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Terms of Trade Shocks: What are They and What Do They Do?

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Abstract

This paper describes and quantifies the macroeconomic effects of different types of terms of trade shocks and their propagation in the Australian economy. Three types of shocks are identified based on their impact on commodity prices, global manufactured prices, and global economic activity. The first two shocks, a world demand shock and a commodity-market specific shock are fairly standard. The third shock, a globalisation shock that may result, for instance, from the increasing importance of China, India and eastern Europe in the global economy is more novel. The globalisation shock is associated with a decline in manufactured prices, a rise in commodity prices, and an increase in global economic activity.

Determining the underlying source of variation in the terms of trade is shown to be important for understanding the impact on the Australian economy as all three shocks propagate through the economy in different ways. The relative contribution of each shock to inflation, output, interest rates, and the exchange rate has also varied over time. The main conclusion of the paper is that a higher terms of trade tends to be expansionary but is not always inflationary. A key result is that the floating exchange rate has provided an important buffer to the external shocks that move the terms of trade.

JEL Classification Numbers: E32, E52, F36, F40
Keywords: terms of trade, sign-restricted VAR

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TERMS OF TRADE SHOCKS: WHAT ARE THEY AND WHAT DO THEY DO?

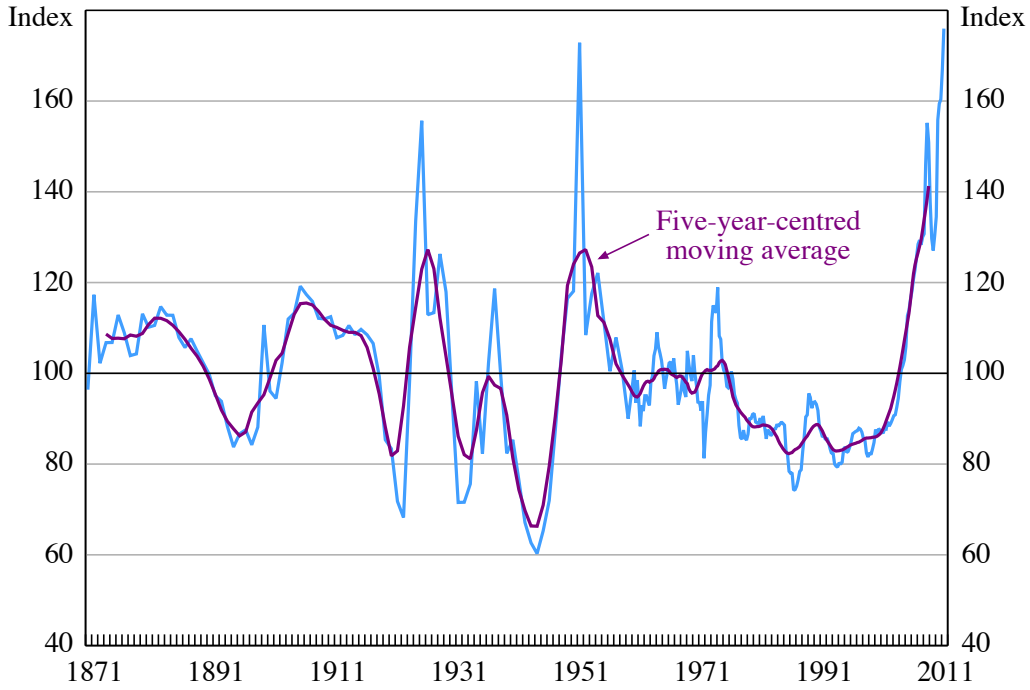
Jarkko Jääskelä and Penelope Smith

1. Introduction

One of the most significant influences on the Australian economy over the past decade has been the booming terms of trade which has risen by almost 80 per cent. The terms of trade are currently around their highest level of the 140-year history of the series. The current boom is comparable in magnitude to the wool booms of the 1920s and the 1950s but has been sustained for much longer. It more than reverses the trend decline in the terms of trade observed over the second half of the 20th century (see Figure 1).

Figure 1: **Australia's Terms of Trade**

Average 1869/70 to 2010/11 = 100



Notes: Annual data from 1870 to 1959; quarterly data from September 1959

Sources: ABS; Gillitzer and Kearns (2005)

As discussed by Battellino (2010), previous terms of trade booms have been associated with significant economic volatility, creating complex challenges

for economic policy. The booms of the 1920s and 1950s, although initially expansionary, were followed by falling output and rising unemployment. With a fixed exchange rate in place during the 1950s, the concurrent rise in export receipts and capital inflows caused a surge in money and credit, resulting in year-ended CPI inflation of almost 20 per cent. In the period since the float of the Australian dollar the exchange rate response to a change in the terms of trade has become central to the macroeconomic outcome. Gruen and Shuetrim (1994) found evidence that, in the period after the float of the Australian dollar, rises in the terms of trade have tended to reduce domestic inflation in the short run.

We argue that the consequences of a rising terms of trade will ultimately depend on the characteristics of the underlying shock, as well as the policy response. In related work, Kilian (2009) and Peersman and Van Robays (2009) demonstrate that the responses of the US and euro area economies to oil price shocks also depend on the nature of the shock. The recent Australian empirical literature, however, largely ignores this idea.

We identify the impact of global shocks on the terms of trade by estimating a sign-restricted vector autoregression (VAR). Three stylised terms of trade shocks are identified: a *world demand shock*, a *commodity-market specific shock*, and a *globalisation shock*. A positive world demand shock is associated with a pick-up in global economic activity and an increase in export *and* import prices. A positive commodity-market specific shock increases export prices without a corresponding pick-up in global economic activity.

Finally, a globalisation shock captures the increasing integration of emerging economies, notably China and India, into the world economy. Increased globalisation has been associated with a fall in the relative price of manufactured goods. As Australian imports are concentrated in manufactured goods this is also likely to increase the terms of trade. At the same time, as more countries integrate in to the world economy, the demand for raw materials increases, exerting upward pressure on (commodity) export prices. Such a shock is also associated with an expansion in world output.

We find that positive terms of trade shocks tend to be expansionary but are not always inflationary. Whether these shocks are inflationary depends on both the source of the shock and the response of monetary policy. We also find that the floating exchange rate provides an important buffer against foreign shocks that

move the terms of trade: the bulk of variation in the real exchange rate is attributed to world shocks, but the world shocks have very little impact on other Australian variables.

The remainder of the paper is structured as follows. In Section 2 we outline our benchmark VAR and discuss identification of the shocks that move the terms of trade. In Section 3 we estimate the effects of these shocks on Australian inflation, output, short-term nominal interest rates, and the real exchange rate. We also obtain the historical contribution of each identified shock to fluctuations in the domestic variables. The concluding remarks are in Section 4.

2. Measuring the Effects of Terms of Trade Shocks

A standard framework for estimating the effects of international relative price shocks on the Australian economy is to estimate a VAR model that is partitioned into an exogenous foreign block, designed to capture conditions in the world economy, and a domestic block that includes output, inflation, interest rates, and the real exchange rate. Movements in international relative prices are captured in several different ways. Berkelmans (2005) and Lawson and Rees (2008) include real commodity prices, while in Dungey and Pagan (2000, 2009) and Otto (2003) the terms of trade are included. Brischetto and Voss (1999) include world oil prices. This international relative price variable is typically included in the world block.

To capture fluctuations in international relative prices that are not explained by movements in world output or world interest rates, a shock is typically applied directly to the relative price variable. The implication of this approach is that all relative price shocks are treated equally. For example, a rise in the terms of trade associated with a fall in the price of manufactured goods is assumed to have similar consequences for the Australian economy as a rise in the terms of trade associated with higher world commodity prices and higher world manufactures prices.

We also adopt a VAR framework, but depart from the standard approach in allowing the response of domestic variables to vary depending on the nature of the terms of trade shock. Liu (2010) also examines the effect of different types of international shocks on the Australian economy but like Dungey and Pagan (2000, 2009), Liu assumes that terms of trade shocks do not influence foreign variables. In contrast, we maintain the small open economy assumption

that the prices of tradeable goods are determined in world markets, implying that all terms of trade shocks originate in (and affect) the world economy.

Before outlining our identification scheme, it is helpful to briefly review the key influences on Australia's terms of trade over recent years. These include the global business cycle, the rapid development of Asian economies, and the sticky response of supply in commodities markets.

As discussed by Kilian (2009), there is little direct evidence of how the global business cycle affects industrial commodity markets, although there is typically a positive correlation between global output growth and commodity prices. For example, the 2000s boom in global commodity prices was associated with strong economic growth worldwide, particularly in Asia. The long time horizons of capital-intensive investment in the mining sector meant supply could not quickly expand to meet unexpected changes to demand and commodity prices rose sharply (see Connolly and Orsmond (2011)).

Strong growth in commodity prices in recent years has also been linked to the unusually high, and rising, intensity of use of metals in industrialising Asia. In 2007, GDP metal intensities in China were 7.5 times higher than in developed countries and 4 times higher than in other developing countries (IBRD/World Bank 2009). This reflects the resource intensity of the infrastructure investment required to support rural–urban migration, investment in physical capital such as plants and infrastructure, as well as lower rates of efficiency in the use of these resources. The composition of Chinese exports also appears to have been important. Roberts and Rush (2010) provide evidence that China's (mainly manufacturing) exports have been at least as important as construction as a driver of China's demand for resource commodities.

The sharp expansion in the supply of manufactured goods accompanying the integration of east Asia into the world economy and the transfer of manufacturing activities to these economies has placed downward pressure on the world price of manufactured goods. As Australian imports are concentrated in manufactured goods, this is an additional factor supporting Australia's terms of trade.

2.1 The Benchmark VAR

To distill the various global shocks underlying movements in the terms of trade we estimate the following sign-restricted VAR:

$$\begin{bmatrix} w_t \\ d_t \end{bmatrix} = \alpha x_t + \sum_{i=1}^{p} A_i \begin{bmatrix} w_{t-i} \\ d_{t-i} \end{bmatrix} + B \begin{bmatrix} \varepsilon_t^w \\ \varepsilon_t^d \end{bmatrix} \tag{1}$$

where w_t and d_t are vectors of endogenous world and domestic variables, x_t is a vector of exogenous variables, and B is the contemporaneous impact matrix of the vectors of mutually uncorrelated world ε_t^w and domestic ε_t^d disturbances.

There are three variables in the world block $w_t = (\pi_t^x, \pi_t^m, \Delta y_t^w)'$ which broadly capture conditions in the world economy that are exogenous to the Australian economy, but relevant to Australia's terms of trade: π_t^x is export price inflation; π_t^m is import price inflation; and y_t^w is quarterly growth in the output of Australia's major trading partners.[1] To abstract from fluctuations in export and import prices caused by movements in the exchange rate, the export and import price series are converted to world prices using the trade-weighted index.[2]

The second group of variables $d_t = (\Delta y_t^d, \pi_t^d, r_t^d, \Delta q_t)'$ are specific to the Australian economy: Δy_t^d denotes domestic output growth; π_t^d is consumer price inflation; r_t^d is the nominal short-term interest rate; and Δq_t is the log difference of the real exchange rate. Appendix A contains a full description of the data and their sources.

The sample used for estimation runs from 1984:Q1 to 2010:Q2. It was selected to include the earlier period of strong commodity price growth in the late 1980s. The start date is constrained by the float of the Australian dollar in December 1983. In order to capture the move to inflation targeting, a constant and a dummy variable are included in the vector x_t. The dummy variable is equal to 1 during the inflation-targeting period from March 1993 onward, and 0 otherwise.

---

1 We also estimated the model with a measure of world industrial production but found that it did not substantially alter the results.

2 We are assuming instantaneous and perfect pass through of the nominal exchange rate into export and import prices. Indices of world manufacturing or commodity prices are typically constructed under this assumption.

Augmented Dickey-Fuller and Phillips-Perron tests indicate that all variables in the benchmark model are $I(1)$, except for the domestic interest rate which is $I(0)$. Trace tests failed to find evidence of a cointegrating relationship amongst the variables in the model and we specify the model in differences rather than in levels. The results presented are for a lag length of $p = 3$.

2.2 Identification Using Sign and Parametric Restrictions

Identification of structural shocks in VAR models is typically achieved by placing restrictions on the model parameters. However, an increasingly popular alternative is to place restrictions on the direction that key variables will move (over a given horizon) in response to different types of shocks. VAR models identified using this technique are known as sign-restricted VARs. Sign restrictions have been used as a method of identifying structural shocks in VAR models by Faust (1998), Canova and De Nicoló (2002), and Uhlig (2005). Peersman and Van Robays (2009) demonstrate the use of sign restrictions in identifying different types of oil price shocks.[3]

We use a combination of sign and parametric restrictions. Sign restrictions are imposed on the estimated responses of the *level* of export prices (p_t^x), import prices (p_t^x), and world output (y_t^w) to identify different types of global shocks that move Australia's terms of trade. This amounts to placing restrictions on the signs of the accumulated impulse responses. The specific shocks that we consider are a 'world demand' shock, a world 'commodity-market specific' shock, and a 'globalisation' shock. The sign restrictions adopted in this paper are presented in Table 1. The restrictions are imposed for four periods following a shock, as is standard in the literature.

The interpretation of the world demand shock in Table 1 is straightforward. It captures movements in export and import prices associated with the global business cycle. A positive world demand shock increases p_t^x, p_t^m, and y_t^w. The globalisation shock captures the integration of emerging market economies into the world trade system, resulting in stronger world growth and higher world commodity prices, while at the same time placing downward pressure on the price of manufactured goods (import prices). Finally, innovations to export prices

3 Fry and Pagan (forthcoming) provide a comprehensive review of literature on sign-restricted VARs.

Table 1: VAR Restrictions on Shocks that Improve the Terms of Trade

	p^x	p^m	y^w	d
World demand shock	+	+	+	*na*
Commodity-market specific shock	+	*na*	−	*na*
Globalisation shock	+	−	+	*na*
Domestic shocks	0	0	0	*na*

Notes: + (−) means a positive (negative) response of the variable in the column to the shock in the row; 0 means no response as implied by the small open economy assumption; *na* means no restriction is imposed on the response

that are not explained by world demand or globalisation shocks are attributed to the commodity-market specific shock. This shock accounts for periods of rising commodity prices that are not associated with a pick-up in world output growth. As this shock also captures financial investment in commodities and precautionary demand, its impact on world output may be positive or negative.

Note that the restrictions used to identify the globalisation shock are the only ones that also restrict the response of the terms of trade. However, because π_t^x is more volatile than π_t^m we expect that positive world demand and commodity market specific shocks will also increase the terms of trade.

In keeping with the small open economy assumption, we restrict the contemporaneous impact matrix B and lag matrices A_i to be block lower triangular. This implies that fluctuations in the world price of Australian exports and imports and world output are only driven by shocks to the world block (ε_t^w). Even though there are seven shocks in the model, we only need to identify the three world shocks to avoid the multiple shocks problem described by Fry and Pagan (forthcoming). Since we are mainly interested in the response of the domestic variables to different types of foreign shocks, we do not place restrictions on the domestic variables or identify domestic shocks. A similar approach is taken by Peersman and Van Robays (2009), although they do not place parametric restrictions on the A_i matrices.

3. Results

3.1 Impulse Responses

We follow Peersman (2005) in using a Bayesian approach for estimation and inference and hence capture both sampling and model uncertainty.[4] A total of 100 000 successful draws from the posterior are used to show the median, 84th and 16th percentiles of the impulse responses.[5] Figure 2 shows the accumulated impulse responses of the world variables to the three identified shocks. The direction of these responses (for the first four periods) correspond to the restrictions outlined in Table 1. The magnitudes of these responses, however, are unrestricted. Figure 2 also shows the impulse responses for the terms of trade, which are constructed from the responses of export and import prices.

Fry and Pagan (forthcoming) criticise the practise of using the median response as a measure of central tendency because it mixes the responses of different candidate models. They suggest selecting a single model, and hence the unique set of impulse responses from the Monte Carlo draws that is closest to the set of median responses. Accordingly, we also report their 'median target' measure. To locate this measure we use the impulse responses from *all* seven variables in the model.

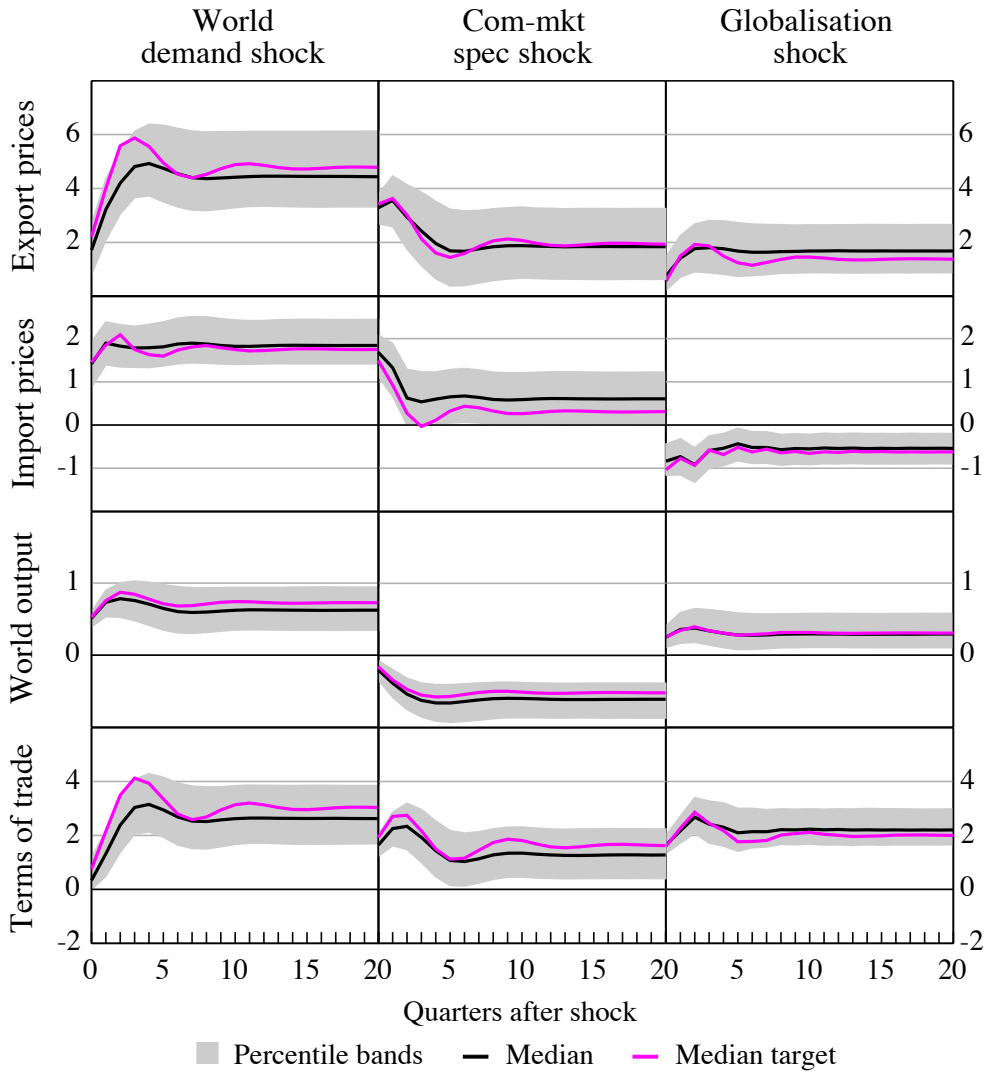
The responses of variables in the world block to world shocks appear to be permanent. This is consistent with pretesting which indicated that each series was I(1). The effect of each shock on the terms of trade also appears to be permanent, providing additional evidence that export prices and import prices are not cointegrated. Although the magnitudes of the responses of export and import prices to each shock are different, the response of the terms of trade is similar. Each identified shock permanently increases the terms of trade by around 2–4 per cent according to the median target measure.

The response of import prices to the commodity-market specific shock is the only unrestricted response in the world block. The response is clearly positive

4 Detailed descriptions of algorithms used for Bayesian inference in these models can be found in Peersman (2005), Uhlig (2005), and Rubio-Ramírez, Waggoner and Zha (2010).

5 Because the point-wise distribution of each impulse response is approximately normal, the 16th and 84th percentiles roughly correspond to a one standard deviation error band.

Figure 2: **Responses of World Variables to Terms of Trade Shocks**

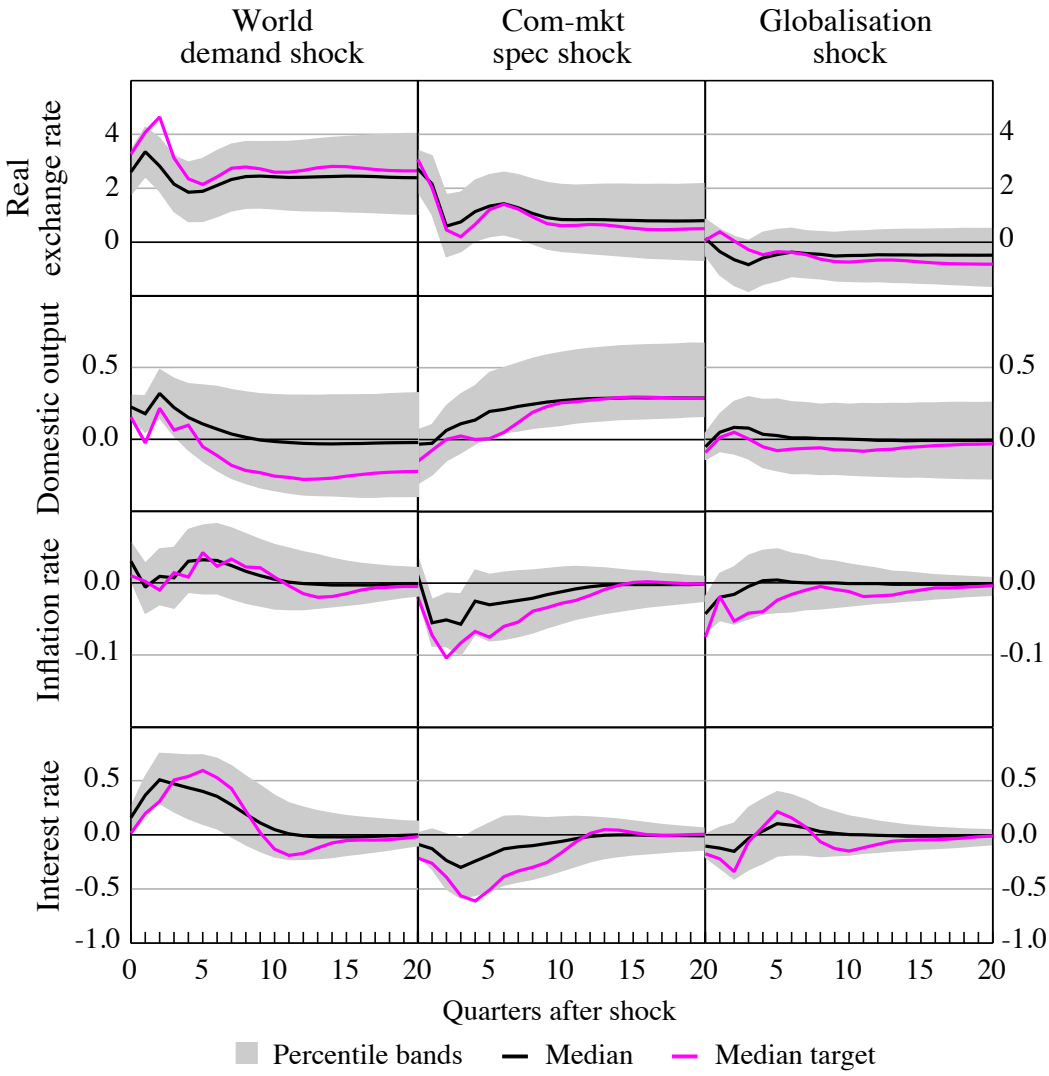


Notes: Figures show the median and median target accumulated impulse responses to the different types of terms of trade shocks, together with the 16th and 84th percentile bands. The impulse responses for the terms of trade are constructed from the impulse responses for export prices and import prices. 'Com-mkt spec shock' is a commodity-market specific shock.

for the first two quarters, before returning to zero. The response of world output to the commodity-market specific shock is clearly negative. The responses to a commodity-market specific shock are consistent with a textbook 'commodity supply' shock, where a disruption to the supply of commodities is followed by an increase in commodity prices, a rise in the price of goods that use those commodities as an input, and a fall in world output. However, without a reliable long-run measure of the world supply of Australia's major export commodities such as coal and iron ore, it is impossible to identify a commodity supply shock.

Figure 3 shows the unrestricted responses of domestic variables to the shocks identified in Table 1. The first column shows the response of the domestic variables to a positive world demand shock. In response to this shock there is a permanent appreciation in the real exchange rate of 2–3 per cent. The median impulse response suggests that level of output is 0.25 per cent higher for three quarters, although the median target measure suggests a somewhat weaker response. Nominal interest rates increase by about 50 basis points and remain elevated for around two years. Inflation is slightly higher on impact (due to higher import prices), but rapidly returns to zero as the exchange rate appreciates and the interest rate increases.

Figure 3: **Responses of Domestic Variables to Terms of Trade Shocks**



Notes: Figures show the median and median target impulse responses to the different types of terms of trade shocks, together with the 16th and 84th percentile bands. The accumulated impulse responses are shown for output and the real exchange rate.

The central column of Figure 3 contains the responses to a commodity-market specific shock. In response to this shock, the real exchange rate appreciates by around 3 per cent on impact and then depreciates by the same amount over the next three quarters. The higher real exchange rate appears to be passed through to lower consumer prices for three quarters after the shock, although the magnitude of the inflation response is small (less than 0.1 per cent per quarter). This suggests that any domestic inflationary pressures that might arise from the higher import prices are offset by the higher real exchange rate, and the interest rate falls accordingly. According to the median and median target, the level of domestic output is permanently higher following a commodity-market specific shock, however the strength of this response is imprecisely measured, with the 16th percentile band touching zero.

The last column of Figure 3 shows the response of the domestic variables to a positive globalisation shock. In this case the real exchange rate appears to depreciate, although the estimated magnitude of this depreciation is small. Although it may be surprising to see the real exchange rate depreciate in response to a positive shock to commodity prices, this response is consistent with a Balassa-Samuelson type effect. Domestic inflation falls on impact before returning to trend in 4 to 8 quarters, perhaps due to the depreciation of the real exchange rate. There is no significant response by the short-term nominal interest rate or output.

To summarise, the evidence presented here is that terms of trade shocks are not necessarily expansionary or inflationary, with the net effect dependent upon the nature of the underlying shock. The real exchange rate appears to have provided an important buffer against foreign shocks over the sample period. Overall, monetary policy – as captured by the short-term market interest rate – has tended to respond to the foreign shocks in such a way that it reduces the inflationary effect of these shocks.

3.2 Variance Decomposition

Table 2 reports the contribution of the three identified shocks to the unconditional variance of the data. We report the results for the median target draw, rather than the median because the construction of variance, and historical, decompositions requires that shocks come from a unique model. We also examined variance

decompositions at shorter horizons, but the results were broadly similar and are not reported here.

Table 2: Variance Decomposition

Per cent

	π^x	π^m	Δy^w	Δq	Δy^d	π^d	r^d
World demand shock							
Median target	43	36	68	39	20	3	18
One std dev interval	(21,51)	(19,55)	(35,75)	(15,41)	(9,23)	(2,16)	(4,26)
Commodity-market specific shock							
Median target	51	45	16	36	6	18	18
One std dev interval	(39,68)	(29,66)	(10,39)	(18,45)	(4,14)	(3,17)	(2,16)
Globalisation shock							
Median target	6	19	15	1	3	6	4
One std dev interval	(4,17)	(7,24)	(5,37)	(3,11)	(3,12)	(1,10)	(1,10)
Shocks to domestic block							
Median target				24	70	73	59
One std dev interval				(24,39)	(59,76)	(63,87)	(57,84)

The variance decomposition indicates that the commodity-market specific shock and the world demand shock account for the largest share of the variance in the world price of Australian exports (51 percent and 43 per cent, respectively) and imports (45 per cent and 36 per cent, respectively). The globalisation shock appears to be less important but notably has a larger impact on Australian import prices: the median target measure suggests that the globalisation shock accounts for 6 per cent of the variance in export prices and 19 per cent of the variance in import prices. Most of the sample variation in world output growth is attributed to the world demand shock (68 per cent), with roughly similar contributions from the commodity-market specific shock (16 per cent) and the globalisation shock (15 per cent).

The variance decomposition can also be used to quantify the extent to which the floating exchange rate has provided a shock absorbing mechanism against global shocks. If the exchange rate effectively stabilises foreign shocks, then these shocks should have a substantial effect on the exchange rate, but much less of an impact on the other domestic variables. Table 2 shows that the variance of the real exchange rate is explained predominantly by the world shocks, with the median target draw indicating that only 24 per cent of variation in the real exchange rate is explained

by 'domestic' factors.[6] Other unidentified shocks explain substantially more of the variation in the remaining domestic variables. According to the median target measure, 70 per cent of the variance in domestic output and 73 per cent of the variance in trimmed-mean inflation is explained by domestic factors. These results indicate that the exchange rate does indeed provide an important buffer against the force of global shocks.

3.3 Historical Decomposition

Historical decompositions can be used to estimate the contribution of the identified shocks to each variable in the model over time. Figure 4 shows the contributions of each shock to quarterly growth in export prices and import prices variables over the sample period using the median target measure.

Export prices appear to have been subject to several sizeable commodity-market specific shocks throughout the sample period, most notably in mid 2008. The commodity-market specific shock appears to be coinciding with a shift in the composition of world growth in the first half of 2008. Although major trading partner growth fell well below the sample average in the June quarter of 2008, Chinese GDP growth remained a little higher than the sample average, though a sluggish supply response may also have contributed to the run-up in commodity prices.[7]

The decline in export prices that followed in late 2008 is, unsurprisingly, explained by a negative world demand shock and subsequent recovery is attributed mainly to a commodity-market specific shock. The recovery broadly coincides with the Chinese fiscal stimulus, which had a strong emphasis on infrastructure projects. Although the globalisation shock explains a relatively small proportion of the variation of export prices, it is estimated to have contributed to the decline – and the subsequent increase – in export prices during the Asian financial crisis in the late 1990s.

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6 We are cautious in the use of the word 'domestic' in this situation because own shocks to the real exchange rate may not be entirely domestic in origin. For example, global risk-premia shocks are often cited as important sources of variation in the exchange rate

7 Annual data from ABARES and the US Geological Survey suggest that growth in the world supply of some commodities, such as iron ore, slowed sharply in 2007 and 2008.

Figure 4: **Historical Decompositions of Export and Import Price Inflation**

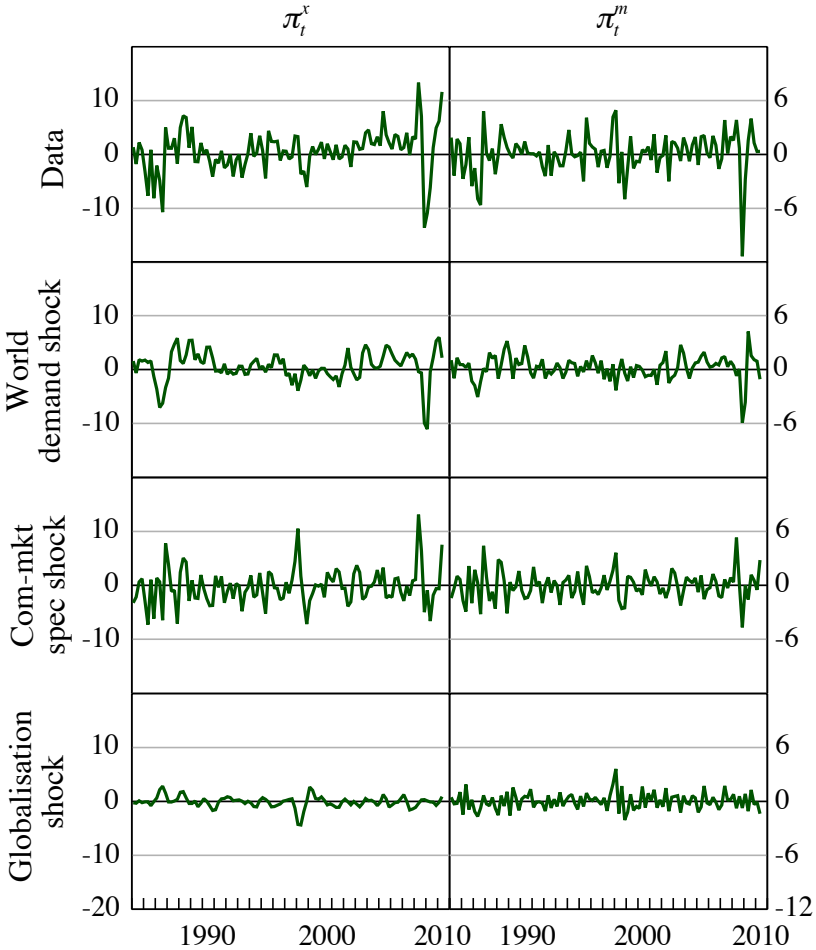


Figure 5 shows the contributions of each shock to quarterly growth in world output and the terms of trade. The decline in world output growth during the Asian financial crisis is explained by the combined effects of a negative globalisation shock and a negative commodity-market specific shock. In contrast, the sharp decline in world output in late 2008 and early 2009 is explained by a negative world demand shock with a smaller contribution from a commodity-market specific shock.

Figure 5: **Historical Decompositions of World Output and the Terms of Trade**

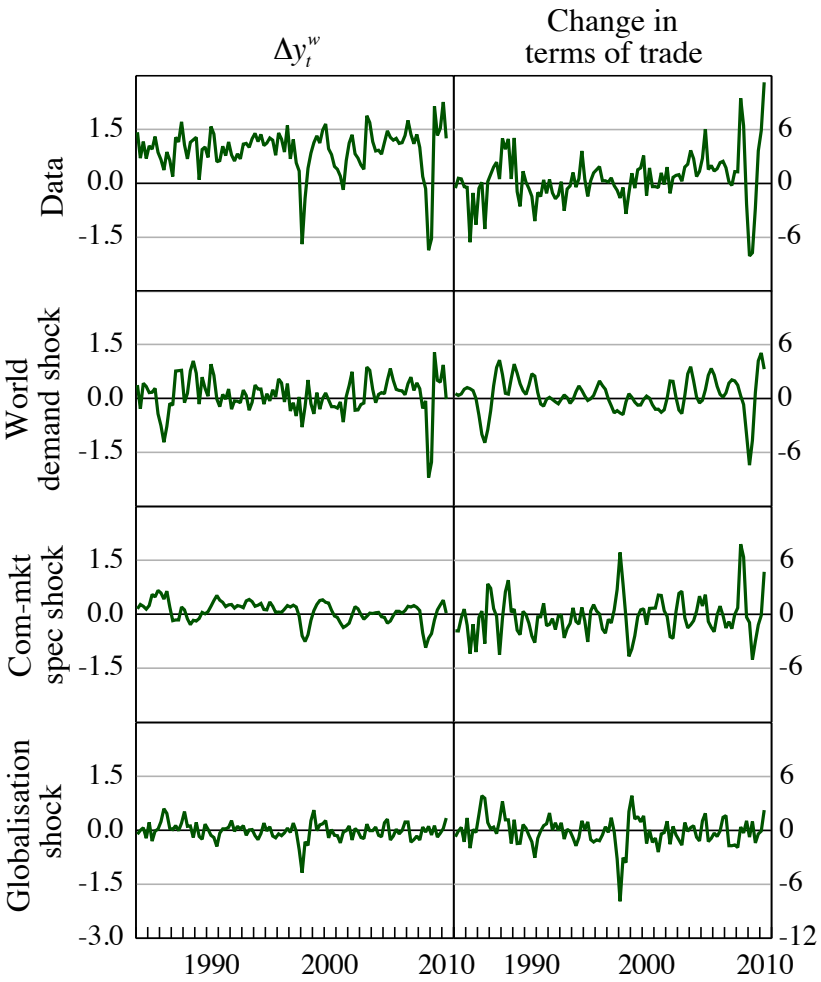


Figure 6 plots the contribution of terms of trade and 'domestic' shocks to quarterly growth in the real exchange rate and domestic output and Figure 7 plots the contribution of these shocks to quarterly inflation and the interest rate. Fluctuations in the real exchange rate are explained by a combination of global and domestic shocks, with a very limited role for the globalisation shock.

The world shocks appear to have made only modest contributions to historical variations in output, inflation, and short-term interest rates. However, a significant proportion of the late 2008 contraction in real GDP growth, and much of the subsequent recovery, is attributed to the combined effects of a negative world demand shock and domestic shocks. This contrasts with the recession of the early 1990s, which the sign-restricted VAR attributes almost entirely to shocks to the domestic block.

Figure 6: **Historical Decompositions of the Real Exchange Rate and Domestic Output**

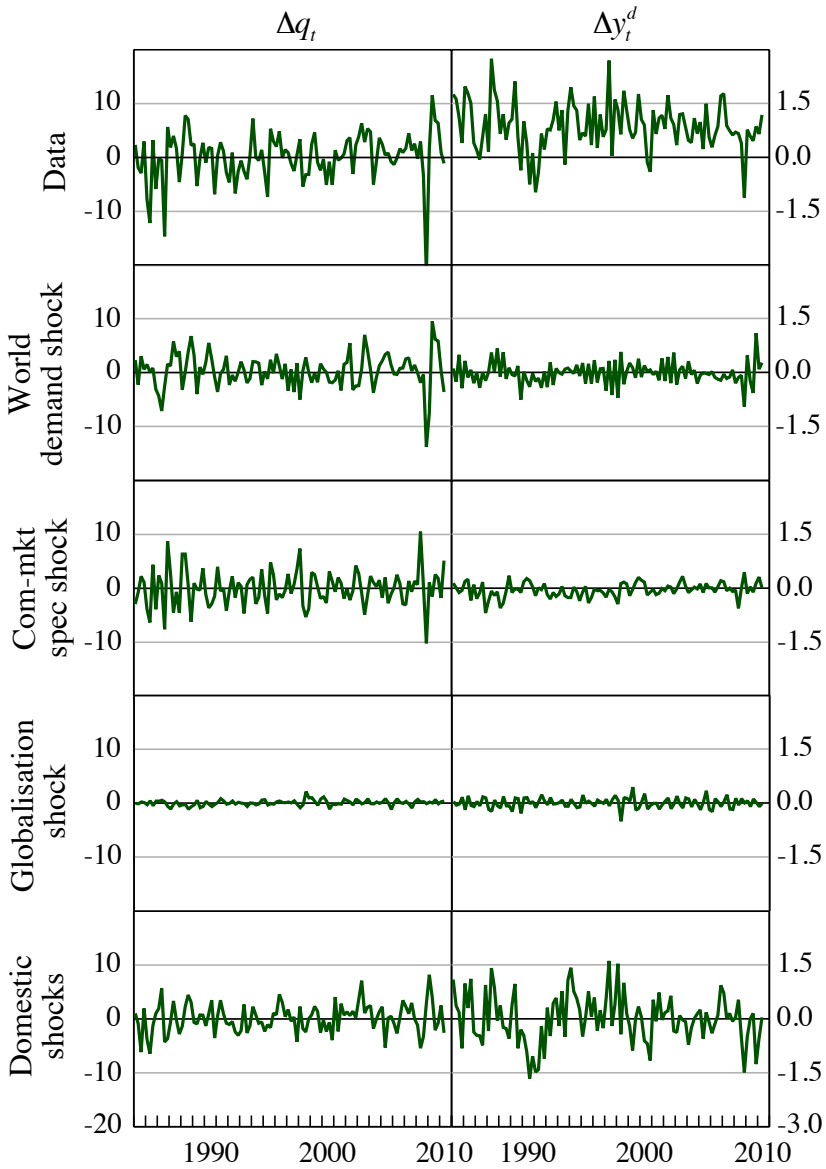
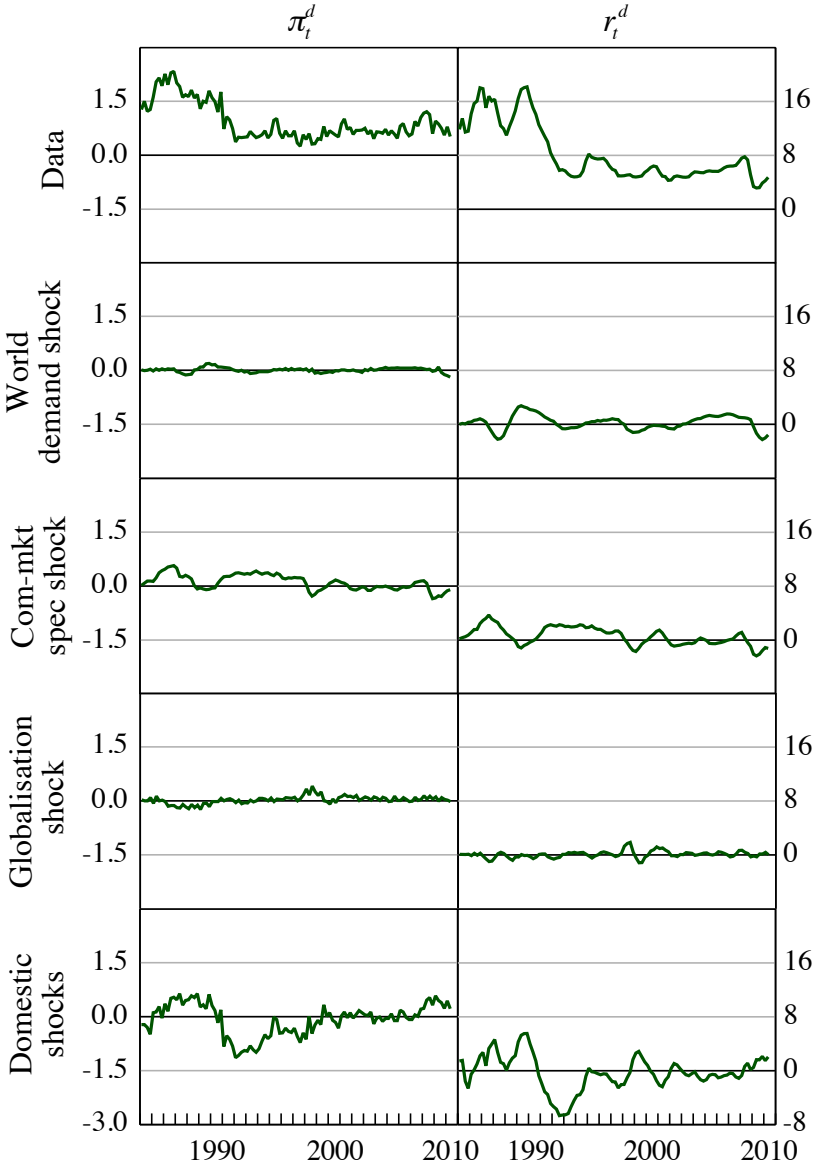


Figure 7: Historical Decompositions of Inflation and the Nominal Interest Rate



3.4 Additional Results and Robustness Checks

3.4.1 Estimation over the inflation-targeting period

As a robustness check, we estimated the benchmark VAR over the inflation-targeting period. The estimated impulse responses are broadly similar, although the one-standard deviation error bands are wider in some cases (see Figures B1 and B2). The variance decomposition is qualitatively similar to the longer sample (see Table B1).

The historical decompositions are shown in Figures B3, B4, B5 and B6. When the model is estimated over the inflation-targeting period, the commodity-market specific shock appears to be somewhat more important for explaining the variation in import prices, world output, and the real exchange rate, and the world demand shock appears to be less important than in the longer sample. Moreover, global shocks are estimated to explain a greater proportion of the variation in interest rates. Of the global shocks, the globalisation shock is estimated to be more important in accounting for variation in inflation while the world demand shock and the commodity-market specific shock explain more of the variation in interest rates.

3.4.2 Direct versus indirect effects on inflation

The consumer price index captures the prices of both tradable and non-tradable goods. Terms of trade shocks will have a direct impact on CPI inflation via the price of tradable goods but there can be indirect (second round) effects as well. To evaluate the relative importance of direct and indirect effects on inflation, we extend the domestic block of the benchmark VAR to include both non-tradable and tradable inflation in place of trimmed-mean inflation.

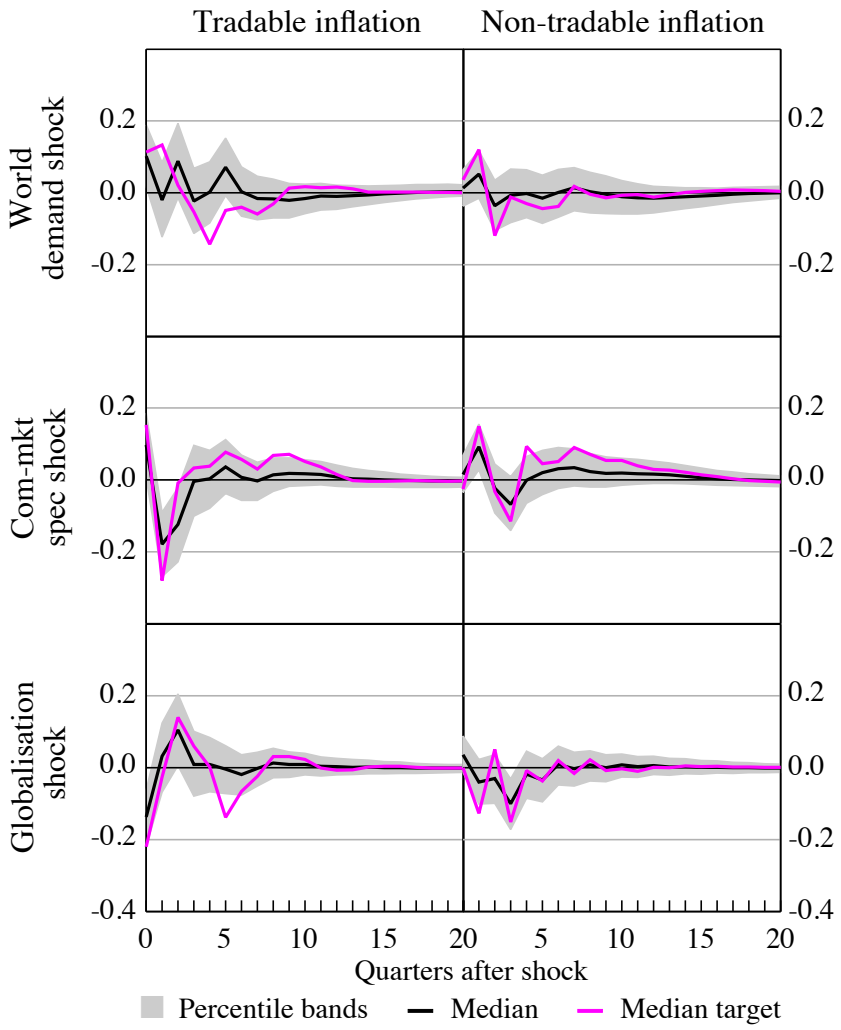
The impulse responses of tradable and non-tradable inflation to the three global shocks are shown in Figure 8. The impulse responses of the remaining variables in the extended VAR are similar to those presented for the benchmark VAR in Figure 3 and are not shown.

The world demand shock has very little impact upon tradable or non-tradable inflation, consistent with the results for trimmed-mean inflation shown in Figure 3. For the commodity-market specific shock, the negative response of consumer price inflation appears to be mainly driven by the response of the tradable component, which is slightly offset by the positive response from the non-tradables component. Inflation is initially lower after a globalisation shock. Figure 8 indicates that this is likely to be due to the decline in tradable inflation. However, tradable inflation rises in subsequent periods, perhaps due to the depreciation of the real exchange rate. The effect of this increase on trimmed-mean inflation is, however, offset by a modest decline in non-tradable inflation.

The variance decompositions for non-tradable and tradable inflation are shown in the last two columns of Table 3. We do not show the variance decomposition

for the world block as this is identical to results presented in Table 2. Not surprisingly, domestic shocks explain a larger share of non-tradable inflation than tradable inflation. This provides further evidence that the floating exchange rate has provided an effective buffer to external shocks.

Figure 8: **Responses of Tradable and Non-tradable Inflation to Terms of Trade Shocks**



Notes: Figures show the median and median target responses to the different types of terms of trade shocks, together with the 16th and 84th percentile bands.

Table 3: Variance Decomposition: Tradable and Non-tradable Inflation

Per cent

	Δq	Δy^d	r^d	π^{nt}	π^t
World demand shock					
Median target	22	30	13	6	9
One std dev interval	(18,43)	(8,20)	(3,20)	(4,13)	(5,14)
Commodity-market specific shock					
Median target	44	8	11	13	18
One std dev interval	(15,41)	(4,13)	(2,13)	(4,14)	(6,17)
Globalisation shock					
Median target	3	3	4	8	13
One std dev interval	(3,11)	(4,11)	(2,11)	(3,12)	(4,12)
Shocks to domestic block					
Median target	31	60	72	73	60
One std dev interval	(27,41)	(62,78)	(63,85)	(67,83)	(62,78)

Notes: Results for the world block are unchanged from Table 2 and are not repeated here; π^{nt} is non-tradable inflation and π^t is tradable inflation

4. Conclusion

This paper has provided empirical evidence on the effects of terms of trade shocks on inflation, output, interest rates and the real exchange rate in the Australian economy. Three shocks to the terms of trade were identified using sign restrictions in a VAR: a world demand shock that increases export prices, import prices and world output; a commodity-market specific shock that pushes up export prices, without a corresponding pick-up in world output; and a globalisation shock that increases export prices and world output, but reduces import prices.

The main conclusion of this paper is that increases in the terms of trade tend to be expansionary but are not always inflationary, with the exchange rate providing an effective buffer to external shocks that move the terms of trade. Inflation and output are found to rise following a world demand shock, but this effect is relatively short-lived due to higher interest rates and the appreciation of the real exchange rate. A commodity-market specific shock, meanwhile, is found to increase import prices, which results in higher trimmed-mean inflation on impact. The appreciation of the real exchange rate, however, offsets the impact on inflation, which is lower in subsequent periods. Finally, the globalisation shock results in

lower domestic inflation on impact but also a depreciation of the real exchange rate, mitigating the deflationary effect in the quarter following the shock.

The terms of trade shocks were found to explain around two-thirds of the variation in the real exchange rate over the sample, but less than one-fifth of variation in the other domestic variables, providing evidence that the floating exchange rate is an important buffer to these shocks. The globalisation shock was found to be of more limited empirical importance in explaining movements in the modelled variables than the world demand shock or the commodity-market specific shock.

Appendix A: Data Description and Sources

Export prices (p^x): seasonally adjusted implicit price deflator for expenditure on exports of goods and services (ABS Cat No 5206.0) multiplied by the quarterly average of the nominal trade-weighted index (RBA Statistical Table F11)

Import prices (p^m): seasonally adjusted implicit price deflator for expenditure on imports of goods and services (ABS Cat No 5206.0) multiplied by the quarterly average of the nominal trade-weighted index (RBA Statistical Table F11)

World output (y^w): seasonally adjusted export-weighted real GDP of Australia's major trading partners (RBA)

Domestic output (y^d): seasonally adjusted chain volume measure of non-farm gross domestic product (ABS Cat No 5206.0)

Trimmed-mean CPI (p^d): seasonally adjusted trimmed-mean consumer price index, 1989/90 = 100, excluding interest charges and adjusted for the tax changes of 1999–2000 (RBA)

Short-term nominal interest rate (r^d): quarterly average of the 90-day bank bill rate (RBA Statistical Table F1)

Real exchange rate (q): real trade-weighted index (RBA Statistical Table F15)

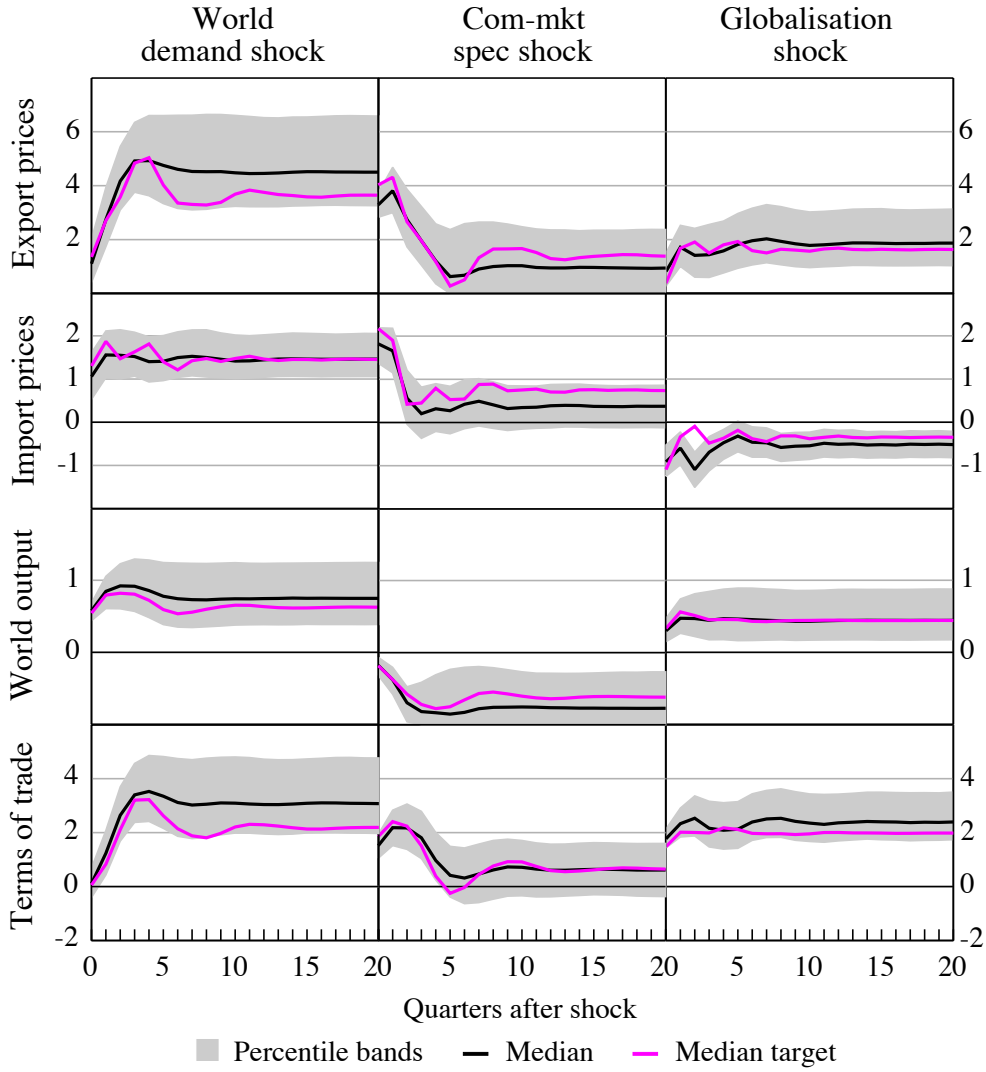
Non-tradables CPI (p^{nt}): seasonally adjusted non-tradables component of the consumer price index, excluding interest charges and adjusted for the tax changes of 1999–2000 (RBA)

Tradables CPI (p^t): seasonally adjusted tradables component of the consumer price index, excluding interest charges and adjusted for the tax changes of 1999–2000 (RBA)

Appendix B: Robustness Checks

Figure B1: **Responses of World Variables to Terms of Trade Shocks**

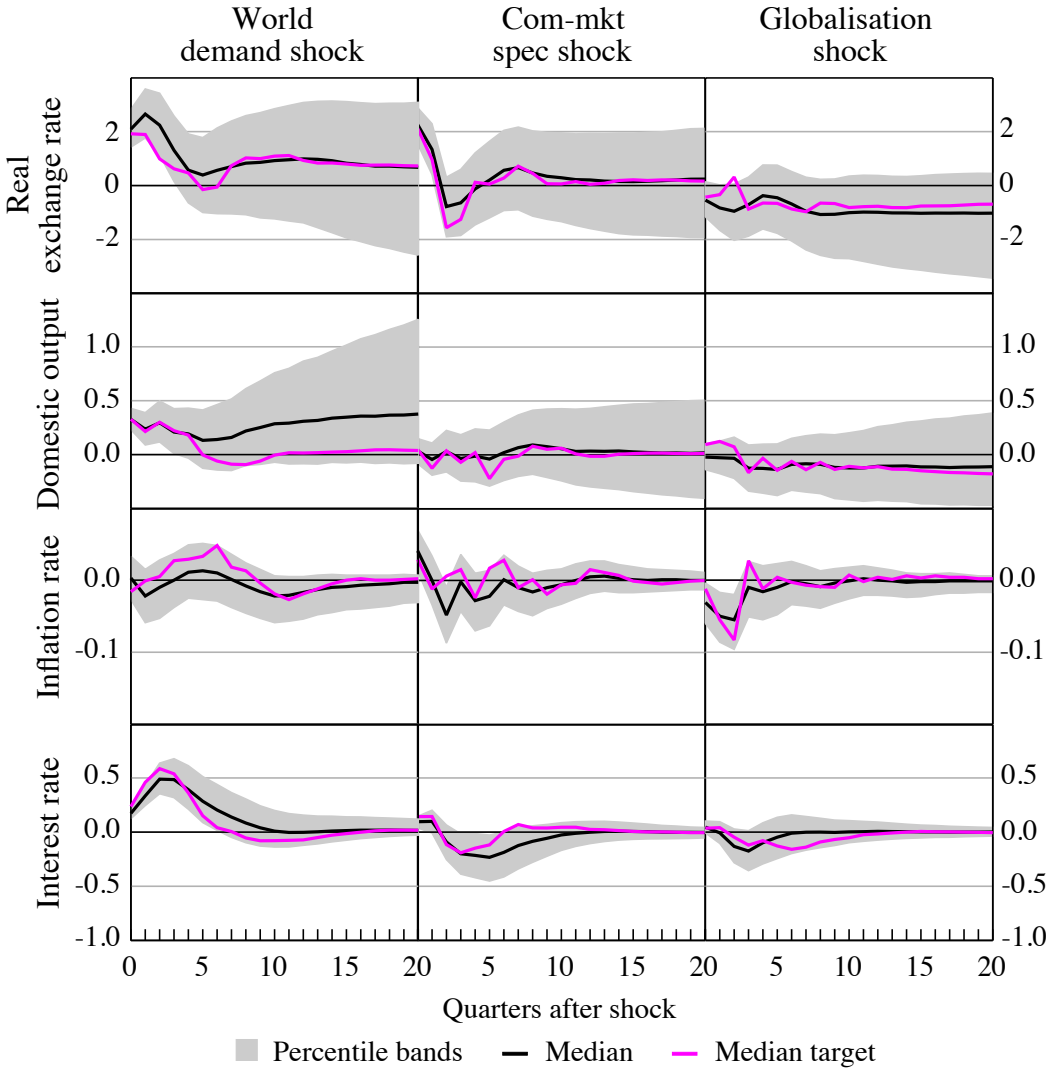
Inflation-targeting sample



Notes: Figures show the median and median target accumulated impulse responses to the different types of terms of trade shocks, together with the 16th and 84th percentile bands. The impulse responses for the terms of trade are constructed from the impulse responses for export prices and import prices.

Figure B2: **Responses of Domestic Variables to Terms of Trade Shocks**

Inflation-targeting sample



Notes: Figures show the median and median target impulse responses to the different types of terms of trade shocks, together with the 16th and 84th percentile bands. The accumulated impulse responses are shown for output and the real exchange rate.

Figure B3: **Historical Decompositions of Export and Import Price Inflation**

Inflation-targeting sample

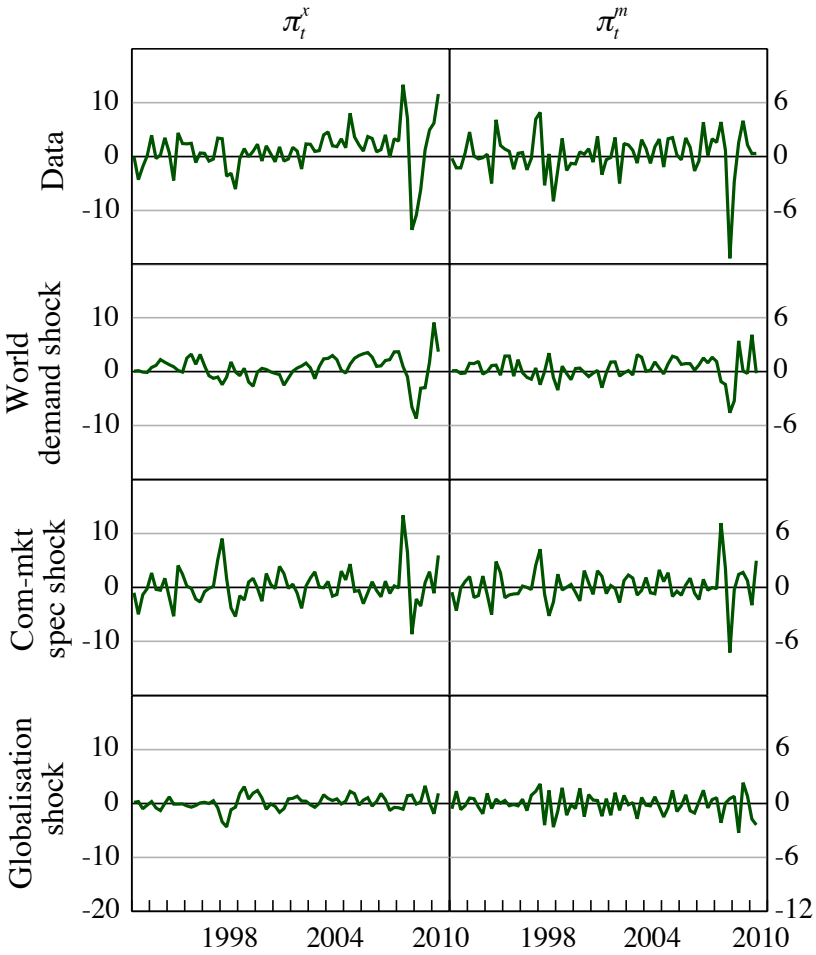


Figure B4: **Historical Decompositions of World Output and the Terms of Trade**

Inflation-targeting sample

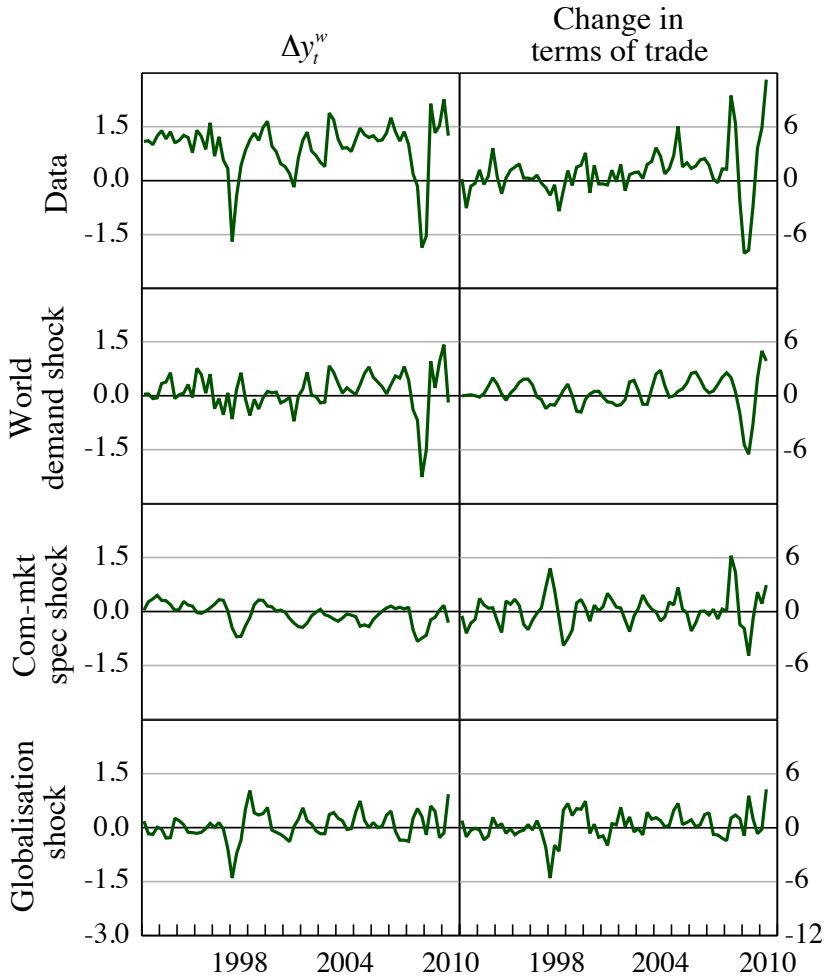


Figure B5: **Historical Decompositions of The Real Exchange Rate and Domestic Output**

Inflation-targeting sample

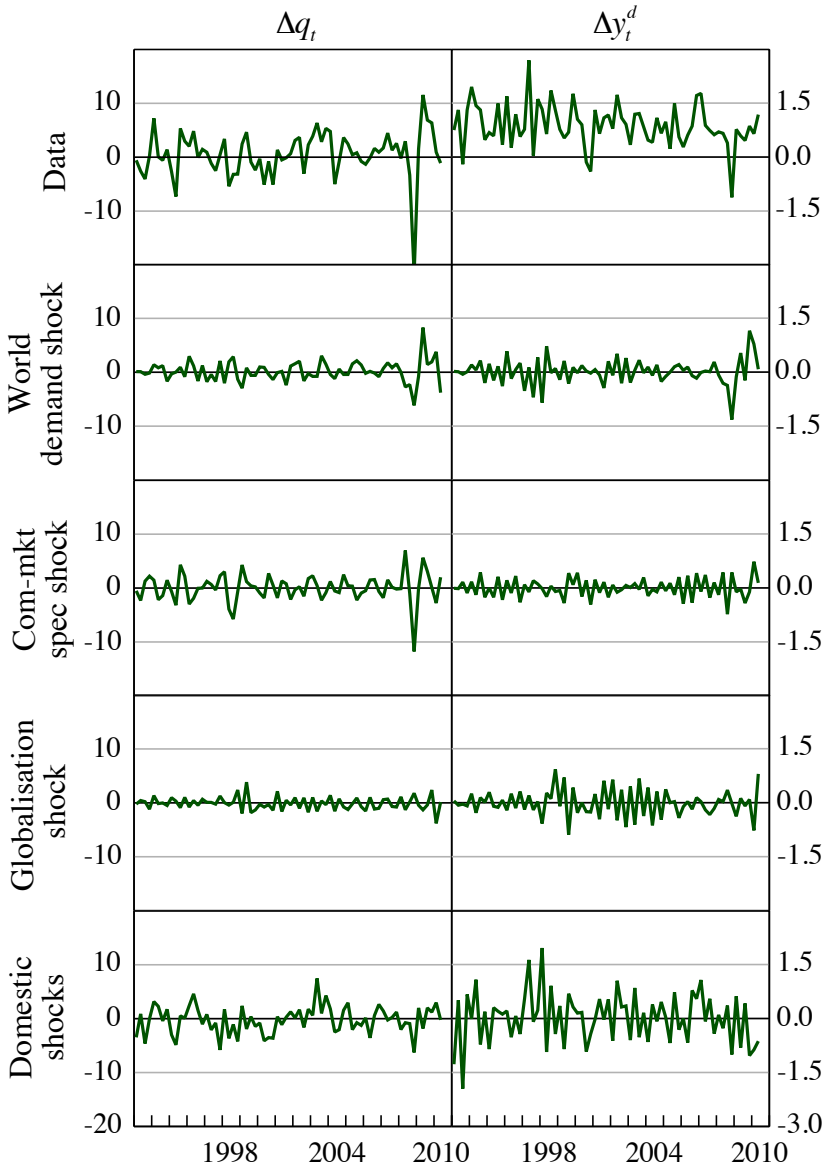


Figure B6: **Historical Decompositions of Inflation and the Nominal Interest Rate**

Inflation-targeting sample

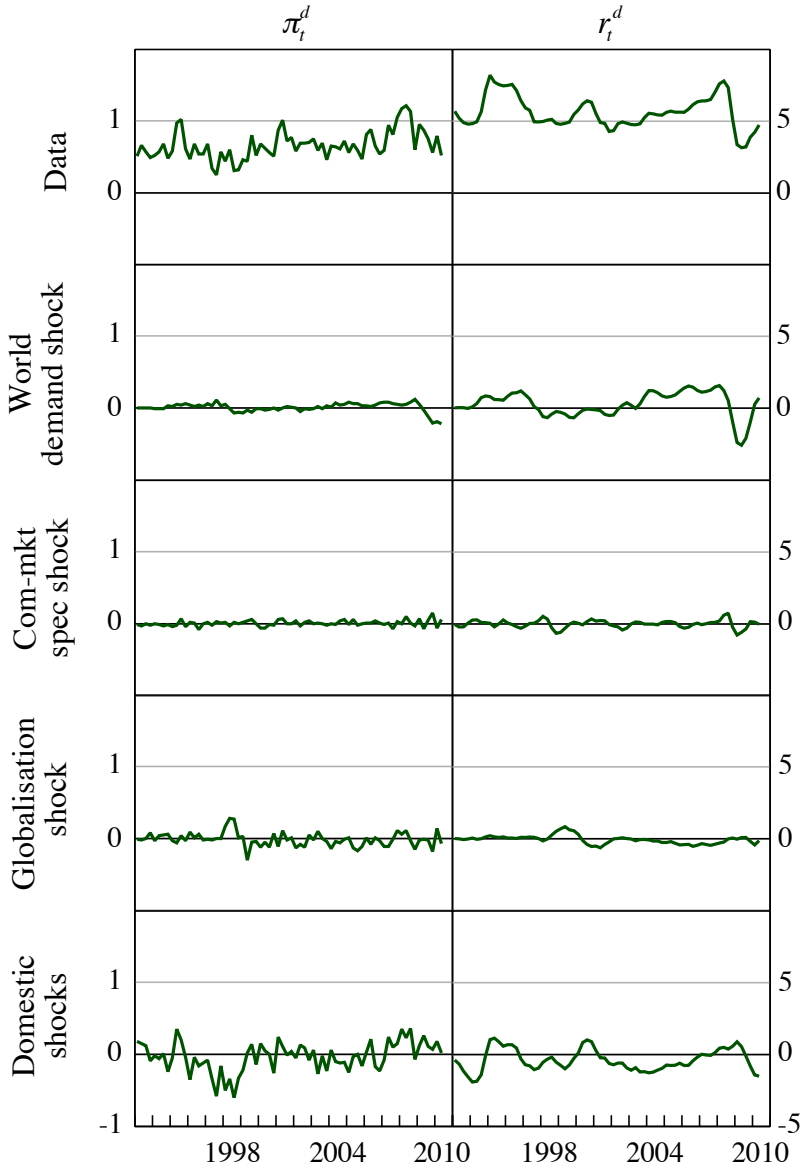
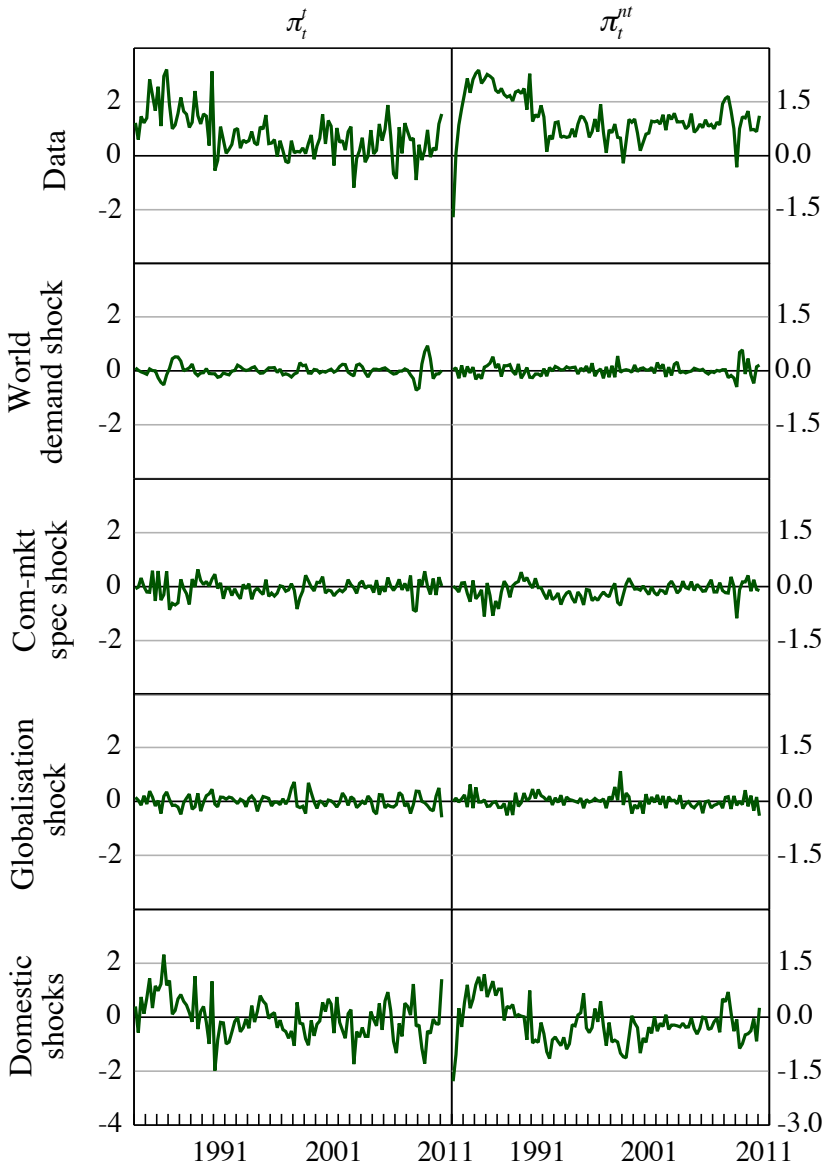


Table B1: **Variance Decomposition**

Inflation-targeting sample, per cent

	π^x	π^m	Δy^w	Δq	Δy^d	π^d	r^d
World demand shock							
Median target	24	21	55	19	15	10	39
One std dev interval	(21,45)	(12,38)	(30,69)	(14,37)	(12,30)	(6,25)	(15,52)
Commodity-market specific shock							
Median target	69	61	22	49	16	5	5
One std dev interval	(42,68)	(40,69)	(15,42)	(18,47)	(5,18)	(5,21)	(4,28)
Globalisation shock							
Median target	7	18	24	8	11	16	4
One std dev interval	(6,20)	(12,29)	(7,37)	(4,15)	(4,17)	(5,20)	(2,17)
Shocks to domestic block							
Median target				24	58	69	53
One std dev interval				(21,42)	(45,68)	(45,71)	(25,59)

Figure B7: **Historical Decompositions of Tradable and Non-tradable Inflation**



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