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What happens when the Kiwi flies? The sectoral effects of the exchange rate shocks

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Keywords

JEL Classification

C22, C32, E21

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What happens when the Kiwi flies? The sectoral effects of the exchange rate shocks*

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1 Introduction

This paper is interested in answering the following questions: What happens to different sectors in the economy when the exchange rate appreciates or depreciates unexpectedly? Do some sectors respond more than the others? Are tradable and non-tradable sectors independent of each other in the face of such exchange rate changes? All these are important questions for a small open economy such as New Zealand.

Although there has been a large body of empirical literature on the identification and the effects of monetary policy shocks, there has been much less focus on the effects of exchange rate shocks. One reason for this is the exchange rate is typically believed to be a shock absorber - that is, it responds to other shocks. For example the exchange rate may fall in response to a decline in economic activity in the domestic economy or to a fall in commodity prices. However, others have argued that the exchange rate can also be an independent source of shock (Farrant and Peersman (2006), Mumtaz and Sunder-Plassmann (2010), Buiter (2000)). One could argue, for example, there may be an exogenous change in demand for the currency, unrelated to the economic cycle, such as those reflecting carry trades and/or portfolio reallocation decisions. Artis and Ehrmann (2006) find evidence for the "source of shock" view in the case of Sweden and Denmark, for example.

If indeed the exchange rate is a source of shock then the effects of such exchange rate shocks on the economy is an important question in an open economy such as New Zealand. Several papers have used the Structural VAR (SVAR) approach to identify the effects of exchange rate shocks on the New Zealand economy. Buckle et al. (2007) find that New Zealand dollar exchange rate shocks do not contribute significantly to deviations in GDP from trend. Whilst, Haug and Smith (2007) show that positive real exchange rate shocks (and associated monetary policy responses) result in a fall in domestic output and inflation. However these studies do not look at how the effects of these exchange rate shocks may differ across the different production sectors of the economy.

In the international context, Hahn (2007) investigates how exchange rate shocks affect sectoral activity and prices in the euro zone. Hahn (2007) uses 5 variable SVARs, identified using Cholesky decompositions, ordering the variables in the following order: exchange rate, aggregate GDP, CPI, sector GDP, short term interest rate. The problem with this approach, however, is that the exchange rate shocks used to assess the impact on each sector will be obtained from different models, implying that exchange rate shocks might well be of different sizes and signs in different models. Further, as is typical in VAR studies, Hahn (2007) uses a small number of variables meaning exchange rate movements are typically not well explained, implying that exchange rate shocks will tend to be larger in magnitude.

To address the above concerns this paper estimates a factor augmented vector autoregression (FAVAR) model for the New Zealand economy to identify common 'unanticipated' exchange rate shocks and to assess the transmission of these common shocks to the different sectors in the economy. The FAVAR approach is suited to examining the exchange rate, as it allows the exchange rate to respond to a large number of New Zealand and international variables (over 300 in our case) rather than, say, four or five as in a traditional VAR model such as those estimated by Hahn (2007).

We have two main findings in our study: First, exchange rate shocks have a significant and negative impact on the tradable sectors of the economy. We find that the manufacturing

sector is the most adversely affected by exchange rate shocks, which the agricultural sector is not affected to a large extent by such shocks. The latter is consistent with earlier research by Buckle et al. (2007) showing that developments in New Zealand's pastoral sector tend to be driven by climatic shocks over the short term. Second, an exchange rate shock also has significant effects on the non-tradable sector. We provide a possible explanation that focuses on the relationship between New Zealand's relative business cycle, migration dynamics, housing and the broader economy. The finding that the exchange rate may affect the non-tradable sector suggests that the assumption common in some models (see Swan (1955) and Salter (1959)) that the exchange rate does not affect the non-tradable sector may be overly simplistic.

The remainder of the paper is structured as follows: Section 2 introduces the empirical framework, and discusses estimation and identification, section 3 presents and discusses the results, and section 4 concludes.

2 Empirical Framework: Model, Estimation and Identification

The VAR approach to measuring the effects of different shocks has produced a lot of useful information on the structural questions researchers and policymakers have in mind. But one of the major criticisms of the VAR approach to identification of shocks is the low dimensionality of the information sets used in VARs. Most small open economy VARs are based only on around a handful of variables. However, central banks consider a much larger information set (in the case of identification of monetary policy shocks) when setting policy rates. Exchange rates are similar: market participants look at large number of variables from both domestic and foreign economies as well as more global variables, such as risk measures, uncertainty and commodity prices.

A related criticism of the use of such limited information VARs, is that researchers and policymakers can only observe the effects of the shocks on the same limited number of variables. Instead, researchers and policymakers may want to see the effects of the shocks on a number of different variables. We use a factor augmented vectorautoregression (FAVAR) approach to analyse the effects of exchange rate shocks. The FAVAR approach combines the traditional SVAR approach with estimated unobserved factors stemming from the more recent dynamic factor literature. The recent dynamic factor model literature argues that a large number of series can be summarised by a small number of factors, which helps overcome the criticism discussed above. The factor approach helps in reduction of dimensionality with large data sets.

Our FAVAR uses the general setup of Bernanke et al. (2005). Since the factors we estimate are unobserved and have to be inferred from the data, the model can naturally be represented in a state space form in the following way:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \beta(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + u_t, \tag{1}$$

where F_t is a set of unobserved factors, and Y_ts are observed variables, the domestic interest rate and the exchange rate in our case. $\beta(L)$ is a conformable lag polynomial of order p and u_t is the reduced form residuals. The relation between the reduced form and structural disturbances follow $u_t = \Omega^{1/2}\varepsilon_t$, with $\varepsilon \sim N(0,1)$ and $\Omega = (A_0^{-1})(A_0^{-1})'$. The observation

equation of the system is:

$$X_t = \Lambda^F F_t + \Lambda^Y Y_t + e_t, \tag{2}$$

where X_t is a N x 1 vector of observables other than the exchange rate and interest rate, Λ^F and Λ^Y are N x K and N x 1 matrixes of factor loadings.[1] Finally e_t is a N x 1 vector of idiosyncratic, zero mean, disturbances.

The large dataset, X_t, contains both domestic and international variables that are of importance in the determination of exchange rates. Like monetary policy settings, the exchange rate responds to all the different data announcements that come out in a given quarter in New Zealand and also from the rest of the world. We argue that the common factors we estimate will capture relative differences in these domestic and the foreign variables.

For the identification of the shocks in the VAR, we use a Cholesky identification scheme and order the factors and the interest rate above the exchange rate. The ordering of interest rates before the exchange rates assumes that the exchange rate responds to the current quarter movements in interest rate but not vice versa.

To identify exchange rate (and also the interest rate shocks), and justify the ordering of the variables described above, we need to ensure that the factors extracted from the X matrix do not include any variable that in theory will react contemporaneously with the exchange rate. For example, the yield curve variables, domestic currency tradable inflation variables and some expectation variables might be responding to the current quarter movements in the exchange rate. This would violate the ordering assumption in the VAR. To address this, we rotate the fast moving variables against both the interest rate and the exchange rate. The rotation essentially takes the contemporaneous effects of the exchange rate and interest rate out of the factors. Once the factors become free of these current quarter responses, we can order them above interest rate and exchange rate.

Following the procedure of Bernanke et al. (2005), we follow the following steps:

1. Extracting the principal components, F^0, from the entire standardised dataset X (see the appendix for details about the standardisation).
2. Extracting principal components, F^s, from the slow-moving variables.
3. Regressing F^0 on F^s interest rate and exchange rate and removing the impact of interest rate and exchange rate from F^0 to obtain F^n.
4. Regressing X on F^n, interest rate and exchange rate to obtain the loadings λ_X and λ_{er}.
5. Estimating a VAR using F^n, the interest rate and exchange rate and calculating the impulse responses of the factors in response to an exchange rate shock.
6. Using the loadings from (4) and the impulse responses from (5) to calculate the impulses for all variables.
7. Bootstrapping to obtain confidence intervals.

One important question in the use of principal component of course is the number of the principal components to include. Statistical tests such as that of Bai and Ng (2002) provide criteria to determine the number of factors present in the dataset X. However,

[1] Λ^Y would be N x 2 in specifications where there are two observables, exchange rate and interest rates.

as Bernanke et al. (2005) argue, this criterion does not address the question of how many factors to include in the VAR in order to identify the shock that we are interested in. We estimate models with three, four and five factors and present all the results. However, we should caution that our sample size is rather limited on the time series dimension (1994Q3 to 2011Q2), which implies that the model may suffer from degrees of freedom issues when an additional factor (variable) is added to the VAR. [2]

3 Results

In this section, we present the results from our estimations. In section 3.1, we show the estimated principal components. In sections 3.2 to 3.5, we present impulse responses to a one per cent shock to the exchange rate. In subsection 3.6 we present the forecast error variance decompositions the historical decomposition.

3.1 Factors

Figure 1 shows the estimated principal components. We take an agnostic position about the factors and do not give them specific economic interpretation by grouping them into activity, prices or similar groupings.[3] We find that the first principal component is highly correlated with expectations of domestic activity from the QSBO survey (trading activity and profitability) and has a 0.70 correlation with real production GDP. The second principal component is highly correlated with domestic inflation expectations (0.71 and 0.77 with 1 and 2 year ahead CPI inflation expectations from the RBNZ survey of expectations). Additionally, it has a correlation of 0.6 or higher with the Producer Price Index input aggregate series and some sub-components of this series namely manufacturing; construction; transport, postal, and warehousing inputs; rental, hiring, and real estate services; rental, hiring, and real estate services; and arts, recreation, and other services. Therefore, this principal component may capture price developments.

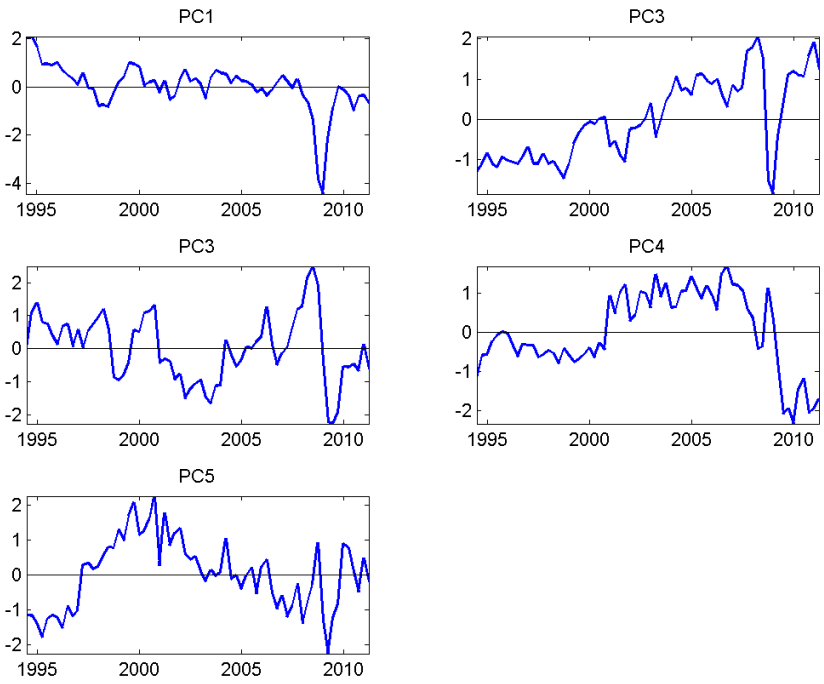
The third principal component, seems to reflect international financial and monetary conditions as it is highly correlated (above 0.5) with short term interest rates in the major western economies (Australia, US, UK, Canada and Japan, most of which make up the Trade Weighted Index that we use in our study as a measure of the exchange rate), as well as import prices of goods series (0.6). The fourth principal component seems to reflect labour market conditions in the domestic economy. It has a correlation coefficient of 0.82 with the unemployment rate, as well as being highly correlated with measures of capacity utilisation and the difficulty in finding labour. Finally, the fifth principal component appears to be more closely related to various countries' effective exchange rates. Overall, these five factors explain around 49 per cent of the total variation in the data.

It is also informative to examine what proportion of variance in some key data is explained by the estimated factors. Table 1 shows the estimated $R - squared$ values for some of the variables that we include in our X matrix. For the quarterly growth rate of the components of the production GDP, the factors explain as little as 3 per cent of the variation (in the

[2] We also estimate the model with only one observed variable and the exchange rate in the model and find very similar results. Those results are available upon request.

[3] Some studies (Mumtaz and Surico (2009)) pool the factors, for example, as they want to identify certain specific shocks. We have some preliminary results from such loose groupings which yielded very similar results for the exchange rate shock.

Figure 1: Estimated Principal Components



case of the agriculture sectors) to as much as 47 per cent (retail trade). The factors explain a high proportion of the variance for the following sectors: metal product manufacturing (42 per cent), transport equipment, machinery and equipment manufacturing (37 per cent), transport, postal and warehousing (32 per cent), petroleum, chemical, polymer and robber product manufacturing (27 per cent), non-metallic mineral product manufacturing (27 per cent) and construction (25 per cent) sectors. Sectors whose output is driven more by idiosyncratic drivers are agriculture (3 per cent), mining (4 per cent), electricity, gas, water and waste services (1 per cent), textile, leather, clothing and footwear manufacturing (4 per cent). Overall factors explain around 62 per cent of overall production-based real GDP.

Strong explanatory power of factors can also be observed for the components of the expenditure GDP. About 39 per cent of variance of private consumption is explained by the factors and 28 per cent in the case of investment. The factors have poor explanatory power for exports of goods, consistent with the findings for the agriculture sector mentioned above, which has been shown to be more driven by climatic conditions (Buckle et al. (2007)). About 16 per cent of variance of exports of services can be explained by the factors, while both goods and services imports are explained reasonably well (20 and 28 per cent, respectively). Interestingly, permanent and long term arrivals are mainly idiosyncratic, while the permanent and long term departures have a large common driver from these factors (27 per cent). The factors can also explain a large fraction of house price movements in New Zealand.

The factors also do a decent job in explaining some of the international variables we have in our model, including foreign GDP, where they explain between 32 per cent (in China)

and 62 per cent (Canada) of the variation.[4]

Table 1: R-squared of Factors for Selected Variables

Variable	3F	4F	5F
GDP,Agriculture	0.02	0.02	0.03
GDP,Forestry and Logging	0.07	0.09	0.09
GDP,Fishing, Aquaculture and Agriculture, Forestry and Fishing Support Services	0.05	0.06	0.06
GDP,Mining	0.01	0.01	0.02
GDP,Food, Beverage and Tobacco Product Manufacturing	0.15	0.15	0.15
GDP,Textile, Leather, Clothing and Footwear Manufacturing	0.04	0.04	0.04
GDP,Wood and Paper Products Manufacturing	0.16	0.17	0.17
GDP,Printing	0.12	0.12	0.13
GDP,Petroleum, Chemical, Polymer and Rubber Product Manufacturing	0.07	0.09	0.09
GDP,Non-Metallic Mineral Product Manufacturing	0.24	0.25	0.27
GDP,Metal Product Manufacturing	0.36	0.39	0.42
GDP,Transport Equipment, Machinery and Equipment Manufacturing	0.32	0.35	0.37
GDP,Furniture and Other Manufacturing	0.14	0.13	0.16
GDP,Electricity, Gas, Water and Waste Services	0.00	0.01	0.01
GDP,Construction	0.20	0.25	0.25
GDP,Wholesale Trade	0.06	0.07	0.08
GDP,Retail Trade	0.43	0.45	0.46
GDP,Accommodation and Food Services	0.08	0.08	0.08
GDP,Transport, Postal and Warehousing	0.30	0.30	0.32
GDP,Information Media and Telecommunications	0.09	0.09	0.10
GDP,Financial and Insurance Services	0.11	0.30	0.35
GDP,Rental, Hiring and Real Estate Services	0.22	0.28	0.28
GDP,Professional, Scientific and Technical Services	0.04	0.06	0.06
GDP,Administrative and Support Services	0.11	0.12	0.13
GDP,Local Government Administration	0.08	0.21	0.33
GDP,Central Government Administration, Defence and Public Safety	0.02	0.12	0.12
GDP,Education and Training	0.12	0.12	0.16
GDP,Health Care and Social Assistance	0.12	0.13	0.13
GDP,Arts and Recreation Services	0.09	0.09	0.11
GDP,Other Services	0.16	0.17	0.19
FTE Total All Industries	0.15	0.18	0.21
Wage Total All Industries	0.13	0.25	0.28
Private Consumption	0.34	0.37	0.39
Government Consumption	0.02	0.02	0.02
Private Investment	0.30	0.32	0.32
Government Investment	0.00	0.01	0.01
Total Investment	0.25	0.28	0.28
Imports of Goods	0.20	0.20	0.20
Imports of Services	0.26	0.26	0.28
Total Imports	0.28	0.28	0.28
Exports of Goods	0.03	0.03	0.04
Exports of Services	0.07	0.08	0.16
Total Exports	0.07	0.07	0.11
Real Production GDP	0.58	0.61	0.62
Perm & long-term migration - arrivals s.a.	0.01	0.01	0.02
Perm & long-term migration - departures s.a.	0.23	0.27	0.27
HPI Total NZ (for houses)	0.43	0.60	0.74
Australia: Gross Domestic Product (SA, Mil.Chn.Q3:09-Q2:10.A$)	0.13	0.14	0.16
EA 17: Gross Domestic Product (SA/WDA, Mil.Chn.2005.Euros)	0.42	0.43	0.52
Canada: Gross Domestic Product (SAAR, Mil.Chn.2002.C$)	0.41	0.44	0.61
Japan: Gross Domestic Product (SAAR, Bil.Chn.2005.Yen)	0.43	0.43	0.45
U.K.: Gross Domestic Product (SA, Mil.Chained.2008.Pounds)	0.55	0.56	0.58
U.S.: Gross Domestic Product (SAAR, Bil.Chn.2005$)	0.40	0.42	0.45

[4]The full version of the Table 1 is available upon request.

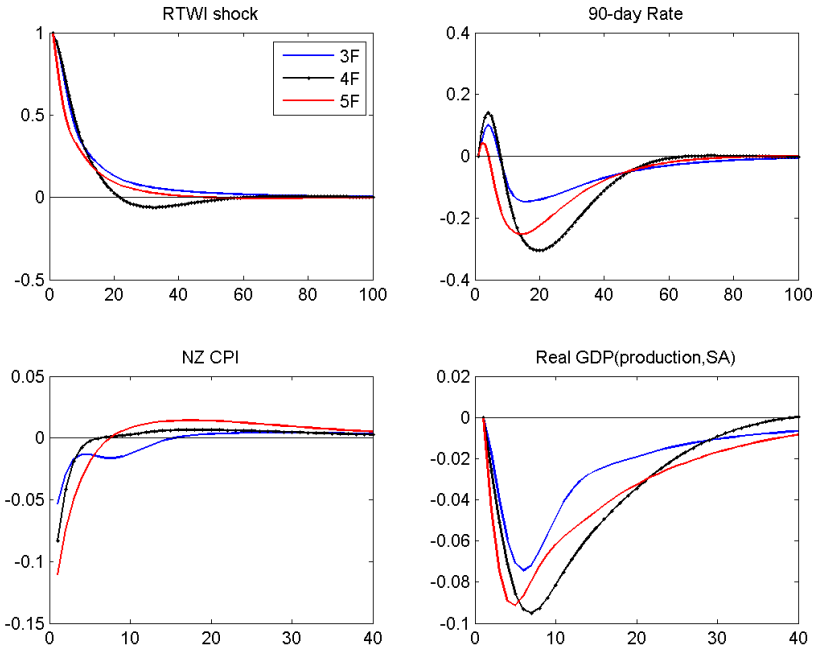
Table 1: R-squared of Factors for Selected Variables

Variable	3F	4F	5F
China: Gross Domestic Product (SA, Bil.2000.Yuan)	0.16	0.17	0.32

3.2 Impulse Responses

We begin by examining the impact of a one per cent shock to the nominal exchange rate (RTWI) on output, inflation and the interest rate when using different numbers of factors (figure 2). All the models yield very similar results. In response to an unexpected positive exchange rate shock (appreciation), we see a fall in inflation partly reflecting the falling tradable prices. Although the fall in inflation would have a positive real income effect, the negative effect of the exchange rate appreciation on activity dominates the positive income effect, and as a result output declines. This decline in activity leads to the fall in non-tradable prices. In response to the fall in both output and inflation the interest rates fall as well. Next, we turn to looking at the impact of the exchange rate shock on different production sectors.

Figure 2: Main Macro Variables



3.3 GDP Components in Volumes

Manufacturing Sector

Figures 3-5 show the impulse responses at sectoral level and Table 3 in the appendix shows the peak responses and level of significance for different sectors and macro variables. All manufacturing sub-sectors respond negatively to a positive exchange rate shock. The peak

impact occurs between five to seven quarters, depending on the sub-sector. Further, the peak and the total impact are larger than in the agriculture and mining sectors (discussed below). The largest effect in the sub-components of the manufacturing category is observed in non-metallic mineral product manufacturing, with a peak impact of around 0.3 per cent. Printing; and textile, leather, clothing and footwear manufacturing also experience significant falls of around 0.2 per cent falls in activity. Producers in these sectors tend to be less differentiated or may have to compete against imported products, which may make it more difficult to compete against them when the exchange rate favours imported products.

Agriculture and Mining Sector

The aggregate fishing, aquaculture and agriculture, forestry and fishing support services sector shows a decline in volumes in response to an exchange rate shock. The fall is larger in models with four and five factors at around 0.1 per cent. Further, the effect is much more persistent and only returns back to zero towards after about 30 quarters. The mining sector experiences a slow fall in volumes, with the peak impact occuring three to four quarters after the initial shock, and it returns back to zero quickly thereafter. Although the impact is very small and insignificant, the agriculture subsector shows a slight increase in volumes in response to a one per cent exchange rate shock (appreciation), which peaks four quarters after the shock.

Figure 3: Sectoral Output

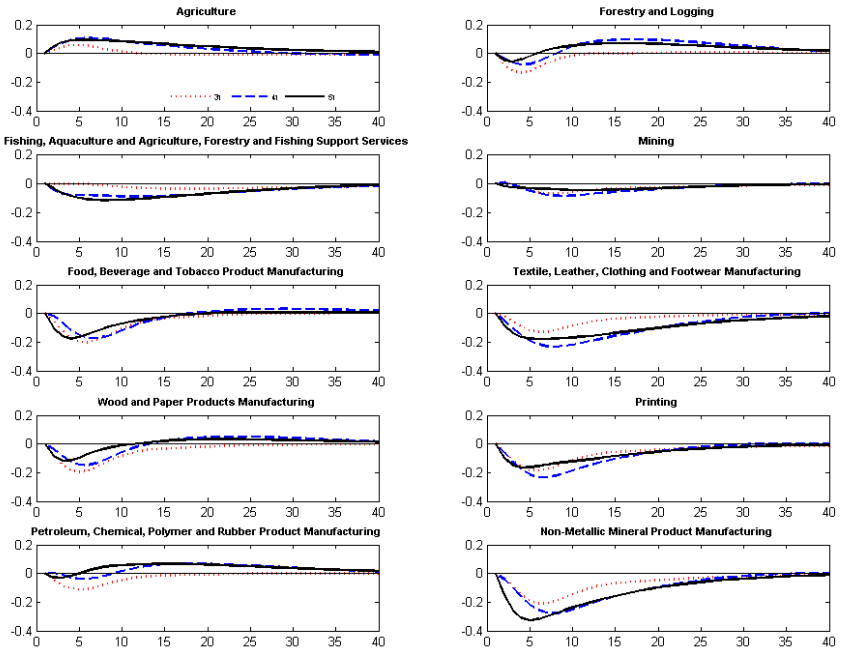


Figure 4: Sectoral Output

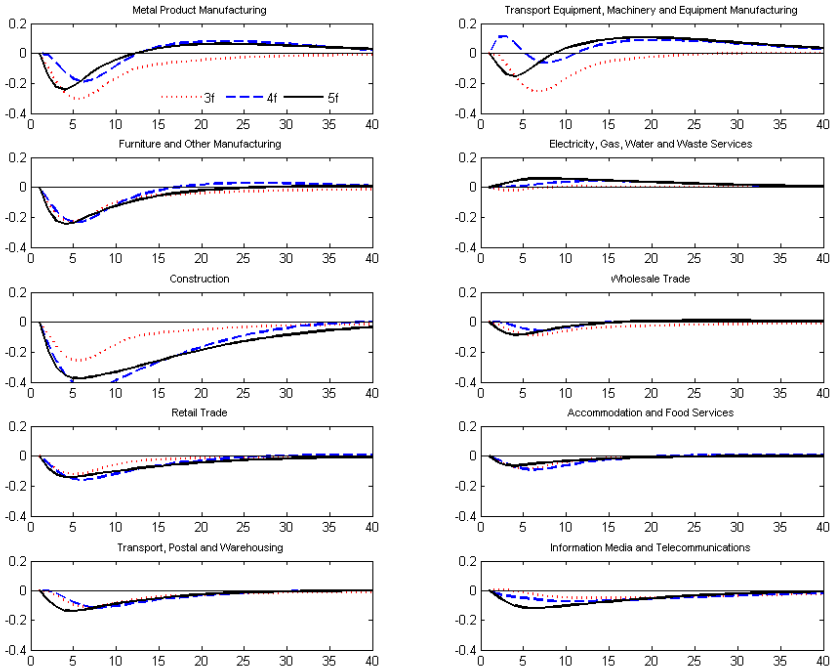
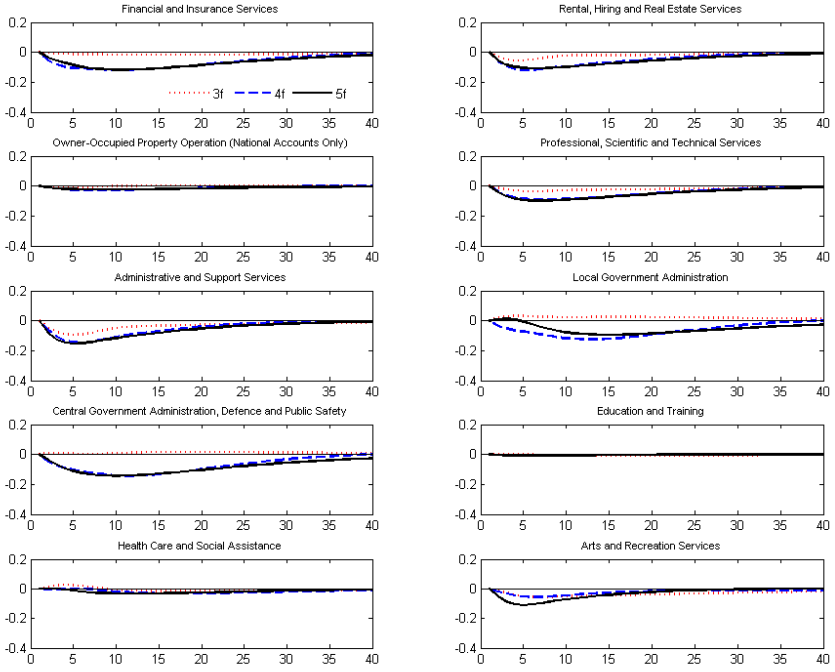


Figure 5: Sectoral Output



Local Government, Government, Education and Health

We observe some positive, albeit very small, responses in local and central government output. Central government expenditure in particular might increase to stimulate the economy as the exchange rate starts affecting demand. However, these responses are largely not statistically significant.

Wholesale and Retail Trade

Figure 4 shows that both the wholesale and the retail trade fall in response to an unexpected exchange rate appreciation. The fall in volumes in these sectors reflects the reduction in demand in the economy. Nonetheless, the decline is smaller than the fall in the manufacturing sector, which is the most adversely affected. This is because both sectors includes some imported content, so exchange rate appreciation would lead to some expenditure switching from domestically produced goods to foreign produced goods.

Utilities and Transport

The results for electricity, gas, water and waste services are sensitive to the number of factors in the estimation. In the three factor model, one observes a slight fall in value added, while the other models lead to a very small increase. Transport, postal and warehousing services also show a fall in output reflecting the slow down in domestic activity.

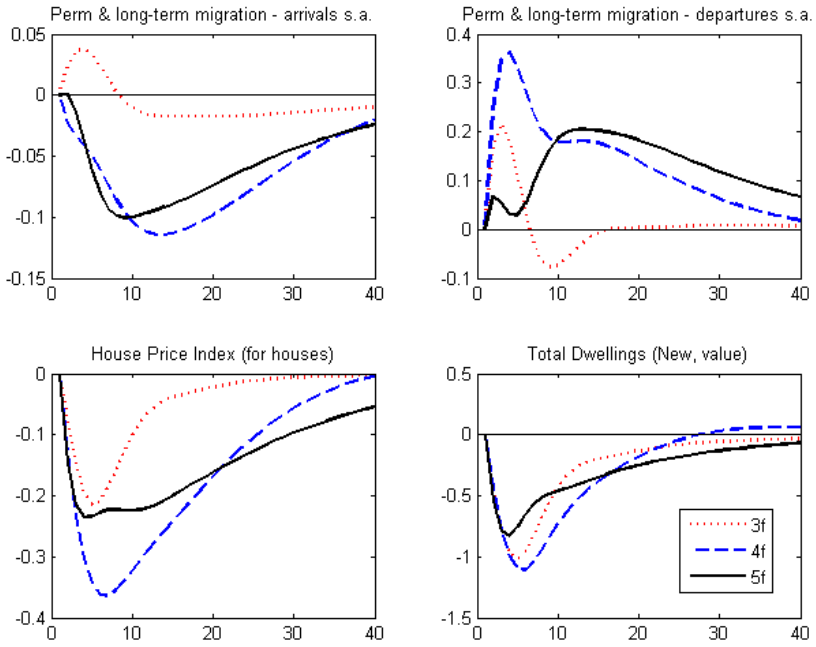
Construction

The results show that the activity in construction sector declines in response to an exchange rate appreciation. Although this may seem surprising at first, the model allows us to identify a potential transmission mechanism behind it (see Figure 6). We describe the transmission to the construction sector as follows. An unexpected appreciation (depreciation) of the exchange rate leads to a deterioration (improvement) in the relative prospects of the economy. Weaker (stronger) employment prospects see permanent and long term departures increase (decrease) significantly. This is consistent with departures data, in particular the departures to Australia (which are the largest proportion of total departures) being very sensitive to the relative business cycles between the two economies (**?**). At the same time, permanent and long term arrivals show some decline although this is smaller than that of departures. Therefore, net permanent and long term migration falls in response to the exchange rate shock. This change in the population dynamics of the economy leads to a fall in house prices, as well as many of the forward looking confidence measures of the domestic economy. As a result, the construction sector and some other non-tradable sectors are adversely affected.

The endogenous and cyclical nature of migration has been a long established fact that dates back to the 1980s (Brosnan and Poot (1987)). Net permanent and long term migration between the two countries is correlated with relative business cycles and labour markets between New Zealand and Australia. Since net migration accounts for a large proportion of population growth, the endogenous nature of net migration leads to changes in population growth. Hence this would affect the economy in a different way than in a model where the population dynamics do not respond to shocks. While the endogenous nature of net

migration is widely cited in New Zealand, to our knowledge, it has not been documented as an endogenous transmission mechanism in a macroeconomic model. We believe this channel deserves further attention in the face of other shocks.

Figure 6: Net Migration and Housing Market



Services

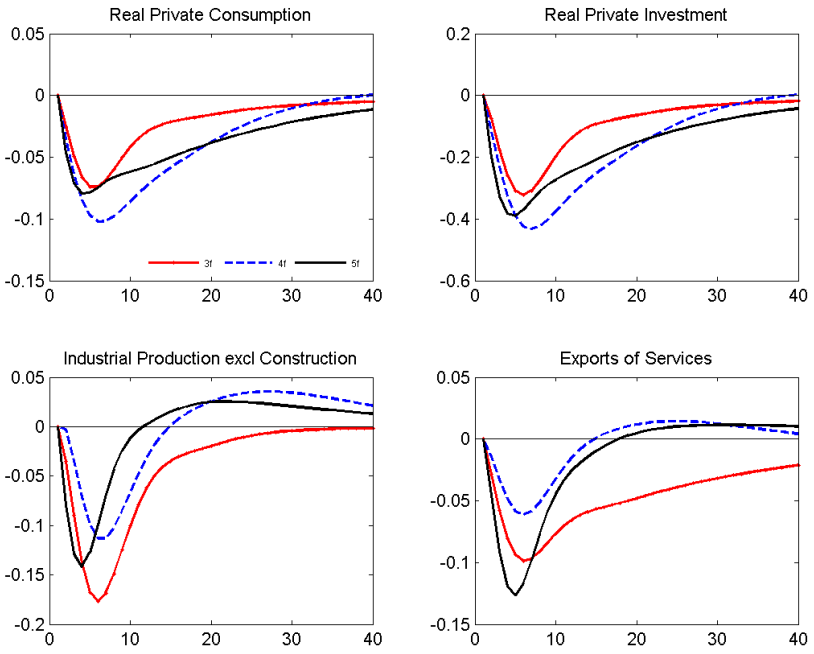
Significant declines in activity are observed in the accommodation and food, administrative and support services; and the rental hiring and real estate services sectors following an exchange rate shock. However, even the largest decline still has a peak impact that is less than 0.1 per cent. Given the importance of the tourism sector to the accommodation services sector, the fall in this sector may reflect the impact of foreign tourists who might delay or reduce their holiday/spending in the face of a more expensive New Zealand dollar. Moreover, domestic consumers might also choose to switch to an overseas holiday instead of a domestic one, resulting in further decline in output in this sector. A fall in population due to migration, as we outlined above, would mean less demand for housing/rentals reducing the output of the rental hiring and real estate services sector.

3.4 GDP Components - Consumption and Investment

Figure 7 shows the impulse responses of some components of the expenditure GDP. Both private consumption and private investment fall in response to the exchange rate shock. But private consumption falls by a very small amount compared to private investment – this reflects the relatively higher import component of private consumption. The fall in consumption is consistent with the fall in output and house prices, which are important drivers of consumption. De Veirman and Dunstan (2011), for example, show a significant

link from house prices to consumption in New Zealand. The fall in private investment is also consistent with the fall in construction sector output and house prices, as well the fall in aggregate demand.

Figure 7: Expenditure GDP Components



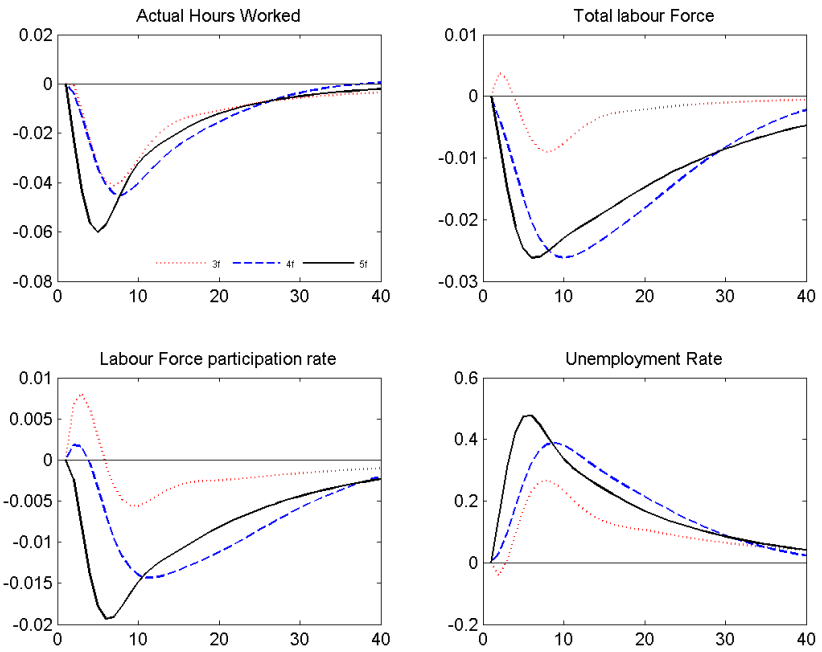
3.5 Labour Markets

Figure 8 shows the impulse responses of some labour market indicators. The seasonally adjusted unemployment rate increases in all models in response to the exchange rate shock. The peak impact ranges between 0.2 and 0.5 percent, depending on the number of factors used. The peak effect unemployment occurs after five to eight quarters, depending on the model, which is consistent with the notion that the unemployment rate is a lagging indicator of activity. Actual hours worked, total labour force and labour force participation rates all fall in response to the shock. Figure 9 also reveals interesting results about employment at a disaggregated level. Most of these employment results are consistent with the output responses of the same sectors. Manufacturing, forestry and mining, retail trade and construction all experience a fall in employment. Employment in some non-tradable sectors such as education and training, health care and social assistance are not sensitive to the exchange rate shock, however.

3.6 Variance and Historical Decompositions

The VAR framework can be used to answer the question of whether the exchange rate plays a shock absorber role in an economy(Farrant and Peersman (2006), Mumtaz and Sunder-Plassmann (2010)). One way of answering this question is to look at the forecast error variance decompositions. Forecast error decompositions seek to identify the proportion of

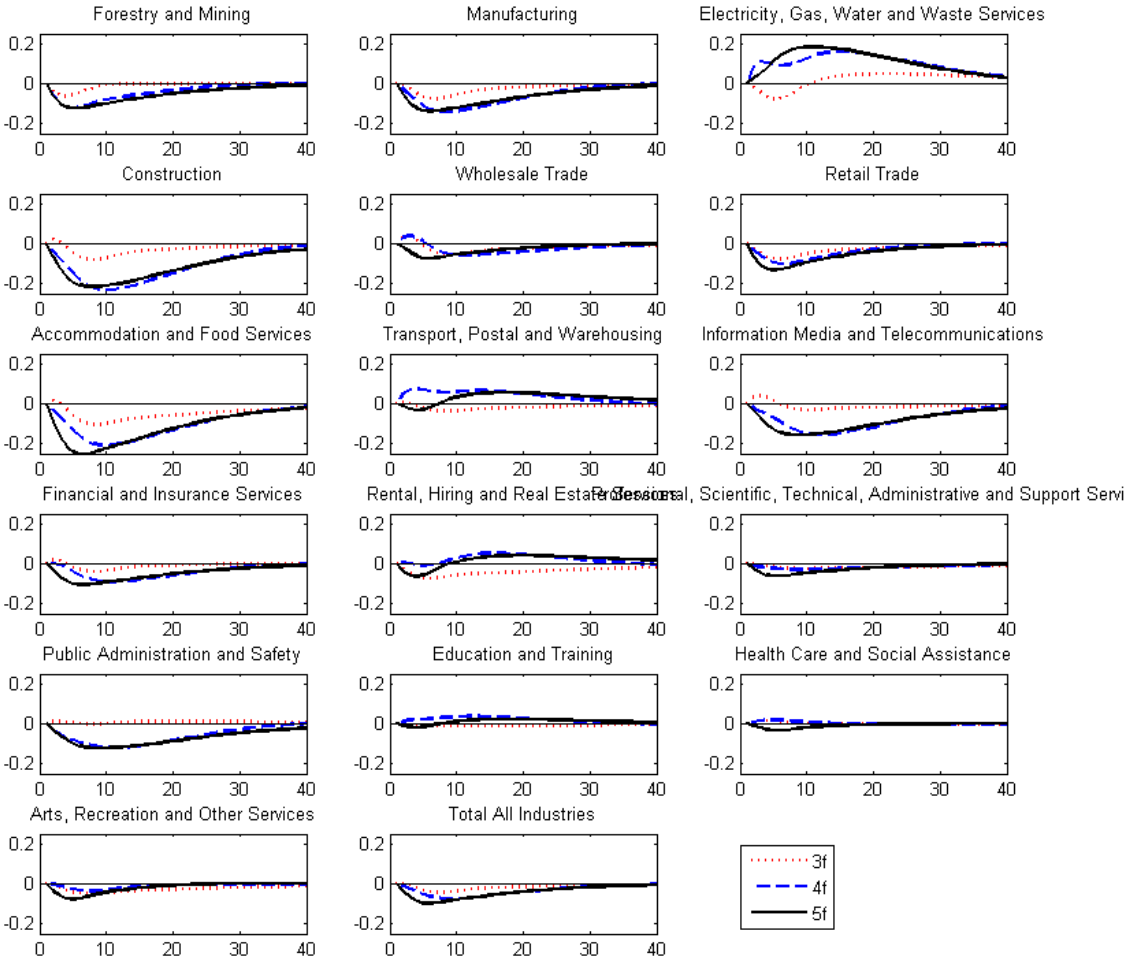
Figure 8: Labour Markets



forecasting error of a variable at a particular horizon that is due to a particular shock; in our case, the factors, the interest rate and the exchange rate itself. Table 2 below presents the percentage of forecast error variances that is due to exchange rate shocks, at different horizons for the models with three, four and five factors respectively. In the very short term forecast errors in the exchange rate are mainly explained by shocks to the exchange itself; with the forecast error variance decreasing from 46 per cent to 34 per cent as we increase the number of factors in the model. At longer horizons, the forecast error due to exchange rate shocks declines to between 9 and 23 per cent. In other words, at the 40 quarter horizon between 9 to 23 per cent of the exchange rate forecast errors are due to the shocks to the exchange rate while between 77 to 91 per cent of forecast error variance is due to the other shocks.

By looking at the Table 2 one may be tempted to conclude that without own exchange rate shocks the exchange rate would have been slightly different over the sample, but not significantly different. In other words economic drivers explain the largest part of the movement in the exchange rate. However we caution such an explanation. This is because any speculative behaviour on behalf of FX markets that is correlated with any variables in our X dataset and therefore factors is not captured as an exchange rate shock but as explained by the factors. To use an example, take speculative search for yield – this will be correlated with domestic and international interest rates in our dataset and therefore factors. Therefore movements in the exchange rate owing to yield search will be (partly) explained by the factors (and anything that is explained by the factors we term as an economic driver) and will not show up completely as an exchange rate shock in our forecast error decomposition. Hence our estimates of the role non-economic drivers explaining the exchange rate (as represented by the estimated own exchange rate shocks) represent the minimum estimate.

Figure 9: Sectoral Employment



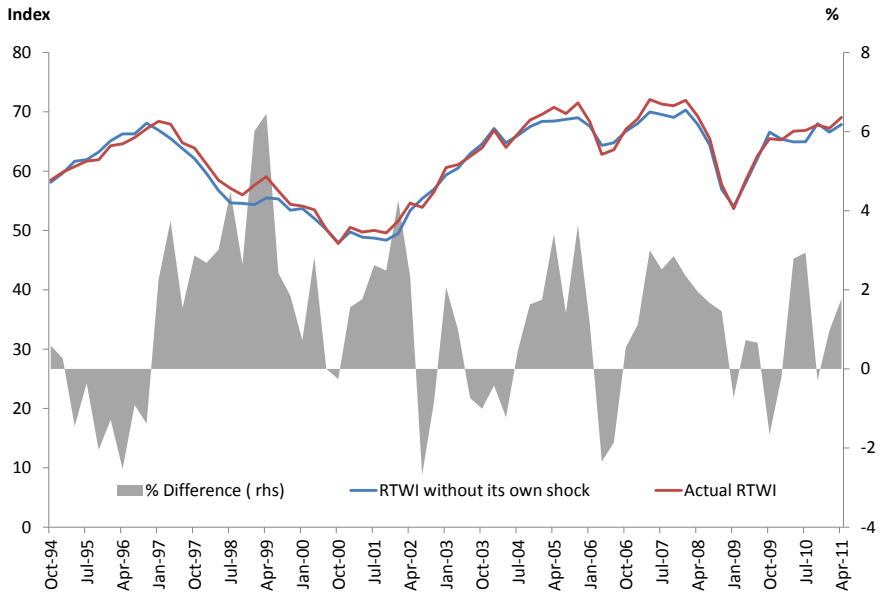
Finally we estimate a"standard" VAR with the exchange rate, interest rate, GDP and the CPI and found the proportion of the exchange rate shock in the variance decomposition is 92 per cent and 56 per cent at 1 and 40 quarters respectively; this compares with 34 per cent and 9 per cent in the FAVAR with 5 factors. We believe this is due to the fact that the enlarged information set we use is significantly closer to the information set that the markets use in determining the exchange rate. This can also be seen from the Table 2 where the additional use of information (i.e. more number of factors) changes the results in favour of the shock absorber story further. However, as we discussed above, this additional information may well include non-fundamental/economic related reaction on behalf of the FX markets and hence our results may well represent the minimum of the source of shock role for the New Zealand dollar.

Table 2: Forecast Error Variance Decomposition

Horizon	3 Factors	4 Factors	5 Factors
1	46	38	34
10	25	23	10
20	24	21	9
40	23	20	9

The historical decomposition of the exchange rate tells the same story developed in the previous section. Figure 10 shows the results obtained from the five-factor model and indicates that without own exchange rate shocks, the exchange rate would have been slightly different over the sample, but not significantly different. Said differently, observed variables explain the largest part of the movement in the exchange rate, under this model. Although we reiterate our caution about the limitations of our approach in detecting non-economic drivers of the exchange rate.

Figure 10: Historical Decomposition



4 Conclusions

In this paper, we estimated a factor augmented vector autoregression (FAVAR) to identify exchange rate shocks and assessed the transmission of these shocks to the economy at the sectoral level. We have two major findings in our paper. First, exchange rate shocks have a significant and negative impact on the tradable sectors of the economy. The manufacturing sector is the most adversely affected by exchange rate shocks. We find that the agricultural sector is not affected to a large extent by such shocks, which is consistent with earlier research Buckle et al. (2007) showing that developments in New Zealand's pastoral sector tend to be driven by climatic shocks over the short term. Second, an exchange rate shock also has significant effects on the non-tradable sectors as well. We provided a possible explanation and evidence that focuses on the relationship between New Zealand's relative business cycle, migration dynamics, housing and the broader economy. Although we find significant role for shock absorber nature for the New Zealand dollar exchange rate, we believe however, our model does not adequately capture the speculative or non-rational behaviour to be adequately answer this question.

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5 Appendix

5.1 Data and Transformation

We use data from various sources. New Zealand data is sourced mainly from Statistics New Zealand and the Reserve Bank of New Zealand, whilst international data from the respective national statistics agencies. Most of the data is retrieved using HAVER. Table 3 in the appendix lists all the data used in the estimation as well as the transformation applied to each raw data. Prior to the estimation, all variables are demeaned and standardised. We use quarterly data covering the period 1994Q3 to 2011Q2. The sample is mainly imposed by New Zealand data availability.

There are 194 domestic variables and 110 international variables. We have heavily weighted the dataset towards New Zealand variables for two reasons. One, given our research question is to look at the sectoral impacts of the exchange rate, we include a lot of disaggregated sectoral GDP components from production GDP to examine how the exchange rate impact varies across them; further we include, amongst other things, commodity price, labour market and survey data, as well as a range of financial variables, to understand the channels through which the exchange rate shock transmits to these sectors.

Our international data is composed of data from the US and major world economies - namely Australia, Canada, China, Japan, the UK and aggregated measures for the seventeen countries of the Euro area. This dataset covers a broad range of macroeconomic and financial variables for these countries: GDP, industrial production, unemployment, interest rates, inflation, stock prices and exchange rates for example.

We use the nominal trade weighted exchange rate as our exchange rate of choice. The trade weighted index is the nominal exchange rates of our major trading partners – US, Japan, Australia, the UK and the Euro countries, weighted 50/50 by New Zealand's trade with these countries and these countries nominal GDPs (in US dollars). We chose the trade weighted index rather than a specific cross rate because, as Fabling and Sanderson (2013) show, New Zealand exporters invoice in a variety of currencies – in particular, the

New Zealand, US and the Australian dollar. We use the nominal exchange rather than the real exchange rate as much of the policy debate has been centred on the level of the nominal exchange rate (for example, Wheeler, 2013); the key results are robust to using the real exchange rate however.

Column three shows the transformations used (1 for no transformation, 2 for first difference, 4 for natural logarithm, 5 for first difference of natural logarithm). Asterisk in the series label denotes slow moving variables.

Table 3: Data

Variable number	Mnenomics	Transformation	Description
1	X101	5	Gross domestic product: Agriculture (SA, Chained vol.1995/6, ANZSIC06 sector classification).
2	X102	5	Gross domestic product: Forestry and Logging (SA, Chained vol.1995/6, ANZSIC06 sector classification).
3	X103	5	Gross domestic product: Fishing, Aquaculture and Agriculture, Forestry and Fishing Support Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
4	X104	5	Gross domestic product: Mining (SA, Chained vol.1995/6, ANZSIC96 sector classification).
5	X105	5	Gross domestic product: Food, Beverage and Tobacco Product Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
6	X106	5	Gross domestic product: Textile, Leather, Clothing and Footwear Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
7	X107	5	Gross domestic product: Wood and Paper Products Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
8	X108	5	Gross domestic product: Printing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
9	X109	5	Gross domestic product: Petroleum, Chemical, Polymer and Rubber Product Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
10	X110	5	Gross domestic product: Non-Metallic Mineral Product Manufacturing (SA, Chained vol.1995/6, ANZSIC96 sector classification).
11	X111	5	Gross domestic product: Metal Product Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
12	X112	5	Gross domestic product: Transport Equipment, Machinery and Equipment Manufacturing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
13	X113	5	Gross domestic product: Furniture and Other Manufacturing (SA, Chained vol.1995/6, ANZSIC96 sector classification).
14	X114	5	Gross domestic product: Electricity, Gas, Water and Waste Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
15	X115	5	Gross domestic product: Construction (SA, Chained vol.1995/6, ANZSIC06 sector classification).
16	X116	5	Gross domestic product: Wholesale trade (SA, Chained vol.1995/6, ANZSIC06 sector classification).
17	X117	5	Gross domestic product: Retail Trade and Accommodation (SA, Chained vol.1995/6, ANZSIC06 sector classification).
18	X118	5	Gross domestic product: Accommodation and Food Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
19	X119	5	Gross domestic product: Transport, Postal and Warehousing (SA, Chained vol.1995/6, ANZSIC06 sector classification).
20	X120	5	Gross domestic product: Information Media and Telecommunications (SA, Chained vol.1995/6, ANZSIC06 sector classification).

Table 3: Data

Variable number	Mnenomics	Transformation	Description
21	X121	5	Gross domestic product: Financial and Insurance Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
22	X122	5	Gross domestic product: Rental, Hiring and Real Estate Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
23	X123	5	Gross domestic product: Owner-Occupied Property Operation (SA, Chained vol.1995/6, ANZSIC06 sector classification).
24	X124	5	Gross domestic product: Professional, Scientific and Technical Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
25	X125	5	Gross domestic product: Administrative and Support Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
26	X126	5	Gross domestic product: Local Government Administration (SA, Chained vol.1995/6, ANZSIC06 sector classification).
27	X127	5	Gross domestic product: Central Government Administration, Defence and Public Safety (SA, Chained vol.1995/6, ANZSIC06 sector classification).
28	X128	5	Gross domestic product: Education and Training (SA, Chained vol.1995/6, ANZSIC06 sector classification).
29	X129	5	Gross domestic product: Health Care and Social Assistance (SA, Chained vol.1995/6, ANZSIC06 sector classification).
30	X130	5	Gross domestic product: Arts and Recreation Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
31	X131	5	Gross domestic product: Other Services (SA, Chained vol.1995/6, ANZSIC06 sector classification).
32	X132	5	Full-Time Equivalent Employees - Forestry and Mining
33	X133	5	Full-Time Equivalent Employees - Manufacturing
34	X134	5	Full-Time Equivalent Employees -Electricity, Gas, Water and Waste Services
35	X135	5	Full-Time Equivalent Employees - Construction
36	X136	5	Full-Time Equivalent Employees - Wholesale Trade
37	X137	5	Full-Time Equivalent Employees - Retail Trade
38	X138	5	Full-Time Equivalent Employees Accommodation and Food Services
39	X139	5	Full-Time Equivalent Employees - Transport, Postal and Warehousing
40	X140	5	Full-Time Equivalent Employees - Information Media and Telecommunications
41	X141	5	Full-Time Equivalent Employees - Financial and Insurance Services
42	X142	5	Full-Time Equivalent Employees - Rental, Hiring and Real Estate Services
43	X143	5	Full-Time Equivalent Employees - Professional, Scientific, Technical, Administrative and Support Services
44	X144	5	Full-Time Equivalent Employees - Public Administration and Safety
45	X145	5	Full-Time Equivalent Employees - Education and Training

Table 3: Data

Variable number	Mnenomics	Transformation	Description
46	X146	5	Full-Time Equivalent Employees - Health Care and Social Assistance
47	X147	5	Full-Time Equivalent Employees - Arts, Recreation and Other Services
48	X148	5	Full-Time Equivalent Employees - Total All Industries
49	X149	5	Labour Cost Index - Salary and wages rates - Forestry and Mining
50	X150	5	Labour Cost Index - Salary and wages rates - Manufacturing
51	X151	5	Labour Cost Index - Salary and wages rates - Electricity, Gas, Water and Waste Services
52	X152	5	Labour Cost Index - Salary and wages rates - Construction
53	X153	5	Labour Cost Index - Salary and wages rates - Wholesale Trade
54	X154	5	Labour Cost Index - Salary and wages rates - Retail Trade
55	X155	5	Labour Cost Index - Salary and wages rates - Accommodation and Food Services
56	X156	5	Labour Cost Index - Salary and wages rates - Transport, Postal and Warehousing
57	X157	5	Labour Cost Index - Salary and wages rates - Information Media and Telecommunications
58	X158	5	Labour Cost Index - Salary and wages rates - Financial and Insurance Services
59	X159	5	Labour Cost Index - Salary and wages rates - Rental, Hiring and Real Estate Services
60	X160	5	Labour Cost Index - Salary and wages rates - Professional, Scientific, Technical, Administrative and Support Services
61	X161	5	Labour Cost Index - Salary and wages rates - Public Administration and Safety
62	X162	5	Labour Cost Index - Salary and wages rates - Education and Training
63	X163	5	Labour Cost Index - Salary and wages rates - Health Care and Social Assistance
64	X164	5	Labour Cost Index - Salary and wages rates - Arts, Recreation and Other Services
65	X165	5	Labour Cost Index - Salary and wages rates - Total All Industries
66	X166	5	Real GDP: Imports of consumption goods (SA)
67	X167	5	Real GDP: Total Household Consumption (SA)
68	X168	5	Real GDP: Total Private Consumption (SA)
69	X169	5	Real GDP: Total Govt Consumption (SA)
70	X170	5	Real GDP: Private Investment Total (SA)
71	X171	5	Real GDP: Govt Investment Total (SA)
72	X172	5	Real GDP: Total Investment (SA)
73	X173	5	Real GDP: Imports Goods Total (SA)
74	X174	5	Real GDP: Imports Services (SA)
75	X175	5	Real GDP: Imports Total (SA)
76	X176	5	Real GDP: Exports of Goods (SA)
77	X177	5	Real GDP: Exports of Services (SA)
78	X178	5	Real GDP: Exports Total (SA)
79	X179	5	Real GDP: Gross National Expenditure (SA)
80	X180	5	Real Production GDP: Manufacturing Total (SA)
81	X181	5	Real GDP: Total Production GDP

Table 3: Data

Variable number	Mnenomics	Transformation	Description
82	X182	5	Real Retail Sales: All industries total (SA, Treasury backdate)
83	X183	5	Real GDP: Private Investment: Dwellings (SA, RBNZ estimates)
84	X184	1	Employment: Total (SA, HLFS)
85	X185	1	Unemployment: Total (SA, HLFS)
86	X186	5	Total number of actual hours worked each week (SA, HLFS)
87	X187	5	Total number of usual hours worked each week (SA, HLFS)
88	X188	5	Total labour force (SA, HLFS)
89	X189	5	Total not in labour force (SA, HLFS)
90	X190	5	Labour force participation rate: Total (SA, HLFS)
91	X191	1	Unemployment rate: Total (SA, HLFS)
92	X192	5	Total gross earnings (SA, QES)
93	X193	5	Filled jobs (Full-time paid employment): Total (SA, QES)
94	X194	5	Total paid hours (SA, QES)
95	X195	5	Labour Cost Index: (Salary and Wages rates): All sectors combined
96	X196	5	Permanent and long-term migration: arrivals (SA)
97	X197	5	Permanent and long-term migration: departures (SA)
98	X198	5	Debt to gross assets (RBNZ estimate)
99	X199	5	Debt to disposable income (RBNZ estimate)
100	X200	5	Housing value as percent of household disposable income
101	X201	5	Household net wealth as percent of household disposable income
102	X202	5	Currency (SA)
103	X203	5	Notes and coins held by the public (SA)
104	X204	5	M1 (SA)
105	X205	5	M2 (SA)
106	X206	5	M3 (SA)
107	X207	5	Private Sector Credit (SA)
108	X208	5	Private Sector Credit Resident (SA)
109	X209	5	Monthly housing price index (REINZ, NSA, 3 month average)
110	X210	5	Quarterly House price Index (Quotable value, SA)
111	X211	5	House sales, Total NZ (Quotable value, SA)
112	X212	5	House price index: Total NZ (for houses, flats, home and income) (Quotable value, NSA)
113	X213	1	RBNZ survey of expectations: Business: Expected HLFS Unemployment Rate: 1 year ahead
114	X214	1	RBNZ survey of expectations: Business: Expected HLFS Unemployment Rate: 2 years ahead
115	X215	1	QSBO survey: Finding skilled labour: Net (SA, NZIER)
116	X216	1	QSBO survey: Economy wide: New Investment: Buildings: Net (SA, NZIER)
117	X217	1	QSBO survey: Economy wide: New Investment: Plant and Machinery: Net (SA, NZIER)
118	X218	1	QSBO survey: Manufacturing: General business situation: Net (SA, NZIER)
119	X219	1	RBNZ survey of expectations: Business: Expected Quarterly (SA) GDP: Previous quarter
120	X220	1	RBNZ survey of expectations: Business: Expected Quarterly (S.A.) GDP: Current quarter

Table 3: Data

Variable number	Mnenomics	Transformation	Description
121	X221	1	RBNZ survey of expectations: Business: Expected Annual % change GDP: 1 year ahead
122	X222	1	RBNZ survey of expectations: Business: Expected Annual % change GDP: 2 years ahead
123	X223	1	QSBO survey: Economy wide: Number employed: past 3 months: Net (SA, NZIER)
124	X224	1	QSBO survey: Economy wide: Number employed: next 3 months: Net (SA,NZIER)
125	X225	1	QSBO survey: Economy wide: Profitability: past 3 months: Net (SA,NZIER)
126	X226	1	QSBO survey: Economy wide: Profitability: next 3 months: Net (SA, NZIER)
127	X227	1	QSBO survey: Economy wide: Domestic trading activity: past 3 months (SA, NZIER)
128	X228	1	QSBO survey: Economy wide: Domestic trading activity: next 3 months (SA, NZIER)
129	X229	1	QSBO survey: Manufacturing and Builders - Capacity Utilization (SA, NZIER)
130	X230	1	QSBO survey: Economy wide: General business situation (SA, NZIER)
131	X231	1	QSBO surveys: Economy wide: Capacity Utilization (NZIER)
132	X232	1	QSBO survey: Economy wide: Exporters Capacity Utilization (NZIER)
133	X233	1	QSBO survey: Economy wide: Past 3 months: Number employed (NZIER)
134	X234	1	QSBO survey: Economy wide: Next 3 months: Number employed (NZIER)
135	X235	1	QSBO survey: Economy wide: Next 3 months: Domestic Trading activity (SA, NZIER)
136	X236	1	QSBO survey: Economy wide: Past 3 months: Domestic Trading activity (SA, NZIER)
137	X237	1	National Bank survey: Business Confidence: Next 12 month: Total (3 month average)
138	X238	1	National Bank survey: Activity Outlook: Next 12 month: Total (3 month average)
139	X239	1	National Bank survey: Interest rate expectations: Next 12 months: Services (3 month average)
140	X240	1	National Bank survey: Capacity Utilisation: Total (3 month average)
141	X241	1	National Bank survey: Capacity Utilisation: Manufacturing (3 month average)
142	X242	1	National Bank survey: Employment intentions: Next 12 months: Total (3 month average)
143	X243	1	National Bank survey: Pricing intentions: Next 3 months: Total (3 month average)
144	X244	1	Westpac-McDermot-Miller Consumer Confidence Index
145	X245	1	Marketscope/UMR survey of expectations: Current inflation
146	X246	1	Marketscope/UMR survey of expectations: Net % Expect Higher Inflation: 12 Months
147	X247	1	Marketscope/UMR survey of expectations: Expected Inflation: 12 Months: Median
148	X248	5	Consents: Dwellings: Total new / altered value (SA)
149	X249	5	Consents: Dwellings: Houses and flats: New: Number (SA)

Table 3: Data

Variable number	Mnenomics	Transformation	Description
150	X250	5	Consents: Dwellings: Total new / altered number (SA)
151	X251	5	Consents: Dwellings: Non-apartment dwelling units: Number (SA)
152	X252	5	Total Dwellings: New: Value (quarterly total)
153	X253	5	Total Dwellings: New: Floor area (quarterly total)
154	X254	5	New residential buildings: Units: Total
155	X255	5	New residential buildings: Value: Total
156	X256	5	Building work put in place: Dwellings: Total (SA)
157	X257	5	Real Building work put in place: Residential (SA)
158	X258	5	Real Building work put in place: Non-residential (SA)
159	X259	5	Real Building work put in place: All buildings (SA)
160	X260	4	Australia: Nominal Effective Exchange Rate (2005=100)
161	X261	4	Euro Area: Nominal Effective Exchange Rate (Avg, NSA,2005=100)
162	X262	4	Euro Area: Real Effective Exchange Rate based on relative CPI (2005=100)
163	X263	4	Japan: Nominal Effective Exchange Rate (Avg, NSA,2005=100)
164	X264	4	Japan: Real Effective Exchange Rate: Consumer Price basis (2005=100)
165	X265	4	United Kingdom: Nominal Effective Exchange Rate (Avg, NSA,2005=100)
166	X266	4	U.K.: Real Effective Exch Rate: Consumer Price basis (2005=100)
167	X267	4	United States: Nominal Effective Exchange Rate (Avg, NSA,2005=100)
168	X268	4	U.S.: Real Effective Exch Rate: Consumer Price basis (2005=100)
169	X269	4	China, PR: Nominal Effective Exchange Rate (2005=100)
170	X270	4	China, PR: Real Effective Exch Rate: Consumer Price basis (2005=100)
171	X271	4	Canada: Nominal Effective Exchange Rate (Avg, NSA,2005=100)
172	X272	4	Canada: Real Effective Exchange Rate: Consumer Price Basis (2005=100)
173	X273	1	Australia: A$ Exchange Rate: USA (EOP, US/A), RBA
174	X274	1	Australia: Official Cash Rate (EOP, %)
175	X275	1	Canada: Overnight Money Market Financing Rate [Target] (EOP, %)
176	X276	1	U.S.: Federal Open Market Committee: Fed Funds Target Rate (EOP, %)
177	X277	1	Australia: 3-Month Bank Accepted Bills (AVG, %)
178	X278	1	U.K.: 3-Month London Interbank Offered Rate: Based on British Pound (AVG, %)
179	X279	1	U.S.: 3-Month London Interbank Offered Rate: Based on US$ (AVG, %)
180	X280	1	Australia: 3-Month Bank Accepted Bills (EOP, %)
181	X281	1	Japan: Call Rate: Uncollateralized 3-Month (EOP, %)
182	X282	1	Australia: 5-Year Treasury Bond Yield (EOP, %)
183	X283	1	Australia: 10-Year Treasury Bond Yield (AVG, %)
184	X284	1	Canada: 1-Year Treasury Bill Yield [Last Wednesday] (EOP, %)

Table 3: Data

Variable number	Mnenomics	Transformation	Description
185	X285	1	Canada: 5-Year Benchmark Bond Yield [Last Wednesday] (EOP, %)
186	X286	1	Canada: 10-Year Benchmark Bond Yield (AVG, %)
187	X287	1	EA 11-17: 5-Year Benchmark Government Bond Yield (AVG, %)
188	X288	1	EA 11-17: 10-Year Benchmark Government Bond Yield (AVG, %)
189	X289	1	Japan: 1-Year Benchmark Government Bond Yield (AVG, % p.a.)
190	X290	1	Japan: 5-Year Benchmark Government Bond Yield (AVG, % p.a.)
191	X291	1	Japan: 10-Year Benchmark Government Bond Yield (AVG, % p.a.)
192	X292	1	New Zealand: 10-Year Government Bond Yield (EOP, %)
193	X293	1	U.K.: 1-Year London Interbank Offered Rate: Based on British Pound (%)
194	X294	1	U.K.: Government Bonds, 5-Year Nominal Par Yield (AVG, %)
195	X295	1	U.K.: Government Bonds, 10-Year Nominal Par Yield (AVG, %)
196	X296	1	U.S.: 1-Year Treasury Bill Yield at Constant Maturity (%)
197	X297	1	U.S.: 5-Year Treasury Note Yield at Constant Maturity (%)
198	X298	1	U.S.: 10-Year Treasury Bond Yield at Constant Maturity (AVG, %)
199	X299	5	Australia: Gross Domestic Product (SA, Mil.Chn.Q3:09-Q2:10.A$)
200	X300	5	EA 17: Gross Domestic Product (SA/WDA, Mil.Chn.2005.Euros)
201	X301	5	Canada: Gross Domestic Product (SAAR, Mil.Chn.2002.C$)
202	X302	5	Japan: Gross Domestic Product (SAAR, Bil.Chn.2005.Yen)
203	X303	5	U.K.: Gross Domestic Product (SA, Mil.Chained.2008.Pounds)
204	X304	5	U.S.: Gross Domestic Product (SAAR, Bil.Chn.2005$)
205	X305	5	China: Gross Domestic Product (SA, Bil.2000.Yuan)
206	X306	5	Canada: Consumer Price Index (SA, 2002=100)
207	X307	5	EA 11-17: Monetary Union: Index of Consumer Prices(SA/H, 2005=100)
208	X308	5	Japan: Consumer Price Index (SA/H, 2010=100)
209	X309	5	U.K.: Harmonized Index of Consumer Prices [HICP] (SA, 2005=100)
210	X310	5	U.S.: Consumer Price Index (SA, 1982-84=100)
211	X311	5	China: Consumer Price Index (SA, 2005=100)
212	X312	5	Canada: Industrial Price Index: All Commodities (SA, 2002=100)
213	X313	5	EA 17: PPI: Industry excluding Construction (SA, 2005=100)
214	X314	5	Japan: Output Price: Manufacturing (SA, 2005=100)
215	X315	5	U.K.: PPI: Net Output Prices: Manufactured Products (SA, 2005=100)
216	X316	5	U.S.: PPI: Finished Goods (SA, 1982=100)

Table 3: Data

Variable number	Mnenomics	Transformation	Description
217	X317	5	Australia: Terms of Trade (SA, 2005=100)
218	X318	5	Canada: Terms of Trade (SA, 2005=100)
219	X319	5	EA 17: Terms of Trade (SA, 2005=100)
220	X320	5	Japan: Terms of Trade (SA, 2005=100)
221	X321	5	U.K.: Terms of Trade (SA, 2005=100)
222	X322	5	U.S.: Terms of Trade (SA, 2005=100)
223	X323	5	Australia: Import Price Index (SA, Q3.89-Q2.90=100)
224	X324	5	Canada: Import Price Index: Laspeyres Fixed Weighted (SA, 2002=100)
225	X325	5	EA 17: Import Prices: Total (SA, 2000=100)
226	X326	5	Japan: Import Price Index: All Commodities (SA, 2005=100)
227	X327	5	U.K.: Import Price Index: Total Goods (SA, 2008=100)
228	X328	5	U.S.: Import Price Index: All Imports (SA, 2000=100)
229	X329	5	Australia: Export Price Index (SA, Q3.89-Q2.90=100)
230	X330	5	Canada: Export Price Index: Laspeyres Fixed Weighted (SA, 2002=100)
231	X331	5	Japan: Export Price Index: All Commodities (SA, 2005=100)
232	X332	5	New Zealand: Export Price Index: Goods (SA, Q2-02=1000)
233	X333	5	U.K.: Export Price Index: Total Goods (SA, 2008=100)
234	X334	5	U.S.: Export Price Index: All Exports (SA, 2000=100)
235	X335	5	Australia: Industrial Production excl Construction (SA, Q3.09-Q2.10=100)
236	X336	5	Canada: Industrial Production Manufacturing, Mining & Utilities (SA, 2002=100)
237	X337	5	EA 17: IP: Industry excluding Construction (SA/WDA, 2005=100)
238	X338	5	New Zealand: Industrial Production excl Construction (SA, Q3.95-Q2.96=100)
239	X339	5	U.K.: Industrial Production excluding Construction (SA, 2008=100)
240	X340	5	U.S.: Industrial Production excluding Construction (SA, 2007=100)
241	X341	1	Australia: Unemployment Rate (SA, %)
242	X342	1	Canada: Unemployment Rate: 15 Years and Over (SA, %)
243	X343	1	EA 17: Unemployment Rate (SA, %)
244	X344	1	Japan: Unemployment Rate (SA, %)
245	X345	1	U.K.: Unemployment Rate: Aged 16 and Over [3-Mo Moving Avg](SA, %)
246	X346	1	U.S.: Civilian Unemployment Rate (SA, %)
247	X347	1	Australia: NAB Business Survey: Capacity Utilization (NSA, %)
248	X348	1	Japan: Operating Rate: Manufacturing (NSA, 2005=100)
249	X349	1	Australia: NAB Business Survey: Capacity Utilization (SA, %)
250	X350	1	Canada: Capacity Utilization: Total Industrial (SA, %)

Table 3: Data

Variable number	Mnenomics	Transformation	Description
251	X351	1	EA 17: Capacity Utilization: Manufacturing (SA, %)
252	X352	1	Japan: Operating Rate: Manufacturing (SA, 2005=100)
253	X353	1	U.S.: Capacity Utilization: Industry (SA, %)
254	X354	5	Australia: Imports of Goods, cif (SA, Mil.A$)
255	X355	5	Canada: Imports of Goods, BOP Basis (SA, Mil C$)
256	X356	5	EA 17: Imports of Goods (SA/WDA, Thous.Euros)
257	X357	5	Japan: Imports of Goods (SA, Bil.Yen)
258	X358	5	New Zealand: Imports of Goods, cif (SA, Mil.NZ$)
259	X359	5	U.K.: Imports of Goods (SA, Mil.Pounds)
260	X360	5	U.S.: Imports of Goods, Customs Value (SA, Mil.$)
261	X361	5	Australia: Exports of Goods, fob (SA, Mil.A$)
262	X362	5	Canada: Exports of Goods, BOP Basis (SA, Mil.C$)
263	X363	5	EA 17: Exports of Goods (SA/WDA, Thous.Euros)
264	X364	5	Japan: Exports of Goods (SA, Bil.Yen)
265	X365	5	New Zealand: Exports of Goods, fob (SA, Mil.NZ$)
266	X366	5	U.K.: Exports of Goods (SA, Mil.Pounds)
267	X367	5	U.S.: Exports of Goods, f.a.s. (SA, Mil.$)
268	X368	5	China: Merchandise Imports, cif (SA, Bil.Yuan)
269	X369	5	China: Merchandise Exports, fob (SA, Bil.Yuan)
270	X370	5	World: Commodity Price Index: All Commodities (2005=100)
271	X371	5	World: Non-fuel Primary Commodities Index (2005=100)
272	X372	5	World: Commodity Price Index: Agricultural Raw Materials (2005=100)
273	X373	5	World: Commodity Price Index: Food & Beverage (2005=100)
274	X374	5	Value of Total Merchandise Exports (excludes re-exports) (SA)
275	X375	5	OTI Value of Total Merchandise Imports (SA)
276	Z101	5	Import Price Index Capital Goods: Total
277	Z102	5	Import price index - Petroleum and Petroleum Products
278	Z103	5	Import price index - Total Non-Commodity Manufactured Goods
279	Z104	5	Import Price Index - Total Non-Oil Commodity Goods
280	Z105	5	Import Price Index - Total Merchandise Imports
281	Z106	5	Export price index: Dairy Products (Agricultural)
282	Z107	5	Export price index: Meat (Food and Beverages)
283	Z108	5	Export price index of Total Manufactures
284	Z109	5	Export Price Index: All Merchandise
285	Z110	5	ANZ Commodity Price Index - NZ$
286	Z111	5	ANZ Commodity Price Index - NZ$ - Meat, skins and wool
287	Z112	5	ANZ Commodity Price Index - NZ$ - Dairy products
288	Z113	5	ANZ Commodity Price Index - NZ$ - Horticultural products
289	Z114	5	New Zealand: Terms of Trade (SA, 2005=100)
290	Z115	1	RBNZ survey of expectations: Business: Expected Annual CPI: 1 year from now
291	Z116	1	RBNZ survey of expectations: Business: Expected Annual CPI: 2 years from now
292	Z117	1	RBNZ survey of expectations: Business: Expected 90-day Bank Bill - End current quarter

Table 3: Data

Variable number	Mnenomics	Transformation	Description
293	Z118	1	RBNZ survey of expectations: Business: Expected 90-day Bank Bill - 3 quarters from now
294	Z119	1	RBNZ survey of expectations: Business: CPI - 1Q expectation (Professional forecaster)
295	Z120	1	RBNZ survey of expectations: Business: CPI - 2Q expectation (Professional forecaster)
296	Z121	1	RBNZ survey of expectations: Business: CPI - 1Y expectation (Professional forecaster)
297	Z122	1	RBNZ survey of expectations: Business: CPI - 2Y expectation (Professional forecaster)
298	Z123	1	New Zealand: 5-Year Government Bond Yield (%)
299	Z124	1	New Zealand: 10-Year Government Bond Yield (AVG, %)
300	Z125	5	New Zealand: Consumer Price Index (SA, Q2-06=1000)
301	Z126	5	New Zealand: Producer Price Index (SA, Q4-10=1000)
302	Z127	5	New Zealand: Import Price Index: Goods (SA, Q2-02=1000)
303	Z128	5	New Zealand: Capital Index: NZSX All Indexes (Jun-30-86=1000)
304	Z129	5	New Zealand: Gross Index: NZSX All Indexes (Jun-30-86=1000)
305	I1	1	New Zealand: 90-Day Bank Bill Yield (AVG, %)
305	I2	1	New Zealand: Trade Weighted Exchange Rate (AVG, %)

Table 4: Peak Impact and Levels of significance

Variable	3 Factors	4 Factors	5 Factors
GDP sectors			
Agriculture	0.09*(4)	0.11*(5)	0.1(4)
Forestry and Logging	-0.18*(4)	-0.13*(4)	0.1(10)
Fishing, Aquaculture and Agriculture, Forestry and Fishing Support Services	-0.03(12)	-0.08*(3)	-0.06*(9)
Mining	-0.11*(6)	-0.1*(7)	-0.1(5)
Food, Beverage and Tobacco Product Manufacturing	-0.3*(5)	-0.25*(5)	-0.23*(5)
Textile, Leather, Clothing and Footwear Manufacturing	-0.19*(6)	-0.23*(6)	-0.21*(5)
Wood and Paper Products Manufacturing	-0.26*(4)	-0.21*(5)	-0.18*(4)
Printing	-0.26*(5)	-0.27*(5)	-0.24*(5)
Petroleum, Chemical, Polymer and Rubber Product Manufacturing	-0.15*(5)	-0.09*(5)	-0.08*(4)
Non-Metallic Mineral Product Manufacturing	-0.31*(6)	-0.35*(6)	-0.32*(6)
Metal Product Manufacturing	-0.43*(5)	-0.33*(5)	-0.3*(5)
Transport Equipment, Machinery and Equipment Manufacturing	-0.41*(6)	-0.28*(6)	-0.25*(6)
Furniture and Other Manufacturing	-0.31*(4)	-0.3*(4)	-0.26*(4)
Electricity, Gas, Water and Waste Services	-0.03*(3)	0.04*(9)	0.04*(8)
Construction	-0.35*(5)	-0.45*(5)	-0.4*(5)
Wholesale Trade	-0.12*(6)	-0.1*(6)	-0.1*(5)
Retail Trade	-0.16*(5)	-0.18*(5)	-0.16*(4)
Accommodation and Food Services	-0.12*(5)	-0.11*(5)	-0.09*(5)
Transport, Postal and Warehousing	-0.17*(6)	-0.17*(6)	-0.15*(6)
Information Media and Telecommunications	-0.04(10)	-0.07*(8)	-0.07*(7)
Financial and Insurance Services	-0.02*(3)	-0.08*(3)	-0.08*(9)
Rental, Hiring and Real Estate Services	-0.08*(4)	-0.12*(4)	-0.09*(4)
Owner-Occupied Property Operation (National Accounts Only)	-0.01*(5)	-0.02*(5)	-0.02*(5)
Professional, Scientific and Technical Services	-0.04*(5)	-0.08*(4)	-0.07*(4)
Administrative and Support Services	-0.13*(4)	-0.16*(4)	-0.14*(4)
Local Government Administration	0.04(3)	-0.09*(10)	-0.09*(10)
Central Government Administration, Defence and Public Safety	0.01*(2)	-0.11*(9)	-0.09*(8)
Education and Training	-0.01(13)	-0.01*(3)	-0.01(2)
Health Care and Social Assistance	0.04*(4)	-0.03*(11)	-0.03*(10)
Arts and Recreation Services	-0.06*(5)	-0.07*(5)	-0.08*(5)
Other Services	-0.07*(4)	-0.1*(4)	-0.09*(4)
Employment			
Forestry and Mining	-0.09*(3)	-0.13*(4)	-0.1*(3)
Manufacturing	-0.11*(6)	-0.15*(6)	-0.13*(6)

Note: The table reports the estimated median peak impact coefficients from bootstrapping the VAR. The values in paranthesis report the quarter when this impact occurs. The stars indicate that these values are statistically significant (i.e. zero is not included within one-standard deviation confidence intervals generated from 5000 replications.)

Table 4: Peak Impact and Levels of significance

Variable	3 Factors	4 Factors	5 Factors
Electricity, Gas, Water and Waste Services	-0.13*(5)	0.12*(11)	0.11*(10)
Construction	-0.13*(7)	-0.23*(7)	-0.21*(7)
Wholesale Trade	-0.1*(7)	-0.11*(8)	-0.1*(7)
Retail Trade	-0.1*(5)	-0.12*(5)	-0.11*(5)
Accommodation and Food Services	-0.15*(7)	-0.22*(7)	-0.21*(6)
Transport, Postal and Warehousing	-0.06*(7)	0.06*(3)	0.06*(12)
Information Media and Telecommunications	0.06(3)	-0.14*(8)	-0.13*(8)
Financial and Insurance Services	-0.08*(7)	-0.11*(7)	-0.1*(7)
Rental, Hiring and Real Estate Services	-0.09*(5)	-0.05*(5)	-0.06*(4)
Professional, Scientific, Technical, Administrative and Support Services	-0.02*(7)	-0.04*(7)	-0.04*(6)
Public Administration and Safety	0.02*(2)	-0.1*(8)	-0.09*(8)
Education and Training	-0.01*(3)	0.03*(9)	0.03(10)
Health Care and Social Assistance	0.02*(4)	0.02*(4)	0.01*(3)
Arts, Recreation and Other Services	-0.06*(6)	-0.06*(6)	-0.06*(5)
Total All Industries	-0.06*(6)	-0.09*(7)	-0.08*(6)
Other			
Private consumption	-0.09(5)	-0.11(5)	-0.1(4)
Private investment	-0.44(5)	-0.51(5)	-0.45(5)
Exports of Services	-0.11(5)	-0.09(5)	-0.09(5)
Production GDP	-0.1(5)	-0.11(5)	-0.1(5)
New Zealand: Industrial Production excl Construction (SA, Q3.95-Q2.96=100)	-0.25(5)	-0.2(5)	-0.18(5)
Tot no of act hrs wrkd each wk - (SA)	-0.06(6)	-0.07(6)	-0.06(6)
HLFS: Lab force partcption rate (tot) - SA	-0.01(7)	-0.02(8)	-0.02(7)
HLFS: unempd rate (tot) - SA	0.42(6)	0.5(7)	0.47(6)
Permenant long-term migration - arrivals s.a.	0.05(3)	-0.1(9)	-0.08(8)
Permenant long-term migration - departures s.a.	-0.29(7)	0.39(3)	0.24(3)
House prices	-0.27(5)	-0.37(5)	-0.32(4)
Total dwellings (value)	-1.24(4)	-1.29(4)	-1.11(4)
New Zealand: Consumer Price Index (SA, Q2-06=1000)	-0.05(1)	-0.07(1)	-0.1(1)

Note: The table reports the estimated median peak impact coefficients from bootstrapping the VAR. The values in paranthesis report the quarter when this impact occurs. The stars indicate that these values are statistically significant (i.e. zero is not included within one-standard deviation confidence intervals generated from 5000 replications.)