The NiGEM Model

All models contain the determinants of domestic demand, export and import volumes, GDP and prices, as well as current accounts and net assets. Interest rates reaction functions and forward looking exchange rates are available for all the individual countries. There are also links between countries in their financial markets via the structure and composition of wealth, emphasising the role and origin of foreign assets and liabilities. The model has complete demand and supply sides and there is an extensive monetary and financial sector.

Recent policy analyses include an evaluation of the impact of US proposals for a Chinese revaluation. Our modelling of the Chinese economy suggests that it is very responsive to shocks, and a revaluation would lead to rapid deflation. The real exchange rate would therefore return to where it had been previously. Hence we suggested that realignment was a solution to the overheating of the Chinese economy, but that it would not help improve the US current account except in the short run.

![Impacts of a Chinese realignment](image)

Results from the model on the impacts of oil prices on the UK economy have also received widespread attention. We have shown that oil price increases are likely to have less impact now than in the 1970s in part because we use less oil, in part because we are more flexible, and also because inflation expectations are well anchored by the independence of the Bank of England.
**International Linkages**

International linkages come from patterns of trade, the influence of trade prices on domestic price, the impacts of exchange rates and patterns of asset holding and associated income flows. Interest rates and exchange rates are determined in the financial market.

**Trade**

These equations depend upon demand and relative competitiveness effects, and the latter are defined in similar ways across countries. It is assumed that exporters compete against others who export to the same market via relative prices and demand is given by the imports in the markets to which the country has previously exported while imports depend upon import prices relative to domestic prices and on demand. As exports depend on imports, they will rise together in the model. Systems of trade equations are ‘closed’ to ensure that the world balance of trade adds up, at least to its normal degree of accuracy, in any simulation.

The equations are estimated in equilibrium correction form, with panel data techniques being used in recent research. The model covers trade in goods and services, with export prices and import prices being linked for consistency using Armington matrices for demand and prices. Trade competitiveness depends upon relative prices, and after any shock the model should return to a long run real equilibrium exchange rate pattern of its own accord.

**Financial markets**

Interest rates and exchange rates are set differently in forecast and simulation mode, as in a forecast the markets contain information, and we would normally only depart from market paths for interest rates and exchange rates when we feel we have specific model based information. Forecasts are generally based on judgments about interest rates and exchange rates. These judgements depend both on model outturns, the implications of small forecasting models, and the discussion of prospects amongst the group. Once interest rates and exchange rates are set financial market developments follow, with an evaluation of potential profits based on the model forecast and hence the construction of a forecast for equity prices. These model based exercises influence forecast outcomes significantly.

In scenario mode, forward looking nominal long rates and long real rates are a forward convolution using expected short-term nominal and real interest rates respectively. Forward looking exchange rates have to look one period forward along the arbitrage relation involving domestic and foreign short term interest rates, with expected exchange rates next period being solved for in the same way to produce a forward recursion. Forward looking equity prices are solved out from the discounted sum of expected discounted profits. The discount factor is made up of the nominal interest rate and the risk premium on equity holding decisions. There are equations for long rates and equity prices in backward scenarios.
**Demand**

In each country block demand depends on external demand for exports of goods and services, and on domestically generated demand, some of which spills over into imports of goods and services. In most countries external demand is less important than domestic demand, with only small countries such as Ireland, Portugal and Switzerland having external demand of a similar size to domestic demand. In the larger countries consumption is the most important single component of demand. Consumption depends on income and wealth, and hence the determination of both the flow of income and the stocks of financial and non financial wealth are central to forecasts and to simulations. Investment is the adjustment of the equilibrium capital stock and depends on the production function, the user cost of capital, equity prices and on costs of adjustment. The factor demand is discussed under supply below. There are also government demand categories.

**Consumption and Personal Income**

Consumption decisions are presumed to depend on income and total wealth in the long run, and follow the pattern discussed in Barrell and Davis (2004)\(^1\) who study a panel of G5 countries. Total wealth is composed of both financial wealth and tangible (housing) wealth where the latter data is available. Financial wealth depends on foreign and domestic equity and bond prices and on the accumulation of assets. In all cases there is an estimate of the decomposition of assets into domestic and foreign equities and bonds.

Where housing wealth is absent house prices play a separate role. The dynamics of adjustment to the long run, which are central to a forecast, are data based, and differ between countries to take account of differences in the relative importance of types of wealth and of liquidity constraints. Personal incomes are also forecast in each country building up from components. Employment income comes from the labour market models. Profits and interest payments from the production model sector, the government model sector and the models of foreign assets. Taxes and transfers come from the public sector models.

**Private Sector Investment**

This is determined by the capital stock adjustment process described in the account of the supply side below.

**The Public Sector**

Each country has a set of equations for the public sector. Both direct and indirect taxes depend upon their respective tax bases and on the tax rate. Corporate taxes also depend upon the corporate tax rate and the level of profits, but with lags related to the complex collection process. Government spending on current goods and services and investment spending depend in part on current plans, and by default rise with trend output. Transfer payments depend upon unemployment and the dependency ratio as well as on policy. Government interest payments are determined by a perpetual inventory model based on the flow deficit and the stock of debt, with the appropriate structure of short and long-term interest payments on the debt stock.

The Supply Side

The quantity of output supplied in each country depends on the production function and the equilibrium in the labour market. International factors affect supply only through real interest rates, except in countries where convergence on US or European levels of output is rapid. For instance in the new member states of the EU (Poland, Hungary and the Czech Republic) the rate of technical progress depends on the stock of foreign direct investment.

Production and prices

For each country there is an underlying CES production function with labour augmenting technical progress. The production function constitutes the theoretical background for the specification of the factor demand equations for employment and the capital stock, and which form the basis for unit total costs and the measure of capacity utilisation which then feed into the price system. The capital stock adjustment equation depends upon the long run equilibrium capital stock, and the user cost of capital is influenced by the forward-looking real long-term rate, as well as by taxes and by depreciation. The speed of adjustment to equilibrium in the investment/capital stock adjustment equations also depends upon the short-term real interest rate, with this effect being similar across countries. The user cost of capital variable is calculated from data for the past, but individual firms take account of risk on their investments when undertaking projects. The risk premium can be varied in scenarios and forecasts.

Labour markets

It is assumed that employers have the power to manage, and hence the bargain in the labour market is over the real wage. In the long run, wages rise in line with productivity, all else equal. Given the determinants of the trajectory for real wages, if unemployment rises then real wages fall relative to trend, and conversely. The equations were estimated in an Equilibrium Correction format with dynamics estimated around the long run. Both the determinants of equilibrium and the dynamics of adjustment can change over time and adjustment, especially in Europe, is slow. We assume that labour markets embody rational expectations, based either on the model or policy related learning over the inflation rate and we assume that wage bargainers use model consistent expectations, either for the immediate period ahead or over a longer-term horizon

Trend GDP

This is calculated by the use of the Baxter-King approximate band-pass filter which calculates the output gap using the current past and forecast GDP. The forecast, and changes to the forecast in simulation mode, are determined by the Supply Side of the model.

Wealth and asset accumulation

Each country on the model has a stock of foreign assets and a stock of liabilities. These are linked to the stock of domestic financial assets and the stock of domestic private sector and public sector liabilities. A proportion of government debt is owned abroad, as are proportions of the national stock of equities and the stock of banking assets. Some national financial wealth is held in foreign equities and bonds as well as banks. Income flows from asset stocks are allocated in relation to ownership, and hence net property income from abroad depends on income receipts and payments on bonds, equity holdings and bank. Once model and judgement based forecasts for asset prices, exchange rates and interest rates have been made the forecast for wealth follows automatically. The wealth and accumulation system allows for flows of saving onto wealth and for revaluations of existing stocks of assets in line with their prices determined as above. When foreign equity and bond prices change, domestically held assets change in value.

Monetary and Fiscal Policy

Fiscal policy is set using both taxes and tax rates and by levels of spending. We model the resulting level of deficits and debt stocks, and these affect behaviour as they are part of the stock of financial assets of the personal and foreign sectors. Monetary policy uses the interest rate as an instrument and these depend on the targets chosen for the monetary authorities in scenario mode.

Policy rules in scenario analyses

Fiscal and monetary policy rules are important in ‘closing the model’ and the rules are discussed at greater length in Barrell and Dury (2000). We use simple rules that are designed to reflect policy frameworks rather than optimal rules. Policy analysis is divided into deterministic simulations, normally on single issue topics and stochastic evaluations of policy regimes using bootstrapping. Feedback parameters can by changed by users. All users can undertake deterministic simulations, but stochastic evaluations are only undertaken in NIESR at present because of the burden of computer usage involved.

Fiscal Policy Rules

Budget deficits are kept within bounds in the longer term, and taxes rise to do this. This simple feedback rule is important in ensuring the long run stability of the model. Without a solvency rule (or a no Ponzi games assumption) there is no necessary solution to a forward-looking model.

Monetary Policy Rules

It is assumed that the monetary authorities adopt simple targeting rules that stabilise the price level or the inflation rate in the long term. If we use different rules in different countries then some of the difference we observe would depend on that policy choice and in this paper we use the same rule for all countries. The European Central Bank (ECB) has been set the objective of maintaining price stability in the medium term. It has set itself a target for inflation within the constraints of a nominal target for the stock of money, and it describes this as the two-pillar strategy. Taylor rules and price level targeting are available for all countries.


4 European Central Bank (2001). We do not target money, as this is a poor indicator of the underlying target, which we take to be nominal GDP.
Model Details of Key Trade equations

XVOL

We have a single behavioural equation for exports of goods and services (XVOL). This is similar in structure to our old equations, and is based on the following model:

$$\Delta XVOL = \alpha_1 + \lambda \left[ XVOL_{t-1} - S_{j,t-1} - \beta_1 \frac{PX}{CPX_{t-1}} - \beta_2 \frac{PX}{DPX_{t-1}} \right] + \beta_3 \Delta S + \beta_4 \Delta \frac{PX}{CPX} + \beta_5 \Delta \frac{PX}{DPX}$$

where $S$ is export market size, $PX$ is an export deflator (goods and services), $CPX$ is a weighted average of competitor's export prices, and $DPX$ is a weighted average of consumer prices in the exporting country's export markets.

MVOL

Similarly, we have a single behavioural equation for imports of goods and services (MVOL). This is similar in structure to our old equations, and is based on the following model:

$$\Delta MVOL = \alpha_1 + \lambda \left[ MVOL_{t-1} - TFE_{t-1} - \beta_1 RPM_{t-1} \right] + \beta_2 \Delta TFE + \beta_3 \Delta RPM$$

where TFE is total final expenditure and RPM is relative import price. We impose a common demand elasticity across all countries of 1.24, based on panel estimation reported in Barrell and Dees (2004).

S

The export market variables $S$, reflect import weights, so the share of the given country’s imports accounted for by the exporting country in our base year. $S$ is currently reported in 2000US$, to ensure absolute differences in the level of imports in each country is properly calculated.

$$S_j = \sum \beta_i XMVOL_i$$

where $\beta_i$ is given by (exports from country $j$ to country $i$)/(total imports in country $i$). $XMVOL_i$ is imports of goods and services in country $i$, calculated in 2000 US$.

CPX

Our model of the export price of competitors now reflects goods and services exports, rather than exports of manufactures.

$$CPX_j = \sum \delta_i PX_i$$

where $\delta_i$ reflects the double weights of competitors and $PX$ is the export price deflator for goods and services.
DPX

Domestic export competitors’ price is especially important in countries where services capture a relative large share of exports.

\[ DPX_j = \sum \alpha_i \frac{CED_i}{RX_i} \cdot 100 / DCEDRX00_i \]

where \( \alpha_i \) is given by \((\text{exports from country } j \text{ to country } i) / (\text{total exports from country } j)\).

\( DCEDRX00 = (CED/RX)@00 \)

PX, PXNCOM and PXCOM

We have a single equation for a total export price of goods and services (PX). The basic equation for PX is based on the following model:

\[
\Delta PX = a_1 + \lambda \left[ PX_{-1} - \beta_1 \frac{CED}{I + ITR} / RX - \beta_2 CPX_{-1} - (1 - \beta_1 - \beta_2) DPX_{-1} \right] + DYNAMICS(DYNAMICALLY HOMOGENOUS)
\]

For countries with large export shares captured by commodities (10% or more) we have disaggregated PX into separate equations for the export price of commodities (PXCOM) and the export price of non-commodities (PXNCOM). The countries that include this distinction are: NW, AU, NZ, MX, RU, BR, OP, DE, LA, FE, AF, CN, NL, UK. The model for PXNCOM is the same as the PX model above:

\[
\Delta PXNCOM = a_1 + \lambda \left[ PXNCOM_{-1} - \beta_1 \frac{CED}{I + ITR} / RX - \beta_2 CPX_{-1} - (1 - \beta_1 - \beta_2) DPX_{-1} \right] + DYNAMICS(DYNAMICALLY HOMOGENOUS)
\]

The model for PXCOM is a simple weighted average of commodity prices. Weights are determined by their share of commodity exports in 2000.

\[
PXCOM = a_1 WDPMM + a_2 WDPFDV + a_3 WDPFLD + a_4 WDPANF + (1 - a_1 - a_2 - a_3 - a_4) WDPO
\]

The total export price deflator is then a weighted average of PXNCOM and PXCOM, where the weights reflect the share of commodities in total exports in 2000.

\[
PX = a_1 PXCOM + (1 - a_1) PXNCOM
\]
**PM equations**

We have a single equation for a total import price of goods and services (PM). The PM is modelled as a weighted average of all other countries PX’s. Weights are determined by the share of country \( j \)’s imports in 2000. This is then converted to domestic currency. The model is the same as we previously used for PMG.

\[
PM_j = \left( \sum \gamma_i PX_i \right) * RX / DRX00
\]

where \( \gamma_i \) is given by (imports into country \( j \) from country \( i \))/(total imports into country \( j \))

**RPM**

Relative import prices reflect whole economy prices, rather than manufacturing prices.

\[
RPM = PM / (CED / (1 + ITR))
\]

**References**