Decomposing New Zealand's Terms of Trade

Phillip Mellor

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Abstract

This paper adds to the understanding of how New Zealand's terms of trade have evolved since 1991. The paper develops a method to decompose the percentage change in the terms of trade into the contributions from different export and import components. The contributions are further decomposed into the contributions attributable to changes in deflators (prices) and contributions from changes in the composition of the export and import baskets. The methodology can be applied to a variety of timeframes to assess the drivers of short and long term fluctuations in the terms of trade. Three key insights emerge from applying the decomposition to New Zealand. Firstly, the decomposition supports the view that increasing export prices have made the largest contribution to gains in the terms of trade over the past two decades. Secondly, the change in the composition of the import basket is shown to have made a material positive contribution to gains in the terms of trade. Import prices have been a drag on the terms of trade over longer timeframes, although in recent years they have made a positive contribution. Finally the paper does not find a material impact from the change in the composition of exports over time.

JEL CLASSIFICATION

E30 General
F10 General
F14 Empirical Studies of Trade
F17 Trade Forecasting and Simulation

KEYWORDS

Terms of Trade; Decomposition; New Zealand

Executive Summary

New Zealand is a small open economy that relies on its external sector as a source of economic growth and development. As a result, New Zealand's terms of trade, or the ratio of export prices to import prices, are a key economic measure. Changes in the terms of trade can have substantial impacts on the economy as a whole, directly through the impact on export revenues and indirectly through the impact of imported goods and services prices on domestic costs and prices. The terms of trade influence tax revenue in a similar manner, directly by increasing or decreasing the profitability of exporters and indirectly by influencing the overall rate of inflation within the economy. Over time, changes in relative prices can lead to alterations in the composition of exports and imports and influence the allocation of productive resources within the economy.

This paper adds to the understanding of how New Zealand's terms of trade have evolved over time by identifying the relative contributions of different components of the export and import baskets. These contributions are further decomposed into the contributions as a result of changes in deflators (prices) and as a result of changes in the relative weightings of the basket of exports and imports. A final decomposition is made to distinguish between movements in world deflators and the exchange rate. The decomposition is initially applied to adjacent time periods, ie, year-on-year or quarter-on-quarter. It can also be applied to non-adjacent time periods (eg, decomposing the change in the terms of trade between 1995 and 2015), although the degree of accuracy diminishes somewhat.

The terms of trade decomposition was originally developed to further enhance the understanding of the key drivers of the Treasury's terms of trade forecasts in the *Economic and Fiscal Updates*. To this end the adjacent period decompositions have been a useful addition to the suite of analytical tools. However, the non-adjacent period approach outlined above provides an opportunity to derive some longer term insights into the evolution of the terms of trade.

Increases in export prices have made the largest contribution to the terms of trade over the past two decades. Dairy prices have been one of the larger contributors, although it is worth noting that there have been price gains across all export components for most of the longer term decompositions. While export prices have contributed to gains in the terms of trade, the composition of exports has not had a material impact. In particular, the shift in the weighting of the export basket from meat towards dairy had a relatively neutral impact in terms of contribution to changes in the terms of trade.

In contrast, the change in the composition of imports has had a material impact. Capital goods and, to a lesser extent, consumer goods have steadily increased as a share of imports in real terms as their deflators have generally declined, while intermediate goods and mineral fuels have done the opposite. Taken together, this has acted to partially offset the overall negative contribution to the terms of trade that import prices have made. Most of the adjustment in import composition took place in the period up to the early 2000s. Since the GFC the compositional effect has faded but import prices have been in overall decline, making a positive contribution to the terms of trade.

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Decomposing New Zealand's Terms of Trade

1 Introduction

New Zealand is a small open economy that relies on its external sector as a source of economic growth and development. As a result, New Zealand's terms of trade, or the ratio of export prices to import prices, are a key economic measure. Changes in the terms of trade can have substantial impacts on the economy as a whole, directly through the impact on export revenues and indirectly through the impact of imported goods and services prices on domestic costs and prices. The terms of trade influence tax revenue in a similar manner, directly by increasing or decreasing the profitability of exporters and indirectly by influencing the overall rate of inflation within the economy. Over time, changes in relative prices can lead to alterations in the composition of exports and imports and influence the allocation of productive resources within the economy.

The initial motivation for developing the terms of trade decomposition was to provide better insight into the evolution of the terms of trade in Treasury's regular macroeconomic forecasts. The literature on terms of trade decomposition is relatively small and this paper has focussed on the techniques developed by Baxter and Kouparitsas (2006) and extended by Cardoso and Esteves (2008) and Loening and Higashi (2011). This paper's decomposition is most similar to the approach adopted by Loening and Higashi, who focus on decomposing the contributions of specific components in the export and import basket. The key difference is that Loening and Higashi express their decomposition in terms of an index relative to a base year while this paper expresses the decomposition as a contribution to the percentage change in the terms of trade.

This paper adds to the understanding of how New Zealand's terms of trade have evolved over time by identifying the relative contributions of different components of the export and import baskets. The contributions are further decomposed into the contributions as a result of changes in deflators (prices) and as a result of changes in the relative weightings of the basket of exports and imports. A final decomposition is made to distinguish between movements in world deflators and the exchange rate. The decomposition is initially applied to adjacent time periods, ie, year-on-year or quarter-on-quarter. It can also be applied to non-adjacent time periods (eg, decomposing the change in the terms of trade between 1995 and 2015), although the degree of accuracy diminishes somewhat.

Section two provides a brief overview of New Zealand's external sector and terms of trade. Section three describes the methodology used to derive the various decompositions, including reference to the relatively sparse literature in this area. The level of aggregation of the components has been aligned with Treasury's economic forecasting approach, although in principle the decomposition could be applied to any consistent set of groupings.

The decomposition methodology is applied empirically in section four. The first part describes the decomposition findings over longer timeframes of up to 25 years. Rising export deflators (prices) provide the largest positive contribution to gains in the terms of trade. However, changes in the composition of the import basket also appear to have made a material positive contribution. The second part of section four reports the findings when the terms of trade are decomposed on a year-on-year basis. The insights are similar to those of the long term decomposition and also show that falling import deflators have made a positive contribution to the terms of trade in recent years. The final part of section four decomposes Treasury's *Budget Economic and Forecast Update 2015* terms of trade forecast. The final section concludes and looks at possible areas of future research.

2 External Sector Background

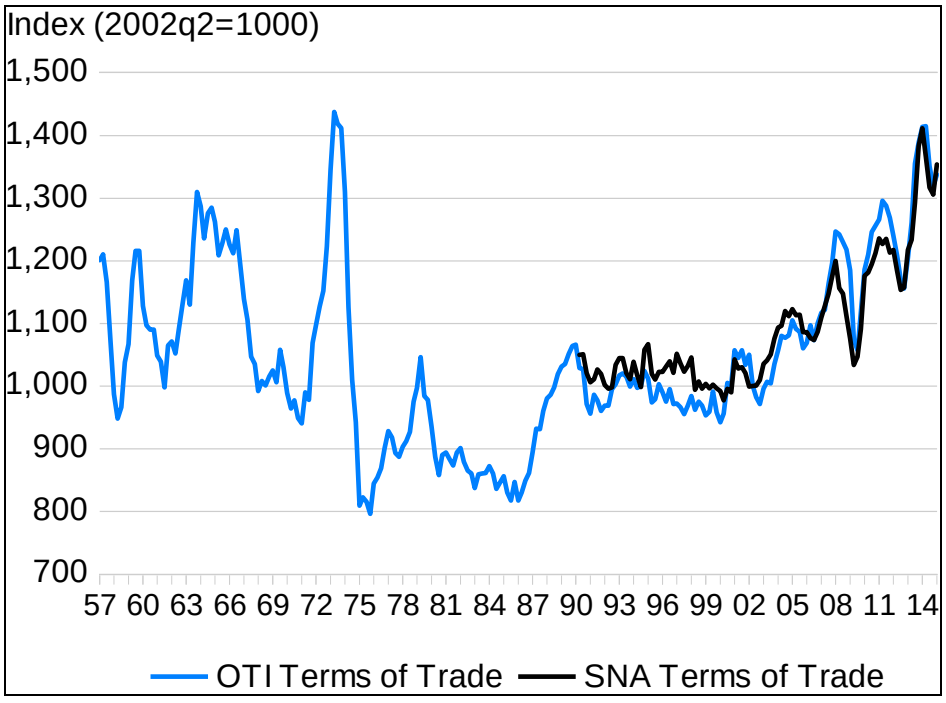
2.1 The terms of trade

The terms of trade are the ratio of export prices to import prices. They effectively measure a country's international purchasing power and as such are an important economic measure income and well being. An increase in the terms of trade implies that a country can purchase more imports for a given quantity of exports.

New Zealand's terms of trade can be measured using two different data sets. The first measure is the ratio of the Overseas Trade Index (OTI) export and import price indices. The second measure is the ratio of the System of National Accounts (SNA) export and import deflators. As the SNA deflators are derived from the OTI indices, the approaches yield similar measures of the terms of trade (Figure 1) and the correlation between the two is 0.97.

New Zealand's total and goods' terms of trade were relatively stable throughout the 1990s and into the early 2000s. Since the mid 2000s, the terms of trade have trended higher although with a much wider cyclical range. Nonetheless, volatility is still much lower than in the 1960s and 1970s. In the March 2014 quarter the terms of trade reached a 41-year high.

Figure 1 – Total Terms of Trade

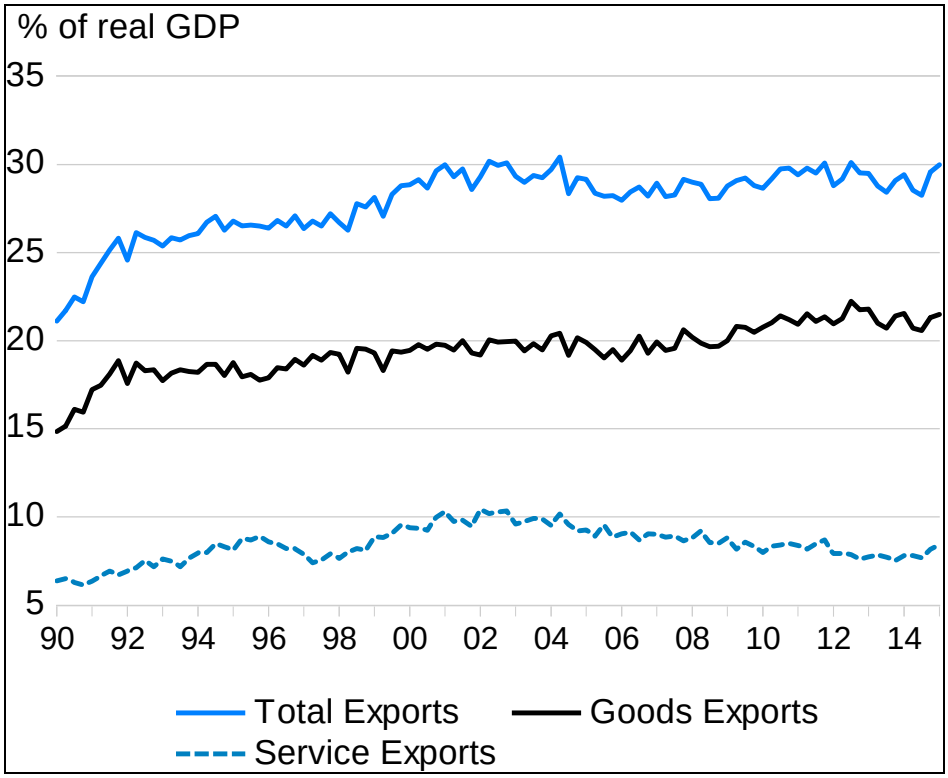


Source: Statistics New Zealand

2.2 Exports of goods and services

New Zealand's real exports to GDP ratio has remained fairly stable over the past two decades (Figure 2). The ratio of goods exports to GDP has trended modestly upwards between 1991 and 2014, lifting from 18.0% to 20.7% over that time with a peak of 22.4% in the September 2012 quarter. Services exports trended higher over the 1990s and into the early 2000s, peaking at 10.4% in 2002, before trending downwards to 8.2%. Putting these together sees the total exports to GDP ratio rising throughout the 1990s before stabilising within a range of 28 – 31% of GDP.

Figure 2 – Exports share of GDP

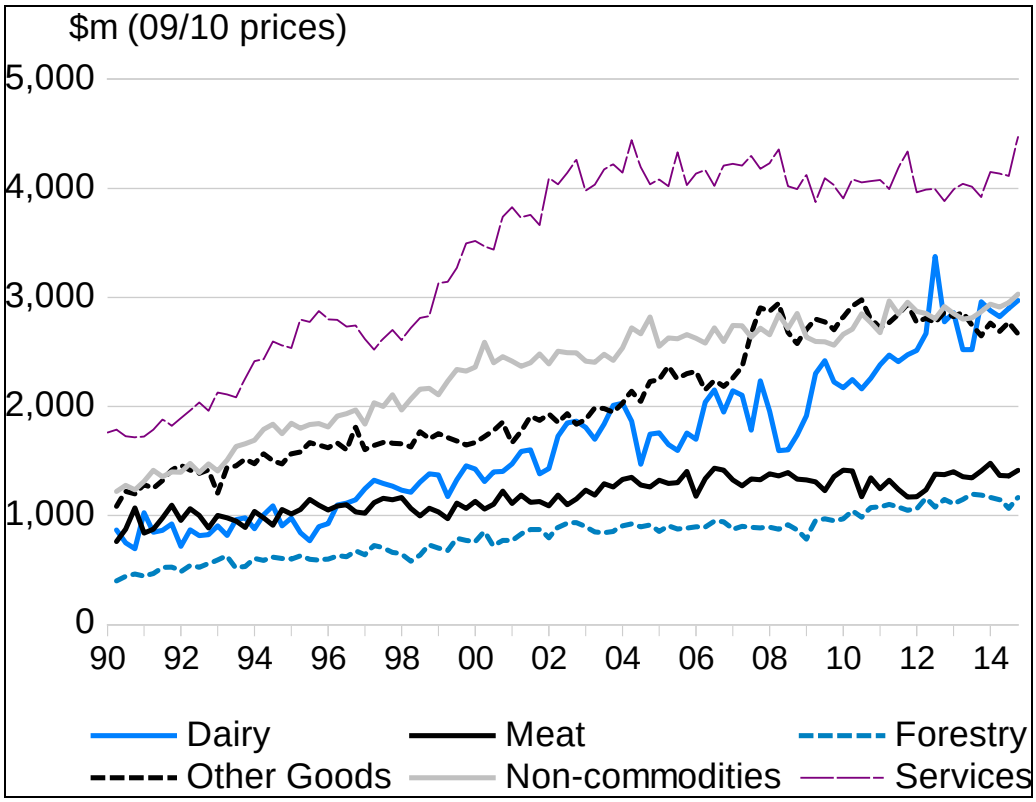


Source: Statistics New Zealand

While all of the export components have grown in real terms, some components have grown faster than others (Figure 3). In particular, exports of dairy products have grown faster than exports as a whole, resulting in dairy's share rising from around 12% of total exports in 1993 to around 19% recently. In contrast, exports of meat products have fallen from about 14% to 9% over the same timeframe. This is evident in New Zealand's land use patterns, where the amount of land dedicated to dairy production has risen, partly through the conversion of beef and lamb farms to dairy farms.1 Forestry, other goods and non-commodities have grown at about the same pace as overall exports, maintaining shares of about 7%, 18% and 29% respectively. Having grown rapidly through the 1990s, services exports have trended downwards slightly in real terms between 2002 and mid 2014.

[1] Davison (2010) estimates 920,000 hectares of sheep and beef land was switched to dairy production between 1990/91 and 2012/13.

Figure 3 – Exports by component



Source: Statistics New Zealand

2.3 Imports of goods and services

In contrast to exports, New Zealand's real imports to GDP ratio has increased steadily since the early 1990s (Figure 4). This in part reflects the liberalisation of New Zealand's trade which has seen the removal of almost all tariff and other trade barriers, thereby making it easier and cheaper for domestic firms to import goods. It also reflects the rise in the terms of trade over this period which has allowed more imports to be purchased for a given level of exports.

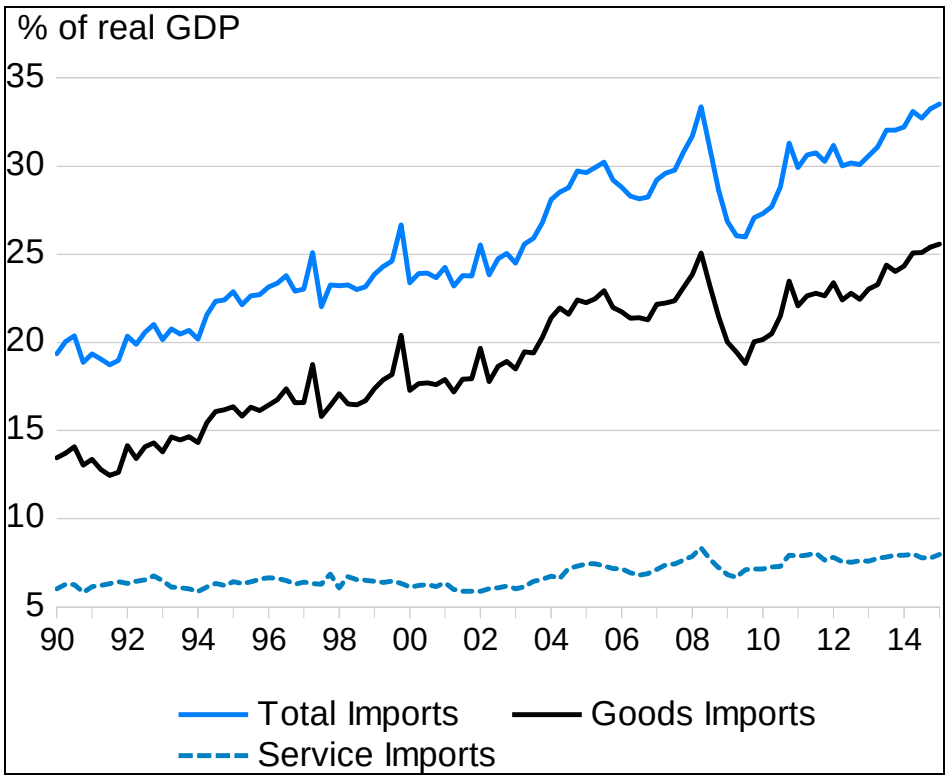
In 1990, the real goods imports to GDP ratio stood at about 15% and the total imports ratio was a little over 20%. By the end of 2014 these ratios had risen to 26% and 34% respectively. There is a noticeable shock to the imports to GDP ratio from the Global Financial Crisis (GFC), as goods imports excluding mineral fuels contracted sharply. The ratio of services imports has remained relatively steady, rising from about 6% to 8%.

Similarly to exports, all import components have grown in real terms but at different paces (Figure 5). Capital goods imports have seen the most rapid growth, tripling their share of imports from 6% in 1993 to 19% in 2014.[2] Consumer goods have also increased as a share of imports from 16% to 20%. Intermediate goods remain the largest import component at

[2] In part the rise in the real share of capital goods can be attributed to technological advances. In particular, the deflator for capital goods incorporates a deflator for computer equipment which takes account of technological enhancements in calculating price- and quality-adjusted import computer volumes. As a practical example, a computer built in 2014 is more powerful by a significant order of magnitude than one built in 1990. Computers make up about one fifth of nominal capital goods imports. While technology improvements are embedded in other import categories as well, they are most apparent in capital goods.

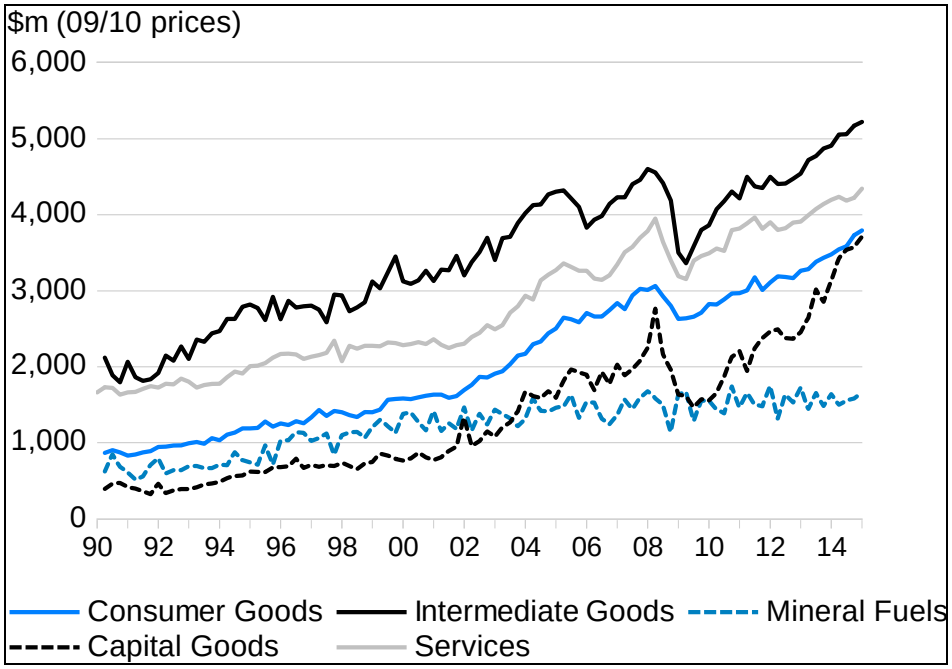
around 29% of imports, down from 36% in 1993. Mineral fuels and services have also declined as shares of imports, from 11% to 9% and 30% to 24% respectively.[3]

Figure 4 – Imports share of GDP



Source: Statistics New Zealand

Figure 5 – Imports by component



Source: Statistics New Zealand

[3] In part this reflects increasing self-sufficiency in mineral fuels and less energy-intensive GDP as services have increased as a share of GDP and energy efficiency has increased. It is also worth noting that New Zealand exports mineral fuels, with crude oil exports accounting for around 2-3% of merchandise export values in recent years.

3 Methodology

3.1 Data sources

The data used for the terms of trade decomposition is Statistics New Zealand's SNA 2008 data for exports and imports. The base year for "real" (chain-weighted) series is 2009/10. Unless otherwise specified, March years are used. Domestic price deflators are constructed by dividing the nominal series by the real series.[4] World price deflators are constructed by inflating the domestic price deflator by the trade weighted exchange rate. The terms of trade are calculated from the SNA-derived domestic price deflators.

The Treasury forecasts higher level aggregations of both exports and imports than published by Statistics New Zealand.[5] These are set out in Tables 1 and 2 below. Total and goods level aggregations are taken from Statistics New Zealand and therefore include balancing items in the "real" (chain-weighted) series. Nominal data for some of the sub-groups aggregated into Forestry, Other Goods and Non-Commodities is not available after 2007 June quarter for confidentiality reasons. These data are estimated using the chain-weighted series and relevant OTI deflator as a proxy for the SNA deflator. Note that military goods imports have been excluded from this analysis due to their "lumpiness". As they are a very small share of total imports in the long run, this does not materially influence the results.

Table 1 – Export groupings

Treasury Component			SNA 2008 Sub-Group
Total Exports	Goods Exports	Dairy	Dairy products
		Meat	Meat products
		Forestry	Forestry primary products
			Wood and paper products
		Other Goods	Agricultural and fishing primary products
			Coal, crude petroleum and ores, minerals and gases
			Other food, beverages, and tobacco
		Non-Commodities	Chemicals, rubber, plastic, and non-metallic minerals
			Metal products, machinery and equipment
			Textiles, apparel, and leather products
	Services Exports	Services Exports	Services Exports

[4] Comments on an earlier draft of this paper suggested using real prices for the decomposition. Given the original objective of the decomposition was to better explain movements in the terms of trade, which are calculated with nominal price deflators, a decision was made to retain nominal price deflators in the calculations. Continuing future research on this topic will investigate decompositions using real prices.

[5] The groupings have been used for consistency with the current Treasury forecast process. Any set of consistent groupings could be used with the methodology outlined in the next section.

Table 2 – Import groupings

Treasury Component			Broad Economic Classification
Total Imports	Goods Imports	Consumer Goods	CG – food and beverage – primary
			CG – food and beverage – processed
			CG – transport equipment – non-industrial
			CG – durables
			CG – semi-durables
			CG – non-durables
		Intermediate Goods	IG – food and beverage – primary
			IG – food and beverage – processed
			IG – industrial supplies – primary
			IG – industrial supplies – processed
			IG – parts and accessories of capital goods
			Passenger cars
		Mineral Fuels	IG – fuels and lubricants – primary
			IG – fuels and lubricants – processed
			Petrol and aviation gas
		Capital Goods	KG – machinery and plant
			KG – transport equipment – industrial
	Services Imports	Services Imports	Services Imports

3.2 Mathematical decomposition

The decomposition technique developed in this paper is similar to that derived by Baxter and Kouparitsas (2006) and extended by Cardoso and Esteves (2008) and Loening and Higashi (2011) in their examination of the Portuguese and Ethiopian terms of trade respectively. The approach of Baxter and Kouparitsas decomposes the terms of trade into a "goods price" element, stemming from the difference in the composition of export and import baskets, and a "country price" element, stemming from deviations in the law of one price. Cardoso and Esteves use different terms for these two elements but otherwise follow a similar approach.

This paper's decomposition is more similar to that developed by Loening and Higashi, who focus on decomposing the contributions of specific components in the export and import basket. The key difference is that Loening and Higashi express their decomposition in terms of an index relative to a base year while this paper expresses the decomposition as a contribution to the percentage change in the terms of trade. The theoretical decomposition technique developed in this paper is independent of a base year, thus allowing for year-on-year and quarter-on-quarter decompositions.[6] The non-adjacent period decomposition technique described later is similar to Loening and Higashi in that it uses a fixed base year.

This paper derives three specifications in decomposing changes in the terms of trade, with subsequent specifications becoming increasingly detailed. The equation for each specification is set out below. Appendix one sets out in detail how each of these equations is derived.

The first specification sets out the decomposition of the terms of trade into the contributions by each export and import component. Each component's contribution to the terms of trade is a function of the percentage change of the component's deflator weighted by the component's share of total export or import volume *and* the ratio of the previous period's component deflator to the previous period's total export or import deflator.

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - \sum_m \%\Delta m_t^P m_t^S \frac{m_{t-z}^P}{M_{t-z}^P} + Bal_t$$

where X and M are total exports and imports respectively, x are the export components (dairy, meat, forestry, other goods, non-commodities and export services) and m the import components (consumer goods, intermediate goods, capital goods, mineral fuels and import services), Bal_t is the residual error (or balancing item), P denotes price (the domestic price deflator), S the share of volume, and z is the time lag.

When z is set to 1 the decomposition is measuring the year-on-year or quarter-on-quarter contribution. However, z can be set to any lag desired for assessing non-adjacent decompositions. The drawback of increasing the lag is to increase the size of the residual term Bal_t. That said, trials using a different base year showed similar results for the decomposition but a different pattern for the residual term (see appendix three). This suggests that the decomposition result itself is reasonably robust with respect to the choice of base period.

The second specification further decomposes each component into the contribution from changes in the deflator and changes in the relative weighting of each component within total exports and imports. The first and third terms refer to the export and import deflator effects respectively. They measure the change in the deflator relative to the old weighting, including both the volume and deflator ratio factors. The second and fourth terms refer to the export and import weighting effects respectively. They measure the change in deflator multiplied by the change in weighting. For adjacent periods these are typically quite small as weightings tend to change relatively gradually. However for non-adjacent periods the weighting effects can be material.

[6] In practice, because the "volume" data is a chain-weighted series an element of indexation remains.

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} + \sum_x \%\Delta x_t^P \left(x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} \right) - \sum_m \%\Delta m_t^P m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P}$$
$$- \sum_m \%\Delta m_t^P \left(m_t^S \frac{m_{t-z}^P}{X_{t-z}^P} - m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} \right) + Bal_t$$

The final specification breaks down the decomposition still further into effects from changes in the world deflator, changes in relative weighting and changes from movements in the exchange rate. The first and fourth terms are the world deflator effects (change in world deflator multiplied by old weighting), the second and fifth terms are the weighting effects, and the third and sixth terms are the exchange rate effects. The exchange rate effect is the change in exchange rate multiplied by the component's share of volume and the lagged ratio of the component's domestic deflator to the total deflator. The export and import exchange rate effects should largely offset one another.

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^{WP} x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} + \sum_x \%\Delta x_t^{WP} \left(x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} \right) - \sum_x \%\Delta\, E_t x_t^S \frac{x_{t-z}^P}{X_{t-z}^P}$$
$$- \sum_m \%\Delta m_t^{WP} m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} - \sum_m \%\Delta m_t^{WP} \left(m_t^S \frac{m_{t-z}^P}{X_{t-z}^P} - m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} \right)$$
$$+ \sum_m \%\Delta\, E_t m_t^S \frac{m_{t-z}^P}{M_{t-z}^P} + Bal_t$$

where WP denotes the world price deflator and E is the trade weighted exchange rate.

4 Findings

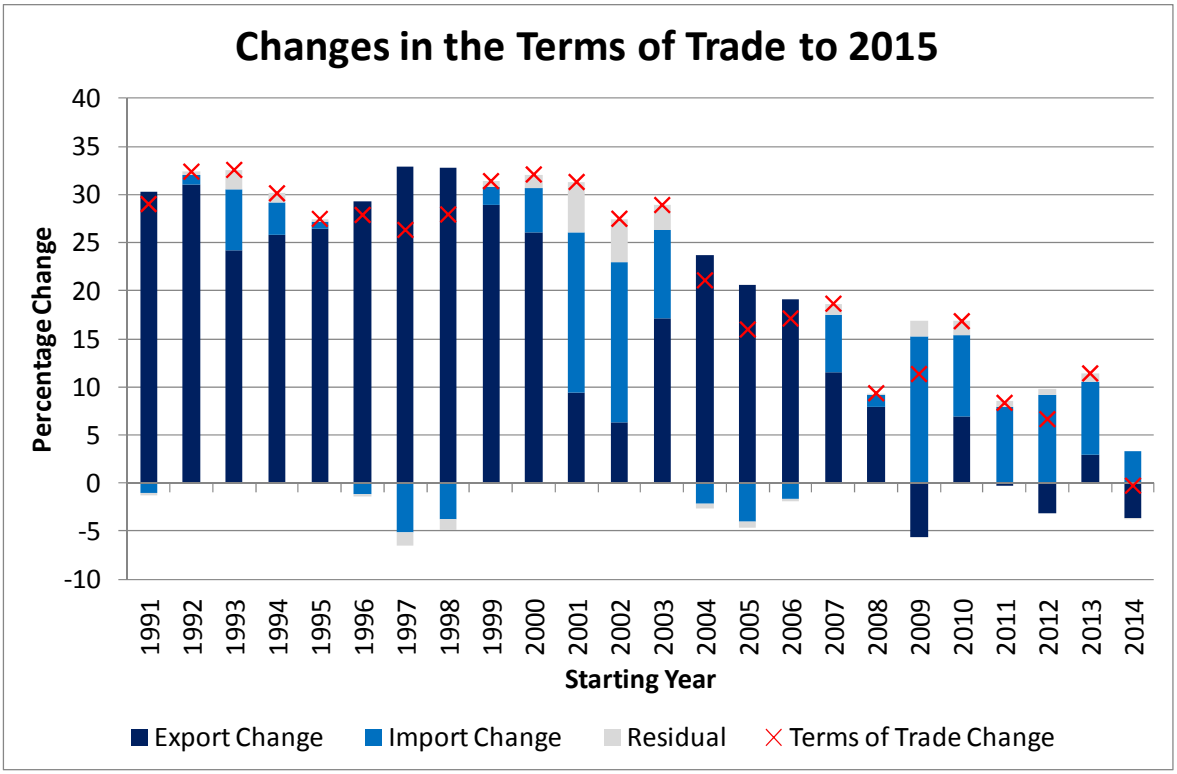
4.1 Historical trends and insights

4.1.1 Decomposing changes in the terms of trade to the year 2015

This paper examines historical trends and insights in the terms of trade decomposition from two angles. The first approach is to decompose the terms of trade between non-adjacent time periods. This approach provides greater insights into effects from the changing composition of exports and imports. However, the insights can differ considerably based on the starting and end points chosen. In addition, as discussed in the methodology section above, the further apart the two points the greater the unexplained variance in the decomposition.

This section uses the approach described above to examine historical trends. Comparisons are made between a fixed end point (year to March 2015) and a variable starting point. This is captured graphically in Figure 6. Each column refers to a non-adjacent decomposition of the terms of trade ie, 1991 shows the decomposition between 1991 and 2015, 1992 shows the decomposition between 1992 and 2015, and so on. The crosses show the actual change in the terms of trade between the two years.

Figure 6 – Export and import contributions



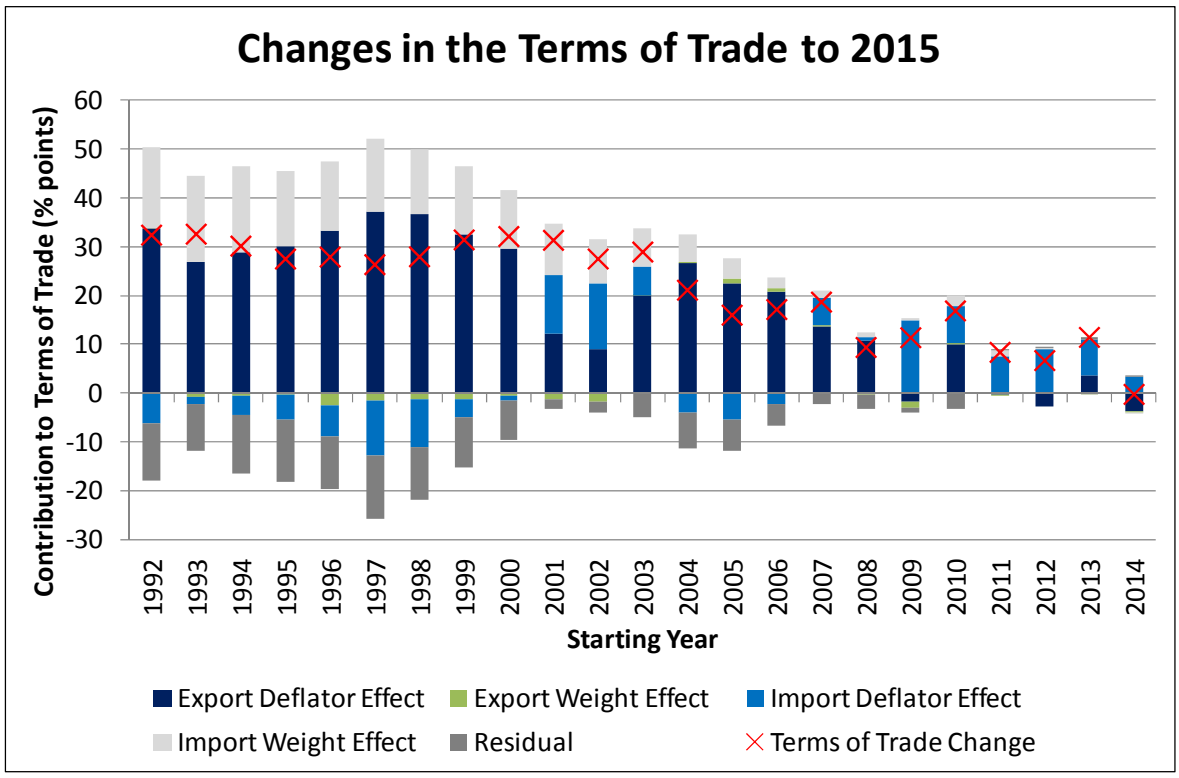
Changes in the terms of trade between the 1990s and 2015 are largely driven by export components. On average, 90% of the change in the total terms of trade can be attributed to exports for this time period. Import components typically provided a small drag on the terms of trade. A similar story emerges between 2003 and 2008, when again the increase in exports is the main driver of the change in the terms of trade. Overall this is consistent with the generally held impression that gains in export prices, and in particular for key

commodities such as dairy, have driven the change in the terms of trade over the past two and half decades or so.

A less widely held view is that falling import prices have also made a notable positive contribution to the change in the terms of trade. In all but two years since 2000, the import deflator has decreased to the year to 2015, making a positive contribution to the terms of trade as a result. In the period from 2001 and 2002 to 2015 and since the GFC, the decline in the import deflator has generally made a greater positive contribution to the terms of trade than the export deflator and in some cases has acted to offset the negative contribution from the export deflator declining.

The non-adjacent decompositions of the terms of trade can be broken down further into changes driven by the deflators and the changes in the composition of the export or import basket. The decompositions are made at the component level and then the results aggregated into four categories – the export deflator effect, the export weighting effect, the import deflator effect and the import weighting effect. This decomposition is shown in Figure 7. Note that the residual term is considerably larger for the longest time period decompositions (those between the 1990s and 2015) so the results needed to be treated with caution. That said, when the decomposition is estimated with 1995/96 as the base year for the chain-weighted "volume" series, the results of the component decompositions are not materially different, suggesting the insights are robust (see appendix three for further details).

Figure 7 – Deflator and weighting effects contributions



In most years prior to the GFC, and particularly in the 1990s, the export deflator effect remains the dominant driver of the change in the terms of trade. For the decompositions between 1992-2000 and 2015, the increase in the export deflator contributed about a 30 percentage point increase in the terms of trade. For the same time frame, the import deflator effect was a modest drag of around 6 percentage points. For the decompositions between 2001-2002 and 2015, the export and import deflator effects were roughly equal and both were positive for the terms of trade. In the years immediately preceding the

GFC, the export deflator effect returned to being the dominant driver of changes in the terms of trade compared to 2015. However, since the GFC, the import deflator effect has tended to be the largest contributor to the change in the terms of trade and this contribution has also been positive.

Perhaps the more interesting insight is the large positive contribution that the import weighting effect has made to the terms of trade, particularly when comparing years before the GFC to 2015. This weight contribution represents a steady shift in the composition of the import basket towards the components whose deflators have declined over time. This has largely been driven by capital goods, which have increased as a share of the import basket from 6% in 1993 to 19% in 2015, with the capital goods import domestic deflator falling from 1.83 to 0.74 over that timeframe. Consumer goods have followed a similar pattern, although on a much less dramatic scale (their share increased from 16% to 20% while the deflator fell from 0.96 to 0.88). Similarly, the reduction in the share of intermediate goods and mineral fuels has acted to partially offset the negative contribution that these components' deflators had on the terms of trade. Overall, the adjustment in import composition appears to be consistent with the aggregation of rational responses by firms to changing relative prices.

In contrast, the change in the composition of exports has not made a material contribution to the terms of trade. There has been some shift in the share of exports towards dairy, predominantly at the expense of meat. However, as both dairy and meat have seen increases in their deflators, the weighting effects (positive for dairy and negative for meat) largely offset one another. As a result, the aggregate export weight effect is small for all non-adjacent decompositions since 1992.

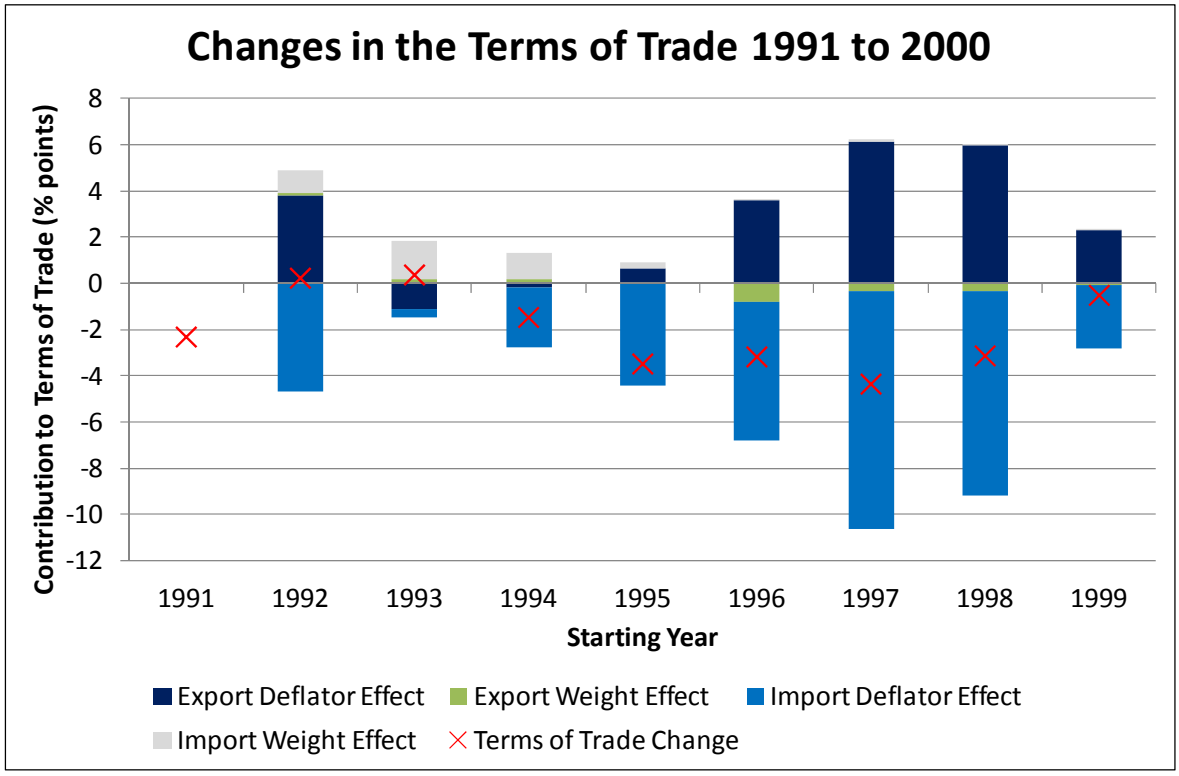
4.1.2 Decomposing changes in the terms of trade by decade

In the previous section the analysis focused on using the non-adjacent terms of trade decomposition to examine changes in the terms of trade relative to 2015. However, the end date in this analysis is somewhat arbitrary. Furthermore, it may influence the conclusions somewhat given the terms of trade were close to a 40 year high in that year. This section applies the same approach to shorter, overlapping time frames: 1991-2000, 1996-2005, 2001-2010 and 2006-2015. These time frames are equally arbitrary, but they do provide a sense check for the results in section 4.1.1. These decompositions are summarised in Figures 8 to 11.

Across these shorter timeframes the export and import deflator effects tend to be the main driver of changes in the terms of trade. Of note, the import deflator effect has a relatively more significant effect across these shorter time periods than it did in the longer decomposition. This result reflects in part the base year effect in the longer decomposition – the import deflator in 2015 is at the lower end of its range of the past two and half decades. Export deflator effects are much more variable in terms of direction across these shorter timeframes, reflecting the differences in starting point relative to different cycles.

Although the deflator effects dominate, there is still a modest positive impact from the import weighting effect in each period studied. This suggests that even over a relatively short timeframe of 10 years or less, the import basket adapts to relative price signals and shifts towards imports that are becoming relatively cheaper. The export weighting effect remains fairly small in comparison in most cases. It is noteworthy that where there is a non-trivial export weighting effect it is typically negative. That is, changes in the export basket have actually been on balance a small drag on the terms of trade in these periods.

Figure 8 – Deflator and weighting effects contributions 1991-2000



Note: there is insufficient data to calculate the 1991-2000 decomposition

Figure 9 – Deflator and weighting effects contributions 1996-2005

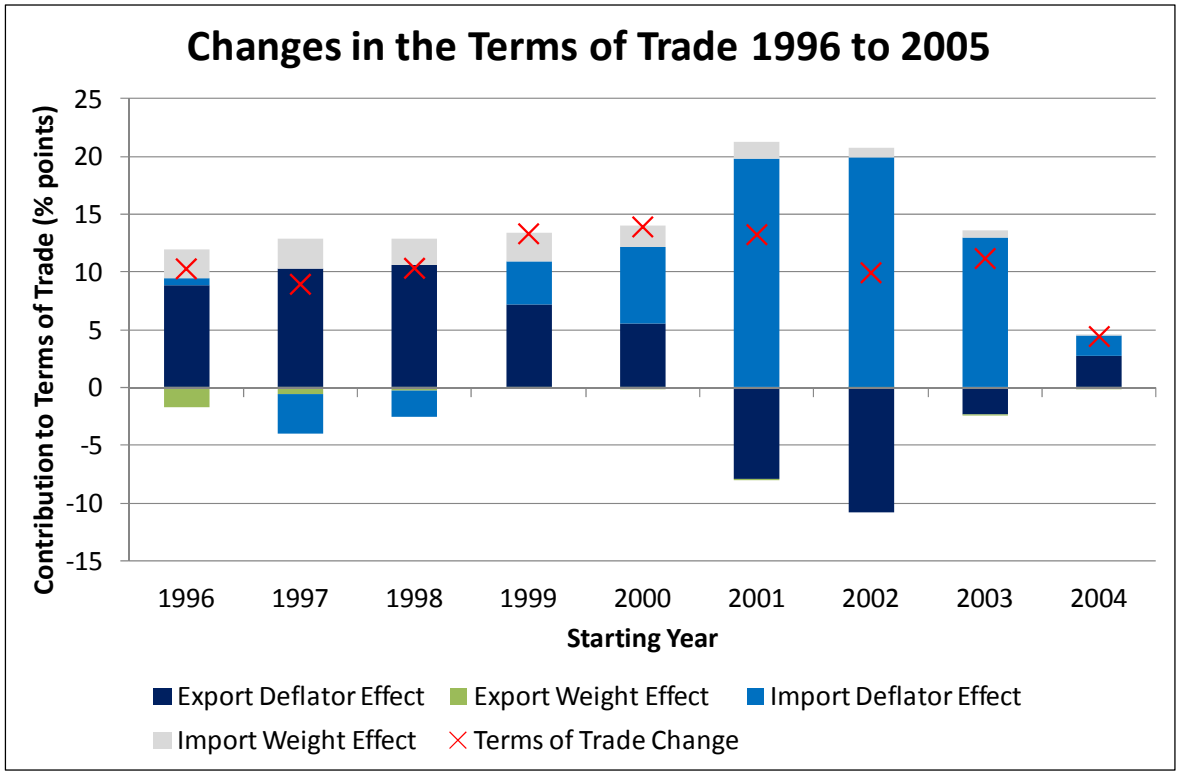


Figure 10 – Deflator and weighting effects contributions 2001-2010

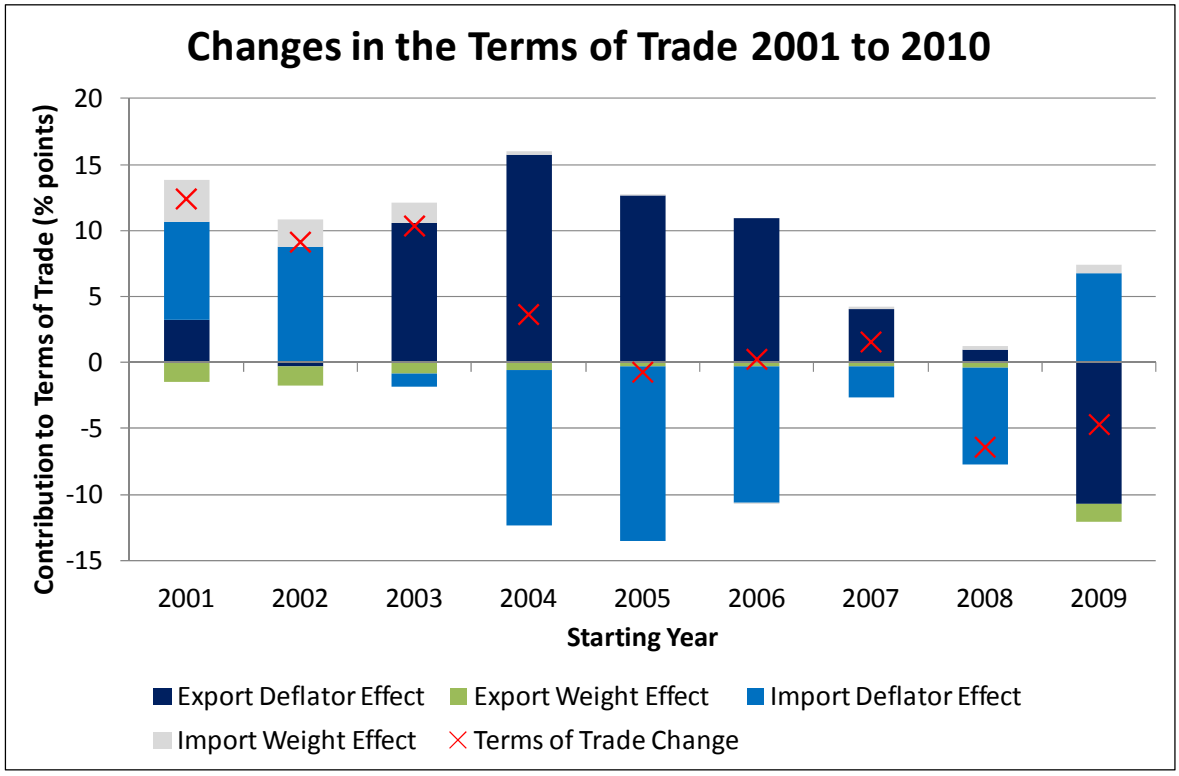
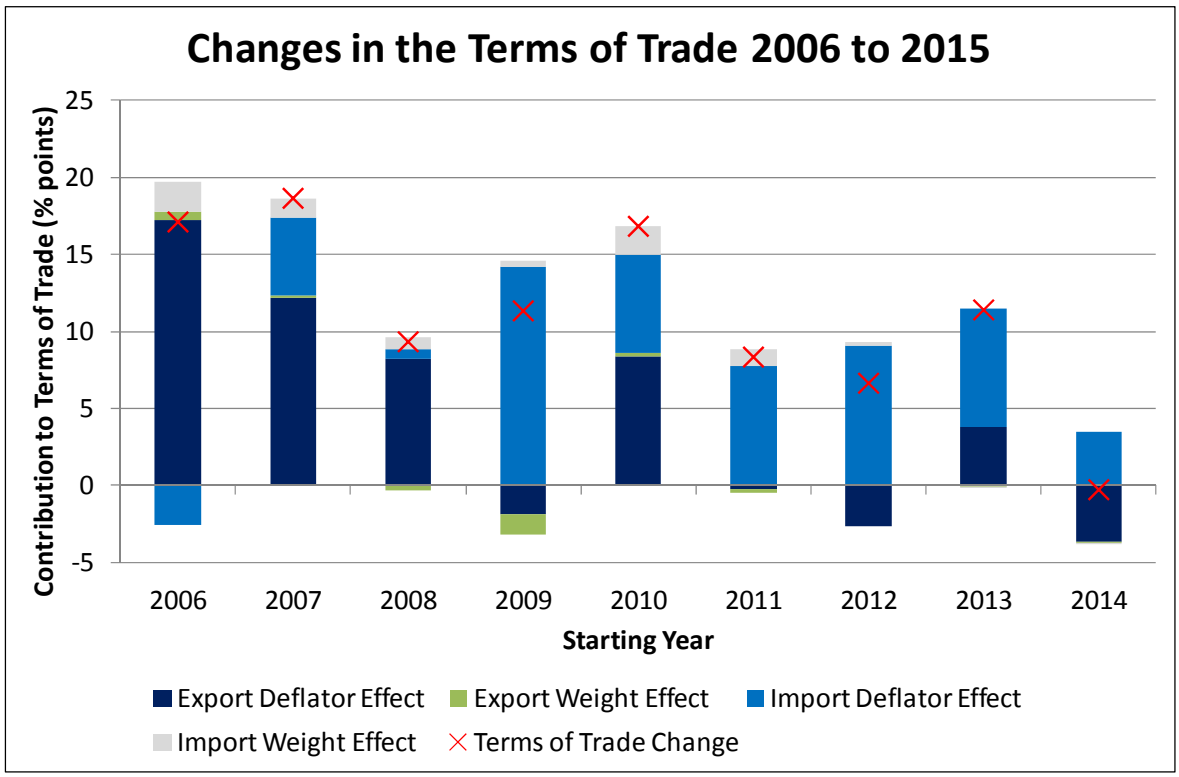


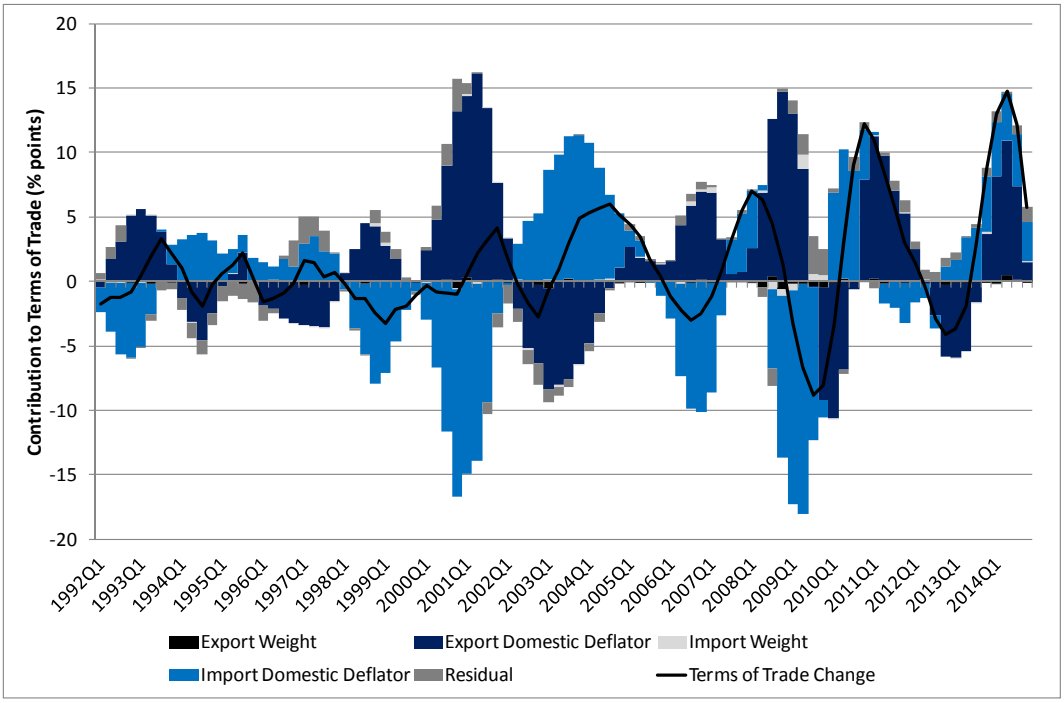
Figure 11 – Deflator and weighting effects contributions 2006-2015



4.1.3 Continuous decomposition of the annual terms of trade

The second approach this paper takes to historical analysis is to examine the decompositions of adjacent periods over time. This results in the decomposition explaining most of the change in the terms of trade. The drawback of this approach is the volatility of the terms of trade can mask trends (particularly when viewing the quarter-on-quarter decompositions). To partially overcome this, the year-on-year decomposition has been calculated for each quarter back to 1992, resulting in a smoother decomposition over time.[7] The shortcoming of this approach is that the composition of exports and imports varies only slowly over time and as a result the weighting effect is very small compared to the deflator effect. This approach is shown in Figure 12.

Figure 12 – Domestic deflator and weighting contributions to changes in the total terms of trade



The cyclicality and volatility of the terms of trade are immediately apparent in the chart. Over the past two and half decades changes in the terms of trade appear to have followed a relatively regular cycle, averaging about six quarters from peak growth to peak contraction and vice versa.[8] While the cycle length is relatively steady, its amplitude has increased steadily over time, indicating that the terms of trade have become more volatile. Through the 1990s and into the early 2000s, annual changes in the terms of trade remained within a -3.3% to +4.1% range. Prior to the GFC the peak changes had crept up to a little over 6.0%. It is worth noting that this was a period of unusually low volatility in the terms of trade relative to history (see Figure 1 in section 2.1 for example). However, since the GFC an 8.8% decline has been recorded (admittedly largely due to the GFC) and two increases over 12.0%. This suggests that the long-term trend of declining volatility in New Zealand's terms of trade observed by Borkin (2006) has reversed since the GFC. It is too early to determine whether this is a permanent reversal or a temporary phenomenon related to the post-GFC recovery.

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7 This can be likened to a moving average total.

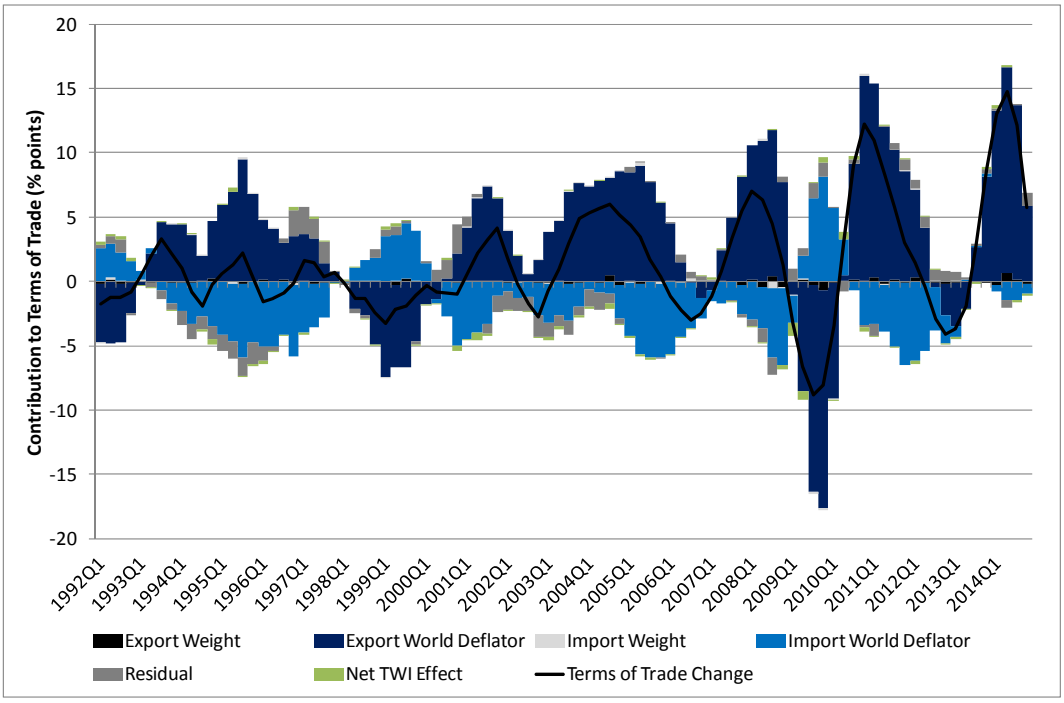
8 Between 1992 and 2014, the average number of quarters from peak to trough was 5.7 and from trough to peak was 6.1. The median for both was 6 quarters.

Export domestic deflators (ie, expressed in NZD terms) have generally made a positive contribution to changes in the terms of trade. Over the period examined, export deflators had seven periods of prolonged positive contributions and five periods of negative contributions. Overall, the periods of positive contribution tended to have a larger magnitude than the negative contributions, leading to the overall upward trend in the terms of trade.

Import domestic deflators experienced six periods of positive contributions and six periods of negative contributions. Prior to the GFC the magnitudes of the positive and negative contributions tended to be relatively similar, with a slight skew towards negative contributions. Since the GFC the import contributions have tended to be positive. This is possibly a reflection of low global inflation in recent years.

Throughout most of the period prior to the GFC, the contributions from export and import domestic deflators tended to be offsetting. This implies that export and import domestic deflators moved in the same direction during each cycle, with the relative size of the move dictating whether the overall change in the terms of trade was positive or negative. Critically, the exchange rate acted to offset some the of the changes in world deflators (ie, expressed in TWI terms), as would be expected given most export and import prices are set in foreign currency.

Figure 13 – World deflator contributions to changes in the total terms of trade

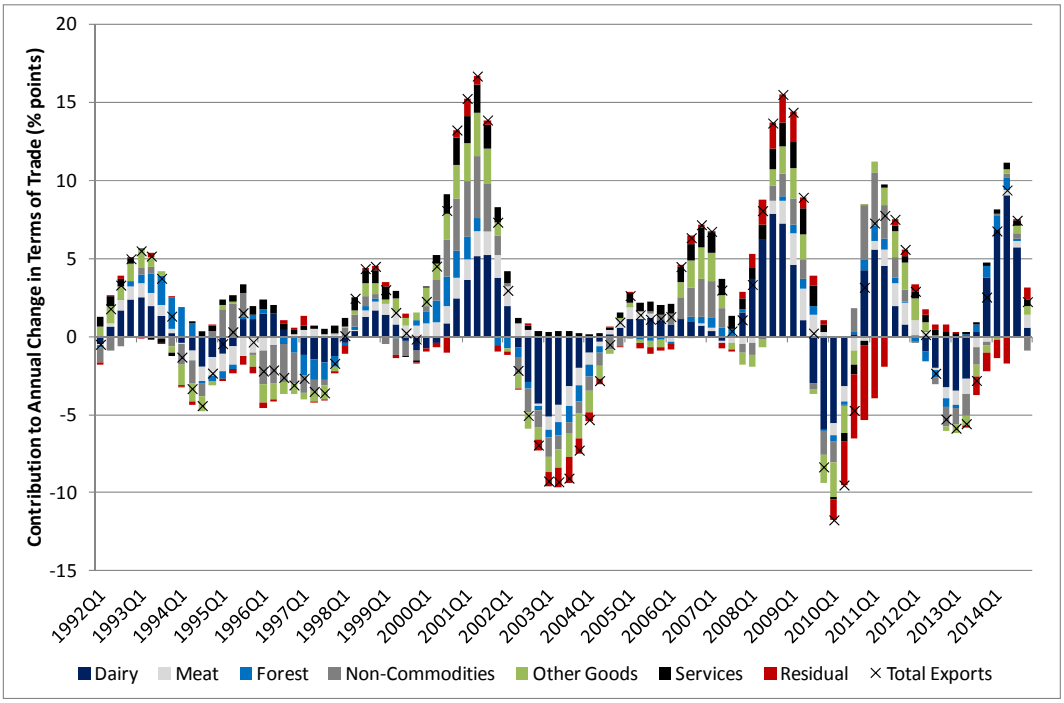


The exchange rate has not acted as its usual buffer in the most recent cycle. The elevated exchange rate has offset some of the large positive contributions from the world export deflator. For example in the year to June 2014 the export world deflator indicated a +16.0% contribution to the terms of trade, which was reduced to a 10.9% contribution in domestic deflator terms. Because the world import deflator was a modest drag of 1.4%, the domestic deflator made a positive contribution of 3.9%. This situation, where both exports and imports have made positive contributions to the terms of trade, has only occurred for more than two quarters on two other occasions (2004/05 and 2007/08). All three occasions where

this has occurred coincide with peaks in the trade weighted exchange rate and small negative contributions from the world import deflator (see Figure 13).[9]

The contributions of each export component to changes in the terms of trade are shown in Figure 14. (Charts of each individual component are available in appendix two). Since 2000, individual components have tended to trend together in terms of contributions to the terms of trade. That is, there has been little in the way of counter-cyclical movements to dampen the overall export contribution to the terms of trade.

Figure 14 – Export component contributions to changes in the terms of trade



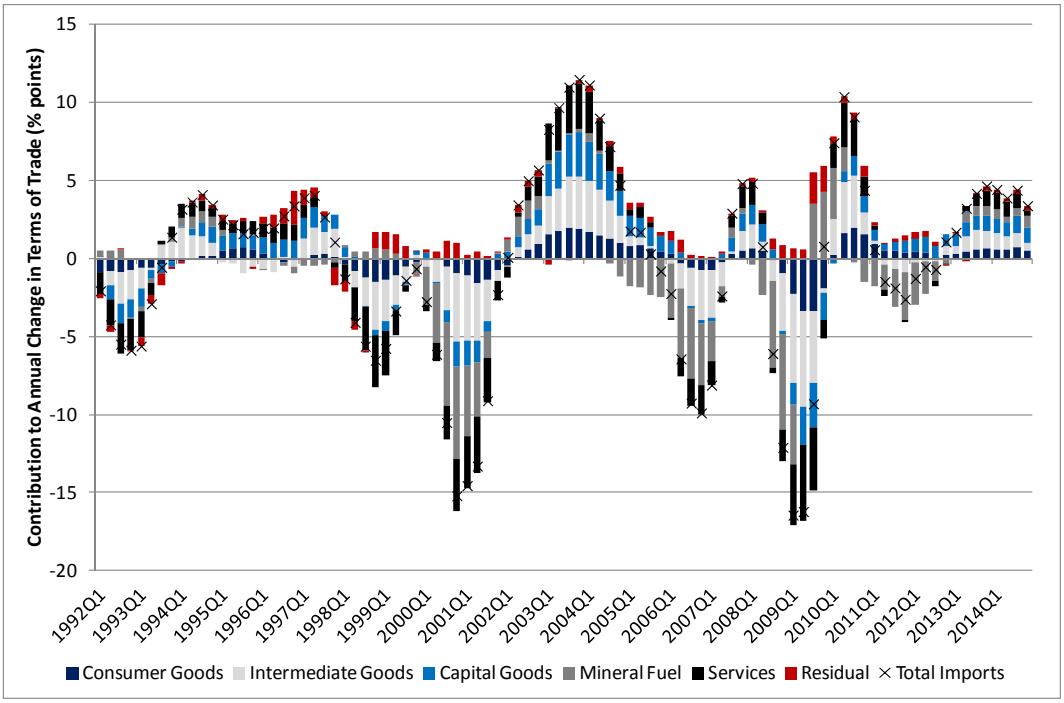
In terms of individual contributions, dairy has tended to make the single largest export contribution to changes in the terms of trade, particularly in the period since 2000. This reflects both dairy's relatively large share of overall exports as well as large movements in the deflator in both directions. Between 1992 and 2014, dairy's contribution to annual changes in the term trade averaged 0.6 percentage points. Services exports made a similar average contribution of around 0.5 percentage points. The remaining four export components each had relatively modest average contributions of 0.1-0.2 percentage points. Median contributions for most components were similar to the average contributions.

Figure 15 shows the import component contributions to changes in the terms of trade. The largest import contribution to annual changes in the terms of trade came from mineral fuels. Mineral fuels' average contribution was -0.7 percentage points (ie, a drag on the terms of trade) although the median contribution was 0.0 percentage points, reflecting changes in mineral fuels usually come in concentrated shocks rather than steady trends. Intermediate goods and import services also made average negative contributions of 0.2 percentage points each, with slightly more positive median contributions. Consumer goods' contribution was neutral. In contrast, and consistent with the non-adjacent

[9] Some caution is required in interpreting the world deflator decompositions as the trade weighted exchange rate used is only an approximation of exchange rate movements. For example, many of our key export commodities such as dairy, beef and forestry are priced in US dollars and movements in this particular currency pairing would be much more correlated with actual changes in world prices.

decomposition findings, capital goods made an average positive contribution to the terms of trade of 0.5 percentage points, with the median contribution slightly higher at 0.8 percentage points.

Figure 15 – Import component contributions to changes in the terms of trade



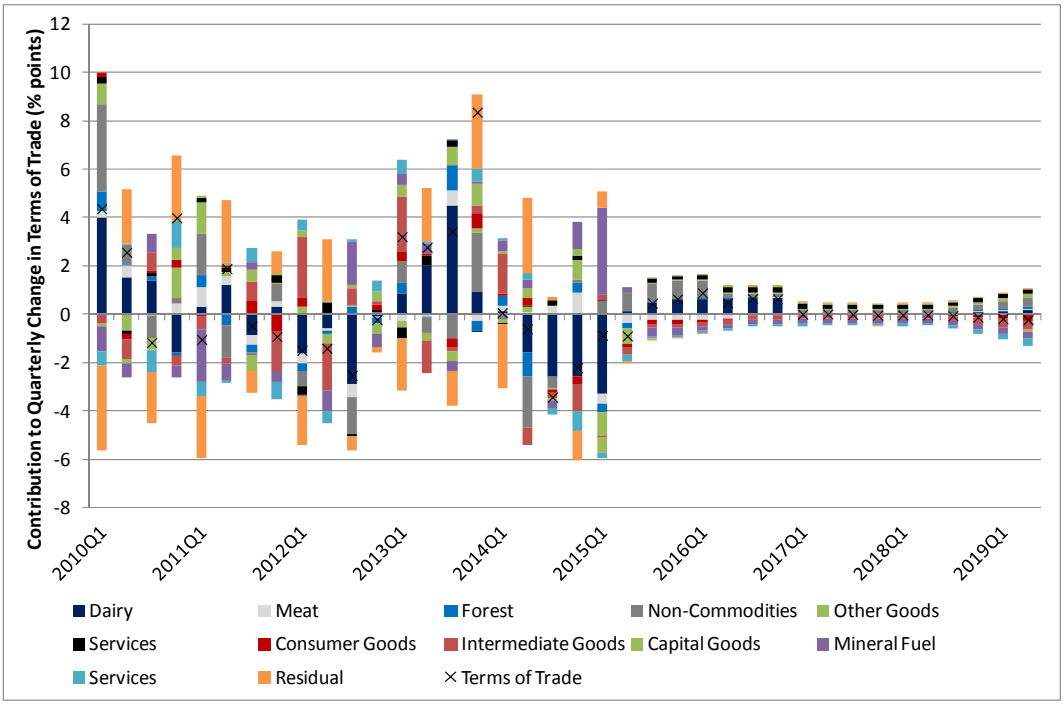
4.2 Forecast trends and insights

The initial motivation for developing the terms of trade decomposition was to provide better insight into the evolution of the terms of trade in Treasury's regular macroeconomic forecasts. Previously developments in each of the export and import components could be viewed in isolation, together with movements in the overall terms of trade. The decomposition provides one approach for looking at all the individual movements in prices together, allowing a better understanding of the key drivers in the evolution of the terms of trade over the forecast period.

Figure 16 shows the quarterly decomposition of recent and forecast[10] changes in the total terms of trade. Over the course of 2014, the sharp decline in dairy prices was the largest driver of the decline in the terms of trade. This was forecast to continue into the first quarter of 2015. The expected recovery in dairy prices then provides a modest positive contribution to the terms of trade from the second half of 2015 and throughout 2016. Over the initial forecast period, an expected increase in the deflator for non-commodity goods also provides a material positive contribution to the terms of trade. The other significant factor in the *Budget Economic and Fiscal Update 2015* external sector forecast was the sharp fall in crude oil prices from the middle of 2014. This impact becomes evident in the contribution from mineral fuels in the fourth quarter of 2014, which provides a sizeable offset to dairy exports' drag on the terms of trade. The positive contribution was forecast to be even larger in the first quarter of 2015.

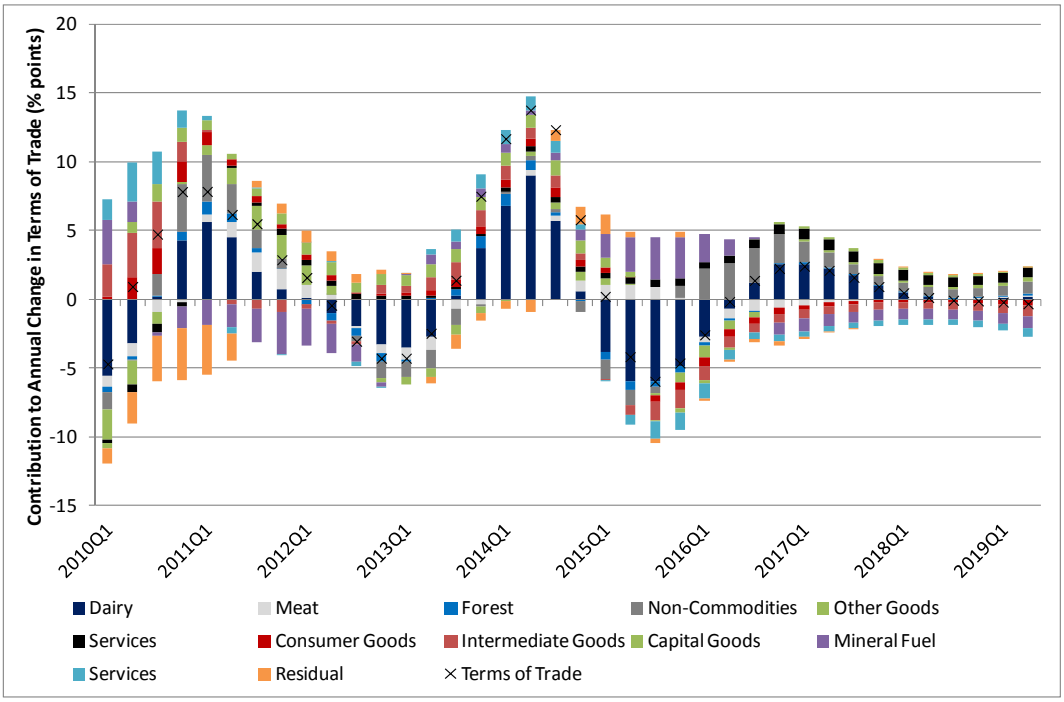
[10] *Budget Economic and Fiscal Update 2015*. Note that 2015 March quarter is the forecast value not the actual outturn.

Figure 16 – Quarterly decomposition of the terms of trade



While the quarterly movements in deflators can be quite large, Figure 17 shows how the effects accumulate and can affect the terms of trade for prolonged periods of time. Although the dairy deflator was forecast to recover from the middle of 2015, it continues to create a significant drag on the annual change in the terms of trade a year later. On a similar note, although the fall in the mineral fuel deflator is mostly concentrated in two consecutive quarters, it is forecast to have a positive impact on the annual change in the terms of trade for nearly two years.

Figure 17 – Annual decomposition of the terms of trade



5 Conclusion

The first part of this paper sets out a method for decomposing changes in the terms of trade into contributions from the constituent components. The methodology was adapted from the approach taken by Baxter and Kouparitsas (2006) and, in particular, Loening and Higashi (2011). This paper extends the approach by expressing the decomposition in contributions to the percentage change in the terms of trade. At the highest level, each component's contribution to the terms of trade is a function of the percentage change of the component's deflator weighted by the component's share of total export or import volume and the ratio of the previous period's component deflator to the previous period's total export or import deflator. This can be further decomposed into contributions from changes in the component's domestic deflator (the price effect) and changes in the component's share of exports or imports (the weighting effect). A third decomposition was also proposed which differentiates between changes in world deflators and changes in the exchange rate.

The terms of trade decomposition was originally developed to further enhance the understanding of the key drivers of the Treasury's terms of trade forecasts in the *Economic and Fiscal Updates*. To this end, the adjacent period decompositions have been a useful addition to the suite of analytical tools. However, the hybrid and non-adjacent approaches provide an opportunity to derive some longer term insights into the evolution of the terms of trade.

Consistent with the widely held view, increases in export prices have made the largest contribution to the terms of trade over the past two decades. Dairy prices have been one of the larger contributors, although it is worth noting that there have been price gains across all export components for most of the longer term decompositions. While export prices have contributed to gains in the terms of trade, the composition of exports has not had a material impact. In particular, the shift in the weighting of the export basket towards dairy largely at the expense of meat has been offsetting in terms of contribution to changes in the terms of trade.

In contrast, the change in the composition of imports has had a material impact. Capital goods and, to a lesser extent, consumer goods have steadily increased as a share of imports as their deflators have generally declined, while intermediate goods and mineral fuels have done the opposite. Taken together, this has acted to partially offset the overall negative contribution to the terms of trade that imports prices have made. Most of the adjustment in import composition took place in the period up to the early 2000s. Since the GFC the compositional effect has faded but import prices have been in overall decline, making a positive contribution to the terms of trade.

Further research could investigate linking the decompositions to economic welfare and productivity. For example, one insight from this paper was the steady decline of the capital goods deflator and the growing importance of capital goods in the imports basket. Has this influenced New Zealand's productivity? There are also potential policy implications to consider. For example, New Zealand's relatively low trade barriers are likely to be one factor behind the shift in the composition of the import basket that had a positive impact on the terms of trade. Are there any other policy measures that could assist with realising future gains from compositional changes? The lack of a material impact on the terms of trade from changes in the composition of exports that this paper finds is also worth exploring further. For example, has the shift towards dairy exports

been as beneficial as expected? Has the change or lack of change in the export and import baskets contributed to the greater volatility observed in the terms of trade in recent years? Finally, this paper has used nominal price deflators as the basis of the decomposition calculations. Developing a measure of the "real" terms of trade (using real price deflators) and decomposing the drivers over time could provide different insights on how the terms of trade have evolved.

To conclude, this paper presents a method for decomposing the terms of trade into contributions from different components of the export and import baskets. The methodology was used to decompose changes in New Zealand's terms of trade over the past two and a half decades. The key insight was that while increasing export prices have made the largest positive contribution to gains in the terms of trade, the changing composition of imports has also made a material positive contribution.

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Appendix One – Mathematical Derivation of the Terms of Trade Decomposition

Decomposition by export and import component

The starting point is to decompose the percentage change in the terms of trade into the impact from export deflators (X^P) and the impact from import deflators (M^P):

$$ToT_t = \frac{X_t^P}{M_t^P}$$

$$\%\Delta ToT_t \approx \%\Delta\, X_t^P - \%\Delta\, M_t^P$$

Over time this relationship holds, with at most 5% of the annual percentage change in the terms of trade since 1992 not explained by the percentage change in export and import deflators. Over the period the variances average 0.07 percentage points and the largest variance is 0.61 percentage points. The relationship is similar for quarterly comparisons, with an average variance of 0.02 percentage points and the largest variance 0.29 percentage points. This variance is captured together with other errors in the residual term (Bal_t) of the final decomposition equations.

With this relationship established, the overall change can be decomposed into the different components that make up exports and imports. First of all, the export and import deflators are divided into value (nominal) and volume (real, chain-weighted) components:

$$X_t^P = \frac{X_t^{Val}}{X_t^{Vol}}$$

$$M_t^P = \frac{M_t^{Val}}{M_t^{Vol}}$$

The value components are defined as:

$$X_t^{Val} = D_t^{Val} + Mt_t^{Val} + F_t^{Val} + NC_t^{Val} + O_t^{Val} + XS_t^{Val}$$

Where D = Dairy, Mt = Meat, F = Forestry, NC = Non-Commodity, O = Other, XS = Export Services

$$M_t^{Val} = C_t^{Val} + I_t^{Val} + K_t^{Val} + MF_t^{Val} + MS_t^{Val}$$

Where C = Consumer Goods, I = Intermediate Goods, K = Capital Goods, MF = Mineral Fuel, MS = Import Services

And domestic deflators for each component are defined as the component value divided by volume (same as the total export deflator and import deflator above). Substituting and rearranging leaves the total deflators defined as the component deflator multiplied by the components share of total export or import volume.

$$X_t^P = \frac{D_t^{Val} + Mt_t^{Val} + F_t^{Val} + NC_t^{Val} + O_t^{Val} + XS_t^{Val}}{X_t^{Vol}}$$

$$X_t^P = \frac{D_t^{Val}}{X_t^{Vol}} + \frac{Mt_t^{Val}}{X_t^{Vol}} + \frac{F_t^{Val}}{X_t^{Vol}} + \frac{NC_t^{Val}}{X_t^{Vol}} + \frac{O_t^{Val}}{X_t^{Vol}} + \frac{XS_t^{Val}}{X_t^{Vol}}$$

$$X_t^P = D_t^P \frac{D_t^{Vol}}{X_t^{Vol}} + Mt_t^P \frac{Mt_t^{Vol}}{X_t^{Vol}} + F_t^P \frac{F_t^{Vol}}{X_t^{Vol}} + NC_t^P \frac{NC_t^{Vol}}{X_t^{Vol}} + O_t^P \frac{O_t^{Vol}}{X_t^{Vol}} + XS_t^P \frac{XS_t^{Vol}}{X_t^{Vol}}$$

$$X_t^P = D_t^P D_t^S + Mt_t^P Mt_t^S + F_t^P F_t^S + NC_t^P NC_t^S + O_t^P O_t^S + XS_t^P XS_t^S$$

Where the superscript S denotes the volume share of that component. Rearranging imports in the same way yields:

$$M_t^P = C_t^P C_t^S + I_t^P I_t^S + K_t^P K_t^S + MF_t^P MF_t^S + MS_t^P MS_t^S$$

These are then expressed in percentage change terms.

$$\%\Delta X_t^P = \left(\frac{X_t^P}{X_{t-1}^P} - 1\right) * 100$$

Substituting in the export deflator formula gives:

$$\%\Delta X_t^P = \left(\frac{D_t^P D_t^S + Mt_t^P Mt_t^S + F_t^P F_t^S + NC_t^P NC_t^S + O_t^P O_t^S + XS_t^P XS_t^S}{X_{t-1}^P} - 1\right) * 100$$

To add in the component percentage change the rearranged and expanded percentage change formula is substituted in for each component (dairy shown as an example).

$$D_t^P = D_{t-1}^P\left(1 + \frac{\%\Delta D_t^P}{100}\right)$$

$$D_t^P = D_{t-1}^P + D_{t-1}^P \frac{\%\Delta D_t^P}{100}$$

Which yields:

$$\%\Delta X_t^P = \frac{\left(D_{t-1}^P + D_{t-1}^P \frac{\%\Delta D_t^P}{100}\right) D_t^S + Mt_t^P Mt_t^S + F_t^P F_t^S + NC_t^P NC_t^S + O_t^P O_t^S + XS_t^P XS_t^S + XB_t^P XB_t^S}{X_{t-1}^P} - 1$$

Doing this for each component gives:

$$\%\Delta X_t^P = \left(\frac{D_{t-1}^P D_t^S + \frac{D_{t-1}^P \%\Delta D_t^P D_t^S}{100}}{X_{t-1}^P} + \frac{MT_{t-1}^P MT_t^S + \frac{MT_{t-1}^P \%\Delta MT_t^P MT_t^S}{100}}{X_{t-1}^P} \right.$$
$$+ \frac{F_{t-1}^P F_t^S + \frac{F_{t-1}^P \%\Delta F_t^P F_t^S}{100}}{X_{t-1}^P} + \frac{NC_{t-1}^P NC_t^S + \frac{NC_{t-1}^P \%\Delta NC_t^P NC_t^S}{100}}{X_{t-1}^P}$$
$$\left. + \frac{O_{t-1}^P O_t^S + \frac{O_{t-1}^P \%\Delta O_t^P O_t^S}{100}}{X_{t-1}^P} + \frac{XS_{t-1}^P XS_t^S + \frac{XS_{t-1}^P \%\Delta XS_t^P XS_t^S}{100}}{X_{t-1}^P} - 1 \right) * 100$$

All of the non percentage change terms can be grouped together:

$$\%\Delta X_t^P = \frac{D_{t-1}^P \%\Delta D_t^P D_t^S}{X_{t-1}^P} + \frac{Mt_{t-1}^P \%\Delta Mt_t^P Mt_t^S}{X_{t-1}^P} + \frac{F_{t-1}^P \%\Delta F_t^P F_t^S}{X_{t-1}^P} + \frac{NC_{t-1}^P \%\Delta NC_t^P NC_t^S}{X_{t-1}^P}$$
$$+ \frac{O_{t-1}^P \%\Delta O_t^P O_t^S}{X_{t-1}^P} + \frac{XS_{t-1}^P \%\Delta XS_t^P XS_t^S}{X_{t-1}^P}$$
$$+ \left(\frac{D_{t-1}^P D_t^S + Mt_{t-1}^P Mt_t^S + F_{t-1}^P F_t^S + NC_{t-1}^P NC_t^S + O_{t-1}^P O_t^S + XS_{t-1}^P XS_t^S}{X_{t-1}^P} - 1 \right)$$
$$* 100$$

The non percentage change term captures most of the variance in export prices that is not explained by the component terms. In practice, some of the variance also relates to the presence of balancing items in the aggregate level data. For convenience this term together with the balancing item variance will be grouped together as a single residual term referred to as the export balancing item. This yields:

$$\%\Delta X_t^P = \%\Delta D_t^P D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta Mt_t^P Mt_t^S \frac{Mt_{t-1}^P}{X_{t-1}^P} + \%\Delta F_t^P F_t^S \frac{F_{t-1}^P}{X_{t-1}^P} + \%\Delta NC_t^P NC_t^S \frac{NC_{t-1}^P}{X_{t-1}^P}$$
$$+ \%\Delta O_t^P O_t^S \frac{O_{t-1}^P}{X_{t-1}^P} + \%\Delta XS_t^P XS_t^S \frac{XS_{t-1}^P}{X_{t-1}^P} + ExBal_t$$

That is, the percentage change in the total export deflator is a function of the percentage change of each component's deflator weighted by the components share of total export volume *and* the ratio of the previous period's component deflator to the previous periods total export deflator.

Following the same process yields the equivalent expression for imports:

$$\%\Delta M_t^P = \%\Delta C_t^P C_t^S \frac{C_{t-1}^P}{M_{t-1}^P} + \%\Delta I_t^P I_t^S \frac{I_{t-1}^P}{M_{t-1}^P} + \%\Delta K_t^P K_t^S \frac{K_{t-1}^P}{M_{t-1}^P} + \%\Delta MF_t^P MF_t^S \frac{MF_{t-1}^P}{M_{t-1}^P}$$
$$+ \%\Delta MS_t^P MS_t^S \frac{MS_{t-1}^P}{M_{t-1}^P} + ImBal_t$$

The exports and imports decompositions can be brought together by substituting into the first equation:

$$\%\Delta ToT_t \approx \%\Delta\, X_t^P - \%\Delta\, M_t^P$$

$$\begin{aligned}\%\Delta ToT_t \approx\ & \%\Delta D_t^P D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta Mt_t^P Mt_t^S \frac{Mt_{t-1}^P}{X_{t-1}^P} + \%\Delta F_t^P F_t^S \frac{F_{t-1}^P}{X_{t-1}^P} + \%\Delta NC_t^P NC_t^S \frac{NC_{t-1}^P}{X_{t-1}^P} \\ & + \%\Delta O_t^P O_t^S \frac{O_{t-1}^P}{X_{t-1}^P} + \%\Delta XS_t^P XS_t^S \frac{XS_{t-1}^P}{X_{t-1}^P} - \%\Delta C_t^P C_t^S \frac{C_{t-1}^P}{M_{t-1}^P} - \%\Delta I_t^P I_t^S \frac{I_{t-1}^P}{M_{t-1}^P} \\ & - \%\Delta K_t^P K_t^S \frac{K_{t-1}^P}{M_{t-1}^P} - \%\Delta MF_t^P MF_t^S \frac{MF_{t-1}^P}{M_{t-1}^P} - \%\Delta MS_t^P MS_t^S \frac{MS_{t-1}^P}{M_{t-1}^P} + Bal_t\end{aligned}$$

Where Bal_t is the net balancing item, calculated as the residual. It largely comprises of $ExBal_t$ less $ImBal_t$.

The decomposition can therefore be summarised as:

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_t^S \frac{x_{t-1}^P}{X_{t-1}^P} - \sum_m \%\Delta m_t^P m_t^S \frac{m_{t-1}^P}{M_{t-1}^P} + Bal_t$$

Where x are the export components and m the import components.

The expression above decomposes the total terms of trade. The same approach can be used to decompose the goods terms of trade, in which case the volume shares are calculated as a share of the goods export or import volume and the service components are excluded.

Decomposition into deflator and weight effects

The decompositions can further be split into deflator effects and weight effects for each component. Dairy is shown as an example, with D_t referring to the total decomposition for dairy at time t:

$$D_t = \%\Delta D_t^P D_t^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

Adding an additional expression gives:

$$D_t = \%\Delta D_t^P D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta D_t^P D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} - \%\Delta D_t^P D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

$$D_t = \%\Delta D_t^P D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta D_t^P \left(D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} - D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} \right)$$

Where the first term refers to the deflator effect (change in deflator multiplied by old weightings, including both the volume and the deflator ratio factors) and the second term refers to the weighting effect (change in world deflator multiplied by difference in weightings). This can be summarised as:

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_{t-1}^S \frac{x_{t-1}^P}{X_{t-1}^P} + \sum_x \Delta x_t^P \left(x_t^S \frac{x_{t-1}^P}{X_{t-1}^P} - x_{t-1}^S \frac{x_{t-1}^P}{X_{t-1}^P} \right) - \sum_m \%\Delta m_t^P m_{t-1}^S \frac{m_{t-1}^P}{X_{t-1}^P} - \sum_m \Delta m_t^P \left(m_t^S \frac{m_{t-1}^P}{X_{t-1}^P} - m_{t-1}^S \frac{m_{t-1}^P}{X_{t-1}^P} \right) + Bal_t$$

Decomposition into world deflator, weight and exchange rate effects

As a final step, the decompositions can further be split into world deflator effects, weight effects and exchange rate effects for each component. Dairy is shown as an example, with D_t referring to the total decomposition for dairy at time t.

Firstly, the relationship between the domestic and world deflator for a component is established as:

$$D_t^P = \frac{D_t^{WP}}{E_t}$$

Where E is the nominal trade weighted exchange rate and the superscript WP denotes the world deflator. As a percentage change this can be approximated as the following

$$\%\Delta D_t^P \approx \%\Delta\, D_t^{WP} - \%\Delta\, E_t$$

This is subbed into the dairy decomposition:

$$D_t = \%\Delta D_t^P D_t^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

$$D_t = (\%\Delta\, D_t^{WP} - \%\Delta\, E_t) D_t^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

Expanding and adding an additional expression gives:

$$D_t = \%\Delta D_t^{WP} D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} - \%\Delta\, E_t D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta D_t^{WP} D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} - \%\Delta D_t^{WP} D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

$$D_t = \%\Delta D_t^{WP} D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} + \%\Delta D_t^{WP} \left(D_t^S \frac{D_{t-1}^P}{X_{t-1}^P} - D_{t-1}^S \frac{D_{t-1}^P}{X_{t-1}^P} \right) - \%\Delta\, E_t D_t^S \frac{D_{t-1}^P}{X_{t-1}^P}$$

Where the first term refers to the world deflator effect (change in world deflator multiplied by old weightings, including both the volume and the domestic deflator ratio factors), the second term refers to the weighting effect (change in world deflator multiplied by difference in weightings) and the third term is the exchange rate effect. This can be summarised as:

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^{WP} x_{t-1}^S \frac{x_{t-1}^P}{X_{t-1}^P} + \sum_x \%\Delta x_t^{WP} \left(x_t^S \frac{x_{t-1}^P}{X_{t-1}^P} - x_{t-1}^S \frac{x_{t-1}^P}{X_{t-1}^P} \right) - \sum_x \%\Delta\, E_t x_t^S \frac{x_{t-1}^P}{X_{t-1}^P}$$
$$- \sum_m \%\Delta m_t^{WP} m_{t-1}^S \frac{m_{t-1}^P}{X_{t-1}^P} - \sum_m \%\Delta m_t^{WP} \left(m_t^S \frac{m_{t-1}^P}{X_{t-1}^P} - m_{t-1}^S \frac{m_{t-1}^P}{X_{t-1}^P} \right)$$
$$+ \sum_m \%\Delta\, E_t m_t^S \frac{m_{t-1}^P}{M_{t-1}^P} + Bal_t$$

Decomposition of non-adjacent time periods

The previous decomposition is based on adjacent time periods (either years or quarters). However, the decomposition can be extended to changes between any two points in time.

Total decomposition:

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - \sum_m \%\Delta m_t^P m_t^S \frac{m_{t-z}^P}{M_{t-z}^P} + Bal_t$$

Decomposition into deflator and weight effects:

$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^P x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} + \sum_x \%\Delta x_t^P \left(x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} \right) - \sum_m \%\Delta m_t^P m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P}$$
$$- \sum_m \%\Delta m_t^P \left(m_t^S \frac{m_{t-z}^P}{X_{t-z}^P} - m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} \right) + Bal_t$$

Decomposition into world deflator, weight and exchange rate effects:

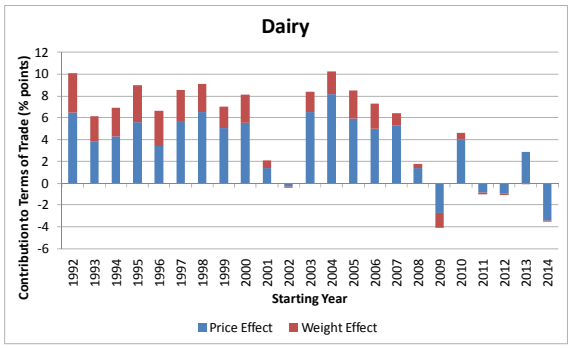
$$\%\Delta ToT_t \approx \sum_x \%\Delta x_t^{WP} x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} + \sum_x \%\Delta x_t^{WP} \left(x_t^S \frac{x_{t-z}^P}{X_{t-z}^P} - x_{t-z}^S \frac{x_{t-z}^P}{X_{t-z}^P} \right) - \sum_x \%\Delta\, E_t x_t^S \frac{x_{t-z}^P}{X_{t-z}^P}$$
$$- \sum_m \%\Delta m_t^{WP} m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} - \sum_m \%\Delta m_t^{WP} \left(m_t^S \frac{m_{t-z}^P}{X_{t-z}^P} - m_{t-z}^S \frac{m_{t-z}^P}{X_{t-z}^P} \right)$$
$$+ \sum_m \%\Delta\, E_t m_t^S \frac{m_{t-z}^P}{M_{t-z}^P} + Bal_t$$

Where z is the desired time lag in years or quarters.

It is worth noting that measuring the decomposition between two points is considerably influenced by both the starting and ending points. It is worth carefully considering what these points should be. Alternatively, as in this paper, multiple comparisons can be made between different starting points and a fixed ending point (or vice versa). Finally, the balancing item (residual) tends to become larger the larger the time lag z becomes.

Appendix Two – Component Decomposition Charts

Figure 18 – Dairy



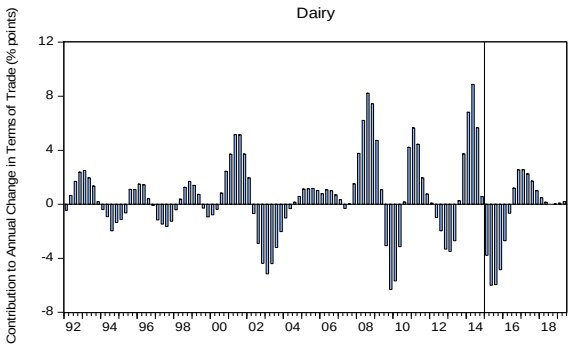
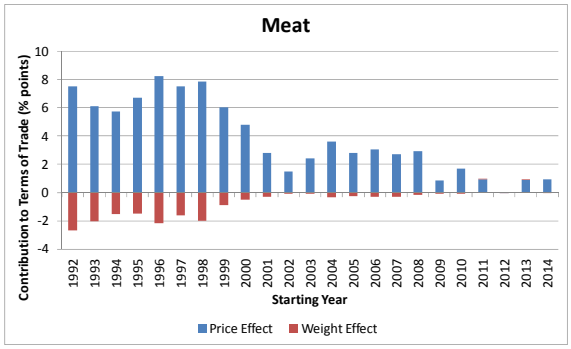


Figure 19 – Meat



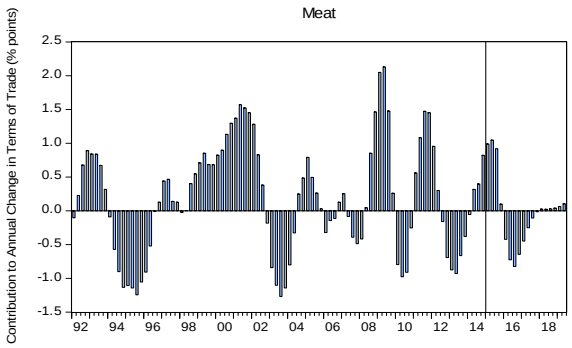
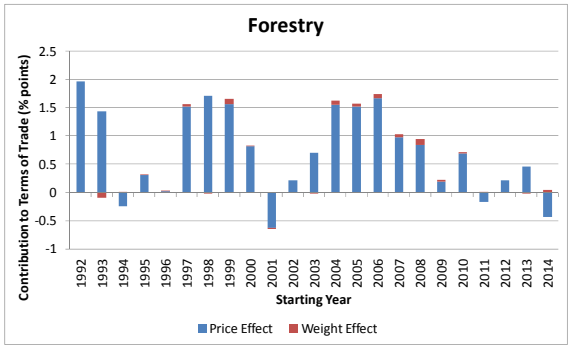


Figure 20 – Forestry



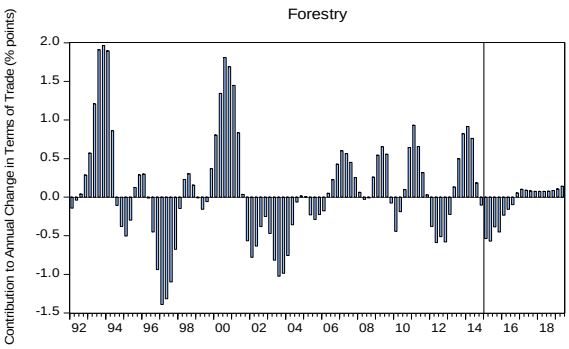
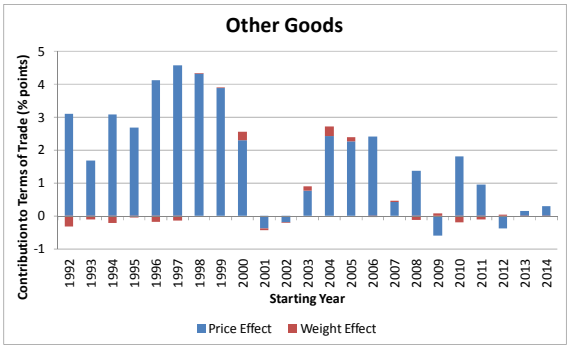


Figure 21 – Other Goods



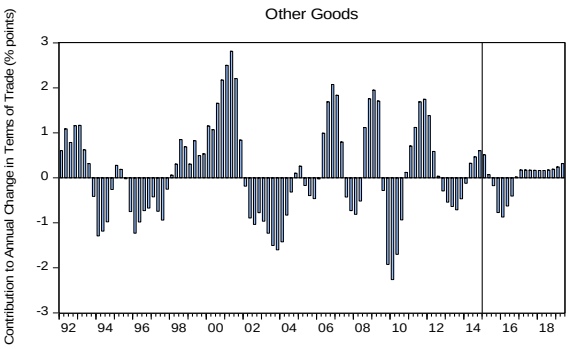
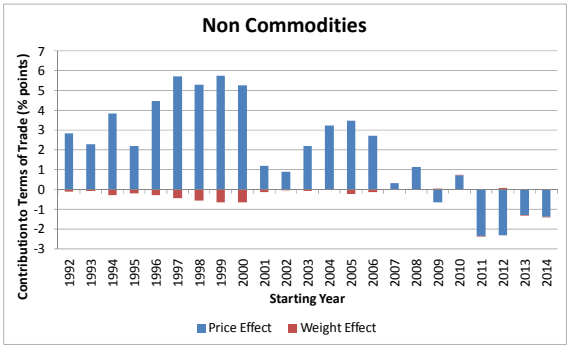


Figure 22 – Non-Commodities



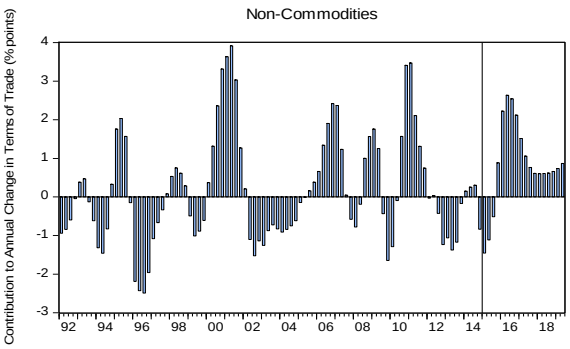
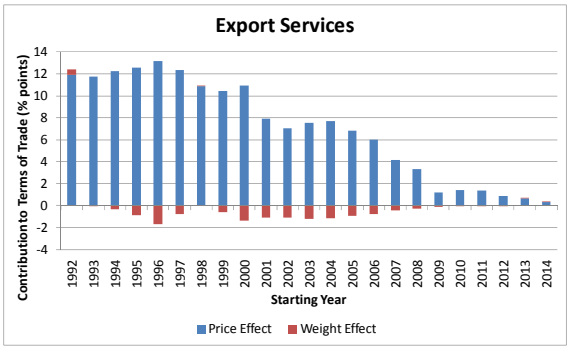


Figure 23 – Export Services



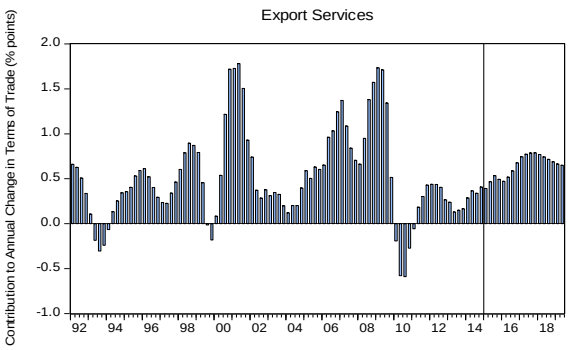
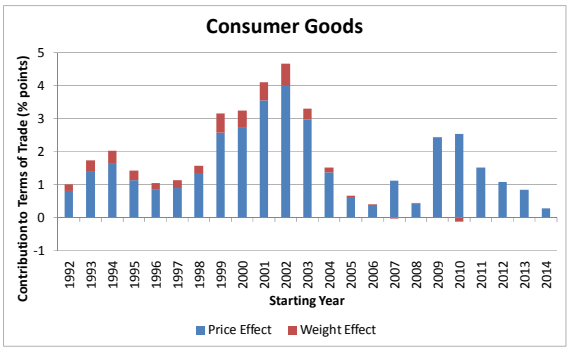


Figure 24 – Consumer Goods



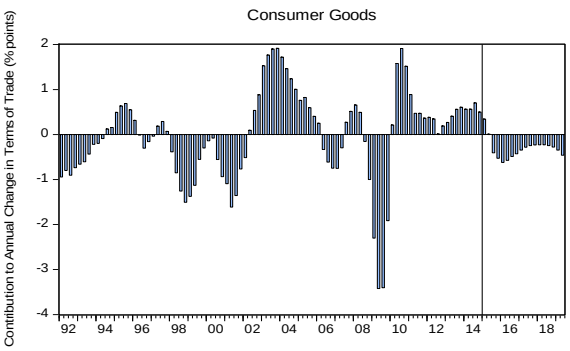
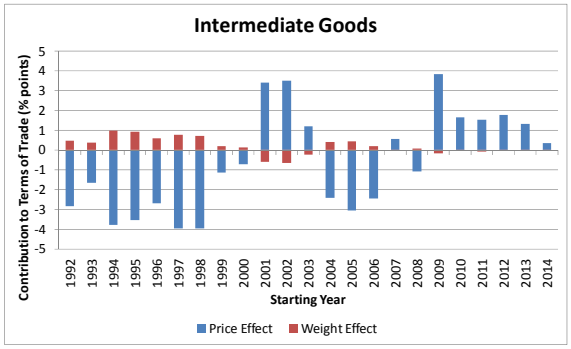


Figure 25 – Intermediate Goods



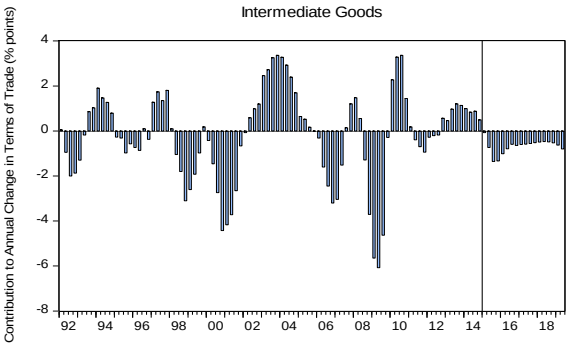
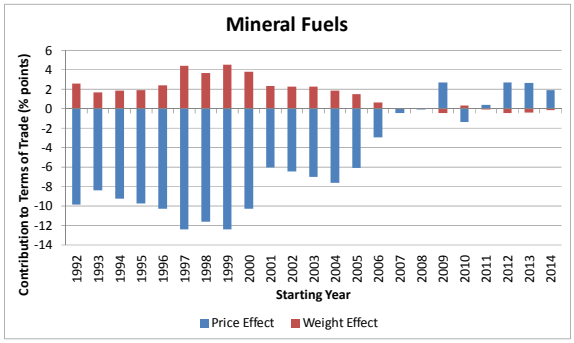


Figure 26 – Mineral Fuels



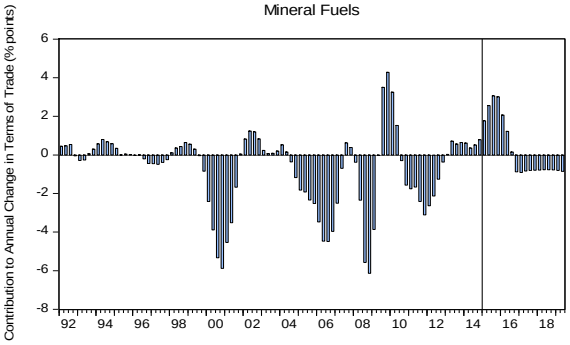
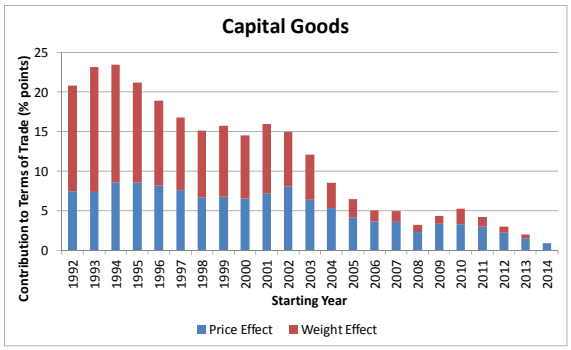


Figure 27 – Capital Goods



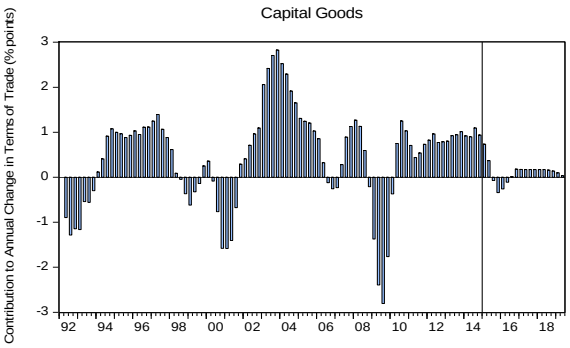
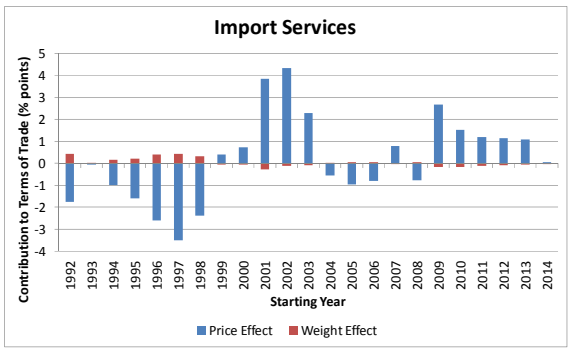
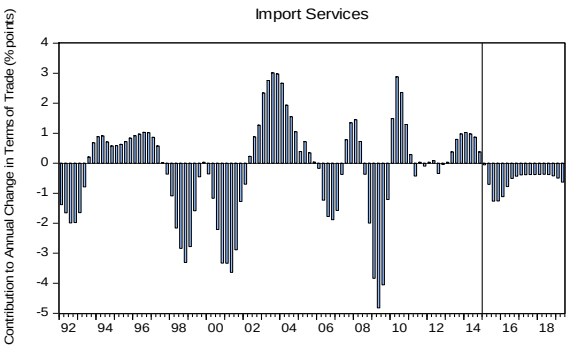


Figure 28 – Import Services





Appendix Three – Comparisons to the 1995/96 Base Year

The empirical testing in this paper uses the chain-weighted "real" series as the basis for determining export and import volumes. The current SNA GDP data published by Statistics New Zealand uses 2009/10 as the base year for the chain-weighted series. Examination of the results, particularly of the long time frame non-adjacent decompositions where large residuals occur, raised concerns as to whether the base year materially influences the insights from the decompositions. Fortunately the use of 2009/10 as the base year is relatively recent and data using the previous 1995/96 base year is available up to the middle of 2014. The charts below show the long term non-adjacent decompositions into deflator and weighting effects using the two different base years. Note the final year of comparison is the year to March 2014, the latest full March year available for the 1995/96 data series.

Comparing the two different base years suggests that the results of the decompositions into component and deflator and weighting effects are robust to changes in the base year. This likely reflects that the relevant OTI deflators are used to derive both series. This is made clearer in the charts over the page which shows the deflator and weighting effects for each of the two base years. On this basis it would appear that the insights that export prices and the composition of imports have both made material positive contributions to changes in the terms of trade are sound.

As expected, where the two base years do differ is in the magnitude of the change in the terms of trade, with the 1995/96 terms of trade seeing an overall larger change than the 2009/10 terms of trade. This in turn is reflected in the residuals which tend to be smaller the closer they are to the base year. So for the 1995/96 base year decompositions the residual is small for decompositions starting in the 1990s and grows larger for decompositions of more recent years. For the 2009/10 base year the reverse is the case.

Figure 29 – 1995/96 Base Year

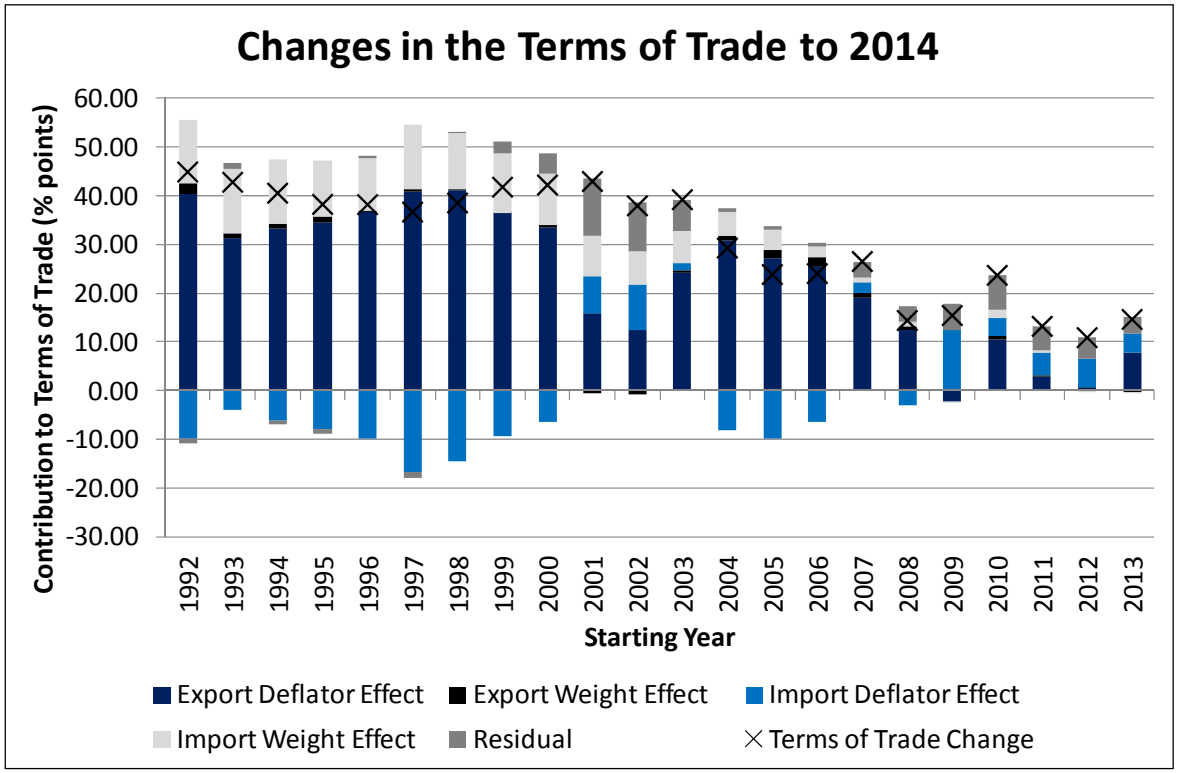


Figure 30 – 2009/12 Base Year

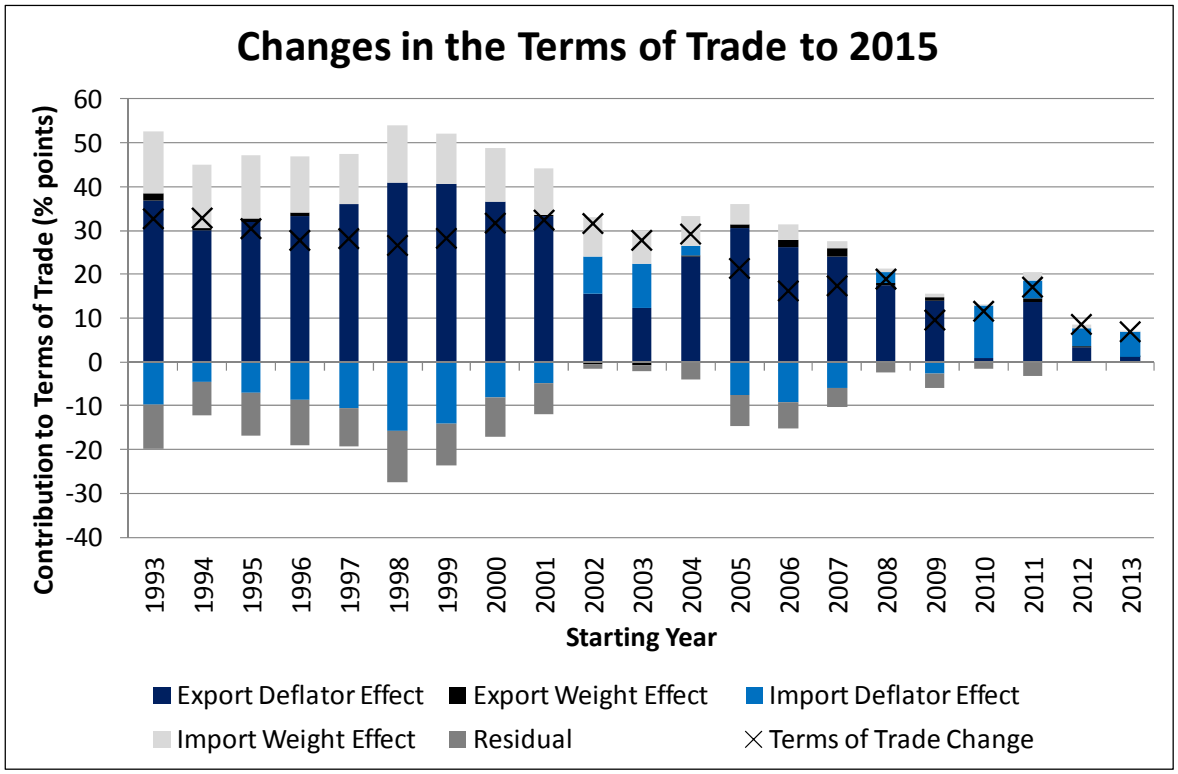


Figure 31 – Terms of Trade

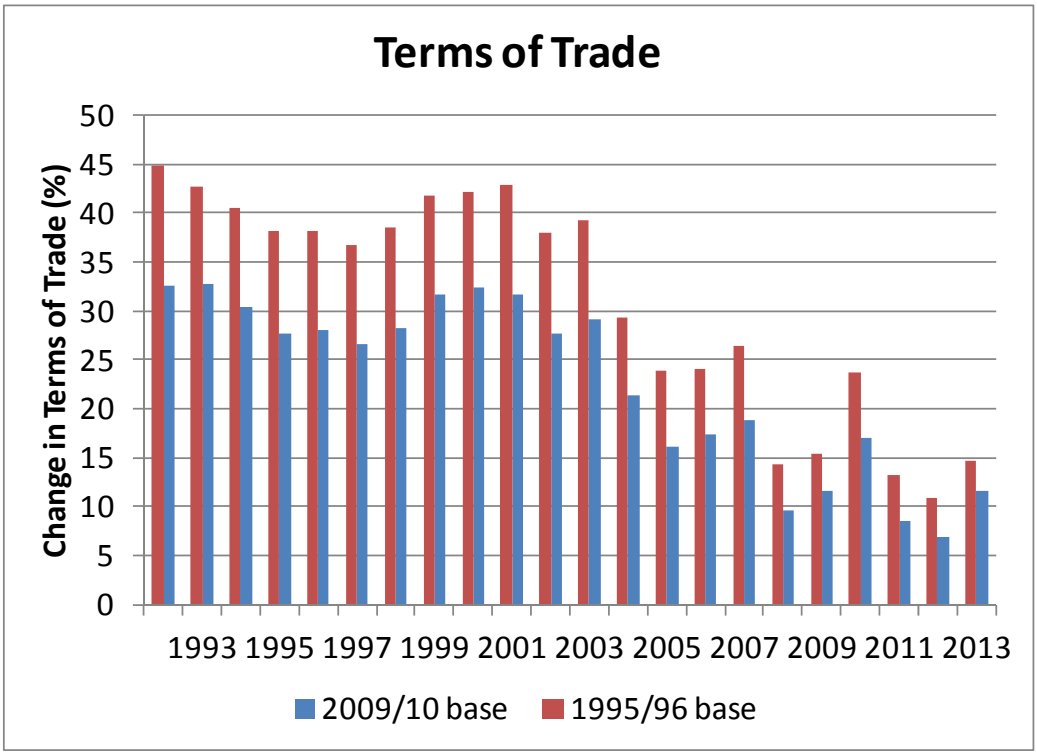


Figure 32 – Residual

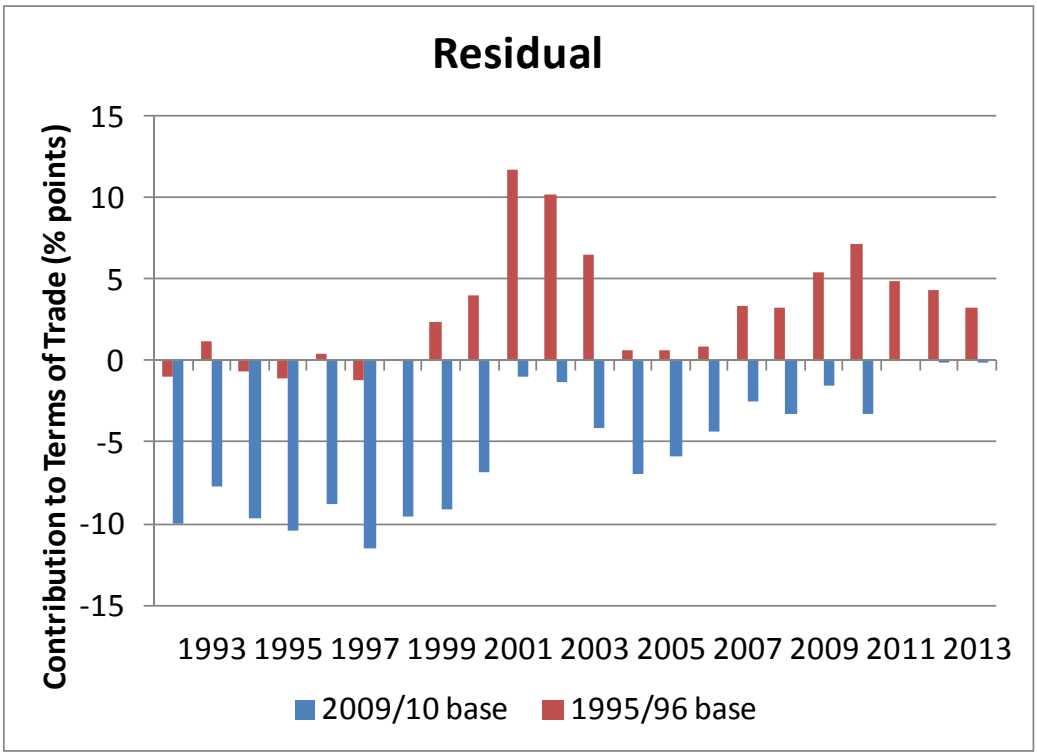


Figure 33 – Export deflator effect

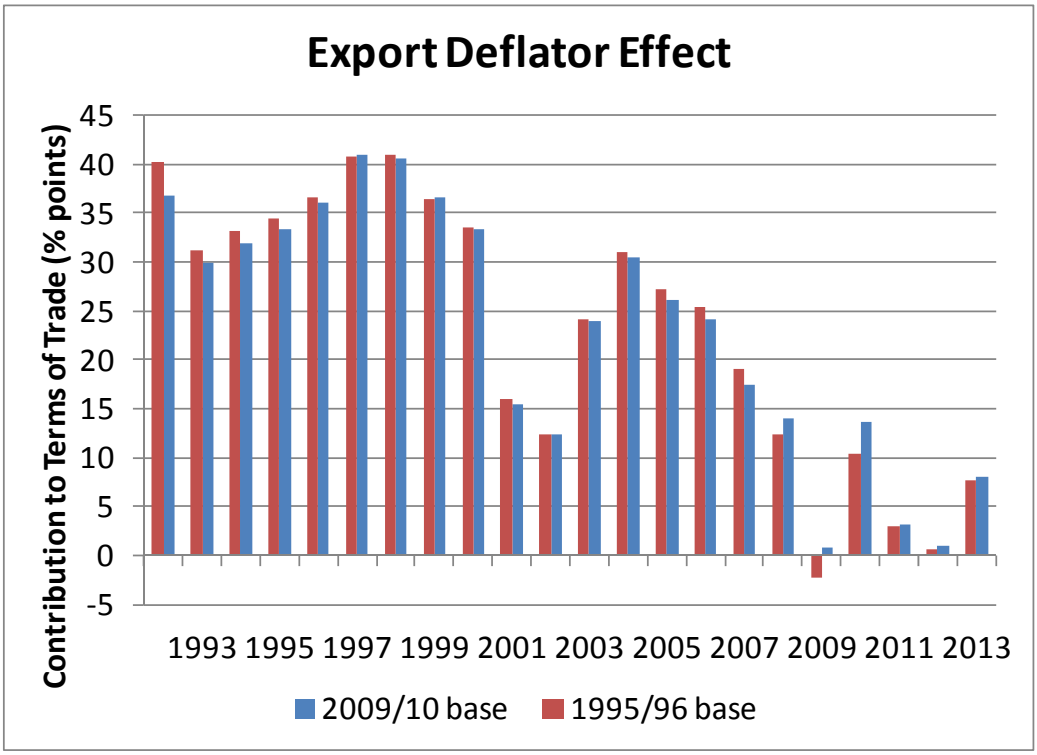


Figure 34 – Import deflator effect

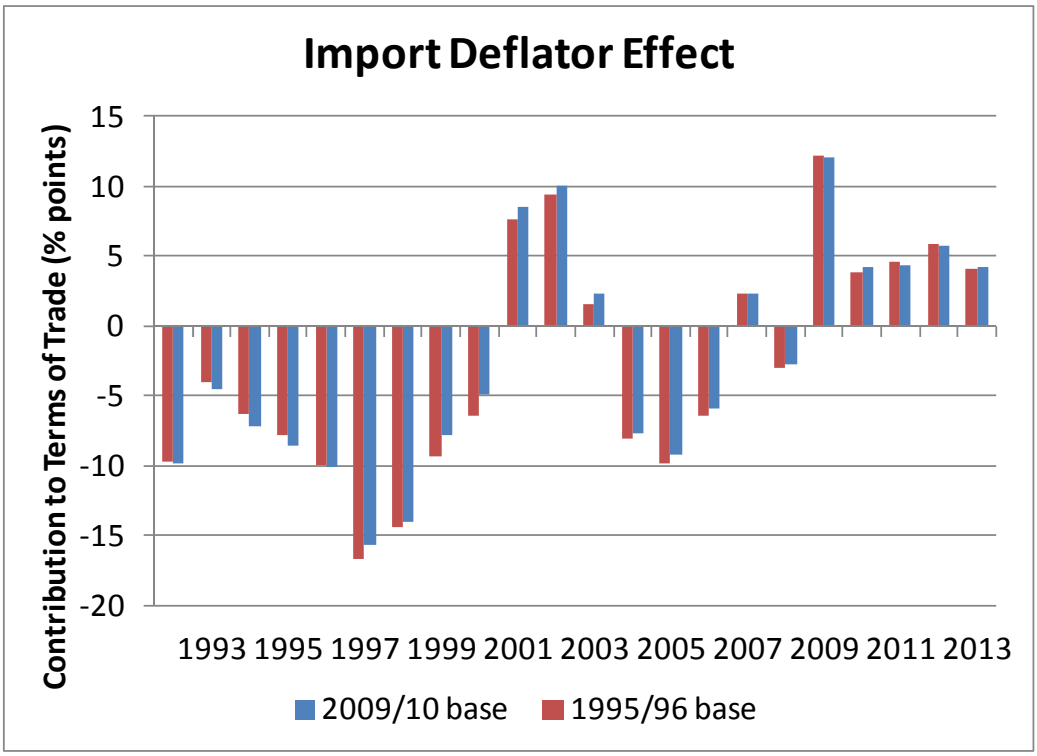


Figure 35 – Export weight effect

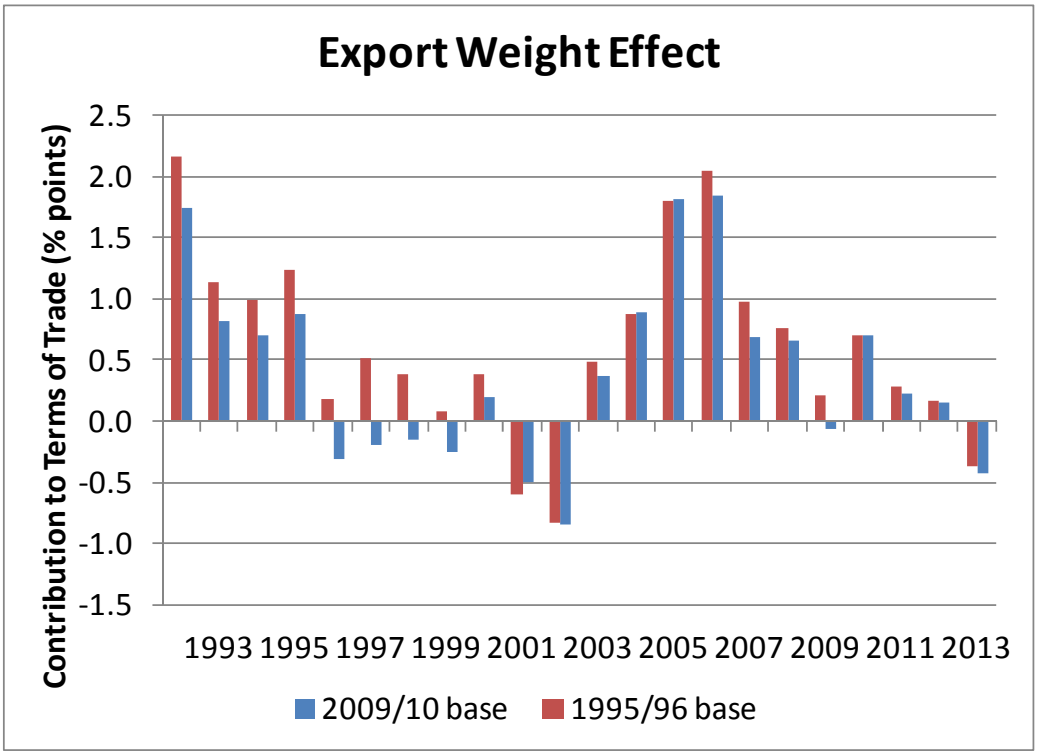


Figure 36 – Import weight effect