*, 2000, to Pain *et al.*, 2005.

3. See Helliwell *et al.*, 1985, Giorno *et al.*, Turner *et al.*, 1996, 1995, Richardson *et al.*, 2001, and Beffy *et al.*, 2006).

provide an important starting point to successive OECD forecasts. Model-based simulation studies are also used to explore specific policy issues and illustrate the implications of specific uncertainties attached to central forecast assessments. In this context, the OECD routinely publishes a wide variety of model-based analyses and scenarios as part of the General Assessment chapter of the OECD *Economic Outlook*.

4. Compared with former versions of the OECD INTERLINK model, described in Richardson (1988) and Dalsgaard *et al.* (2001), the new global model differs in a number of important respects, whilst retaining some important similarities. Firstly, consistent with the current format of the OECD *Economic Outlook* projections and assessments, the model is quarterly rather than semi-annual, providing a clearer view of short-term dynamics and adjustment processes. In spite of being more compact and more regionally aggregated than its predecessors, the new model has a more comprehensive and global scope. Reflecting the most recent focus of policy interests in global trade and financial developments, the model includes separate country models for the United States, Japan, the euro area and China, with all other economies combined into groups that reflect the strength of trading and financial links with one or more of these major economies/regions. Thus the remaining OECD economies are combined into two blocs, "Other OECD Europe" and "Other OECD".[4] The remaining non-OECD economies are divided into three broad regional groupings -- "Other non-OECD Asia", "Non-OECD Europe" and "Africa, the Middle East and Latin America". Reflecting practical data limitations, the models for the non-OECD economies are typically less detailed than those for the OECD, retaining the same trade and payments relationships but including more reduced form models of domestic demand and inflation.

5. Overall, the broad structure of the new model is similar to its predecessors in certain respects, with country and regional models combining short-term Keynesian-type dynamics with a consistent neo-classical supply-side in the long run. The presence of nominal rigidities in wage and price setting serve to slow the process of adjustment to external events, so that output is largely demand-driven in the short term, but supply-driven in the longer term. The speeds of adjustment towards the long term are largely data determined. Potential output is modelled as depending on trend productivity, trend employment, trend hours worked and the capital stock (following the same approach as Beffy *et al*., 2006). All economies are assumed to have a constant returns-to-scale Cobb Douglas production function, with the demand for labour and capital derived from the first-order conditions for profit maximisation under imperfect competition.

3. While the new model retains the global focus of previous OECD models, with an explicit treatment of international trade volume and price linkages, it is also capable of handling a wider range of shocks and analytical needs. A particularly important improvement is the greater degree of stock-flow consistency, both within and across countries and regions. Assets and liabilities are modelled explicitly for domestic and overseas sectors, as are the associated income streams. Household expenditure is affected by changes in the real value of household net wealth (financial plus housing).[5] Net household financial assets are affected by household sector net savings and net foreign assets are influenced by the current-account balance. Developments in financial markets and housing markets also affect the valuation of assets, and hence domestic expenditure, via movements in house prices, equity prices, interest rates and exchange rates. Financial market expectations are assumed to be adaptive in the preliminary version of the model, although alternative, more forward-looking, expectations mechanisms may be explored in the future.

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4. The Other OECD Europe bloc comprises the United Kingdom, Denmark, Sweden, Norway, Switzerland, Iceland, the Czech Republic, Hungary, Poland and the Slovak Republic. The Other OECD bloc consists of Canada, Mexico, Korea, Australia and New Zealand.

5. The model makes an important simplifying assumption that the household and foreign sectors ultimately own the company sector in each OECD economy. Households thus see through the "corporate veil". This is not the case for international assets held by non-OECD economies, many of whom have large public sector holdings of foreign exchange reserves.

4. Consistent with developments in other international macroeconomic models, monetary and fiscal policy settings are endogenous in the model, although alternative policy rules can be set to override the specific defaults. Monetary policy is assumed to be typically set using a Taylor-type rule so as to return consumer price inflation to its baseline level in the medium term. Thus, short-term policy-determined nominal interest rates respond to any increase in inflation and also to movements in the output gap. Long-term government bond rates change if short-term rates change, although the adjustment is only partial. Fiscal stability is assumed to be ensured over the medium-term horizon by varying the effective direct tax rate on households so as to eliminate any deviation of public-sector deficits (as a per cent of GDP) from their baseline levels. This is the default rule in the model. It would be possible to implement alternative settings, with expenditure rather than taxes being varied to ensure fiscal stability. The short-to-medium-term simulation responses of the model are sensitive to the speed and form of the monetary and fiscal policy adjustments.

5. The remainder of this paper is in two sections. Section 2 provides a more detailed description of the main structural relationships in the model, with a main focus on cross-country similarities and also differences as represented largely in the relevant key parameter estimates. Section 3 then gives an overview of the models properties as reflected in a series of standard simulations. These are not intended to provide precise analyses of specific policies, which would require more detailed input assumptions and exogenous judgments, but rather to give a guide to the model's broad properties in response to specific shocks. These serve to highlight a number of important similarities and differences in individual country properties, reflecting underlying differences in structural features and parameters.

2. Overview of model structure and key structural equations

6. This section provides a broad overview of the main structural features of the model and its key relationships by sector and underlying economic theoretical underpinnings. A guide to key short and long-term elasticities in a selection of main relationships is given in Tables 1 and 2.

2.1 The supply sector and factor demand

7. In common with other new Keynesian models, the new OECD model combines short-term demand determined behaviour with an explicit supply determined long-run potential output path, with wages and prices adjusting only slowly to eliminate supply-side disequilibria in product and labour markets, as represented by the gaps between expenditures demand and potential output (GAP) and the actual and underlying structural rates of unemployment (UNR and the NAIRU). The influence of demand-side shocks working through the usual income-expenditure mechanisms therefore tends to have only a short to medium-term influence on output, but over the longer term feedbacks from the wage and price sectors combined with other mechanisms, such as competitiveness, wealth effects and policy rules, serve to return output and output growth to their underlying potential paths. Similarly, sustained shocks to key supply-side variables, for example working population, trend productivity or the NAIRU, will have lasting long-term effects on potential and actual output, but work slowly through corresponding effects on wages, prices, competitiveness and real wealth on demand-side expenditure variables.

Table 1. Long-run properties of key equations for OECD countries and regions

Country/region	United States	Japan	Euro area	Other OECD Europe	Other OECD
	Long-run elasticity				
Consumption w.r.t.					
Real disposable income	0.70[c]	0.80[c]	0.85[c]	0.80[c]	0.80[c]
Real household wealth	0.30[c]	0.20[c]	0.15[c]	0.20[c]	0.20[c]
ECM	*-0.095*	*-0.107*	*-0.679*	*-0.198*	*-0.145*
Investment w.r.t.					
GDP	1.0[i]	1.0[i]	1.0[i]	1.0[i]	1.0[i]
Cost of capital	-1.0[i]	-1.0[i]	-1.0[i]	-1.0[i]	-1.0[i]
ECM	*-0.02*	*-0.07*	*-0.05*	*-0.14*	*-0.24*
Employment w.r.t.					
GDP	1.0[i]	1.0[i]	1.0[i]	1.0[i]	1.0[i]
Real wages	-1.0[i]	-1.0[i]	-1.0[i]	-1.0[i]	-1.0[i]
ECM	*-0.16*	*-0.20*	*-0.20*	*-0.25*	*-0.21*
GDP deflator w.r.t.					
Labour costs	0.67[c]	0.40[c]	0.67[c]	0.70[c]	0.75[c]
Cost of capital	0.33[c]	0.60[c]	0.33[c]	0.30[c]	0.25[c]
ECM	*-0.002*	*-0.032*	*-0.006*	*-0.006*	*-0.002*
Consumer prices w.r.t.					
Domestic costs	0.92[c]	0.85[c]	0.89[c]	0.80[c]	0.80[c]
Import prices	0.08[c]	0.15[c]	0.11[c]	0.20[c]	0.20[c]
ECM	*-0.047*	*-0.040*	*-0.104*	*-0.400*	*-0.400*
Export volumes w.r.t.					
Export markets	1.00[i]	1.00[i]	1.00[i]	1.00[i]	1.00[i]
Export competitiveness	-0.60	-1.00	-0.51	-0.34	-0.44
ECM	*-0.277*	*-0.130*	*-0.178*	*-0.065*	*-0.265*
Import volumes w.r.t.					
Final expenditures	1.00[i]	1.00[i]	1.00[i]	1.00[i]	1.00[i]
Import competitiveness	-0.32	-0.40	-0.43	-0.64	-0.53
ECM	*-0.134*	*-0.149*	*-0.067*	*-0.152*	*-0.069*
Export prices w.r.t.					
Competitors prices	0.08[c]	0.28[c]	0.22[c]	0.39[c]	0.09[c c]
Domestic costs	0.92[c]	0.72[c]	0.78[c]	0.61[c]	0.91
ECM	*-0.206*	*-0.295*	*-0.165*	*-0.168*	*-0.103*
Import prices w.r.t.					
Competitors prices	0.35[c]	0.51[c]	0.60[c]	0.77[c]	0.97[c]
Domestic prices	0.65[c]	0.49[c]	0.40[c]	0.23[c]	0.03[c]
ECM	*-0.079*	*-0.335*	*-0.182*	*-0.2*	*-0.3*

Notes: Superscripts [i] indicate imposed long-run values; [c] indicates a constrained sum across parameters. Since the model frequency is quarterly, the error-correction (ECM) terms relate to quarterly speeds of adjustment.

Table 2. Short-run elasticity responses of key relationships for OECD countries and regions

Country/region	United States		Japan		Euro area		Other OECD Europe		Other OECD	
	Short-run cumulative elasticity in year									
	1	2	1	2	1	2	1	2	1	2
Consumption w.r.t.										
Real disposable income	0.45	0.58	0.30	0.61	0.80	0.81	0.56	0.74	0.46	0.75
Household real wealth	0.08	0.20	0.05	0.14	0.19	0.19	0.20	0.22	0.07	0.17
Investment w.r.t.										
GDP	1.33	1.40	0.88	0.96	1.52	1.54	0.87	0.96	0.90	1.00
Cost of capital	-0.08	-0.34	-0.19	-0.60	-0.14	-0.47	-0.36	-0.80	-0.61	-1.00
Employment w.r.t.										
GDP	0.91	1.01	0.56	1.03	1.09	0.92	1.20	0.95	0.77	0.99
Real wages	-0.63	-1.00	-0.54	-1.00	-0.88	-0.98	-0.96	-0.96	-0.71	-0.98
GDP deflator w.r.t.										
Labour cotsts	0.50	0.94	0.44	0.88	0.25	0.90	0.10	0.50	0.10	0.52
Cost of capital	0.00	0.01	0.05	0.20	0.01	0.03	0.01	0.03	0.00	0.01
Consumer prices w.r.t.										
Domestic costs	0.94	0.94	0.95	0.97	0.89	0.89	0.85	0.79	0.86	0.79
Import costs	0.06	0.06	0.05	0.03	0.11	0.11	0.15	0.21	0.14	0.21
Export volumes w.r.t.										
Export markets	1.00	1.00	1.19	1.07	0.84	0.98	0.76	0.86	0.97	1.00
Export competitiveness	0.37	0.58	0.42	0.80	0.32	0.49	0.31	0.39	0.31	0.43
Import volumes w.r.t.										
Final expenditures	1.20	0.99	1.16	0.93	1.10	0.95	1.34	0.88	0.88	0.85
Export volumes	0.24	0.12	0.32	0.16	0.76	0.47	0.49	0.25	0.63	0.42
Import competitiveness	0.31	0.32	0.22	0.37	0.20	0.32	0.30	0.58	0.48	0.50
Export prices w.r.t.										
Competitors prices	0.09	0.08	0.20	0.28	0.26	0.22	0.35	0.38	0.26	0.16
Domestic prices	1.01	0.92	0.81	0.72	0.82	0.79	0.67	0.62	0.74	0.84
Import prices w.r.t.										
Competitors prices	0.29	0.33	0.42	0.51	0.41	0.60	0.53	0.73	1.04	0.97
Domestic prices	0.77	0.69	0.53	0.49	0.69	0.40	0.59	0.29	0.04	0.03

8. Following the broad approach of Beffy *et al.*, 2006, potential output is represented by a constant-returns-to-scale Cobb-Douglas production function with two factor inputs -- labour and capital stock -- and under the assumption of Harrod neutral labour augmenting technical progress, expressed in terms of two-factor trend productivity. Labour inputs, expressed in terms of total hours worked, are given by trend employment, a function of labour supply, trend hours, trend labour force participation and the NAIRU rate of unemployment. With the exception of capital stock, these variables are largely exogenous to the model and remain unchanged in simulation unless modified directly.[6]

6. The NAIRU estimates used in the model are imposed on the basis of previous OECD estimates. See for example Richardson *et al.* (2002), Turner *et al.* (2002) and Gianella *et al.* (2008).

9. For the given production function, the demands for labour and capital are then derived from the first-order conditions for profit maximisation under imperfect competition. This requires that the long-run relative capital-labour ratio is equal to the ratio of real producer wages to the real cost of capital with domestic costs a weighted average of labour and capital costs, reflecting the respective long-run factor shares in total output. Allowing for adjustment dynamics, employment and capital demand are given by error correction equations of the following form:

$$\Delta \ln(ET)_{j,t} = \alpha_0 + \alpha_1 \left[\ln(ET)_{j,t-1} - \ln(GDPV)_{j,t-1} + \ln(WSSE/PGDP)_{j,t-1} \right] + \sum_{i=1}^{5} \alpha_{2,i} \Delta \ln(ET)_{j,t-i} + \sum_{i=1}^{5} \alpha_{3,i} \Delta \ln(GDPV)_{j,t-i} + \sum_{i=1}^{2} \alpha_{4,i} \Delta \ln(WSSE/PGDP)_{j,t-i} + \alpha_5 trend$$

$$\Delta \ln(IV)_{j,t} = \alpha_0 + \alpha_1 \left[\ln(IV)_{j,t-1} - \ln(GDPV)_{j,t-1} + \ln(CKR)_{j,t-1} \right] + \sum_{i=1}^{5} \alpha_{2,i} \Delta \ln(IV)_{j,t-i} + \sum_{i=1}^{3} \alpha_{3,i} \Delta \ln(GDPV)_{j,t-i} + \alpha_4 \Delta \ln(GOS/(PI/KV))_{j,t} + \alpha_5 \Delta \ln(PI)_{j,t}$$

where ET corresponds to total employment, IV gross fixed capital formation, GDPV gross domestic product, WSSE the compensation rate per employee and PGDP, the GDP deflator, CKR the real cost of capital, GOS gross operating profits, PI the investment deflator, and KV the capital stock in volume terms.

10. Consistent with a Cobb-Douglas specification, the long run output elasticities for labour and capital demands for all countries are imposed at unity, as are the corresponding long-run real wage and real cost of capital elasticities. However, as illustrated in Table 2, estimated speeds of adjustment differ between countries and factors. For investment, adjustment to equilibrium is somewhat drawn out. The responses to output typically overshoot in the short term before returning gradually to equilibrium, whilst responses to changes in the cost of capital build up more gradually over time. Across countries, investment is typically found to be more output responsive in the short term in the United States and the euro area compared with Japan and the other OECD countries and regions, whilst the other OECD Europe and other OECD regions appear most responsive in the short term to changes in the cost of capital. By contrast, employment adjustments to output and wage costs are more homogeneous and quicker.

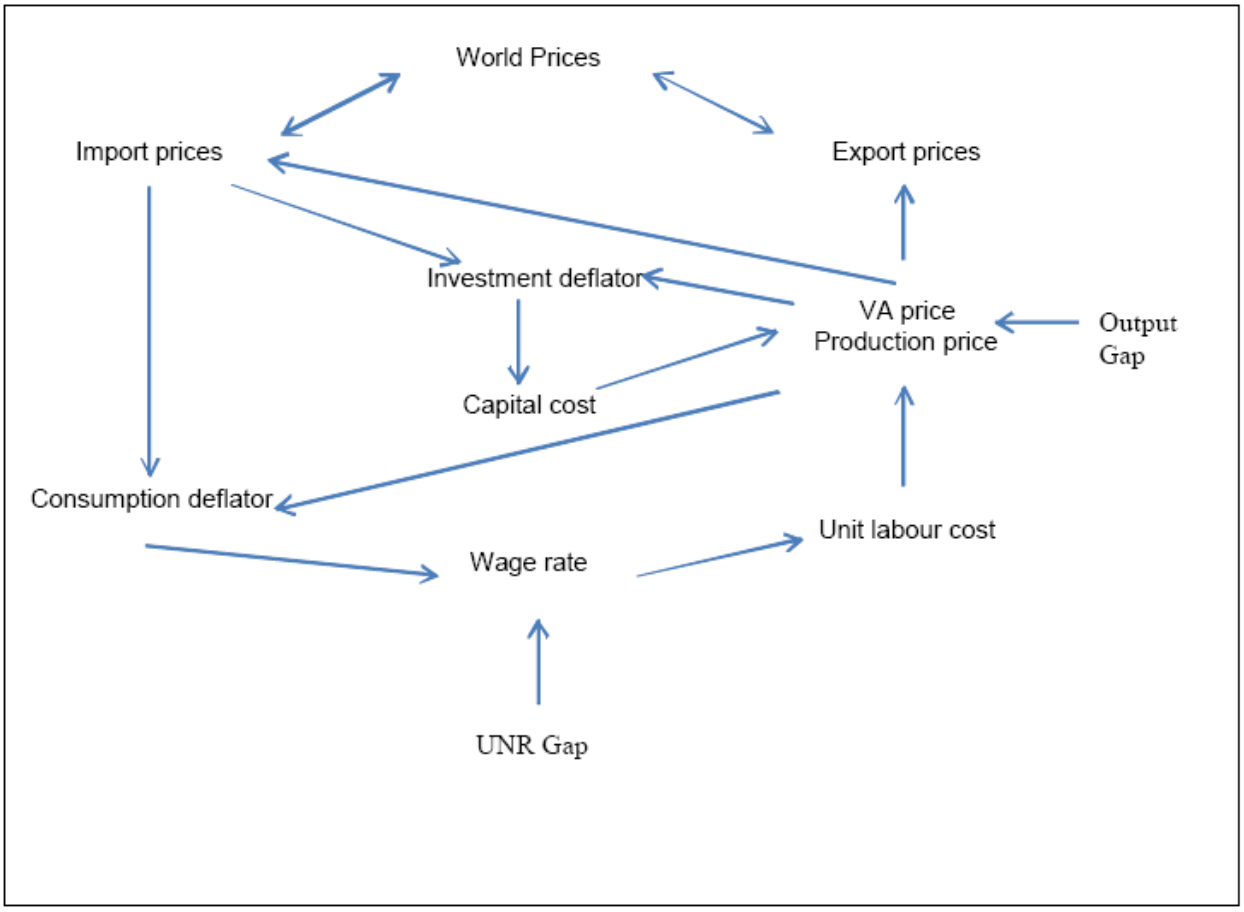
2.2 Wages and prices

11. The key interactions within the wage price system are summarised in Figure 1. Wages are modelled using a Phillips-type equation, with wage inflation being influenced by price inflation, trend productivity growth and the gap between the unemployment rate and the estimated NAIRU:

$$\Delta \left[\ln(WR) - EFF \right]_{j,t} = \alpha_0 + \Delta \ln(PCP)_{j,t} + \alpha_1 (UNRGAP)_{j,t}$$

where WR denotes wages, EFF trend labour efficiency, PCP the private consumption deflator and UNRGAP, the gap between actual and structural rates of unemployment (NAIRU-UNR).

Figure 1. Interactions in the wage-price system



12. In the current version of the model, wage inflation is assumed to adjust simultaneously to price inflation. The wage inflation sensitivity to the gap between the unemployment rate and the NAIRU is similar for the three largest OECD economies implying at around 0.2 (implying a 0.2% increase in inflation per 1 percentage point increase in the NAIRU gap), whilst those for the other OECD economies are higher in the range 0.3 to 0.4.

13. All price equations are constrained to be statically and dynamically homogenous with respect to domestic costs and foreign prices, and include error-correction terms, so that they ultimately determine the respective price levels rather than rates of price inflation. Domestic prices are primarily driven by domestic costs, foreign prices and movements in the domestic output gap. Thus if demand determined output is above potential, then prices rise more rapidly than their determinants would otherwise suggest.

14. Within the system, the domestic value-added price deflator, PDGP, plays a pivotal role, feeding into the other domestic price equations as a measure of domestic costs. Following the production function specification, PDGP is determined by domestic labour and capital costs in the longer term, with short-run influences coming from the output gap, lagged changes in labour costs, import prices and output growth, as represented by the following equation:

$$\begin{aligned}\Delta \ln(PGDP)_{j,t} &= \alpha_0 + \alpha_1 \left[\ln(PGDP)_{j,t-1} - \alpha_2 \ln(WSSE/EFF)_{j,t-1} - (1-\alpha_2)\ln(CKR \times PGDP)_{j,t-1}\right] \\ &+ \sum_{i=1}^{5} \alpha_{3,i} \Delta \ln(PGDP)_{j,t-i} + \sum_{i=1}^{5} \alpha_{4,i} \Delta \ln(WSSE \times ET/GDPV)_{j,t-i} + \sum_{i=1}^{3} \alpha_{5,i} \Delta \ln(PM)_{j,t-i} \\ &+ \alpha_6 \Delta \ln(GDPV)_{j,t} + \alpha_7 (GAP)_{j,t-1}\end{aligned}$$

15. As shown in Table 1, labour shares vary somewhat across the OECD countries and regions, being typically lower for Japan at around 0.4, compared with 0.67 to 0.75 for the other OECD economies. This is partially compensated for a somewhat faster speed of adjustment for Japan. Nonetheless, in the short term, the changes in the unit wage costs play a dominant role in the determination of value added prices for all countries with near one-to-one adjustments in prices to changes in wages within a two-year period for the larger economies, somewhat lower for the others. By contrast, import prices have a larger impact in the two other OECD models than in the three big countries. Short-term GDP growth effects are included for all regions, whilst GAP effects are present only for the United States, the euro area and the other OECD region.

16. The consumers' expenditure deflator and the investment deflators are determined as weighted averages of domestic value-added prices and import prices. Allowance is also made for changes in indirect taxes and subsidies and, in the short run, a distinction is also made between price of non-commodity imports of goods and services and price of commodity imports.

17. The consumers' expenditure deflator is given by the following equation:

$$\begin{aligned}\Delta \ln(PCP)_{j,t} &= \alpha_0 + \alpha_1 \left[\ln(PCP)_{j,t-1} - \alpha_2 \ln(PGDP)_{j,t-1} - (1-\alpha_2)\ln(PMGS)_{j,t-1}\right] \\ &+ \sum_{i=1}^{5} \alpha_{3,i} \Delta \ln\left[PCP/(1+(Tind - Tsub)/GDP)\right]_{j,t-i} + \alpha_4 \Delta \ln(PGDP)_{j,t} \\ &+ \sum_{i=1}^{5} \alpha_{5,i} \Delta \ln(PMGSX)_{j,t-i} + \alpha_6 \Delta \ln(PNMW)_{j,t}\end{aligned}$$

where PMGS denotes the price of imports of goods and services, PMGSX price of non-commodity imports of goods and services, PMNW price of commodity imports, $Tind$ and $Tsub$ are respectively indirect taxes and subsidies.

18. In the long run, the consumer prices are mainly driven by domestic costs, especially in the United States, whilst import prices have a larger long-term influence on the other economies, notably for the two regional groupings comprising mostly smaller trade dependant economies. The same is broadly true for investment price deflators, with the domestic cost influences dominating responses for the three larger OECD countries/regions and import prices having a more significant role for the smaller country groupings.

19. Export and import prices of goods and services, are based on the set of equations described in Pain *et al*. (2005). Within this system, export prices reflect both domestic and foreign influences, through costs/output prices and competitors' prices, calculated as a trade weighted average of other exporters' prices in third markets and expressed in domestic currencies. Import prices similarly depend on domestic prices and a "shadow" world import price, calculated as the trade weighted average of the export prices of suppliers to the importing economy. Both sets of trade price equations included time trends to reflect the

long-run tendency of trade prices to decline relative to the general price levels. For the three regional groupings, the pass-through elasticities are an aggregation of those obtained by Pain *et al*. (2005).

20. Overall, export prices are typically found to be more sensitive to domestic costs, whilst import prices are most sensitive to foreign prices, in both the short and long term. As illustrated in Tables 1 and 2, there are considerable differences across countries and regions in the degree of pricing to market by exporters and exchange rate pass-through by importers. Most notably, for the United States, domestic costs and prices tend to dominate in short and long run, for both export and import prices, though imports are more responsive than exports to foreign influences. By contrast, the other countries, in the main, give more weight to competitors prices in setting export prices (with weights of 30 to 40%) and exert lesser influence on their own import prices. For imports as whole, the other OECD group is characterised as having near full pass through with the other countries having more moderate rates in the range of 50 to 60%.

2.3 Household consumption

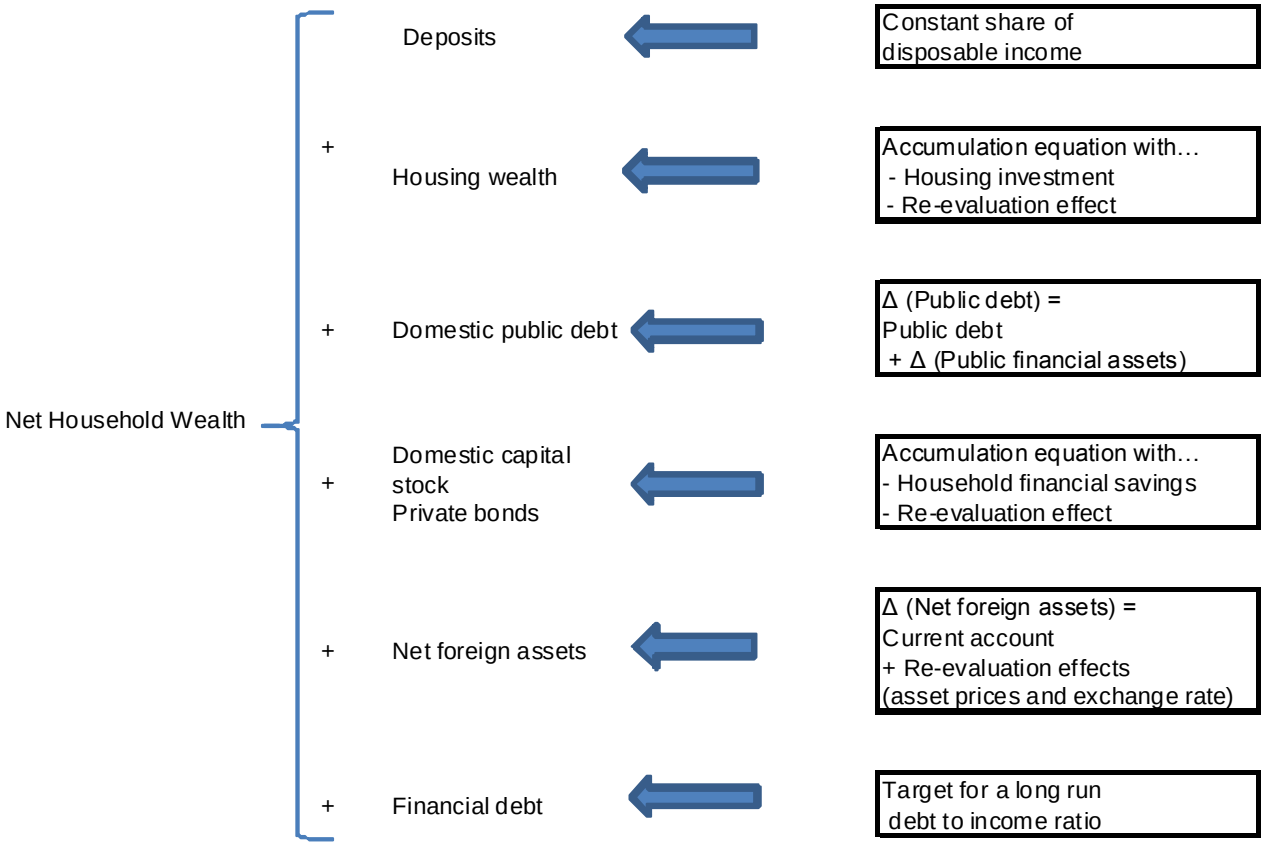
21. Household consumption is modelled as a function of real household disposable income and real net wealth in the long run. Income is defined to include labour compensation, government transfers net of taxes and other net non-labour incomes while net wealth is given by the sum of household financial assets, including foreign and domestic equity and bond prices, and housing assets, less household financial liabilities (see Figure 2). The long-run coefficients on income and wealth are constrained to sum to unity, so that the long-run saving ratio is ultimately a function of the ratio of net wealth to income. This wealth equilibrium for the household sector, along with the solvency condition for the public sector (as embodied in a public sector fiscal rule), tie down the net asset holdings of the foreign sector.

22. In addition to the wealth and income error-correction terms, consumption is modelled as being influenced negatively in the short run by increases in consumer price inflation and real interest rates, as well as dynamic terms in income and wealth, thus:

$$\begin{aligned}\Delta \ln(CPV)_{j,t} = \alpha_0 + \alpha_1 \left[\ln(CPV)_{j,t-1} - \alpha_2 \ln(YDH/PCP)_{j,t-1} - (1-\alpha_2)\ln(NWH)_{j,t-1}\right] \\ + \sum_{i=1}^{4} \alpha_{3,i} \Delta \ln(CPV)_{j,t-i} + \sum_{i=1}^{2} \alpha_{4,i} \Delta \ln(YDH/PCP)_{j,t-i} + \alpha_5 \Delta \ln(NWH/PCP)_{j,t} \\ + \sum_{i=1}^{5} \alpha_{6,i} \Delta(INF)_{j,t-i} + \sum_{i=1}^{5} \alpha_{7,i} \Delta(IRLR)_{j,t-i}\end{aligned}$$

where CPV denotes private consumption, YDH , household disposable income, NWH, household net wealth, INF the annual rate of consumer price inflation and IRLR the long term real interest rate. Housing investment is modelled separately as a function of real disposable income, house price inflation and long-term real interest rates, with house prices modelled explicitly taking into account consumer prices, long-term interest rates and, in the short run, equity prices.

Figure 2. The structure of household wealth



23. As shown in Table 1, the long-run elasticity on real net wealth is highest in the United States, at 0.3 compared with 0.15 for the euro area and 0.2 for other countries/regions.[7] By construction therefore, the long-term response of consumption to a change in real incomes is smaller in the United States than elsewhere. Over the shorter term, however, (see Table 2), the differences across economies are less clear cut, with euro area and the Other OECD Europe model having larger short-term responses to changes in wealth. The euro area model also has higher short-term responses to changes in real disposable incomes and converges relatively quickly to its steady state. By contrast the US model has the smallest error-correction term and tends to adjust more slowly than the other OECD economies. Evidence of negative real interest rate and inflation responsiveness is somewhat diverse across countries and regions, being highest for the United States and Japan (semi elasticities of around -0.004), somewhat lower for the euro area and other OECD region (-0.002) and absent for the other OECD European region.

2.4 International trade volumes

24. As for trade prices, the trade volume equations are broadly based on those estimated by Pain *et al*. (2005). Export volumes depend on market growth, measured as a trade weighted average of the import

7. In spite of these differences, the corresponding marginal propensities to consume out of wealth are more similar across the major OECD countries and, for the United States is reassuringly close to the Federal Reserve's conventional "4-5 cents" rule of thumb, whereby each additional dollar of consumer wealth is reckoned to account for 4 to 5 cents of additional consumption.

volume demands of trading partners, and the prices of exports relative to those of competitors. Import demand in the OECD and the non-OECD economies depends on weighted final expenditures in the importing economy and the price of imports relative to domestic prices. Allowance is made for different types of domestic expenditure having different marginal import propensities, with exports, fixed investment and inventories having in general higher import content than other categories of expenditure. Both import and export equations are typically estimated in error correction form, combining relatively unconstrained short-term dynamics with long-term equilibrium relationships between trade and activity.

25. Two important sets of restrictions are also imposed to ensure consistent and stable long run properties across and within countries. The first is that the long-run export elasticities with respect to market growth tend to unity. This ensures that for a given, say 1%, increase in import volumes in all economies, exports volumes in all countries increase by the same amount, say, 1%. Otherwise, market shares could rise or fall without bound and there would no guarantee of long-run trade consistency or balance between the demand and supply of world imports/exports. In practice, such a constraint fits the data reasonably well for most economies in the longer run, provided allowance is made for excluded trend factors which might determine trend movements or shifts in market shares over time. In the shorter term, however (see Table 2) there is considerable support for market growth elasticities in excess of unity for some countries (notably Japan and certain non-OECD regions) and less than unity for others (notably the European economies), consistent with slower adjustment to market opportunities. Such differences are less important provided they are confined to the shorter term and largely balance out across the world as a whole.

26. A second important constraint is that import elasticities with respect to final expenditures also tend to unity in the long run. Otherwise there would be no constraint on average import propensities exceeding 100% over a prolonged projection period, implying potentially negative output multipliers. In practice, there is considerable evidence of greater than unity short-term import expenditure elasticities, most notably for the larger economies, implying rising marginal propensities over what may often be a protracted period. Again this is not a problem for overall model properties, provided it is attenuated in the longer term and, in estimation, by inclusion of appropriate trend factors to allow for structural shifts.

27. Consistent with previous studies, exports from Japan and the non-OECD economies, especially in Asia, are found to be more sensitive to movements in relative prices, with long-run elasticities at or above -1, whilst those for the remaining OECD economies are typically in the range -0.35 to -0.6% (Tables 1 and 2). For most countries, import volumes are typically less sensitive to relative prices than export volumes, with long-run price elasticities in the range -0.3% and -0.65% for all OECD economies. With regard to speeds of adjustment, export volumes are typically faster to adjust than imports, though there are some exceptions.

2.5 The public sector

28. The public sector plays an important part in the model because of its influence on personal and corporate incomes and overall financial conditions. This role is reflected in a set of equations and identities representing government expenditures, current revenues (taxes), interest payments and transfers, with non-interest expenditures comprising final consumption, fixed capital investment and transfer payments to the private and the foreign sectors. Government revenues, including personal direct taxes (personal income taxes and social security contributions), corporate taxes and indirect taxes are typically modelled in terms of exogenous tax rates and corresponding tax bases, whilst expenditures are either exogenous or depend on fixed benefit rates linked to corresponding bases or measures of activity and the cycle. Government deficits are assumed to be bond financed (see Figure 3), whilst interest payments depend on the existing gross debt stock of the government, with the effective rate of interest paid changing only slowly in response to movements in current market interest rates.

29. The model includes explicit accounting between short-term flows of government surplus/deficits and the cumulated stocks of assets and liabilities and overall debt position. In simulation, the long-term stability of the fiscal balance, and hence the debt stock, is ensured in the model by adopting an endogenous fiscal rule. Thus, if there is any permanent rise or fall in final expenditures, tax revenues will need to rise or fall to offset changes in the fiscal balance and debt stock. In practice, such rules are imposed fairly gradually over time implying, for example that the effects of any short-term fiscal action on the government deficit is eventually reversed and offset over a longer term period to ensure longer term solvency.

2.6 Financial markets and monetary policies

30. As outlined previously, monetary policies are reflected in the model in the form of monetary rules, whereby the monetary authorities are assumed to target price levels or inflation through short-term interest rates. The policy reaction function is typically expressed in terms of standard Taylor-type rules adjusting short-term policy controlled interest rates relative to an underlying equilibrium rate according to deviations of consumer price inflation from announced targets and movements in the output gap, giving intermediate weight to output and unemployment disequilibria in policy targeting. Longer term government bond rates are then assumed to be linked to short-term policy rates, although adjustment is only partial, with some weight also given to inflation and, for some countries/regions, the government deficit ratios.

2.7 International financial flows, assets and liabilities

31. Over time, the steady integration of world capital markets has been an increasingly important feature of international linkages. Firstly it has been a fundamental determinant of external sustainability in many open market economies. Secondly, many of the positive and negative influences of financial globalisation are linked to the holdings of foreign assets and liabilities. Thirdly, the composition of international asset positions as between equity and debt, is likely to play an important role in understanding the vulnerability of economies to external shocks.

32. To address these issues, the model incorporates both stocks and flows of foreign assets and liabilities, split into three categories -- foreign direct investment (FDI), foreign portfolio investment (FPI) and a residual category, including banking sector international assets and liabilities and foreign exchange reserve holdings (Figure 3). The value of all three categories is influenced by movements in bilateral exchange rates in the model, with the impact of a change in any individual bilateral rate depending on the structure of asset and liability holdings, as reflected in a (partially estimated) matrix of bilateral asset and liability holdings in 2005**.** Movements in equity prices also affect the valuation of portfolio investment assets and liabilities. In principle equity price movements could also affect the value of FDI assets and liabilities if they are measured at market values rather than book values. This effect is not incorporated in the preliminary version of the model.

33. Households are assumed to hold four forms of financial asset -- liquid assets, equities, bonds and other assets. Total household net wealth is the sum of total financial assets plus housing assets less total financial liabilities. The value of domestic assets is affected directly by changes in foreign asset prices and exchange rates as well as by movements in domestic equity, bond and house prices. The value of equity assets held by households is set equal to the total stock of domestic equities plus equities held abroad less equities held in the country by the foreign sector. Equities held abroad are given by the sum of outward FDI plus a fixed proportion of outward FPI. Equities held by foreign residents in the domestic economy are given by the sum of inward FDI plus a fixed proportion of inward FPI. Household holdings of bonds are set equal to the government debt stock, plus the domestic stock of corporate bonds, plus the remaining proportion of outward FPI, less the remaining proportion of inward FPI.

Figure 3. The sectoral decomposition of financial assets and liabilities

Households Sector

Assets	Deposits Housing wealth Domestic public debt held by households Domestic capital stock held by households Private bonds held by households Foreign assets held by households
Liabilities	Financial household debt

Foreign Sector

Assets	Domestic public bonds held by foreigners Domestic capital stock held by foreigners Private bonds held by foreigners Other domestic assets held by foreigners
Liabilities	Foreign public bonds held by households Foreign capital stock held by households Foreign private bonds held by households Other foreign assets held by households

Government Sector: public assets/public bonds
Private Sector: capital stock/private bonds+equities

34. With the "other assets" category being modelled to include the remaining components of net international assets, total net international assets appear directly in the net wealth of domestic residents. This is an important stabilising mechanism in the model in the medium term. The returns from holding assets and the payments on liabilities are modelled as a function of the implicit rates of return and the asset and liability stocks. The implicit returns are mainly modelled as a mark-up on interest rates, with the size of the mark-up being calibrated from the level of the implicit rates of return over the recent past. For international investment income, the preliminary version of the model has only equations for total payments and receipts.

35. Overall, the individual economies and regions in the model are linked together through international trade (volumes and prices), international capital markets, the returns from international assets and liabilities. The consistency of trade and capital flows at the global level is ensured by a set of adjustment mechanisms that ensure that the growth rates of exports in value and volume are equal to those of imports and that changes in international liabilities and international investment income payments are fully reflected in international assets and investment income receipts.

2.8 The form and role of the non-OECD country regions within the model

36. Consistent with the need to provide as complete coverage as possible, the model includes four specific non-OECD country and regional grouping chosen in part to reflect the dominant trading and financial links with the OECD country/regional groupings, including a separate model for China and regional models for the rest of non-OECD Asia, non-OECD Europe and a residual group comprising Africa, the Middle East and Latin America. Each of these is included fully into the international trade and payments and the financial stocks and flows sectors of the system. Imports are typically driven by domestic demand and exports, with a unit long-run elasticity, and a zero or near-zero, in the case of China, price competitiveness term. For exports, the same unitary elasticity is imposed on market growth, although the corresponding short-term elasticities commonly exceed one, notably for China, other Asia and European groupings, reflecting a more dynamic export performance in the near term. As for the OECD countries, export price competitiveness effects lie in the range 0.3 to 0.6, although notably higher for China, which is close to one.

37. The three regional models also include, for completeness, a rudimentary reduced-form domestic demand equation essentially adjusting demand according to movements in the terms of trade and deviations in output from an exogenous trend potential. The prototype model for China is more elaborate and includes rudimentary wage, price, employment and supply-side relationships, and policy interest rates variables, as well as a reduced-form equation relating domestic demand to the wage incomes in real terms, with additional short run influences from changes in real interest rates, inflation and the changes in real wage incomes. The unreliability and erratic nature of the data as well as the massive structural change which has been undergone in China, means that rather less confidence can be given to the results for China specific shocks, although in response to OECD specific shocks its behaviour is in general not unreasonable.

3. Simulation properties of the new global model

38. This section presents the results for a number of standard shocks made on the basis of the current version of the model.[8] These simulations are not intended to provide a detailed analysis of specific policy issues, which would require more detailed input assumptions and exogenous judgments, but rather to give a broad guide to the model's general properties in response to different stylised supply, demand and financial shocks.[9] The results also serve to illustrate some of the key mechanisms involved and highlight a number of important similarities and differences in individual country properties, which in turn reflect underlying differences in structural features and parameters. The specific shocks include:

- Sustained increases in government current real expenditures (by 1% of GDP), individually for the United States, Japan and the euro area;
- Sustained increases in short-term interest rates (by 100 basis points), individually for the United States, Japan and the euro area;
- Sustained currency depreciations (by 10% in effective terms), individually for the US dollar, the Japanese yen and the euro;
- A sustained 10% increase in non-OECD domestic demand.

8. The simulations are based on the version of the model available in May 2009.

9. More detailed simulation analyses of more specific current policy issues and uncertainties using the new global model are routinely reported and discussed in the General Assessment chapter of the *OECD Economic Outlook*, and its technical annexes. See, for example, *OECD Economic Outlook* No.83, June 2008.

39. All shocks were carried out over a five-year period. Unless otherwise stated, government expenditures were assumed to be unchanged in real terms, subject to a fiscal rule adjusting income tax rates so as to bring government balances back to baseline over a long-term period, thereby stabilising the government debt to GDP ratio. Monetary policies were set by a simple Taylor rule adjusting nominal policy controlled short-term interest rates according to the output gap and the gap between inflation and a target rate. Unless otherwise stated, nominal exchange rates are assumed to remain unchanged at baseline rates and expectations to be backward looking.

3.1 Fiscal shocks

40. The fiscal shocks assume a sustained increase in real government current expenditures, equivalent to 1% of baseline real GDP. Monetary policies are keyed to follow a standard Taylor rule, and a fiscal rule is also applied progressively over the period to ensure longer-term fiscal sustainability.[10] To illustrate regional linkages, the shocks are made for each of the three main OECD economies individually, rather than for all economies collectively. The choice of an increase as opposed to a decrease in government spending is essentially arbitrary and has no specific implications for model properties which are essentially symmetric.

41. Given the long-run supply-side properties of the model, the effect of a demand shock on activity is expected to be temporary, with GDP returning to the pre-shock levels over the longer term. Although supply responses build up slowly over time, the adjustment process is speeded up by the nature of the fiscal and monetary rules which rein in demand over the medium-to-long term through interest rate and tax responses to supply-side and public sector disequilibria. Crowding out also occurs through adverse wealth effects as inflationary pressures build up and through the trade channels, reflecting import leakages and losses of competitiveness. An important point of comparison is the speed with which output returns to supply equilibrium and the extent to which inflation rises above its steady state level before returning to baseline.

42. The immediate effect of increased government expenditure is to raise demand and output through the standard income–expenditure multiplier-accelerator mechanisms. Higher demand impacts on both domestic and foreign markets, through imports, affecting both the country in question and its close trading partners, with further minor feedbacks. The split between domestic and foreign goods is affected by the marginal propensity to import and the evolution of relative prices, driven mainly by the supply side and wage-price characteristics of the economy.

43. Higher demand for domestic goods raises domestic output and the demand for factors of production, result in subsequent boosts to employment and investment, a fall in unemployment and an increase in the output gap. Both tend to put upward pressure on wage and price levels, which in turn lead to negative spill-overs through trade-competitiveness and consumption-wealth effects. At the same time, monetary policy tightens and short-term interest rates increase, whilst progressive increases in tax rates required to restore fiscal balance gradually reduces the overall fiscal stimulus. Although output is essentially pinned down in the very long run by relatively fixed supply potential in the model, its path is affected by underlying adjustment dynamics and for some countries/regions a degree of damped cycling cannot be ruled out, with short-term positive gains being offset in the medium term as the boost to output is put into reverse.

10. More specifically, the fiscal rule was set to raise direct taxes by approximately one fifth (per annum) of the deviation in the deficit as a percentage of GDP from its baseline path. In the present case, for the countries undertaking fiscal stimulus, this implies more-or-less linear increases in household taxes, rising to be approximately 1 percentage point higher by the fifth year of the shock.

44. In the near term, the net effects on trade and current accounts are likely to be uniformly negative in the country/region undertaking the stimulus, reflecting trade leakages and competitiveness losses, but are more ambiguous over the medium term if for example output temporarily falls below baseline, leading to a subsequent contraction and cycling in import demand. The actual scale and profiles of trade spill-over effects reflect the combination of import propensities and regional trading patterns as well as the evolving paths of domestic demand and international competitiveness. As illustrated below, such linkages can be fairly weak in the case of individual country shocks (as opposed to global demand shocks).

45. Turning to the country specific country results (Tables 3 to 5), there are clear differences in the scale of GDP multipliers and adjustment dynamics as between the three main OECD countries/regions. Thus although first year multipliers are quite similar at around 0.8%, their profiles thereafter are quite different, with the euro area characterised by a fairly smooth adjustment towards baseline, Japan by a rising multiplier, falling only towards the end of the period, and the United States by a rise then rapidly falling multiplier (zero and negative beyond the third year). For the United States, the more cyclical profile reflects a somewhat slower build up in inflation (and hence later but more pronounced monetary policy reaction), combined with the impact of larger negative wealth and competitiveness effects as domestic price levels rise progressively. For Japan, the combination of greater nominal inertia, smaller import leakages, a more prolonged investment accelerator and lower interest rate responsiveness implies relatively little crowding out until the later years. GDP responses for the euro area lie somewhere between these two extremes, with a more moderate short-term profile followed by steady crowding out reflecting the combination of larger import leakages, larger short-term inflation effects but moderate wealth effects.

46. GDP linkages over the five-year period reflect the degree of import leakages and trading partner relationships. Hence linkage effects from Japan are quite small for other OECD countries and regions, and largest (at most 0.2%) for China and the other non-OECD Asian region. Amongst the OECD economies the impact of the US shock is greatest (at around 0.3%) for the non European members, which include Canada, Mexico and Korea, whilst within the non-OECD region the greatest impacts, at least in the short-term are in China and other Asia. For the euro area, the largest impact is on the other OECD European economies.

47. Whilst inflation responses generally decline over the period and return to baseline, the specific profiles vary somewhat across countries reflecting the combination of the strength of output and unemployment gap effects, country specific dynamics, the effectiveness of monetary policy instruments and the speed of crowding out. The US response is characterised by a steady build-up over the first three years, reversing sharply as policies tighten and wealth effects kick in. The responses for the euro area also build up over the same period, but are more moderate, reflecting lower income multipliers and slower employment adjustment. The Japanese response is significantly stronger in the near term, and remains more substantial over the period, reflecting larger multipliers and a slower rate of crowding out. International spill-overs to inflation are more or less negligible reflecting generally low linkage multipliers and the dominant influence of own-country domestic costs in price setting.

48. The given fiscal rules are more or less sufficient to hold back deficit responses in the range 0.5 to 0.8% of GDP over the short to medium term. This occurs in spite of a rising interest debt component, as interest rates rise over the period, and falling revenue effects as activity returns to baseline. The deficit effect for the euro area is typically smaller than for either the United States or Japan, largely reflecting more moderate interest rate responses. Current account responses typically reflect the pattern of demand, with small deficits followed by small surpluses as short-term import responses fall back, crowding out sets in and linkage effects feed-back. The exception is for Japan, where higher activity and the lack of significant crowding over the period continue to stimulate import demand, leading to a sustained deterioration.

Table 3. Sustained increase in US public expenditures (1% of GDP)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.9	1.0	0.6	0.0	-0.5
Inflation	0.1	0.3	0.9	0.7	0.1
Interest rates (basis points)	60	95	155	95	-10
Government net lending (% GDP)	-0.8	-0.6	-0.6	-0.8	-0.8
Current Account (% GDP)	-0.2	-0.1	0.1	0.2	0.3
Japan					
GDP level	0.2	0.2	0.1	0.0	-0.1
Inflation	0.1	0.0	0.1	0.1	0.0
Interest rates (basis points)	20	10	25	10	-10
Government net lending (% GDP)	0.0	0.0	0.0	0.0	-0.1
Current Account (% GDP)	0.1	0.1	0.0	-0.1	-0.1
Euro					
GDP level	0.1	0.1	0.1	0.1	0.0
Inflation	0.0	0.1	0.1	0.1	0.0
Interest rates (basis points)	10	15	20	15	10
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Current Account (% GDP)	0.1	0.1	0.2	0.2	0.2
GDP level					
Other OECD Europe	0.2	0.2	0.2	0.1	0.1
Other OECD	0.3	0.3	0.3	0.2	0.0
Total OECD	*0.4*	*0.5*	*0.3*	*0.0*	*-0.2*
China	0.2	0.3	0.2	0.0	-0.1
Other non-OECD Asia	0.5	0.0	-0.3	-0.3	-0.2
Non-OECD Europe	0.1	0.1	0.0	0.0	-0.1
Other non-OECD	0.1	0.1	-0.1	-0.2	-0.2
Total non-OECD	*0.2*	*0.1*	*-0.1*	*-0.1*	*-0.1*
World	*0.4*	*0.4*	*0.3*	*0.0*	*-0.2*

Table 4. Sustained increase in Japanese public expenditures (1% of GDP)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.0	0.1	0.0	0.0	0.0
Inflation	0.0	0.0	0.1	0.0	0.0
Interest rates (basis points)	0	5	10	10	0
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Current Account (% GDP)	0.1	0.1	0.1	0.2	0.2
Japan					
GDP level	0.8	0.9	1.1	0.9	0.7
Inflation	0.4	0.1	0.7	0.6	0.3
Interest rates (basis points)	100	60	150	120	70
Government net lending (% GDP)	-0.8	-0.6	-0.5	-0.6	-0.6
Current Account (% GDP)	-0.5	-0.4	-0.3	-0.3	-0.3
Euro					
GDP level	0.0	0.0	0.0	0.0	0.1
Inflation	0.0	0.0	0.0	0.0	0.0
Interest rates (basis points)	0	5	10	10	10
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Current Account (% GDP)	0.1	0.1	0.1	0.1	0.1
GDP level					
Other OECD Europe	0.0	0.1	0.1	0.1	0.1
Other OECD	0.1	0.1	0.1	0.1	0.1
Total OECD	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
China	0.2	0.2	0.1	0.1	0.1
Other non-OECD Asia	0.2	0.0	-0.1	-0.1	0.0
Non-OECD Europe	0.0	0.0	0.0	0.0	0.0
Other non-OECD	0.0	0.0	0.0	0.0	0.0
Total non-OECD	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*
World	*0.2*	*0.2*	*0.2*	*0.2*	*0.1*

Table 5. Sustained increase in euro area public expenditures (1% of GDP)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.1	0.1	0.0	0.0	-0.1
Inflation	0.0	0.0	0.1	0.1	0.0
Interest rates (basis points)	5	10	15	10	-5
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Current Account (% GDP)	0.1	0.2	0.2	0.2	0.2
Japan					
GDP level	0.1	0.1	0.1	0.0	0.0
Inflation	0.0	0.0	0.1	0.0	0.0
Interest rates (basis points)	10	5	10	10	-5
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Current Account (% GDP)	0.1	0.1	0.0	0.0	-0.1
Euro					
GDP level	0.8	0.8	0.5	0.3	0.1
Inflation	0.2	0.3	0.4	0.1	0.0
Interest rates (basis points)	60	70	80	30	5
Government net lending (% GDP)	-0.6	-0.4	-0.4	-0.4	-0.3
Current Account (% GDP)	-0.4	-0.3	0.0	0.2	0
GDP level					
Other OECD Europe	0.2	0.3	0.3	0.2	0.1
Other OECD	0.1	0.1	0.1	0.0	0.0
Total OECD	*0.3*	*0.3*	*0.2*	*0.1*	*0.0*
China	0.1	0.2	0.1	0.0	0.0
Other non-OECD Asia	0.3	0.0	-0.2	-0.2	-0.1
Non-OECD Europe	0.2	0.1	-0.1	-0.2	-0.2
Other non-OECD	0.1	0.1	0.0	-0.1	-0.1
Total non-OECD	*0.1*	*0.1*	*-0.1*	*-0.1*	*-0.1*
World	*0.2*	*0.2*	*0.1*	*0.0*	*0.0*

3.2 Interest rate shocks

49. The interest rate shocks, illustrating the influence of monetary policy changes, assume a sustained increase of 100 basis points in policy determined nominal short-term interest rates for the United States, Japan and the euro area individually, with fiscal policies set by standard Taylor rules and nominal exchange rates assumed to be exogenous. In the absence of forward-looking expectations in financial markets and endogenous exchange rate reactions, the simulated effects are primarily felt through the impact of higher interest rates on market rates and thereby the cost of borrowing, the cost of capital and credit conditions, with negative effects on consumption and investment expenditures and thereby output and employment. Negative wealth effects coming through lower equity prices also put additional negative pressure on consumption spending and activity. The overall effects on output and activity are generally slow to build up, reflecting both the dynamics of expenditure effects and the gradual and incomplete adjustment of long-term interest rates to higher short rates.

50. In the absence of exchange rate reactions, the primary effects on inflation occur only gradually through downward pressure via output and unemployment gap influences. In the short-to-medium term, the government account deteriorates in line with higher debt servicing and lower revenue effects coming through reduced activity, although the decline is limited by higher taxes coming through the fiscal rule.

51. Current-account effects for the country taking action are generally positive, reflecting lower activity and thereby import demand, which more than offset possibly higher interest payments. Downward pressure on domestic costs and prices also serve to international competitiveness and thereby boost net exports. With interest rate increases made on a single country basis, linkage effects are likely to be relatively weak and slow to build up, reflecting import propensities, the profile of activity effects and underlying trade patterns.

52. Turning to country specific results (Tables 6 to 8), the US model shows the largest and quickest GDP effects falling by up to 1% over a five-year period. This compares with slower and more moderate reductions for Japan and the euro area, with real GDP falling by ½ to ¾ per cent of GDP respectively by the fifth year. Larger and relatively faster responses for the United States reflect a combination of larger wealth elasticities and more immediate consumption responses, as well as more lively investment dynamics. Inflation effects are similarly stronger and more immediate for the United States falling by up to ½ per cent over the period, reflecting the correspondingly larger changes in output and unemployment gaps. By contrast, inflation falls by less than ¼ per cent over the period in the euro area and Japan.

53. Current account effects are broadly similar for the United States and the euro area, improving by ¼ to ½ per cent of GDP over the period. With the GDP responses for Japan lagging somewhat behind those for the other main economies, its current account improvements are correspondingly smaller, improving by a little under ¼ per cent of GDP by the fifth year. Dominated by the direct effects of higher interest rates on interest debt payments, the impact on government deficits are broadly similar across the three regions, increasing by 0.2 to 0.3% of GDP over the period.

54. As expected, the international linkage effects on activity, coming primarily through the negative effects on activity and imports of the individual country where the shock occurs, are broadly proportionate to the overall GDP effects and correspondingly slow to build up. For the United States shock, the effects generally largest and felt most by close trading partners in the other OECD (which includes Canada and Mexico) and China, with GDP lower by up to 0.4 to 0.3% respectively in the fifth year. For the euro area shock, the main impact is on the other European economies, with GDP reduced by up to 0.3%, whilst spill-over effects for the Japan shock are small or negligible, reflecting both a lower impact on domestic GDP and relatively lower import propensities. The international spill-over effects to inflation are negligible in all cases.

Table 6. Sustained increase in US interest rates (100 basis points)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	-0.1	-0.4	-0.7	-0.9	-1.1
Inflation	0.0	-0.1	-0.3	-0.5	-0.7
Current account (%GDP)	0.1	0.2	0.2	0.3	0.4
Government net lending (% GDP)	0.0	-0.1	-0.2	-0.2	-0.3
Japan					
GDP level	0.0	-0.1	-0.1	-0.2	-0.2
Inflation	0.0	0.0	0.0	-0.1	-0.1
Current account (%GDP)	0.0	-0.1	-0.1	-0.1	-0.2
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Euro					
GDP level	0.0	0.0	-0.1	-0.1	-0.2
Inflation	0.0	0.0	0.0	-0.1	-0.1
Current account (%GDP)	0.1	0.1	0.1	0.0	0.0
GDP level					
Other OECD Europe	0.0	-0.1	-0.1	-0.2	-0.3
Other OECD	0.0	-0.1	-0.2	-0.3	-0.4
Total OECD	*-0.1*	*-0.2*	*-0.3*	*-0.5*	*-0.6*
China	0.0	-0.1	-0.2	-0.2	-0.3
Other non-OECD Asia	0.0	-0.1	-0.1	-0.1	-0.1
Non-OECD Europe	0.0	0.0	0.0	-0.1	-0.1
Other non-OECD	0.0	0.0	0.0	0.0	0.0
Total non-OECD	*0.0*	*-0.1*	*-0.1*	*-0.1*	*-0.1*
World	*-0.1*	*-0.2*	*-0.3*	*-0.4*	*-0.5*

Table 7. Sustained increase in Japanese interest rates (100 basis points)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.0	0.0	0.0	0.0	0.0
Inflation	0.0	0.0	0.0	0.0	0.0
Current account (%GDP)	0.1	0.1	0.1	0.1	0.1
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Japan					
GDP level	0.0	-0.1	-0.2	-0.4	-0.5
Inflation	0.0	-0.1	-0.1	-0.2	-0.2
Current account (%GDP)	0.0	0.0	0.1	0.1	0.2
Government net lending (% GDP)	0.0	-0.1	-0.2	-0.2	-0.3
Euro					
GDP level	0.0	0.0	0.0	0.0	0.0
Inflation	0.0	0.0	0.0	0.0	0.0
Current account (%GDP)	0.1	0.1	0.1	0.1	0.1
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
GDP level					
Other OECD Europe	0.0	0.0	0.0	0.0	0.0
Other OECD	0.0	0.0	0.0	0.0	0.0
Total OECD	*0.0*	*0.0*	*-0.1*	*-0.1*	*-0.1*
China	0.0	0.0	0.0	0.0	-0.1
Other non-OECD Asia	0.0	0.0	0.0	0.0	0.0
Non-OECD Europe	0.0	0.0	0.0	0.0	0.0
Other non-OECD	0.0	0.0	0.0	0.0	0.0
Total non-OECD	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
World	*0.0*	*0.0*	*0.0*	*-0.1*	*-0.1*

Table 8. Sustained increase in euro area interest rates (100 basis points)

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.0	0.0	0.0	-0.1	-0.1
Inflation	0.0	0.0	0.0	0.0	0.0
Current account (%GDP)	0.1	0.1	0.1	0.1	0.1
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Japan					
GDP level	0.0	0.0	0.0	-0.1	-0.1
Inflation	0.0	0.0	0.0	0.0	0.0
Current account (%GDP)	0.0	0.0	-0.1	-0.1	-0.1
Government net lending (% GDP)	0.0	0.0	0.0	0.0	0.0
Euro					
GDP level	0.0	-0.1	-0.3	-0.5	-0.7
Inflation	0.0	0.0	-0.1	-0.1	-0.2
Current account (%GDP)	0.1	0.2	0.3	0.4	0.5
Government net lending (% GDP)	0.0	-0.1	-0.2	-0.2	-0.2
GDP level					
Other OECD Europe	0.0	0.0	-0.1	-0.2	-0.3
Other OECD	0.0	0.0	0.0	-0.1	-0.1
Total OECD	*0.0*	*0.0*	*-0.1*	*-0.2*	*-0.3*
China	0.0	0.0	-0.1	-0.1	-0.1
Other non-OECD Asia	0.0	0.0	-0.1	-0.1	0.0
Non-OECD Europe	0.0	0.0	-0.1	-0.1	-0.1
Other non-OECD	0.0	0.0	0.0	0.0	0.0
Total non-OECD	*0.0*	*0.0*	*-0.1*	*-0.1*	*-0.1*
World	*0.0*	*0.0*	*-0.1*	*-0.2*	*-0.2*

3.3 Exchange-rate shocks

55. The exchange rate simulations assume sustained 10% nominal effective depreciations, individually for US dollar, yen and euro rates, against all other currencies, assuming that monetary policy follows a standard Taylor rule and that fiscal policy is set by endogenous rule. Following depreciation in the first quarter, the exchange rate is assumed to remain at the new level throughout the simulation period with the sustained shift assumed to be exogenous, coming from unexplained movements in markets expectations, rather than being policy induced or reflecting an identifiable change in economic fundamentals. The possible endogenous influence of simulated changes in interest rates on exchange rates, which might tend to offset the original shock, is therefore not taken into account. For this reason, these shocks are not particularly realistic, but serve rather to illustrate the role and transmission channels of exchange rates in the model.[11] In common with the other shocks discussed, the model's properties with

11. Real world shocks are more likely to be either temporary, in the sense that the initial shock is triggered by changes that are discounted or offset by subsequent changes in policies, or sustained but associated with important changes in underlying fundamentals, policies or economic structure with concomitant impacts elsewhere in the economy.

respect to currency depreciation are broadly symmetric to those for currency appreciation, allowing for minor scale differences.[12]

56. The immediate impact of currency depreciation is to boost import prices, subject to adjustment lags and the extent to which goods and services are priced to market. This in turn puts steady upward pressure on domestic prices, wages and costs. Whilst export (and domestic production) experience a considerable gains in competitiveness in the short term, these also adjust over time to higher foreign prices and domestic costs, thereby eroding such initial gains over the period. Nonetheless, improved price competitiveness in domestic and foreign markets serve to raise exports and reduce imports, thereby boosting domestic output and expenditures at the expense of competitor countries and regions in both the short and medium term. At the same time positive valuation effects on net foreign assets and foreign earnings boost the domestic value of real wealth and domestic consumption in the short term, although such improvements are gradually reversed as higher domestic price levels steadily erode real wealth over time.

57. The current-account balance of payments is also boosted both by improved trade balances with the higher value of exports more than offsetting any increase in the cost of imports in nominal or real terms, and the higher domestic value of foreign earnings.

58. The main policy reaction is to raise interest rates to combat domestic inflation pressures and increased output gaps. Since expectations are assumed to be backward looking, these increases build up only slowly over the period, but eventually moderate investment and compound the negative effects of lower real wealth on consumption, and as competitiveness gains begin to wane, help bring output back towards potential. The effects on fiscal balances and government debt are relatively muted, with second order positive effects of higher activity broadly offset by increases in the cost of servicing interest debt.

59. At the global level, currency depreciation/appreciation serves largely to redistribute real output and nominal inflation across countries and regions, with little or no net effect on world production or prices. Thus, the gains/losses in depreciating/appreciating countries are entirely at the expense/benefit of its trading partners. Indeed, the broad range of effects on variables in other individual countries are typically of opposite sign but of smaller magnitude, with absolute effects being spread across many individual trading partners.

60. Looking across countries (Tables 9 to 11), the simulated effects of individual currency depreciations are seen to be broadly similar across the three main regions, although the timing and magnitude of effects are seen to differ somewhat reflecting differing degrees of openness, resilience and a number of underlying parameters. Thus the GDP gains for the United States, peaking at around 1% in years 2 and 3, are smaller and more quickly eroded than for either the euro area or Japan, reflecting a lower share of trade in domestic production, generally faster speeds of adjustment and crowding out, the larger impact of real wealth on consumption and a greater leverage of higher interest rates on investment and consumption (as illustrated in the previous shocks). By comparison, the peak GDP effects for Japan and the euro area are larger, in the range 1½ to 1¾ per cent, and erode more slowly. Inflation responses across individual shocks are somewhat more similar, peaking at ¾ to 1% per annum, as are current-account gains, although for Japan typically benefits from a somewhat larger export response reflecting a higher underlying competitiveness elasticity. The patterns of spill-over effects mainly reflect dominant trading relationships, with the United States having greater short-term impact on the non-European OECD economies, and the euro area having greater impact on the rest of Europe and the other OECD groups.

12. The results for a 10% currency depreciation are arithmetically equivalent to those for an 11.1% currency appreciation but with the opposite sign.

Table 9. 10% US dollar depreciation

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.5	1.0	1.1	0.8	0.4
Inflation	0.3	0.4	0.9	1.1	0.9
Interest rates (basis points)	62	108	175	196	148
Current account (% GDP)	0.2	0.5	0.7	0.8	1.0
Japan					
GDP level	0.0	-0.2	-0.3	-0.5	-0.6
Inflation	0.0	-0.2	-0.1	-0.2	-0.3
Interest rates (basis points)	-4	-29	-33	-56	-72
Current account (% GDP)	-0.4	-0.2	-0.3	-0.4	-0.5
Euro					
GDP level	-0.2	-0.4	-0.6	-0.7	-0.7
Inflation	-0.1	-0.2	-0.3	-0.3	-0.3
Interest rates (basis points)	-22	-42	-73	-80	-80
Current account (% GDP)	0.1	-0.1	-0.2	-0.2	-0.3
GDP level					
Other OECD Europe	-0.4	-0.7	-0.9	-1.0	-1.1
Other OECD	-1.0	-1.0	-0.8	-0.6	-0.3
Total OECD	*0.0*	*0.1*	*0.1*	*-0.1*	*-0.3*
China	-0.3	-0.5	-0.6	-0.7	-0.7
Other non-OECD Asia	0.0	-0.2	-0.2	-0.1	-0.1
Non-OECD Europe	-0.4	-0.5	-0.3	-0.1	0.0
Other non-OECD	0.2	0.2	0.1	0.1	0.1
Total non-OECD	*0.0*	*-0.1*	*-0.1*	*-0.1*	*-0.1*
World	*0.0*	*0.1*	*0.1*	*-0.1*	*-0.2*

Table 10. 10% yen depreciation

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.0	-0.1	-0.2	-0.1	-0.1
Inflation	0.0	0.0	-0.1	-0.1	-0.1
Interest rates (basis points)	-10	-10	-20	-25	-25
Current account (% GDP)	0.1	0.0	0.0	0.0	0.0
Japan					
GDP level	0.4	0.8	1.2	1.5	1.6
Inflation	0.4	0.5	0.7	0.8	0.8
Interest rates (basis points)	80	110	150	185	190
Current account (% GDP)	0.8	0.9	1.1	1.2	1.3
Euro					
GDP level	-0.1	-0.1	-0.2	-0.2	-0.3
Inflation	0.0	-0.1	-0.1	-0.1	-0.1
Interest rates (basis points)	-5	-15	-25	-30	-30
Current account (% GDP)	0.0	0.0	0.0	0.0	0.0
GDP level					
Other OECD Europe	-0.1	-0.2	-0.3	-0.4	-0.4
Other OECD	-0.2	-0.2	-0.2	-0.2	-0.2
Total OECD	*0.0*	*0.0*	*0.1*	*0.1*	*0.2*
China	-0.1	-0.1	-0.2	-0.2	-0.2
Other non-OECD Asia	0.1	0.1	0.0	0.0	0.0
Non-OECD Europe	-0.1	-0.1	-0.1	-0.1	0.0
Other non-OECD	0.0	0.0	0.0	0.0	0.0
Total non-OECD	*0.0*	*0.0*	*-0.1*	*-0.1*	*0.0*
World	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*

Table 11. 10% euro depreciation

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	-0.1	-0.2	-0.2	-0.3	-0.3
Inflation	-0.1	-0.1	-0.1	-0.2	-0.3
Interest rates (basis points)	-10	-20	-30	-45	-50
Current account (% GDP)	0.1	0.0	0.0	0.0	-0.1
Japan					
GDP level	0.0	-0.1	-0.2	-0.3	-0.4
Inflation	-0.1	-0.1	-0.1	-0.1	-0.2
Interest rates (basis points)	-10	-20	-20	-35	-50
Current account (% GDP)	-0.1	-0.2	-0.3	-0.4	-0.4
Euro					
GDP level	0.7	1.3	1.7	1.8	1.6
Inflation	0.3	0.7	1.0	0.9	0.9
Interest rates (basis points)	85	165	220	210	200
Current account (% GDP)	0.3	0.2	0.5	0.8	1.0
GDP level					
Other OECD Europe	-0.2	-0.3	-0.4	-0.5	-0.5
Other OECD	-0.3	-0.4	-0.4	-0.4	-0.3
Total OECD	*0.1*	*0.2*	*0.2*	*0.2*	*0.1*
China	-0.1	-0.1	-0.2	-0.4	-0.4
Other non-OECD Asia	0.2	0.0	-0.2	-0.2	-0.2
Non-OECD Europe	0.7	0.7	0.5	0.2	-0.1
Other non-OECD	0.5	0.5	0.2	0.1	0.0
Total non-OECD	*0.3*	*0.3*	*0.1*	*-0.1*	*-0.1*
World	*0.2*	*0.2*	*0.2*	*0.1*	*0.1*

3.4 A sustained increase in non-OECD demand

61. The final simulation features a 10% sustained increase in non-OECD domestic demand. Again, such a shock is not particularly realistic, say, in relation to typical real world cycles or policy reactions, but is useful in illustrating the underlying mechanisms and the relative linkages between the OECD and non-OECD countries and regions and differences between the current states of the non-OECD models. It is carried out across non-OECD regions primarily because the links from individual non-OECD regions to the OECD economies are, in spite of ongoing globalisation, still rather weak, as is also reflected in the scale of the shock, which is again fairly atypical. Thus a shock to demand in any individual non-OECD region, apart say from China, is unlikely to show significant effects across the board.

62. An important feature of the simulation results (reported in Table 12) and the model is that a given exogenous shock to non-OECD demand is not fully reflected in non-OECD GDP. This of course reflects the degree to which a shock to demand is passed on via non-OECD import leakage (rising by 10% or more in the short-term) to the OECD countries via exports. Thus even allowing for dynamics, total non-OECD GDP increases by no more 7.5 to 8% compared with the initial 10% shock. An important outlier is China where the impact effect on GDP is much lower, at around 6%, is eroded steadily over the period to 3% by the fifth years. This difference reflects a fundamental difference in model specification, whereby the China

model, though still relatively crude incorporates a considerably more complete specification of wages and prices. Thus a shock to China's domestic demand generates quite considerable inflation pressures which in turn reduces competitiveness and serves to increase import leakages, thereby boosting the stimulus to the OECD economies. Clearly if a feature were also present in the other non-OECD economy models, the impacts would be greater both on OECD output and world prices. The lack of such mechanisms clearly limits the realism of the shock, as does its sustained nature.

Table 12. Sustained 10% increase in non-OECD domestic demand

Percentage deviations from baseline

	Years after shock				
	Year 1	Year 2	Year 3	Year 4	Year 5
UNITED STATES					
GDP level	0.6	0.9	0.8	0.5	0.5
Inflation	0.1	0.2	0.8	0.8	0.6
Interest rates (basis points)	41	72	147	142	99
Current account (% GDP)	0.5	0.6	0.7	0.9	1.1
Japan					
GDP level	1.2	1.4	1.6	1.6	1.5
Inflation	0.6	0.7	1.2	1.0	0.7
Interest rates (basis points)	150	80	243	209	164
Current account (% GDP)	0.9	0.9	0.9	0.9	0.9
Euro					
GDP level	0.7	1.1	1.5	1.7	1.8
Inflation	0.2	0.4	0.7	0.8	0.9
Interest rates (basis points)	60	106	178	192	206
Current account (% GDP)	0.4	0.4	0.6	0.8	1.0
GDP level					
Other OECD Europe	1.1	1.6	2.0	2.3	2.5
Other OECD	1.0	1.1	1.3	1.4	1.3
Total OECD	*0.8*	*1.1*	*1.3*	*1.2*	*1.2*
China	6.1	6.7	5.2	4.0	3.0
Other non-OECD Asia	9.5	8.4	8.2	8.1	8.0
Non-OECD Europe	6.7	7.2	7.7	8.2	8.4
Other non-OECD	7.8	8.6	8.9	9.0	9.2
Total non-OECD	*7.8*	*8.0*	*7.8*	*7.6*	*7.5*
World	*2.0*	*2.4*	*2.5*	*2.4*	*2.3*

63. On the whole, the corresponding effects on the OECD economies are moderate in relation to the scale of the apparent scale of the shock. This reflects both the dampening due to the share of imports in non-OECD demand and also the share of exports in OECD GDP. Thus OECD exports increase by an average 4 to 5% over the period and, allowing for OECD import leakages and internal crowding-out, real GDP by 1 to 1.3%. There is nonetheless considerable variation in GDP responses across the OECD, with the highest gains being for the more trade-intensive economies and regions. Japan's GDP and current accounts, in particular benefit from an above average short-term export response to market growth plus a greater specialisation in trade with the non-OECD countries, especially within the Other Asia region, with GDP effects averaging 1½ per cent. The impact on the euro area is of the same order of magnitude, but slower to build up, while that for the Other OECD Europe is highest, rising to around 2½ per cent reflecting greater openness and linkages to other exporting countries. By contrast United States responses are considerably lower, reflecting typically lower export shares in non-OECD markets, lower trade multipliers and faster rate of crowding out through interest rate and real wealth effects. By contrast OECD

inflation responses are broadly similar, rising over the period but staying generally below 1% per annum, with the exception of Japan, where lagging but substantial increases in policy rates have little immediate leverage on inflation.

64. The overall effects on current account balances are broadly zero across regions, with an overall improvement of up to 1% of GDP for the OECD area, mirrored by a deterioration of up to 2¾ per cent of GDP for the non-OECD, reflecting the relative scale of OECD and non-OECD GDPs.

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