Shocked by the world! Introducing the three block open economy FAVAR*

Özer Karagedikli† Leif Anders Thorsrud‡

November 15, 2010

Abstract

We estimate a three block FAVAR with separate world, regional and domestic blocks. The domestic block is assumed to be too small to influence the region, and the region is assumed to be too small to influence the world. The model is tested on New Zealand data, where the region is defined as Oceania. We identify three world shocks (world demand, world supply and world interest rate shocks), two region specific shocks (regional demand and regional supply shocks), and a domestic monetary policy shock using two different identification schemes (recursive and sign restrictions). Our main results are as follows: (i) World shocks have significant effect on both the region and the New Zealand economy. (ii) The effects of the world inflation factor (directly or indirectly) are very important in the transmission of international shocks to the New Zealand economy (iii) The regional price factor seems to be especially important for non-tradables inflation in New Zealand. (iv) The responses to a domestic monetary policy shock are all in accordance with economic theory and exhibit none of the well known puzzles.

*The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Reserve Bank of New Zealand. The authors would like to thank Güneş Kamber, Haroon Mumtaz, and members of the modeling team at the Reserve Bank of New Zealand for valuable comments and fruitful discussions, and one anonymous referee for providing comments on an earlier draft. Any remaining errors are the authors's sole responsibility.

†Reserve Bank of New Zealand. Email: Ozer.Karagedikli@rbnz.govt.nz

‡Norges Bank and Reserve Bank of New Zealand. Email: leif-anders.thorsrud@rbnz.govt.nz

1 Introduction

The last decades have been characterised as the globalisation era. The share of total trade to world GDP has increased significantly[1], while liberalisation of economic policies and financial markets have boosted financial integration. At the same time different regions of the world experience different growth paths, their own shocks and display heterogeneity in response to global developments. For policy institutions in small open economies it is important to understand how these international developments transmit into the domestic economy.

In this paper we propose and develop a three-block factor augmented vector autoregression (FAVAR) with separate world, regional and domestic blocks. The model enables us to describe the transmission mechanisms through which international and regional demand and supply shocks, international interest rate shocks and domestic monetary policy shocks affect a small open economy. We apply the model to New Zealand data, where we have defined the region as Oceania.

Investigating the transmission mechanisms and contribution of international shocks to domestic macro variables is high on the research agenda, and there is a large literature on the existence and effects of a "world business cycle" on different economies. In a seminal paper Kose et al. [2003] show that for the 1960-1990 period a common world factor accounts for a large part of the business cycle fluctuations in developed economies[2] (examples of related studies include Backus et al. [1995], Baxter and Kouparitsas [2005] and Kose et al. [2008]), while a recent and emerging literature argues that domestic inflation in many countries has become more of an international phenomenon, driven by international factors (see for example Mumtaz and Surico [2008], Monacelli and Sala [2009] and Ciccarelli and Mojon [2005]).[3] Similar global output and price pressures also affects the synchronisation of domestic interest rates, as more countries conduct counter-inflationary monetary policies. The role of international financial shocks and their transmissions across economies

[1] The global economy has become more open. In 1990 the total value of trade was less than 40 percent of global GDP; by 2004 the world economy had grown 50 percent and two-way trade exceeded 55 percent of global GDP (http://devdata.worldbank.org/wdi2006/contents/Section6_1.htm.

[2] Interestingly however, they find the world and regional factor to explain much less of the business cycle fluctuations in New Zealand compared with other developed economies.

[3] Karagedikli et al. [2010] argue that the co-movement in headline inflation rates found in these studies come from high co-movements in relative prices, which is found to be greater with products that are traded more for example.

have been well recognised and also highlighted by the recent global financial crisis. Mumtaz and Surico [2009] for example, show how a shock to short term interest rates in the rest of the world affects a broad range of domestic UK variables.

Not all variation in domestic variables can be attributed to international developments. The role of regional factors are also found to be important. Forni et al. [2007], using a generalised dynamic factor model to data of 10 European economies found that a common European activity factor explains between 35 percent and 96 percent of the variation in country level GDP. Clark and Shin [2000], found that a common factor explains a substantial proportion of variations in industrial production of European economies. Hall and McDermott [2008] finds the existence of a regional business cycle in the Oceanian region, while Coleman [2007] finds a high long term co-movement between the relative prices of tradable, and also non-tradable goods between Australia and New Zealand.[4] Conway [1998] found that the shocks from Australia are equally as important for the New Zealand economy as the shocks from the US economy, while Dungey and Fry [2003] in a three block structural factor autoregression finds the Japanese economy needs to be taken into account when estimating the effects of the rest of the world on the Australian economy.

Traditionally the open and closed economy VAR literature have modelled the dynamics of economic variables by means of a few series. This limited information set approach has tended to produce a few anomalies such as the exchange rate and price puzzles. The pioneering work by Bernanke et al. [2005] proposed to augment the standard VAR with latent factors extracted from large data-sets, instead of the limited information set typically used in VAR studies, to circumvent these problems. For a closed economy specification they demonstrate how the FAVAR methodology produces responses to monetary policy shocks that are in accordance with economic theory. Recently the literature has started applying the FAVAR methodology to open economy specifications as well. Boivin and Giannoni [2007], Mumtaz and Surico [2009], and Baumeister et al. [2009] are examples of this approach, and Mumtaz and Surico [2009] argue that many of the anomalies typically found in standard open economy VAR analysis are overcome by using the FAVAR methodology. Moreover, an additional advantage of this approach is that instead of estimating and identifying the responses to only a few

[4]In a high frequency event study Coleman and Karagedikli [2010] find strong response of the New Zealand-US dollar exchange rate to Australian specific activity and monetary policy surprises.

variables, the FAVAR approach deliver the responses to all the variables included in the data set used to estimate the latent factors. This data set can potentially include hundreds of variables.

To our knowledge this is the first paper that utilises the FAVAR methodology to identify world, regional and domestic shocks.[5] Following much of the later literature we use two different identification schemes; recursive identification and sign restrictions[6], and show that by including both a large data set and regional and world factors our model is able to produce results that are in accordance with economic theory and not affected by the typical anomalies found in open and closed economy studies.[7]

Our work is closely related to Kose et al. [2003] approach of separating out the the effects of the world, region and the country specific factors, and the international FAVAR literature discussed above. In contrast to the work by Kose et al. [2003] however, our approach allows us to identify both price and monetary policy shocks in addition to the activity shocks. Our approach also utilises a much bigger domestic data set, which allows for a richer description of the domestic responses to different international and regional shocks. Further, we believe that augmenting the FAVAR proposed by Mumtaz and Surico [2009] with regional factors might be important for correctly identifying the heterogeneity of economic development across different regions of the world.

This paper is also, loosely, related to the global VAR (GVAR) approach of Dees et al. [2007]. The GVAR approach is particularly useful in linking a number of countries to each others by means of smaller VARs for each country. Moreover, it is more convenient when one tries to understands the impacts of shocks that originates in a particular country, while our approach is more convenient as we are trying to understand the effects of the world and the region on the domestic economy. Another branch of the literature has circumvented the omitted variable bias problem, common for regular VAR studies, by utilising large Bayesian VARs (De Mol et al. [2008]).[8] This strand of the literature has however focused mainly on forecasting, and identification of structural shocks quickly becomes difficult as the number of variables

[5]For the New Zealand economy an identified FAVAR have never been applied neither for a closed or open economy. In fact, few studies have investigated the transmission of international shocks in New Zealand.

[6]See for example Canova [2005] and Scholl and Uhlig [2008].

[7]We use information from nearly 400 variables, where the international and regional block of data accounts for over half the size of the data set. In addition to testing the models structural properties we also investigate the FAVAR's forecasting performance.

[8]See Bloor and Matheson [2009] for an example using New Zealand data.

included in the model gets large.

Our main findings are as follows: (i) The transmission of shocks between the identified world, regional and domestic factors are all in accordance with the conventional wisdom, (ii) the world activity factor effects the New Zealand economy stronger than what have been found in many earlier studies. Especially we find the effects of the world inflation factor (directly or indirectly) to be a important factor in transmission of international shocks to the New Zealand economy, (iii) regional factors have significant effects on some key domestic macro economic variables such as wages and non-tradable inflation, highlighting the importance of regional factors and shocks, (iv) the responses to a domestic monetary policy shock are all in accordance with economic theory and exhibits no "puzzles"

The remainder of the paper is structured as follows: Section 2 describes the model, the different identification schemes and the estimation procedure. In section 3 we report the results. First we describe the estimated factors, then we show the impulse responses of the international and regional factors as well as some main domestic variables to the identified shocks. We also give a detailed description of the variance decomposition for some of the main domestic variables. In section 4 we describe the sensitivity analysis we have conducted, compare the FAVAR results to a standard VAR approach, and summarise the model's forecasting properties. Section 5 concludes.

2 The model

We assume that the world economy is driven by some fundamental unobserved factors and that these factors can be categorised into activity, prices and interest rate factors. Further we believe that regions of the world are affected differently by these factors and also that the regions themselves are affected by some fundamental regional specific factors, which we also categorise into activity and price factors. Finally we believe that the domestic economy is driven by some purely domestic factors. For monetary policy authorities the effect of the monetary policy instrument is of special interest. We thus include this as an observable factor in our model.[9]

[9]We do not include a regional interest rate factor in the model for two reasons: An additional factor will make the model (especially the dynamic specification of the model) bigger and require estimation of more parameters. We also believe that the domestic and regional interest rate market are very interlinked, and thus would be difficult do separately identify.

Our factor augmented vector autoregression (FAVAR) follow the general setup of Bernanke et al. [2005], and extended to the international economy by Mumtaz and Surico [2009]. As already mentioned, the factors are generally unobserved, and have to be inferred from the data. Thus, the model can naturally be represented in a state space form. Following Mumtaz and Surico [2009], we specify the transition equation as:

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

where F_t is a set of unobserved world, regional and domestic factors, and R is a observed domestic interest rate factor. $\beta(L)$ is a conformable lag polynomial of order p and u_t is the reduced form residuals. The structural disturbances follow $u_t = \Omega^{1/2}\varepsilon_t$, with $\varepsilon \sim N(0,1)$ and $\Omega = A_0(A_0)'$.

The observation equation of the system is:

$$X_t = \Lambda^F F + \Lambda^R R + e_t, \tag{2}$$

where X_t is a N x 1 vector, Λ^F and Λ^R are N x K and N x 1 matrixes of factor loadings. Finally e_t is a N x 1 vector of idiosyncratic, zero mean, disturbances.

2.1 Identification

In the two following sections we describe how we identify the FAVAR. Generally, restricting the factor loadings in equation 2, ensures identification of the factors, while restrictions on the lag polynomial and the ordering of the factors in equation 1, identifies structural shocks, ε_t.

2.1.1 Identifying the factors

To identify the unobserved factors, the X matrix in the observation equation is portioned into 6 different blocks. Each block consists of either global, regional or domestic data. As already mentioned, we assume that the different blocks of data share some common underlying factors. These unobserved factors will be linear combinations of the different blocks of data, defined by the size and sign of the factor loadings. By restricting the different data blocks in X_t, and also the factor loading matrix Λ in equation 2, we argue

that we can identify the unobserved factors, or the underlying driving forces of the world, regional and domestic economy.

In our application the X matrix is portioned as:

$$X_t = \begin{bmatrix} X^{act*} & X^{pri*} & X^{r*} & X^{act**} & X^{pri**} & X^{D} & X^{R} \end{bmatrix},$$

where act, pri, r, D and R. are abbreviations for activity, price, interest rate, domestic and domestic interest rate numbers respectively. A * indicates that the block consists of world or global variables, while ** indicates that the variable block consists of regional variables.

The unobserved factors in equation 1 are then related to the different blocks of data according to the restricted factor loading matrix:

$$\begin{bmatrix} X^{act*} \\ X^{pri*} \\ X^{r*} \\ X^{act**} \\ X^{pri**} \\ X^{D} \\ X^{R} \end{bmatrix} = \begin{bmatrix} \lambda_{i,act*} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \lambda_{i,pri*} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \lambda_{i,r*} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \lambda_{i,act**} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \lambda_{i,pri**} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \lambda_{i,D} & \lambda_{i,R} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} F^{act*} \\ F^{pri*} \\ F^{r*} \\ F^{act**} \\ F^{pri**} \\ F^{D} \\ R \end{bmatrix} + \epsilon, \quad (3)$$

where X is the T x N block portioned matrix. λ is a the factor loading. The i reflects that each variable in the X matrix has its own factor loading, thus $i = 1, 2, ..., N$. F is the identified unobserved factors, while R is an observed interest rate factor. ϵ is the idiosyncratic error term.

The diagonal structure of the international part of the loading matrix above ensures that we can uniquely identify the international unobserved factors as global activity, price and interest rate factors, and regional activity and price factors. Note that we have not put any restrictions on the signs of the factor loadings.

The domestic factors, F^D, have not been given any economic interpretation. Restricting the domestic factors to rely on specific variables, and thereby identify them as for example inflation or output factors could easily have been done. These extra identification restrictions would however have limited the potential heterogenous responses of the domestic variables to shocks in the transition equation. We are mostly interested in how international shocks affects the domestic economy, and have thus left the domestic factors unrestricted.

Section 2.3 describes the details of the estimation procedure. Here it is sufficient to note that the unobserved factors are estimated by principal components. To avoid the rotational indeterminacy problem associated with principal component analysis, we use the standard normalisation implicit in the literature and restrict $C'C/T = I$, where $C(\cdot)$ represents the common space by the factors of X in each block of data.

2.1.2 Identifying the shocks

We apply two different identification schemes for the transition equation. These are the standard recursive ordering of the variables, or Cholesky identification, and the later method of sign restrictions directly on the structural shocks. For both identification schemes we assume a block exogenous structure in the transition equation. That is, the $\beta(L)$ term from equation 1 is restricted according to the scheme illustrated in equation 4 below. Regional (F^{**}) and domestic factors (F) do not affect the world (F^{*}), regional factors are affected by the world, but not the domestic factors, and finally the domestic factors are affected by both the world, regional and domestic factors themselves. This scheme is in accordance with the relative sizes and the importance of New Zealand and the region. The difference between our approach and Boivin and Giannoni [2007] is that we 'directly' identify the "worldwide shocks", which would affect simultaneously domestic and international (both world and regional) factors.

$$\begin{bmatrix} F_t^* \\ F_t^{**} \\ F_t \end{bmatrix} = \begin{bmatrix} \beta_{11}(L) & 0 & 0 \\ \beta_{21}(L) & \beta_{22}(L) & 0 \\ \beta_{31}(L) & \beta_{32}(L) & \beta_{33}(L) \end{bmatrix} \begin{bmatrix} F_{t-1}^* \\ F_{t-1}^{**} \\ F_{t-1} \end{bmatrix} \begin{bmatrix} u_t^* \\ u_t^{**} \\ u_t \end{bmatrix} \tag{4}$$

For the recursive identification scheme activity factors are ordered before price and interest rate factors within each block, following the ordering outlined in equation 3, and impulse responses and variance decompositions can be computed using standard VAR techniques. Given the identification of the factors, we argue that we can uncover six different shocks using the Cholesky ordering, namely international activity, price and interest rate shocks, regional activity and price shocks, and also a domestic monetary policy shock.

The implementation of the sign restrictions assumes the same ordering of the variables as in the recursive identification scheme, but put additional restrictions on the structural disturbances. Especially we restrict Ω, defined in section 2, to follow the structure:

$$\begin{bmatrix} u^{act*} \\ u^{pri*} \\ u^{r*} \\ u^{act**} \\ u^{pri**} \\ u^{D} \\ u^{R} \end{bmatrix} = \begin{bmatrix} + & + & - & 0 & 0 & 0 & 0 \\ + & - & - & 0 & 0 & 0 & 0 \\ + & - & + & 0 & 0 & 0 & 0 \\ x & x & x & + & + & 0 & 0 \\ x & x & x & + & - & 0 & 0 \\ x & x & x & x & x & x & 0 \\ x & x & x & x & x & x & + \end{bmatrix} \begin{bmatrix} \varepsilon^{demand*} \\ \varepsilon^{supply*} \\ \varepsilon^{r*} \\ \varepsilon^{demand**} \\ \varepsilon^{supply**} \\ \varepsilon^{D} \\ \varepsilon^{R} \end{bmatrix} \tag{5}$$

where a + indicates that the parameter must be positive, a − restricts the parameter to be negative, x leaves the parameter unrestricted, and finally zero imposes exclusion restrictions.

Following this identification scheme we can identify both global and regional demand and supply shocks. A positive structural international demand shock increases global activity, prices and interest rates. A positive supply shock increases global activity, but has a negative impact on international prices and interest rates. International interest rates shocks are restricted to reduce international activity and prices, but rise interest rates. The regional shocks are identified as demand and supply shocks following the same restrictions as for the international demand and supply shocks. The restrictions only affect the regional block itself though. The domestic shocks are mostly left unrestricted, and for both the global demand, supply and interest rate shocks we have left the responses of the domestic variables unrestricted. The zero restrictions follow the block exogenous assumption outlined above. Domestic shocks does not affect the region, while regional shocks does not affect the world. For New Zealand and the region including Australia these are reasonable assumptions given their relative sizes.

As thoroughly described in both Bernanke et al. [2005], Boivin and Giannoni [2007] and Mumtaz and Surico [2009], one final point regarding identification should be mentioned: The variables in the domestic block includes both interest rates and different exchange rates and other financial variables. These are all fast moving variables. To correctly identify the domestic monetary policy shock, and justify the ordering of the variables described above, we thus need ensure that the factors extracted from the X_D matrix are not the interest rate or any other variable that in theory will react contemporaneously with the interest rate. To do so, we follow the procedure outlined in Boivin and Giannoni [2007]. Starting from an initial principal component estimate of F^D, denoted by F^0, we iterate through the following steps:

1. Regress X^D on F^0 and R to obtain λ_D and λ_R

2. Compute $\widetilde{X}^D = X^D - \lambda_R R$
3. Estimate F^1 as the first K-1 principal components of $\widetilde{X}^D$
4. Back to 1

We end the iterations when the change in the factor estimate is less than some predefined criteria.[10]

2.2 The data

We include 363 variables from 28 different countries in the FAVAR. The data includes variables from the US, UK, Switzerland, Norway, Netherlands, Japan, Italy, France, Finland, Denmark, Canada, Sweden, Spain, Luxembourg, Germany, Belgium, Austria, Ireland, Korea, China, Malaysia, India, Taiwan, Hong Kong, Thailand, Singapore, Australia and New Zealand. The domestic block consist of data from New Zealand, the regional block data from Australia, and the world block includes date from all the other countries.[11]

For each of the countries entering into the international block we have used data measuring real activity, prices and interest rates. In the regional block we have only used activity and price measures.[12] Since we are mainly interested in investigating how the different world and regional shocks affect the domestic economy, the variables entering into the domestic block is collected from a much wider pool of series. The domestic data block thus includes a total of different 175 series, measuring activity, prices and disaggregated prices, wages, long and short interest rates, exchange rates, immigration and

[10] In this application we have implicitly assumed that the region is not part of the world variables or factors. For a different region, e.g. Europe, this is of course not a valid assumption, and the same identification "problem" associated with the domestic block and the interest rate arises. The rotation procedure described above can however be used to correctly identify the regional contributions, and justify ordering the world before the region. Thus making the three block FAVAR useful for studies of other regions and domestic economies as well.

[11] Compared to the data set used by Mumtaz and Surico [2009], our data set includes a much bigger share of variables from the emerging and developed Asian economies. We believe this is important to accurately capture the through but unobserved world factors.

[12] The number of series in the world interest rate block is only 18. We have deliberately excluded many of the countries mentioned above from this block due to their more or less fixed exchange rate regime with the US. Because the regional block only includes Australia, the number of price series used is 15.

expectations. Appendix 6 gives a more detailed description of the variables entering into the model.

The model is estimated on quarterly observations from 1992:Q2 to 2007:Q4. Some monthly series are included in the model, these are aggregated to quarterly series by taking the mean. All non-stationary variables are in quarterly growth rates, and variables affected by seasonality are seasonally adjusted using the X12 ARIMA procedure. To make the estimation of the factors invariant to scale, all variables are standardised prior to estimation.

2.3 Estimation

Bernanke et al. [2005] investigate two different methods for estimating the state space system in equation 1 and 2; a two step procedure and a joint estimation by likelihood-based Gibbs sampling techniques. Bernanke et al. [2005] show that the two procedures produce very similar results. The two step procedure is however simpler, and much less computational intensive.

In this application we follow the two step approach.[13] The unobserved factors and loadings are first estimated by principal components. The international activity factor(s) is extracted based on the international activity numbers, the international price factor(s) is extracted based on the international price data, etc. The factor loadings are restricted as described in section 2.1 and equation 3. In the second step the estimated factors are used as observed variables in a VAR framework. Bai and Ng [2002] propose different criteria for how many factors to extract from each block of data. We have not followed a formal statistical procedure in this application. To keep the system at a reasonable size we have extracted only one factor from each of the international data blocks, while we have chosen to use three factors from the domestic block.

Given our relatively short estimation sample we estimate the VAR in equation 1 using Bayesian techniques. In our baseline model we restrict the number of lags to 2. Restrictions on the world and regional block of the VAR follow naturally from our identification strategy. We do however not have any priors regarding the dynamics of the domestic block of the VAR, which therefore contains 2 lags of all variables.

We apply a independent normal-Wishart prior for the VAR and use the Gibbs sampler to derive the posterior distributions of the parameters. The further

[13] This is also the route taken in Mumtaz and Surico [2009], who note that the panel of data in Bernanke et al. [2005] "only" includes 120 variables, which makes the joint estimation more feasible.

avoid the problem of overfitting we adopt a Minnesota-type prior on the coefficients. That is, we set the prior of the first own lag of the dependant variable in each equation equal to its AR(1) coefficient, while the prior mean for all other variables are set to zero. For the prior variances we adjust for differences in scale between the variables and the lag length of the system according to the following scheme:

$$V_{i,jj} = \begin{cases} \frac{a1}{p^2} & \text{for coeffcients on own lags} \\ \frac{a2\sigma_{ii}}{p^2\sigma jj} & \text{for coeffcients on lags of variable } j \neq i \\ \frac{a3}{\sigma ii} & \text{for coeffcients on exogenous variables} \end{cases}$$

where the standard errors are derived from AR(p) estimations, where p is equal to the number of lags in the full system. We specify the hyperparameters a1, a2 and a3 as 0.6, 0.3 and 0.1 respectively. The degrees of freedom prior is set to 30, and the prior covariance matrix equals $I(n) * 0.01$, where n is equal to the number of equation in the system. Thus, our prior is relatively tight, and imposes a fair amount of shrinkage. Finally, we make 10000 iterations of the Gibbs sampler, with 2000 iterations used as burn-in.

Sign restrictions are implemented with some minor changes to the procedure outlined in Rubio-Ramirez and Zha [2009] and modified in Mumtaz and Surico [2009]. Specifically we implement the following algorithm for each draw of the reduced form covariance matrix Ω:

1. Let $Omega = PP'$ be the Cholesky decomposition of the VAR covariance matrix Ω, and $\tilde{A}_0 = P$.
2. Draw an independent standard normal n x k matrix J, where n is the size of the block (e.g. international or regional block) and k is the number of shocks affecting that block according to the block exogenous structure outlined in section 2.1 and equation 5. Let $J = QR$ be the "economy size" QR decomposition of J with the diagonal of R normalised to be positive.
3. Compute a candidate structural impact matrix $A_0 = \tilde{A}_0 \cdot \tilde{Q}$, where $\tilde{Q}$ is a N x N identity matrix with Q' in the n x k block associated with either the international or regional block in equation 5.
4. Redo step 1-3 for the next block of international or regional data.

The candidate matrix A_0 will have a lower triangular structure for the domestic block, as in the standard Cholesky decomposition, while also satisfying the zero restrictions outlined in equation 5. If the candidate matrix satisfies the sign restrictions, we keep it. Otherwise the procedure above is repeated.

3 Results

In this section we discuss the estimated world and regional factors, the impulse responses for the identified structural shocks as well as the variance decomposition of some key domestic variables. Irrespective of which identification scheme we use, recursive identification or sign restriction, the model produces very similar results. Thus, we argue that the shocks we have identified are; world demand, supply and interest rate shock, regional demand and supply shocks and the domestic monetary policy shock.[14]

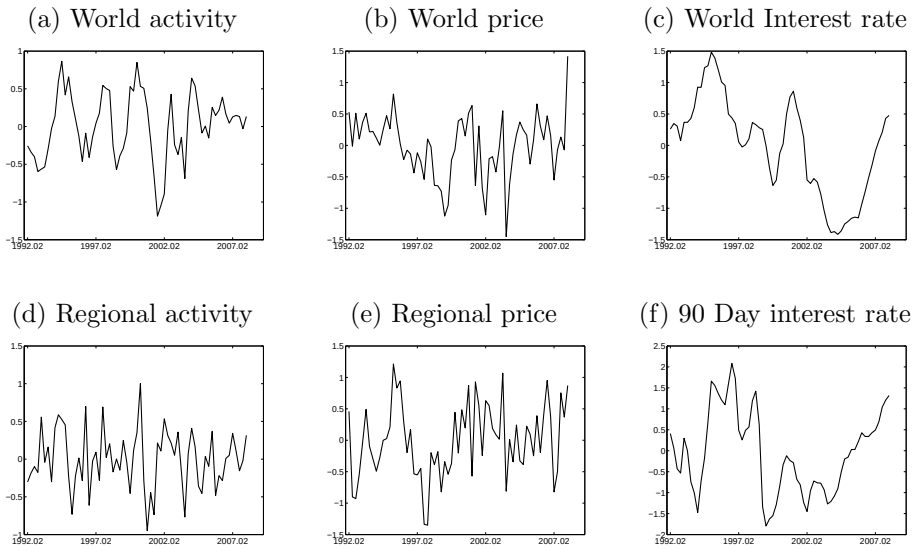
3.1 Identified factors

Figure 1 shows the estimated factors; world activity, price, and interest rate factors, regional activity and price factors, and the observed domestic short term interest rate (90-day bank bill) factor.[15]. Generally our estimated world factors resembles the factors extracted by Mumtaz and Surico [2009].

[14] The separate results from the two different identification schemes are available from authors upon request.

[15] We do not show the three estimated domestic (New Zealand) factors, as we do not identify them

Figure 1: **Identified factors**



Notes: World factors and regional factors are estimated. The 90 Day interest rate is the observed short term interest rate for New Zealand.

The world activity factor captures the important features of the world business cycle the last 20 years. In the early 90's the world was coming out of a recession. The succeeding boom was followed by the Asian crisis which induced a recession in many countries, and thus a downturn in the world business cycle. The world activity factor also captures the 2001 slowdown, which was deeper than the other recessions in our sample period. The world price factor inhabits the global co-movement in inflation rates across the world found in earlier studies, such as Mumtaz and Surico [2009] and Ciccarelli and Mojon [2005]. Particularly striking is the significant upturn at the end of the sample, probably representing a hike in commodity prices. The world interest rate factor represents the co-movement in the short-term interest rates across the globe. The peaks and the troughs in the interest rate factor follows the world price factor cycles rather closely, confirming the inflation fighting mandates of many central banks around the world. One interesting observation is the persistent and very large deviation of the interest rate factor from its historical mean in the early to mid 2000s.

The regional factors captures the Oceania specific business cycles. Given our definition of the region, and the data used to estimate the regional factors, these are closely related to Australian GDP and inflation.

The variance explained by the international factors are typically in the range 20-30 percent, while the three domestic factors explain around 40 percent of the variance of the domestic block. Extracting one or more domestic factors only increases the variance explained by 5 percent or less.

3.2 A positive shock to world demand

We expect an increase in the world demand to have a positive effect on the New Zealand economy via the trade channel. We would also expect the strong world to have an effect on the New Zealand economy indirectly, via its effect on the regional economy.

Figure 2 shows the impulse responses to a positive world demand shock. Panels (a) - (f) in the figure show the impulse responses of the factors (three world factors, two regional factors) and the observed domestic interest rates.[16] The responses of the factors are all in accordance with conventional wisdom and appear to be well identified. An unexpected increase in the world demand is persistent and stays positive for around a year. It leads to a quick and slightly more persistent increase in world inflation. In response to higher world activity and inflation the world interest rate factor increase significantly by 0.8 percent after a year, and does only return to its original level after about 5 years. In response to the world demand shock, regional activity immediately increase by 0.4 percent while the regional price factor reaches its peak after almost a year. Finally the domestic interest rate increase in response to the shock.

Panels (g) - (o) in figure 2 show the impulse responses of some of the domestic macroeconomic variables to the world demand shock. A rise in headline inflation is caused by an increase in tradable inflation, which initially increases by 0.2 percent. Inflation expectations also responds positively to the world demand shock. After about one year non-tradable inflation, and thus headline inflation, starts falling. The fall is probably caused by the interest rate response, which peaks after about one year, before it slowly reverts back to normal.

The responses of the domestic real variables are interesting. Both GDP and consumption fall. The initial reaction of both variables is close to zero, but after around one year the growth rates are significantly below zero. We speculate this might be coming from two sources: High tradable prices, all else being equal, would create a fall in demand due to income effects, while

[16] We do not show or discuss the domestic factors as we leave them unidentified.

high interest rates puts downward pressure on domestic activity. Higher world prices also increases the costs of imported intermediate inputs, such as oil. The responses of the real variables are supported by the movements in import and export prices as a world demand shock increases import prices more than export prices (not shown), thus worsening the terms of trade. [17]

The earlier literature used the US GDP as a proxy for the world GDP. The problem with using the US GDP as a proxy for the world GDP or activity measure is that the US GDP alone may not be sufficient to capture the effects the world activity on world prices. Therefore one may not be capturing the price effect associated with the international activity that we observe in our FAVAR. So a VAR that identifies the shocks to the US GDP is not necessarily identifying an activity shock that is worldwide (or widespread) as it is in our analysis. In short, the shock we identify should be thought of as a shock to some kind of underlying world activity that is common across a number of countries.

3.3 A negative world supply shock

A world supply shock may be interpreted as a technology shock or a productivity shock. The technology shocks are usually assumed to be very persistent, whereas productivity shocks may inhabit less persistence. The classic example of this type of shock would be the 1970s episode when oil prices rose unexpectedly (e.g. a supply shock) and inflation increased while activity fell all over the world.

Panels (a) - (f) in figure 3 show the impulse responses of the factors and the domestic interest rates to a negative world supply shock. Given the relatively low persistence of the shock, we interpret this as a negative productivity shock. The unexpected increase in world inflation leads the world activity factor to fall sharply. It takes up to two years before world activity returns back to normal. World interest rates respond positively, but only by just over 0.1 percent. Both the regional activity and price factors follow the responses of the world factors. The New Zealand interest rates increase in response to the negative world supply shock. In sum, these impulse responses are as expected.

We believe the impulse responses shown in panels (g) - (o), are in line with the recent emerging literature on the globalisation of domestic inflation rates

[17] Also earlier studies document the same pattern of response to an international demand or activity shock, see for example Buckle et al. [2007] and Haug and Smith [2007].

(Mumtaz and Surico [2008] and Monacelli and Sala [2009]). The negative supply shock causes tradable inflation to increase sharply, which in turn leads to a sharp increase in the headline inflation rate (New Zealand's headline inflation measure includes just under 50 percent tradable products). The non-tradable inflation rate increase only marginally.[18], while the exchange rate depreciates initially in response to the negative world supply shock. This depreciation would exacerbate the increase in tradable inflation even further. The domestic GDP response is very erratic. It increases for a quarter, before it decreases for a one or two quarters. Beyond 3 quarters GDP does not respond significantly to the negative world supply shock. The same pattern of response can be found for domestic consumption, capacity utilisation and unemployment. As was the case for the world demand shock, the main transmission mechanism of the international supply shock to the New Zealand economy seems to be via tradable prices, as opposed to through activity measures. The increase in tradable inflation leads to higher headline inflation, and in return the central bank raises interest rates. As was the case for the international demand shock, the interest rate rise suppresses the real variables.

3.4 A positive world interest rate shock

In this section we discuss the effects of a shock that increases the world interest rates by 1 percent on average. This can be interpreted as a special circumstance such as the 2008 period where a number of central banks changed interest rates more or less simultaneously.

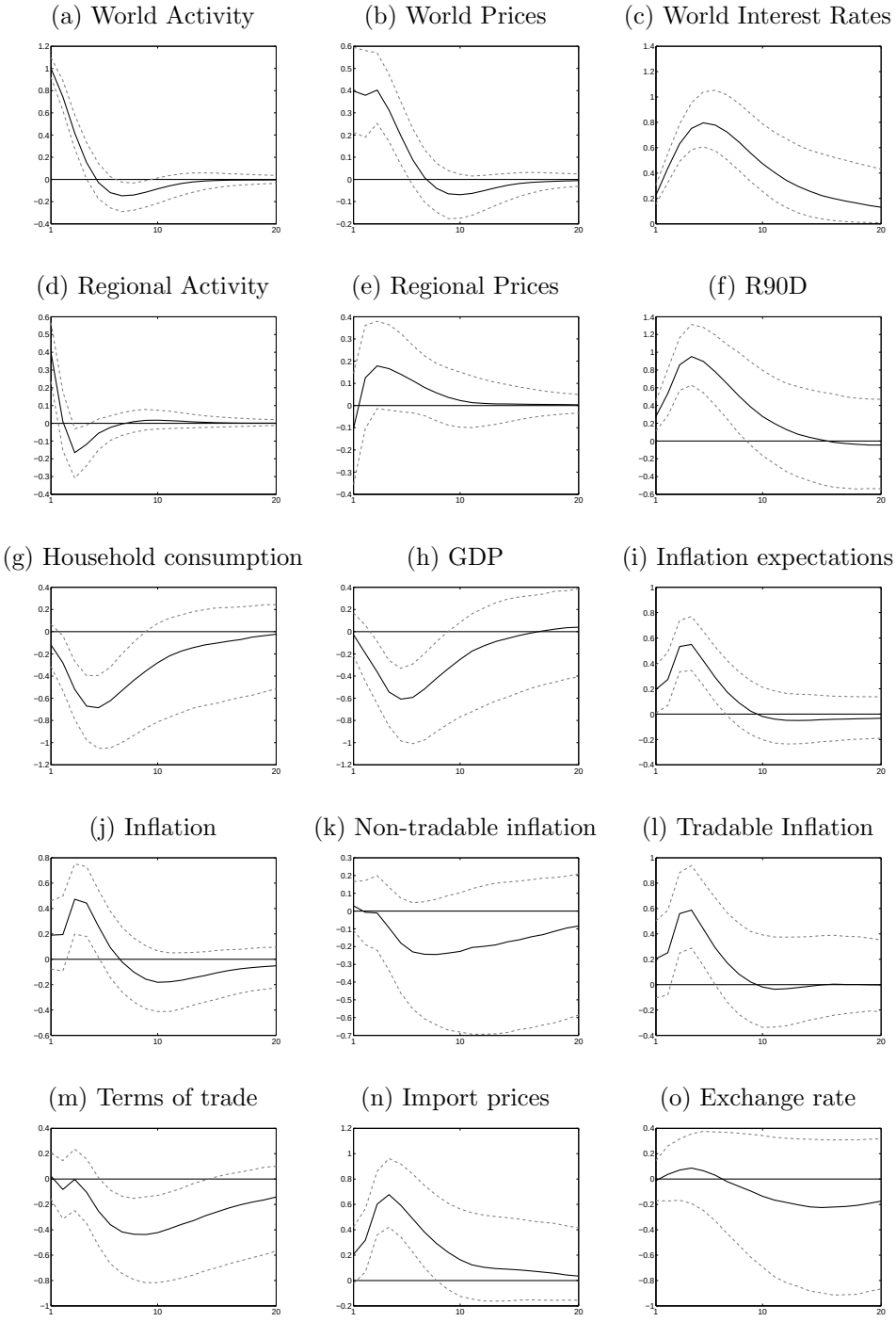
Panels (a) - (f) in figure 4 show the estimated impulse responses of the factors and the domestic interest rates. The world interest rate shock is very persistent. Interestingly, world inflation increases as a response to the world interest rate rise, while the world activity factor initially falls, as expected. The regional price factor responds negatively to the world interest rate rise, and returns to normal after about one year. Finally, the domestic 90-day interest rate increase by around 50 basis points after 3-4 quarters.

Panels (g) - (o) in figure 4 show the estimated impulse responses for the domestic New Zealand variables. We expect an international monetary policy shock to have offsetting effects on the domestic economy due to the exchange rate and the foreign demand effects. The New Zealand exchange rate depre-

[18]This may partly reflect the influence of the regional price factor on New Zealand's non-tradable inflation rate, which we will be discussing more in section 3.5 and 3.7.

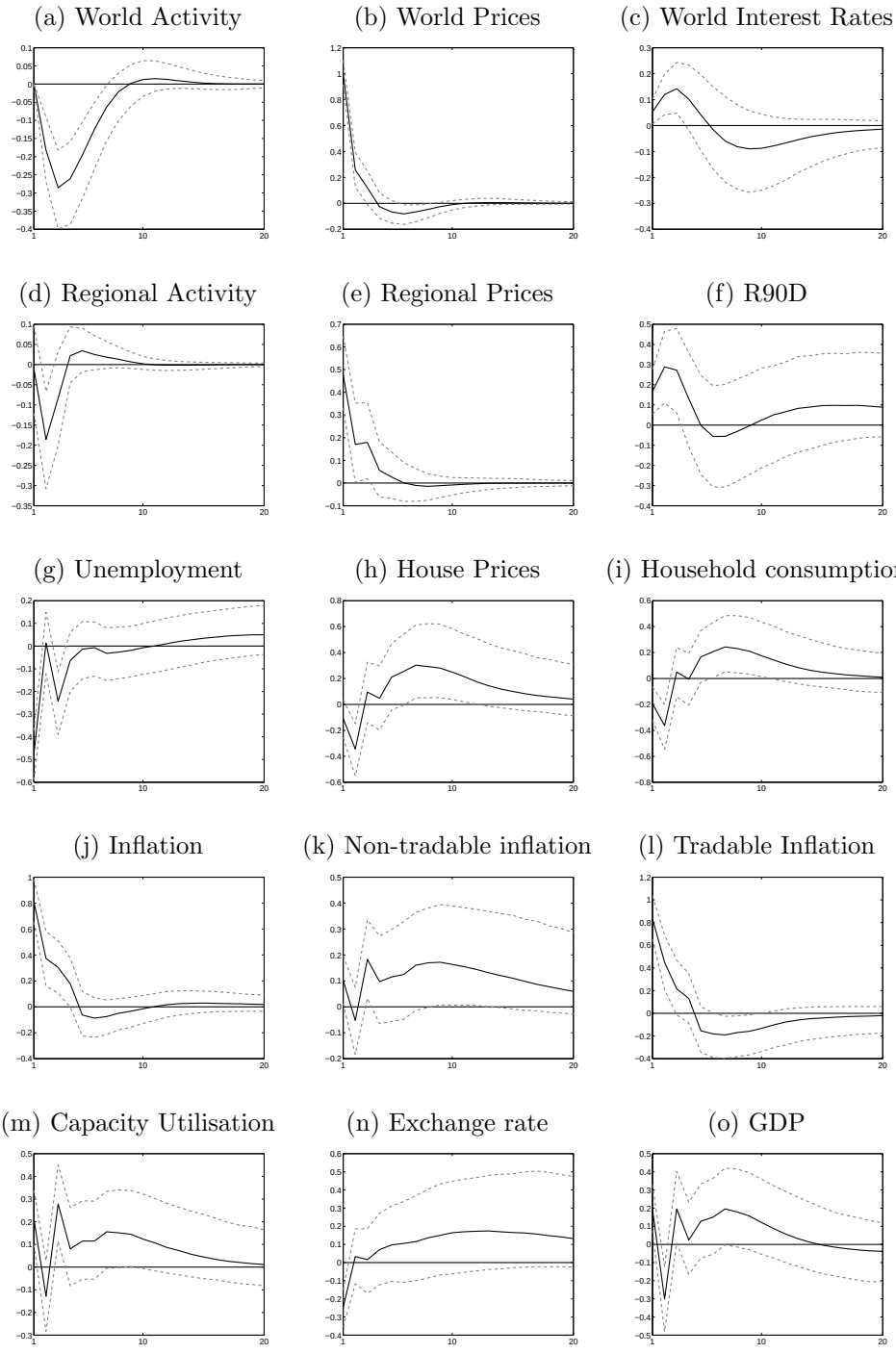
ciates in response to the shock. As a result, New Zealand exports increase. The additional demand pressure generated by increased exports can be seen on falling unemployment, increased GDP growth, and increased capacity utilisation numbers. Tradable prices increase as a result of the depreciation in the currency. Also headline inflation increases, but the inflation rate falls as the domestic interest rate responds positively to the international interest rate shock after about 1 year. These responses are all consistent with simple open economy models.

Figure 2: **Impulse responses of factors to world demand shock**



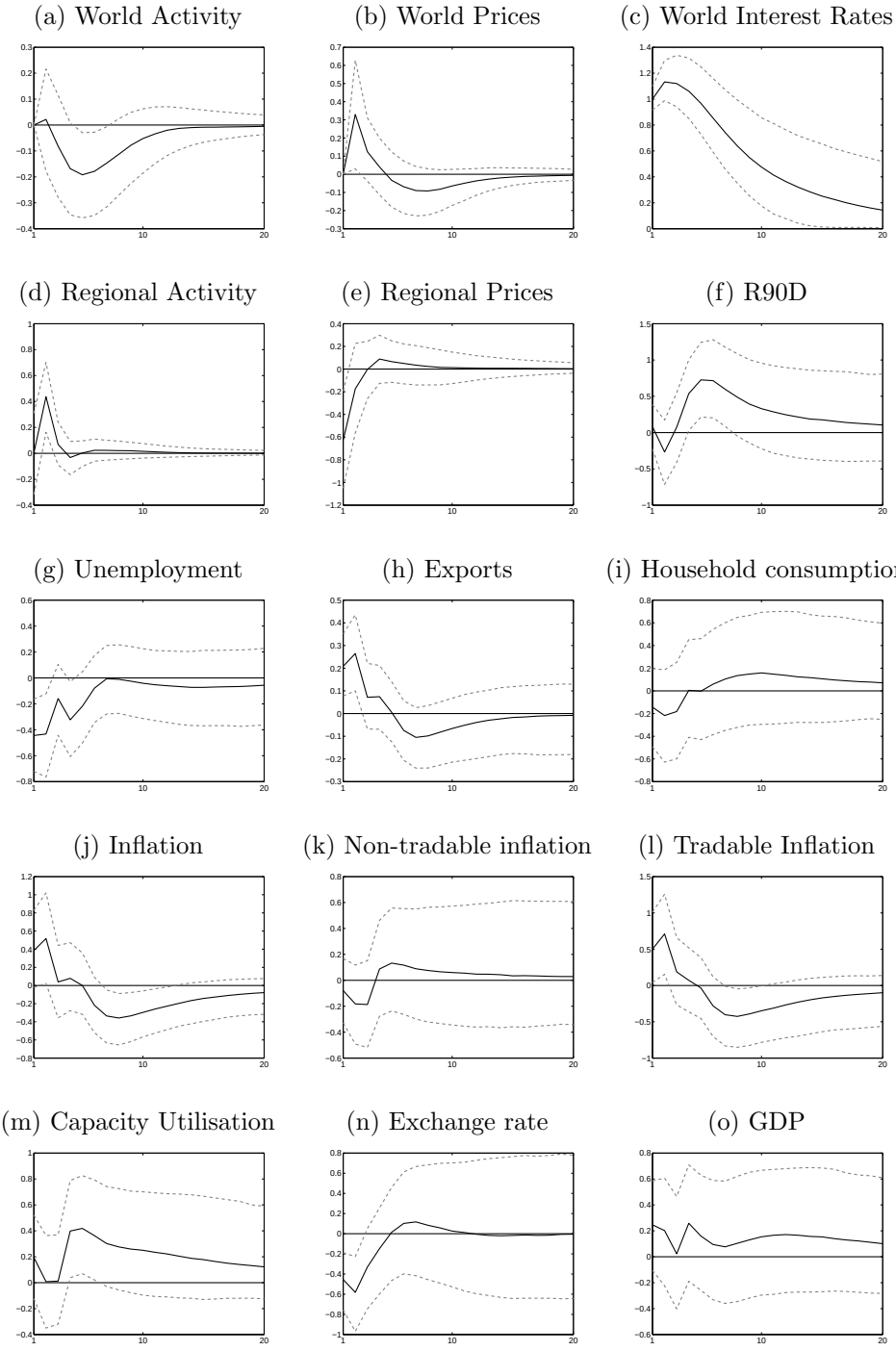
Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

Figure 3: **Impulse responses of factors to negative world supply shock**



Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

Figure 4: **Impulse responses of factors to world interest rate shock**



Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

3.5 Regional demand and supply shocks

Figure 5 shows the responses of the regional factors and some selected New Zealand variables to a positive regional demand shock. Firstly, the shock is not very persistent. The regional activity factor grows above normal for just over 2–3 quarters, and the shock causes almost no reaction in the regional price factor.

After an unanticipated shock to regional demand, the New Zealand exchange rate appreciates significantly the first year after the impulse. The appreciation of the exchange rate significantly affects tradable inflation, which falls for over a year. The exchange rate response is consistent with recent findings in Coleman and Karagedikli [2010].[19] Further, as a result of the exchange rate appreciation, exports go down[20] and imports go up, and the model produces a very small and short lived expansion in output. While a regional activity boom is thought to be beneficial for the New Zealand economy, our results indicate that the exchange rate effects undermines these positive impulses. However, the short lived increase in New Zealand output is apparently enough to generate non-tradable inflation, which again leads the central bank to raise interest rates.

As displayed in figure 6, a negative regional supply shock increases regional prices significantly. The effects of the shock on the regional prices do however not last for more than a year, and the effects on the regional activity factor are minor.

Domestic non-tradable inflation increases as a result of the negative regional supply shock and the exchange rate appreciates. The significant domestic non-tradable inflation response is supported by findings in Coleman [2007], and will be discussed further in section 3.7. Also wages increase significantly as a response to the negative supply shock. This is not surprising given the large labour mobility within the region. Domestic activity variables show a positive response to the negative regional supply shock. These responses are probably driven by the strong and positive reaction of the terms of trade, which lasts for almost 3 years. These results are also consistent with Neely

[19] Applying an event analysis on New Zealand and Australian data Coleman and Karagedikli [2010] find that unexpected real economy surprises (e.g. an unanticipated shock to demand) lead to an appreciation of the New Zealand - US dollar exchange rate, and presumably all the New Zealand dollar exchange rates (except the cross-rate between New Zealand and Australia).

[20] This is total New Zealand exports. Although one would expect New Zealand dollar to depreciate against the Australian dollar, and hence an increase in exports to Australia, the total exports fall.

and Rapach [2008] which finds that the regional factors explain around 30 per cent of the variation in headline inflation rates in Australia and New Zealand over the 1979-2006 period. This country factors become after the regional factors in terms of explaining the overall variation.

Overall these regional impulse responses and the transmission of shocks to the domestic economy seem reasonable. The results confirm findings in earlier regional studies, and thus highlights the importance of including regional factors in open economy models as the FAVAR.

Although we assumed the region is 'Oceania' for New Zealand, it would still be wise to discuss how we define a region. What defines a region may be an arbitrary choice at times. Most empirical studies would put New Zealand and Australia together as the region of 'Oceania' (Kose et al. [2003], Neely and Rapach [2008] for example). While this might geographically appropriate, in terms of economic (both trade and financial) linkages, it may not represent the 'true' economic region(s). For example, up until 1973 most of New Zealand's exports were imported by the United Kingdom. By 2010 the Asian economies make up the largest destination for the New Zealand exports.

3.6 An unanticipated shock to domestic monetary policy

As discussed in the introduction, VAR based impulse responses derived from "limited information" sets typically exhibit some well known anomalies, such as the exchange rate and price puzzles (see e.g. Eichenbaum and Evans [1995] and Kim and Roubini [2000]). The FAVAR literature proposed by Bernanke et al. [2005] argue that the FAVAR methodology is a very useful tool to overcome many of the empirical anomalies associated with identifying a domestic monetary policy shock. Our results, reported in figure 8 confirms this.

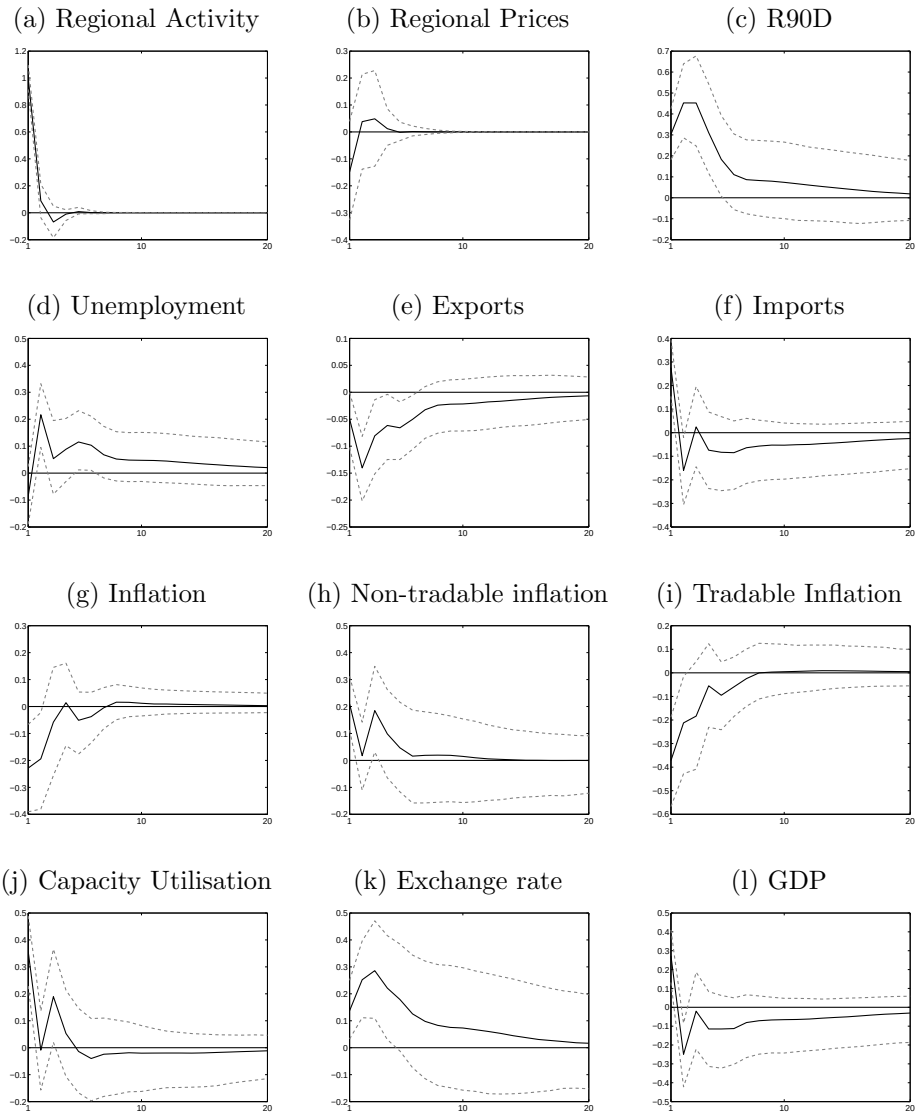
A 1 percent unexpected increase in the short term interest rates in New Zealand has a significant and negative effect on activity, consumption, investment and capacity utilisation. The effects on consumption and investment peak after three quarters, while the effects on capacity utilisation peaks after five quarters. GDP growth initially falls by 0.5 percent, but returns to normal after about two and a half years. The exchange rate responds immediately to the unexpected shock to the interest rates, before it gradually depreciates to baseline. This leads to a immediate fall in tradable inflation.

Non tradable inflation also falls, but not as strongly as tradable inflation. Accordingly, headline inflation also falls. The response in house prices are negative, and lasts for over two years.

The exchange rate response is in accordance with the exchange rate overshooting hypothesis. We believe it is the FAVAR's big data set and contemporaneous interaction between the exchange rate and the interest rate that ensures this result.[21] Further, the model does not show any sign of the typical price puzzle, which is also found in other FAVAR literature, such as Boivin et al. [2009] and Mumtaz and Surico [2009].

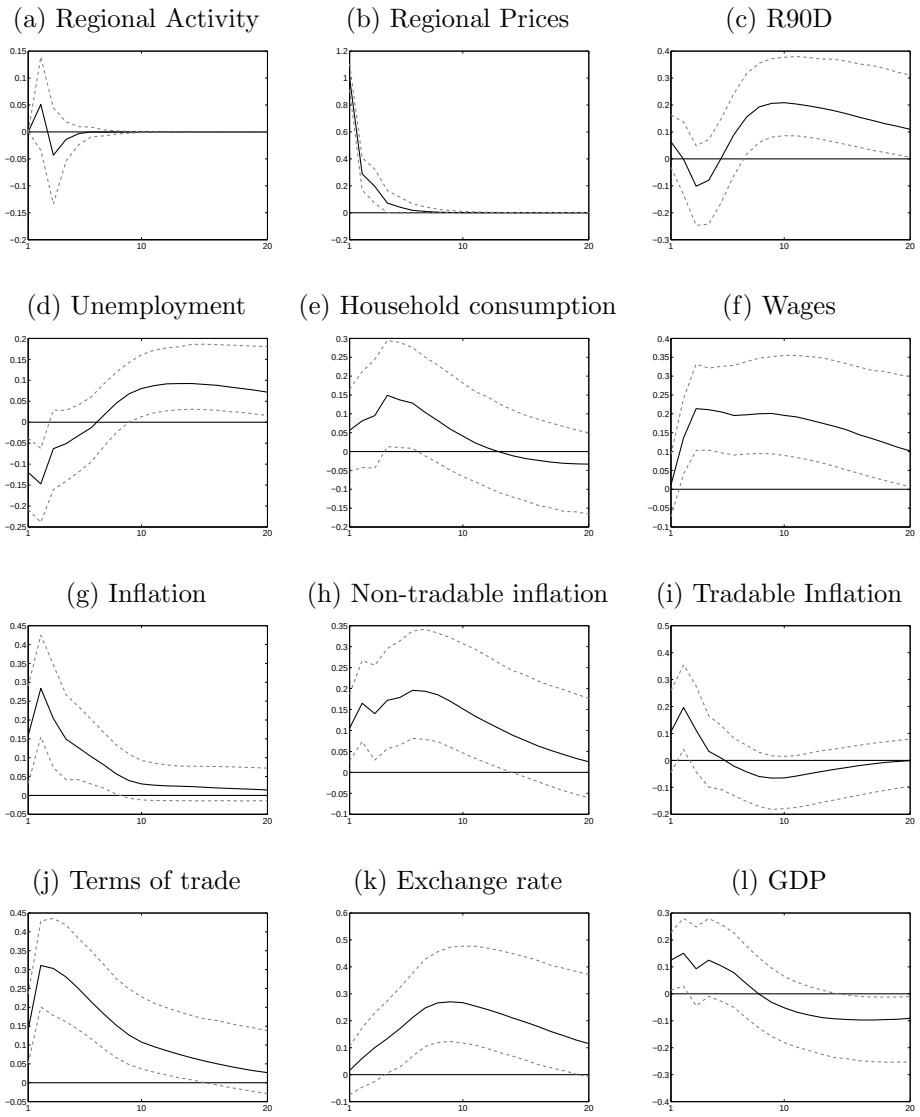
[21] A similar argument is used by Bjørnland [2009], who identifies a monetary policy shock in four economies (including New Zealand), by using long-run neutrality restrictions on the exchange rate.

Figure 5: **Impulse responses regional demand shock**



Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

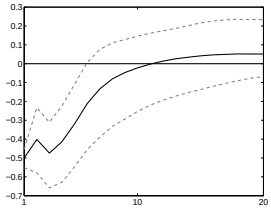
Figure 6: **Impulse responses to a negative regional supply shock**



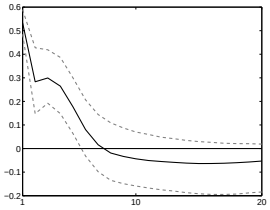
Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

Figure 7: **Impulse responses domestic monetary policy shock**

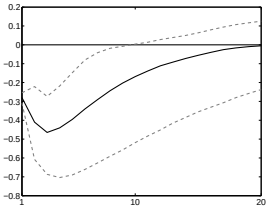
(a) GDP



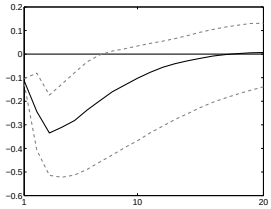
(b) Unemployment



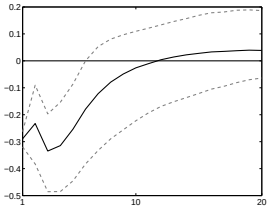
(c) House Prices



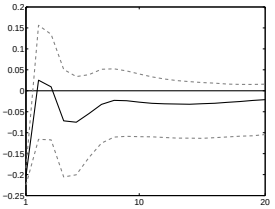
(d) Household consumption



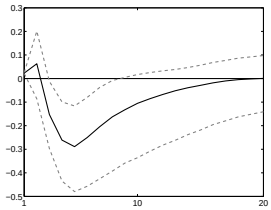
(e) Investment



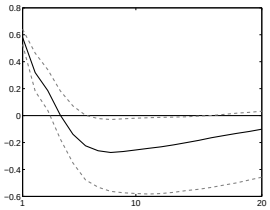
(f) Inflation Expectations



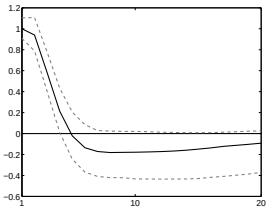
(g) Capacity utilisation



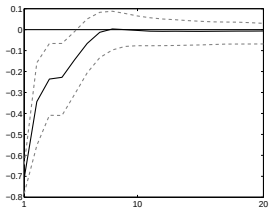
(h) Exchange Rate



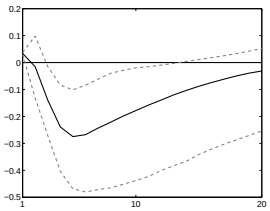
(i) R90D



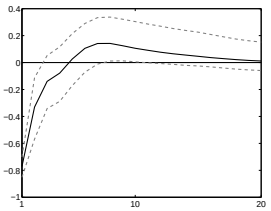
(j) Inflation



(k) Non-tradable inflation



(l) Tradable Inflation



Notes: The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters. The initial shocks are normalised to 1%, while we report the responses up to 20 quarters ahead.

3.7 Shocked by the world

In this section we discuss the variance decomposition results for some key domestic macro variables. The individual variables in the different blocks of data described in section 2 are explained by some common factors as well as some purely idiosyncratic factors. The numbers reported in table 1 are the variance explained by the factors only. The last column of the table do however show the total amount of variance explained by all the factors. On average the factors explain 35 percent of the variance of the domestic variables, and the idiosyncratic component thus explains 65 percent of the variance for each variable on average, see table 2.[22]

The variance decomposition results highlight the pattern from the impulse response analysis: World prices are an important transmission mechanisms for international shocks to the New Zealand economy. The "world inflation" story is also consistent with the recent literature on the transmission of international shocks to small open economies (Mumtaz and Surico [2008], Monacelli and Sala [2009], Karagedikli et al. [2010]). This literature argues that the domestic inflation in advanced economies have become more of an international phenomenon. Further, the world activity factor explains much more of the forecast error variance of many domestic variables than has been shown in comparable studies for the New Zealand economy (see e.g. Benes et al. [2009]).

The international price factor explains a high share of the forecast error variance of variables such as tradable inflation, headline inflation, import prices and inflation expectations. Moreover, the variance decomposition of activity numbers such as capacity utilisation, employment and unemployment are also explained very well by the world price factor. The world activity factor stands out as important for the domestic variables such as the GDP, consumption, commodity prices of New Zealand commodities, investment and 90 day interest rates. However, the world interest rate factor does not explain much of the variation in New Zealand variables.

In section 3.5 we described the transmission mechanisms of regional demand and supply shocks to the domestic economy. For some of the main domestic macro economic variables these shocks appear to be very important. Combined the regional factors explain 10 percent of the forecast error variance of the domestic 90 day interest rate, around 11 percent of capacity utilisation,

[22] There are however big deviations from these averages. For some variables the model explains over 90 percent of the forecast error variance. Note also that for the observed factor, the 90 day rate, the variance explained is 1 by construction.

and around 13 percent of New Zealand exports. One very interesting result is that 15 percent of the variation in non-tradable inflation is explained by the regional price factor. This finding is consistent with the analysis of Coleman [2007], who finds that in the medium term, even the non-tradable price changes are highly correlated between New Zealand and Australia. Lastly, the regional price factors explains 17 and 25 percent of the variance in respectively domestic wages and the terms of trade.

The variance explained by the regional factors may seem to be small overall. However, as we discussed their effects on some key domestic variables are sizable and large. Moreover, if one considers the relative size of the 'Oceania' as the region, one could appreciate the importance of the region for the New Zealand economy. In terms of population the wor

Compared to the results in Kose et al. [2003] for the New Zealand economy, our world activity measure contributes 22 percent to the forecast error variation of output, compared with 10.9 percent in Kose et al. [2003], while the same factor contributes 28 percent to the forecast error variance in New Zealand consumption as opposed to 9 percent in Kose et al. [2003].[23] Our results thus confirms the general finding of a world business cycle, but highlights that this cycle also affects the New Zealand economy significantly, especially through price and activity factors.[24]

[23] However, it should be noted that Kose et al. [2003] put relatively little weight on their results for the New Zealand economy since their estimation sample for this region only includes 6 macroeconomic series from two countries (Australia and New Zealand).

[24] Further, our results for the variance decomposition of domestic output also resembles the results reported in Bloor and Matheson [2009], who use a large Bayesian VAR and block exogenous restrictions to assess the contribution from the international block.

Table 1: Variance decomposition for selected variables: horizon 8

	World			Region		Domestic		R^2
	Act	**Pri**	**R**	**Act**	**Pri**	**NZ**	**OCR**	
90 day rate	0.36	0.04	0.06	0.08	0.02	0.31	0.11	1.00
Commodity prices	0.33	0.16	0.01	0.02	0.01	0.47	0.02	0.16
Investment	0.18	0.09	0.01	0.04	0.02	0.60	0.05	0.34
Consumption	0.28	0.11	0.00	0.02	0.04	0.51	0.03	0.44
GDP	0.22	0.09	0.01	0.04	0.03	0.54	0.07	0.50
House prices	0.27	0.09	0.01	0.01	0.09	0.49	0.05	0.75
Import prices	0.27	0.23	0.03	0.01	0.02	0.44	0.01	0.43
Import	0.24	0.11	0.01	0.03	0.02	0.57	0.03	0.20
Export	0.04	0.23	0.06	0.08	0.05	0.39	0.16	0.07
Inflation expectations 1y	0.25	0.29	0.02	0.01	0.05	0.37	0.01	0.38
Inflation expectations 2y	0.13	0.29	0.03	0.03	0.08	0.41	0.03	0.23
Unemployment	0.04	0.22	0.06	0.05	0.05	0.50	0.10	0.33
Employment	0.11	0.18	0.02	0.03	0.10	0.44	0.12	0.56
Inflation	0.10	0.34	0.04	0.02	0.10	0.34	0.06	0.53
Tradable inflation	0.12	0.29	0.04	0.04	0.02	0.43	0.05	0.62
Non-tradable inflation	0.04	0.07	0.01	0.03	0.15	0.66	0.04	0.41
Wages	0.04	0.02	0.09	0.03	0.17	0.63	0.01	0.71
Terms of trade	0.11	0.13	0.04	0.02	0.25	0.33	0.12	0.58
Capacity utilisation	0.03	0.11	0.04	0.05	0.06	0.67	0.04	0.45
Exchange rate	0.00	0.04	0.03	0.06	0.11	0.69	0.06	0.79

Notes: The R^2 for the observed factor, the 90 day rate, is 1 by construction.

Table 2 shows the average variance explained by the different factors in each block of data two years ahead. On average the world activity factor explains 50 percent of the forecast error variance of the international variables, 34 percent of the variance is explained by the world price factor and 16 percent by the world interest rate factor. The high explanatory power by the world activity and world price factor is consistent with the earlier literature.

Combined the world factors explain about 57 percent of the variation in the regional block. The biggest contribution comes from the world activity factor, while the regional activity and price factors contribute almost equally to the forecast error variance.

The proportion of variation explained by the world factors in the domestic block is 36 percent in total. Interestingly the world activity and world price factor explain 15 percent of the domestic block each, potentially confirming the importance of the world price factor and its effects (direct and indirect) on the New Zealand economy. Regional factors explain only 4 percent of the variation of the New Zealand data. However, as discussed above, for certain variables the regional factors play a much larger role. In total the interna-

tional and regional factors explain as much as 40 percent of the variance in the domestic variables. New Zealand is an small open economy, shocked by the world.

Table 2: Mean variance decomposition across blocks

	World			Region		Domestic		R^2
	Act	**Pri**	**R**	**Act**	**Pri**	**NZ**	**OCR**	
International block	0.50	0.34	0.16	0.00	0.00	0.00	0.00	0.27
Regional block	0.27	0.12	0.18	0.20	0.23	0.00	0.00	0.20
Domestic block	0.15	0.15	0.06	0.02	0.02	0.53	0.07	0.35

Notes: The international block consists of 137 variables, the regional block of 51 variables and the domestic block of 175variables. The columns containing zeros follow the block exogenous identification scheme.

4 Robustness

In this section we shortly describe the results from three types of robustness checks; alternative model specifications, model comparison with a standard BVAR.

4.1 Alternative specifications

To results reported in section 3 are not very sensitive to the number of lags used in the transition equation of the system (see equation 1. We have tried specifying the model using from 1 up to 4 lags. This does not have a material impact on the impulse responses, but the variance decompositions reported in section 3.7 do however tend to attribute less weight on the international economy if fewer lags are used.

Since we have not identified the domestic factors (except for the interest rate), it would a priori be impossible to know in which order the domestic factors should enter into the model. We have tried different orderings of the three factors, and conclude that the results are not sensitive to their ordering.

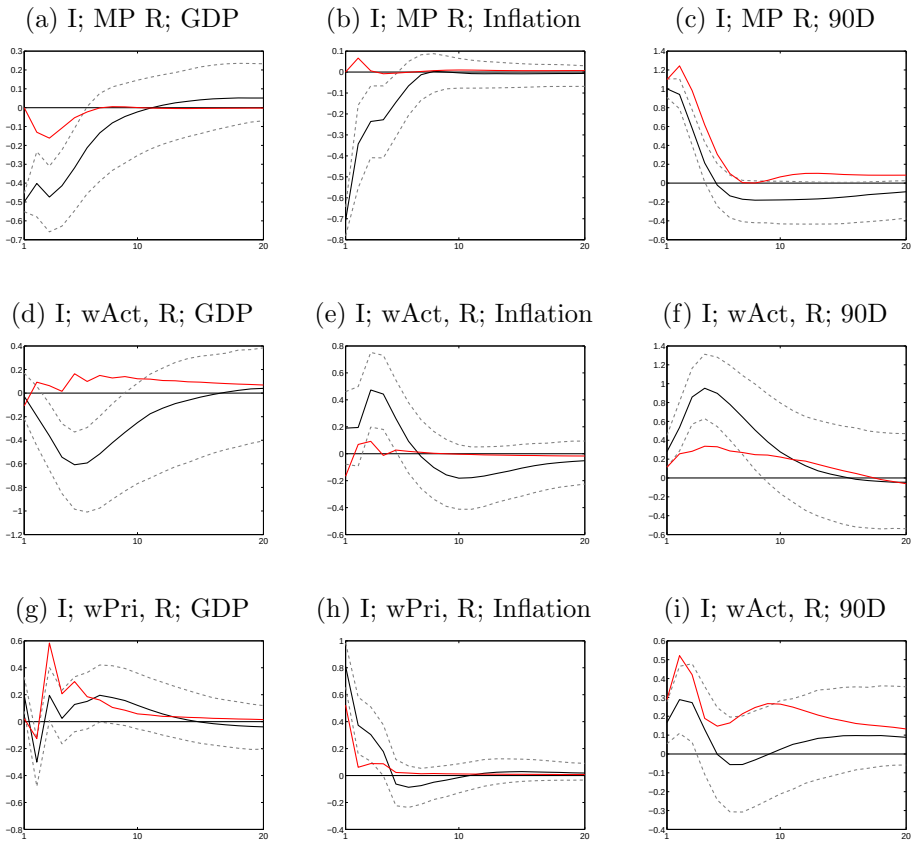
The most sensitive choice regarding model specification seems to be the number of domestic factors. Including more factors, affects the identification of the domestic monetary policy shock. As mentioned in section 2 we have not used any formal statistical procedure to estimate the correct number of factors, but find that extracting three domestic factors captures the main varia-

tion in the data set. Extracting additional domestic factors only increases the variance explained by 5 percent or less, and might add more noise than signal to the model. Given our relatively short estimation sample, the changes in responses might also be a function of the number of parameters entering into the model, which by including more domestic factors quickly becomes relatively large. Including more lags did probably not have the same effect on the estimation, since our chosen prior introduces a significant amount of shrinkage as the lag length increases.

4.2 VAR or FAVAR?

To evaluate the potential value added of the FAVAR methodology to more standard approaches, we have compared the recursively identified FAVAR with a standard Bayesian VAR (BVAR), estimated using only observable factors. We have used US GDP, prices and 90 day interest rate as proxies for the world activity, price and interest rate factors. The regional activity and price factors have been replaced with Australian GDP and prices, and we used domestic GDP, prices and the exchange rate as replacements for the domestic factors. Finally, we kept the domestic 90 day rate as specified in the model above.

Figure 8: **Impulse responses: FAVAR and BVAR**



Notes: Red lines are the benckmark VAR impulse responses in variables applicable. The solid black line is the FAVAR median impulses while the dashed black lines are one standard deviation confidence bands based on the posterior distribution of the parameters.

The benchmark model was identified using the same recursive ordering as our main model. Note however that the benchmark model explicitly identifies also the domestic factors by ordering the activity variable before the prices and the exchange rate. Besides from the differences in factors we applied the same model specifications for our benchmark model as for the main model. Thus, the estimation period, the number of lags and the specification of the priors are all the same.

In figure 8 we show the results from three different shocks: a 1 % domestic monetary policy shock, a world activity shock and a world price shock. A positive world activity shock has almost no effect on domestic GDP or infla-

tion in the benchmark model. The 90 day interest rate do however increase in a response to the increased world activity. In the FAVAR, the world activity shock causes domestic activity to fall, but both inflation and the interest rate increase as expected. A positive shock to world prices have much the same effects in the two models although the interest rate response seems to be stronger in the benchmark model. Finally, the benchmark model responds with a fall in activity to a unanticipated increase in the domestic interest rate, while domestic inflation increases. The FAVAR responses to the same shock do not inhabit the same prize puzzle.

We conclude from this experiment that the FAVAR have impulse responses that are more in accordance with economic theory, and thus better identified, than the benchmark model.[25] Further, the number of impulse response functions described by the benchmark model is very limited compared to the FAVAR, which therefore gives a much better description of the transition mechanisms of international and regional shocks to the domestic economy than the benchmark model does.

5 Conclusion

In this paper we have proposed and developed a three-block factor augmented vector autoregression (FAVAR) with separate world, regional and domestic blocks. In our application the region has been defined as Oceania, and the domestic economy as New Zealand. We have identified six shocks; world demand, supply and interest rate shocks, regional demand and supply shocks and a domestic monetary policy shock, and described the transition mechanisms through which these shocks transmit to the domestic economy. By separatively identifying world and regional factors the model allow for heterogeneity in regional developments around the world.

Our main results show that the world have significant effect on both the regional (Oceania) and the domestic (New Zealand) economies, thus highlighting the existence of a world business cycle. Further, our model indicates that the effects of the world inflation factor is a very important factor in the transmission of international shocks to the New Zealand economy, while the regional price factor seems to be important for non-tradables inflation, as well as for the development of terms of trade and domestic wages. Finally,

[25] We do of course acknowledge that our specification of the benchmark model is very simplistic. A more sophisticated identification scheme would perhaps have yielded better results also for the BVAR (see for example Bjørnland [2009]).

the responses to a domestic monetary policy shock are all in accordance with economic theory and exhibits non of the so called "puzzles", e.g. prize and exchange rate puzzles.

We believe the FAVAR's structural properties can be attributed to the use of a large data set and the contemporaries restrictions between fast moving and slow moving variables in the domestic block of the model. The large data set alleviates the problem of omitted variable bias, while the contemporaries restrictions allow interest rates and exchange rates to respond simultaneously to shocks.

In further research we plan to test the model on other small open economies and different regions. It would also be interesting to investigate if our results are sensitive to the two step estimation procedure we have applied, and estimate the whole model simultaneously.

References

References

David Backus, Patrick J. Kehoe, and Finn E. Kydland. International business cycles: Theory and evidence. In C. Plosser, editor, *Frontiers of Business Cycle Research*, pages 331–257. Princeton University Press, 1995.

Jushan Bai and Serena Ng. Determining the number of factors in approximate factor models. *Econometrica*, 70(1):191–221, January 2002. URL http://ideas.repec.org/a/ecm/emetrp/v70y2002i1p191-221.html.

Christiane Baumeister, Philip Liu, and Haroon Mumtaz. Changes in the transmission of monetary policy: Evidence from a time-varying factor-augmented var. mimeo, Bank of England, 2009.

Marianne Baxter and Michael A. Kouparitsas. Determinants of business cycle comovement: a robust analysis. *Journal of Monetary Economics*, 52(1): 113–157, January 2005. URL http://ideas.repec.org/a/eee/moneco/v52y2005i1p113-157.html.

Jaromir Benes, Andrew Binning, Martin Fukac, Kirdan Lees, and Troy Matheson. *KITT: Kiwi Inflation Targeting Technology*. Reserve Bank of New Zealand., 2009.

Ben Bernanke, Jean Boivin, and Piotr S. Eliasz. Measuring the effects of monetary policy: A factor-augmented vector autoregressive (favar) approach. *The Quarterly Journal of Economics*, 120(1):387–422, January 2005. URL http://ideas.repec.org/a/tpr/qjecon/v120y2005i1p387-422.html.

Hilde C. Bjørnland. Monetary policy and exchange rate overshooting: Dornbusch was right after all. *Journal of International Economics*, 79(1): 64–77, September 2009. URL http://ideas.repec.org/a/eee/inecon/v79y2009i1p64-77.html.

Chris Bloor and Troy Matheson. Real-time conditional forecasts with bayesian vars: An application to new zealand. Reserve Bank of New Zealand Discussion Paper Series DP2009/02, Reserve Bank of New Zealand, April 2009.

Jean Boivin and Marc P. Giannoni. Global forces and monetary policy effectiveness. In *International Dimensions of Monetary Policy*, NBER Chapters, pages 429–478. National Bureau of Economic Research, Inc, 2007. URL http://ideas.repec.org/h/nbr/nberch/0515.html.

Jean Boivin, Marc P. Giannoni, and Ilian Mihov. Sticky prices and monetary policy: Evidence from disaggregated us data. *American Economic Review*, 99(1):350–84, 2009. URL http://ideas.repec.org/a/aea/aecrev/v99y2009i1p350-84.html.

R. A. Buckle, K. Kim, H. Kirkham, N. McLellan, and J. Sharma. A structural var business cycle model for a volatile small open economy. *Economic Modelling*, 24(6):990 – 1017, 2007. ISSN 0264-9993. doi: DOI:10.1016/j.econmod.2007.04.003. URL http://www.sciencedirect.com/science/article/B6VB1-4NVCD36-1/2/12307eb0d972a2009a513587fbccb89b.

Fabio Canova. The transmission of us shocks to latin america. *Journal of Applied Econometrics*, 20(2):229–251, 2005. URL http://ideas.repec.org/a/jae/japmet/v20y2005i2p229-251.html.

Matteo Ciccarelli and Benoît Mojon. Global inflation. Working Papers Central Bank of Chile 357, Central Bank of Chile, December 2005. URL http://ideas.repec.org/p/chb/bcchwp/357.html.

Todd Clark and Kwanho Shin. The sources of fluctuations within and across countries. In *Intranational macroeconomics*, pages 189–220. Cambridge University Press, Boston, MA, 2000.

Andrew Coleman. Tradables and non-tradables inflation in australia and new zealand. *Reserve Bank of New Zealand Bulletin*, 70, March 2007. URL http://ideas.repec.org/a/nzb/nzbbul/march20075.html.

Andrew Coleman and Ozer Karagedikli. Does the kiwi fly when the kangaroo jumps? the effects of the australian macro news on the new zealand dollar. Discussion papers, Reserve Bank of New Zealand, 2010. (Forthcoming).

Paul Conway. Macroeconomic variability in New Zealand: An SVAR study. *New Zealand Economic Papers*, December 1998.

Christine De Mol, Domenico Giannone, and Lucrezia Reichlin. Forecasting using a large number of predictors: Is bayesian shrinkage a valid alternative to principal components? *Journal of Econometrics*, 146(2): 318–328, October 2008. URL http://ideas.repec.org/a/eee/econom/v146y2008i2p318-328.html.

Stephane Dees, Filippo di Mauro, L. Vanessa Smith, and M. Hashem Pesaran. Exploring the international linkages of the euro area: a global var analysis. *Journal of Applied Econometrics*, 22(1):1–38, 2007. URL http://ideas.repec.org/a/jae/japmet/v22y2007i1p1-38.html.

Mardi Dungey and Renée Fry. International shocks on australia - the japanese effect. *Australian Economic Papers*, 42(2):158–182, 06 2003. URL http://ideas.repec.org/a/bla/ausecp/v42y2003i2p158-182.html.

Martin Eichenbaum and Charles L Evans. Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *The Quarterly Journal of Economics*, 110(4):975–1009, November 1995. URL http://ideas.repec.org/a/tpr/qjecon/v110y1995i4p975-1009.html.

Mario Forni, Domenico Giannone, Marco Lippi, and Lucrezia Reichlin. Opening the black box - structural factor models with large gross-sections. Working Paper Series 712, European Central Bank, January 2007. URL http://ideas.repec.org/p/ecb/ecbwps/20070712.html.

Viv Hall and John McDermott. An unobserved components common cycle for australia? implications for a common currency. CAMA Working Papers 2008-11, Australian National University, Centre for Applied Macroeconomic Analysis, April 2008. URL http://ideas.repec.org/p/acb/camaaa/2008-11.html.

Alfred A Haug and Christie Smith. Local linear impulse responses for a small open economy. Reserve Bank of New Zealand Discussion Paper

Series DP2007/09, Reserve Bank of New Zealand, April 2007. URL http://ideas.repec.org/p/nzb/nzbdps/2007-09.html.

Ozer Karagedikli, Haroon Mumtaz, and Misa Tanaka. All together now? do world factors explain relative price (co)-movements? Working paper series, Bank of England, April 2010.

Soyoung Kim and Nouriel Roubini. Exchange rate anomalies in the industrial countries: A solution with a structural var approach. *Journal of Monetary Economics*, 45(3):561–586, June 2000. URL http://ideas.repec.org/a/eee/moneco/v45y2000i3p561-586.html.

M. Ayhan Kose, Christopher Otrok, and Charles H. Whiteman. International business cycles: World, region, and country-specific factors. *American Economic Review*, 93(4):1216–1239, September 2003. URL http://ideas.repec.org/a/aea/aecrev/v93y2003i4p1216-1239.html.

M. Ayhan Kose, Christopher Otrok, and Eswar Prasad. Global business cycles: Convergence or decoupling? IZA Discussion Papers 3442, Institute for the Study of Labor (IZA), April 2008. URL http://ideas.repec.org/p/iza/izadps/dp3442.html.

Tommaso Monacelli and Luca Sala. The international dimension of inflation: Evidence from disaggregated consumer price data. *Journal of Money, Credit and Banking*, 41(s1):101–120, 02 2009. URL http://ideas.repec.org/a/mcb/jmoncb/v41y2009is1p101-120.html.

Haroon Mumtaz and Paolo Surico. Evolving international inflation dynamics: evidence from a time-varying dynamic factor model. Bank of England working papers 341, Bank of England, 2008. URL http://ideas.repec.org/p/boe/boeewp/341.html.

Haroon Mumtaz and Paolo Surico. The transmission of international shocks: A factor-augmented var approach. *Journal of Money, Credit and Banking*, 41(s1):71–100, 02 2009. URL http://ideas.repec.org/a/mcb/jmoncb/v41y2009is1p71-100.html.

Christopher Neely and David E Rapach. International comovements in inflation rates and country characteristics. Technical Report 2008-025D, Federal Reserve Bank of St. Louis, 2008.

Daniel F. Waggoner Rubio-Ramirez, Juan F. and Tau Zha. Structural vector autoregressions: Theory of identification and algorithms for inference. *Review of Economic Studies*, (4):1–34, 2009.

Almuth Scholl and Harald Uhlig. New evidence on the puzzles: Results from agnostic identification on monetary policy and exchange rates. *Journal of International Economics*, 76(1):1–13, September 2008. URL http://ideas.repec.org/a/eee/inecon/v76y2008i1p1-13.html.

6 Appendix: The data

In this section we summarise the data we have used. Table 3 lists the series used in each block of the model and also displays the different transformation we have used. Act, Pri, R, D and R. are abbreviations for activity, price, interest rate, domestic and domestic interest rate numbers respectively. A * indicates that the block consists of world or global variables, while ** indicates that the variable block consists of regional variables. m and q are abbreviations for monthly and quarterly frequency respectively. The following transformation codes have been applied: 0 = no transformation, 2 = difference and 6 = growth rates. The international and regional data is collected from HAVER Analytics Database.

Table 3: Data overview

Var. num.	Freq.	Trans.	Block	Description
1	q	6	Act*	U.S.: Gross Domestic Product (SAAR, Bil.Chn.2005$)
2	q	6	Act*	U.K.: Gross Domestic Product (SA, Mil.Chained.2005.Pounds)
3	q	6	Act*	Switzerland: Gross Domestic Product (SA, Mil.Chn.2000.Francs)
4	q	6	Act*	Norway: Gross Domestic Product (SA, Mil.Chn.2006.Kroner)
5	q	6	Act*	Netherlands: Gross Domestic Product (SA/WDA, Mil.Chained.2000.Euros)
6	q	6	Act*	Japan: Gross Domestic Product (SAAR, Bil.Chn.2000.Yen)
7	q	6	Act*	Italy: Gross Domestic Product (SA/WDA, Mil.Chn.2000.Euros)
8	q	6	Act*	France: Gross Domestic Product (SA/WDA, Mil.Chn.2000.Euros)
9	q	6	Act*	Finland: Gross Domestic Product (SA, Mil.Chn.2000.Euros)
10	q	6	Act*	Denmark: Gross Domestic Product (SA, Mil.Chn.2000.Kroner)
11	q	6	Act*	Canada: Gross Domestic Product (SAAR, Mil.Chn.2002.C$)
12	q	6	Act*	U.S.: Industrial Production excluding Construction (SA, 2002=100)
13	q	6	Act*	U.K.: Industrial Production excluding Construction (SA, 2005=100)
14	q	6	Act*	Switzerland: Industrial Production excluding Construction (SA, 1995=100)
15	q	6	Act*	Sweden: Industrial Production excluding Construction (SA/WDA, 2005=100)
16	q	6	Act*	Spain: Industrial Production excluding Construction (SA/H, 2005=100)
17	q	6	Act*	Norway: Industrial Production excluding Construction (SA/WDA, 2005=100)
18	q	6	Act*	Luxembourg: Industrial Production excluding Construction (SA/WDA, 2005=100)
19	q	6	Act*	Italy: IP: Total Industry excl Construction (SA/WDA, 2005=100)
20	q	6	Act*	Ireland: Industrial Production excluding Construction (SWDA, 2005=100)
21	q	6	Act*	Germany: Industrial Production: Total Industry ex Construction(SA/WDA, 2005=100)
22	q	6	Act*	France: Industrial Production excluding Construction (SA/WDA, 2005=100)
23	q	6	Act*	Canada: Industrial Production: Manufacturing, Mining & Utilities (SA, 2002=100)
24	q	6	Act*	Belgium: Industrial Production excluding Construction (SA, 2000=100)
25	q	6	Act*	Austria: Industrial Production: Industry excl Construction (SA/WDA, 2005=100)
26	q	6	Act*	U.S.: Capacity Utilization: Industry (SA, %)
27	q	6	Act*	U.K.: Harmonized Capacity Utilization: Manufacturing (SA, %)
28	q	6	Act*	Netherlands: Harmonized Capacity Utilization: Manufacturing (SA, %)
29	q	6	Act*	Italy: Harmonized Capacity Utilization: Manufacturing (SA, %)
30	q	6	Act*	Germany: Harmonized Capacity Utilization: Manufacturing (SA, %)
31	q	6	Act*	Denmark: Harmonized Capacity Utilization: Manufacturing (SA, %)
32	q	6	Act*	Belgium: Harmonized Capacity Utilization: Manufacturing (SA, %)
33	q	2	Act*	U.S.: Civilian Unemployment Rate (SA, %)
34	q	2	Act*	Switzerland: Registered Unemployment Rate (SA, %)
35	q	2	Act*	Sweden: Unemployment Rate (SA, %)
36	q	2	Act*	Spain: Unemployment Rate (SA, %)
37	q	2	Act*	Japan: Unemployment Rate (SA, %)
38	q	2	Act*	France: LFS: Unemployment Rate (SA, %)
39	q	2	Act*	Finland: Unemployment Rate (SA, %)
40	q	2	Act*	Canada: Unemployment Rate: 15 Years and Over (SA, %)
41	q	2	Act*	Austria: Registered Unemployment Rate (SA, %)
42	q	6	Act*	US: S&P/Case-Shiller Home Price Index (SA, Q1-00=100)
43	q	6	Act*	Switzerland: Housing Prices, Single-Family Homes (SA, Q1-70=100)
44	q	6	Act*	Sweden: Housing Prices, Single-Family & 2-Family Homes (SA, 1981=100)
45	q	6	Act*	Ireland: Average Price of Existing Homes (SA, Euros)
46	q	6	Act*	Finland: Housing Prices, Detached Houses (SA, 1985=100)
47	q	6	Act*	Canada: Housing Prices, New Houses (SA, 1997=100)
48	q	6	Act*	U.S.: Housing Starts (SAAR, Thous.Units)
49	q	6	Act*	India: IP: Total Industry excl Construction (SA, FY93=100)
50	q	6	Act*	Korea: IP: Total Industry excl Construction (SA, 2005=100)

Continued on next page

Table 3 – continued from previous page

Var. number	Freq.	Trans.	Block	Description
51	q	6	Act*	Malaysia: IP: All Divisions excl Construction (SA, 2005=100)
52	q	6	Act*	Taiwan: IP: Total Industry incl Construction (SA, 2006=100)
53	q	6	Act*	Taiwan: IP: Manufacturing (SA, 2006=100)
54	q	6	Act*	Singapore: IP: Manufacturing excl Rubber Processing (SA, 2007=100)
55	q	6	Act*	Korea: IP: Manufacturing (SA, 2005=100)
56	q	6	Act*	Hong Kong: IP: Manufacturing (SA, 2008=100)
57	q	6	Act*	Hong Kong: Gross Domestic Product (SA, Mil.Chn.2007.HK $)
58	q	6	Act*	Singapore: Gross Domestic Product (SA, Mil.2000.S $)
59	q	6	Act*	Taiwan: Gross Domestic Product (SA, Mil.2001.NT $)
60	q	2	Act*	Taiwan: Unemployment Rate (SA, %)
61	q	6	Act*	China: Merchandise Exports, fob (SA, Bil.Yuan)
62	q	6	Act*	Hong Kong: Merchandise Exports (SA, Mil.HK $)
63	q	6	Act*	India: Merchandise Exports (SA, Bil.Rupees)
64	q	6	Act*	Malaysia: Merchandise Exports, fob (SA, Mil.Ringgit)
65	q	6	Act*	Singapore: Merchandise Exports, fob (SA, Mil.S $)
66	q	6	Act*	Korea: Merchandise Exports (SA, Bil.Won)
67	q	6	Act*	Thailand: Merchandise Exports, fob (SA, Mil.Bahts)
68	q	6	Act*	China: Merchandise Imports, cif (SA, Bil.Yuan)
69	q	6	Act*	Hong Kong: Merchandise Imports (SA, Mil.HK $)
70	q	6	Act*	India: Merchandise Imports (SA, Bil.Rupees)
71	q	6	Act*	Malaysia: Merchandise Imports, fob (SA, Mil.Ringgit)
72	q	6	Act*	Singapore: Merchandise Imports, cif (SA, Mil.S $)
73	q	6	Act*	Korea: Merchandise Imports (SA, Bil.Won)
74	q	6	Act*	Thailand: Merchandise Imports, cif (SA, Mil.Bahts)
75	q	0	Act*	Singapore: Business Expectations: Manufacturing Sector (NSA, %)
76	q	6	Pri*	U.S.: Consumer Price Index (SA, 1982-84=100)
77	q	6	Pri*	U.K.: Harmonized Index of Consumer Prices [HICP] (SA, 2005=100)
78	q	6	Pri*	Switzerland: Consumer Price Index (SA, December 2005=100)
79	q	6	Pri*	Sweden: Consumer Price Index (SA, 1980=100)
80	q	6	Pri*	Spain: Consumer Price Index (SA, 2006=100)
81	q	6	Pri*	Portugal: Consumer Price Index (SA, 2008=100)
82	q	6	Pri*	Norway: Consumer Price Index (SA, 1998=100)
83	q	6	Pri*	Luxembourg: Consumer Price Index (SA, 2005=100)
84	q	6	Pri*	Japan: Consumer Price Index (SA/H, 2005=100)
85	q	6	Pri*	Italy: Consumer Price Index (SA, 1995=100)
86	q	6	Pri*	Ireland: Consumer Price Index (SA, Dec-06=100)
87	q	6	Pri*	Greece: Consumer Price Index (SA, 2005=100)
88	q	6	Pri*	Germany: Consumer Price Index (SA, 2005=100)
89	q	6	Pri*	France: Consumer Price Index (SA, 1998=100)
90	q	6	Pri*	Finland: Consumer Price Index (SA, 2005=100)
91	q	6	Pri*	Denmark: Consumer Price Index (SA, 2000=100)
92	q	6	Pri*	Belgium: Consumer Price Index (SA, 2004=100)
93	q	6	Pri*	U.K.: PPI: Net Output Prices: Manufactured Products (SA, 2005=100)
94	q	6	Pri*	Switzerland: Producer Price Index (SA, May-03=100)
95	q	6	Pri*	Spain: Industrial Prices: Total Industry (SA, 2005=100)
96	q	6	Pri*	Portugal: Industrial Price Index (SA, 2005=100)
97	q	6	Pri*	Norway: Producer Price Index (SA, 2000=100)
98	q	6	Pri*	Netherlands: PPI: Manufacturing (SA, 2005=100)
99	q	6	Pri*	Japan: Output Price: Manufacturing (SA, 2000=100)
100	q	6	Pri*	Italy: Producer Price Index (SA, 2005=100)
101	q	6	Pri*	Germany: PPI: Total Industry excluding Construction (SA, 2005=100)
102	q	6	Pri*	Canada: Industrial Price Index: All Commodities (SA, 1997=100)
103	q	6	Pri*	Belgium: Producer Price Index: Output Prices (SA, 2000=100)
104	q	6	Pri*	India: Wholesale Price Index: All Items (SA, FY, 1993=100)
105	q	6	Pri*	Korea: Producer Price Index: All Items (SA, 2005=100)
106	q	6	Pri*	Philippines: Wholesale Price Index: All Items (SA, 1998=100)
107	q	6	Pri*	Singapore: Wholesale Price Index: Domestic Supply (SA, 2006=100)
108	q	6	Pri*	Taiwan: Wholesale Price Index (SA, 2006=100)
109	q	6	Pri*	Australia: Producer Price Index: Manufacturing (NSA, 1989-90=100)
110	q	6	Pri*	Australia: Export Price Index (NSA, Q3:89-Q2:90=100)
111	q	6	Pri*	U.S.: Export Price Index: All Exports (SA, 2000=100)
112	q	6	Pri*	U.K.: Export Price Index: Total Goods (SA, 2005=100)
113	q	6	Pri*	Sweden: Export Price Index: Total Agriculture/Industry excl Constr(SA, 2005=100)
114	q	6	Pri*	Spain: Export Price Index (SA, 2000=100)
115	q	6	Pri*	Norway: Export Price Index (SA, 2000=100)
116	q	6	Pri*	Germany: Export Price Index (SA, 2005=100)
117	q	6	Pri*	Australia: Export Price Index (SA, Q3:89-Q2:90=100)
118	q	6	Pri*	Hong Kong: Trade Unit Value Index: Exports (SA, 2000=100)
119	q	6	Pri*	Taiwan: Export Prices (SA, 2006=100)
120	q	0	R*	Australia: 3-Month Bank Accepted Bills (AVG, %)
121	q	0	R*	Belgium: Treasury Bill Rate: 3 Months (AVG, %)
122	q	0	R*	Canada: 3-Month Treasury Bill Yield (AVG, %)
123	q	0	R*	Denmark: Interbank Offered Rate: 3-months (AVG, %)
124	q	0	R*	Euro Area11-16: 3-Month Average Money Market Rate (AVG, %)
125	q	0	R*	France: 3-Month Treasury Bill Bid Yield (AVG, %)
126	q	0	R*	Germany: 3-Month Interbank Offered Rate FIBOR (AVG, %)
127	q	0	R*	Netherlands: Loans to Local Government: 3-months (AVG, %)
128	q	0	R*	New Zealand: 90-Day Bank Bill Yield (AVG, %)
129	q	0	R*	Norway: 3-Month Interbank Offered Rate NIBOR (AVG, %)
130	q	0	R*	Spain: 3-Month Interbank Offered Rate Nontransferable Deposits (AVG, %)
131	q	0	R*	Sweden: 3-Month Treasury Bill Yield (AVG, %)

Continued on next page

Table 3 – continued from previous page

Var. number	Freq.	Trans.	Block	Description
132	q	0	R*	Switzerland: 3-Month Interbank Offered Rate Swiss Franc LIBOR (AVG, %)
133	q	0	R*	U.K.: 3-Month London Interbank Offered Rate: Based on British Pound (AVG, %)
134	q	0	R*	U.S.: 3-Month London Interbank Offered Rate: Based on US $ (AVG, %)
135	q	0	R*	Hong Kong: Interbank Rate: 3-month (Avg, % per annum)
136	q	0	R*	Singapore: 3-Month Interbank Rate (% per annum)
137	q	0	R*	Thailand: Commercial Banks Time Deposit Rate: 3-month (% per annum)
138	q	6	Act**	Australia: Gross Domestic Product (SA, Mil.Chn.Q3/06-Q2/07.A $)
139	q	6	Act**	Australia: Industrial Production excl Construction (SA, Q3/06-Q2/07=100)
140	q	6	Act**	Australia: Unemployment Rate (SA, %)
141	q	6	Act**	Australia: Housing Prices, Existing Homes (SA, Q3:03-Q2:04=100)
142	q	6	Act**	Australia: Number of Buildings Started (SA, Units)
143	q	6	Act**	Australia: Pvt Capital Exp: Buildings & Structures (SA, Mil.Chn.Q3:06-Q2:07.A $)
144	q	6	Act**	Australia: Pvt Capital Exp: Eqpt, Plant & Machinery (SA, Mil.Chn.Q3:06-Q2:07.A $)
145	q	6	Act**	Australia: Private New Actual Capital Exp: Mining (SA, Mil.Chn.Q3:06-Q2:07.A $)
146	q	6	Act**	Australia: Private New Actual Capital Exp: Mfg (SA, Mil.Chn.Q3:06-Q2:07.A $)
147	q	6	Act**	Australia: IP: Manufacturing (SA, Q3:06-Q2:07=100)
148	q	6	Act**	Australia: IP: Mining (SA, Q3:06-Q2:07=100)
149	q	6	Act**	Australia: IP: Other Manufacturing (SA, Q3:06-Q2:07=100)
150	q	6	Act**	Australia: IP: Printing, Publish, Recorded Media (SA, Q3:06-Q2:07=100)
151	q	6	Act**	Australia: IP: Wood and Paper Products (SA, Q3:06-Q2:07=100)
152	q	6	Act**	Australia: IP: Metal Products (SA, Q3:06-Q2:07=100)
153	q	6	Act**	Australia: IP: Machinery and Equipment (SA, Q3:06-Q2:07=100)
154	q	6	Act**	Australia: IP: Non-metallic Mineral Products (SA, Q3:06-Q2:07=100)
155	q	6	Act**	Australia: IP: Petroleum, Coal, Chemical, etc (SA, Q3:06-Q2:07=100)
156	q	6	Act**	Australia: IP: Textile, Clothing, Footwear (SA, Q3:06-Q2:07=100)
157	q	6	Act**	Australia: IP: Food, Beverage and Tobacco (SA, Q3:06-Q2:07=100)
158	q	6	Act**	Australia: Dwelling Units Approved: New Houses (NSA, Units)
159	q	6	Act**	Australia: Dwelling Units Approved: New Other Residential (NSA, Units)
160	q	6	Act**	Australia: Dwelling Units Approved: Total (NSA, Units)
161	q	6	Act**	Australia: Construction Work Done: Public Construction (SA, Chn.Q3:06-Q2:07.A $)
162	q	6	Act**	Australia: Construction Work Done: Private Construction (SA, Chn.Q3:06-Q2:07.A $)
163	q	6	Act**	Australia: Average Weekly Actual Hours Worked (NSA, Hours)
164	q	6	Act**	Australia: Retail Sales (SA, Mil.A $)
165	q	6	Act**	Australia: Sales: Total Manufacturing (SA, Mil.A $)
166	q	6	Act**	Australia: GDP: Final Consumption Expenditure (SA, Mil.Chn.Q3:07-Q2:08.A $)
167	q	6	Act**	Australia: GDP: Gross Fixed Capital Formation (SA, Mil.Chn.Q3:07-Q2:08.A $)
168	q	6	Act**	Australia: GDP: Public Gross Fixed Cap Formation (SA, Mil.Chn.Q3:07-Q2:08.A $)
169	q	6	Act**	Australia: GDP: Exports of Goods and Services (SA, Mil.Chn.Q3:07-Q2:08.A $)
170	q	6	Act**	Australia: GDP: Imports of Goods and Services (SA, Mil.Chn.Q3:07-Q2:08.A $)
171	q	0	Act**	Australia: Westpac-Melbourne Institute Consumer Sentiment Index (SA, Index)
172	q	0	Act**	Australia: NAB Business Confidence Index: Net Balance (NSA, %)
173	q	6	Act**	Australia: Industrial Production (SA, Q3:06-Q2:07=100)
174	q	6	Pri**	Australia: Export Price Index (SA, Q3:89-Q2:90=100)
175	q	6	Pri**	Australia: Consumer Price Index (SA, Q3/89-Q2/90=100)
176	q	0	Pri**	Australia: CPI Market Prices: Total excl Volatile Items (NSA, Qtr/Qtr % Chg)
177	q	0	Pri**	Australia: CPI Market Prices: Goods excl Volatile Items (NSA, Qtr/Qtr % Chg)
178	q	0	Pri**	Australia: CPI Market Prices: Services excl Volatile Items(NSA, Qtr/Qtr % Chg)
179	q	6	Pri**	Australia: CPI Weighted Median (SA, QTR % Change)
180	q	6	Pri**	Australia: CPI Trimmed Mean (SA, QTR % Change)
181	q	6	Pri**	Australia: CPI: Sydney (NSA, Q3.89-Q2.90=100)
182	q	6	Pri**	Australia: CPI: Melbourne (NSA, Q3.89-Q2.90=100)
183	q	6	Pri**	Australia: CPI: Brisbane (NSA, Q3.89-Q2.90=100)
184	q	6	Pri**	Australia: CPI: Adelaide (NSA, Q3.89-Q2.90=100)
185	q	6	Pri**	Australia: CPI: Housing: Rents (NSA, Q3.89-Q2.90=100)
186	q	6	Pri**	Australia: CPI: Housing: Electricity (NSA, Q3.89-Q2.90=100)
187	q	6	Pri**	Australia: CPI: Housing: Gas and Other Household Fuels (NSA, Q3.89-Q2.90=100)
188	q	6	Pri**	Australia: CPI: Housing: House Repairs and Maintenance (NSA, Q3.89-Q2.90=100)
189	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, North Asia: Total all age groups
190	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, China, ACTUAL
191	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, India, ACTUAL
192	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, Korea, ACTUAL
193	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, United Kingdom, ACTUAL
194	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, Other, ACTUAL
195	m	6	D	PERM & LONG-TERM MIGRATION - Arrivals, South Africa, ACTUAL
196	q	6	D	QES Total Paid Hours - Total All Industries
197	q	6	D	QES Filled Jobs Total Status - Manufacturing
198	q	6	D	QES Filled Jobs Total All Industries - Total Status
199	q	6	D	Full Time Equivalent - total
200	q	6	D	HLFS OFFICIAL EMPLOYED
201	q	6	D	HLFS OFFICIAL LAB. FORCE
202	q	6	D	HLFS WORKING AGE POPULATION
203	q	2	D	HLFS TOTAL PARTICIPATION RATE
204	q	6	D	HLFS OFFICIAL UNEMPD
205	q	2	D	HLFS OFFICIAL UNEMPLOYMENT RATE
206	q	6	D	REAL RETAIL SALES - GRAND TOTAL - S.A.
207	q	6	D	REAL RETAIL SALES - SUB - S.A.
208	q	6	D	Real GDP - Total Household Consumption (SA)
209	q	6	D	Real GDP - Total Private Consumption (SA)
210	q	6	D	Real GDP - Market Investment total (including dwellings) (s.a.)
211	q	6	D	Real GDP - Private Investment Total (SA)
212	q	6	D	Real GDP - Govt Investment Total (SA)

Continued on next page

Table 3 – continued from previous page

Var. number	Freq.	Trans.	Block	Description
213	q	6	D	Real GDP - Total Investment (SA)
214	q	6	D	Real GDP - Imports Goods Total (SA)
215	q	6	D	Real GDP - Imports Services (SA)
216	q	6	D	Real GDP - Imports Total (SA)
217	q	6	D	Real GDP - Exports of Goods (SA)
218	q	6	D	Real GDP - Exports of Services (SA)
219	q	6	D	Real GDP - Exports Total (SA)
220	q	6	D	Real GDP - Exports - Dairy Products (SA)
221	q	6	D	Real GDP - Gross National Expenditure (SA)
222	q	6	D	Real Prod GDP - Manufacturing - Total (SA) (HOTP, prior to 87q2: RBNZ backdate)
223	q	6	D	Real GDP - Total Production GDP (SA) (For RBNZ backdate: see f.notes)
224	m	6	D	Cement sales, confidencial do not release
225	q	0	D	QSBO - ECONOMY-WIDE - NEXT 3 MONTHS - Domestic Trading Activity
226	q	0	D	QSBO - ECONOMY-WIDE - PAST 3 MONTHS - Domestic Trading Activity
227	q	0	D	QSBO: RBNZ Calculated - MANUFACTURERS - Capacity Utilisation - Average Measure
228	q	0	D	QSBO - ECONOMY-WIDE - Capacity Utilisation
229	m	6	D	Consents - OTHER BUILDING -TOTAL NEW VALUE - TOTAL NZ
230	m	6	D	Consents - DWELLINGS - HOUSES & FLATS - NEW - VALUE - TOTAL NZ
231	m	6	D	Consents - DWELLINGS - TOTAL NEW/ALTERED VALUE - NZ
232	m	6	D	Consents - DWELLINGS - TOTAL ADD/ALT - NUMBER - NZ
233	m	6	D	Consents - DWELLINGS - TOTAL NEW/ALTERED NUMBER - NZ
234	m	6	D	New residential buildings - units - total (see ADNPH)
235	m	6	D	New residential buildings - value - total (see ADVPH)
236	m	6	D	Total Dwellings - New - value
237	m	6	D	Total Dwellings - New - floor area
238	q	0	D	Terms of Trade Index
239	q	6	D	Real building work
240	q	6	D	Real building work
241	q	6	D	Real building work
242	q	6	D	Building work
243	q	6	D	Building work
244	m	6	D	DWELLING PRICE - REINZ
245	q	6	D	QUARTERLY HOUSE PRICE INDEX - s.a.
246	q	6	D	Headline
247	q	6	D	Non-tradable
248	q	6	D	Tradable
249	q	6	D	Meat and poultry
250	q	6	D	Fish and other seafood
251	q	6	D	Bread and cereals
252	q	6	D	Milk, cheese and eggs
253	q	6	D	Food additives and condiments
254	q	6	D	Soft drinks, waters and juices
255	q	6	D	Restaurant meals
256	q	6	D	Ready-to-eat food
257	q	6	D	Spirits and liqueurs
258	q	6	D	Cigarettes and tobacco
259	q	6	D	Mens clothing
260	q	6	D	Womens clothing
261	q	6	D	Childrens and infants clothing
262	q	6	D	Mens footwear
263	q	6	D	Childrens and infant' footwear
264	q	6	D	Actual rentals for housing
265	q	6	D	Purchase of housing
266	q	6	D	Property maintenance services
267	q	6	D	Electricity
268	q	6	D	Solid fuels
269	q	6	D	Furniture and furnishings
270	q	6	D	Carpets and other floor coverings
271	q	6	D	Household textiles
272	q	6	D	Major household appliances
273	q	6	D	Small electrical household appliances
274	q	6	D	Repair and hire of household appliances
275	q	6	D	Glassware, tableware and household utensils
276	q	6	D	Major tools and equipment for the house and garden
277	q	6	D	Other household services
278	q	6	D	Dental services
279	q	6	D	Purchase of new motor cars
280	q	6	D	Purchase of second-hand motor cars
281	q	6	D	Purchase of motorcycles
282	q	6	D	Purchase of bicycles
283	q	6	D	Vehicle parts and accessories
284	q	6	D	Petrol
285	q	6	D	Other vehicle fuels and lubricants
286	q	6	D	Vehicle servicing and repairs
287	q	6	D	Domestic air transport
288	q	6	D	International air transport
289	q	6	D	Postal services
290	q	6	D	Audio-visual equipment
291	q	6	D	Games, toys and hobbies
292	q	6	D	Equipment for sport, camping and outdoor recreation
293	q	6	D	Plants, flowers and gardening supplies

Continued on next page

Table 3 – continued from previous page

Var. number	Freq.	Trans.	Block	Description
294	q	6	D	Recreational and sporting services
295	q	6	D	Veterinary services
296	q	6	D	Early childhood education
297	q	6	D	Hairdressing and personal grooming services
298	q	6	D	Other appliances, articles and products for personal care
299	q	6	D	Jewellery and watches
300	q	6	D	Dwelling insurance
301	q	6	D	Contents insurance
302	q	6	D	Health insurance
303	q	6	D	Vehicle insurance
304	q	6	D	Direct credit service charges
305	q	6	D	Professional services
306	q	6	D	Real estate services
307	q	6	D	Other miscellaneous services nec
308	q	6	D	Wage Rates Private Sector - Agriculture
309	q	6	D	Wage Rates Private Sector - Mining
310	q	6	D	Wage Rates Private Sector - Food, Bev & Tabacco
311	q	6	D	Wage Rates Private Sector - Textiles, Apparel etc.
312	q	6	D	Wage Rates Private Sector - Wood & Paper Products
313	q	6	D	Wage Rates Private Sector - Printing, Publishing & Recorded Media
314	q	6	D	Wage Rates Private Sector - Chemicals, Petroleum etc.
315	q	6	D	Wage Rates Private Sector - Nonmetalic Mineral Products
316	q	6	D	Wage Rates Private Sector - Metal Products
317	q	6	D	Wage Rates Private Sector - Machinery & Equipment
318	q	6	D	Wage Rates Private Sector - Total Manufacturing
319	q	6	D	Wage Rates Private Sector - Construction
320	q	6	D	Wage Rates Private Sector - Transport & Storage
321	q	6	D	Wage Rates Private Sector - Finance & Insurance
322	q	6	D	Wage Rates Private Sector
323	q	6	D	Wage Rates Public Sector
324	q	6	D	Wage Rates All Sectors
325	q	6	D	PPI Inputs - All Industries
326	q	6	D	PPI Outputs - All Industries
327	q	6	D	PPII - Agriculture
328	q	6	D	Import price index - Petroleum and Petroleum Products
329	q	6	D	Import price index - Total Non-Commodity Manufactured Goods
330	q	6	D	Import Price Index - Total Non-Oil Commodity Goods
331	q	6	D	Import Price Index Total Merchandise Imports
332	q	6	D	Import Price Index Capital Goods - Total
333	q	0	D	CPI BASED REAL EXCHANGE RATE: Relative TWeighted CPI's
334	m	0	D	Real NZ/AU exchange rate
335	m	0	D	Real NZ/US exchange rate
336	m	0	D	Real NZ/Japan exchange rate
337	m	0	D	Real NZ/UK exchange rate
338	m	0	D	Real NZ/EU exchange rate
339	m	0	D	Real NZ/Korea exchange rate
340	m	0	D	Real NZ/China exchange rate
341	m	0	D	Real NZ/Malaysia exchange rate
342	m	0	D	Real NZ/Hong Kong exchange rate
343	m	0	D	Real NZ/Indonesia exchange rate
344	m	0	D	Real NZ/Thailand exchange rate
345	m	0	D	Real NZ/Singapore exchange rate
346	m	0	D	Real NZ/Canada exchange rate
347	m	0	D	Real NZ/Taiwan exchange rate
348	m	6	D	ANZ COMMODITY PRICE INDEX - NZ$
349	m	6	D	ANZ COMMODITY PRICE INDEX - NZ$ - MEAT, SKINS & WOOL
350	m	6	D	ANZ COMMODITY PRICE INDEX - NZ$ - HORTICULTURAL PRODUCTS
351	m	6	D	ANZ COMMODITY PRICE INDEX - NZ$ - DAIRY PRODUCTS
352	q	0	D	SURVEY OF EXPECTATIONS - Exp Ann CPI - 1 year from now
353	q	0	D	SURVEY OF EXPECTATIONS - Exp Ann CPI - 2 years from now
354	m	0	D	NATIONAL BANK - PRICING INTENTIONS - Next 3 Months - Total (all sectors)
355	m	0	D	30 day Bank Bill yield (average 11am)
356	m	0	D	60 day Bank Bill yield (average 11am)
357	m	0	D	180 day Bank Bill yield (average 11am)
358	m	0	D	1 year Government Bond yield (average 11am)
359	m	0	D	2 year Government Bond yield (average 11am).
360	m	0	D	3 year Government Bond yield (average 11am)
361	m	0	D	5 year Government Bond Yield (average 11am).
362	m	0	D	10 year Government Bond Yield (average 11am).
363	m	0	R	3-month bank bill rate at 11am