

The Forecasting and Policy System: an introduction

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This article briefly describes the Bank's new Forecasting and Policy System (FPS) models.

Executive summary

The Forecasting and Policy System (FPS) comprises a system of models which is used to prepare economic projections and to analyse a wide range of policy issues relating to monetary policy. The system comprises three elements: a small, high-level, core model of the New Zealand economy; satellite models which deal in greater detail with various components of the economy; and indicator models which use statistical techniques and a range of current economic indicators to assist in making short-term projections (covering the next one or two quarters).

Work is still in progress on the satellite and indicator models, but the core model is operational. It is being used in preparing economic projections, beginning with those reported in the Bank's June 1997 *Monetary Policy Statement*.

The core model is a simplified representation of the key features of the New Zealand economy. It describes how people balance consumption and saving decisions; how businesses decide how much output to produce and how much capital to accumulate and labour to employ; and how the New Zealand economy borrows and trades in international markets. The Government and the Reserve Bank are important parts of this description. Government decisions about expenditure levels and how much debt to raise and repay affect how much tax revenue must be raised. Monetary policy operates to achieve an inflation target by altering monetary conditions.

1 Introduction

Late in 1995 work began in the Reserve Bank on a new macroeconomic modelling framework, labelled the *Forecasting and Policy System* (FPS). The name summarises our expectations of the new system: that it will provide a rigorous analytical approach to both the quarterly projections and the investigation of specific policy issues. Experience at the Bank and at other institutions had demonstrated that satisfying these twin objectives is not an easy task for a single macroeconomic model. Consequently, considerable attention has been paid to the design of a system to accomplish both objectives. This note provides brief introduction to this system; a more thorough account is found in the FPS *Research Paper*.²

Well-designed models offer advantages because of the discipline that they bring to economic analysis. When examining policy issues, this discipline comes from accounting and behavioural constraints on agents and the distinction between the short run and the long run. Less complete analytical tools often fail to enforce these critical constraints. For example, they may imply an implausible output response to an increase in government expenditure because important issues such as the sustainability of the fiscal balance or the initial stresses on the productive capacity of the economy are ignored.

However, no model is going to capture all the forces at work in the economy. A model is by definition an abstraction, and can only incorporate the most important linkages. Moreover, the fact that we live in a continually changing world might seem to mitigate against the usefulness of a model. In fact, models prove their worth by facilitating the analysis of this aspect of the world. A well-designed model allows the user to examine alternative scenarios so that assumptions can be tested and risks assessed.

The basic requirements of projections and policy analysis led us to the concept of the *Forecasting and Policy System*, as described in section 2. In section 3 some key design features of the core model are summarised. Section 4 provides a non-technical guide to the economic logic of

¹ The Forecasting and Policy System was built by a team comprising Vincenzo Cassino, Aaron Drew, Eric Hansen, Benjamin Hunt and Alasdair Scott (all Reserve Bank of New Zealand), and Richard Black and David Rose (QED SOLUTIONS, Ottawa, Canada). Acknowledgement is also due to the Bank of Canada where a similar modelling framework was initially developed, and with which Richard Black and Benjamin Hunt also have affiliations.

² See Black, Cassino, Drew, Hansen, Hunt, Rose and Scott (1997), "The Forecasting and Policy System: the core model", Reserve Bank of New Zealand *Research Paper* No.43, Wellington.

the core model. Section 5 concludes with a discussion of how the model will affect the presentation of economic projections.

2 The FPS concept

Policy experiments and projections place quite different demands on macroeconomic models. Models that are detailed enough to relate as closely to the data as is required for making short-term projections are usually not tractable and adaptable enough to be practically useful for higher level policy analysis. As a solution, one model could be used for projections and another for policy analysis. However, there are two basic problems with such an approach. First, the same long-run theoretical considerations that are essential for policy analysis are also critical for ensuring that short-run projections are consistent with a plausible medium-term view. Secondly, in order to analyse and rank alternative policy choices, it is important to capture the different short-run dynamic adjustment processes that alternative policies involve. The solution chosen by the Bank has been to develop a *system* of models, comprising a single core macroeconomic model, satellite models that deal in greater detail with specific components of the economy, and indicator models that are time-series based and designed to capture the high frequency information in the data.

2.1 Using a model for policy analysis

For policy analysis it can be more important for the model to capture our understanding of how the economy works than it is to provide a view of the current state of the economy. The model should also solve quickly, so that it can be used in simulation experiments that approximate uncertainty (ie *stochastic simulations*, where the model is subjected to a large number of random shocks). For these reasons, policy questions are best tackled using only the core model.

2.2 Using a model for quarterly projections

Hypothetical scenarios used in policy analysis usually assume that the economy begins in equilibrium. For making quarterly projections, however, the starting point matters considerably. Because of this, it is important to incorporate substantial information about the short run. This involves making judgements about the current state of the economy, the nature of the disequilibria, and how persistent the disequilibria are expected to be.

The FPS 'projection environment' consists of the whole system; the core model, satellite models, and indicator

models. One of the main benefits of the core model is the clarity which it brings to the projection, by focusing on the "big picture". Using indicator and satellite models to supplement the core model's analysis means that the level of detail required for making projections can be satisfied without sacrificing the speed and efficiency of model simulations. Indicator models allow sector analysts to develop their view of the starting points, while the detailed results from satellite models enable them to review the impact of their assumptions on the whole projection. In this way the projection environment allows for different views to be tested.

The Forecasting and Policy System is represented in figure 1, opposite.

3 Key features of the core model

The core model differs significantly from previous Reserve Bank models. These departures are based on lessons from modelling projects at the Bank and internationally. The key features described in this section are generic to modern macroeconomic models, though specific implementations do differ across models.

3.1 A well-defined steady state

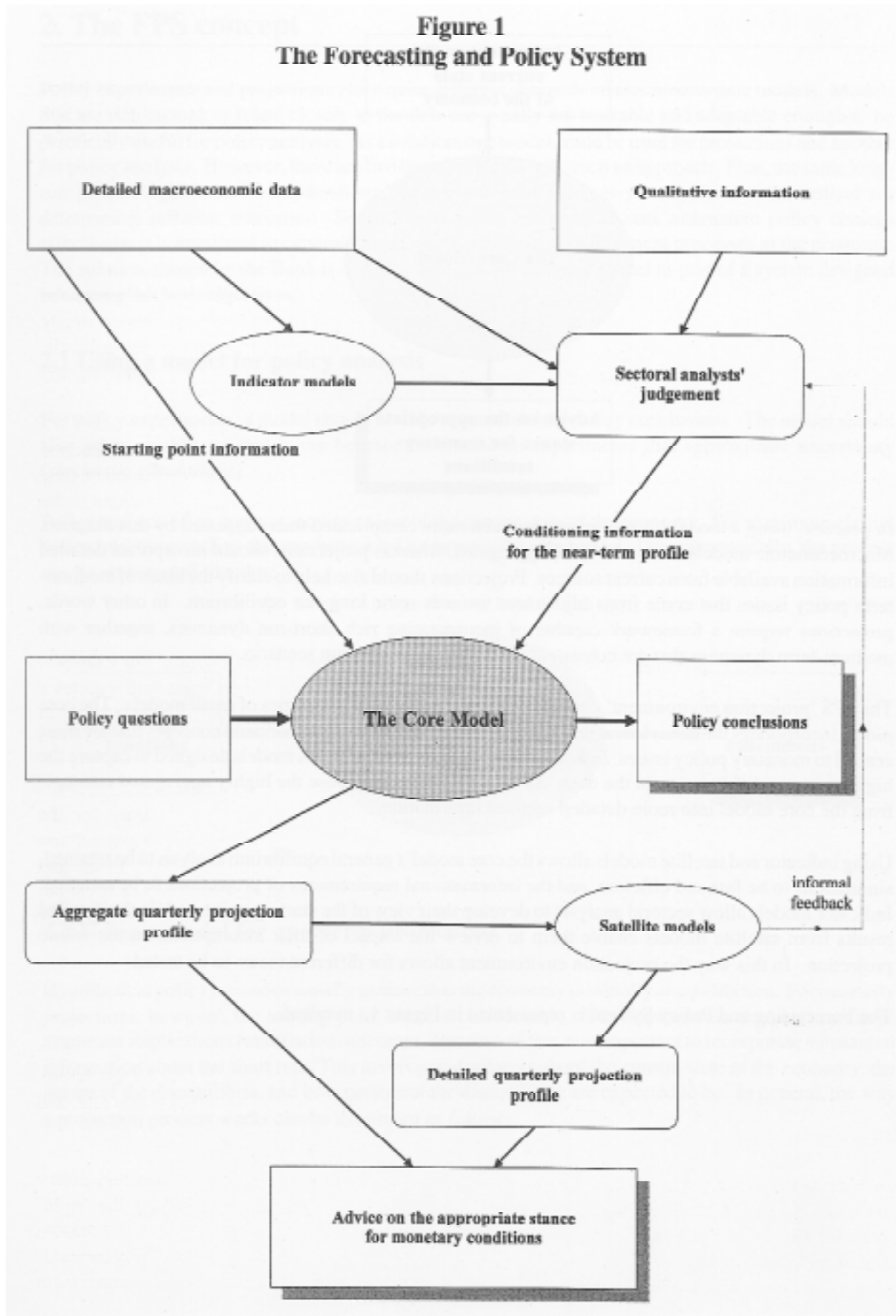
An understanding of the economy's short-term evolution requires an understanding of where the economy is heading in the long run. To achieve this, the core model embodies a well-defined steady state. This means that in the long run, all the variables in the model settle to long-run equilibrium levels. These levels are mutually consistent - they all 'add up', agents' objectives are achieved, and disequilibria have been resolved.

3.2 Stock-flow accounting and budget constraints

In the core model, expenditure flows adjust to achieve long-run desired asset stocks. For example, profit-maximising firms aim for a desired level of capital stock. In the steady state, this requires a constant flow of investment to replace depreciation. If firms want to build up a higher equilibrium level of capital stock, they have to raise investment for a period *above* the new long-run equilibrium flow.

Together with budget constraints, the stock-flow accounting has important implications for the sustainability of agents' actions: there are no 'free lunches', where an agent can choose expenditure today without regard to the im-

Figure 1:
The Forecasting and Policy System



plications for expenditure tomorrow. Thus households, firms, and the government cannot spend without regard to their debt burden. Equally, the monetary authority cannot stimulate consumption above the equilibrium rate indefinitely, since this would imply an erosion of households' wealth, which they would not ignore forever.

3.3 Expectations

The core model contains explicit representations of expectations that agents hold about the future. These include expectations of future wealth, labour income, return on capital, the exchange rate, and inflation.

Models where expectations adjust instantaneously tend to be uninteresting from a monetary policy perspective, since the monetary authority would have no role. Private agents, knowing the 'right' solution and what the authority would do, simply adjust their behaviour immediately. For this reason, inflation expectations in the core model are characterised as partially backward- and partially forward-looking. As a result, there is no free ride for the monetary authority stemming from announcement effects. Instead, following a disturbance to the economy, the monetary authority has to act to re-anchor inflation expectations.

3.4 Endogenous monetary and fiscal policy

A policy model should express clear roles for monetary and fiscal policy and identify how they affect private agents. In the core model, the behaviour of the monetary and fiscal authorities is characterised by reaction functions. These functions are particularly appropriate in the context of the institutional framework provided by the 1989 *Reserve Bank Act* and the 1994 *Fiscal Responsibility Act*. Moreover, endogenous policy functions are standard features of all modern macroeconomic models. These functions reflect the fact that the monetary and fiscal authorities do not set policy independently of the rest of the economy. To anchor inflation near the middle of the target range, the stance of monetary policy is adjusted in light of projected economic conditions.

3.5 A well-articulated supply side

The core model incorporates a description of the production process, which includes factors such as depreciation, taxes, finance costs, the price of capital goods, and expected returns to capital. This supply-side specification allows for the view that inflation is not just a demand phenomenon - a fall in the ability to supply goods will be just as inflationary as a rise in demand.

4 The economic structure of the core model

4.1 Agents and the real economy

The core model describes the behaviour and interactions of households, firms, a fiscal authority, a monetary authority, and an external sector.

4.1.1 Households, wealth, and consumption

Households are modelled using a convenient theoretical device known as 'overlapping generations.' Consumers live an uncertain length of time and must plan their consumption and savings accordingly. In doing so, they must balance the desire for consumption today with the need to sustain consumption levels later in life. They accomplish this goal by accumulating financial assets that provide income over and above their labour income.

4.1.2 Firms, capital, and investment

Firms aim to maximise profits by hiring labour services and buying capital to produce output. Labour supply is exogenous in the long run. Firms aim for a desired level of capital stock based on the return to capital and its cost. This desired level of capital stock in turn determines expenditures on investment. Thus, when there is a permanent change affecting the return to capital or its cost, desired capital stock will change and with it investment flows.

However, it is costly to change investment plans, so firms do not reach their desired stock levels immediately. Firms also face 'time-to-build' constraints, which mean that it takes time for any added investment to contribute to productive capacity. In the long run, these costs and constraints are overcome and the desired level of capital is attained. Investment converges at the level necessary to provide for depreciation and for equilibrium growth in the stock of capital.

4.1.3 Fiscal authority, government debt, and spending

The public sector ("the government") is represented by one single entity, which consolidates all levels of government. The government buys output and pays for it by raising taxes and/or selling debt. It aims at long-run targets for transfer payments, government spending, and government debt. Given revenue from direct capital taxes and indirect taxes on expenditures (including tariffs), the reaction function specifies that labour income taxes adjust to satisfy the fiscal budget constraint and ensure the achievement of the fiscal targets.

4.1.4 The external sector

All claims on firms' assets and government debt must be held either by domestic households or foreigners. The external sector is assumed to be a passive holder of the claims not held by households. Thus, the level of foreign assets is a residual determined jointly by the decisions of households, firms and the government. In the case of New Zealand, households choose to hold only part of the capital stock and government bonds, so that New Zealand maintains a net debt with the external sector. The service cost of this debt determines the trade balance that must hold in long-run equilibrium. In turn, the equilibrium real exchange rate ensures that exports and imports achieve this long-run balance.

Equilibrium in the real economy is therefore described by agents' objectives and the decisions they make. This can be expressed in terms of stocks and flows, as portrayed in figure 2:

4.2 The monetary authority and the nominal economy

Whereas the objectives of the other agents anchor the real economy, the role for the monetary authority is to anchor the nominal economy. To implement this, a reaction function is specified where the monetary authority targets an annual inflation rate of 1.5 per cent, the mid-point of New Zealand's inflation target range. A particularly important feature of our specification is that the monetary authority is forward-looking. The monetary authority is concerned with *projected* deviations of inflation from the mid-point of the target range. Although the general nature of this formulation is consistent with how monetary policy operates in New Zealand, the precise specification of the reaction function is *not* an official Reserve Bank 'rule' for setting desired monetary conditions.

Figure 2
Objectives (stocks) and decisions (flows)

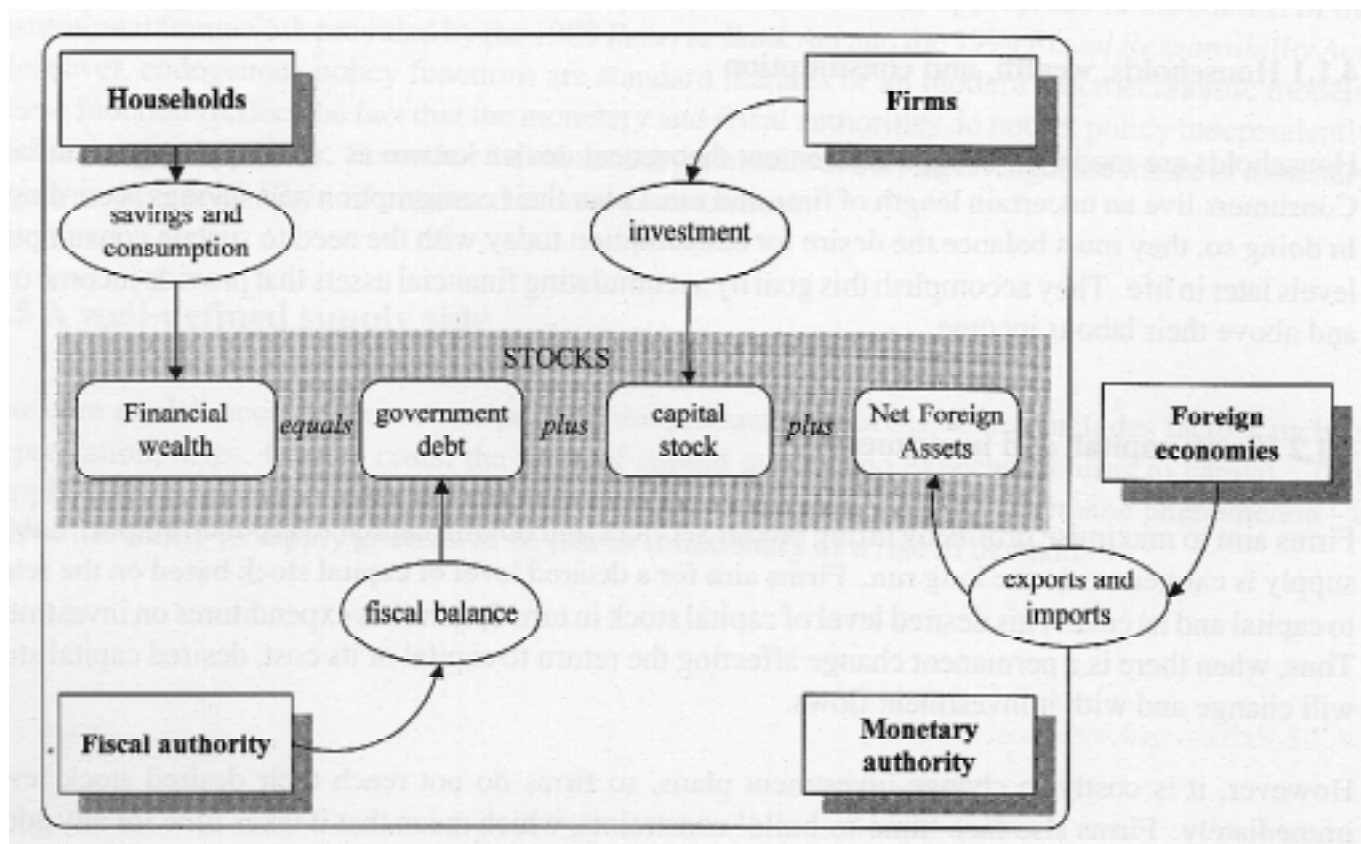
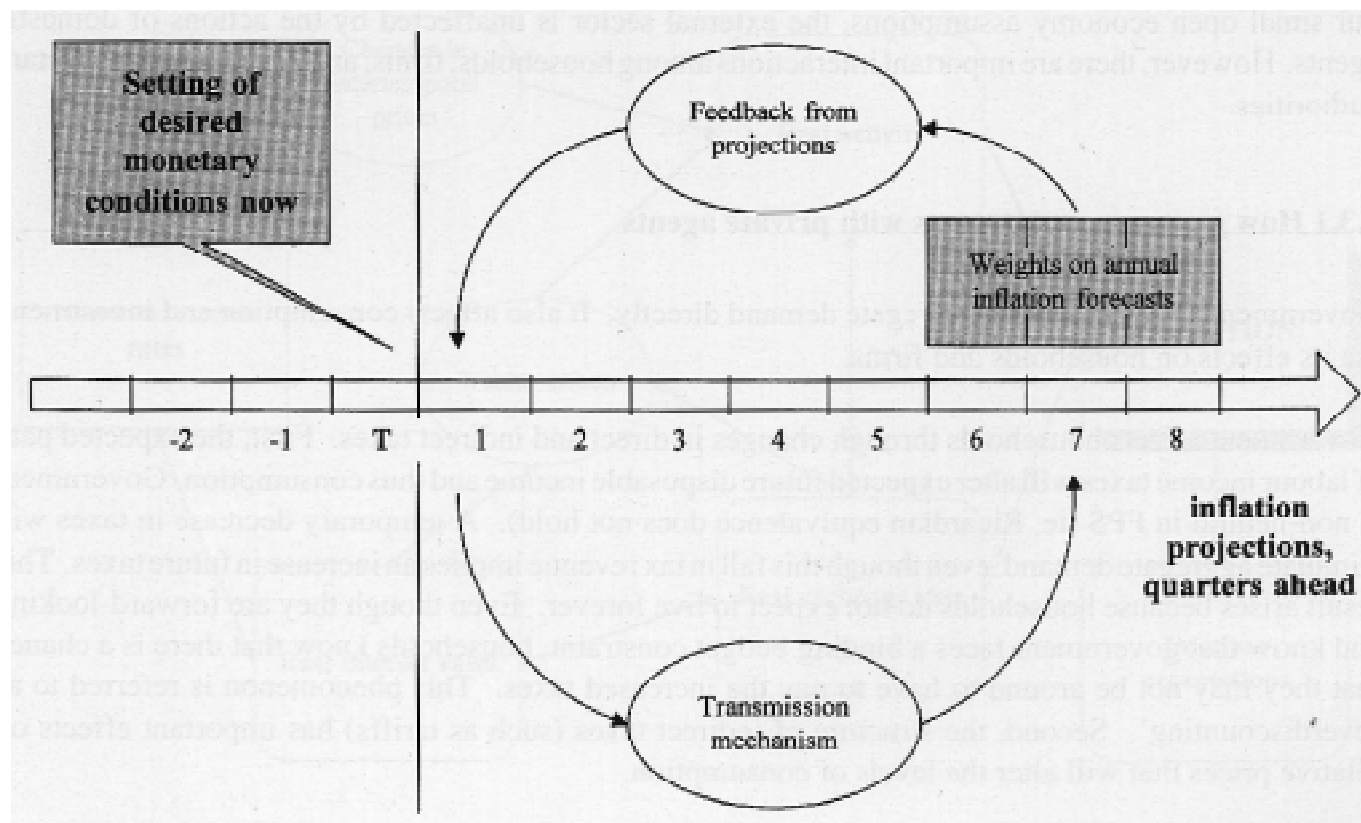


Figure 3
The monetary policy process in FPS



This framework is fundamentally different to more traditional methods which ask ‘What happens to the economy if monetary conditions are set this way?’ In the core model this question is inverted to become ‘What are the monetary conditions *required* through time to achieve and maintain the target?’ Figure 3 is a graphical representation of how this question is answered using the core model. The behaviour of the monetary authority depends on how far ahead it projects inflation and how strongly it responds to projected deviations of inflation from the target.

4.2.1 Prices and inflation

The model contains a structure of relative prices that distinguishes products according to their origins and their end uses. Goods produced domestically can be used either at home or exported. Exported products are determined by the world price and the exchange rate. Products sold at home bear prices determined by domestic market conditions, but domestic products must compete with imports for domestic sales. In the core model, three types of domestic use are accounted for explicitly; consumption, investment, and government purchases. Each of these has a relative price, which reflects the particular goods and services used in that sector, import penetration in the sector, and the structure of indirect taxes.

Inflation dynamics are overlaid on top of relative prices. The complete structure characterises inflationary pressures as potentially arising from many different sources, with the implication that no single monetary response will always be appropriate. All agents - households, firms, the government and foreigners - can create inflationary pressures. There are four main sources of inflation in the core model:

- **The output gap.** If demand for goods and services exceeds the economy’s productive capacity, inflation will accelerate. Since it is the output *gap* that matters for inflation, the monetary authority will react to supply shocks as well as demand shocks.
- **Cost pressures.** Changes to the costs of production inputs can accelerate inflation, even if there is no output gap. These costs include wages and indirect taxes.
- **Foreign prices and the exchange rate.** Since traded goods prices are set in world markets, there are significant direct effects from import prices, export prices and fluctuations in the exchange rate.
- **Inflation expectations.** Finally, forward-looking agents’ expectations of inflation are an important part of the inflation process.

Although all four pressures enter the inflation process directly, there are important links between them. The structure of the model emphasises that different shocks flow

through to inflation in different ways, and so present different problems to the monetary authority.

4.3 The effects of monetary and fiscal policy

An important characteristic of the core model is the role of the monetary and fiscal authorities. Given our small open economy assumptions, the external sector is unaffected by the actions of domestic agents. However, there are important interactions among households, firms, and the fiscal and monetary authorities.

4.3.1 How the government interacts with private agents

Government spending enters aggregate demand directly. It also affects private consumption and investment, via its effects on households and firms.

The government affects households through changes in direct and indirect taxes. First, the expected path of labour income taxes will alter expected future disposable income and thus consumption. The government is non-neutral in FPS (ie Ricardian equivalence does not hold). A temporary decrease in taxes will stimulate aggregate demand, even though this fall in tax revenue implies an increase in future taxes. This result arises because households do not expect to live forever. Even though they are

forward-looking and know that government faces a binding budget constraint, households know that there is a chance that they may not be around to have to pay the increased taxes. This phenomenon is referred to as 'over-discounting'. Secondly, the structure of indirect taxes (such as tariffs) has important effects on relative prices that will alter the levels of consumption.

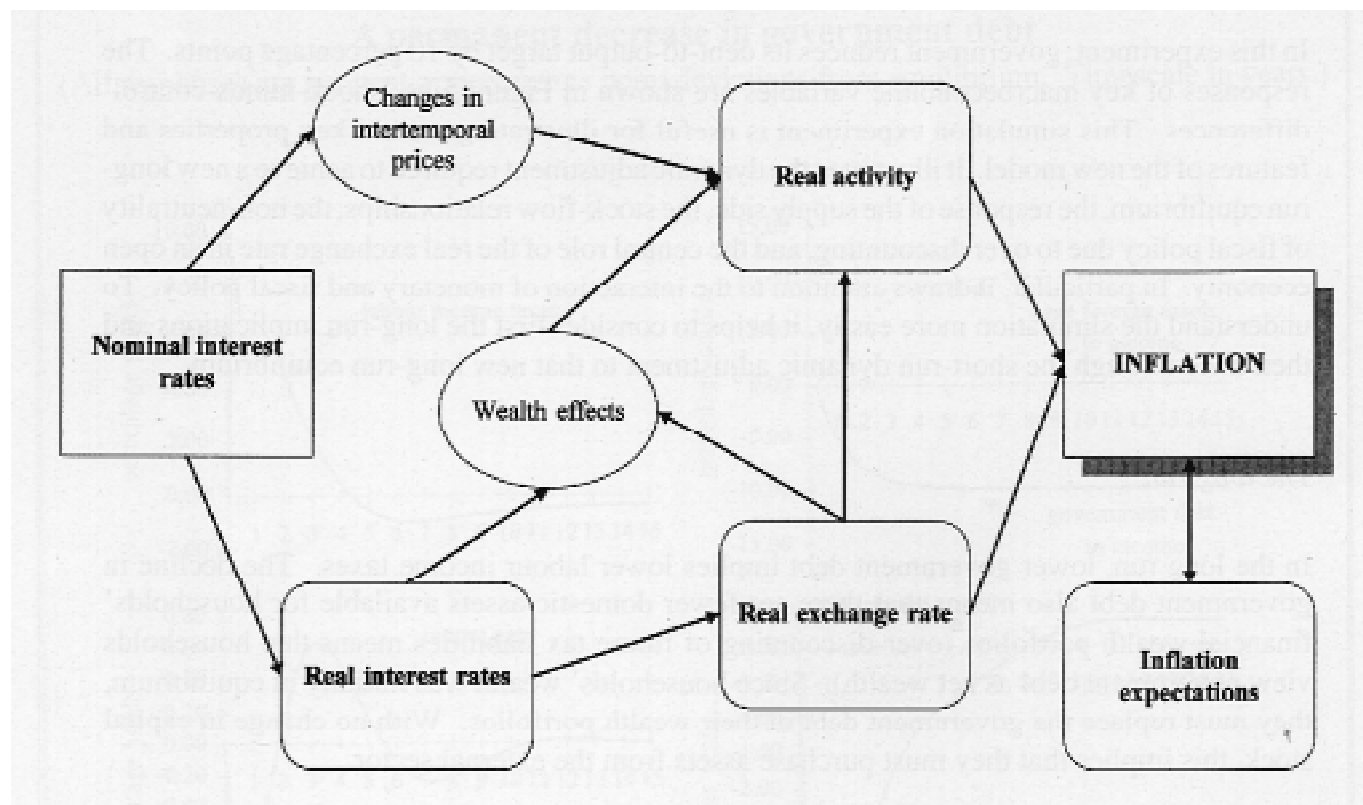
The government affects expected returns on capital by influencing aggregate demand. Direct taxes also play an important role in determining the return on capital, while indirect taxes affect the relative price of investment goods, which changes the cost of capital.

4.3.2 How the monetary authority interacts with private agents

Whereas the government can create permanent effects, the monetary authority has no ability to affect the real economy in the long run. The monetary authority cannot 'buy' more output permanently. In the long run, output is determined purely by the growth of the capital stock, the labour force, and productivity. Hence there is no exploitable trade-off, for example, between inflation and employment.

In the short run, of course, the monetary authority does have a large impact. A simplified representation of the process is provided in figure 4:

Figure 4
Monetary transmission in the core model



The monetary authority succeeds in influencing the real economy by being able to move nominal short-term interest rates. This results in changes to the intertemporal prices of consumption and investment that alter the level of demand. Further, because prices are sticky, nominal interest rate movements result in real interest rate movements to which the real exchange rate responds. The real exchange rate influences the net export position. Both exchange rate and interest rate changes affect household wealth, which has consequent effects on consumption demand. Furthermore, movements in interest rates change the service cost of government debt, which leads to income tax effects that alter consumption demand.

Inflation responds to the output gap, both directly and through the indirect effect on wages. Further, changes in the exchange rate have direct (and quantitatively very important) effects on import prices.

Inflation expectations depend on past price increases and future inflation outcomes. It might be argued that inflation expectations depend on the anti-inflation reputation that the central bank builds up over time. However, in the core model the monetary authority does not have a 'stock' of credibility that prevents expectations rising if actual inflation rises. Instead, policy actions are required to anchor inflation expectations at the target.

In the core model, the inflation process is asymmetric. This means that inflation rises relatively easily, but is difficult to reduce. As a consequence, more output is lost reducing inflation than is gained by allowing it to rise. This implies that the monetary authority should try to react as soon as possible, preventing the build-up of inflationary pressures. However, the monetary authority has to respect the lags in the transmission mechanism, and should not try to target inflation over which it has no control. A policy horizon that is too short will cause unnecessary volatility in the economy.

This completes the description of the economic structure of the core model. To illustrate the theory and some of the model's features, the box describes the outcome of a government debt shock.

5 How FPS will affect economic projections

The most obvious change to the Bank's economic projections arising from the new system comes from the switch to endogenous monetary conditions. Prior to June 1997, the Bank's projections assumed fixed paths for nominal interest rates and the nominal exchange rate throughout the projection period. In other words, the projected infla-

tion path was conditional on the assumed path for nominal monetary conditions. If the inflation projection was inconsistent with maintaining price stability over the medium term, it was evident that monetary conditions would need to adjust. As seen in the June 1997 *Monetary Policy Statement*, the evolution of monetary conditions is now endogenous. The Bank's projections now specify a path for nominal interest rates and the nominal exchange rate that is consistent with the Bank's inflation target. In one sense, this is a matter of presentation: changes in inflation pressures will be reflected to a much greater extent in the projected path of monetary conditions rather than in the course of inflation itself. The benefit is that it makes the implications for future monetary conditions more transparent.

Most of the new system's advantages, however, will not be directly obvious. One key advantage is the ability to test assumptions more easily than was possible before. Even when assumptions are analysed rigorously, a given projection is clearly not the only possible outcome. The ability to generate alternative scenarios will be valuable for assessing desired monetary conditions. More generally, the model opens up new techniques for the analysis of risk and uncertainty.

Finally, we emphasise that projections ultimately depend on the judgements of those producing them. FPS does not change that. In essence, models do not produce projections, people do. The new system provides us with a superior tool, and should assist in ensuring greater internal consistency in our projections.

Example: What if the government reduces its debt target?

In this experiment, the government reduces its debt-to-output target by 10 percentage points. The responses of key macroeconomic variables are shown in figure 5 as 'shock-minus-control' differences. This simulation experiment is useful for illustrating several key properties and features of the core model. It illustrates the dynamic adjustment required to achieve a new long-run equilibrium, the response of the supply side, the stock-flow relationships, the non-neutrality of fiscal policy due to over-discounting, and the central role of the real exchange rate in an open economy. In particular, it draws attention to the interaction of monetary and fiscal policy. To understand the simulation more easily, it is useful to consider first the long-run implications and then trace through the short-run dynamic adjustment to that new long-run equilibrium.

The long run

In the long run, lower government debt implies lower government debt servicing costs and therefore lower labour income taxes. The decline in government debt also means that there are fewer domestic assets available for households' financial wealth portfolios (over-discounting of future tax liabilities means that households view government debt as net wealth). Since households' wealth was initially in equilibrium, they must replace the government debt in their wealth portfolios. With no change in capital stock, this implies that they must purchase assets from the external sector.

All else being equal, the new equilibrium net foreign asset-to-output ratio increases by exactly the same amount as the fall in the government debt-to-income ratio. The decline in net foreign liabilities means a lower external debt servicing burden, so the domestic economy will not need to export as much output. Consequently, the real exchange rate appreciates and previously exported goods are now available for domestic use. Some are consumed, as consumption's share of output is higher in the new equilibrium, and some are invested because of the real exchange rate's effect on the cost of capital. The appreciation in the exchange rate reduces the price of imported investment goods, thereby lowering the cost of capital. This induces firms to increase their desired capital stock, increasing the long-run productive capacity of the economy.

In summary, the new long run has a lower labour income tax rate, an improved net foreign asset position, a lower net export position supported by a stronger real exchange rate, a higher level of both consumption and investment, and more productive capacity.

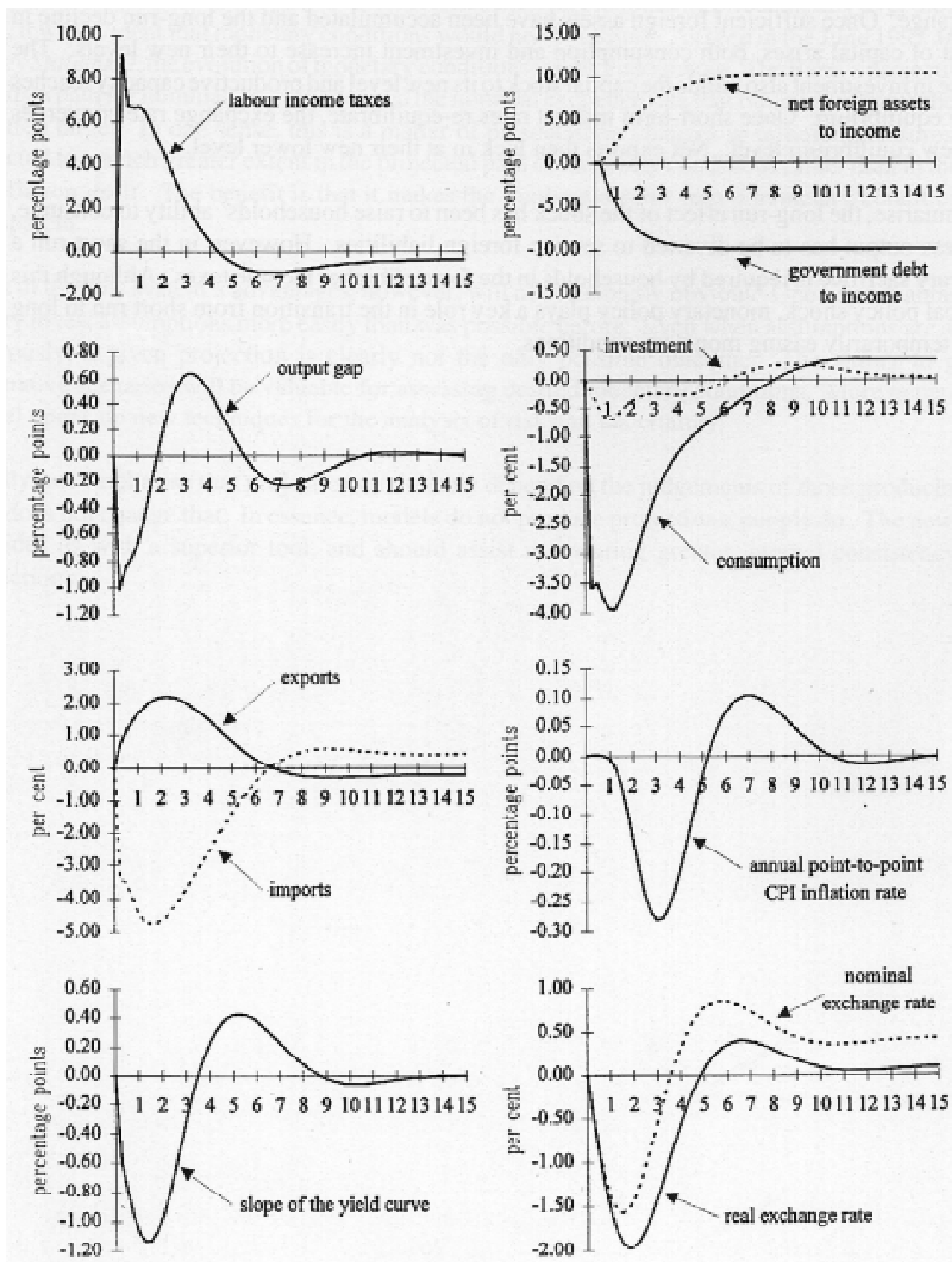
The dynamic adjustment path

The dynamic adjustment looks quite different from the long-run equilibrium. To achieve the reduction in outstanding debt, tax rates are raised on labour income. With less disposable income, households reduce consumption and demand falls below supply. The forward-looking monetary authority responds to the projected decline in inflation below its target by reducing short-term interest rates. The exchange rate depreciates in response to the smaller differential between domestic and foreign interest rates. The exchange rate effect more than offsets the interest rate effect, and a temporary increase in the user cost of capital results in an initial decline in investment that contributes to the excess supply. On the other hand, the exchange rate depreciation stimulates temporary growth in exports and that, combined with a significant decline in imports, results in an improvement in the current account. The improved current account flows accumulate into a less negative net foreign asset position, moving the economy towards its new long-run position.

The easing in monetary conditions eventually raises demand above supply some two years after the initial change to the fiscal target. The stimulus works primarily through the trade sector. Excess demand over a three year period arrests the fall in inflation and re-anchors inflation expectations. Once sufficient foreign assets have been accumulated and the long-run decline in the cost of capital comes through, both consumption and investment increase to their new levels. The increase in investment also builds the capital stock to its new level and productive capacity reaches its new equilibrium. Once short-term interest rates re-equilibrate, the exchange rate converges to its new equilibrium level. Net exports then lock in at their new lower level.

Figure 5
A permanent decrease in government debt

(All responses are percent or percentage deviations from equilibrium. Timescale in years.)



To summarise, the long-run effect of the shock has been to raise households' ability to consume, since less output has to be diverted to service foreign liabilities. However, in the short run a temporary sacrifice is required by households in the form of higher income taxes. Although this is a fiscal policy shock, monetary policy plays a key role in the transition from the short run to the long run by temporarily easing monetary conditions.

