Identifying Terms of Trade Shocks and Their Transmission to the New Zealand Economy*

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Abstract

Terms of trade shocks are important sources of fluctuations in New Zealand business cycles. In this paper we attempt to identify the drivers of New Zealand's terms of trade and how those different drivers affect the New Zealand economy. We use a two-block Bayesian structural vector autoregression to identify shocks to world demand, export and import prices, and commodity prices. We find that export and import prices are mostly explained by common shocks that drive them together. We also find that the shocks that are specific to New Zealand's export prices are rare and have little significant effect on the New Zealand economy. Although each of the three shocks identified is found to unambiguously increase the terms of trade, the effects of each shock on New Zealand variables are very different.

Keywords: terms of trade, VAR, sign restrictions, Bayesian estimation.

JEL classification: E30, F41.

*The views expressed here are the views of the authors and do not necessarily reflect the views of our employer, the Reserve Bank of New Zealand. The authors wish to thank Haroon Mumtaz, Renee Fry, Konstantinos Theodoridis and seminar participants at the Reserve Bank of New Zealand for helpful comments. All remaining errors are our own. Correspondence: Gael Price, gael.price@rbnz.govt.nz

1 Introduction

The swings in New Zealand's terms of trade have significant implications for the New Zealand economy both in the medium term and in the longer term. These swings bring a number of challenges for an inflation targeting central bank. The challenges they bring are further complicated by the so-called 'commodity currency'[1] nature of the New Zealand dollar, where the New Zealand dollar closely follows the movements in New Zealand's export commodity prices.

To put in perspective the large swings in New Zealand's terms of trade over history, Figure 1 shows the historical series of the quarterly terms of trade, export and import prices between 1952 and 2011, measured using Statistics New Zealand's Overseas Trade Indices (OTIs). New Zealand's terms of trade have experienced large cycles as well as some more long-term changes. What is interesting, in our view, is the apparent change in the co-movements between export and import prices. The two series, in US dollar terms, had no apparent co-movement in the 1950s and 1960s, with export prices having huge swings while import prices were less volatile. From 1967 onwards the two prices became very synchronised. Since this co-movement is visible in the world price series, it is almost independent of changes to the exchange rate regime.[2]

A 30 quarter moving window correlation between the two prices reveals a negative correlation up until 1967Q3 and then a sudden jump to a positive correlation of around 0.65.[3] This correlation declines in the second half of the 1970s but then rises again in the mid-1980s to around 0.8. Part of this might be explained by changes in the composition of the New Zealand's export and import price baskets. For example, dairy has become a more important part of the New Zealand's export price basket than wool and meat, although this is a recent phenomenon. Nevertheless, we do see the change in the correlation structure of these two series as an indication of some fundamental change in the nature of the shocks driving the co-movements in import and export prices. More specifically, we argue that instead of being driven by different and idiosyncratic shocks, import and export prices might be driven by common shocks in similar directions. Our aim is to understand whether this is the case and, if so, what the consequences are for the New Zealand economy.

In this paper we are interested in identifying the drivers of New Zealand's commodity prices and terms of trade. We would like to understand whether New Zealand's commodity prices rise and fall due to idiosyncratic shocks specific to commodities that New Zealand exports, or whether they are driven by some common factors that also drive the prices of other commodities, including those

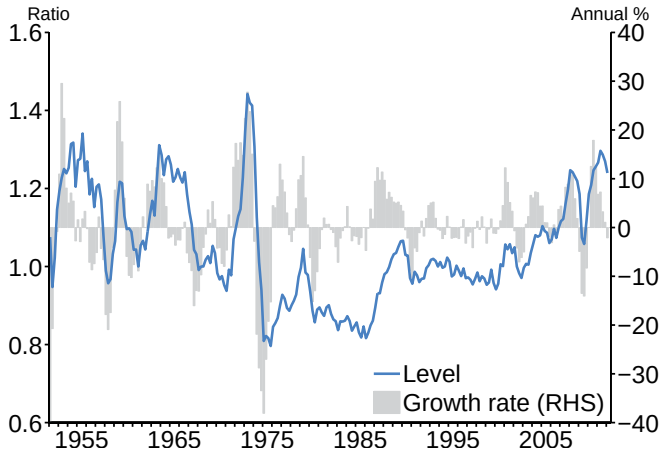
[1] The term is owed to Chen and Rogoff (2003).

[2] Our conversion of the New Zealand dollar series, measured by Statistics New Zealand, into US dollars is not perfect. Prices would have been originally measured in foreign-currency terms, then converted into New Zealand dollars using some prevailing exchange rate. It is likely that the exchange rate then used was not the same as the spot rate series we have used for the present conversion. For example, OTI prices today are compiled using New Zealand Customs Service exchange rates, which are measured with a lag of up to two weeks.

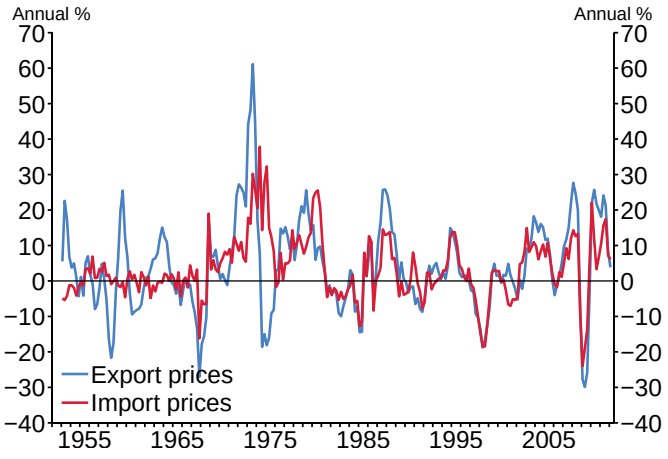
[3] The apparent structural break in 1967Q4 is robust to a range of currency specifications.

that the New Zealand imports. These are important questions since the effects of changes in export and import prices, and hence the terms of trade, on the New Zealand economy are dependent on what kinds of shocks are driving such changes. Kilian (2009) shows, for example, that in the case of oil prices, the effects depend on the underlying nature of the shock. For example, the shock might be a pure New Zealand export price specific shock or a common shock where import and export prices increase together.

Figure 1: Terms of Trade, Export and Import Prices



(a) Terms of trade



(b) Export and import price growth (USD)

For many countries, the most important effects of rising commodity prices would be about the trade-off between rising inflation and falling output due to negative income effects. However, for a commodity exporter such as New Zealand the effects are likely to be different and to arrive via different channels. One of the most important effects of a commodity price shock would be felt in exporters' incomes. This would likely be combined with a negative income ef-

fect upon households, particularly if the shock is common to export and import prices. Moreover, New Zealand's currency is a so-called 'commodity currency' so shifts in commodity prices and terms of trade may also have significant influence over the exchange rate in New Zealand.

To address these issues we identify three world shocks that, we postulate, drive New Zealand's export and import prices. Specifically, we estimate a small open economy Bayesian vector autoregression (BVAR) to identify the international shocks with sign restrictions. We identify only international shocks, as New Zealand is a price taker with its import and export prices determined in the world market. We find that the most important shocks are the common demand and supply shocks, with the former being the most dominant. We find that the shock that is specific to New Zealand's exports is not a dominant one. Our results indicate that, when thinking about the terms of trade, it is important to consider how the underlying shocks may affect both export and import prices, as we find that export prices seldom shift in isolation.

The remainder of the paper is structured as follows. Section 2 discusses the literature and the issue in more detail. Section 3 introduces the empirical methodology and the identification strategy. Section 4 presents results and section 5 concludes.

2 Literature review

There has been a long literature on the co-movement of commodity prices (or lack of it), which, to our knowledge, dates back to Pyndyk and Rotemberg (1987) where they term the co-movement in commodity prices "excessive" based on the fundamental drivers of commodity prices. Cashin and McDermott and Scott (1999) on the other hand, by using a concordance measure of co-movement, argue that co-moving commodity prices are a myth, at least in their sample. However, in the last decade or so the co-movement in commodity prices seems to have been more pronounced. Vansteenkiste (2009) has argued that commodity prices do exhibit some strong co-movements, measured using dynamic factor models wherein a few common factors explain a significant proportion of the variation across commodity prices.

One of the reasons put forward for the increased co-movement in commodity prices over recent years is that they are driven by common factors, possibly linked to the entry of a number of large emerging economies into the industrialisation phase, particularly China. The increased dominance of these countries in world demand for commodities, soft or hard, means that there might well be a shift in the drivers of commodity prices leading to more synchronised price movements.

A prototype commodities model would have three fundamental shocks for a particular commodity (Deaton and Laroque 2003, Kilian 2009): A commodity-specific demand shock, a world demand shock and a commodity-specific supply shock. A positive commodity-specific demand shock would increase the price of

the commodity while having no effect on the prices of other commodities. In the case of New Zealand this might be a shock to the demand for dairy products from overseas. Foreign buyers might have a change in their preferences towards dairy or New Zealand dairy products. This kind of a commodity price shock would have very different implications for the New Zealand economy from other kinds of shocks that drive commodity prices.

A world demand shock is a shock to incomes and would also increase the price of the commodity in question. However, this kind of shock would have implications for the prices of all other commodities. In the case of New Zealand, this kind of shock would increase the price of dairy products, for example, and also increase the prices of imported commodities such as oil. Therefore it is important to empirically find out what would be the likely effects of such a shock on import and export prices, and hence the net effect on the terms of trade.

The third shock is on the supply side of the commodity in question. Such a shock is not always easy to identify, mainly due to data restrictions. Data is not available on the world production of many commodities at quarterly frequency. The most available production data is for oil, and at monthly frequency this only goes back to 1970s. Many metals, minerals and some agricultural commodities have production data going back to 1900 at annual frequency, but this is insufficient for detailed commodity supply modelling. As a result, we are unable to identify a commodity-specific supply shock. Kilian (2009) uses oil production data to accurately identify an oil supply shock, but nonetheless finds that world demand shocks are dominant.

Jääskelä and Smith (2011) propose an additional shock (or a slight change to the commodity-specific demand shock) that aims to capture the integration of emerging economies into the world economy. Such a shock is assumed to put positive pressure on Australian export prices while putting downward pressure on import prices, due to cheaper imports supplied by these emerging economies, such as China.

3 Model

We follow the method of Jääskelä and Smith (2011) in estimating the following sign-restricted VAR:

$$\begin{bmatrix} w_t \\ d_t \end{bmatrix} = \alpha x_t + \sum_{k=1}^{p} A_k \begin{bmatrix} w_{t-k} \\ d_{t-k} \end{bmatrix} + B \begin{bmatrix} \epsilon_t^w \\ \epsilon_t^d \end{bmatrix}$$

In this notation, w_t and d_t are respectively vectors of world and domestic (New Zealand) variables (see section 3.1 below); x_t is a vector of exogenous variables; and B is the contemporaneous impact matrix of the (mutually uncorrelated) shock vectors ϵ_t^w and ϵ_t^d.

The reduced-form parameter matrices A_k (together with α) are estimated using a Bayesian approach with the Gibbs sampler (see section 3.2). Each A_k

is restricted to be block lower triangular to enforce the block structure of the model, so that lags of New Zealand variables do not affect world variables. This is to satisfy the assumption that the New Zealand is a price taker and its import and export prices are determined in the world market, with no spillover from New Zealand variables to world variables. The impact matrix B is found using a sign-restriction algorithm, and is also restricted to be block lower triangular, thus extending the small open economy assumption to the contemporaneous period (see section 3.3).

3.1 Specification and data

We specify the data in quarterly growth rates, as follows.

$$
\begin{aligned}
w_t &= (\pi_t^c, \Delta y_t^w, \pi_t^w, \pi_t^m, \pi_t^x)' \\
d_t &= \left(\Delta y_t^d, \pi_t^d, i_t^d, \Delta e_t\right)' \\
x_t &= \begin{cases} \begin{bmatrix} 1 & 0 \end{bmatrix}' & \text{before 1992Q1} \\ \begin{bmatrix} 1 & 1 \end{bmatrix}' & \text{subsequently} \end{cases}
\end{aligned}
$$

In the world block, π_t^c is world commodity price inflation, Δy_t^w is growth in world GDP, π_t^w is world CPI inflation, π_t^m is import price inflation, and π_t^x is export price inflation. For world GDP and world CPI we use the Reserve Bank of New Zealand's in-house measures, which are constructed using a weighted set of 16 trading partner economies[4]. Import and export prices are New Zealand's OTI import and export prices. To abstract from exchange rate fluctuations, we express all prices as world prices, with import and export prices deflated by the trade-weighted index (TWI), and commodity prices by the USD/SDR exchange rate.

Instead of including the terms of trade as variable in its own right, we specify the model to include import and export prices separately. This decision was made to reflect our belief that, far from being driven by 'terms of trade shocks', the terms of trade are driven by shocks that act independently upon import and export prices.

For a consistent measure of commodity prices, we use the first principal component extracted from a dataset of 51 price series. Of these, 49 are individual commodity prices measured by the International Monetary Fund[5], and the

[4]The economies used are: United States, euro area, United Kingdom, Canada, Japan, China, India, Philippines, Thailand, Indonesia, Malaysia, Taiwan, Hong Kong, Singapore, Korea, Australia.

[5]The commodities included are: Aluminum, Bananas, Barley, Beef, Coal, Cocoa beans, Coffee arabica, Coffee robusta, Rapeseed oil, Copper, Cotton, Fishmeal, Groundnuts (peanuts), Hides, Iron ore, Lamb, Lead, Soft Logs, Hard Logs, Maize (corn), Nickel, Oil (average Brent), Crude Oil (petroleum) Brent, Oil (Dubai), Crude Oil (petroleum) WTI, Olive Oil, Oranges, Palm oil, Swine (pork), Poultry (chicken), Rice, Rubber, Fish (salmon), Hard Sawnwood, Soft Sawnwood, Shrimp, Soybean Meal, Soybean Oil, Soybeans, Sugar (free market), Sugar (U.S. import), Sunflower oil, Tea, Tin, Uranium, Wheat, Wool coarse, Wool fine,

other two are New Zealand's OTI export and import prices, converted to world terms. The OTI prices are included to force the first principal component to have the highest possible comovement with the prices that are relevant to New Zealand.

In the New Zealand block, Δy_t^d is growth in New Zealand GDP, π_t^d is New Zealand CPI inflation, i_t^d is the nominal 90-day interest rate (as a level), and Δe_t is nominal exchange rate appreciation, measured using the trade-weighted index (TWI).

The exogenous vector, x_t, includes a constant term and a dummy variable that captures the move to inflation targeting in 1992.

The sample period is 1987Q2 to 2011Q4. Results are reported for a lag length of $p = 4$.

3.2 Estimation

We estimate the parameters using 100,000 draws of the Gibbs sampler, and retain the last 20,000.[6] A Minnesota prior[7] is imposed upon the parameter estimates, with hyperparameters $\begin{bmatrix}\beta & \lambda_1 & \lambda_2 & \lambda_3 & \lambda_4\end{bmatrix} = \begin{bmatrix}0.9 & 0.9 & 0.9 & 0.8 & 1.0\end{bmatrix}$. Here, β is the prior mean on the AR(1) parameter in each equation; λ_1 is an overall tightness parameter; λ_2 controls the tightness of parameters on independent variables in each equation; λ_3 controls the rate at which parameters on higher lags of all variables tend toward zero; and λ_4 controls the tightness of parameters on the exogenous variables in x_t. Note that the selection of $\beta = 0.9$ implies a prior belief that each variable is very persistent, but not unit root.

We deviate from the usual structure of the Minnesota prior in order to enforce the block structure of the model. On all parameters that would violate this block structure if nonzero – that is, the coefficients on New Zealand variables in world equations – we set a very tight prior of zero (specifically, the priors for these parameters have mean zero and variance 10^{-9}). This approach has the advantage that the symmetry of the VAR equations is maintained, meaning that the system can be initially estimated equation-by-equation using OLS, while still effectively placing zero restrictions on some parameters.

3.3 Identification

We identify the structural shocks in the world block of the VAR using sign restrictions. Sign restrictions have become a popular means of shock identification in structural VAR literature, dating back to Faust (1998), Peersman (2005) and Uhlig (2005). Sign restrictions can be imposed on a few horizons, or a single horizon. In our paper we place the sign restrictions on the contemporaneous quarter only. Fry and Pagan (2011) reviews this literature critically

Zinc. Data was sourced from http://www.imf.org/external/np/res/commod/index.aspx.

[6] Evidence on the convergence of the Gibbs sampler is available upon request.

[7] See the appendix for full prior specification.

and identifies a number of shortcomings, some of which we address in this paper.

We use a sign restriction algorithm similar to that used by Mumtaz and Sunder-Plassmann (2010). The identified shocks are specified in terms of their effects on world-block variables, with the domestic block left unrestricted. The sign restriction scheme is described in Table 1 below. Although there are five variables in the world block, we identify only three shocks. In order to address the Fry and Pagan (2011) criticism of multiple shocks, we restrict the other world shocks not to have the identical signs to the ones we impose.

Consistent with the small open economy assumption, we restrict the contemporaneous impact matrix B and lag matrices A_k to be block lower triangular.

Table 1: Sign Restrictions

	Commodity factor	World GDP	World CPI	Import prices	Export prices
World demand	+	+	+	+	+
World supply	+	−	×	×	+
Globalisation	×	+	×	−	+

The 'world demand' shock is a shock that is common to import and export prices. As discussed in section 1, this shock is specified to increase the prices of all commodities, as well as New Zealand's import and export prices. This shock can be thought of a global business cycle shock: the global economy booms and positively affects all prices in the contemporaneous period. Consequently, full specification of this shock also requires a positive restriction on world activity.

The 'world supply' shock is specified in such a way that it may be common to import and export prices if the data support such commonality. The supply shock may be thought of as an idiosyncratic shock to commodity prices, which may be a commodity supply shock (as discussed in the introduction, commodity supply shocks cannot be modelled explicitly). This shock increases commodity prices and contemporaneously reduces world GDP via a negative income effect. This shock is also restricted to increase New Zealand's export prices, while the effects on world CPI and import prices are left unrestricted.

The third shock drives import and export prices in opposite directions, and hence is the only shock that is specific to New Zealand's export commodities. This shock, which is labelled a 'globalisation' shock by Jääskelä and Smith (2011), attempts to capture the entry of large emerging economies onto the world stage. Such entry is postulated to have three distinct effects: world GDP increases as the world economy is now bigger; New Zealand's export prices increase as the new entrant creates excess demand for primary products; New Zealand's import prices decrease as the new entrant supplies the world with

low-cost manufactures. The sign restrictions for this shock are specified accordingly, with the other two world variables left unrestricted.

The globalisation shock is the only one that restricts the response of the terms of trade. We remain agnostic on the effect of the other two shocks upon the terms of trade.

4 Results

In this section we discuss the results. We will first look at impulse responses (section 4.1). Then we turn to forecast error variance decompositions (section 4.2) and the historical decompositions for selected variables (section 4.3).

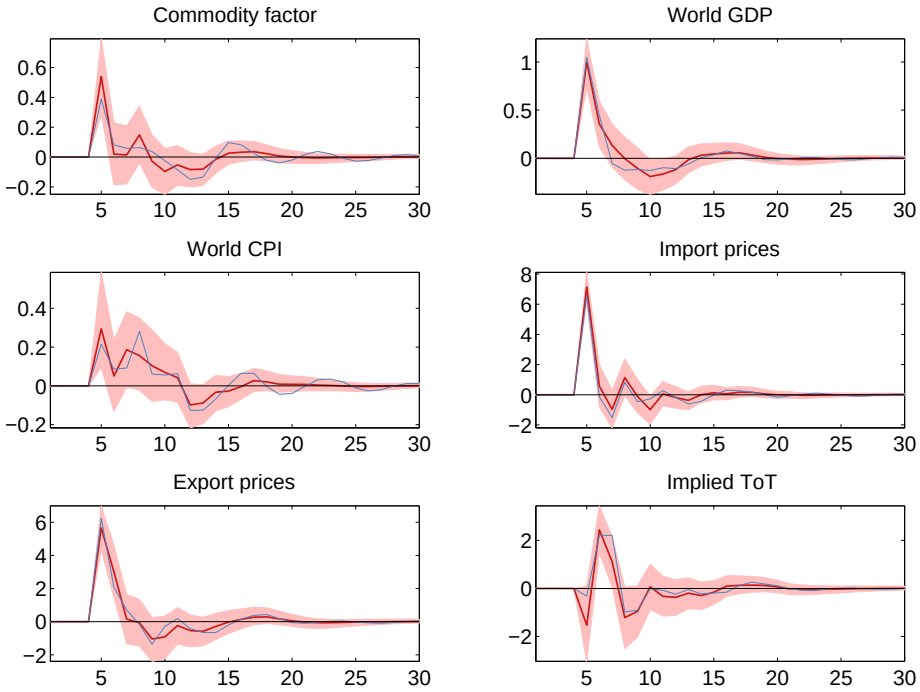
4.1 Impulse Responses

This section reports impulse responses to the three identified shocks in quarterly log differences (except for the domestic interest rate, which is reported in percentage point levels throughout). For each shock and variable we report two 'median' impulse responses: the pointwise median as a heavy red line, and as a light blue line, the single impulse response nearest to the pointwise median across all variables. This is similar to the 'median target' measure proposed by Fry and Pagan (2011), and is included to ensure that a single model is used to compare the impulse responses for each shock.

We start with the world demand shock (or world business cycle shock), which we identified as a shock that increases world economic activity and prices. Figure 2 shows the impulse responses of the world variables to this shock. This shock is associated with an increase in both activity (world GDP) and all the prices: commodity factor, world CPI, and New Zealand's import and export prices. Interestingly, New Zealand's import prices rise more than New Zealand's export prices initially. As a result New Zealand's terms of trade falls. However, the export price rise is much more persistent, which leads to an increase in the terms of trade in the medium term. This could be due to the fact that New Zealand's import basket includes oil, which is more volatile in nature and can over-respond to shocks at times.

Figure 3 shows the impulse responses of the domestic New Zealand variables to the same shock. New Zealand's GDP increases significantly, although possibly not as much as one might have expected. Given New Zealand is a commodity exporter, why is the net effect on New Zealand GDP rather weak? We believe this is due to a few opposing effects. The increase in world prices, as well as in New Zealand's own CPI, leads to a negative income effect. Vasishtha and Maier (2011) find evidence for a similar negative income effect in the case of Canada. Moreover, the increased activity and inflation would lead to a response by the central bank, as we can see in the rise in domestic interest rates. On top of this, the increased terms of trade and interest rates lead to a rise, although short lived, in the exchange rate, which dampens net exports and puts further downward pressure on GDP.

Figure 2: Impulse response functions – World to demand shock



The positive effect coming from a positive demand shock, despite the conventional wisdom, is something that has not been found in the data previously. Buckle et al (2002) for example finds a negative terms of trade effect coming from the world demand shock, and an insignificant response of New Zealand GDP. Haug and Smith (2007) finds an insignificant response in New Zealand GDP, which becomes significant only after almost 4 years. Karagedikli and Thorsrud (2010) finds, by using a factor-augmented VAR, that the net effect on New Zealand GDP was small and negative after the endogenous responses of the exchange rate and the interest rates in the model. In this paper, on the other hand, we find that the net effect of a world demand shock on New Zealand GDP is positive – but small and short-lived. The weight of evidence, therefore, would appear to indicate that there is little reason to expect a large increase in New Zealand GDP following a positive world demand shock.

Figure 4 shows the impulse responses to a world supply shock. When there is a world supply shock this is associated with a sharp increase in the commodity factor and a sharp and persistent fall in world GDP arising from the negative income effect. Both import and export prices increase as a result, although import prices were left unrestricted. The world CPI does not increase.

Although the response of world CPI might seem strange, two opposite effects are in force here. The increased commodity factor would be expected to increase world CPI given these items are part of the world CPI basket (although some of

the commodity variables we have, such as metals, minerals and energy prices, may not have a direct effect on consumer prices). At the same time, however, the negative income effect shrinks world GDP considerably and hence places downward pressure on world CPI from the demand side. Given how persistent is this fall in world GDP, the almost zero response of world CPI seems reasonable.

Figure 3: Impulse response functions – Domestic to demand shock

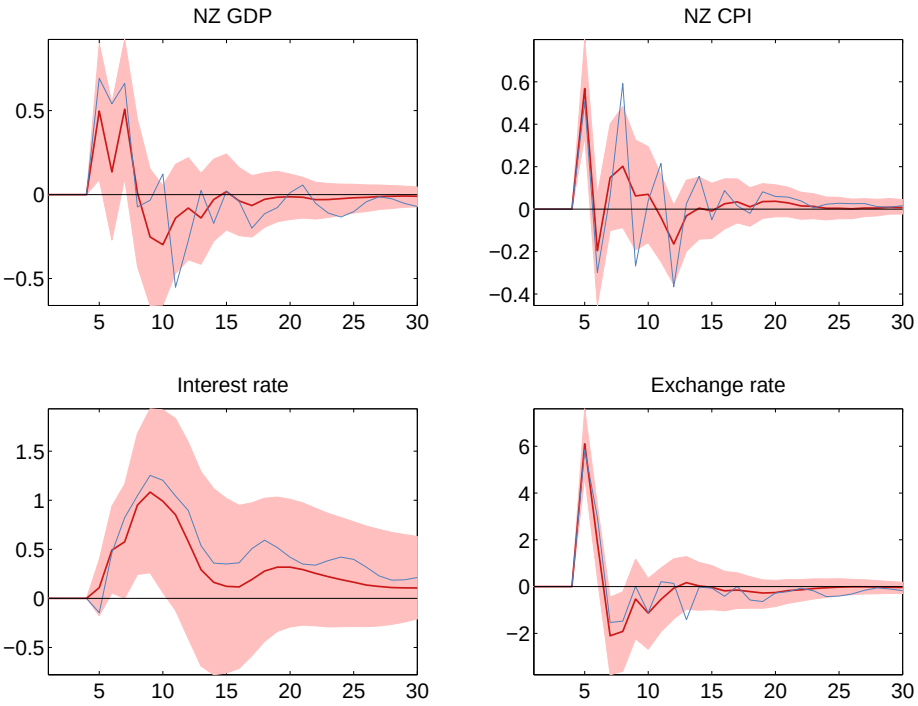


Figure 5 shows the responses of the domestic New Zealand variables to the same shock, the supply shock. New Zealand GDP falls sharply in response to this supply shock. Although New Zealand CPI increases initially, this is very short lived and the CPI does not change significantly after the first quarter. Given there is no persistent inflation effect the central bank lowers interest rates in response to the fall in output.

Figure 6 shows the impulse responses of the world variable to the globalisation shock. This shock increases world activity as well as the commodity factor, although the latter is insignificant. However, the (sign-restricted) changes in export and import prices are significant, and the net effect on New Zealand's terms of trade is positive.

Figure 4: Impulse response functions – World to supply shock

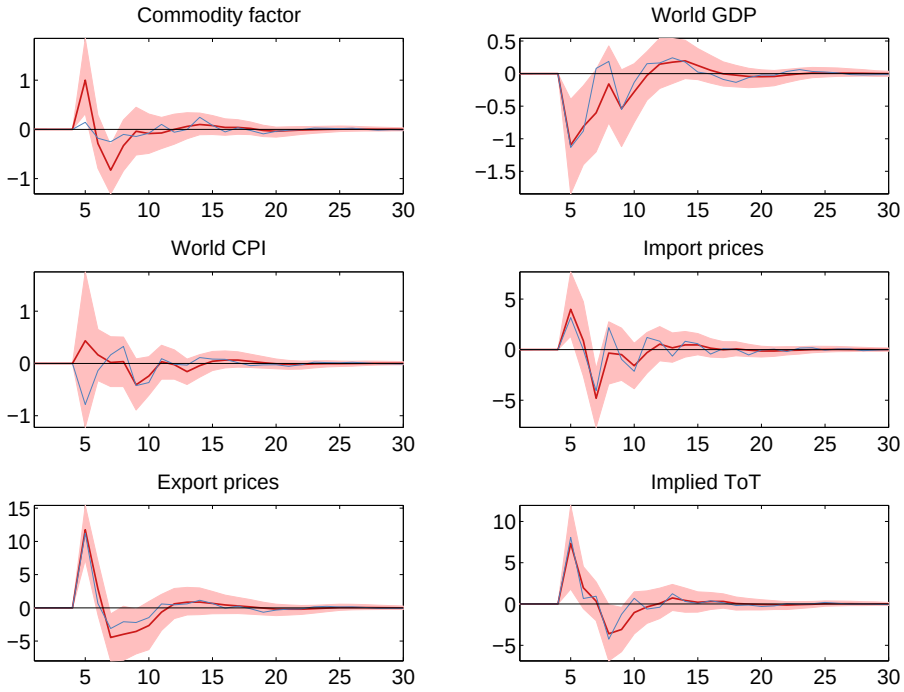


Figure 5: Impulse response functions – Domestic to supply shock

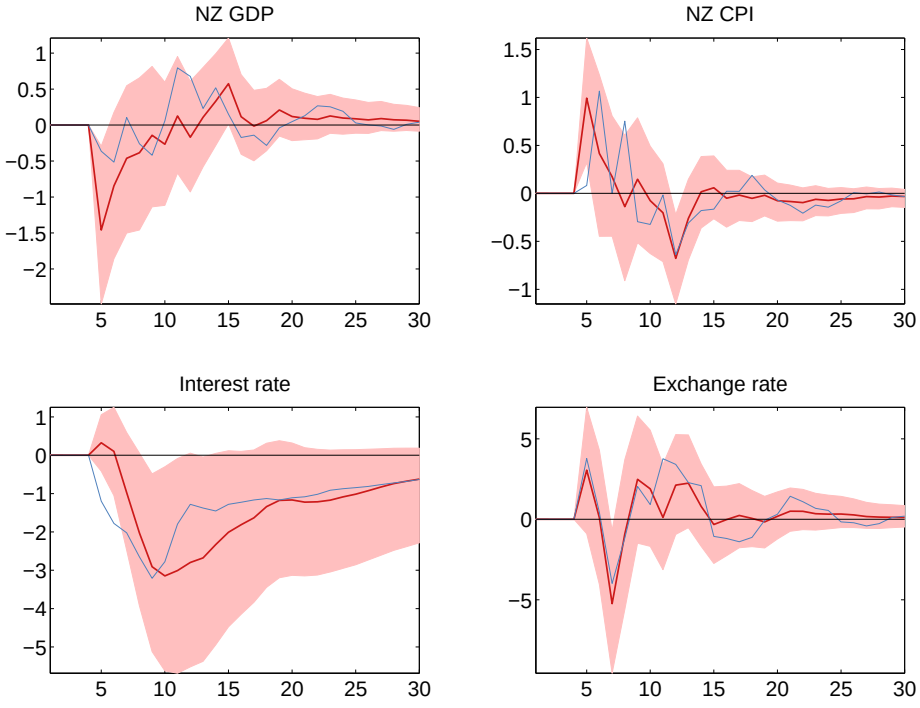


Figure 6: Impulse response functions – World to globalisation shock

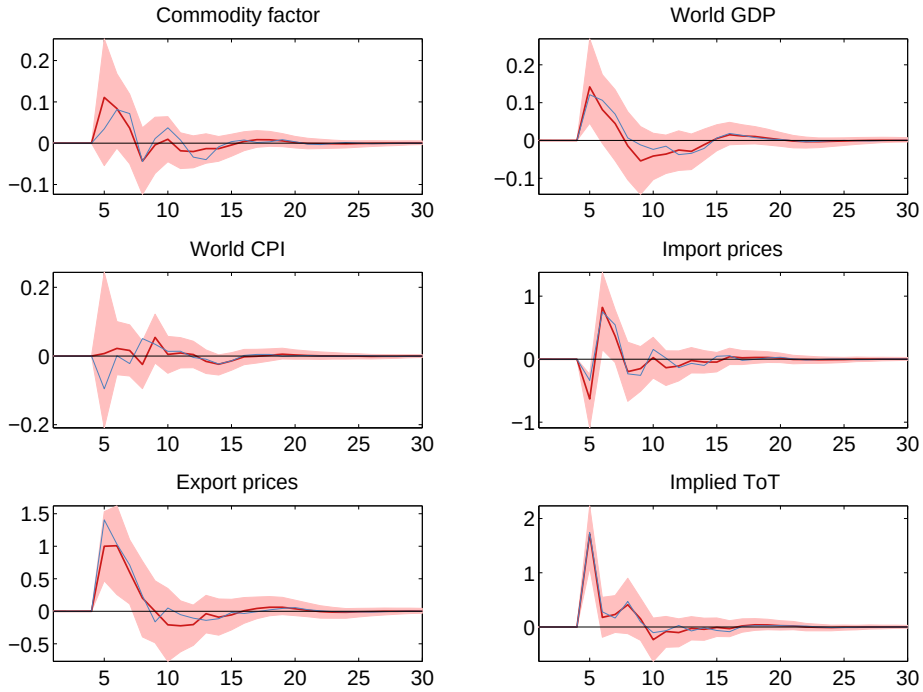


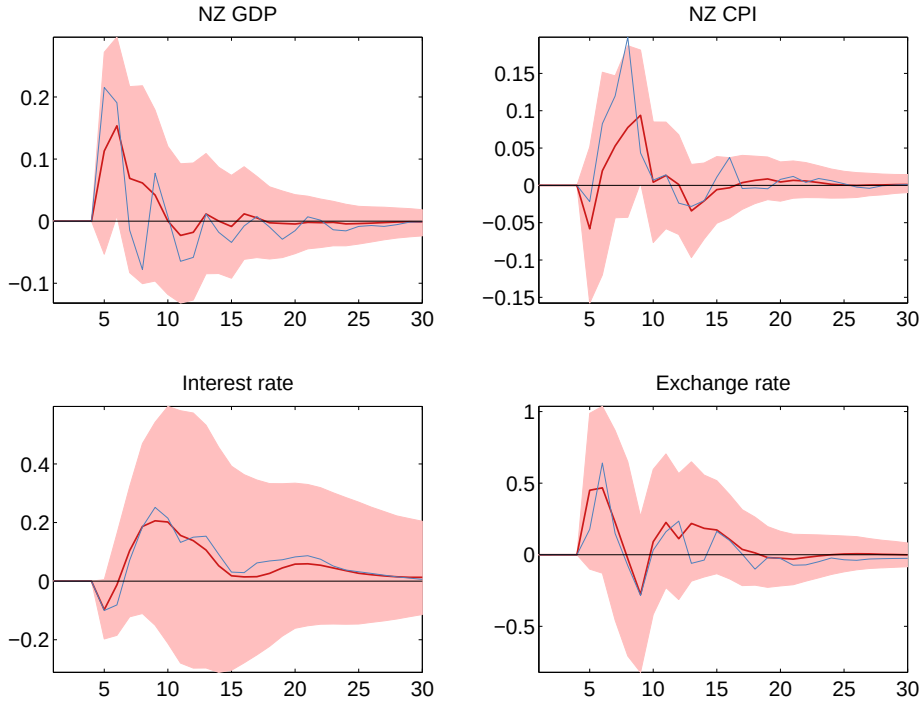
Figure 7 shows the impulse responses of the domestic variables to this shock. Although the signs of the impulse responses seem reasonable, they are all insignificant. Moreover, the magnitudes are very small. As we will see in the historical decompositions, this shock does not appear to be supported much in the data as a key driver of either domestic New Zealand variables or import and export prices.

Buckle et al (2002) finds that a New Zealand export price shock contributes significantly to New Zealand's business cycles. Our results are at odds with their results as we find that it is hard to distinguish a shock specific to the New Zealand export prices, as most of the time it is a shock correlated with New Zealand's import prices. We believe this is one of the distinguishing features of our results: one needs to think of the shocks to New Zealand's export and import prices as common shocks, as opposed to shocks specific to either import or export prices alone.

4.2 Variance Decomposition

We now turn to forecast error variance decompositions. Figures 8 and 9 show the contributions of each of the shocks we identified to the unconditional variance of different series in our model. The posterior mode of the retained Gibbs

Figure 7: Impulse response functions – Domestic to globalisation shock



draws is used for the decompositions in both this and the next section.[8]

There is evidence that the three identified shocks do occur: the shocks we identified explain about 40 per cent of the variation in the commodity factor. World demand and globalisation shocks explain around 40 and 30 per cent, respectively, of the variation in world GDP. The world demand shock also appears to be the most important shock for both import and export prices, in particular for import prices (explaining around 60 per cent of the variation).

The identified world shocks are less important for New Zealand variables, as New Zealand shocks have a significant influence in the New Zealand block. For example the world shocks we identified seem to explain only around 20 per cent of the variation in the New Zealand GDP, while explaining around 30 per cent of the CPI. However, interestingly for the New Zealand dollar exchange rate they account for around 40 per cent of the variation.

[8]Results for the credible bands are available from the authors upon request.

Figure 8: FEVD – World

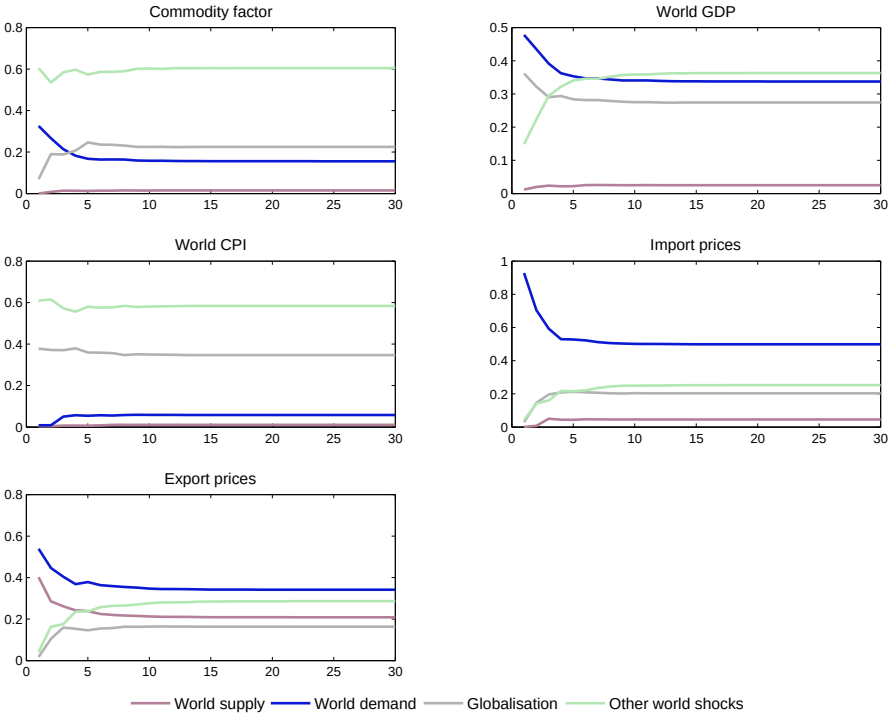
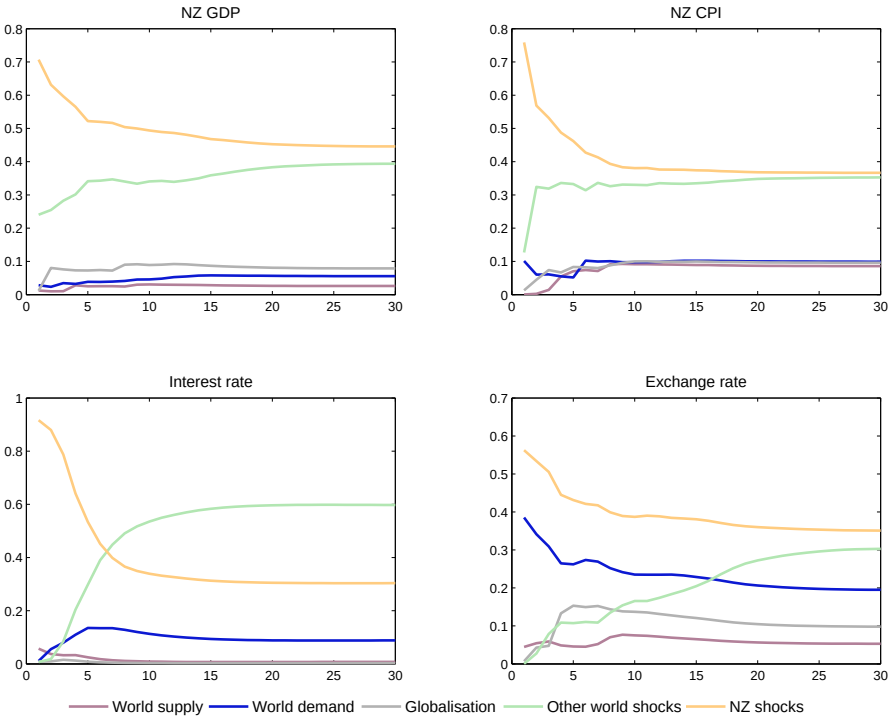


Figure 9: FEVD – Domestic



4.3 Historical Decompositions

Impulse response functions are useful for understanding the effects of different shocks in isolation. However, we are also interested in how each of these shocks might have contributed to the movements of variables at different points in history. Historical decompositions are useful in understanding the historical contributions of different shocks to each variable.

This section presents decompositions of selected variables over history in quarterly log differences. Again, the draw used is the posterior mode of the retained Gibbs draws. A new identification matrix was re-created from the residuals of this particular draw, in order to force the decomposed shocks to match the residuals in magnitude.

Figure 10 shows the historical decomposition for world GDP. What this figure shows is that most of the variation in world GDP over the sample is explained by two main shocks: world demand and world supply shocks. In particular the contribution of world demand shocks to world GDP was very strong throughout the 1990s and 2000s. The two large global recessions – the 1997-1998 recession following the Asian crisis, and the post GFC recession – are both explained by world demand shocks. However, as one would expect, the more recent recession has a large 'other' shock element as well, which is probably due to the financial shocks that we are not taking into account in our model. Moreover, the recoveries from both of these recessions are driven by world demand shocks. 'Other shocks' have been pushing world GDP down in the last year or two, which again we think might be related to financial shocks.

Figure 11 shows the historical decomposition of the terms of trade. Changes in New Zealand's terms of trade are largely driven by the world demand, world supply and globalisation shocks. The strong run-up in New Zealand commodity prices prior to the crisis is partly world demand and partly a globalisation story. However, the fall in the terms of trade following the GFC is largely a world demand story.

Figure 12 shows the historical decomposition of the commodity factor. Interestingly this factor is driven by all the shocks we estimate: world demand, world supply and the globalisation shock. The fall in this factor following the Asian crisis recession was mainly due to the world demand factor. However, as with world GDP, the fall in the commodity factor after the GFC is due to demand, globalisation and other shocks as well as some supply shocks.

Finally, in figure 13 we look at the historical decomposition of New Zealand GDP. This would essentially tell us the contributions of the shocks we identified to the New Zealand business cycles over our sample. It appears that the New Zealand business cycle is driven largely by domestic shocks and partly by the international shocks we identified. Starting with the 1991 recession New Zealand, we see strong contributions from the domestic shocks and also international shocks. This is consistent with Buckle, Kim and McLellan (2003) that international shocks, domestic non-financial shocks, and monetary policy shocks were the main drivers behind the 1991 recession in New Zealand. The negative

role of the domestic shocks can be linked to two major events: one was the disinflation, the other was the fiscal tightening in the *Budget* of that year. The subsequent recovery also has a significant amount domestic shock component.

Two other interesting episodes are the 1997-1998 and the 2008-2009 recessions in New Zealand. The former has a large world demand shock component, which was the fall in demand for New Zealand products in Asia following the Asian crisis. However, at the earlier part of the recession there is also a large New Zealand shock element. As discussed in detail in Buckle et al (2002 and 2003), these shocks are related to drought and tight monetary policy under the MCI regime.

It is also interesting to see that the boom of the early/mid 2000s is mainly due to domestic shocks. This is consistent with our belief that the rising house prices and related wealth effects on consumption, and high inward migration, were the drivers of the domestic economy at the time. These factors were combined with low interest rates, at least in the earlier part of the boom. Interestingly, at the end of the sample, the domestic shocks are pulling New Zealand GDP down while the international shocks are pushing it up. This is consistent with weakness in the domestic economy stemming from deleveraging, tighter fiscal policy, and natural disasters.

One striking feature of the results as far as the drivers of the New Zealand business cycles are concerned is the large contribution of the domestic shocks, despite New Zealand being a small open economy.

Figure 10: Historical decomposition – Terms of Trade

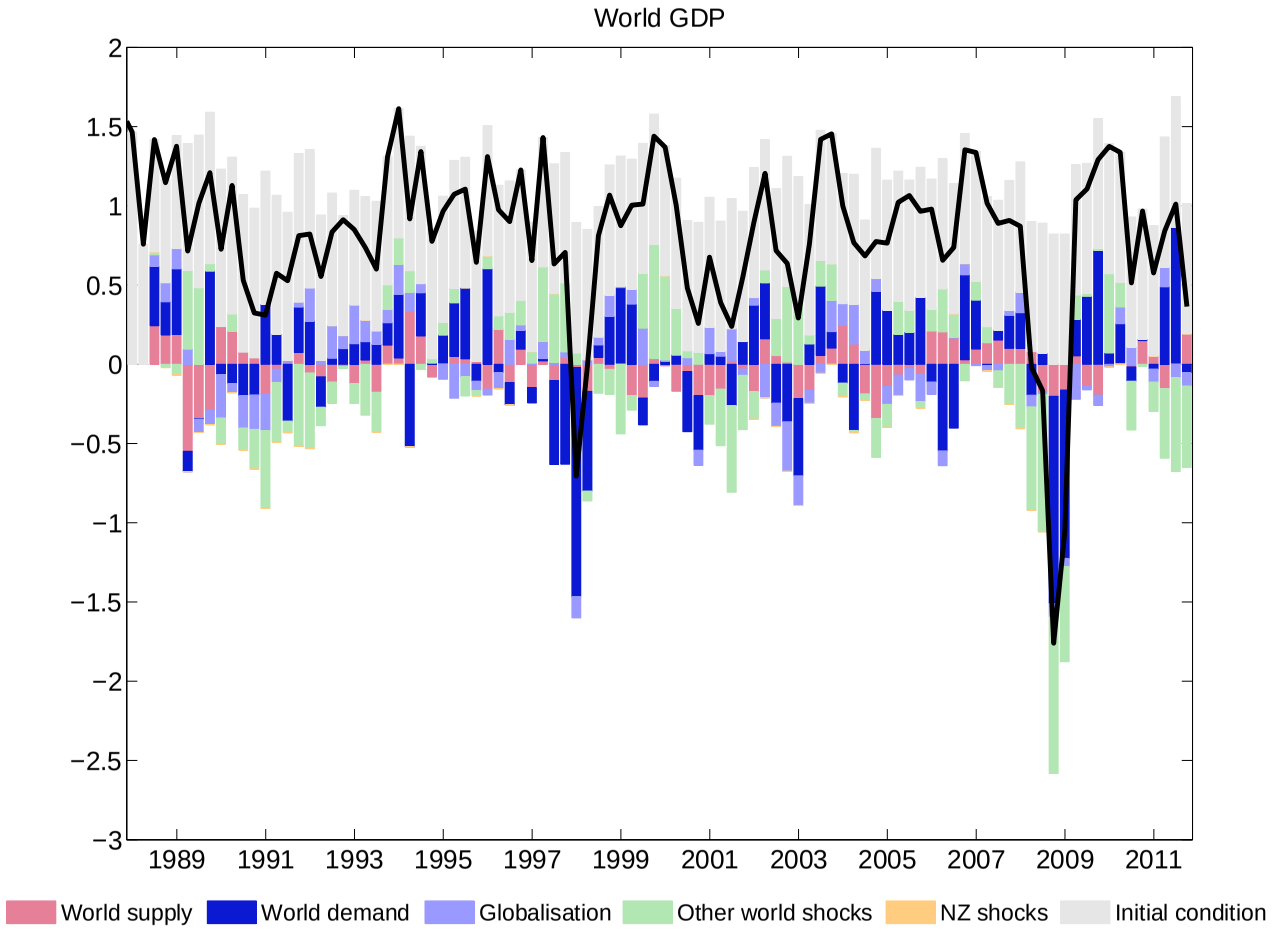


Figure 11: Historical decomposition – Terms of Trade

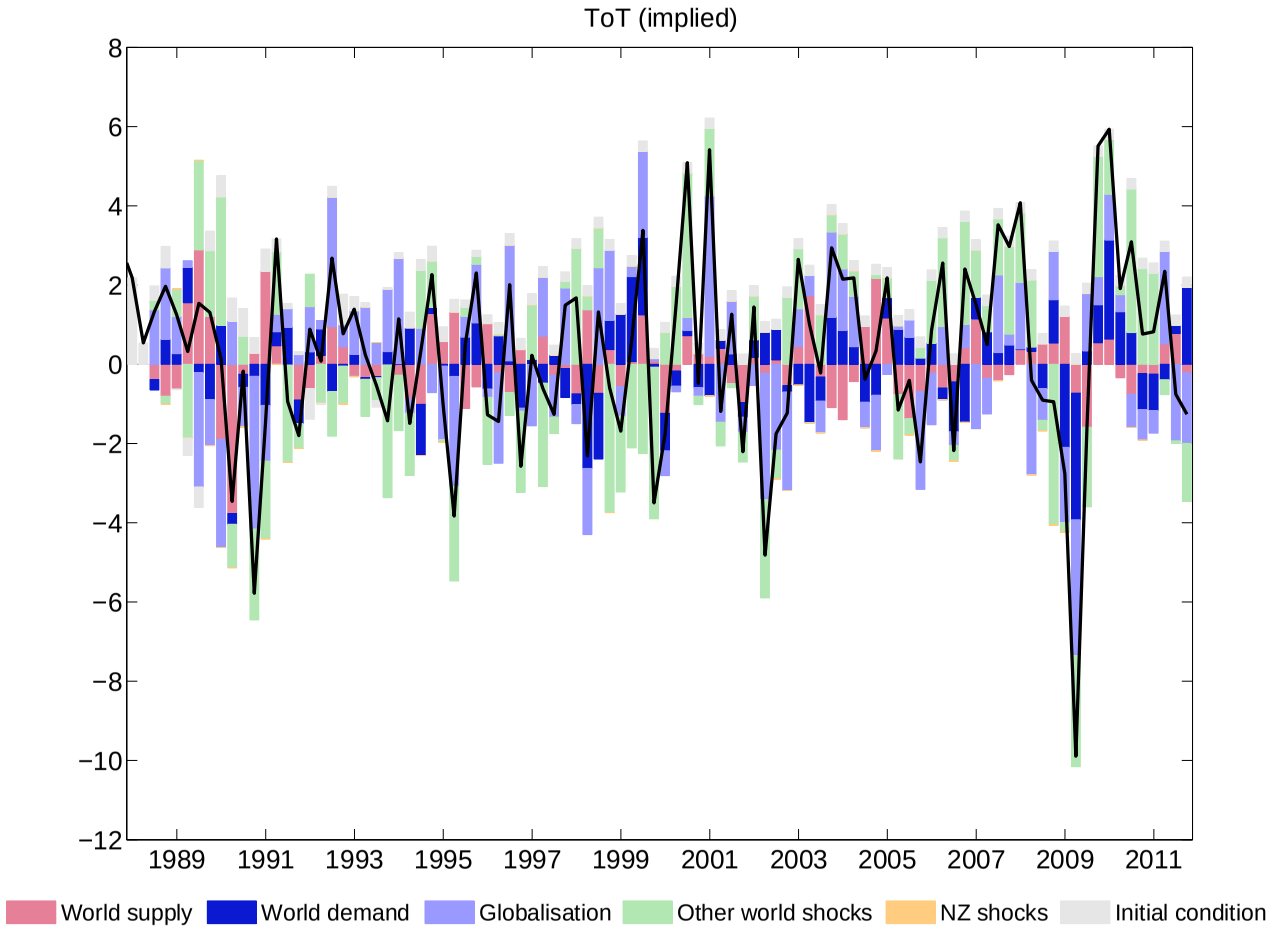


Figure 12: Historical decomposition – Commodities factor

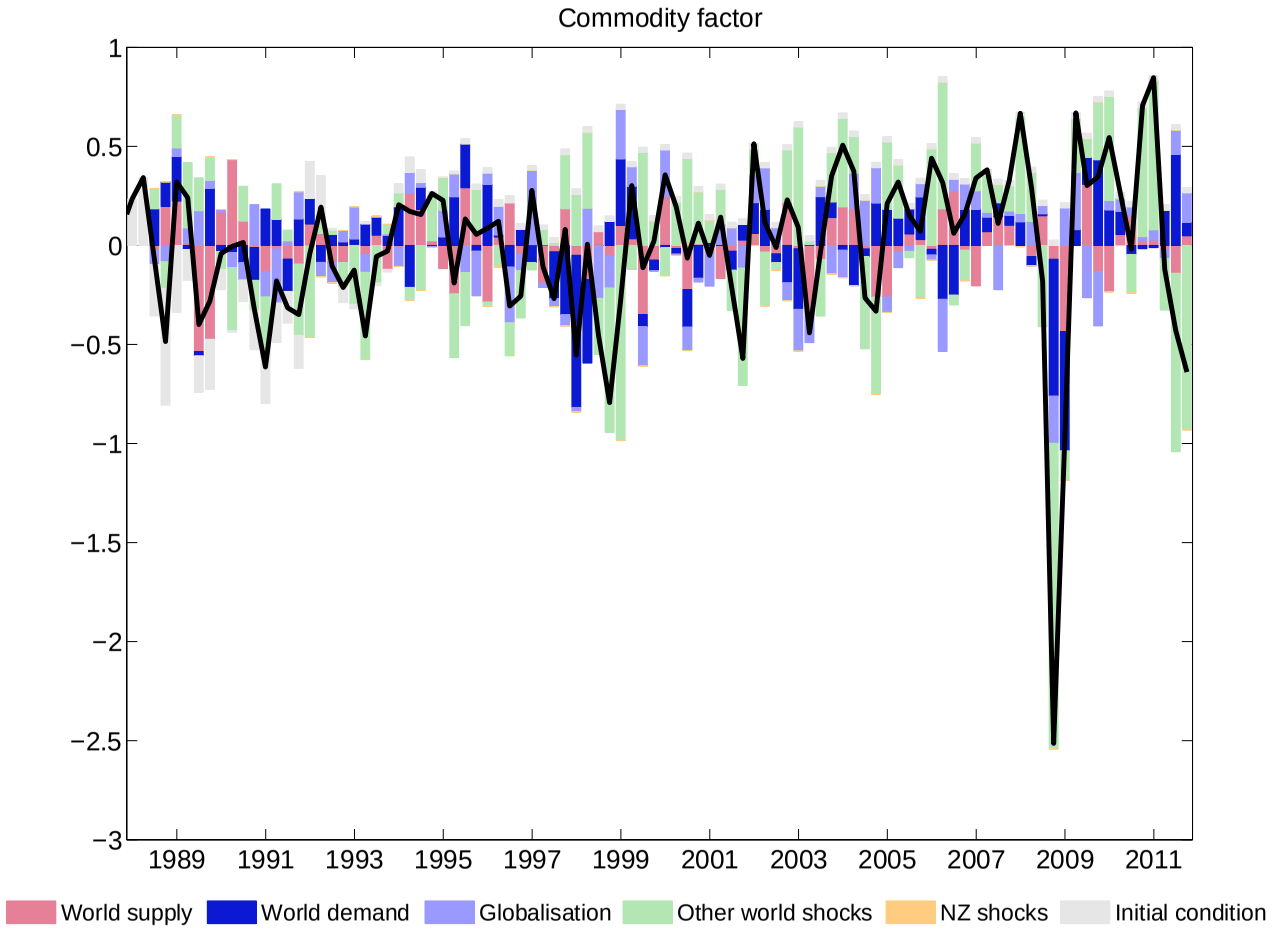
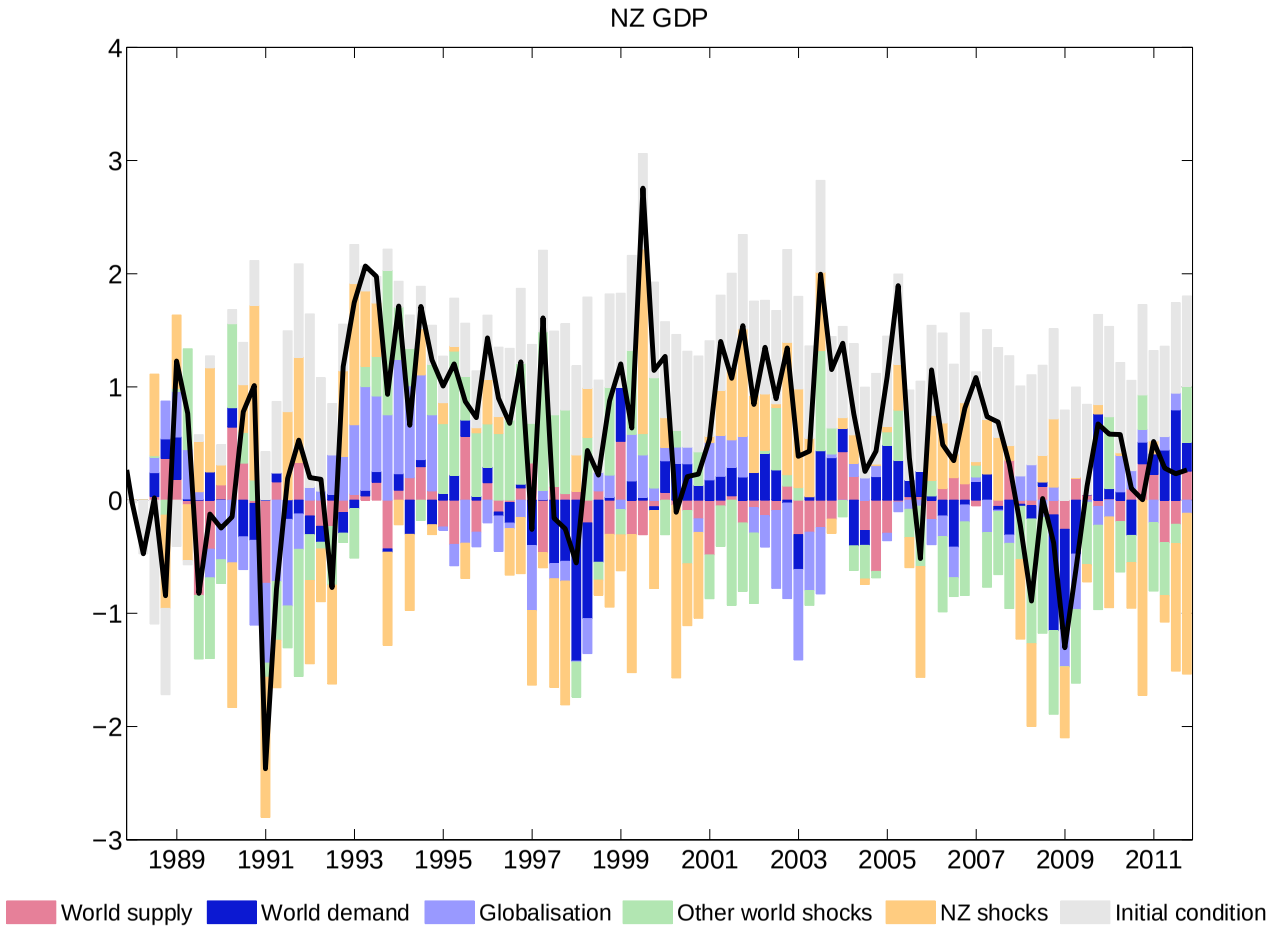


Figure 13: Historical decomposition – New Zealand GDP



5 Conclusions

In this paper we attempted to identify the drivers of New Zealand's terms of trade, and whether those shocks driving New Zealand's terms of trade are common or idiosyncratic shocks. We found that the common shocks, shocks that are common to a large number of commodity prices and other prices, are more likely to be the drivers of the New Zealand's terms of trade, as opposed to idiosyncratic shocks. We also find that the world demand shocks are an important driver. The globalisation shock, on the other hand, has not played such an important role. This small role for the single export-specific shock highlights the dominance of the co-movement between export and import prices in the data.

Three shocks were identified, all of which have a positive impact upon the terms of trade. However, the effects of the three shocks on New Zealand variables are significantly different: one (world demand) temporarily increases New Zealand's GDP, another (world supply) temporarily decreases it, and the third (globalisation) has little effect. This divergence of responses, any of which may be expected if a terms of trade increase is observed in isolation, highlights the importance of remaining aware of the drivers of terms of trade changes. No terms of trade increase can be said to unambiguously boost aggregate demand in New Zealand; the effect depends upon the underlying cause of the increase in the terms of trade.

Appendix

The Minnesota prior is imposed upon the estimated parameters by setting the following moments for the prior distribution of the parameters:

$$
\begin{aligned}
E\left[(A_k)_{ij}\right] &= \begin{cases} \beta & i=j, k=1 \\ 0 & \text{otherwise} \end{cases} \\
E\left[\alpha_i\right] &= \begin{bmatrix} 0 & 0 \end{bmatrix} && \forall i \\
V\left[(A_k)_{ij}\right] &= \begin{cases} \left(\frac{\lambda_1}{k^{\lambda_3}}\right)^2 & i=j \\ \left(\frac{\sigma_i \lambda_1 \lambda_2}{\sigma_j k^{\lambda_3}}\right)^2 & i \neq j \end{cases} \\
V\left[\alpha_i\right] &= \begin{bmatrix} (\sigma_i \lambda_4)^2 & 0 \\ 0 & (\sigma_i \lambda_4)^2 \end{bmatrix} && \forall i
\end{aligned}
$$

The prior distribution of the parameters is assumed to be normal. We set the hyperparameters $\begin{bmatrix} \beta & \lambda_1 & \lambda_2 & \lambda_3 & \lambda_4 \end{bmatrix} = \begin{bmatrix} 0.9 & 0.9 & 0.9 & 0.8 & 1.0 \end{bmatrix}$, and estimate each σ_i from the residuals of the OLS equations.

The prior distribution of the covariance matrix is assumed to be inverse Wishart.

References

Buckle, R A, K Kim, H Kirkham, N McLellan and J Sharma (2002), 'A structural VAR model of the New Zealand business cycle', New Zealand Treasury, *Treasury Working Paper Series* 02/26.

Buckle, R A, K Kim and N McLellan (2003), 'The impact of monetary policy on New Zealand business cycles and inflation variability', New Zealand Treasury, *Treasury Working Paper Series* 03/09.

Cashin, P, C J McDermott and A Scott (1999), 'The myth of co-moving commodity prices', Reserve Bank of New Zealand, *Reserve Bank of New Zealand Discussion Paper Series* G99/9.

Chen, Y-C and K Rogoff (2003), 'Commodity currencies', *Journal of International Economics*, Elsevier, vol. 60(1), pages 133-160.

Deaton, A and G Laroque (2003), 'A model of commodity prices after Sir Arthur Lewis', *Journal of Development Economics*, Elsevier, vol. 71(2), pages 289-310.

Faust, J (1998), 'Robustness of identified VAR conclusions about money', *Carnegie-Rochester Conference Series on Public Policy*, 49, pp 207-244.

Fry, R and A Pagan (2011), 'Sign restrictions in structural vector autoregressions: A critical review', *Journal of Economic Literature*, American Economic Association, vol. 49(4), pages 938-60.

Grimes, A (2006), 'A smooth ride: Terms of trade, volatility and GDP growth', *Journal of Asian Economics* 17, 583-600.

Haug, A A and C Smith (2007), 'Local linear impulse responses for a small open economy', Reserve Bank of New Zealand, *Reserve Bank of New Zealand Discussion Paper Series* 07/09.

Jääskelä, J and P Smith (2011), 'Terms of trade shocks: What are they and what do they do?', Reserve Bank of Australia, *Reserve Bank of Australia Research Discussion Paper* 2011-05.

Karagedikli, O and L A Thorsrud (2010), 'Shocked by the world: Introducing the three block open economy FAVAR', Reserve Bank of New Zealand, mimeo.

Kilian, L (2009), 'Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market', *American Economic Review*, American Economic Association, vol. 99(3), pages 1053-69.

Kim, K., 1994. 'The role of terms of trade shocks in a real business cycle model of a small open economy', Victoria University of Wellington, working paper.

Mumtaz, H and L Sunder-Plassman (2010), 'Time-varying dynamics of the real exchange rate. A structural VAR analysis', Bank of England, *Bank of England*

Working Paper No. 382.

Peersman, G (2005), 'What caused the early millennium slowdown? Evidence based on vector autoregressions', *Journal of Applied Econometrics*, vol. 20(2), pages 185-207.

Pyndyk, R S and J Rotemberg (1990), 'The excess co-movement of commodity prices', *Economic Journal*, vol. 100(403), pages 1173-89.

Uhlig, H (2005), 'What are the effects of monetary policy on output? Results from an agnostic identification procedure', *Journal of Monetary Economics*, 52(2a), pp 381-419.

Vansteenkiste, I (2009), 'How important are common factors in driving non-fuel commodity prices? A dynamic factor analysis', European Central Bank, *ECB Working Paper Series* No. 1072.

Vasishtha, G and P Maier (2011), 'The impact of the global business cycle on small open economies: A FAVAR approach for Canada', Bank of Canada, *Bank of Canada Working Paper Series* 2011-2.

Wells, G and L Evans (1985), 'The impact of traded good prices on the New Zealand economy', *The Economic Record* 61, 421-435.