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Keywords

News shocks, business cycles, open economy macroeconomics, financial frictions, VAR

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News-driven business cycles in small open economies ^{*}

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25 November 2013

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1 Introduction

Does news about future total factor productivity generate business cycles in small open economies? There is a long tradition in macroeconomics and some recent empirical evidence that suggests news about the future might be an important driver of the business cycle.¹ There has been a lot of recent interest in incorporating this idea into modern business cycle models. One of the main challenges emerging from this literature is to develop equilibrium business cycle models that replicate data-congruent macroeconomic co-movement in response to news shocks.² The emphasis in most of this literature, particularly on the empirical side, is on the effect of news shocks in closed economies.

In this paper, we provide some empirical evidence and develop a theoretical model to show that news about the future productivity generate economic booms and co-movement between macroeconomic aggregates in developed small open economies.

We make two contributions. The first contribution is to identify the dynamic macroeconomic effects of news shocks in four small open economies: Australia, Canada, New Zealand and the United Kingdom. To this end, we construct, for each country, a measure of total factor productivity. We then estimate a structural vector autoregression (SVAR) with our measure of TFP and six macroeconomic variables. The SVAR enables us to identify country-specific news shocks using a combination of sign and zero type restrictions or shape restrictions.

Our identification strategy closely follows Beaudry, Nam, and Wang (2011). Their baseline specification identifies what they call optimism shocks under the assumption that these shocks do not have a contemporaneous effect on TFP but still generate an increase in stock prices. In order to ensure that we can identify news as opposed to optimism shocks we impose additional sign restrictions on the path of TFP. In particular, we restrict the productivity measure to rise for four quarters after the first impact of the news shock on TFP. In Beaudry et al. (2011), positive shocks to optimism are not necessarily associated with a subsequent increase in TFP. Since our restrictions forces TFP to increase following

¹See for instance Barsky and Sims (2011) Beaudry et al. (2011), Beaudry and Portier (2004, 2006), Schmitt-Grohé and Uribe (2012) and Fujiwara et al. (2011) and Khan and Tsoukalas (2012)

²Beaudry and Portier (2004, 2007), Jaimovich and Rebelo (2009), Beaudry et al. (2011)

the shock, they allow us to interpret this shock as positive news about future level of TFP.

Within this framework, several alternative identification schemes are investigated. We consider cases where news arrives one and two period in advance, and examine the effects of imposing additional sign restrictions on the path of consumption and investment. Overall, a consistent message emerges from the empirical analysis. In line with the previous VAR evidence for the US economy, we find that good news about future TFP generates a boom in output and a positive co-movement between output, hours worked, consumption and investment.³ News shocks are also associated with countercyclical current account dynamics.

Our second contribution is to develop a small open economy model that is able to replicate the positive co-movements of macro aggregates identified in the data. The model also generates an increase in share prices that underlies our empirical identification scheme. We incorporate financial frictions *à la* Jermann and Quadrini (2012) (JQ) into an otherwise canonical small open economy model. The financial friction in this model arises because firms need to arrange a working capital loan prior to production taking place. Access to finance is constrained by the firm's net wealth position. News shocks interact with the financial friction by relaxing the borrowing constraint faced by firms. This allows firms to increase their demand for labour, which raises output and investment in the anticipation of future increases in TFP. Greater investment and labour input today, creates the expectation of higher dividends in the future, thus raising the share price in anticipation of future TFP.

In the following section, we present results from structural VARs for the four small open economies in the sample. The main focus is on the impulse response functions of macroeconomic aggregates to news shocks. In order to gauge the relative importance of news shocks over the business cycle, we also present variance decomposition of macroeconomic variables implied by the structural VARs. In sections 3 and 4, we discuss the related literature and present our small open economy model with financial frictions. In

³See for instance Beaudry et al. (2011).

section 5, we show that the presence of financial frictions brings the model implied impulse responses close to the ones found in the empirical section. The model nests Jaimovich and Rebelo (2008) as a special case. That allows us to evaluate the relative importance of financial frictions under alternative specifications of wealth effects in households' utility. In the last section, we provide concluding remarks and provide some discussion about the directions the model can be extended in the future.

2 News shocks in open economies

We are interested in analyzing the effects of news shocks in four industrialized small open economies: Australia, Canada, New Zealand and the United Kingdom. In this section, we first present the data used in the empirical exercise. We then describe our time series model and discuss the results under alternative identification schemes. To our best knowledge this is the first rigorous attempt of identifying news shocks in advanced small open economies. In a recent paper, Nam and Wang (2010) investigate the effect of news shock on international trade but their contribution remains focused on the US economy.

2.1 Data

We estimate the VAR model using data on total factor productivity, stock prices and five macroeconomic aggregates: output, consumption, investment, total hours worked and net trade. For each country our data is from OECD and obtained via HAVER. Our sample period is mainly dictated by data availability and covers 1989Q3 to 2011Q3. Output and consumption correspond to gross domestic product and private consumption in real prices, respectively. Investment refers to private non-residential fixed capital formation in real prices. Total hours for each country is constructed as a product of employment and hours worked per employee. All the macroeconomic aggregates are divided by working age population and therefore expressed in per capita terms. Net trade is the difference between exports and imports of goods and services divided by output. Stock prices are

stock market indexes deflated by CPI for each country.

We construct time series for total factor productivity as, to our knowledge, there is no publicly available data for the countries we consider. We use a growth-accounting approach to construct quarterly measure of TFP. We assume quarterly per capita output is modelled by a Cobb-Douglas production function:

$$y_t = a_t + \alpha(u_t + k_t) + (1 - \alpha)n_t \quad (1)$$

where y_t is output, u_t is capital utilization rate, k_t is physical capital input, n_t is total hours worked and α is the capital share. Consistently with the model we develop in section 4, we set α to 0.3. Using quarterly data on these variables, it is straightforward to construct a measure of total factor productivity, a_t . There is, however, no quarterly data available for capital input. We therefore use annual capital data from OECD and transform it to quarterly frequency using information on quarterly investment. Our approach consists of allocating capital into each quarter proportionally to the investment on that particular quarter.

Figure 1 displays the time series used in the estimation. In order to make country comparisons easier, each variable is normalized to 1 at the beginning of the sample. There is a fair amount of heterogeneity in individual country business cycle experiences. There is therefore no a priori reason that the macroeconomic dynamics conditional on news shocks are going to be similar across countries. We see this as a desirable feature as our objective is to investigate whether we can extract some empirical regularities about the effect of expected productivity shocks across countries.

In calculating the TFP, our methodology accounts for movements in the variable capital utilization but ignores changes arising from the intensity with which labor input is used. For the US, Kimball, Fernald, and Basu (2006) constructs a measure of TFP accounting for utilization variations in all the inputs. This is for example the data used in Beaudry, Nam, and Wang (2011). As an external check on the potential impact of this omission on our results, we use the same methodology described above to derive a measure of TFP for the US. In Appendix C, we have replicated Beaudry, Nam, and Wang (2011)

estimation using this alternative measure of TFP. This exercise can be viewed as a test to our methodology of deriving non-US TFP measures. The impulse responses in Figure 11 and variance decompositions in Table 5 show that, although there are some quantitative differences, the overall results are very similar under both measures and suggest that our TFP measure contains the same information as the one derived by Kimball, Fernald, and Basu (2006).

2.2 The Time Series Model

In this section we describe the structure of the time-series model and explains its estimation details. Our empirical model is a vector autoregressive model of order K – VAR(K)

$$\tilde{y}_t = \sum_{i=1}^K \Theta_i \tilde{y}_{t-i} + u_t \quad (2)$$

where u_t is the $N \times 1$ vector of reduced-form errors that is normally distributed with zero and Σ variance-covariance matrix. It is helpful to re-express the VAR model in the following format

$$Y = X\Psi + V$$

where $Y = [\tilde{y}_{h+1}, \dots, \tilde{y}_T]$ is a $N \times T$ matrix containing all the data points in $\tilde{y}_t$, $X = Y_{-h}$ is a $(NK) \times T$ matrix containing the h -th lag of Y , $\Theta = \begin{bmatrix} \Theta_1 & \dots & \Theta_K \end{bmatrix}$ is a $N \times (NK)$ matrix, and $U = [u_{h+1}, \dots, u_T]$ is a $N \times T$ matrix of disturbances.

The number of lags has been selected using information criteria (likelihood ratio test statistic, final prediction error and Akaike's information criterion). All selection criteria suggest that a VAR model with two lags is sufficient to capture the dynamic properties of the macroeconomic data and this is the case for all countries. In order to ensure that our inference is not driven by the selection of a particular lag length we repeat the same analysis using lag choices (VAR(1), VAR(3) and VAR(4)) and the results remain unchanged.

The model has seven variables and the two lags imply a large number of parameters. Their estimation poses serious difficulties with only 22 years of macroeconomic data.

Classical inference techniques deliver estimates that are subject to a large uncertainty and to avoid this we turn into Bayesian inference, where data is combined with prior information. We use Minnesota type priors (Doan et al. (1984), Litterman (1986)), which “shrink” the VAR(K) model towards N independent autoregressive of order one models. This is motivated by the belief/sylised fact that random walk models achieve a very good forecasting performance. Furthermore, evidence provided by Bandbura et al. (2010) and Koop (2011) suggest that when large VAR models are combined with Minnesota priors their projection properties improve dramatically.

The posterior inference is derived as follows. We proceed with the assumption that the prior distribution of the VAR parameter vector has a Normal-Wishart conjugate form

$$\theta|\Sigma \sim N(\theta_0, \Sigma \otimes \Omega_0), \quad \Sigma \sim IW(v_0, S_0). \quad (3)$$

where θ is obtained by stacking the columns of Θ . The prior moments of θ are given by

$$E[(\Theta_k) i, j] = \begin{cases} \delta_i & i = j, k = 1 \\ 0 & \text{otherwise} \end{cases}, \quad Var[(\Theta_k) i, j] = \lambda \sigma_i^2 / \sigma_j^2,$$

and as it is explained by Bandbura et al. (2010) they can be constructed using the following dummy observations

$$Y_D = \begin{pmatrix} \frac{diag(\delta_1 \sigma_1 \dots \delta_N \sigma_N)}{\lambda} \\ 0_{N \times (K-1)N} \\ \dots \\ diag(\sigma_1 \dots \sigma_N) \\ \dots \\ 0_{1 \times N} \end{pmatrix} \quad \text{and} \quad X_D = \begin{pmatrix} \frac{J_K \otimes diag(\sigma_1 \dots \sigma_N)}{\lambda} \\ 0_{N \times NK} \\ \dots \\ 0_{1 \times NK} \end{pmatrix} \quad (4)$$

where $J_K = diag(1, 2, \dots, K)$ and $diag$ denotes the diagonal matrix. The prior moments of (3) are just functions of Y_D and X_D , $\Theta_0 = Y_D X_D' (X_D X_D')^{-1}$, $\Omega_0 = (X_D X_D')^{-1}$, $S_0 = (Y_D - \Theta_0 X_D) (Y_D - \Theta_0 X_D)'$ and $v_0 = T_D - NK$. Finally, the hyper-parameter λ

controls the tightness of the prior.

Since the normal-inverted Wishart prior is conjugate, the conditional posterior distribution of this model is also normal-inverted Wishart Kadiyala and Karlsson (1997)

$$\theta|\Sigma, Y \sim N(\bar{\theta}, \Sigma \otimes \bar{\Omega}), \quad \Sigma|Y \sim IW(\bar{v}, \bar{S}), \quad (5)$$

where the bar denotes that the parameters are those of the posterior distribution. Defining $\hat{\Theta}$ and $\hat{U}$ as the OLS estimates, we have that $\bar{\Theta} = (\Omega_0^{-1}\Psi_0 + YX')(\Omega_0^{-1} + X'X)^{-1}$, $\bar{\Omega} = (\Omega_0^{-1} + X'X)^{-1}$, $\bar{v} = v_0 + T$, and $\bar{S} = \hat{\Theta}X X' \hat{\Theta}' + \Theta_0 \Omega_0^{-1} \Theta_0 + S_0 + \hat{U} \hat{U}' - \bar{\Theta} \bar{\Omega}^{-1} \bar{\Theta}'$.

The values of the persistence – δ_i – and the error standard deviation – σ_i – parameters of the AR(1) model are obtained from its OLS estimation. Sensitivity analysis reveals that the results are robust to different selections of VAR lags. Finally, λ has been set equal to 1, implying relatively loose priors.

2.3 Identification

As in Beaudry et al. (2011), we identify news TFP shock using a combination of zero type and sign restrictions (Uhlig (2005)). To be precise, the TFP shock anticipated in $t + h$ period is identified by imposing zero restrictions on TFP for periods $t, t + 1, \dots, t + h - 1$ and sign restrictions on the responses of a set of variables in the system. In particular, we impose stock prices and consumption to increase after a positive news about future TFP.⁴

Our methodological strategy also enables us to consider, in a VAR framework, news shocks beyond the first period (see, Barsky and Sims (2011) and Beaudry et al. (2011)). That makes the VAR identified responses more comparable to DSGE ones so the former responses can serve a useful device to either asses the empirical predictions of the structural model about new shocks or/and to calibrate the structural parameter vector

⁴We have also considered alternative sign restrictions by restricting the sign of the response of (i) only stock prices, (ii) stock prices and investment and (iii) stock prices, consumption and investment. Given we have four countries, two alternative measure of TFP and consider various durations of zero restrictions on TFP, this gives us an additional 48 sets of impulse responses. The results appear relatively robust to alternative schemes across countries and we do not report them to save space. They are available upon request.

in order the DSGE model to replicate the responses estimated in the data. This closes an important gap in the literature since so far the comparison was achievable only for DSGE model with only one quarter anticipation period (see Barsky and Sims (2011), Kurmann and Otrok (2013), Theodoridis and Zanetti (2013) and Pinter et al. (2013)).

In order to make the paper self contained we describe in this section the mechanics of the identification process starting from the vector moving average representation of the system (2). Under relatively weak restrictions (see Lutkepohl (2007)) the reduced-form model (2) has the following moving average representation

$$\tilde{y}_t = B(L) v_t. \quad (6)$$

The mapping between the reduced-form errors and the structural shocks is given by

$$v_t = A\varepsilon_t, \quad (7)$$

with $AA' = \Sigma$. For any arbitrary orthogonalization of Σ such as the Cholesky decomposition $\Sigma = \tilde{A}\tilde{A}'$ and an orthonormal matrix such that $DD' = I_{dy}$ (where I_{dy} is the $dy \times dy$ identity matrix) the mapping between the reduced-form and structural errors can be reexpressed as

$$v_t = \tilde{A}D\varepsilon_t \quad (8)$$

Having identified the structural shocks the response of variable j to shock i in period h can be obtained as

$$R(j, i, h) = J_j \check{\Theta}^{h-1} \left(\mathbf{1}_K \otimes \tilde{A}D \right) J_i' \quad (9)$$

where $\check{\Theta}$ is the companion matrix of the system (2), $\mathbf{1}_K$ is a $(K \times 1)$ vector of ones, $\otimes$ denotes the Kronecker product and J_v is a selection $(1 \times Kdy)$ vector of one in position v and zeros everywhere else.

As it has been discussed earlier the identification of the news shock requires – on top of some zero type restrictions – the response of a set of variables indexed by $\mathcal{R}_+$ to be positive and these restrictions can last for a number of periods $\mathcal{H}_+$. Beaudry et al.

(2011) achieve the identification of the news shock by employing the procedure developed by Uhlig (2005) and Mountford and Uhlig (2009) and it is known as penalty function approach. This framework allows the user to easily combine zero and sign restrictions by solving the following minimisation problem

$$d^* = \arg \min \sum_{j \in \mathcal{R}_+} \sum_{h_j \in \mathcal{H}_+} f \left(- \frac{J_j \ddot{\Theta}^{h-1} (\mathbf{1}_K \otimes \tilde{A}d)}{\sigma_j} \right) \quad (10)$$

s.t.

$$d'd = 1 \quad (11)$$

$$R(1, 2, \tilde{h}) = 0 \quad (12)$$

where $d = De'_i$, $\tilde{h} = 1, 2, 3$, e_i denotes the column i of I_N , σ_j is the standard deviation of $R(j, i, h)$ and $f(x) = \begin{cases} 100x & \text{if } x \geq 0 \\ x & \text{otherwise} \end{cases}$. Expression (11) indicates that d^* must be a column of an orthonormal matrix D , while equation (12) says that the news shock ($i = 2$) cannot have an effect on TFP ($j = 1$) for periods $\tilde{h}$. Finally, the objective function (10) is scaled by the standard deviation of impulse response $R(j, i, h)$ to make it comparable across different variables.

2.4 Empirical results

In this section, we discuss impulse responses and forecast error variance decompositions obtained from the structural VAR. The identification puts restrictions on the responses of TFP, consumption and share prices. We consider two alternative sets of zero restrictions on the response of TFP. In the first one, we restrict the initial response of TFP to be zero for one quarter and then positive for the following four quarters. In the second, TFP is restricted to remain at zero for two quarters. In both cases, consumption and share prices are restricted to increase on impact following a positive news shock.

Figure 2 shows the corresponding impulse responses for the case TFP is restricted

to be zero for one quarter. After the restriction window ends, TFP remains persistently above its pre-shock level in all countries except in Canada. Stock prices also increase on impact but again with the exception of Canada the peak impact occurs several quarters after the shock. Possibly reflecting their volatility, the impact response of stock prices are one order of magnitude higher than the response of TFP.

Turning to the response of macroeconomic variables; output, consumption, investment and hours worked all increase in response to news. There is, however, some degree of heterogeneity in the magnitude and subsequent path of these variables. The impact response of consumption is around 0.4% for all economies. In Australia and Canada, however, the rise in consumption is somewhat less persistent than in New Zealand and the United Kingdom.

For all countries the response of GDP displays a hump-shaped pattern. The peak response of GDP is reached between four and six quarters after the shock. In the United Kingdom the response of GDP is less front loaded. Consistent with the delayed response of GDP, total hours also increase gradually in the UK. In the other economies in our sample, hours increase on impact. For all countries, the initial response of investment is small, but rises strongly in subsequent quarters.

We find that net trade is countercyclical in all four countries following a positive news shock, with some small differences in the initial responses. Except for Canada, the initial response of net trade is small, as is the case for investment. In the periods after the shock, net trade deteriorates in all economies.

Figure 3 shows the impulse responses when we restrict both the initial and the second period response of TFP to zero. Overall this does not alter our results. Only in the case of New Zealand is the initial impact on GDP somewhat reduced, which results in a more strongly countercyclical net trade. Qualitatively, the results are very similar across our two identification schemes. The conclusion we draw from our empirical analysis so far is that for our set of small open economies, news about total factor productivity generates a positive co-movement between macroeconomic aggregates and countercyclical net trade.

So far, we have interpreted our identified news shocks as a purely domestic shock.

It is likely that TFP growth in small open economies has both a domestic as well as a global component. To take account of this, we construct a measure of TFP for each country relative to a measure of global TFP. This allows us to isolate country specific shocks. There is, however, no obvious measure of world TFP available. Hence, we take US TFP as a proxy. Figure 4 and 5 show the resulting impulse responses from replicating our baseline estimation using relative TFP. Overall the results are very similar, both qualitatively and quantitatively. For Canada, the economy with the closest links to the US in our sample, we observe the largest difference. When we use the relative TFP, first, the news shock leads to a more significant subsequent increase in TFP and second, the response of share prices is more pronounced. Additionally, net trade displays a greater degree of counter-cyclicality.

We now turn to the relative importance of the identified news shocks in shaping the business cycle dynamics in our set of small open economies.

Table 1 reports, for the baseline identification scheme, the share of the news shock in the forecast error variance decomposition for the seven variables in the VAR. The news shock accounts for between 10% to 44% of the 20-quarter ahead forecast error variance of GDP. For consumption, the figures are between 16% and 51%, and for investment between 11% and 33%. The shock also accounts for between 7% and 35% of the 20-quarter ahead forecast error variance of Net trade.

The large range of these results reflects heterogeneity between countries. In Australia and Canada, the contribution of new shocks to the 20-quarter ahead forecast error variance of GDP is much lower than in the UK or New Zealand. The relatively low share of news shocks in the forecast error decomposition of macroeconomic variables in some of the countries in our sample is in contrast with the results for the US. For instance, Beaudry and Portier (2006), Barsky and Sims (2011) and Beaudry et al. (2011), identify news shocks for the US economy using alternative identification schemes in estimated VARs. Their findings suggest that news shocks account for around 40% to 50% of fluctuations in GDP and consumption in the US. One possible reason behind the discrepancy is the role of foreign or rest of the world shocks in driving the business cycle dynamics

in these small open economies. For example, Justiniano and Preston (2010) document that US shocks account half of the variation in Canadian macroeconomic variables. In the light of these results, it is not surprising that we find a lower share for domestic TFP news.

In Table 2 we consider the importance of new shocks identified by imposing a zero restriction on TFP for the first two periods. For GDP, there is an across the board decline in the role of news shocks compared to our baseline model.

Tables 3 and 4 show that using relative TFP, raises the contribution of news shocks to the 20-quarter ahead forecast error variance of GDP, particularly in Australia and Canada, economies in which the baseline news shock played only a modest role. To a lesser extent the same is also true for the UK. Only in New Zealand does the contribution of news shocks to GDP fall when we use relative as opposed to country specific TFP.

In our set of small open economies, the role of news shocks in the the 20-quarter ahead forecast error variance of GDP is found to be somewhat lower than in the US. This is particularly so for Australia and Canada. News shocks identified as a shock that raises TFP after two periods, tend to have a lesser role in the forecast error variance of GDP. News shocks identified using relative, as opposed to country-specific TFP are more important for GDP, particularly in Australia and Canada.

2.5 External validation

Having determined that our estimated news shocks generate data congruent business cycles and contributes to a certain degree to the forecast error variance decomposition, we now compare our identified news shocks to survey based measures of expected business and consumer confidence. It is not straightforward to find a one to one mapping between the identified news shocks and expectations measured in the data. Comparing the one-quarter ahead news shock to one-quarter ahead business and consumer confidence is one possible way of externally validating our identified news shocks.

Figure 6 plots survey measures of producer and consumer confidence versus our baseline news shocks and display their contemporaneous correlation. The overall correlations

between the two series range from about 25% for Australia to about 43% for New Zealand. This correlation reflects the fact that business and consumer confidence are influenced by factors other than expected TFP. For small open economies such as those in our sample, news about the rest of the world real and financial conditions probably plays a significant role in business and consumer sentiment. Our identified shocks are, however, good at picking up the sharp downturn in sentiment in the run up to the financial crisis of 2007 - 2009 as well as the subsequent pickup. There are also other episodes where the news shock strongly comoves with the measure of confidence. For example, in New Zealand, our identified closely mirrors the decline and the recovery in the business confidence in the second half of nineties in particular around the Asian crisis.

3 Literature and model choice

Our empirical results clearly suggest that news can cause business cycles. Upon announcement of news, output, hours worked, consumption and investment rise, while net trade deteriorates. In identifying news shocks, we also impose a positive sign restriction on the price of equity. This part of the paper, analyses a model that allows these features of VAR based impulse responses to be matched.

Simply introducing news shocks into a standard real business cycle type small open economy model does not generate news-driven business or Pigou cycles. In this class of model, news about a future TFP improvement creates a positive wealth effect that raises both household consumption and leisure, thus reducing the supply of labour. In the absence of an actual increase in TFP labour demand remains unchanged and as a result output and investment fall in response to news.

Our modelling approach relies on a simple form of financial frictions to introduce a wedge between the marginal product of labour and the real wage. Following Jermann and Quadrini (2012), we assume that because of limited enforcement of financial contracts, firms face an enforcement constraint on working capital loans. Because firms have to borrow the wage bill, the ‘tightness’ of the enforcement constraint creates a wedge between

the marginal product of labour and the real wage. Related to our analysis is Walentin (2012), who examines news shocks in a model with limited enforcement where firms face a collateral constraint when securing external finance. As in our model, the arrival of news relaxes the borrowing constraint and raises share prices, which leads to an accelerator type effect on investment. The key difference between our approach and that of Walentin (2012) is that in our model, the firm faces the enforcement constraint on working capital, whereas in Walentin (2012), the loan is inter-temporal. This difference matters, because only in the former case does the financial friction create the aforementioned labour wedge that is helpful in generating a positive co-movement between consumption and hours.⁵

The literature offers several alternatives to overcome the negative co-movement between consumption and hours following a news shock. Beaudry and Portier (2004) in a closed economy setting and Beaudry, Dupaigne, and Portier (2011) using a two-country model extend the standard neo-classical business cycle model to allow a multi-sector production structure. They show that imperfect allocation of inputs between sectors enable the model to generate news-driven business cycles both domestically and internationally. Den Haan and Kaltenbrunner (2009) and Den Haan and Lozej (2010), using a closed economy and small open economy models, respectively, highlight the role of labour market frictions in generating positive comovement in response to news. The intuition is that because job creation is costly and time consuming process, investment starts to increase when the news is announced.

Jaimovich and Rebelo (2008, 2009) show that when preferences are such that the wealth effect on labour is small, hours worked do at least not decline following a news shock. Adding variable capital utilization to such a model causes the marginal product of labour and thus the demand for labour to rise on impact, causing an expansion in output in response to positive news. An additional mechanism suggested in Jaimovich and Rebelo (2008) are labour adjustment costs that penalize large changes in labour effort, which cause agents to bring forward the increase in labour supplied as soon as the news is announced. In our model, we adopt their utility function. We show that

⁵In Walentin (2012), a positive response of labour to news shocks requires a relatively large degree of habit persistence in hours, in addition to the financial friction.

our main results do not depend on the particular strength of the wealth effect. Financial frictions is enough to generate a positive response of consumption, investment and hours even under separable preferences.

The intuition behind our results are similar to Pavlov and Weder (2013) who consider a model with counter-cyclical mark-ups. In their setting, mark-ups create a wedge between the marginal product of labour and the real wage. A news shock that lowers the mark-up also reduces the labour wedge, raising labour demand. With standard separable preferences, the net effect on hours worked depends on whether the effect of the reduction in the mark-up is greater than the wealth effect on consumption.

4 A simple small open economy model with financial frictions

We extend the flexible price version of the model presented in Jermann and Quadrini (2012) into a small open economy setting. To turn a closed economy real business cycle model into a small open economy model requires only a few changes to be made to the structure of the model. In an open economy, the savings of households do not have to equal the borrowing by firms. The gap between savings and investment equals the current account balance. Unlike a closed economy, the gross or pre-tax interest rate faced by households and firms is exogenous in a small open economy setting. This rate is determined instead by the world interest rate as well as a small risk premium to ensure a well defined steady state.⁶ Firms and households produce and consume a homogeneous good. This good is a perfect substitute for output produced in the rest of the world. As a result, the terms of trade defined as the price of imports relative to exports are constant. We make the one-good assumption for two reasons. First, abstracting from terms of trade movements allows us to focus more clearly on the role of financial frictions in the transmission of news shocks. Second, for commodity producers such as Australia, Canada and New Zealand, assuming an exogenous terms of trade is quite realistic, although this

⁶See Schmitt-Grohe and Uribe (2003) for alternative ways to close small open economy models.

is probably not the case for the UK.

As in Jermann and Quadrini (2012), we introduce financial frictions into the environment in which domestic firms are operating. The household sector, on the other hand, faces a standard optimization problem.

4.1 Borrowing constrained firms

At any time t , the representative firm combines hired labour, n_t and accumulated capital stock, k_{t-1} in a Cobb-Douglas production function $F(z_t, k_{t-1}, n_t) = z_t k_{t-1}^\alpha n_t^{1-\alpha}$. The variable z_t is the level of productivity which follows a stochastic AR(1) process.

Capital accumulation is subject to investment adjustment costs of the type proposed by Christiano et al. (2005)

$$k_t = (1 - \delta) k_{t-1} + i_t \left(1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) \quad (13)$$

where i_t is investment, δ the depreciation rate of capita and ϕ a parameter capturing the curvature of the adjustment cost function.

As in Jermann and Quadrini (2012), firms can finance investment projects either by issuing equity, d_t , or debt, b_t^f . Reducing equity payouts to finance investment projects does not affect a firm's tax liabilities in the same way as issuing new debt. As a result, firms prefer debt to equity finance in this model. This preference for debt finance is captured by a constant tax benefit, or subsidy. The effective interest rate faced by firms is $R_t = 1 + r_t(1 - \tau)$, where r_t is the world rate of interest (adjusted by a net-debt elastic risk premium) and τ captures the tax benefit on debt issuance.

The firm has to make its payments to its workers, shareholders, and creditors, as well as undertake investment before revenues are realized. To cover this cash flow mismatch, the firm has to get an intra-temporal working capital loan equal to its production at the beginning of the period.

After receiving the working capital loan, the firm can either pay its factors of production, produce and pay back the inter-temporal loan at the end of the period, or it can

choose not to produce, abscond with the loan and default. To rule out the latter scenario, the firm is subject to the following enforcement constraint:

$$\xi \left(k_t - \frac{b_t^f}{1 + r_t} \right) = F(z_t, k_{t-1}, n_t) \quad (14)$$

where ξ denotes the probability that the lender can recover the full value of the firm's capital stock in the case of a default.

A key feature that determines the effect of this enforcement constraint on the model economy is an assumed rigidity affecting the substitution between equity and debt. If we define total intra-temporal borrowing, l_t , as:

$$l_t = F(z_t, k_{t-1}, n_t) = w_t n_t + i_t + d_t + b_{t-1}^f - \frac{b_t^f}{R_t}$$

then the firm will always be able to keep the demand for intra-period loans, l_t , constant simply by changing the composition between debt and equity finance. In this case, shocks that affect the firm's ability to borrow intra-temporally will have no effect on the firm's choice of labour input or investment.

To make sure the enforcement constraint is binding, we introduce a cost of adjusting equity payouts, similar to that of Jermann and Quadrini (2012)

$$\varphi(d_t) = \left(1 + \kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right)^2 \right) d_t \quad (15)$$

where y_t denotes GDP, κ a positive adjustment cost parameter and variables without time subscripts denote values along the balanced growth path.

Given these adjustment costs, the firm's budget constraint can be written as:

$$F(z_t, k_{t-1}, n_t) - w_t n_t - i_t - b_{t-1}^f + \frac{b_t^f}{R_t} - \varphi(d_t) = 0. \quad (16)$$

The firm's optimization problem consists of maximizing equity payouts, subject to the budget (16), capital accumulation (13) and enforcement (14) constraints. The first order conditions for the optimal choice of labour, inter-temporal borrowing, capital and

investment are:

$$(1 - \Delta_t \varphi'(d_t)) F_{n,t} = w_t \quad (17)$$

$$E_t \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} R_t + \Delta_t \varphi'(d_t) \frac{R_t}{1 + r_t} \xi = 1 \quad (18)$$

$$E_t \beta \frac{\lambda_{t+1}}{\lambda_t} \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} (F_{k,t} (1 - \Delta_{t+1} \varphi'(d_{t+1})) + Q_{t+1} (1 - \delta)) + \Delta_t \varphi'(d_t) \xi = Q_t \quad (19)$$

$$Q_t \left(1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right) - \phi \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} \right) + E_t \beta Q_{t+1} \frac{\lambda_{t+1}}{\lambda_t} \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \phi \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 = 1 \quad (20)$$

The variable λ_t denotes the marginal utility of consumption of households, who are the owners of the firm. The variables q_t , v_t and μ_t are the Lagrange multipliers on constraints (16), (13) and (14), respectively. These shadow prices are used to define the following composite variables: $Q_t = \frac{v_t}{\lambda_t} \varphi'(d_t)$, $\Delta_t = \frac{\mu_t}{\lambda_t}$, and $\frac{\lambda_t}{\varphi'(d_t)} = q_t$.

Because changing its financial structure is costly, the effective discount factor of the firm $\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{\varphi'(d_t)}{\varphi'(d_{t+1})}$ differs from that of the household. The first derivative of the dividend adjustment costs (15) is a positive function of the level of dividend payouts. A one-off decrease in dividend payments (where $\varphi'(d_t)$ decreases but not $\varphi'(d_{t+1})$) lowers the discount factor applicable to firms. A more gradual decrease of dividend payments, on the other hand (where $\varphi'(d_t)$ increases by less than $\varphi'(d_{t+1})$), raises the discount factor.

4.2 Households

The representative household maximizes the expected utility function defined over

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t - \psi n_t^\theta x_t)^{1-\sigma} - 1}{1 - \sigma} \quad (21)$$

where

$$x_t = c_t^\gamma x_{t-1}^{1-\gamma} \quad (22)$$

consumption, c_t , and labour effort, n_t . Following Jaimovich and Rebelo (2008), we choose a functional form for the utility function that allows utility to be both separable ($\gamma \approx 1$) and non-separable ($\gamma \approx 0$) over consumption and hours worked. The household's discount

factor is denoted by β and has the usual properties that $0 < \beta < 1$. Expected utility is maximized subject to the following budget constraint:

$$w_t n_t + b_{t-1} + s_t(d_t + p_t) = \frac{b_t}{1 + r_t} + s_{t+1}p_t + c_t + T_t. \quad (23)$$

At the beginning of each period, the household receives wage income, $w_t n_t$, and a dividend payment, d_t . The household also holds a stock of internationally traded bonds, b_{t-1} . The household's income stream is used to purchase consumption goods, pay taxes, T_t , and purchase new bonds, b_t at a price of $1/(1 + r_t)$ per unit, and purchase new shares, s_{t+1} , at price p_t . Taxation is used to finance the tax benefit enjoyed by firms when borrowing. $T_t = b_t^f/R_t - b_t^f/(1 + r_t)$.

The representative household maximises expected utility, (21) subject to (22) and (23).

The household's first-order conditions for the optimal choice of c_t , n_t , x_t , b_t and s_{t+1} are:

$$(c_t - \psi n_t^\theta x_t)^{-\sigma} + \omega_t \gamma c_t^{\gamma-1} x_{t-1}^{1-\gamma} = \lambda_t \quad (24)$$

$$(c_t - \psi n_t^\theta x_t)^{-\sigma} \theta \psi n_t^{\theta-1} x_t = \lambda_t w_t \quad (25)$$

$$(c_t - \psi n_t^\theta x_t)^{-\sigma} \psi n_t^\theta + \omega_t = \beta E_t \omega_{t+1} (1 - \gamma) c_{t+1}^\gamma x_t^{-\gamma} \quad (26)$$

$$\frac{\beta E_t \lambda_{t+1}}{\lambda_t} (1 + r_t) = 1 \quad (27)$$

$$\frac{\beta E_t \lambda_{t+1}}{\lambda_t} (d_{t+1} + p_{t+1}) = p_t \quad (28)$$

where ω_t and λ_t are the Lagrange multipliers associated with constraints (22) and (23), respectively.

4.3 Consolidated budget constraint

Combining the budget constraints of the representative firm (16) with that of the representative household (23) and aggregating over all individuals yields the economy wide

budget constraint⁷:

$$F(z_t, k_{t-1}, n_t) = c_t + i_t + \frac{(b_t - b_t^f)}{1 + r_t} - (b_{t-1} - b_{t-1}^f) + \varphi(d_t) - d_t \quad (29)$$

Where the net foreign asset position is defined as the difference between household savings and firm borrowing, $(b_t - b_t^f)$. The trade balance, which we assume to be zero in the steady state, is defined as:

$$TB_t = y_t - c_t - i_t - \varphi(d_t) + d_t \quad (30)$$

5 News about total factor productivity

In Figures 7 to 8 we assess the contribution of financial frictions to the generation of positive co-movement between consumption and hours worked in response to news shocks. To do this, we compare our baseline model to a version where the dividend payout cost is set to zero. This version of our model is similar to the model in Jaimovich and Rebelo (2008). The calibration of our model follows Jermann and Quadrini (2012) for the financial frictions part of the model, such that $\xi = 0.162$ and $\tau = 0.35$. We set $\kappa = 3$, which is different from JQ, but given that we use a different functional form of the dividend adjustment cost function, our baseline value corresponds to roughly to the same elasticity of the dividend adjustment cost used in JQ. For technology, we use standard parameters from the literature. The share of capital in output, the depreciation rate as well as the investment adjustment cost parameter are $\alpha = 0.3$, $\delta = 0.025$, $\phi = 1$. In terms of preferences, we assume a value for the risk free discount rate of $\beta = 0.985$. The parameters of the utility function are $\sigma = 1$, $\theta = 1.2$ and $\gamma = 0.001$. The value of ψ is set in such a way as to yield a steady state value of hours worked of $\bar{n} = 0.2$.

Figure 7 analyses the response of key macroeconomic aggregates to an increase in TFP that is expected to occur in period $t + 3$ and announced in period t .⁸ In our baseline model, hours worked and GDP both increase as soon as the news about future

⁷The number of shares held by all households is normalized to unity.

⁸We follow business cycle tradition in analysing the responses of temporary rather than permanent shocks. In the news literature, there are examples of both.

productivity becomes available. This is in line with the VAR evidence and in contrast to the model without financial frictions. Without financial frictions, the agent's preferences over consumption and labour ensure that wealth effect on hours worked is weak. However, given our value of γ , the wealth effect is small, but not zero, and hence hours worked decline on impact.

In the baseline model, labour effort rises on impact, because an anticipated shock to TFP drives a wedge between the marginal product of labour and the real wage. This wedge can be easily illustrated by combining the household's and the firm's first-order conditions for labour. For expositional purposes, we assume that $\gamma = 0$, such that the wealth effect on hours is absent.

$$F_n(z_t, k_{t-1}, n_t)(1 - \Delta_t \varphi'(d_t)) = \theta \psi n_t^{\theta-1}$$

Following a positive news shock about TFP the term $\Delta_t \varphi'(d_t)$ falls which, for a given marginal product of labour, raises the real wage. The rise in the real wage causes agents to increase hours worked and thus output to rise.

Once TFP increases, the firm's borrowing constraint become more binding, Δ_t rises, due to more output needing to be financed in advance of production. A feature of the Jermann and Quadrini (2012) model is that a tightening of the borrowing constraint causes hours worked to decline. In the next subsection, we analyse why the borrowing constraint is relaxed during the news period, causing hours worked to rise.

5.1 Intuition

In Jermann and Quadrini (2012) a positive contemporaneous TFP shock causes firms to reduce their equity payouts, d_t while reducing their inter-temporal borrowing, b_t^f . For a given net wealth of firms (see the enforcement constraint), a positive TFP shock tightens the enforcement constraint, as firms seek more working capital to expand output. Since inter-temporal borrowing reduces the net wealth of firms further, limited enforcement ensures that new investment is financed through retained earnings by cutting equity

payouts.

The key question in this paper is what happens when the TFP expansion is anticipated? One of the key assumptions of Jermann and Quadrini (2012) is that changes in the financial structure of firms are costly. The dividend adjustment cost function (15) penalizes large changes in the dividend to GDP ratio. The firm therefore has an incentive to smooth the reduction in equity payouts and firm borrowing over time. Even though the increase in TFP is expected to occur in the future, the firm will start to gradually reduce dividends (equity payouts) upon announcement of the news.

With dividends falling in anticipation of an increase in TFP, the firm is incurring a cost associated with changes in its financial structure. The cost of falling dividends, raises the firm's effective discount factor, via the term $\frac{\varphi'(d_t)}{\varphi'(d_{t+1})}$. A rise in the firm's effective discount factor causes the firm to reduce its debt holding.

As debt is repaid and the capital stock augmented, the net worth of firms increase, which in turn relaxes the enforcement constraint faced by firms. We can illustrate this using the firm's first order condition of for optimal inter-temporal borrowing. Using the household's Euler equation and assuming that in our small open economy neither $1 + r_t$ nor R_t change in response to news we obtain:

$$\left(\frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \right) \frac{R}{1+r} + \Delta_t \varphi'(d_t) \xi_t \frac{R}{1+r} = 1.$$

If a change in equity payouts creates a cost that raises the firm's effective discount factor via $\frac{\varphi'(d_t)}{\varphi'(d_{t+1})}$, the optimal bond holding condition requires that $\Delta_t \varphi'(d_t) \xi$ falls, thus reducing the labour wedge and causing hours worked to increase.

5.2 Separable preferences

By relaxing the enforcement constraint, the mechanism above raises the real wage, and if preferences are such that the negative wealth effect on labour of a rise in consumption is small, the amount of hours worked rises as well. Is this mechanism strong enough to overcome the negative wealth effect on hours that arises under separable preferences? The

utility function put forward by Jaimovich and Rebelo (2008) nests both non-separable (when γ is close to zero) and separable preferences (when γ is close to unity) over consumption and labour. Figure 8 shows the response to a news shock when $\gamma = 0.9$ for an otherwise unchanged calibration. Here, hours worked increases in anticipation of news, but declines once the TFP shock materializes. Labour declines when TFP increases, because as output rises, the demand for intra-period borrowing also rises. The increase in the demand for finance causes the enforcement constraint to tighten, which as we have shown above reduces the demand for labour.

5.3 Alternative enforcement constraint

In our baseline model, firms have to arrange a working capital loan to cover an entire period's production. Therefore, as TFP raises GDP, the demand for working capital increases. For a given net wealth, this causes the enforcement constraint to tighten, leading to the 'kink' in hours in Figures 7 and 8. Jermann and Quadrini (2012) show that one can overcome the counter cyclical response of labour to TFP shocks by assuming the the firm only requires a working capital loan to cover the wage bill. The enforcement constraint faced by firms is therefore:

$$\xi \left(k_t - \frac{b_t^f}{1 + r_t} \right) = w_t n_t. \quad (31)$$

The response to a news shock for this version of the model, keeping the same calibration as before, is shown in Figures 9 and 10. With non-separable preferences, the enforcement constraint (31) no longer leads to a decline in hours once TFP increases. Hours rise gradually, both prior to and after the increase in TFP. Upon announcement of news, there is a modest (relative to the baseline case) increase in hours worked. Compared to the alternative with $\kappa = 0$, there is no longer a sharp upward shift in hours once TFP increases.

Figure 10 shows that the reduction in the labour wedge is not, however, strong enough to overcome the wealth effect once preferences are close to separable. Setting $\gamma = 0.9$,

causes hours to decline when news is announced, however, it does so by less than in the case where $\kappa = 0$. In this version of the model, the financial friction only applies to financing the wage bill, as opposed to GDP, hence the the model is somewhat closer to a model without financial frictions.

6 Conclusion

News about future TFP can be a source of business cycle fluctuations in small open economies. For a set of advanced small open economies, we show that news about future TFP causes positive co-movement between GDP, hours, consumption and investment. News shocks are also associated with counter-cyclical current accounts. The key difference between news shocks in small open economies an the United States is their contribution to the variance of GDP. The forecast error variance decomposition of news shocks for GDP is substantially less in our set of small open economies than in the United States.

In addition to our empirical contribution, we also put forward a theoretical small open economy model that is able to generate business cycles from news shocks. We introduce financial frictions, as in Jermann and Quadrini (2012) as a mechanism to generate the positive co-movement between hours worked and consumption that is a challenge for canonical small open economy models.

This paper is a first pass at analysing news shocks in open economies. As such, we have taken a deliberately parsimonious approach to modelling open economies. In future work, we address the important issue of real exchange dynamics in the transmission of news shocks.

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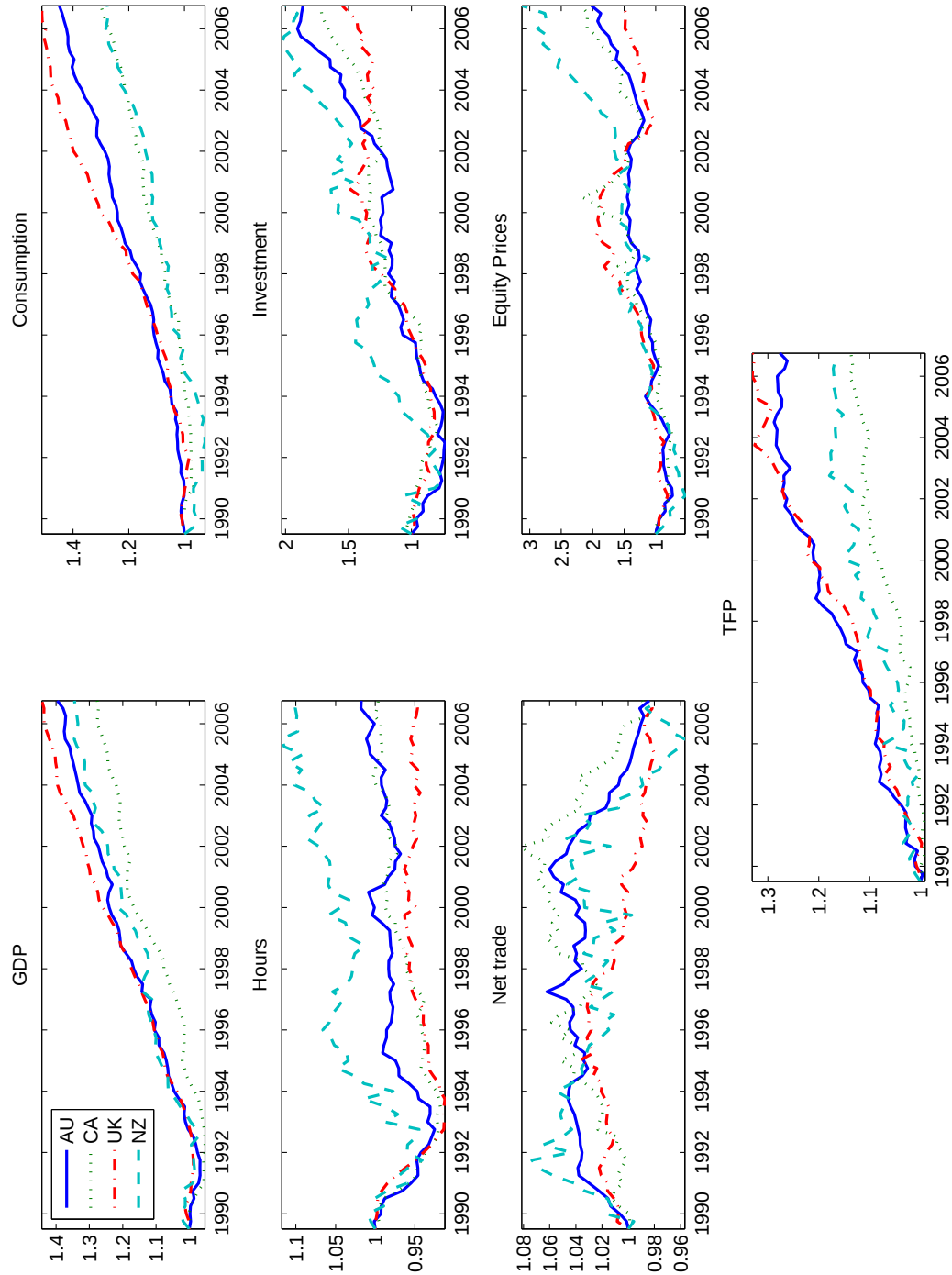
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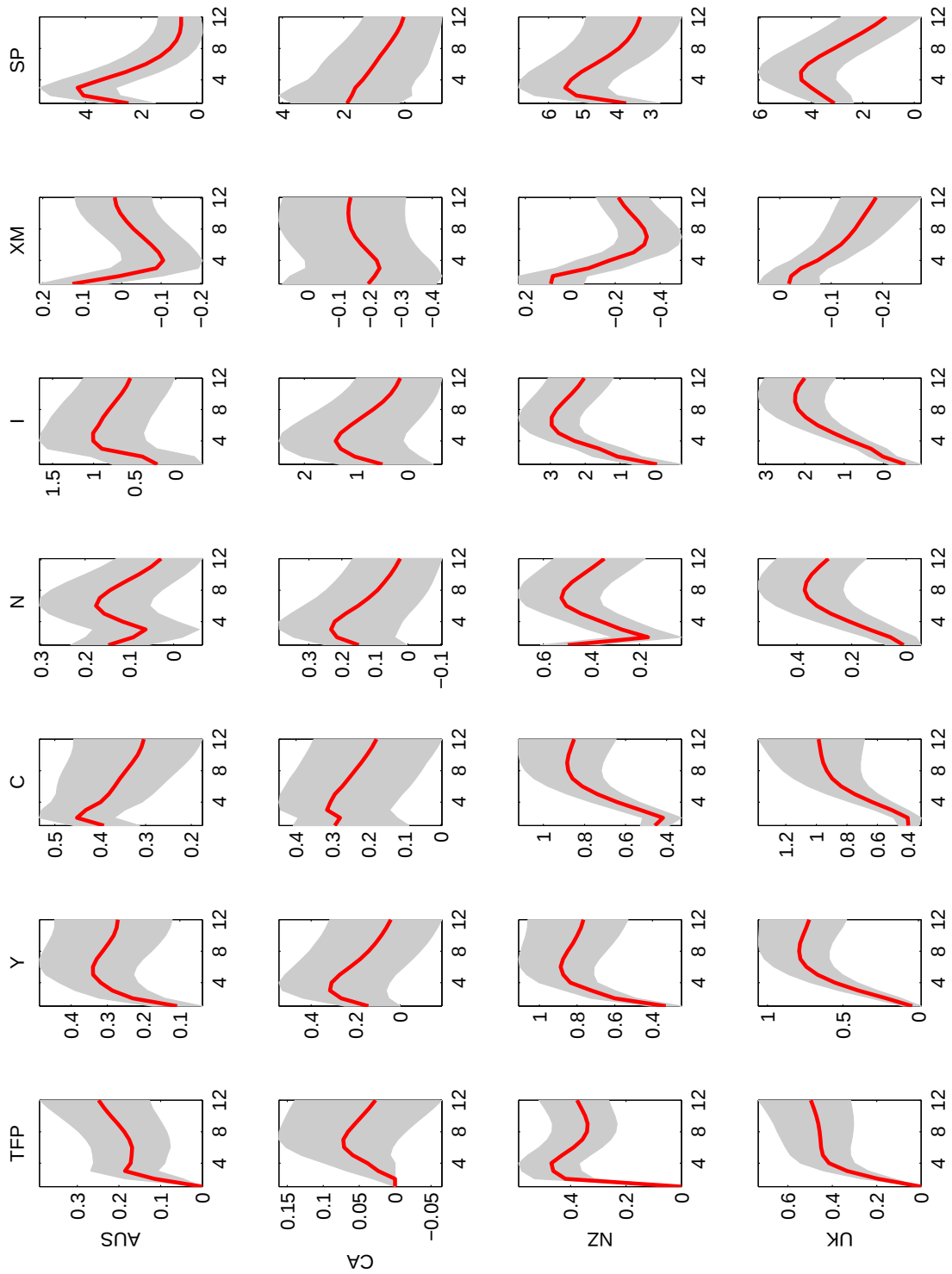
A Figures

Figure 1: Data



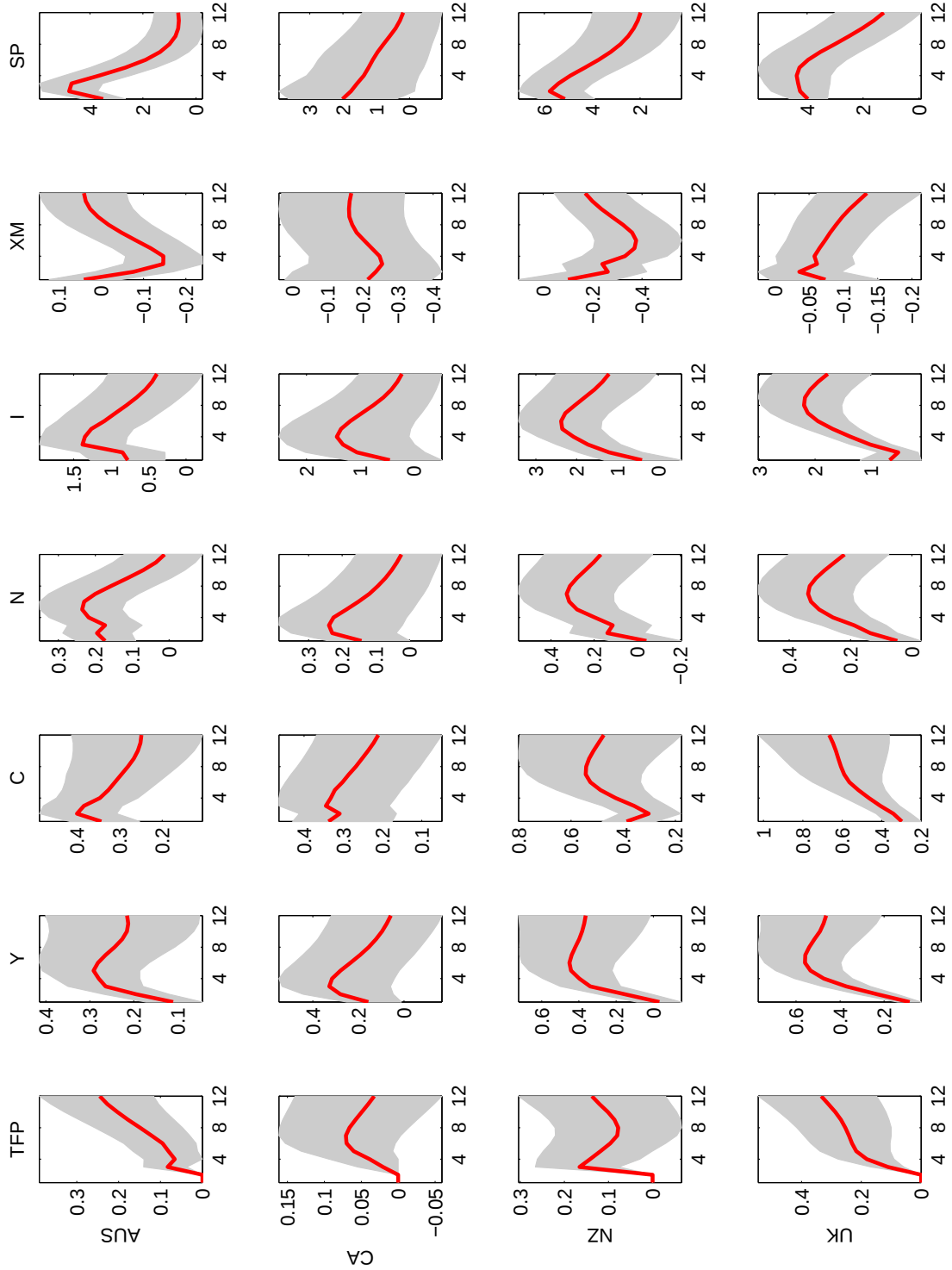
Note: Data used in the estimation of the VAR. See text and appendix for data definitions.

Figure 2: News about TFP open economies - $t+1$ shock



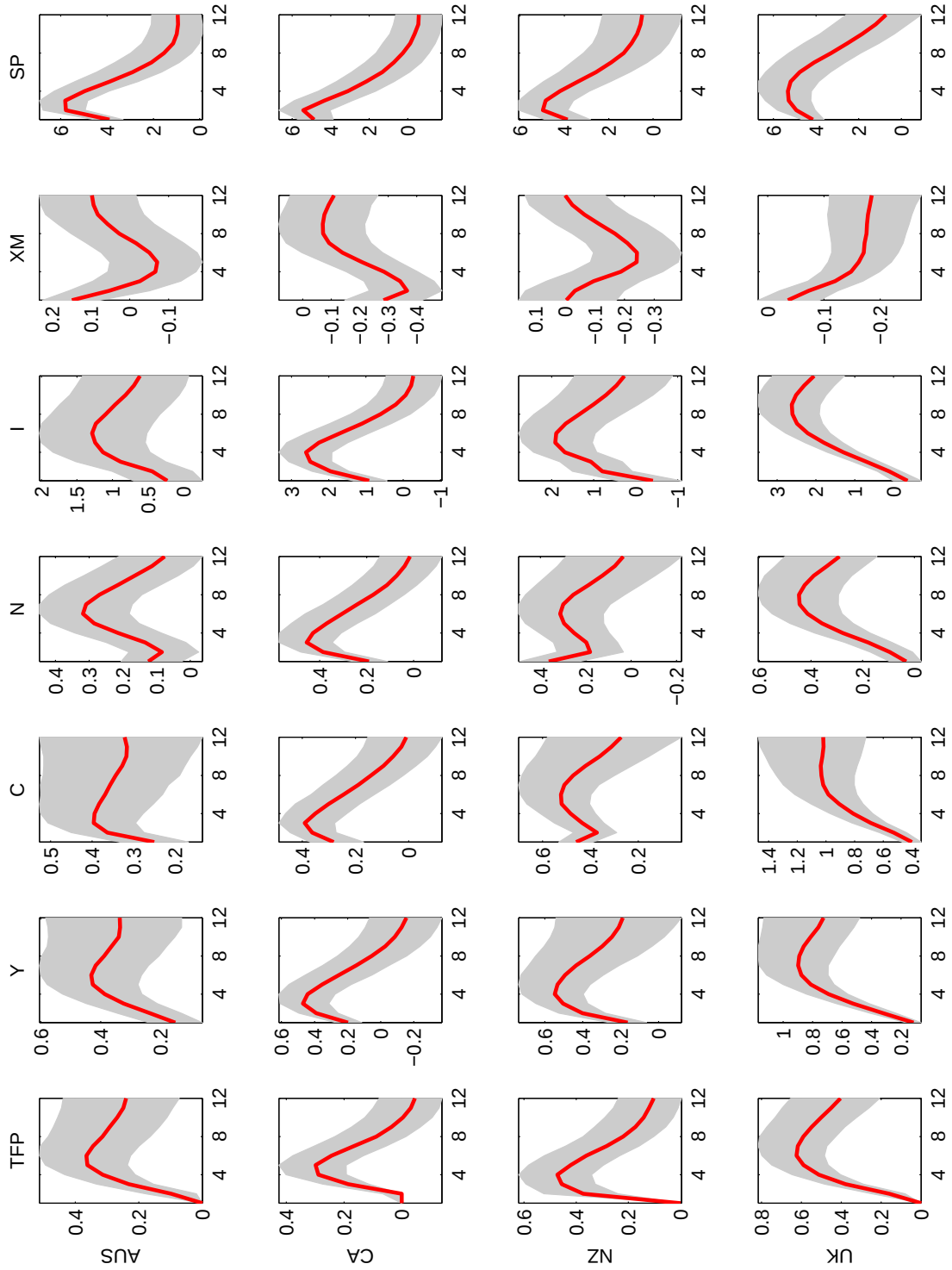
Note: Beaudry identification method. TFP = total factor productivity, Y = GDP, C = consumption, N = hours worked, I = investment, XM = net trade, SP = share price. TFP is restricted to be zero for 1 quarter and consumption and stock prices are restricted to increase on impact.

Figure 3: News about TFP in open economies - $t+2$ shock



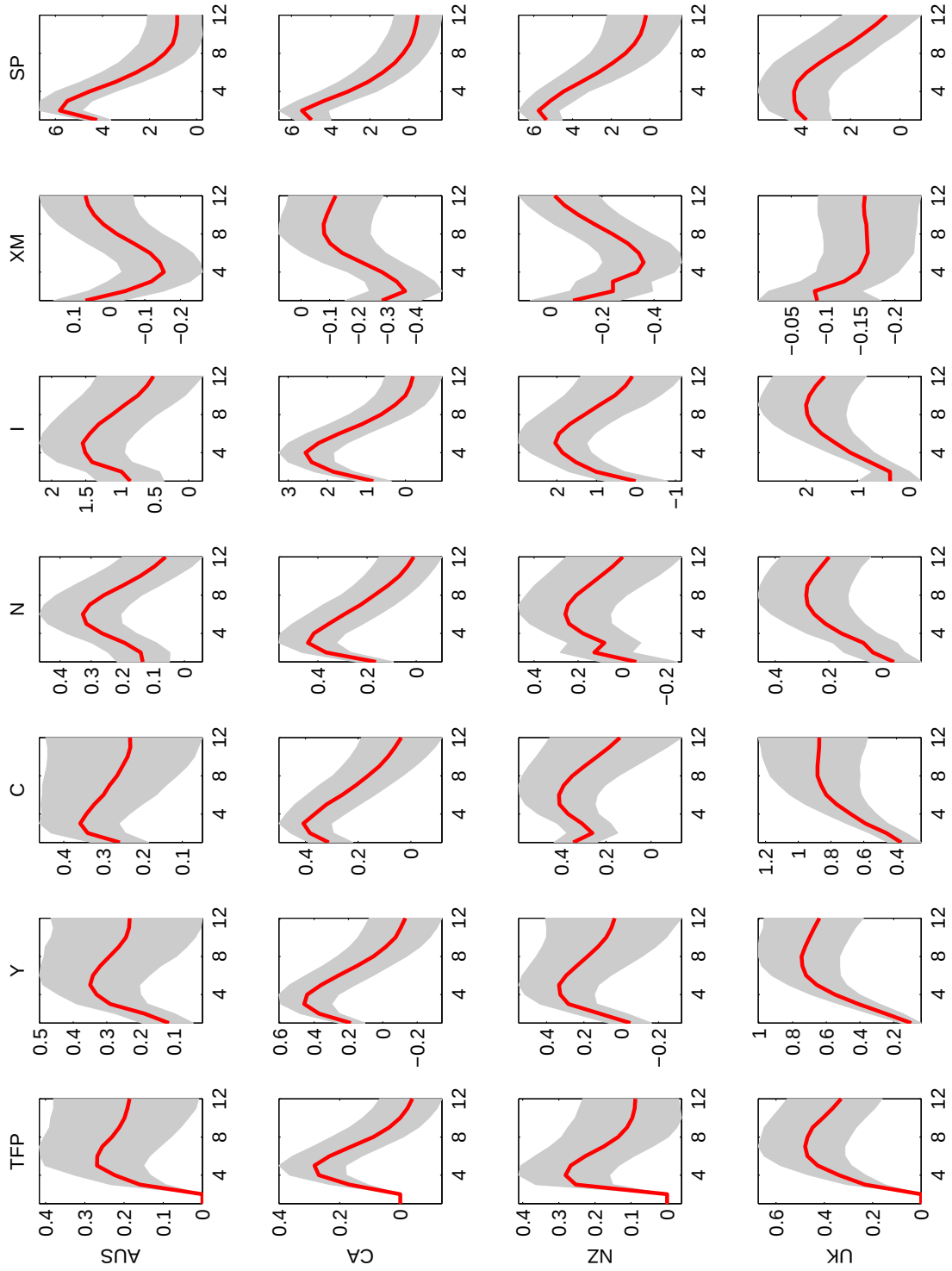
Note: Beaudry identification method. TFP = total factor productivity, Y = GDP, C = consumption, N = hours worked, I = investment, XM = net trade, SP = share price. TFP is restricted to be zero for 2 quarters and consumption and stock prices are restricted to increase on impact.

Figure 4: News about Relative TFP open economies - $t+1$ shock



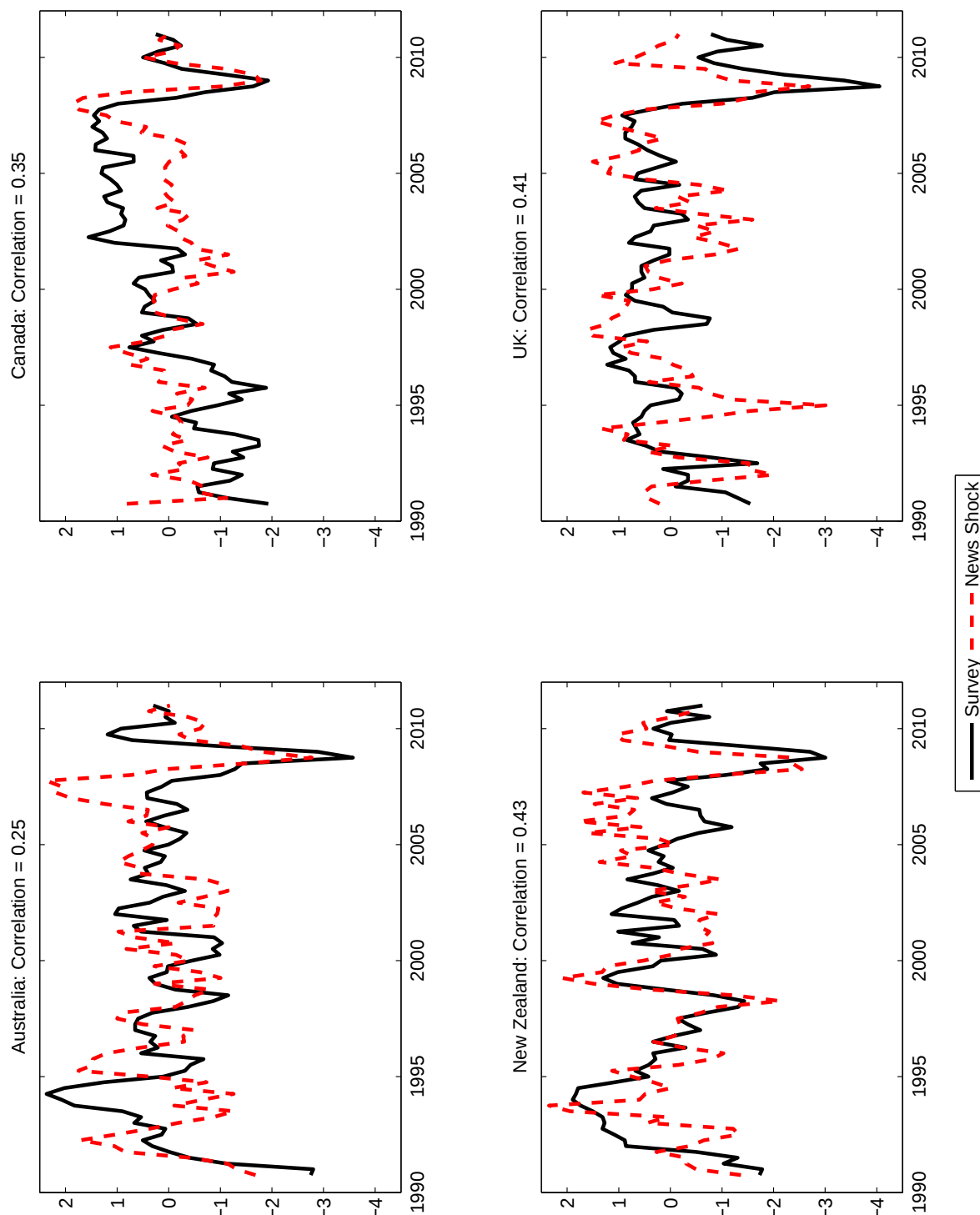
Note: Beaudry identification method with relative TFP. TFP = total factor productivity, Y = GDP, C = consumption, N = hours worked, I = investment, XM = net trade, SP = share price. TFP is restricted to be zero for 1 quarter and consumption and stock prices are restricted to increase on impact.

Figure 5: News about Relative TFP in open economies - $t+2$ shock



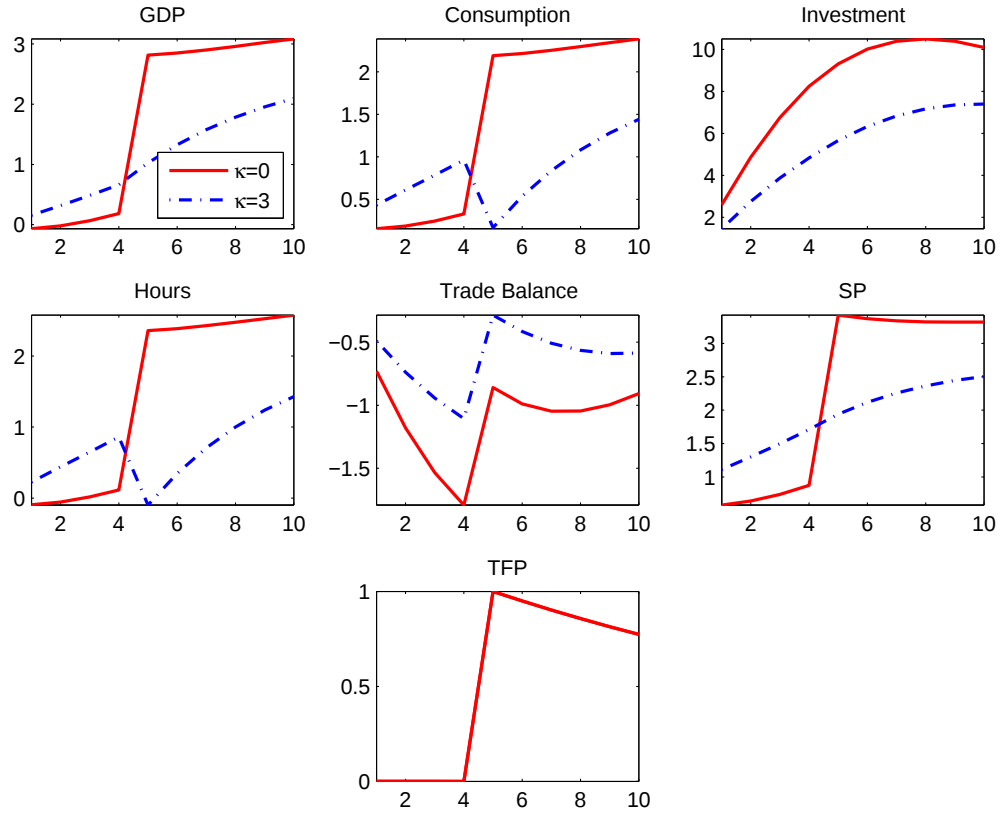
Note: Beaudry identification method with relative TFP. TFP = total factor productivity, Y = GDP, C = consumption, N = hours worked, I = investment, XM = net trade, SP = share price. TFP is restricted to be zero for 2 quarters and consumption and stock prices are restricted to increase on impact.

Figure 6: Estimated news shocks and survey based confidence measures



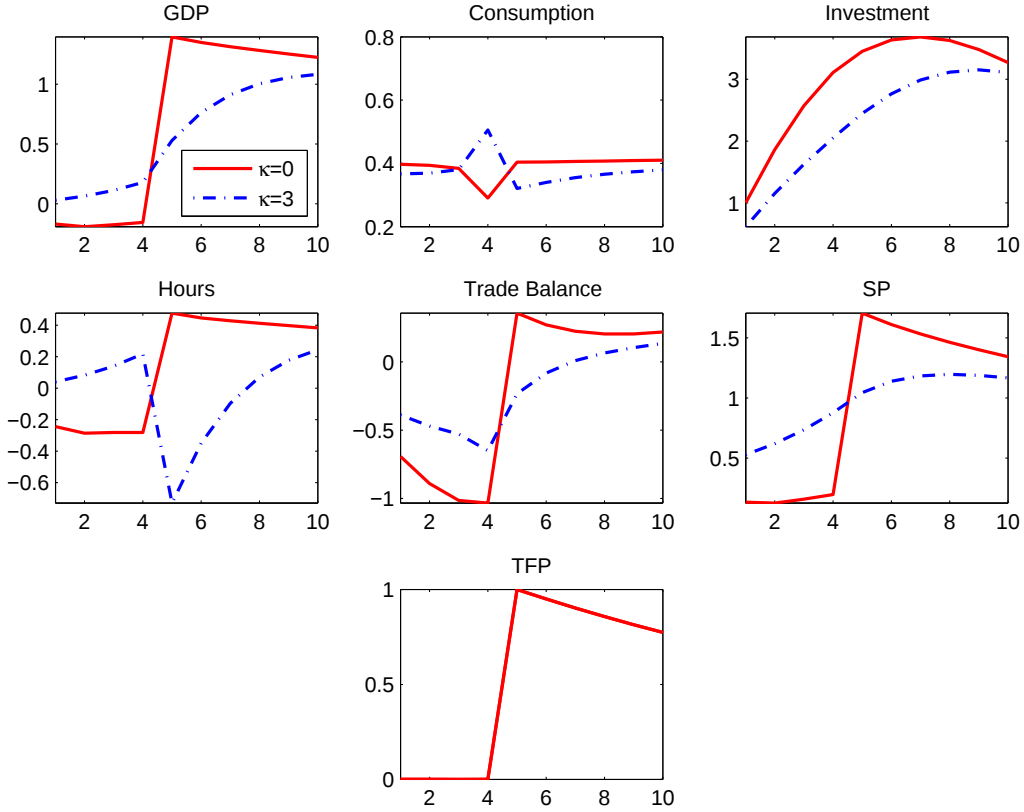
Note: Each graph plots the identified news shock in our baseline specification versus a survey measure for each country. Survey measures are standardized. The data for survey measures are as follow; Australia: NAB business confidence, next 3 months, Canada: Consumer confidence from OECD, New Zealand: Economy wide, next 3 months, domestic Trading Activity, from Quarterly survey of business opinions, U.K.: Services Sector Business Confidence from British Chambers of Commerce

Figure 7: News about total factor productivity



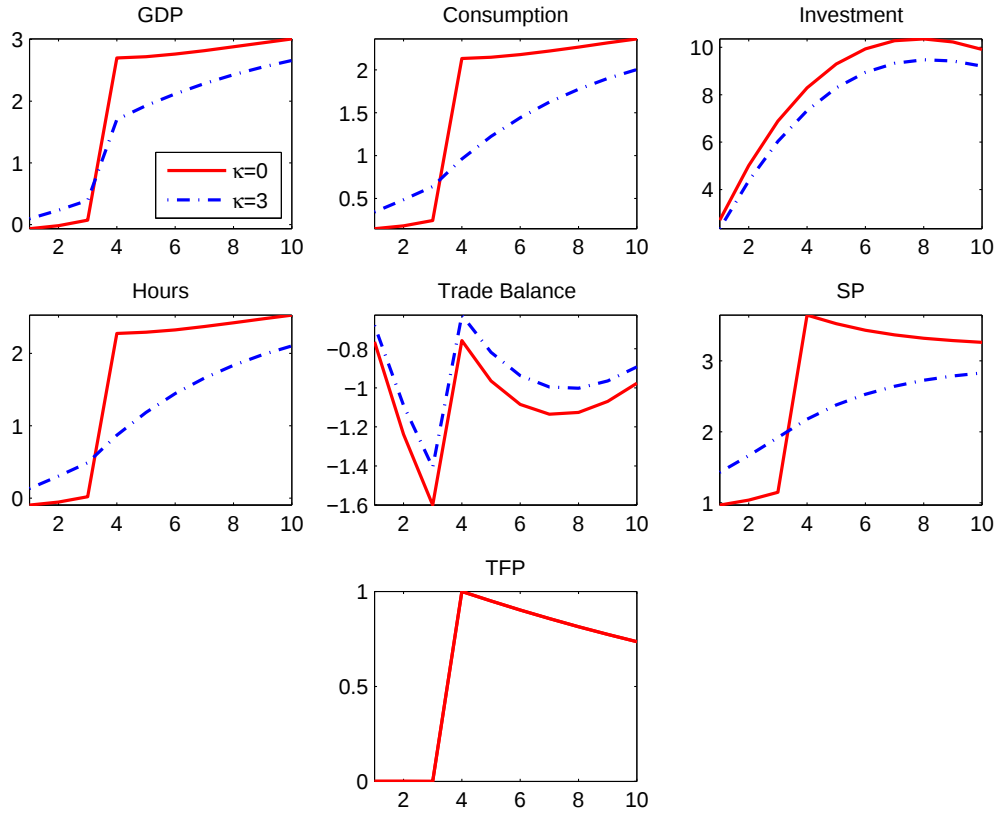
Note: The response of to news about productivity that is expected to occur in period 3. The solid lines show the impulse responses generated by a model akin to Jaimovich and Rebelo (2008). The dashed lines show the impulse responses of our baseline model, which augments the JR model by financial frictions as in Jermann and Quadrini (2012). The calibration used is as follows. Technology: $\alpha = 0.3$, $\delta = 0.025$, $\phi = 1$. Preferences: $\beta = 0.985$, $\sigma = 1$, $\theta = 1.2$, $\gamma = 0.001$, $\bar{n} = 0.2$. Financial frictions: $\xi = 0.162$, $\tau = 0.35$, κ =varied, Bond holding cost: 0.001.

Figure 8: News about total factor productivity - nearly separable preferences



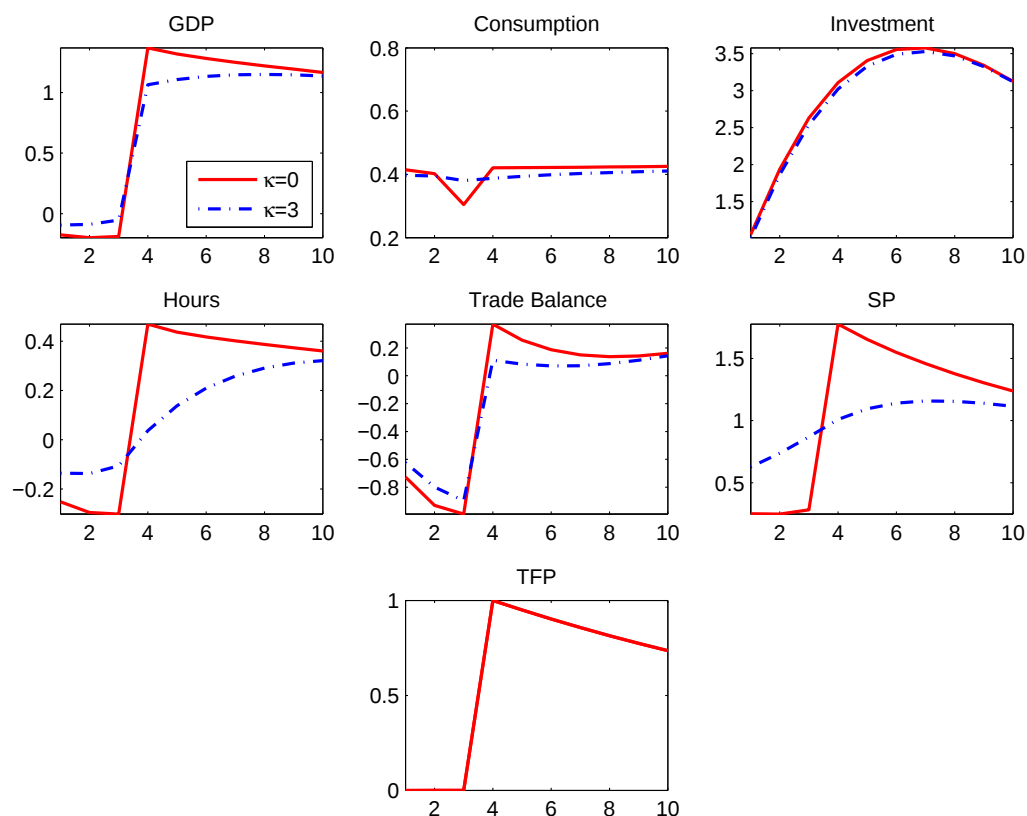
Note: The response of to news about productivity that is expected to occur in period 3. The solid lines show the impulse responses generated by a model akin to Jaimovich and Rebelo (2008). The dashed lines show the impulse responses of our baseline model, which augments the JR model by financial frictions as in Jermann and Quadrini (2012). The calibration used is as follows. Technology: $\alpha = 0.3$, $\delta = 0.025$, $\phi = 1$. Preferences: $\beta = 0.985$, $\sigma = 1$, $\theta = 1.2$, $\gamma = 0.9$, $\bar{n} = 0.2$. Financial frictions: $\xi = 0.162$, $\tau = 0.35$, κ =varied, Bond holding cost: 0.001.

Figure 9: News about total factor productivity - $l_t = w_t n_t$



Note: The response of to news about productivity that is expected to occur in period 3. The solid lines show the impulse responses generated by a model akin to Jaimovich and Rebelo (2008). The dashed lines show the impulse responses of a version of our model where firms have to arrange a working capital loan to cover the wage bill only. The calibration used is as follows. Technology: $\alpha = 0.3$, $\delta = 0.025$, $\phi = 1$. Preferences: $\beta = 0.985$, $\sigma = 1$, $\theta = 1.2$, $\gamma = 0.001$, $\bar{n} = 0.2$. Financial frictions: $\xi = 0.162$, $\tau = 0.35$, $\kappa=\text{varied}$, Bond holding cost: 0.001.

Figure 10: News about total factor productivity - nearly separable preferences - $l_t = w_t n_t$



Note: The response of to news about productivity that is expected to occur in period 3. The solid lines show the impulse responses generated by a model akin to Jaimovich and Rebelo (2008). The dashed lines show the impulse responses of a version of our model where firms have to arrange a working capital loan to cover the wage bill only. The calibration used is as follows. Technology: $\alpha = 0.3$, $\delta = 0.025$, $\phi = 1$. Preferences: $\beta = 0.985$, $\sigma = 1$, $\theta = 1.2$, $\gamma = 0.9$, $\bar{n} = 0.2$. Financial frictions: $\xi = 0.162$, $\tau = 0.35$, $\kappa = \text{varied}$, Bond holding cost: 0.001.

B Tables

Table 1: FEVD -Baseline (SPC1)

	AUS		CA		NZ		UK	
	h=1	h=10	h=1	h=10	h=1	h=10	h=1	h=10
TFP	0.00 [0.00, 0.00]	13.04 [4.76, 24.69]	0.00 [0.00, 0.00]	3.80 [0.83, 13.06]	0.00 [0.00, 0.00]	35.81 [24.89, 47.42]	0.00 [0.00, 0.00]	31.61 [17.46, 47.56]
Output	3.54 [0.57, 9.35]	20.12 [9.49, 34.33]	13.60 [1.54, 36.68]	11.39 [3.18, 28.37]	19.19 [11.02, 28.75]	53.37 [39.30, 66.45]	1.54 [0.15, 6.20]	46.23 [30.72, 61.43]
Consumption	60.08 [40.23, 75.98]	42.08 [27.73, 57.14]	32.98 [2.99, 63.08]	25.17 [6.67, 46.26]	54.00 [41.89, 65.08]	68.17 [56.82, 77.79]	55.71 [40.64, 69.31]	51.38 [35.43, 66.91]
Hours	7.11 [1.34, 16.87]	9.78 [3.20, 21.09]	12.45 [1.34, 32.16]	13.78 [3.74, 34.63]	20.20 [12.65, 29.02]	27.20 [15.43, 40.18]	0.90 [0.09, 3.84]	24.92 [10.38, 41.80]
Investment	2.11 [0.19, 8.76]	11.34 [3.36, 25.39]	9.81 [0.88, 33.17]	13.80 [3.44, 35.87]	1.01 [0.09, 4.25]	31.98 [18.98, 45.21]	5.03 [0.68, 14.03]	31.41 [16.58, 47.32]
Net trade	7.21 [1.05, 19.14]	7.24 [3.40, 14.93]	11.07 [1.04, 35.21]	15.44 [3.98, 38.07]	1.22 [0.11, 4.96]	14.84 [7.50, 24.93]	1.35 [0.12, 5.86]	19.43 [8.70, 33.11]
Stock prices	21.74 [8.14, 38.15]	30.53 [15.12, 47.79]	8.88 [0.12, 33.59]	10.19 [2.53, 27.60]	25.58 [14.15, 37.60]	45.20 [30.77, 58.54]	37.26 [22.75, 51.44]	36.82 [21.18, 53.33]

Notes: Each column corresponds to the contribution of news shock to the variance of observables at horizon h. The values in square brackets are 90% Bayesian confidence intervals.

Table 2: FEVD -Baseline (SPC2)

	AUS		CA		NZ		UK	
	h=1	h=10	h=1	h=10	h=1	h=10	h=1	h=10
	h=1	h=20	h=1	h=20	h=1	h=20	h=1	h=20
TFP	0.00 [0.00, 0.00]	6.16 [1.33, 15.76] [3.53, 29.99]	0.00 [0.00, 0.00]	3.49 [0.71, 12.65] [1.39, 13.76]	0.00 [0.00, 0.00]	3.68 [1.02, 10.67] [1.46, 18.04]	0.00 [0.00, 0.00]	8.49 [1.88, 19.99] [5.28, 35.69]
Output	3.73 [0.73, 8.96]	14.07 [5.73, 26.67] [4.40, 30.50]	16.23 [2.53, 37.55] [2.53, 37.55]	11.75 [3.33, 28.52] [3.32, 21.06]	1.24 [0.11, 5.37]	12.58 [3.32, 28.74] [2.66, 28.28]	4.40 [0.76, 11.63]	24.92 [12.62, 40.93] [23.48, 23.48]
Consumption	46.48 [25.39, 64.34]	31.11 [17.82, 46.85] [11.07, 41.38]	44.05 [11.70, 68.60]	30.88 [10.66, 49.69] [7.61, 36.90]	38.95 [19.76, 56.93]	28.64 [13.23, 47.51] [6.48, 38.01]	31.30 [14.11, 49.57]	23.70 [11.44, 40.49] [25.79, 25.79]
Hours	9.61 [2.73, 19.54]	15.87 [6.55, 28.67] [6.79, 26.63]	11.90 [1.49, 29.84]	14.09 [3.70, 33.90] [4.40, 27.67]	1.05 [0.09, 4.56]	9.74 [2.79, 23.32] [3.09, 22.76]	1.94 [0.16, 8.60]	23.28 [8.28, 41.10] [22.89, 22.89]
Investment	7.97 [1.34, 20.33]	16.84 [6.16, 32.51] [5.80, 29.08]	8.76 [0.87, 29.59]	14.29 [3.43, 36.63] [4.13, 30.58]	2.19 [0.20, 9.16]	21.34 [8.31, 37.89] [6.09, 34.36]	7.29 [0.85, 22.03]	36.99 [21.28, 53.19] [32.48, 32.48]
Net trade	1.95 [0.17, 7.93]	8.02 [3.57, 16.69] [3.75, 17.31]	10.87 [1.21, 31.46]	16.93 [4.49, 37.36] [5.03, 38.40]	2.10 [0.19, 8.65]	20.92 [9.04, 35.10] [9.80, 35.02]	5.01 [0.48, 17.57]	10.73 [3.45, 23.59] [22.30, 22.30]
Stock prices	43.74 [25.83, 61.21]	39.11 [23.16, 55.26] [20.66, 51.16]	10.00 [0.40, 32.53]	9.83 [2.54, 26.78] [3.28, 24.34]	49.49 [29.82, 66.24]	39.08 [21.95, 56.99] [27.36, 27.36]	61.21 [43.38, 75.92]	39.64 [22.54, 57.30] [32.62, 32.62]

Notes: Each column corresponds to the contribution of news shock to the variance of observables at horizon h. The values in square brackets are 90% Bayesian confidence intervals.

Table 3: FEVD -Baseline with relative TFP (SPC1)

	AUS		CA		NZ		UK			
	h=1	h=20	h=1	h=20	h=1	h=20	h=1	h=20		
TFP	0.00 [0.00, 0.00]	21.85 [10.35, 35.88]	19.79 [8.37, 35.15]	0.00 [0.00, 0.00]	15.15 [7.20, 25.70]	15.24 [8.09, 25.19]	0.00 [0.00, 0.00]	25.67 [16.02, 36.62]	23.74 [14.66, 34.10]	46.65 [31.93, 61.66]
Output	7.17 [1.12, 16.77]	27.72 [12.30, 44.40]	23.93 [10.05, 44.30]	23.20 [7.77, 41.49]	19.24 [9.90, 32.03]	15.28 [8.13, 24.75]	4.95 [0.85, 12.29]	18.01 [7.91, 33.49]	10.41 [4.71, 24.18]	55.67 [39.66, 71.34]
Consumption	23.73 [11.61, 38.76]	34.34 [20.69, 50.77]	28.03 [13.87, 46.63]	31.37 [11.61, 51.48]	30.04 [15.94, 46.78]	17.58 [9.82, 28.61]	56.11 [43.56, 67.26]	34.77 [21.88, 50.86]	15.10 [7.89, 30.60]	62.83 [46.59, 77.32]
Hours	5.06 [0.61, 12.95]	22.42 [9.94, 37.29]	22.43 [10.45, 36.43]	17.89 [6.06, 32.06]	36.53 [20.74, 54.10]	28.33 [16.79, 44.56]	10.34 [4.38, 18.46]	10.08 [3.85, 21.63]	9.06 [3.98, 19.53]	36.85 [19.82, 53.88]
Investment	1.84 [0.16, 7.11]	15.98 [4.29, 35.11]	16.65 [5.58, 36.14]	15.17 [3.78, 32.15]	34.64 [19.68, 50.51]	26.88 [15.54, 40.75]	1.49 [0.13, 5.45]	12.76 [4.60, 24.76]	10.19 [4.15, 21.09]	42.33 [25.32, 57.62]
Net trade	9.87 [2.61, 20.96]	7.41 [3.41, 14.98]	9.07 [3.90, 20.09]	16.24 [4.55, 34.01]	18.10 [7.64, 33.00]	15.89 [6.49, 30.66]	1.07 [0.09, 4.66]	7.85 [2.89, 17.41]	8.50 [3.63, 16.54]	46.79 [32.33, 62.24]
Stock prices	56.13 [41.95, 69.07]	59.02 [45.43, 70.88]	52.47 [38.96, 65.47]	57.98 [37.46, 74.77]	33.58 [19.28, 48.91]	28.36 [16.99, 41.98]	29.03 [16.95, 42.59]	25.93 [14.54, 40.05]	17.98 [9.93, 30.72]	44.11 [30.93, 58.20]

Notes: Each column corresponds to the contribution of news shock to the variance of observables at horizon h. The values in square brackets are 90% Bayesian confidence intervals.

Table 4: FEVD -Baseline with relative TFP (SPC2)

	AUS		CA		NZ		UK	
	h=1	h=10	h=1	h=10	h=1	h=10	h=1	h=10
TFP	0.00 [0.00, 0.00]	11.57 [3.35, 24.54]	0.00 [0.00, 0.00]	13.27 [6.53, 22.93]	0.00 [0.00, 0.00]	9.00 [3.17, 18.30]	0.00 [0.00, 0.00]	28.68 [12.53, 46.45]
Output	4.31 [0.79, 11.39]	17.38 [6.00, 32.75]	21.15 [6.97, 38.38]	17.97 [9.07, 30.50]	1.31 [0.17, 6.09]	6.69 [2.51, 16.94]	5.79 [1.24, 14.43]	44.37 [23.90, 61.49]
Consumption	26.04 [14.23, 39.20]	26.14 [12.85, 42.01]	38.64 [19.08, 53.78]	34.37 [18.10, 48.56]	31.93 [16.15, 46.68]	19.90 [8.24, 35.15]	44.31 [20.13, 61.24]	52.79 [30.26, 71.10]
Hours	5.99 [1.00, 14.84]	25.67 [12.16, 39.67]	13.54 [4.44, 29.00]	33.69 [17.25, 49.86]	1.19 [0.10, 5.62]	6.48 [2.12, 16.17]	2.65 [0.23, 11.57]	15.24 [4.64, 34.48]
Investment	9.79 [1.94, 21.99]	24.18 [9.56, 39.91]	12.60 [2.68, 28.18]	32.21 [18.20, 46.91]	1.26 [0.13, 5.31]	14.02 [5.89, 27.59]	3.96 [0.39, 17.40]	30.16 [13.20, 48.78]
Net trade	2.89 [0.39, 10.71]	8.29 [3.64, 18.24]	16.05 [4.92, 34.04]	17.81 [7.91, 34.48]	1.47 [0.12, 6.26]	16.50 [7.36, 29.52]	6.65 [0.96, 23.18]	32.08 [13.66, 49.77]
Stock prices	66.35 [51.04, 77.47]	53.53 [37.89, 67.68]	60.17 [37.51, 77.09]	33.40 [20.02, 48.14]	57.08 [42.95, 71.11]	31.97 [19.72, 46.58]	55.39 [27.44, 72.04]	37.51 [17.15, 56.01]

Notes: Each column corresponds to the contribution of news shock to the variance of observables at horizon h. The values in square brackets are 90% Bayesian confidence intervals.

C US TFP measures comparison

This section investigates the quality of our TFP measure by comparing it against the one developed by Kimball, Fernald, and Basu (2006) and which is also used by Beaudry et al. (2011). The exercise is as follows:

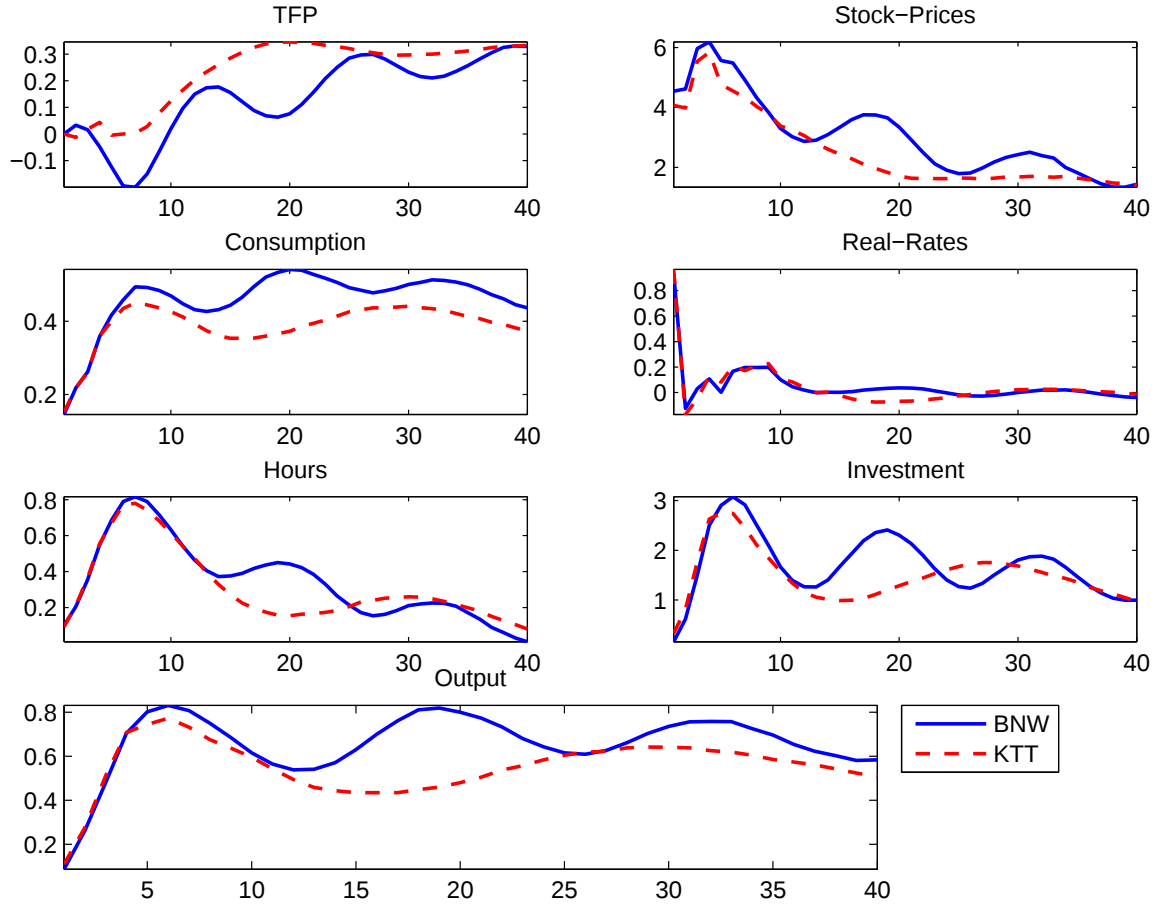
- we first estimate the seven variable VAR model of Beaudry et al. (2011) using their data set, however, the sample size is different now 1985Q4 – 2010Q4
- we next replace the TFP series in Beaudry et al. (2011) data set with our measure for the US. We keep all the other series unchanged. We then conduct the same exercise

Figure 11 displays the impulse responses to a news TFP shock from the two estimations, while Table 5 reports the two forecast variance decompositions. The results are self revealing and suggest that our TFP measure contains the same information as the one developed by Kimball et al. (2006) for the US. In other words, our methodology to recover the true TFP process appears to be correct and this increases our confidence about the non US results.

Table 5: Forecast Variance Decomposition

HORIZON	0	4	8	16	24	40
<i>Beaudry-Nam-Wang</i>						
TFP	0.00	0.02	0.11	0.16	0.22	0.35
Stock Prices	0.38	0.63	0.59	0.51	0.44	0.42
Consumption	0.27	0.56	0.56	0.49	0.48	0.48
Real Rates	0.34	0.26	0.26	0.24	0.22	0.22
Hours	0.08	0.46	0.51	0.34	0.29	0.28
Investment	0.01	0.35	0.37	0.30	0.32	0.35
Output	0.02	0.45	0.45	0.39	0.39	0.43
<i>Kamber-Theodoridis-Thoenissen</i>						
TFP	0.00	0.01	0.01	0.22	0.32	0.38
Stock Prices	0.32	0.47	0.46	0.45	0.43	0.42
Consumption	0.30	0.57	0.56	0.49	0.47	0.47
Real Rates	0.39	0.29	0.29	0.28	0.28	0.28
Hours	0.06	0.39	0.48	0.37	0.30	0.30
Investment	0.02	0.35	0.38	0.31	0.32	0.36
Output	0.03	0.41	0.45	0.40	0.40	0.43

Figure 11: IRFs to News in the US with alternative TFP measures



Note: The impulse responses show the impact of a news TFP shock in the US. The blue line (BNW) is obtained using Kimball, Fernald, and Basu (2006)' measure of TFP. The red dotted line (KTT) is obtained using our own measure of TFP. See section 2.1 for details.

D Steady States

$$R^h = \frac{\gamma}{\beta} \quad (32)$$

$$\frac{k}{i} = \frac{\gamma}{\gamma - 1 + \delta} \quad (33)$$

$$\frac{\mu}{\lambda} = \frac{\gamma - \beta R}{\gamma} \frac{R^h}{\xi R} \quad (34)$$

$$\frac{y}{k} = \frac{\left(1 - \frac{\mu}{\lambda} \xi\right) \frac{\gamma}{\beta} - 1 + \delta}{\left(1 - \frac{\mu}{\lambda}\right) \theta \gamma} \quad (35)$$

$$k = \left(\frac{\frac{y}{k}}{\frac{A}{\gamma^\theta} n^{1-\theta}} \right)^{\frac{1}{\theta-1}} \quad (36)$$

$$b^f = \left(k - \frac{y}{\xi} \right) R^h \quad (37)$$

$$(1 - \theta) \frac{y}{n} \left(1 - \frac{\mu}{\lambda} \right) = w \quad (38)$$

$$y - wn - i + b^f \left(\frac{1}{R} - \frac{1}{\gamma} \right) = d \quad (39)$$

$$b = b^f \quad (40)$$

$$wn + b \left(\frac{1}{\gamma} - \frac{1}{R} \right) + d = c \quad (41)$$

$$\frac{1}{c} = \lambda \quad (42)$$

$$\frac{\lambda w}{n^\eta} = \alpha \quad (43)$$

D.1 Summary of Stationary Equations

$$\frac{1}{c_t} - \lambda_t = 0$$

$$-\alpha n_t^\eta + \lambda_t w_t = 0$$

$$\frac{\beta \lambda_{t+1}}{\lambda_t \gamma_{t+1}} R_t^h = 1$$

$$w_t n_t + \frac{b_{t-1}}{\gamma_t} + d_t = \frac{b_t}{R_t} + c_t$$

$$y_t = A_t \left(\frac{k_{t-1}}{\gamma_t} \right)^\theta n_t^{1-\theta}$$

$$F_n(z_t, k_{t-1}, n_t) = (1 - \theta) \frac{y_t}{n_t}$$

$$F_k(z_t, k_{t-1}, n_t) = \theta \gamma_t \frac{y_t}{k_{t-1}}$$

$$(1 - \theta) \frac{y_t}{n_t} \left(1 - \frac{\mu_t}{\lambda_t} \varphi'(d_t) \right) = w_t$$

$$\frac{\beta \lambda_{t+1}}{\lambda_t \gamma_{t+1}} \left(\frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \right) R_t + \frac{\mu_t}{\lambda_t} \varphi'(d_t) \xi_t \frac{R_t}{R_t^h} = 1$$

$$\frac{\beta \lambda_{t+1}}{\lambda_t \gamma_{t+1}} \left(\frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \right) \left[q_{t+1}(1 - \delta) + \left(1 - \frac{\mu_{t+1}}{\lambda_{t+1}} \varphi'(d_{t+1}) \right) \theta \gamma_{t+1} \frac{y_{t+1}}{k_t} \right] + \frac{\mu_t}{\lambda_t} \varphi'(d_t) \xi_t = q_t$$

$$\varphi(d_t) = \left(1 + \kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right)^2 \right) d_t$$

$$\varphi'(d_t) = \left(1 + \kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right)^2 \right) + 2\kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right) \frac{d_t}{y_t}$$

$$\begin{aligned} \varphi'(d_t) &= 1 + 2\kappa \left(\frac{d}{y} \right)^2 (\hat{d}_t - \hat{y}_t) \\ \frac{\varphi'(d_t) - \varphi'(d)}{\varphi'(d)} &= 2\kappa \left(\frac{d}{y} \right)^2 (\hat{d}_t - \hat{y}_t) \\ \varphi'(\hat{d}_t) &= 2\kappa \left(\frac{d}{y} \right)^2 (\hat{d}_t - \hat{y}_t) \end{aligned}$$

$$y_t - w_t n_t - i_t - \frac{b_{t-1}^f}{\gamma_t} + \frac{b_t^f}{R_t} - \varphi(d_t) = 0$$

$$\xi_t \left(k_t - \frac{b_t^f}{R_t^h} \right) = y_t$$

$$R_t^h = R^h - \psi \left(e^{\left(\frac{b_{t-1}}{\gamma_t} - \frac{b_{t-1}^f}{\gamma_t} \right)} - 1 \right) \quad (44)$$

$$k_t = (1 - \delta) \frac{k_{t-1}}{\gamma_t} + \left(1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} \gamma_t - \gamma \right)^2 \right) i_t$$

$$1 = q_t \left(1 - \frac{\phi}{2} \left(\frac{i_t}{i_{t-1}} \gamma_t - \gamma \right)^2 - \phi \left(\frac{i_t}{i_{t-1}} \gamma_t - \gamma \right) \frac{i_t}{i_{t-1}} \gamma_t \right) + \beta \frac{\lambda_{t+1}}{\lambda_t \gamma_{t+1}} q_{t+1} \phi \left(\frac{i_{t+1}}{i_t} \gamma_{t+1} - \gamma \right) \left(\frac{i_{t+1}}{i_t} \gamma_{t+1} \right)^2$$

E Linearised Model

$$\hat{\lambda}_t = -\hat{c}_t \quad (45)$$

$$\hat{n}_t = \frac{1}{\eta} \left(\hat{\lambda}_t + \hat{w}_t \right) \quad (46)$$

$$0 = \hat{\lambda}_{t+1} - \hat{\lambda}_t - \hat{\gamma}_{t+1} + \hat{R}_t^h \quad (47)$$

$$\frac{wn}{c} (\hat{w}_t + \hat{n}_t) + \frac{b}{c\gamma} (\hat{b}_{t-1} - \hat{\gamma}_t) + \frac{d}{c} \hat{d}_t - \frac{b}{cR} (\hat{b}_t - \hat{R}_t) = \hat{c}_t \quad (48)$$

$$\hat{y}_t = \hat{A}_t + \theta (\hat{k}_{t-1} - \hat{\gamma}_t) + (1 - \theta) \hat{n}_t \quad (49)$$

$$\left(1 - \frac{\mu}{\lambda}\right) (\hat{y}_t - \hat{n}_t) - \frac{\mu}{\lambda} (\hat{\mu}_t - \hat{\lambda}_t + \hat{\varphi}'(\hat{d}_t)) = \hat{w}_t \quad (50)$$

$$\begin{aligned} 0 = & \frac{\beta}{\gamma} R \left(\hat{\lambda}_{t+1} - \hat{\lambda}_t - \hat{\gamma}_{t+1} + \hat{\varphi}'(\hat{d}_t) - \hat{\varphi}'(\hat{d}_{t+1}) + \hat{R}_t \right) \\ & + \frac{\mu}{\lambda} \xi \frac{R}{R^h} \left(\hat{\mu}_t - \hat{\lambda}_t + \hat{\varphi}'(\hat{d}_t) + \hat{\xi}_t + \hat{R}_t - \hat{R}_t^h \right) \end{aligned} \quad (51)$$

$$\begin{aligned} \frac{\beta\lambda_{t+1}}{\lambda_t\gamma_{t+1}} \left(\frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \right) \left[q_{t+1}(1 - \delta) + \left(1 - \frac{\mu_{t+1}}{\lambda_{t+1}} \varphi'(d_{t+1}) \right) \theta \gamma_{t+1} \frac{y_{t+1}}{k_t} \right] + \frac{\mu_t}{\lambda_t} \varphi'(d_t) \xi_t &= q_t \\ \frac{\beta\lambda_{t+1}}{\lambda_t\gamma_{t+1}} \left(\frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \right) \left[q_{t+1}(1 - \delta) + \theta \gamma_{t+1} \frac{y_{t+1}}{k_t} - \frac{\mu_{t+1}}{\lambda_{t+1}} \varphi'(d_{t+1}) \theta \gamma_{t+1} \frac{y_{t+1}}{k_t} \right] + \frac{\mu_t}{\lambda_t} \varphi'(d_t) \xi_t &= q_t \end{aligned}$$

$$\begin{aligned} \hat{q}_t = & \frac{(1 - \delta)\beta}{\gamma} \left(\hat{\lambda}_{t+1} - \hat{\lambda}_t - \hat{\gamma}_{t+1} + \hat{\varphi}'(\hat{d}_t) - \hat{\varphi}'(\hat{d}_{t+1}) + \hat{q}_{t+1} \right) \\ & + \frac{\beta\theta y}{k} \left(\hat{\lambda}_{t+1} - \hat{\lambda}_t + \hat{\varphi}'(\hat{d}_t) - \hat{\varphi}'(\hat{d}_{t+1}) + \hat{y}_{t+1} - \hat{k}_t \right) \\ & - \frac{\beta\theta y \mu}{k\lambda} \left(-\hat{\lambda}_t + \hat{\varphi}'(\hat{d}_t) + \hat{\mu}_{t+1} + \hat{y}_{t+1} - \hat{k}_t \right) \\ & + \frac{\mu}{\lambda} \xi \left(\hat{\mu}_t - \hat{\lambda}_t + \hat{\varphi}'(\hat{d}_t) + \hat{\xi}_t \right) \end{aligned} \quad (52)$$

$$\begin{aligned} \varphi(d_t) &= \left(1 + \kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right)^2 \right) d_t \\ &= d_t + \kappa \left(\frac{d_t}{y_t} - \frac{d}{y} \right)^2 d_t \end{aligned}$$

$$\begin{aligned} \varphi(d_t) &= d + d\hat{d}_t \\ \hat{\varphi}(\hat{d}_t) &= \hat{d}_t \end{aligned}$$

$$\hat{\varphi}'\left(\hat{d}_t\right)=2 \kappa\left(\frac{d}{y}\right)^2\left(\hat{d}_t-\hat{y}_t\right) \quad (53)$$

$$\hat{y}_t-\frac{w n}{y}\left(\hat{w}_t+\hat{n}_t\right)-\frac{i}{y} \hat{i}_t-\frac{b^f}{y \gamma}\left(\hat{b}_{t-1}^f-\hat{\gamma}_t\right)+\frac{b^f}{y R}\left(\hat{b}_t^f-\hat{R}_t\right)-\frac{d}{y} \hat{d}_t=0 \quad (54)$$

$$\frac{\xi k}{y}\left(\hat{\xi}_t+\hat{k}_t\right)-\frac{\xi b^f}{y R^h}\left(\hat{\xi}_t+\hat{b}_t^f-\hat{R}_t^h\right)=\hat{y}_t$$

$$\hat{R}_t^h=-\psi \frac{b}{R^h \gamma}\left(b_{t-1}-b_{t-1}^f\right)$$

$$\hat{k}_t=\frac{1-\delta}{\gamma}\left(\hat{k}_{t-1}-\hat{\gamma}_t\right)+\frac{i}{k} \hat{i}_t \quad (55)$$

$$\hat{i}_t=\frac{1}{1+\beta}\left(\hat{i}_{t-1}-\hat{\gamma}_t\right)+\frac{\beta}{1+\beta}\left(\hat{i}_{t+1}+\hat{\gamma}_{t+1}\right)+\frac{1}{(1+\beta) \phi \gamma^2} \hat{q}_t \quad (56)$$