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

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Abstract

Terms of trade shocks are important sources of fluctuations for the evolution of New Zealand business cycles. In this paper we attempt to identify the drivers of New Zealand’s terms of trade and how those different drivers affect the New Zealand economy. We use a two-block structural vector autoregression to identify shocks to world demand, export and import prices. Similar to Kilian (2009) in the case of real crude oil prices, we find that the common world demand shock is the key driver of New Zealand’s terms of trade. We also find that the shocks that are specific to New Zealand’s export prices are rare and have little significant effect on the New Zealand economy. Although each of the three shocks identified is found to unambiguously increase the terms of trade, the effects of each shock on New Zealand variables are very different.

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1 Introduction

Swings in New Zealand’s terms of trade have significant implications for the New Zealand economy both in the medium term and in the longer term. These swings bring a number of challenges for an inflation targeting central bank. The challenges they bring are further complicated with the so-called ‘commodity currency’ nature of the New Zealand dollar where the New Zealand dollar follows the movements in its commodity prices rather closely.

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

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

It is common to evaluate the responses of domestic (New Zealand) macroeconomic variables to exogenous changes in the terms of trade. As Kilian (2009) argues in the case of real crude oil prices “implicit in this approach is a thought

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1 The term is owed to Chen and Rogoff (2003).
2 Our conversion of the New Zealand dollar series, measured by Statistics New Zealand, into US dollars is not perfect. Prices would have been originally measured in foreign-currency terms, then converted into New Zealand dollars using some prevailing exchange rate. It is likely that the exchange rate then used was not the same as the spot rate series we have used for the present conversion. For example, OTI prices today are compiled using New Zealand Customs Service exchange rates, which are measured with a lag of up to two weeks.
3 The apparent structural break in 1967Q4 is robust to a range of currency specifications.
There are two potential problems with this thought experiment, Kilian (2009) argues. First is related to identification and reverse causality. Reverse causality from global macro aggregates to export and import prices (terms of trade) means that cause and effect are no longer well defined when relating changes in the terms of trade to global macroeconomic outcomes. Second, commodity prices that determine New Zealand’s terms of trade are driven by distinct demand and supply shocks. Not only does each of these shocks have different dynamic effects on New Zealand’s terms of trade and hence on the New Zealand economy, but global demand shocks, in particular, may have direct effects on the domestic (New Zealand economy) as well as an indirect effect working through import

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4In the case of real oil prices, see Barsky and Kilian 2002 for this.
and export prices. This fact immediately invalidates the ceteris paribus assumption, even controlling for reverse causality. In other words, New Zealand’s terms of trade is an ‘endogenous’ variable in the world economy and what drives the terms of trade does matter in its implications for the New Zealand economy.

In this paper we are interested in identifying the drivers of New Zealand’s terms of trade. We would like to understand whether New Zealand’s terms of trade (or commodity prices) rise and fall due to idiosyncratic shocks specific to commodities that New Zealand exports, or whether they are driven by some common factors that also drive the prices of other commodities, including those that the New Zealand imports. Specifically, we estimate a two block structural vector autoregression that jointly addresses these issues. The first objective of our paper is to identify the underlying drivers, demand and supply shocks, of New Zealand’s export and import prices, and hence the terms of trade. The second objective of this paper is to estimate, within the same framework, the effects of each of these drivers of New Zealand’s terms of trade on the New Zealand economy. We decompose New Zealand’s terms of trade into three main drivers: A global demand shock that increases both export and import prices, a New Zealand export price shock, which may be due to a demand for New Zealand exports or a short of supply, and finally a New Zealand import price shock. We provide estimates of the dynamic effects of these shocks on the New Zealand’s terms of trade and how much each of these shocks contributed to the evolution of the terms of trade over the 1987-2012 period.

The main message of our paper is that New Zealand’s terms of trade increases may have very different effects on the domestic economy, depending on the underlying cause of the shift in the terms of trade. Among the three possible causes that we explore here, we find that a terms of trade increase could lead to an inflationary lift in activity, could lead to a lift in activity with little associated inflation, or could have negligible effect on the domestic economy. The difference depends entirely on what drove the increase in the terms of trade.

For many countries, the most important effects of rising commodity prices would be about the trade-off between rising inflation and falling output due to negative income effects. However, for a commodity exporter such as New Zealand the effects are likely to be different and to arrive via different channels. One of the most important effects of a commodity price shock would be felt in exporters’ incomes. This would likely be combined with a negative income effect upon households, particularly if the shock is common to export and import prices. Moreover, New Zealand’s is a ‘commodity currency’ so shifts in commodity prices and terms of trade may also have significant influence over the exchange rate in New Zealand.

Our results are consistent with Kilian (2009) in the case of oil prices that the source of shock does matter. In the case of oil prices, Kilian (2009) show that not all oil price increases can be treated as the same. And, similar to Kilian
(2009), we find that the world demand shock is the major driver of the New Zealand’s terms of trade.

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

2 Literature Review

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

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

A prototype commodities model would have three fundamental shocks for a particular commodity (Deaton and Laroque 2003, Kilian 2009): A commodity specific demand shock, a world demand shock and a commodity-specific supply shock. A positive commodity-specific demand shock would increase the price of the commodity while having no effect on the prices of other commodities. In the case of New Zealand this might be a shock to the demand for dairy products from overseas. Foreign buyers might have a change in their preferences towards dairy or New Zealand dairy products. This kind of a commodity price shock would have very different implications for the New Zealand economy from other kinds of shocks that drive commodity prices.

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

The third shock is on the supply side of the commodity in question. Such a
shock is not always easy to identify, mainly due to data restrictions. Data is not
available on the world production of many commodities at quarterly frequency.
The most available production data is for oil, and at monthly frequency this only
goes back to 1970s. Many metals, minerals and some agricultural commodities
have production data going back to 1900 at annual frequency, but this is insuf-
ficient for detailed commodity supply modelling. As a result, we are unable to
identify a commodity-specific supply shock. Kilian (2009) uses oil production
data to accurately identify an oil supply shock, but nonetheless finds that world
demand shocks are dominant.\footnote{Jääskelä and Smith (2011) propose an additional shock (or a slight change to the
commodity-specific demand shock) that aims to capture the integration of emerging economies
into the world economy. Such a shock is assumed to put positive pressure on Australian export
prices while putting downward pressure on import prices, due to cheaper imports supplied by
these emerging economies, such as China.}

A closely related paper to ours is Jääskelä and Smith (2011), which identifies
very similar shocks and similarly finds that the effects of terms of trade shocks
in Australia depend upon the underlying source of the shock.

3 Model

We estimate the following sign-restricted VAR:

\[
\begin{bmatrix}
    w_t \\
    d_t
\end{bmatrix} = \alpha x_t + \sum_{i=1}^{p} A_i \begin{bmatrix}
    w_{t-i} \\
    d_{t-i}
\end{bmatrix} + B \begin{bmatrix}
    \epsilon^w_t \\
    \epsilon^d_t
\end{bmatrix}
\]

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

We estimate the model as a seemingly unrelated regression (SUR). In this way,
each \(A_i\) is restricted to be block lower triangular to enforce the block structure
of the model, so that lags of New Zealand variables do not affect world vari-
ables. This is to satisfy the assumption that the New Zealand is a price taker
and its import and export prices are determined in the world market, with no
spillover from New Zealand variables to world variables. The impact matrix
\(B\) is found using a sign-restriction algorithm, and is also restricted to be block
lower triangular, thus extending the small open economy assumption to the contemporaneous period (see section 3.2).

3.1 Specification and Data

We specify the data in quarterly growth rates, as follows. The sample period is 1985Q1 to 2012Q2.

\[ w_t = (\Delta y^w_t, \pi^m_t, \pi^x_t)' \]
\[ d_t = (\Delta y^d_t, \pi^d_t, i^d_t, \Delta e_t)' \]
\[ x_t = (c, \kappa_t)' \]

In the world block, \( \Delta y^w_t \) is growth in world GDP, \( \pi^m_t \) is import price inflation, and \( \pi^x_t \) is export price inflation. For world GDP we use the Reserve Bank of New Zealand’s in-house measure, which is constructed using a weighted set of 16 trading partner economies.\(^6\) Import and export prices are measured as Statistics New Zealand’s Overseas Trade Indices (OTIs) for import and export prices. To abstract from exchange rate fluctuations, we express all prices as world prices, with import and export prices deflated by the trade-weighted index (TWI).\(^7\)

For world GDP Kilian (2009) develops and uses a different measure, which aims to capture the component of worldwide real economic activity that drives demand for industrial commodities in global markets. His index is based on dry cargo single voyage ocean freight rates and is explicitly designed to capture shifts in the demand for industrial commodities in global business markets. We opt not to use this for two reasons: First, it aims to capture the drivers of industrial commodities. Second, the freight prices are also driven by demand and supply conditions in the international freight market.

In the New Zealand block, \( \Delta y^d_t \) is growth in New Zealand GDP, \( \pi^d_t \) is New Zealand CPI inflation, \( i^d_t \) is the nominal 90-day interest rate (as a level), and \( \Delta e_t \) is nominal exchange rate appreciation, measured using the trade-weighted index (TWI). In the exogenous vector, \( x_t, c \) is a constant term and \( \kappa_t \), which enters only into domestic equations (i.e. \( \alpha \) is lower triangular) is a dummy variable that captures the move to inflation targeting in 1992. \( \kappa_t \) takes the value zero prior to the first quarter of 1992, and one thereafter.

A lag length of \( p = 1 \) was selected using the Bayesian Information Criterion.

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\(^6\)The economies used are: United States, euro area, United Kingdom, Canada, Japan, China, India, Philippines, Thailand, Indonesia, Malaysia, Taiwan, Hong Kong, Singapore, Korea, Australia.

\(^7\)We also estimated a version of the model where import and export prices are in domestic currency terms and placed in the domestic block to allow the exchange rates to affect them. These results are available upon request.
3.2 Identification

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

We use a sign restriction algorithm similar to that used by Mumtaz and Sunder-Plassmann (2010). The identified shocks are specified in terms of their effects on world-block variables, with the domestic block left mostly unrestricted. The sign restriction scheme is described in Table 1 below. The sign restriction algorithm was run until 100,000 $B$ matrices were found that match the restrictions.

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

<table>
<thead>
<tr>
<th></th>
<th>World GDP</th>
<th>Import prices</th>
<th>Export prices</th>
<th>Exchange rate</th>
<th>Other domestic variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>World demand</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>×</td>
<td>×</td>
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<tr>
<td>World supply</td>
<td>–</td>
<td>+</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<tr>
<td>(import price)</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>×</td>
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<tr>
<td>Export price</td>
<td>–</td>
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<td>+</td>
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<td>×</td>
</tr>
</tbody>
</table>

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

The “world supply” or “import price” shock is a shock that increases import prices and reduces world GDP via a negative income effect. Such a shock has an ambiguous effect upon export prices; export prices might be expected to rise as the cost of imported inputs rises, or to fall as world demand for exports falls in response to the income effect. Consequently, the effect of this shock upon New Zealand’s export prices is left unrestricted.

The third shock is the idiosyncratic export price shock for New Zealand’s export prices, which may be due to product-specific demand or supply. This shock is restricted to have non-positive effects upon both import prices and world activ-
ity, in order to distinguish it from the world demand shock. To improve shock identification, we restrict the export price shock to increase New Zealand’s exchange rate, in line with the commodity currency literature. In the case of oil prices, Kilian (2009) is able to identify both an oil-specific demand shock and an oil-specific supply shock. Since we do not have quantities in the model, we are unable to distinguish between export-specific demand and supply shocks, so this one shock may be capturing both types.

4 Results

In this section we discuss the results: impulse responses (section 4.1) and forecast error variance decompositions (section 4.2).

4.1 Impulse Responses

The charts in this section show impulse responses for a representative sample of the 100,000 models that were drawn in the sign restriction algorithm. The sample was selected using a variation of the Fry and Pagan (2011) “median target” approach for a range of percentiles between the 5th and 95th. The heavy red line in each chart is the median target itself, and represents the same model in every chart.

Figure 2 shows the impulse responses of the world variables to a world demand shock that increases world activity by 1 percent. This shock is associated with an increase in world GDP and both import and export prices in the same quarter. New Zealand’s export prices increase more than its import prices, leading to an increase in terms of trade by the first quarter after the shock. The implied terms of trade increases by around 2-5 per cent and the effect is very persistent. The persistence in the terms of trade partly reflects a more persistent export price response to the shock, which takes around two years to die out.

Figure 3 shows the impulse responses of the domestic New Zealand variables to the same shock. New Zealand’s GDP increases significantly, although this is probably not as much as one might have expected. Being a commodity exporter, why is the net effect on the New Zealand GDP rather weak? We believe this is due to a few opposing effects: An increase in world prices, as well as New Zealand’s own CPI leads to a negative income effect. In other words, New Zealand households have to pay higher prices and given income they have less for other spending. Moreover, the increased activity and inflation would lead to a response by the central bank, as we can see in the rises in domestic interest rates. On top of this the increased terms of trade and the interest rates lead to a rise, although short lived, in the exchange rate, which dampens net exports.
and puts further downward pressure on GDP.

The positive effect coming from a positive demand shock, despite the conventional wisdom, is something that has not been found in the data previously. Buckle et al (2002) for example finds a negative terms of trade effect coming from the world demand shock, and an insignificant response of New Zealand GDP. Haug and Smith (2010) finds insignificant response in New Zealand GDP and only a significant response almost 4 years after the shock. Karagedikli and Thorsrud (2010) finds, by using a factor-augmented VAR, that the net effect on New Zealand GDP was small and negative after the endogenous responses of the exchange rate and the interest rate in the model. Our results in this paper are that the net effect of the world shock on the New Zealand GDP is positive.

Interestingly, the central bank response to this shock is large and very persistent, perhaps reflecting the persistent response of inflation. We believe this comes from two sources. First, tradable inflation is higher due to higher import prices (although this would partly be dampened by exchange rate appreciation).
At the same time, the higher export prices lead to an income effect for commodity exporters. These two factors together might lead to inflationary pressure and hence to a persistent response by the central bank.

Figure 4 shows the impulse responses to a world supply shock that increases import prices by 1 percent. This shock is associated with a sharp and persistent fall in world GDP, mainly coming from the negative income effect. This negative income effect is persistent and eventually leads to an undershooting of import prices. New Zealand’s export prices also fall (although this was not restricted in the model), probably reflecting the positive correlation in the data.

Figure 5 shows the responses of the domestic New Zealand variables to the same shock, the supply shock. New Zealand GDP falls sharply in response to this shock, probably due to lower world demand. Although the New Zealand CPI increases initially, this is very short lived. New Zealand’s exchange rate does not seem to respond by much. This shock is interesting as it captures elements
Figure 4: Impulse response functions - World variables to world supply shock

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

Figure 6 shows the responses of the world variables to an export price shock that increases export prices by 1 percent. This shock is different from the world demand shock as it is specific to the New Zealand export prices. In other words, it is the idiosyncratic driver of New Zealand export prices. This shock is restricted to have non-positive effects on world block variables other than export prices. It turns out that the magnitudes of the responses are quite small rela-
Figure 5: Impulse response functions - Domestic variables to world supply shock

tive to the usual variance in the data, which is consistent with this shock being a genuinely idiosyncratic export-specific shock. The contemporaneous fall in world GDP is only around 0.1 percent, compared with a mean absolute growth rate of 0.9 percent over the sample. Similarly, import prices only fall by about 0.2 percent on impact, compared with a mean absolute inflation rate of around 2 percent over the sample. These small responses in world variables leave us reasonably comfortable describing the export price shock as idiosyncratic.

Figure 7 shows the responses of the domestic variables to the export price shock. As we noted earlier, it is not possible to distinguish whether this idiosyncratic shock is due to demand or supply. In order to better identify the effects of this shock, we restricted the effects of this shock on the New Zealand dollar exchange rate, following the commodity currency literature. Interestingly, we find very little response to this shock in the domestic economy; the magnitudes of the responses are extremely small. This is consistent with Kilian’s (2009) findings that the main driver of oil prices are world demand shocks.
4.2 Variance Decomposition

We now turn to forecast error variance decompositions (FEVDs). The charts in this section show, shaded in grey, the full range of contributions by each shock to the unconditional variance of each variable across all of the 100,000 models drawn. The black lines represent every 10th percentile within this range, and the thick red line is the indicative median contribution by each shock to each variable. Unlike in the previous section, the red lines do not represent a single model, and consequently do not add up to 100 percent for each shock.

New Zealand’s export and import prices are both primarily explained by the common world demand and world supply shocks. The idiosyncratic export price shock explains only 20-40 percent of the variation in export prices (figure 8). Its contribution to import prices is even smaller, consistent with this shock being export-price specific (figure 9).

Although the common shocks are important for explaining the terms of trade,
Figure 7: Impulse response functions - Domestic variables to export price shock

they have a much smaller contribution to New Zealand domestic variables, which are mostly driven by domestic shocks (which we have not identified). Domestic shocks explain 80-90 per cent of the forecast error variance for GDP, CPI and the interest rate, for example (see figures 10 to 12). This is partly consistent with the kind of shocks the New Zealand economy has been hit by during the sample period, such as population, house prices, drought, and domestic monetary policy shocks (such as around 1996-1997 during the MCI period). However, the world demand and world supply shocks each explain around 20 per cent of the forecast error variance of domestic GDP.

Unsurprisingly, the New Zealand exchange rate is better explained by the world shocks than are the other New Zealand variables, with only around half of its variance arising from domestic shocks (figure 13).
Figure 8: FEVD - Export prices

Figure 9: FEVD - Import prices
Figure 10: FEVD - NZ GDP

Figure 11: FEVD - NZ CPI
Figure 12: FEVD - NZ interest rate

Figure 13: FEVD - TWI exchange rate
5 Conclusions

It is common to evaluate the responses of domestic (New Zealand) macroeconomic variables to exogenous changes in the terms of trade. However, the endogenous nature of the terms of trade requires the identification of the shocks that drive the terms of trade. In this paper we estimated a two block structural vector autoregression to identify the shocks and then analyse their effects on the New Zealand economy.

In this paper we attempted to identify the drivers of New Zealand’s terms of trade, and whether those shocks driving New Zealand’s terms of trade are global (world demand and supply) or idiosyncratic shocks specific to New Zealand’s export prices. We found that the world demand shock is a key driver of New Zealand’s terms of trade. Interestingly, a common world demand shock raises New Zealand’s export prices more than its import prices and hence leads to an increase in the terms of trade. We find only a limited role for the idiosyncratic export price shock that is specific to New Zealand’s exports.

A key message of our paper is that New Zealand’s terms of trade increases may have very different effects on the domestic economy, depending on the underlying cause of the shift in the terms of trade. Of the three shocks that we investigate here, we find one, the world demand shock, that increases the terms of trade and has both expansionary and inflationary effects on the domestic economy; one, the world supply shock, that increases the terms of trade (if the shock is negative) and has expansionary but limited inflationary effects on the domestic economy; and one, the export price shock, that increases the terms of trade but has negligible effect on the domestic economy. These findings suggest that movements in the terms of trade must be interpreted with care by policy makers.
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