A Comparison of the NZTM and FPS Models of the NZ Economy

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NEW ZEALAND TREASURY

WORKING PAPER 03/25

SEPTEMBER 2003

THE TREASURY

Kaitohutohu Kaupapa Rawa

NZ TREASURY WORKING PAPER 03/25

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MONTH/YEAR

September 2003

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ACKNOWLEDGEMENTS

We thank Bob Buckle, Nathan McLellan, Peter Mawson, Grant Scobie and Christopher Plantier for detailed comments for the early version of the paper.

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Abstract

This paper investigates and compares the dynamic properties of the New Zealand Treasury model (NZTM) and the current version of the Reserve Bank's Forecasting and Policy System model (FPS). The main use of both models is to produce macroeconomic forecasts. The NZTM model produces forecasts that are used as an input into the final forecast numbers presented in the Economic and Fiscal Updates. The FPS model is used to produce the published forecasts in the Reserve Bank's quarterly Monetary Policy Statement. Both models contain a number of judgements around the structure of the economy, the key shocks that impact on the economy, and how the economy evolves in response to these shocks.

The paper concludes that one of the main differences between the two models occurs in the impact of a world price shock on the real exchange rate and subsequently on exports and imports. Another key difference is the mechanism through which the net foreign asset position returns towards equilibrium. In FPS, the external balance is partly attained by forward-looking consumers who adjust spending to reach desired wealth positions. In contrast, the real exchange rate is the key mechanism in NZTM for re-establishing equilibrium.

JEL CLASSIFICATION E10, E17, E63

KEYWORDS New Zealand; NZTM; FPS; Macroeconomic forecasts; Net foreign asset position; forwarding-looking consumers; Real exchange rate.

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1 Introduction

1.1 Motivation

This paper compares the dynamic properties of the New Zealand Treasury model (NZTM) and the current version of the Reserve Bank of New Zealand's (RBNZ) Forecasting and Policy System (FPS) model. The main use of the two models is for producing macroeconomic forecasts. The NZTM model is used to produce forecasts that are used as an input into the final forecast numbers presented in the Economic and Fiscal Updates. The FPS model is used to produce the published forecasts in the Reserve Bank's quarterly Monetary Policy Statement. Both models involve a number of differing judgements concerning the structure of the economy, the important shocks that impact on the economy, and how the economy responds to these shocks. These judgements provide us with a basis for comparison between the two models.

The New Zealand Treasury has been through a period of considerable macroeconomic model development over the last few years. Following an internal review of the existing New Zealand Model (NZM) in 2000, the Treasury decided to make a number of improvements on the existing model structure. The outcome was the development of a new model structure called the New Zealand Treasury Model (NZTM), which is documented in Szeto (2001 and 2002).

The RBNZ which first started using the FPS model in 1997, is documented in Black, Cassino, Drew, Hansen, Hunt, Rose and Scott (1997). This model has been used to produce the Reserve Bank's forecasts since that time. During the process of using the model to produce forecasts and research, a number of changes have also been made to FPS.

An early attempt at comparing these models (Drew and Hunt, 2000) was undertaken before the extensive redevelopment of the Treasury model. The current comparison changes their approach in two key areas. First, the response functions for monetary and fiscal policy are not calibrated to be the same for the two models. Second, the shocks investigated are all temporary. We have not attempted to compare the steady states of the two models, which are very similar. Rather, we focussed on the way the business cycle evolves following a temporary shock.

The results indicate that while the NZTM has some similarities with the FPS, there are important differences. These result in different adjustment paths following various shocks.

The remainder of the paper is organised as follows: Section 2 contains a brief overview of the two models. In section 3, the results from the shocks are presented. Section 4 contains a summary and future work is described in section 5.

2 Overview of the NZTM and FPS models

2.1 Overview

The section provides a brief overview of the main similarities and differences of NZTM (Szeto, 2002) and FPS (Black et al., 1997). According to Pagan (2003), FPS is known as an incomplete dynamic stochastic general equilibrium model (IDSGE) and NZTM is known as a Type II hybrid model[1].

In both types of models, the structure of the economy is described by a solid microeconomic theoretical framework that determines how economic agents make their decisions. The main advantage of these types of models is that they are better at dealing with regime shifts. A change in the regime should not affect a "fundamental" set of parameters that determine the shape of functions being optimised by economic agents. This means that these types of models are less subject to the "Lucas critique" (Lucas 1976) compared to other large traditional macro models.

This theoretical underpinning leads to models which can trace out an equilibrium path along which the economy evolves. The NZTM equilibrium path is constructed explicitly using a steady state version of the model. In reality, it is unlikely that the economy would evolve along this equilibrium path as it is continuously bombarded by shocks. However, both models assume there is a long-run tendency for the economy to converge towards a balanced equilibrium path.

2.1.1 Adjustment

A notable difference between FPS and NZTM is the approach to the determination of the adjustment path when the economy deviates from its equilibrium. For NZTM, the dynamic adjustment structure is based on a partial adjustment process. Partial adjustment occurs when economic agents cannot fully adjust to changes in the short run. The adjustment process is rather mechanically and empirically driven without reference to economic theory. In contrast, the dynamic adjustment structure in FPS is formulated on the basis of adjustment costs. Economic agents are faced with two types of cost: the cost from not being at the "equilibrium" value, and the costs of adjusting to that equilibrium value. The adjustment path is chosen to minimise an implicit cost function (Black et al., 1997).

[1] A Type II hybrid model refers to a type of model that contains a well specified microeconomic foundation and a steady state equilibrium path. An IDSGE is similar to the Type II model but the dynamic process is more theoretically based.

2.1.2 Production and supply

In both models, the behaviour of the representative firm is based on the assumption that firm's desire to maximize profits for given costs and prices, subject to an underlying production function. In FPS, the economy produces a single good and the production technology is Cobb-Douglas with labour and capital as the inputs. The single good is differentiated by a system of relative prices.

In NZTM, the supply side of the model has a more comprehensive structure, comprising a three-good economy with two distinct traded goods (exports and imports) and one non-traded good.

Prior to 1970, some models including Swan (1955) and Salter (1959) treated exportables and importables as a composite tradable good and other models use the term of trade to represent the external price. These models limited their capabilities to analyse the impact of external price shocks. During the 1970s, the adverse changes in the terms of trade due to oil price shocks faced by many countries and the increasing importance of commercial policy on the terms of trade led to the development of the three-good model that emphasises the distinction between imports, exports and non-traded goods. Example of such models are Dornbusch (1974), Edwards and van Wijnbergen (1987), and Murphy (1988).

The importance of making the distinction between exports and imports for the New Zealand economy was demonstrated by Wells and Evans (1985) and more recently by Buckle, Kim, Kirkham, McLellan and Sharma (2002). Both studies provide evidence that the effects of import and export price shocks on domestic real output and inflation are different.

Another reason for adopting a three-good model is that a substantial proportion of New Zealand's exported goods are primary based products, which are not easily transformed into domestic goods in the production process. Furthermore, Buckle, Haugh and Thomson (2001) highlight the significance of the primary sector as a source of volatility for the New Zealand economy. They estimated that the primary sector, at round 10 percent of GDP, has similar and sometimes a higher weighted standard deviation of its growth rate than the manufacturing sector and even the services sector, which accounts for around 50 percent of GDP. Buckle et al. (2002) further suggested that the volatility of primary output could be partly attributed to climatic shocks.

NZTM treats imports as an intermediate input in the production of exports and domestic goods. The majority of imports in fact consist of capital goods and intermediate goods. Also imports, which are ultimately consumed, must go through transporting, wholesaling and retailing before meeting final demand.

In NZTM, the production block consists of a nested constant elasticity of substitution function, which combines three inputs (capital, labour and imports) to produce one unique output. This unique output is then split into domestic goods and exported goods using a constant elasticity of transformation function. This production structure assumes that input-mix and output-mix decisions can be made independently.

2.1.3 Consumption

The FPS model has two types of households: 30% are "rule-of-thumb" and 70% are "forward-looking". "Forward-looking" households maximize their expected discounted lifetime utility subject to a budget constraint and a fixed probability of death. This type of household is able to plan and achieve a smooth lifetime consumption path. On the other hand, rule-of thumb households are unable to smooth their consumption and spend all their disposable income each period (see Mankiw and Campbell, 1990).

In NZTM, consumption is based on a model of households that choose to consume at a level consistent with their income and wealth in the long-run. The consumption decisions are assumed to approximate the life-cycle hypothesis developed by Ando and Modiglianli (1963). In the short term, the dynamics of consumption are driven mainly by its own lag and the adjustment of consumption towards its long run equilibrium. There are two types of consumption goods: housing services and other consumption. Once households have decided on their total level of consumption, they maximize their utility by choosing the optimal allocation between consumption of housing services and other consumption.

2.1.4 Monetary Policy

Another important agent in the model is the monetary authority. According to the Policy Targets Agreement (2002), the main role of the monetary authority is to maintain a stable general level of prices with an inflation target of 1 to 3 percent on average over the medium term. Both NZTM and FPS have a forward looking monetary policy rule that employs the short-term interest rate as the monetary policy instrument to achieve an inflation target of 2 percent in the long-run. Like the fiscal reaction function discussed below, this is a simple linear characterisation of policy behaviour, rather than an attempt to capture all the complexities of actual policy.

2.1.5 Fiscal Policy

Both FPS and NZTM have a similar fiscal policy response function, which adjusts labour income tax rates to attain a long run debt target. These fiscal reaction functions ensure the government meets an inter-temporal budget constraint. For NZTM, the government is forward looking and targets the gross debt to GDP ratio. The fiscal policy target for FPS is a net debt to GDP ratio while the fiscal policy rule is backward looking.

2.2 Recent changes to model specification for the Treasury model

There have been a number of developments made to the Treasury model since it was updated by Murphy (1998). These developments reflect changes in judgements about the appropriate model structure for the New Zealand economy and changes in judgements about how the economy evolves in response to shocks. This section summarises the key changes to the NZ Treasury model structure.

2.2.1 Inflation-targeting rule

When NZM was last updated (Murphy, 1998), the RBNZ used the Monetary Conditions Index (MCI) as its monetary policy tool. As a consequence the NZM model incorporated the MCI as the policy instrument. In addition, given the structure of NZM, the monetary reaction function needed to be specified as a contemporaneous price-level-targeting rule. Since then, the RBNZ has adopted a cash rate as its primary instrument for operating monetary policy and the policy target has changed to keep CPI inflation within a 1 to 3 percent range on average over the medium term.

Drew and Hunt (2000) compared the dynamic responses of FPS to a demand shock under both a price-level targeting rule and an inflation-targeting rule. The key insight from this comparison is that under the price-level rule, an extra cycle was observed with monetary policy needing to be tighter for longer. The variability of inflation and the variability of output are greater under price-level targeting than under inflation targeting because base level drift is not accepted under price-level targeting.

Since the core structure of NZM was based on price levels, it was not possible to formulate an inflation targeting monetary policy rule. This deficiency of NZM led to the development of a relative price structure in NZTM that allows the monetary policy rule to be specified as an inflation target.

2.2.2 Demand-pull framework

In NZM, firms were able to adjust their prices in the medium term to maximize their profits for given input costs. In other words, the key determinants of the inflationary process were cost factors including unit labour costs, the world price of exports and of imports, and the exchange rate. The cost-push approach to modelling the inflation process was commonly adopted in the past in RBNZ models (see Clements, Hansen and Hames, 1986). This paradigm was particularly appropriate for the New Zealand economy for the period prior to the mid 1980s and early 1990s product and labour market reforms. Product markets were protected from international competition by import licensing and tariffs. The wage setting system was a highly regulated system and relatively strong unions could exert influence on the outcome of annual wage movements.

However, the conventional cost-push model for inflation became less appropriate in the New Zealand context after the removal of border protection, price controls, the introduction of both the Reserve Bank Act (1989) and the Employment Contracts Act (ECA, 1991). The ECA made compulsory unionism illegal and led to the decentralisation of the institutional structure of the New Zealand labour market. The ECA achieved a competitive wage setting system based on bargaining at the individual firm level[2]. In addition, using Granger-causality tests Hampton (2001) found that over the 1990s prices have tended to lead wages, rather than the other way round.

The key feature of the Reserve Bank Act (1989) is that monetary policy has the primary objective of controlling inflation. As a result, the Reserve Bank succeeded in reducing price uncertainty and lowering inflation expectations in the 1990s. As a consequence, price and wages are now more responsive to domestic demand factors.

[2] Conway (1999) found evidence that the introduction of the ECA resulted in major changes in the wage bargaining environment and a significant reduction in wages for supermarket workers in the post-ECA period.

In NZTM, inflation is modelled as a combination of a demand-pull process and a cost-push process with relatively more weight placed on the first channel. In a demand-pull process, inflation pressures develop when demand pressures exceed the economy's potential to supply. The output gap is used to proxy demand pressures for the economy.

2.2.3 The determination of the real exchange rate

In NZM, the evolution of the real exchange rate and its impact on the dynamic adjustment of the model was unclear. With a three-sector economy, NZTM has two relevant real exchange rates. One is the relative price of imports to non-tradables. The other is the relative price of exports to non-tradables. In a steady state, the framework of the determination of the equilibrium exchange rate is similar to that developed by Edwards (1987, 1989). The equilibrium exchange rate is reached when the economy attains both internal and external equilibrium. Internal equilibrium means that the non-tradable goods market clears in all periods. External equilibrium means that current account balances are consistent with long-run sustainable capital flows.

In NZTM, the long-run sustainable capital flows are determined by the desired ratio of net household wealth to GDP. In theory, this desired ratio could be derived using a full inter-temporal optimisation framework and is a function of various structural factors such as the demographic structure and the stage of a country's economic development. However, this steady state ratio is set exogenously in NZTM.

The short-run dynamics of cyclical fluctuations in demand and prices causes the economy to deviate from the balanced growth path. Responding to both internal and external imbalances, the real exchange rate would be required to deviate from its steady state value so that the economy is able to converge back to its balanced growth path. Furthermore, financial agents are forward looking so the real exchange rate will adjust immediately in response to an anticipated future shock. The short-run dynamics of the real exchange rate are also influenced by interest rate differentials.

2.3 Recent changes to model specification for FPS

The FPS model has been used to generate the projections in the Reserve Bank's Monetary Policy Statement since the middle of 1997, as described in Drew and Hunt (1998). The quarterly use of the model to generate published forecasts has meant continuous scrutiny of the FPS calibration, and some significant changes have been made since 1997.

A number of changes have been made in the way inflation process is modelled. Inflation is generated through two sources: excess demand and inflation expectations. The lags through which excess demand feeds into inflation have been shortened and inflation is less sluggish than in the initial model calibration. This feature also means that the monetary policy is able to stabilise inflation more effectively.

There has been a reduction in the response of inflation expectations to cyclical deviations of inflation from its target. This is consistent with the stability of surveyed inflation expectations since the temporary spike in CPI inflation during 2000.

The key instrument for monetary policy has changed from the yield curve to the 90-day rate. While long interest rates still influence the economy, the new specification makes short term interest rates less responsive to fluctuations in long term interest rates.

Another change is that the impact of the exchange rate on the economy has been muted. This means that when the real exchange rate deviates from its equilibrium, the impact on the economy is now smaller and slower This change was made in response to the surprisingly slow impact the weak New Zealand dollar had on New Zealand activity between 1998 and 2000.

Finally, based on recent trends there has been continued adjustment of some of the steady state ratios in the model. For example, the equilibrium exchange rate has been revised down somewhat after the weakness of the currency between 1998 and 2000, and the steady state capital to output ratio has also been lowered.

These adjustments to the dynamic parameters and steady state ratios have been made to bring the model's initial design closer to the Bank's evolving view of the economy. But these adjustments have been made to a core model structure that has remained quite stable over the last six years. Basdevant and Hargreaves (2003) describe some features of FPS that may have contributed to this stability, including the treatment of stochastic trends and the continuous review of dynamic parameters.

3 Simulation properties

In this section, the dynamic properties of the models are investigated by analysing the results of the model to various shock experiments. The rationale for the selection of the shocks is:

I. to draw out the significant differences between the two models in response to demand shocks. We have thus subjected the two models to two demand shocks. The first one is an increase in non-tradeable consumption demand, while the second is an increase in the tradeable export demand. These experiments illustrate that the dynamic paths of the economy following these two different demand shocks are quite different in NZTM. However, the responses to these shocks in FPS are similar, reflecting the one good paradigm;

II. to include those shocks that have been identified as some of the key drivers of the New Zealand business cycle over recent decades. Following the work of Wells and Evans (1985) and Buckle et al. (2002) who use VAR models to highlight the contribution of export and import price shocks, these experiments includes export and import price shocks; and

III. to understand the monetary policy transmission mechanism in the two models by looking at the effect that interest rates and the exchange rate have on the business cycle.

Graphs plot the responses of the endogenous variables to these shocks. These responses are expressed either as per cent or percentage point deviations from the control (the steady state level). The time scale is in years. Note that for FPS the real exchange rate is defined as the price of domestic currency in units of foreign currency adjusted for the ratio of domestic and foreign price levels. An increase in the real exchange rate represents an appreciation. For the NZTM, the real exchange rate is defined as the relative price of importables to non-tradables (RPM) or exportables to non-tradables (RPTEX). However, all the charts plot the inverse of RPM and the inverse of RPTEX for comparability with FPS except for Figure 3. Note also that the yield curve is the difference between short (90-day) and long (10-year) nominal interest rates. Any positive deviations from the equilibrium represent a tightening in monetary conditions and vice versa.

3.1 Consumption shock

In this shock private consumption is increased by 1% above the steady state for 1 quarter. While residential investment and private consumption are modelled separately in NZTM, in FPS residential investment is included in private consumption. For comparability, NZTM results reflect a combined 1% rise in residential investment and private consumption. The dynamic paths of eight principal variables are shown in Figure 1.

The 1% increase to private consumption results for both models in a positive output gap opening up of around 0.5% at its peak in the first quarter following the shock. The positive output gap then begins to close. In FPS the output gap turns negative after a year and a half while in NZTM the positive output gap persists for some time. Both gaps are closed after 6 years following the shock. The different profiles for the output gap are explained as follows.

With a positive output gap opening up, inflation pressures develop in both models. In NZTM there is a slight lag before inflationary pressures develop while in FPS this inflation response is quicker. Both profiles for inflation peak just after a year and then begin to dissipate. However, inflation pressures are more persistent in FPS with inflation back to the steady state after 4½ years. In contrast, inflation falls back to the steady state after 2½ years in NZTM. This reflects the greater persistence that inflation has in FPS through the modelling of inflation expectations. This greater persistence in FPS arises because current inflation has a greater impact on inflation expectations than in NZTM.

In response to these inflationary pressures, the monetary authority raises short-term interest rates. Due to the greater persistence of inflation, the increase in interest rates is considerably larger in FPS than NZTM. The timing of the peak in interest rates is similar in both models - 6 months after the shock with interest rates easing after that. In FPS, interest rates return to the steady state after 3½ years and then persist in a period of weaker rates. In contrast, interest rates in NZTM remain slightly above the steady state value and are not back to equilibrium until after 6 years.

Higher interest rates help to close the positive output gap in FPS through their impact on consumption and to a lesser degree on business investment. Higher interest rates drive consumption below the steady state as forward-looking consumers are encouraged to raise current saving. Business investment is also negatively impacted by higher interest rates.

In NZTM, consumption is still positively influenced by the momentum in the first few quarters after the shock. In the long run, consumption is determined by labour income and wealth. As the additional spending is achieved by running down financial assets relative to the steady state, consumption is gradually affected by the lagged impact of the deterioration in wealth.

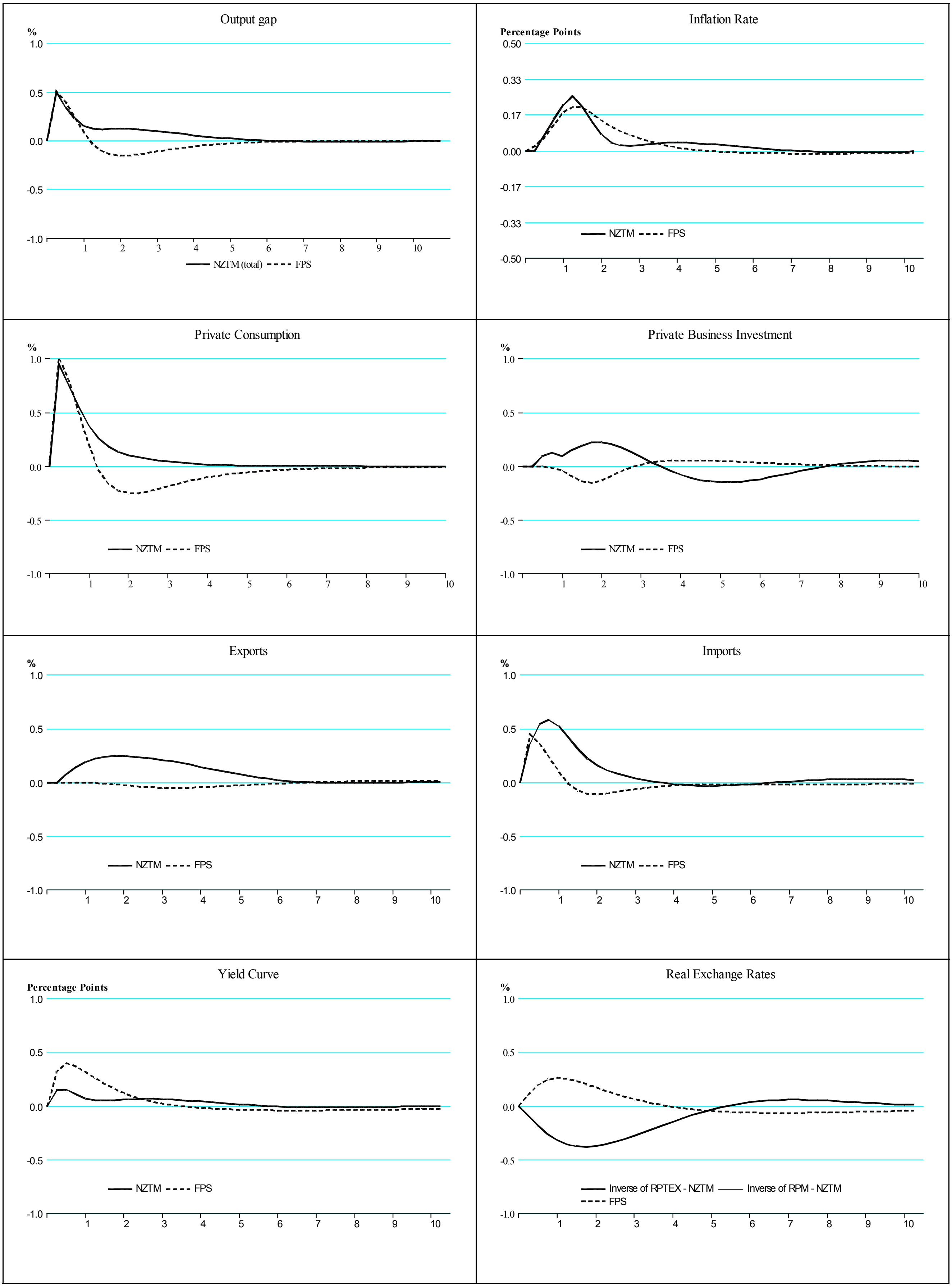
In comparison with FPS, interest rates have less of an impact on consumption in NZTM. Higher interest rates also impact on business investment but not immediately and the impact of higher interest rates on investment is more than offset by the Tobin-q factor. As firms see higher future profits resulting from strong domestic activity, business investment is higher than the steady state and coincides with the level of domestic activity.

As demand increases, spending on imports rises, which helps to close the positive output gap as demand is satisfied to a degree via imported goods. In general, the response of imports reflects the profile of domestic activities for both models.

The path of the real exchange rate highlights another clear difference between the two models. In NZTM, as a result of the autonomous demand shock consumers have run up debt to finance spending. As such the net foreign debt position is higher than the desired steady state position. As a result, the real exchange rate depreciates. This depreciation puts exporters in a more competitive position, which sees a volume response. This helps to bring the net external position back into steady state through encouraging exports and discouraging imports.

In contrast, in FPS the real exchange rate appreciates as a result of a weak uncovered interest parity condition (UIP). Despite the appreciation of the real exchange rate there is minimal impact on exports. Thus, the net foreign debt position partly adjusts back towards equilibrium via adjustment in consumption and hence imports. This is partly why the level of consumption is required to fall below the steady state.

Figure 1 – Consumption shock



3.2 Export demand shock

In this shock (summarized in Figure 2), export volumes are increased by 1% above the steady state for 1 quarter. In this experiment, the increase in exports is not due to supply shocks such as extreme climatic events or an increase in productivity. It is due to a greater foreign demand for our manufactured exports and export services. In this shock the reaction of FPS is similar to that of the previous shock, reflecting the one good paradigm. In other words, the response of the model to demand pressure does not depend on the source of change to aggregate demand. In NZTM, the dynamic adjustment of this shock is quite different from that of the previous shock. The consumption shock is a domestic demand shock that will adversely impact on the current account and hence cause real exchange rates to fall. On the other hand, the export demand shock will result in an improvement in current account and hence cause real exchange rates to rise.

Both models initially display a positive output gap, which peaks around 0.4% in the first quarter. The output gaps are closed after 1½ years. Again inflationary pressures build and while the peak in inflation is similar in the two models the persistence we saw in the consumption shock in FPS is again a feature. The monetary authority increases interest rates more aggressively in FPS and for a longer period of time. In NZTM, interest rates are actually lower than the steady state after a year as the output gap becomes negative and inflation drops below target.

The movement in consumption is fairly small because of the small magnitude of the shock. Both models initially have a fall in consumption below steady state and this is most pronounced in FPS. The fall in consumption in FPS results from an increase in interest rates as a result of inflation rising above target. This encourages households to save and postpone consumption today. Consumption returns to the steady state after 6 years.

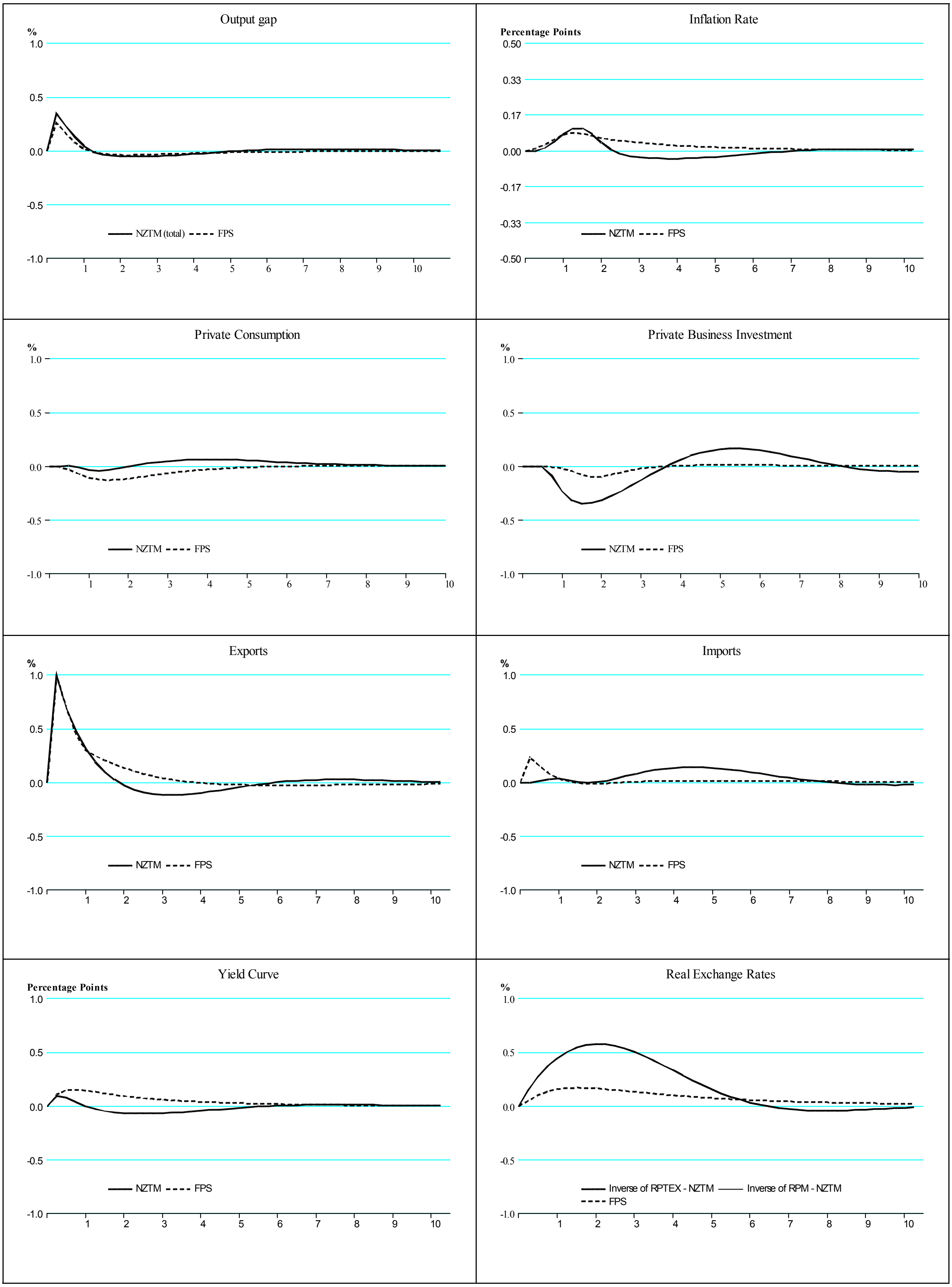
In NZTM, after an initial fall in consumption resulting from higher interest rates, consumption then increases above the steady state. Unlike the consumption shock, higher export volumes lead to an improvement in financial wealth and income of the households, which results in higher consumption. Overall, there is a cumulative consumption gain following a shock, which raises export demand.

Like the consumption shock, business investment is negatively affected by an increase in interest rates in FPS. In contrast, business investment displays an opposite response to the consumption shock in NZTM. There are two main reasons why firms react differently. Firstly, an increase in export volumes does not translate into higher export prices in NZTM because New Zealand is a price taker. Secondly, an improvement in the net foreign debt position decreases the relative price of both exports and imports, which translates into a loss of competitiveness for export and domestic firms. Combined with higher interest rates, these two factors lead to a decline in business investment in response to an increase in export volumes.

The reaction of imports is different between the two models. Imports increase initially in FPS reflecting the increase in demand. However, the magnitude of the increase is small. Imports in NZTM do not react until further out in the period as both consumption and investment increase slightly above steady state. Again the magnitude of the increase is relatively small.

Once again the direction of the real exchange rate movement in FPS is the same as in the consumption shock but the magnitude differs. The driver of the real exchange rate appreciation in FPS is the UIP condition. In NZTM, the net foreign debt position is lower than the desired level because of the positive boost to exports. Thus the real exchange rate is required to appreciate to dampen exports and thus return the economy to the desired net debt position.

Figure 2 – Export demand shock



3.3 Export price shock

For this shock, export prices (measured in foreign price terms) are increased by 5% above the steady state for the duration of 4 quarters. This experiment shows that export volumes are more responsive to price changes in NZTM than in FPS. Before we describe the dynamics of the shock, it is important to mention again that the real exchange rate takes a different form in the two models. In FPS, the real exchange rate (RER) is defined as:

$$RER = \frac{e * P_d}{P_f}$$

where RER is the real exchange rate; e is defined as the price of domestic currency in units of foreign currency; P_d and P_f are the domestic and foreign price levels respectively.

In the NZTM, the real exchange rate is defined as the relative price of exports (RPTEX) or the relative price of imports (RPM):

$$RPTEX = \frac{P_x}{e * P_d}$$

and

$$RPM = \frac{P_m}{e * P_d}$$

where P_x and P_m are the world prices of New Zealand's exports and imports respectively. The inverse of RPTEX and of RPM are equivalent to RER if no distinction is made between traded and non-traded goods (i.e. $P_f = P_x = P_m$).

In FPS, there is near-complete passthrough into domestic prices of persistent shocks to world export and import prices. However, a temporary shock to world prices does not lead to complete passthrough because of the model's adjustment cost structure (which implies some temporary buffering through the margins of international distributors). In NZTM, world export and import prices are derived historically from domestic export and import price deflators adjusted for the trade weighted exchange rate index so a complete passthrough is assumed. Therefore, there is a difference in the definition of world prices between the two models. This is partly why the response of FPS to world price shocks is smaller than that of NZTM (see Figure 4).

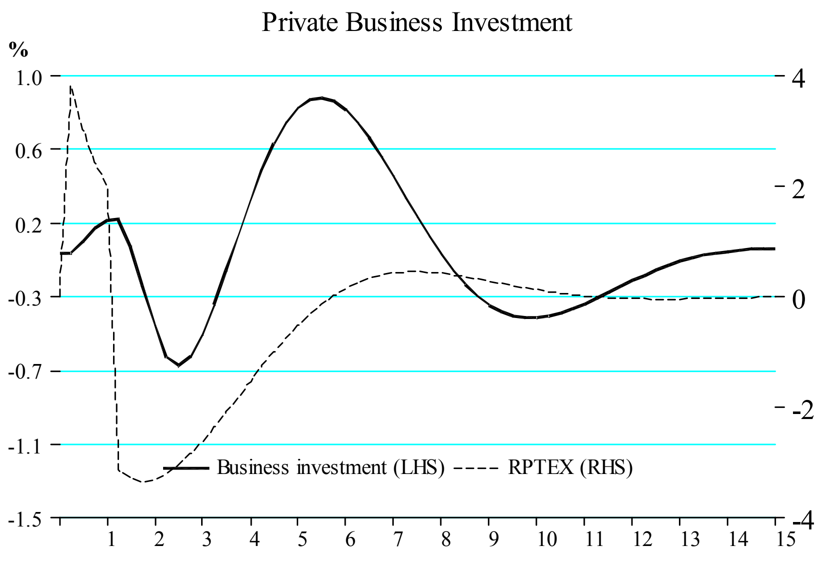
In this experiment, the path of the real exchange rate is a key difference between the two models. In NZTM, an increase in the world export price (P_x), which has a direct impact on the relative price of exports (RPTEX), increases RPTEX instantly by less than the increase in P_x. This is due to the fact that the impact of the shock is partially offset by a higher nominal exchange rate as the financial agents are forward looking. The higher nominal exchange rate is why the relative price of imports (RPM) appreciates gradually and peaks two years after the shock. When the export price shock comes off after a year, RPTEX converges immediately to RPM, which is about 3% above the steady state.

In FPS, there is no direct link between the world export price and the foreign price level. In addition, the nominal exchange rate does not respond to temporary price shocks. As a result, there is a negligible movement in the real exchange rate in FPS.

In NZTM, exports are boosted as resources move to the exporting sector in response to the increase in the relative price of exports. However, the nominal exchange rate responds immediately to the improvement in the current account. Hence, the expansion is gradually eroded by the higher nominal exchange rate, which lowers the relative price of imports and increases imports considerably over the forecast horizon. In FPS, export volumes react to the increase in price after 1½ years with the peak around 2½ years. In general, the reaction is more subdued and less immediate than in NZTM. A temporary 5% increase in the world export price for a year leads to a 0.8% increase in export volumes at their peak in NZTM while the same shock only leads to a 0.25% increase in export volumes at their peak in FPS.

Figure 3 shows that the profile of business investment follows mainly the profile of the relative price of exports in NZTM. An initial surge in the RPTEX leads to a small increase in business investment. With the world export price back to its steady state after a year, the appreciation of the real exchange rate makes both the domestic and export sector less profitable and competitive, which in turn dampens business investment for the next two years. However, business investment makes a significant rebound three years after the price shock, as firms attempt to achieve their desired capital stock levels and because of a fall in the short term interest rates. In FPS, again the reaction is more muted with business investment decreasing slightly reflecting the increase in the interest rate, as shown in Figure 4.

Figure 3 – Business investment and RPTEX responses to an export price rise in NZTM

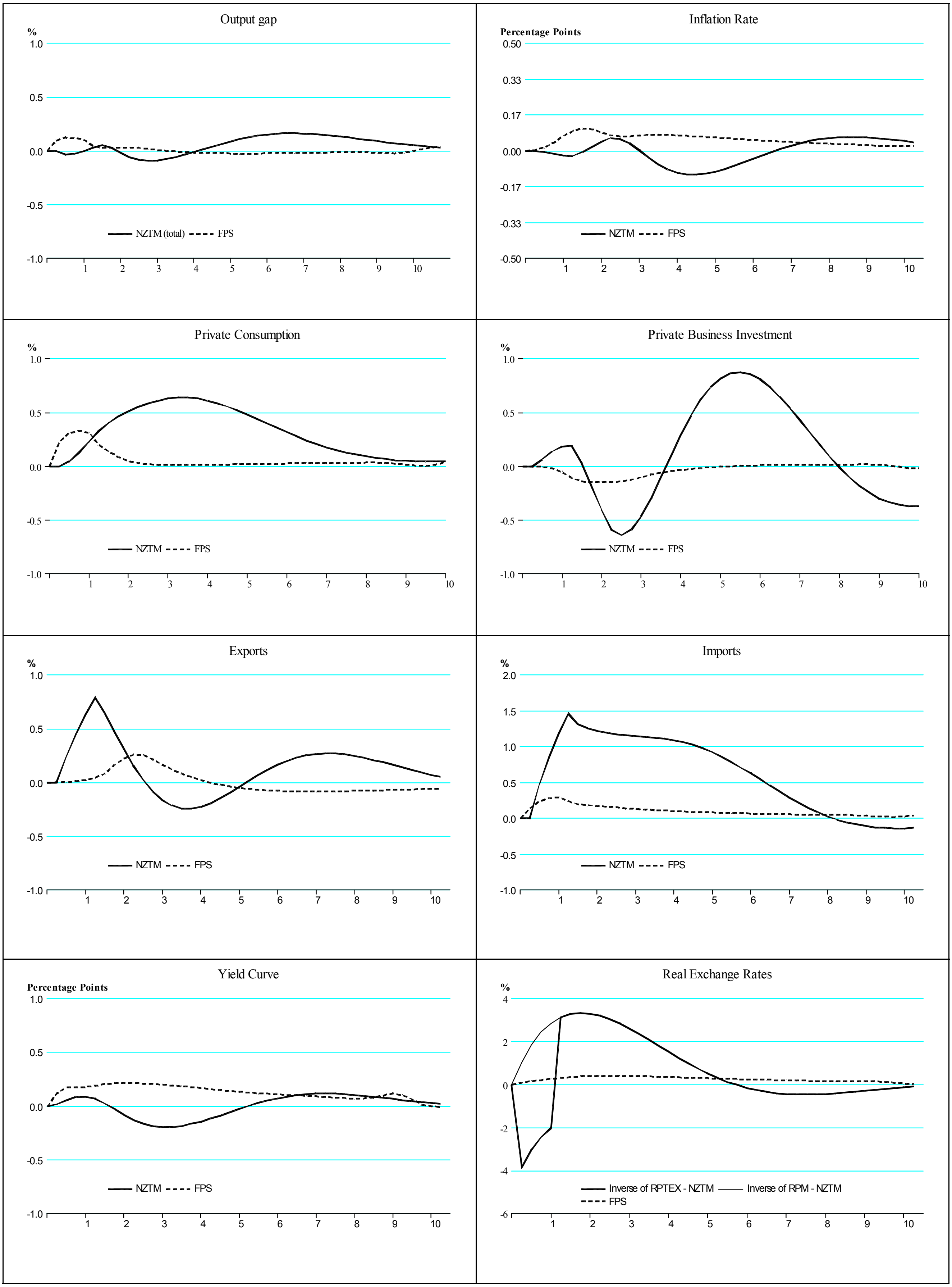


Consumption reacts positively in both models to the boost in incomes following the increase in export prices with a quicker response in FPS reflecting the forward looking behaviour of consumers. In NZTM, consumers spend all their extra income arising from the increase in the world export price so that their desired net foreign asset ratio remains constant. The consumption response of FPS is smaller reflecting the slow adjustment of the (improved) net foreign debt position back to equilibrium.

As discussed earlier, in FPS the net foreign asset position re-equilibrates as consumers adjust spending to reach desired wealth positions. This happens considerably more slowly than the exchange rate led re-equilibration in NZTM: in fact, in FPS asset positions are still returning to equilibrium at the end of the simulation period.

Although the magnitude of the movement of consumption and exports is large in NZTM, the magnitude of the output gap is small. This is due to the fact that the overall increase in consumption is supplied by imports and the initial surge in exports is also offset by higher imports. In FPS, the magnitude of the output gap is negligible reflecting that the model is not responsive to temporary price shocks. Consequently, inflationary pressures are muted in both models.

Figure 4 – Export price shock



3.4 Import price shock

In this shock import prices (measured in foreign price terms) are increased by 5% above the steady state for 4 quarters. One purpose of this shock is to investigate whether the impact of the world price shock is symmetric to the export price shock. As with the export price shock, there is an immediate impact on the real exchange rate in NZTM and once again the real exchange rate response is muted in FPS (see Figure 5).

In response to the 5% increase in the world import price, the relative price of imports in NZTM depreciates by more than 5%, as this price shock has an immediate and negative impact on the current account, which further lowers the real exchange rate. When the price shock comes off after a year, RPM converges back to RPTEX, which is about 2% lower than the steady state. It is interesting to note that the magnitude of the change in the relative price is smaller than that in the previous shock at the end of the price shock, reflecting the fact that the economy is more responsive to import price shocks than to export price shocks in NZTM.

As the relative price of imports rises, consumption falls in response to a decrease in both real income and wealth. The price shock leads to a 0.8% decrease in consumption at its peak in NZTM while the same shock only leads to a 0.4% decrease in consumption in FPS. Compared with the previous shock, households' response to the import price shock is much faster in NZTM. On the other hand, there is no significant difference in responsiveness in FPS.

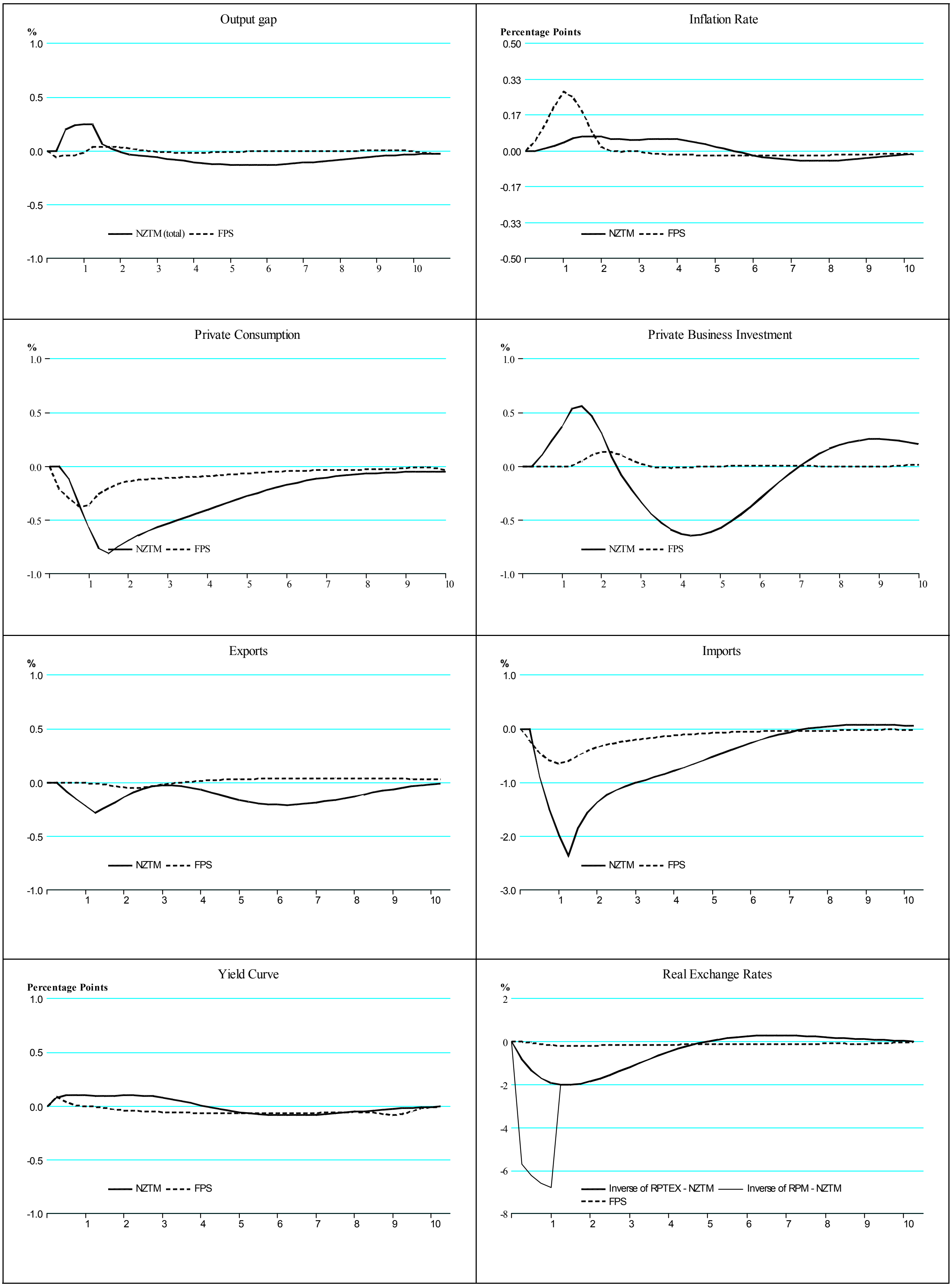
In NZTM, the impact of the shock on imports is augmented by the real exchange rate depreciation. Therefore, with lower consumption, the level of imports falls sharply, which reaches a trough of 2.5% below the steady state. This sharp fall in imports has a significant impact on the output gap. With the fall in imports greater than that in domestic demand, a small positive output gap is generated. For FPS, imports are less responsive to the shock which results in a 0.6% decrease in imports volumes. Once again there is a negligible change in the output gap in FPS.

Unlike the export price shock, higher import prices generate significant inflationary pressures in FPS. On the other hand, inflationary pressures are much weaker in NZTM. This suggests that the first round pass-through from import prices to consumer prices is much stronger in FPS than in NZTM.

Like the export price shock, there is an initial surge in business investment in NZTM but for different reasons. In NZTM imports are an intermediate input into the production function just like capital and labour. With an increase in the relative price of imports, firms switch to more capital. Furthermore, increasing the relative price of import enhances the competitiveness of the domestic sector. In contrast, increasing import prices has no significant impact on business investment in FPS.

Although there is a substantial depreciation in the real exchange rate in NZTM, the level of exports remains below the steady state. It is due to the fact that some components of our exports require intermediate imports and the impact of the real exchange rate depreciation on exports is offset by higher import prices, leading to a fall in production.

Figure 5 – Import price shock



3.5 Interest rate shock

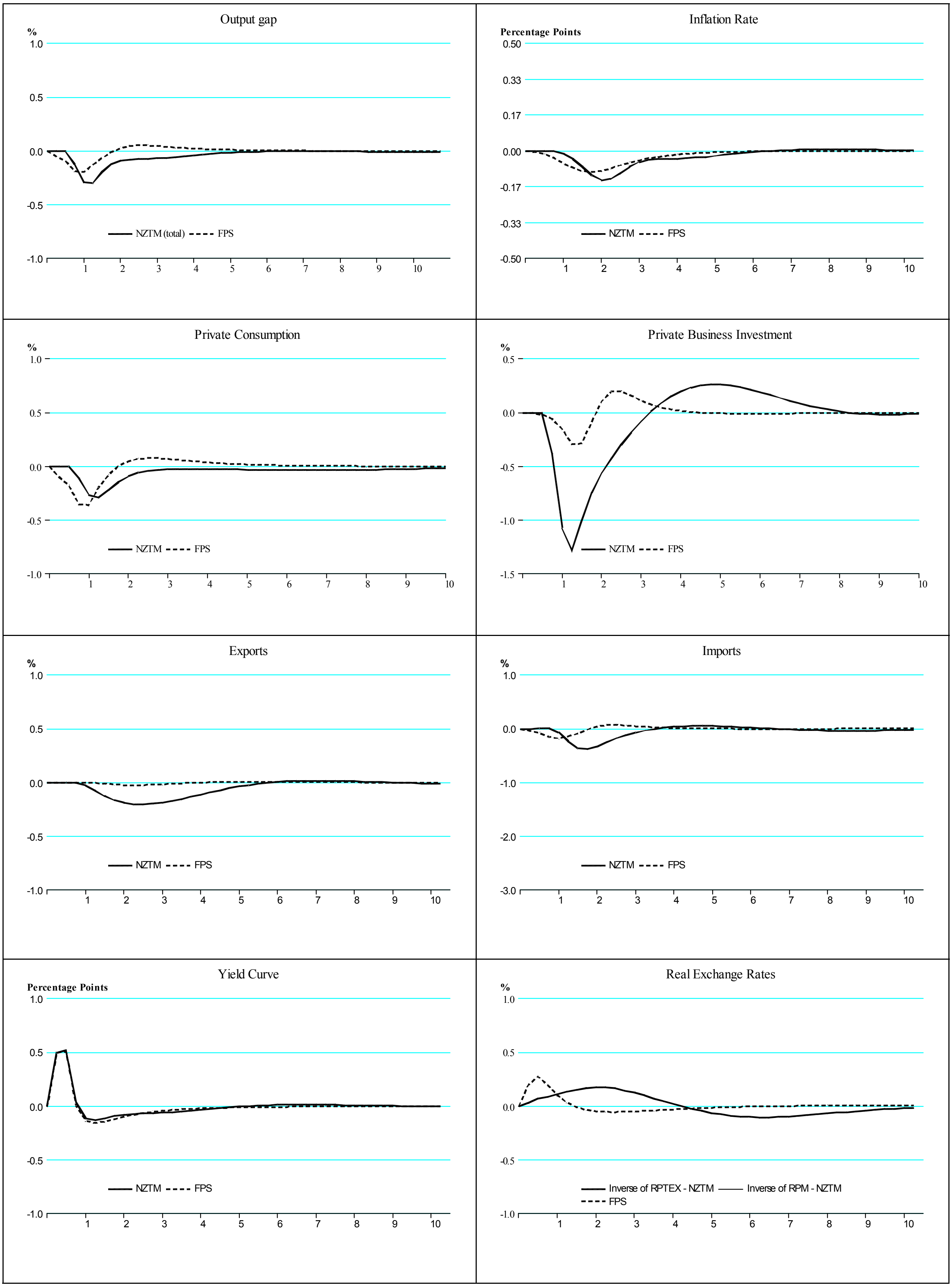
In this shock the short-term interest rate is increased by 50 basis points above the steady state for the first 2 quarters. A reason for this shock is to look at the response of the exchange rate to a pure monetary policy shock. In NZTM, this is normally masked by the effects of the desired net debt constraint (see Figure 6).

One noticeable feature with this shock is that the effect of an increase in interest rates is not immediate in NZTM: real variables remain at equilibrium in the first period. In contrast, adjustment begins instantly in FPS. This reflects the forward-looking nature of consumers in FPS, where consumption spending drops immediately, leading to a negative output gap opening immediately. After two quarters a slightly larger negative output gap opens in NZTM.

While the size of the decline in consumption is very similar between the two models, exports also contract considerably in NZTM as the exchange rate appreciates, while the impact on exports in FPS is much smaller. With interest rates increasing, and consumption and exports both declining this sees business investment contract considerably in NZTM with a corresponding rebound further out as capital is increased back to the desired level. The investment cycle in FPS is more muted.

Inflationary pressures ease in both models but with the larger size of the negative output gap in NZTM, inflation falls more than in FPS. Once the shock to interest rates has been removed, the monetary authority in both models eases interest rates to allow inflation to return to target.

Figure 6 – Interest rate shock



3.6 Exchange rate shock

In this simulation, the exchange rate is shocked to generate a 5% appreciation above the steady state in the first quarter (see Figure 7). The real exchange rate remains above the control over the first year and a half, reflecting similar persistence of the real exchange rate in both models.

After the first one and half years there is a substantial period in which the real exchange rate depreciates below the steady state in NZTM. This is because the shock has a negative impact on the net foreign debt position (with exports declining and imports increasing). In order to return the net foreign debt position to equilibrium, the real exchange rate must depreciate and overshoot its equilibrium. For FPS, the real exchange rate remains above the control over the entire simulation period because the net foreign debt position is not required to return to equilibrium.

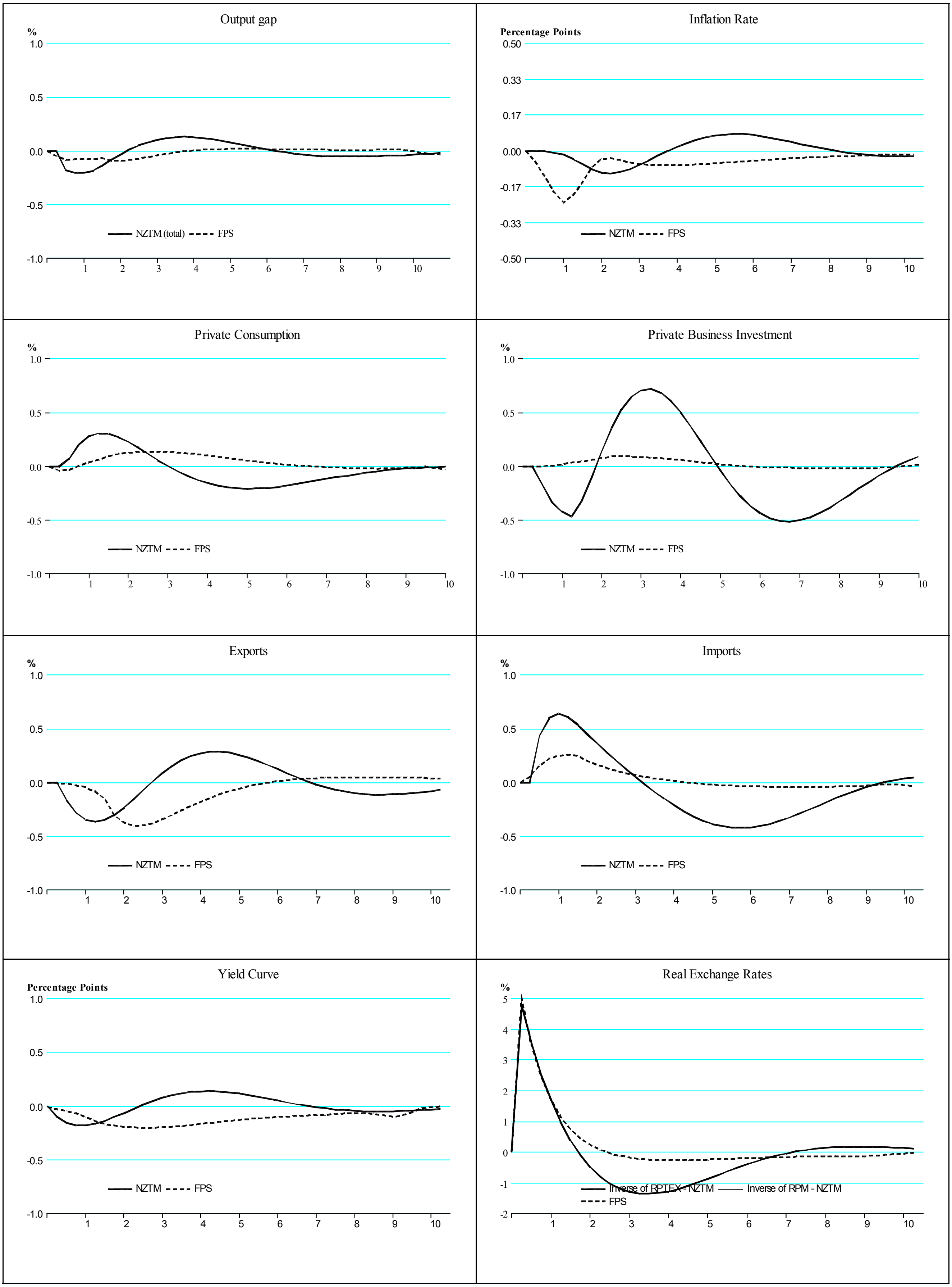
The previous shocks have shown that exports and imports generally respond more in NZTM than FPS. Furthermore, there is a substantial delay in the export response in FPS in comparison with NZTM. The initial decrease in net exports generates a significant negative output gap in NZTM. The output gap becomes positive when the external sector responds to the exchange rate depreciation. In FPS, there is a small negative output gap for the first four years of the simulation period, reflecting the fact that net exports are lower than the steady state level for the corresponding period.

In FPS, monetary policy loosens over the simulation period reflecting the excess supply in the economy. For NZTM, monetary policy loosens initially to prevent inflation falling further when output gap is negative. The loosening is short-lived and is reversed when there is excess demand in the economy.

In NZTM, the profile of business investment is mainly determined by the profitability of firms, which in turn is driven by the real exchange rate cycle. When the real exchange rate appreciates, firms are reluctant to invest. On the other hand, the depreciation in the exchange rate causes renewed investment in capital goods. Like other shocks, the response of business investment is muted in FPS.

Consumption also follows the real exchange rate cycle in NZTM in this simulation. Initially, the real exchange rate appreciation lowers the price of imports which serves to stimulate demand for consumption. Similarly, the real exchange rate depreciation causes consumption to decrease.

Figure 7 – Exchange rate shock



4 Summary

In this paper, two macro models of the New Zealand have been compared. The analysis investigates the dynamic properties of the models over the business cycle following a variety of temporary shocks. Although the models are both based on a similar microeconomic theoretical framework and are both characterised by a balanced growth path, there are some differences in the model structures that are highlighted by the simulations.

Providing the major contrast between the two models is the adjustment mechanism through which the economy returns to the equilibrium after a shock. In FPS, the 90-day rate is the key variable that helps the economy to adjust to the impact of various shocks. It seems the demand side of the FPS is more responsive to monetary policy than that of the NZTM. Most noticeably, changes in monetary policy lead to an immediate change in consumption, as some consumers are forward-looking. In contrast, there is always a lagged response from consumption to changes in the yield curve in NZTM.

In NZTM, relative prices (and the real exchange rate) play a significant role in the model, determining how resources are shifted from one sector to the other. On the demand side of the economy, the demand for imports and nontraded goods are also a function of income and the real exchange rate. Thus, NZTM is sensitive to external price shocks as there is a direct connection between the real exchange rate and world prices. In contrast, FPS displays a more muted response to external price shocks.

Furthermore, the dynamics of the real exchange are strongly influenced by external imbalances in NZTM, as the real exchange rate is the key variable enabling the economy to attain its external equilibrium. However, in FPS the real exchange rate is not responsive to external imbalances and the external balance is partly attained by adjusting consumption.

Another notable difference is the dynamic behaviour of investment. In FPS, the adjustment of business investment is rather muted and slow in response to shocks compared with NZTM. As mentioned above, the 90-day rate is the key factor in determining the level of investment in FPS. In NZTM, besides relative prices, current sales and profits are major factors in determining the level of investment. High profits and sales could be interpreted as an indication of future demand for the firm's product, which in turn affects the desired capital stock.

Inflation is slightly more persistent in FPS than in NZTM. This reflects inflation expectations being more stable in NZTM. Therefore, FPS generally requires a larger monetary response than does NZTM to return inflation to the target rate in response to a demand shock.

5 Future work

As all models are an abstraction of the real world, significant differences can arise between models. The initial aim of this paper was to identify the key differences in the dynamic properties of FPS and NZTM. An obvious next step is to look at the properties of actual New Zealand economic data and data driven models (such as SVARs), to determine which of the two models (or a combination of both) more closely represents the underlying structure of the New Zealand economy.

We are interested in exploring this further. For example, recent empirical work has been undertaken using a SVAR approach to model the New Zealand business cycle by Buckle et al. (2002). This model, which is more data driven than either NZTM or FPS, may provide a useful benchmark for further comparison work: for example, we could subject the SVAR to similar shocks and compare the impulse responses from the SVAR with the responses in this paper. Another technique for comparing models to the data is to undertake stochastic simulations (where the model is subjected to a battery of shocks similar to those seen over history), and compare the variability, co-movement and persistence of variables like exchange rate and exports in the model simulations to actual history. Furthermore, we could look at some of the specific drivers of the two models. For example, investigating the strength of the relationship between world commodity prices and the real exchange rate should help inform the external price transmission mechanism of the economy.

However, we are not sure that further comparison of FPS and NZTM to the data will lead to definitive conclusions about the true properties of the New Zealand economy. Significant parts of both models have been calibrated precisely because some empirical relationships are very hard to pin down, particularly in economies like New Zealand which have been subject to a lot of structural change. For example, it is difficult to generate strong empirical evidence about the short-term dynamics of the exchange rate, and even harder to determine whether the medium-term dynamics of the exchange rate are related to variables like net foreign assets (which is one key point of difference between the two models). While the increasing length of New Zealand's post reform dataset makes empirical analysis increasingly useful, we think macroeconomic modelling in New Zealand (and all other countries) will continue to be involved significant measures of theory and judgement.

References

Ando, A. and F. Modigliani (1963) “The life-cycle hypothesis of saving: Aggregate implications and test”, *American Economic Review*, 53(1), 55-84.

Basdevant, A. and D. Hargreaves (2003) “Modelling structural change: the case of New Zealand”, Reserve Bank Discussion Paper G03/3.

Black, R., V. Cassino, A. Drew, B. Hunt, A. Rose and A. Scott (1997), “The Forecasting and Policy System: the core model”, Reserve Bank of New Zealand Research Paper 43.

Buckle, R., D. Haugh and P. Thomson (2002) “Growth and volatility regime switching models for New Zealand GDP data.” Wellington, New Zealand Treasury, Working Paper 02/08. http://www.treasury.govt.nz/workingpapers/2002/02-08.asp

Buckle, R., K. Kim, H. Kirkham, N. McLellan and J. Sharma (2002) “A structural VAR model of the New Zealand business cycle.” Wellington, New Zealand Treasury, Working Paper 02/06. http://www.treasury.govt.nz/workingpapers/2002/02-26.asp

Campbell, J. and G. Mankiw (1990), “Permanent income, current income, and consumption.” *Journal of Business and Economic Statistics*, 8, 265-279.

Clements, R. , C. Hansen and M. Hames (1986) “The Reserve Bank econometric model of the New Zealand economy: Model XI.” Research Paper No. 40.

Conway, P. (1999) “An ‘unlucky generation’? The wages of supermarket workers post-ECA.” *Labour Market Bulletin*, 23-50.

Dornbusch, R. (1974) “Tariffs and nontraded goods.” *Journal of International Economics*, 4, 177-85.

Drew, A. and B. Hunt (1998) “The Forecasting and Policy System: preparing economic projections,” Reserve Bank Discussion Paper G98/7.

Drew, A. and B. Hunt (2000) “ A comparison of the properties of NZM and FPS.” Reserve Bank Discussion Paper G00/2.

Edwards, S. (1987) “Tariffs, terms of trade, and the real exchange rate in an intertemporal optimising model of the current account.” NBER Working Paper No. 2175.

Edwards, S. (1989) “Temporary terms of trade disturbances, the real exchange rate and the current account”, *Economica*, 56, 343-57.

Edwards, S. and S. van Wijnbergen (1987) “Tariffs, the real exchange rate and the terms of trade: On two popular propositions in international economics.” *Oxford Economics Paper*, 458-64.

Hampton, T (2001) “Do wages lead prices?” Internal Paper, Reserve Bank of New Zealand.

Lucas, R. E. (1976), “Econometric policy evaluation: A critique.” *Carnegie-Rochester Conference Series on Public Policy* 1: 19-46.

Murphy, C. (1998), “New Zealand Model 1998”, *A Report to the New Zealand Treasury*, Wellington, September 1998.

Pagan, A. (2003) “Report on modelling and forecasting at the Bank of England.” The Pagan Report, Bank of England.

Salter, W. E. G. (1959) “Internal and external balance: The role of price and expenditure effects.” *The Economic Record*, 35, 226-38.

Swan, T. (1955) “Longer run problems of the balance of payments.” *In the Australian economy: A volume of readings*, Arndt, H. W. and Corden, W. M., eds., Melbourne:Cheshire, 284-95.

Szeto, K. L. (2001) “An econometric analysis of a production function for New Zealand.” The New Zealand Treasury Working Paper No. 01/30. http://www.treasury.govt.nz/workingpapers/2001/01-31.asp

Szeto, K. L. (2002) “A dynamic computable general equilibrium (CGE) model of the New Zealand economy.” .The New Zealand Treasury Working Paper No. 02/07. http://www.treasury.govt.nz/workingpapers/2002/02-7.asp

Wells, G and L. Evans (1985) “The impact of traded goods prices on the New Zealand Economy.” *The Economic Record*, 61, 421-435.