EXPORT PRICES, TERMS OF TRADE, REAL EXCHANGE RATE AND STRUCTURAL CHANGES IN THE AUSTRALIAN ECONOMY

by

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A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Faculty of Rural Management

The University of Sydney

March 2017

ABSTRACT

Australia has long been considered a commodity-based economy, with reliance on a few primary export commodities a key reason. Structural change in the economy since the mid-1980s has seen a growing role of the traded sector within the Australian economy, with expansion in both the export and import sector. A sustained price-led boom from 2003 to 2008 in Australian export commodities has triggered discussion around the Gregory thesis and wider Dutch Disease theory. This thesis examines the impact of the price-led boom and the longer-term structural change on the Australian economy, manufacturing sector (at an aggregate and disaggregate level), and the real exchange rate. The key conclusions are: (i) that the aggregate manufacturing sector was impacted by the mineral export-price boom, although not as expected; (ii) at a disaggregate level there are differences in how the boom impacted each manufacturing sub-sector; (iii) underlying structural change in the Australian economy and OECD manufacturing remains an important influence on Australian manufacturing; and, (iv) despite these structural changes, the underlying co-integrated relationship between the terms of trade and real exchange rate is largely unchanged. The role of underlying structural change within the economy is an important consideration for policy makers and future research opportunities.

DECLARATION

I certify that this thesis does not incorporate, without acknowledgement, any material previously submitted for a degree or diploma in any university. It does not contain any material previously published or written by another person except where due reference is made in the text.

This thesis does not exceed 32,000 words.

Mark Frost

Signed:

DEDICATION

This thesis is dedicated to the memory of Dr. Miklos Szentkiralyi (1911 – 2003), an economist who survived two World Wars and the Hungarian uprising. After retiring he proceeded to spend the final 25 years of his life as a volunteer on the Pacific Island of Pohnpei, where I had the privilege of working with him.

ACKNOWLEDGEMENTS

There is a common phrase that "an army is only as good as its supply line". I have come to realise that this phrase could apply to any PhD, and in particular one like mine that has been completed on a part-time basis. It is difficult to know where and with whom to start. There have been many friends, family and colleagues with me on this journey and all have assisted me in some small part along the way. My thanks extend to everyone who falls into this category. Notwithstanding this, there are a few people who I would like to recognise for their support and assistance.

The first are my immediate line managers who have been unwavering in their support of my candidature. Included in this list are Professors Ken Dillon and Lesley White. Your support, encouragement, and words of wisdom along the way are truly appreciated.

The second is my associate supervisor Dr. Jammie Penm, who has been a great sounding board and whose rigour has greatly assisted the development of my thesis. His knowledge of the Australian agricultural and resource sectors is second-to-none and it has been a privilege working with him.

The next group I would like to acknowledge is my immediate family - my wonderful children Pam, Ken and Jess, my wife Di, and also my parents. All have shared the journey, and their willingness to forgo family time has been appreciated.

Finally I would like to acknowledge my supervisor Professor Kevin Parton. It has been a long journey and anything I say cannot adequately describe the pastoral, academic and spiritual support he has provided. We have had many long and very rewarding discussions along the way, both thesis and non-thesis related. There is some sadness that these stimulating interactions may become less frequent, and my week will be the poorer as a result. Thank you for everything you have done.

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Chapter 1 Introduction

1.1 Objective of the Thesis

There are three major objectives of this thesis. The first is to disentangle the impact of a price-driven booming Australian mineral export sector on the Australian economy, from longer-term structural change that has been occurring over the last 30 years. The theoretical framework to judge the response of an economy to such a mineral export boom has widely become known as Dutch Disease. Early authors such as Gregory (1976), Corden and Neary (1982), and Corden (1984) all predicted that the effect of an emerging mineral sector would be widespread and adversely affect the import and import-competing sector, the non-booming export sectors and the non-traded sector of the Australian economy. Furthermore, the increased demand from increased income from a booming (mineral) export sector would draw labour and capital from the non-booming export sectors and the non-traded sector, leading to a wider "deindustrialisation" of the economy.

At the time of Gregory's publication in 1976, Australia was still a largely regulated economy, with fixed interest rates, a managed float of the exchange rate, and significant trade protection. It was at the beginning of a period of economic turmoil following the collapse of the Bretton Woods Agreement, expanding international trade and high world inflation. In 1983 the Australian economy was deregulated with the floating of the exchange rate and deregulation of the domestic money market. Resulting from these was a restructure of the Australian economy and traded sector.

Over the last decade there has been a sustained mineral export boom that has been triggered by sustained high export prices. Gregory (2011) suggested that this growth in the resource sector was export-price driven. In contrast export growth in the 1970s (and covered in Gregory, 1976) was volume driven. As such the impact of this price-driven change may be different from volume-driven changes and this creates "the opportunity for new research agendas" (p. 3).

Furthermore, the studies such as Acharya and Coulombe (2009), Beine *et al.* (2011), Thompson *et al.* (2012) and Hambur and Norman (2013) have all suggested that the longer-term structural change needs to be included together with disaggregated analysis when the impact of a mineral export-price boom is being assessed. The addition of these factors allows for the inclusion of different labour-capital requirements of various sub-sectors, the interaction between these various sub-sectors as well as worldwide economic development trends.

The first objective of this thesis is to investigate the impact of longer-term realignment of the Australian economy with the mineral export-price boom. This was achieved through examining the mineral export sector, and identifying the impact on the import sector, import-competing sector, non-booming export sector and non-traded sector, and their relative contributions to the Australian economy. At first glance this may seem straightforward. However, in an Australian context, the combination of this price-driven export boom, combined with a multi-commodity mineral sector, as well as a restructured economy and traded sector, suggests that the impact may be more complex than initially thought.

Analysis of the manufacturing sector at an aggregate level included its contribution to Australian GDP, total Australian employment and total real capital expenditure. Furthermore, the contribution of Australian manufacturing to the Australian economy was compared with that of the United States and the OECD.

The second objective of this research is to examine in more detail the impact of the price-led booming export sector on the disaggregated manufacturing sector and to compare this analysis with that of the aggregated manufacturing sector. This comparison and contrast highlighted different responses within the disaggregated manufacturing sector to the mineral export-price boom, some of which confirmed Dutch Disease-like responses, but other sectors had responses unlike Dutch Disease. At a policy level these are important considerations as Dutch Disease theory (Gregory 1976; Corden 1984; Jones & Neary 1985: Sachs &Warner 2001) suggested that a booming export sector will draw key labour and capital resources from the non-booming export and non-traded sectors. However, these studies also assumed capital and labour mobility as well as fixed prices and did not include the role of a floating exchange rate as a buffer.

The final objective of the thesis is to re-examine the relationship between the terms of trade and the real exchange rate. The relationship has been previously well documented (Gruen & Wilkinson 1991; Blundell-Wignall *et al.*, 1993; Bullock *et al.,* 1993; Swift, 1998, 2001, 2004; Webber, 1997; Bagchi *et al*., 2004; Wren-Lewis, 2004). These studies, among others, have concluded a strong contemporaneous and co-integrated relationship between these two key variables. However, as detailed in Chapters 2 and 3, the growth of the traded sector, foreign indebtedness and the income balance within the current account suggest that monetary considerations may be an emerging influence on the exchange rate rather than solely trade, and as often assumed commodity exports. The growth in the traded sector has been due to a relative increase in the contribution of the import sector as well as the export sector, while trade intensity has also grown substantially. That is, where trade intensity is defined as the combined contribution of the export sector and the import sector expressed as a percentage of Australian GDP. Similarly, the increase in foreign indebtedness now sees the income balance a more significant component of the current account. The income balance relates to the financial transaction component of the current account that represents interest payments, dividends, and other monetary related payments.

The third objective of this thesis is a re-examination of the relationship between the terms of trade and the real exchange rate, extending the work of Gruen and Wilkinson (1991) by developing a model that includes the role of trade intensity and the income balance.

1.2 Structure of the Thesis

This thesis is structured as follows. Chapter 2 provides background literature to the research project. The literature selected was focussed around the development of Dutch Disease, both in the development of theoretical concepts as well as identifying recent studies that could be useful in an Australian context. Included in this theme are authors such as Gregory (1976; 2011), Corden and Neary (1982), Corden (1984), Lindert (1991), Davis (1995), Sachs and Warner (2001), McKissak *et al.*

(2008), Acharya and Coulombe (2009), Ismail (2010), Beine *et al.* (2012), and Hambur and Norman (2013). From this literature relevant models and empirical techniques were highlighted.

The purpose of Chapter 3 is to provide an historical and theoretical context for this research project through identifying the developments in the Australian economy and traded sector since 1983. This latter period coincides with the expansion of the mineral sector and also structural changes in the Australian economy and traded sector resulting from the floating of the exchange rate and deregulation of the financial system in the early 1980s.

These structural changes are covered in detail in Chapter 3, which contains an overview of the sectoral composition of the Australian economy, the growing role of the traded sector, including key export and import goods, and the increasing importance of income balance within the current account balance. Of particular note was the role of manufacturing within the Australian economy with reference to its contribution to Australian GDP, total employment and contribution to real private capital expenditure.

From this analysis, three hypotheses were formed, namely:

1. That the mineral export-price boom of 2003 to 2008 did not impact the Australian manufacturing sector as predicted by Dutch Disease theory;

2. That at a disaggregated level, the mineral export-price boom of 2003 to 2008 did impact sub-sectors of Australian manufacturing as predicted by Dutch Disease theory;

3. That the growing role of the income balance within the current account, and the real interest rate differential have altered the relationship between the Australian exchange rate and the Australian terms of trade.

Chapter 4 summarises the research methods that were utilised when examining these three hypotheses. The analysis of the first two hypotheses were exploratory in nature and utilised themes introduced in Acharya and Coulombe (2009) and Beine *et al.* (2012). Commentary within this chapter highlights limited empirical studies to date and those undertaken are largely testing theoretical concepts. The techniques utilised in Hambur and Norman (2013) have been identified as suitable for future research, but were not utilised directly in this thesis. In their study these authors had no predefined construct and utilised their empirical results to develop the resultant theoretical model. However their techniques would form an important part of identified future research. Data utilised were from various publications of the Australian Bureau of Statistics (ABS), the Reserve Bank of Australia (RBA) and other Australian Government agencies such as the Productivity Commission, Department of Agriculture, Fisheries and Forestry, and the Australian Bureau of Agriculture and Resource Economics and Sciences.

The final hypothesis is a re-examination of the co-integrated relationship between the terms of trade and the real Australian exchange rate. In this section, key exchange rate studies are introduced and an overview of error correction techniques as proposed by Engle and Granger (1987) and Johansen (1988) is introduced. These are linked with key Australian studies such as Gruen and Wilkinson (1991), Blundell-Wignall *et al.* (1993), Bullock *et al*. (1993), Bleaney (1996), Webber (1997), Swift (1998; 2001; 2004), Cashin and McDermott (2002), Chen and Rogoff (2003), Bagchi *et al.* (2004) and Hatzinikolaou and Polasek (2005). From this discussion the proposed econometric model is generated.

Chapter 5 contains the results of the estimation and subsequent discussion covers the importance of these findings. The conclusion to the first hypothesis is that the manufacturing sector is performing better than expected under traditional Dutch Disease theory. This is based on the findings that while there is a significant relationship between the mineral export-price boom and manufacturing income, the coefficient sign suggests that the impact of the boom on the real exchange rate has offset the longer-term change in manufacturing rather than exaggerate the change. This thesis suggests that the relative contribution of manufacturing to the Australian economy (as measured by contribution to Australian GDP and employment) is slightly lower, but in absolute terms it is still contributing strongly to the Australian economy. That is, in nominal terms the value of manufacturing income and employment is unchanged, however its contribution to the Australian economy has decreased as Australian GDP and total Australian employment has increased.

At a disaggregated level, the conclusion to the second hypothesis is that there are varied results on the relationship between each respective sub-sector manufacturing income and the mineral export-price boom. In a couple of cases there is evidence of

Dutch Disease-like symptoms from the mineral export-price boom. However, in other sub-sectors longer-term structural change in these sub-sectors has seen them immune to these Dutch Disease-like symptoms. One reason for this discrepancy relates to the existing relationship with the real exchange rate and the mineral sector. Another reason for the discrepancy relates to the fact that the structural change has been occurring over a 30-year period compared to the five-year mineral export-price boom. This has highlighted that any analysis of the impact of a mineral export-price boom on the manufacturing sector needs to be undertaken at a disaggregated level and include longer-term structural change at an aggregate level, and also relationships between the various sub-sectors.

The results from the final hypothesis are in line with previous studies. That is, that there remains a long-term co-integrating relationship between the real exchange rate and the terms of trade. In this case a 1 percent change in the terms of trade leads to a 0.73 to 0.83 change in the real exchange rate. This is consistent with previous studies such as Gruen and Wilkinson (1991), Blundell-Wignall *et al.* (1993), Bleaney (1996), Wren-Lewis (2004) and Hatzinikolaou and Polasek (2005). The range of co-integrating relationships from these studies was between 0.50 and 1.08.

Similarly, the error correction value of 0.6 is also broadly in line with the 0.67 established by Hatzinikolaou and Polasek (2005). This is not surprising as their study period is from 1984 to 2004, and the current analysis concluded in 2010. This suggests that 60 percent of any deviation from the long-term equilibrium is corrected in the same quarter, 24 percent the second (i.e., 60 percent of the remaining 40 percent), 10 percent the third quarter (i.e., 60 percent of the remaining 16 percent) and so forth.

In the final chapter, key findings are summarised, future research identified and limitations of this research are discussed. Combined they reinforce Gregory's (2011) conclusions that further research is needed to further explore the relationship between a price-driven export boom and the manufacturing sector. Similarly Hambur and Norman (2013) examine industry-specific impacts of the Australian mineral export price boom and conclude that care should be taken when examining aggregated sectors as there may be differing impacts at a disaggregated level within the Australian economy. There are gaps in analysis in the first two findings from this project that would all merit additional detailed investigation in their own right, and which were beyond the scope of this project. For example future studies could include additional sectors such as agriculture, education, finance and insurance, both in their own right and also collectively. The key issue is that the majority of the previous research is macroeconomic in nature whereas detailed analysis would require more microeconomic investigation.

The realignment and interaction of sub sectors within the manufacturing sector is worthy of further investigation given this sector's contribution to both total employment, private capital expenditure and Australian GDP. This could include examining the realignment from more traditional manufacturing sub-categories towards resource-related manufacturing such as: (i) metal manufacture; (ii) chemical, rubber and petroleum; (iii) machinery and equipment; and (iv) food and beverage. All four sub-categories have a different reliance on capital and labour inputs, as well as different contribution to output (either as intermediate goods or final goods). Microeconomic analysis could also include geographic considerations.

The next chapter provides background to Dutch Disease literature and Australian exchange rate studies.

Chapter 2 Trade Theory and Dutch Disease

2.1 Introduction

International trade has always been an important component of the Australian economy. Kriesler (1995) suggested that since European settlement in 1788 the Australian economy has been dependent on the economic well-being of the rest of the world for its own economic health. Furthermore Australia has largely exported primary products, imported manufactured goods, and has been reliant on the importation of foreign labour and capital (Promfret, 1995). Australia has also run persistent current account deficits accompanied by capital account surpluses (Kearney, 1995).

Cashin and McDermott (2002) suggested that the dominance of a small number of primary products in the production and trade profiles of countries has long been an important factor in the development of economies. For example, the 19th Century Britannica colonial economies of Australia, Canada, New Zealand, South Africa and Argentina had several similarities, including a dependence on the importation of labour and capital, and an abundance of open grassland (with high available land-to-labour ratios) that resulted in a relatively narrow range of agricultural and mineral exports.

The 25 years after WWII have been classified by some as the Golden Age, when the world economy grew at an annual average rate of 5 percent per annum for the period 1950 to 1973, which was more than double the estimated annual average rate of 2.3 percent per annum for the 80 years to 1950. This steady growth was assisted by reconstruction after WWII, a shortage of housing and public infrastructure, and increased savings rates by business and consumers after the experiences of the Depression and WWII (MacFarlane, 2006).

In comparison, Australia under-performed against the world economy, as Australian growth did not match that of the OECD over the same period. In the Golden Age annual average Australian growth was 4.7 percent per annum (versus the OECD average of 5 percent), whilst for the 80 years prior to 1950 Australian average growth was 2.9 percent per annum (against that of the OECD of 2.3 percent). In addition, the performance of Australia in the Golden Age was probably overstated as much of the economic growth was related to population increase rather than per capita productivity (MacFarlane, 2006).

2.2 Recent Developments in Trade Theory

The collapse of the Bretton Woods Agreement in 1973 saw increased interest in international trade theory as economies responded to trade intensification, increased international capital mobility, deregulation of capital and financial markets, removal of trade barriers and more open economies.

Bullock *et al.* (1993) suggested that since 1960 international trade has grown approximately twice as fast as average GDP growth in OECD countries. This is reflected in the rise in exports as a proportion of GDP in most industrial countries, and this trend has continued since then. These factors have all contributed to recent key developments in trade theory over the last 30 years.

Traditional trade models assumed homogenous goods, constant returns to scale in production, consistent consumer preferences across countries, and perfect competition in markets. Recent models developed in response to these changes have included the Heckscher-Ohlin Theory (H-O), Dutch Disease, the Prebisch-Singer Hypothesis, as well as other models that have allowed for differences in productivity, factor-endowment, product differentiation, imperfect competition, regional trade arrangements and technological gains (Lindert, 1991; Bullock *et al.*, 1993; Krugman & Obstfeld, 1994; Leamer, 1995; Anderson, 1998; Van Berkum & Meijl, 2000; Salvatore, 2001).

Under the H-O theory a country will bias towards the production and export of a commodity which uses the factor in which it is most relatively endowed. For example, in Australia this implies the use of land for agriculture and mineral resources against low labour availability in general when compared to other economies. Similarly, Leamer (1995) added that each country will export the good made by the relatively intensive use of the country's abundant factor, and while the cost of production is endogenous, the relative price of such output should be cheaper than those of its trading competitors. The H-O theory is now more commonly utilised than earlier models that utilised finished goods (Lindert, 1991), and it contributes a component of the background to the analytical work in this thesis.

Most approaches to trade theory have focussed on the trade of goods. Inter-temporal considerations expand on the contribution of income within the wider current account balance. Obstfeld and Rogoff (1988) view the inter-temporal approach to the current account as the outcome of forward looking saving and investment decisions. If the current balance is negative (including income transactions) then this implies that additional foreign capital is required, which takes a future claim on domestic output/income. The inter-temporal approach bases the external financing decisions on the impact of current and future prices on savings and investment.

In Australia, inter-temporal issues have always been a consideration in trade given Australia's reliance on capital inflows to counter low domestic savings. Inter-temporal trade allows countries to concentrate on producing things they are good at, and use foreign savings to turn current output into future output (Bullock *et al*., 1993; Krugman & Obstfeld, 1994; Obstfeld & Rogoff, 1988). Clearly this aspect is a consideration to be included in the analytical work of this thesis.

Another aspect of trade theory that includes intertemporal aspects is the Prebisch-Singer hypothesis. It states that over time the price ratio of commodity to manufactured goods will fall, as demand for manufactured goods will increase at a faster rate than demand for primary commodities. Feenstra and Taylor (2008) suggest that this is largely due to different income elasticities of demand. They conclude that for a commodity economy such as Australia, the terms of trade should decline over time on the assumption that exports are predominantly commodity based and imports are predominantly manufacture based.

Grilli and Yang (1988) support this hypothesis, showing that the price of primary products relative to manufactures in international markets appears to have been on a long-run decline for a century or more. The most common explanation is that the demand for primary products, particularly food, is income and price inelastic.

Bleaney and Greenaway (1993) also examined the long-term ratio of primary product prices to manufactured goods prices, and concluded there was a long-run decline of 0.7 percent per annum. However, they also concluded that price instability in commodity prices is more important to policy makers than the decline in this ratio.

For a different reason, Anderson (1998) also questioned the relevance of the Prebisch-Singer hypothesis to Australia. He quotes an OECD report that shows a higher total rate of productivity growth in the 1970s and 1980s for agriculture than other sectors of the economy; for example, 2.6 percent for agriculture compared to 1.2 percent for industry. The positive impact of this productivity growth in primary production more than compensates for the negative terms of trade effect. (Anderson 1998).

In contrast, Gillitzer and Kearns (2005) questioned the Prebisch-Singer hypothesis more directly. By examining 135 years of terms of trade data, they showed that Australia has diversified into commodities with faster price growth. In effect, while theory suggests that the Australian terms of trade should experience a long-term decline, this study concluded that since the 1980s there had been a strong improvement.

An underlying reason for the strong price performance in primary commodity exports is that Australian mining exporters have greater market power as well as greater scope for continual productivity increases. Another suggestion is that the improvement in the terms of trade is due to a fall in Australia's import prices relative to world manufactures prices since the mid-1980s. This could be due to compositional differences between goods imported into Australia and the goods utilised in the world manufactures price index.

Hence, at first glance, the Prebisch-Singer hypothesis would seem to be relevant to Australia, given that the hypothesis is linked closely with the composition of the Australian traded sector, that is, an export sector dominated by primary agricultural and mineral commodities and an import sector that is dominated by manufactured goods imports. However, the evidence for Australian exports and imports, particularly in recent years, is far from supportive of the Prebisch-Singer hypothesis.

In an Australian context Gregory's (1976) seminal work examined the then growing role of the mineral sector. This work was released as the mineral sector was expanding rapidly and concluded that this new sector was influencing the price ratio between traded and non-traded goods and crowding out established export sectors, as evidenced by the relative decline in manufacturing output and employment (Gregory 2011).

Despite the policy focus on an across-the-board tariff cut, Gregory (1976) still provided some useful analysis of the impact of a booming export sector. He concluded that that an emerging new (mineral) export sector triggers a fall in the quantity of exports from the existing export sector and that the quantity of imports will increase at the expense of the import-competing sector. He also concluded that the new (mineral) export sector will encounter an under-realisation of expectations if those expectations are based on the old price ratio.

The model utilised by Gregory (1976) embedded the small country assumption and examined the effect of relative prices on the supply of exports and the demand for imports. International traded export and import prices were utilised relative to the price of non-traded goods. The model "*abstracts from terms of trade effects"* (Gregory 1976, p. 73). That is, the terms of trade are assumed fixed. Key assumptions included a flexible exchange rate, non-sticky domestic prices, and labour mobility. The actual impact of the emergence of a new export sector will also not be uniformly distributed through the economy or through time as in Gregory's model.

Gregory (2011) reflected at the time of a major anniversary of the seminal 1976 work and provided an updated approach based on a world-price driven booming export sector. The author indicates that while traditionally previous Australian commodity-price booms tended to be short-lived (e.g., 1972-73, 1988-89), the recent mineral price boom had been more persistent in duration and magnitude than previous export price booms, and as such the impact of this in the economy also needs to be examined in as much detail as a sustained volume-driven boom would have been in the past.

He suggested that the recent mineral boom will see greater resource-reallocation effects than in 1976, but it will be more dispersed across different sub-sectors, including within the service sector and perhaps also affect the ratio of full-time and part-time employees (Gregory 2011).

The purpose of the 2011 paper was to examine the impact on Australian living standards from increased terms of trade and the relevance of measuring these changes. It concluded that export price increases have had their largest impact on import volumes and little impact on export volumes. As detailed next this is consistent with the spending effect within Dutch Disease theory. It is interesting to note that while the original intention of Gregory (1976) was to use a booming export sector as a proxy for possible tariff change implications, the model and conclusions have relevance in the Australian context today. While never directly attributed, it is also reasonable to assume that this model was a key building block in the development and emergence of Dutch Disease theory.

Seminal work on Dutch Disease by Corden and Neary (1982) provided a systematic analysis of structural change in an open economy; in particular examining the issue of the co-existence and interaction of booming and lagging sub-sectors within the traded goods sector. It highlighted that (at the time) the majority of booming traded sectors related to extracted goods (e.g. minerals in Australia, natural gas in the Netherlands and oil in the United Kingdom, Norway and some members of OPEC) at the expense of the traditional manufacturing sector. It is this *de-industrialisation* that is the key focus of Dutch Disease.

The focus of the paper was the medium-term impact on resource allocation and income distribution. The use of real values rather than nominal values allowed analysis to ignore monetary considerations. The model assumed a small open economy that produced two traded goods (a booming good (energy) and a lagging good (manufactures)) and a third non-traded good (services).

Trade was balanced overall and relative prices were utilised such that national income and expenditure were equal. Real wages were flexible and full employment maintained, although there were no allowances for the role of geography, technology or urbanisation. Labour was mobile between sectors so as to equalise its wage in all three sectors. All factors were internationally immobile. Terms of trade were given such that the relative price of the two traded goods was constant, although the real exchange rate was flexible (price of traded goods to non-traded goods).

There were two distinct effects of the boom – a resource movement effect and a spending effect. The resource movement effect was where the booming energy sector raised the marginal product of the mobile factors employed which drew labour and capital from other sectors (i.e. the lagging and the non-traded sectors). The spending effect was where higher real income from the booming sector led to additional domestic spending in the non-traded sector which raised the price of these goods and produced a real exchange rate appreciation. It also saw increased demand for mobile factors within the non-traded sector and away from the lagging traded sector. If the booming sector used few resources then the resource movement effect would be negligible and the major impact of the boom was through the spending effect (Corden & Neary 1982).

Corden and Neary (1982) also concluded that while the specific factor return in manufacturing must decline in absolute terms, it didn't have to fall relative to the same factor returns in other sectors. For example if the share of labour in the value of manufacturing output was smaller than in other sectors, then a given wage rise reduced the profitability of manufacturing by less than it reduced profitability in the non-traded sector. Alternatively if manufacturing was more capital-intensive than the energy sector and the spending effect dominated, it is possible that manufacturing profitability could fall by less than the booming sector. These raise the issue as to whether the boom necessarily leads to automatic de-industrialisation.

Corden and Neary's (1982) underlying model assumes that the boom in energy was triggered by an exogenous technological improvement. If instead the trigger was exogenous foreign capital inflow into the energy sector then the changes in the resource effect are considered the same as for a technological improvement, but if this additional income from the booming energy sector is repatriated then the spending effect is diluted.

They also concluded that an increase in booming energy prices would have the same resource effect as for a technological improvement. However the spending effect may not be the same as energy prices impact national income differently from technology changes.

An important consideration from Corden (1984) is the paradox where the two traded goods could utilise different combinations of labour and capital factors. This is a mini HO economy. If the lagging sector was capital intensive it may be that this sector increases output under the resource movement effect.

The lagging sector could also be decomposed into several industries with the impact dependent on factor utilisation and mobility between the disaggregated sectors. Another variation was where the lagging sector produces both import-competing goods as well as exportable goods. This sector would become more capital intensive as labour moved into the booming sector and some de-industrialisation occurred as output fell. However the spending effect would see demand for its outputs increase. Assuming constant prices, demand for lagging-sector goods would increase due to the spending effect (Corden 1984). This is relevant to the Australian context as the booming sector could include several resource commodities that boom at different times, as well as manufacturing, agricultural and service sectors that have both traded and non-traded components.

Lindert (1991) summarised Dutch disease as a potential economic condition where new (or increased) natural resource exports first erode the profits and production in the traded manufactured/other export goods sector. This is due to resources, labour and capital being transferred to the booming mineral sector from the manufactured lagging sector. An increase in exports from the resource sector also leads to an appreciation of the exchange rate which reduces the competitiveness (and overseas demand) for these other (manufactured) exports, thereby exacerbating the decline in the non-boom export sector.

Fardmanesh (1991) observed a number of the effects predicted by Dutch Disease Theory. As incomes increased in the resource sector there was an increase in demand for non-traded goods and demand for additional labour which was transferred from the non-resource export sector to the non-traded goods sector. The demand for non-traded goods could lead to a price increase in non-traded goods and further appreciation in the real exchange rate. However there were several oil-related developing countries during the 1970s, in which the lagging (manufacturing) sector expanded while the agricultural sector declined.

A common theme of the majority of Dutch Disease analyses was their focus on developing economies and the conclusion that the overall development within that economy is not always maximised (Davis 1995). In particular this relates to per-capita economic growth, where there was under-performance when compared to like economies of similar size and level of economic development, but without a booming resource export sector.

Davis (1995) highlighted that these studies were mainly in relation to oil-producing economies from the oil price boom in the 1970s, where price volatility may have impacted the subsequent reallocation of resources as it created fluctuating export and fiscal revenues. This paper expanded previous studies by looking at a wider group of economies. Davis (1995) also provided a narrative around the perception that mineral development was less favoured as a lever for economic development when compared to agriculture and manufacturing. In particular mineral development was more “explosive” whereas sustained development would come from these other sectors.

Davis (1995) also suggested that Dutch Disease and the resource curse are two different things. Manufacturing is often protected and the impact of Dutch Disease is more likely to be seen through a booming government sector and reduced role of the agricultural sector. Using empirical analysis of 91 developing countries over the period 1970 to 1991, it was found that mineral dependent economies performed well when compared against other economies.

McKissack *et al*. (2008) concluded that the response of the Australian economy to recent export price rises matched the Gregory thesis, although manufacturing over-performed against expectations due to its role in mining development. Other traded sectors did not contract as much as expected either.

They also attempted to link the Gregory effect/Dutch Disease and the terms of trade by suggesting that previous booms in Australian terms of trade had been temporary and led to economic instability. However, they assumed that the current mineral price boom was more enduring and will lead to ongoing structural change. The study examined the impact of a sustained boom on the labour market, selected industry sectors and regional implications. It concluded that as at 2008 the impact of the resource boom and higher real exchange rate had not impacted the remaining traded sector as expected, as the booming sector had been able to utilise under-employed production factors (McKissack *et al.* 2008).

Ismail (2010) tested for the impact on manufacturing sectors from permanent oil-price shocks over the period 1977 to 2004 across 90 countries. They found that there is a negative impact on the respective manufacturing sectors as predicted by Dutch Disease, and that the impact is greater in those economies with more open capital markets. However higher capital-intensive manufacturing sectors are less impacted and also become more capital intensive over time, and the relative factor price of labour to capital appreciates. All these effects seem to have parallels in the Australian situation.

Ismail (2010) also suggested that the booming resource sector resulted in shrinking non-resource tradeable goods, which saw the economy more specialised and thus more vulnerable to resource-specific shocks. Fiscal policy can mitigate the impact of Dutch Disease by decreasing the amount of windfall spent on non-tradeable services, foreign investment and imports. Increased immigration can also offset the labour factor pressures on non-traded and lagged export sectors. The author also suggested that utilising aggregated manufacturing data can provide misleading results as it doesn’t take into account relative factor intensities at the disaggregated level. Again this seems relevant to analysing the Australian situation.

Beine *et al*. (2012) examined Dutch Disease in a Canadian context, and sought to distinguish between the impact of increased oil production between Canadian dollar appreciation and underlying United States dollar depreciation due to other factors. They also disentangled the impact on the Canadian manufacturing sector into wider manufacturing sector evolution (i.e. being felt by all manufacturing sectors worldwide) and that in response to the booming Canadian oil sector.

While not directly linked with Gregory (2011), it does again raise the issue of underlying structural change, previous structural change, and the longer-term evolution of the economy. The empirical analysis undertaken by Beine *et al.* (2012) is covered in detail in Chapter 5 Methods.

Thompson *et al.* (2012) suggested that since 1970 the Australian terms of trade have risen some 30 percent, of which 20 percent is related to export price increases (mainly mineral commodity export prices) and 10 percent related to import price falls. The authors also suggest that any attempt to prevent a resource reallocation would be very expensive as it would require the economy to forgo part of the increased domestic demand. They also conclude that should the booming export prices ever ultimately fall, then subsequent exchange rate depreciation would see import prices increase and resources reallocated towards other export and import-competing industries.

Hambur and Norman (2013) contend that to date most analysis on Dutch Disease in an Australian context has been theoretically based with either minimal empirical work or the empirical work based on aggregated data in shorter time frames. Their study confirmed mixed evidence that the price-led mining boom was having a negative impact on the manufacturing sector and that these conflicting results were more evident when examining disaggregated data. A conclusion from this is a possible a two-speed economy, which is consistent with previous commentary from Gregory (2011) on the impact at a disaggregated level. They utilised a VAR approach to test the level of de-industrialisation while allowing for differing responses in each sub-sector.

Hambur and Norman (2013) also provide a succinct summary of the development of Dutch Disease theory with supporting background. While beyond the scope of this project they introduce the notion of the "resource curse thesis" through the work of Sachs and Warner (1995), Mikesell (1997), Devlin and Lewin (2005) and Iimi (2007). Dutch Disease is one component of this, namely where a booming resource export sector affects the wider economy's structure and economic growth.

They also provide background on the development of empirical work measuring Dutch Disease and this is covered in Chapter 5 Methods.

2.3 Discussion

The impact of a booming export mineral sector on the Australian economy remains an important consideration given the potential structural changes that could eventuate in the non-traded, import and non-mineral export sectors. While Dutch Disease theory is widely known and has been covered in detail by authors such as Corden and Neary (1982), Corden (1984), Jones and Neary (1985), Fardmanesh (1991), Davis (1995) and Sachs and Warner (2001), there have been fewer empirical studies completed in an Australian context. Hambur and Norman (2013) provide a good summary of previous Dutch Disease studies across several countries, which includes Norway, the UK, the Netherlands, Russia and Colombia and highlight that empirical analysis in an Australian context is not extensive. Beine *et al.* (2012) examine Dutch Disease in a Canadian context, which has some features in common with Australia.

Furthermore there are differences in approaches in what constitutes Dutch Disease and the impact it has on the economy in question. Corden and Neary (1982) detail the expected deindustrialisation of the traded manufacturing sector from a booming energy sector, while the net impact on the non-traded sector is dependent on the offset between the initial resource effect and the subsequent spending effect from increased national income. However the roles of relative factor intensities as well as mixed sectors (that comprise both traded and non-traded components) have been raised by Gregory (1976; 2011), Corden and Neary (1982), Corden (1984), Fardmanesh (1991) and Davis (1995).

Finally Gregory (2011) also suggested that the impact of the then current mineral price boom may not have been as great as expected as significant factor reallocation may have taken place in response to the earlier mineral booms and wider economic restructuring from deregulation.

2.4 Summary

In summary, the expected effect of a booming mineral export sector is de-industrialisation of the traded manufacturing sector. The extent of the effect may be dependent on the initial source of the mineral boom: technical change, new commodity reserves or an increase in world prices. Some reasons why such de-industrialisation may not occur to the extent expected include that the resource effect is small, possibly with the booming sector employing underutilised resources; that there is high capital intensity in some sub-sectors of manufacturing (and movement of relative factor prices may induce further intensity); and that some sub-sectors of manufacturing may be strongly linked to the mineral export sector. The next chapter seeks to examine important elements of the Australian economy in response to these issues.

Chapter 3 Structural Change in the Australian Economy

3.1 Introduction

The previous chapter detailed recent literature on expected structural change in an economy in response to a booming mineral export sector. The chapter concluded that these responses can vary depending on the composition of factors within the traded and non-traded sectors of the economy – both at the aggregate and disaggregate level. Similarly the response may also vary depending on the initial trigger of the booming sector; namely an improvement in technology, new commodity reserves, and / or an increase in the world price.

This chapter examines the Australian economy and traded sectors since the 1980s and identifies possible structural change that has emerged that is consistent with the theory discussed in Chapter 2. The next section introduces the Australian economy including an overview of the contribution of various sectors of the economy to real GDP, total Australian employment and real private capital expenditure. This is followed by an overview of the traded sector and current account balance. The chapter concludes with some observations that are developed into the underlying hypotheses of this dissertation.

3.2 An Overview of the Australian Economy circa 1980s

Cashin and McDermott (2002) suggested that the dominance of a small number of primary products in the production and trade profiles of countries has long been an important factor in the development of economies. For example, the 19th Century

Britannica colonial economies of Australia, Canada, New Zealand, South Africa and Argentina had several similarities, including a dependence on the importation of labour and capital, and an abundance of open grassland (with high land-to-labour ratios) that resulted in a relatively narrow range of agricultural and mineral exports.

Pomfret (1995) reinforced this view stating that Australia has always largely exported primary products, imported manufactured goods, and has been reliant on the importation of foreign labour and capital. Kearney (1995) concluded that Australia has traditionally been a capital importing country, which has run persistent current account deficits accompanied by capital account surpluses.

Mineral resource production has been active, in one form or another, since coal production commenced in 1804 in New South Wales (NSW). From its first discovery in the 1850s, gold was the dominant mineral industry that saw increased export earnings and increased capital investment from Britain into both public (i.e., rail, road, and harbour infrastructure) and private industry (Butlin 1987). In effect even in the lead up to Federation in 1901, Australia was an economy that was largely reliant on two major primary commodities – principally wool and gold. It largely exported these commodities and imported labour, capital and manufactured goods.

As detailed in Chapter 2, the 25 years after WWII have been classified as the Golden Age (MacFarlane 2006). He also suggested that the Golden Age was sustained due to continual low unemployment rates and minimal inflation. The long-term absence of inflation saw macroeconomic policy largely focussed on maintaining high levels of employment within the Australian economy. At that time, economic managers considered that small rises in inflation were an acceptable trade-off to reduce unemployment. However, at the same time Australia's traded sector and wider economy were highly regulated and utilised policies such as tariffs, quotas and price measures to protect import-competing firms (Thompson *et al*., 2012).

A catalyst for the end of the Golden Age and the catalyst of structural changes in the world and Australian economy was the collapse of the Bretton Woods Agreement in 1973. Oil price shocks of the early 1980s resulted in high world inflation rates that exceeded the acceptable levels under the Bretton Woods Agreement (Bullock *et al.*, 1993). . One benefit of the large increase in oil prices (and by nature other energy commodities) and high inflation rates in the 1970s was that the mineral sector (and thus exports) in Australia were stimulated with the assistance of Japanese exploration, as Japan sought to establish more secure energy sources (Anderson 1995).

The International Monetary Fund (IMF 2005) showed that growth in Australia was uneven in the 1970s, unemployment had risen and inflation had become entrenched at low double digit rates. Highly centralised wage setting added to wage pressures as wage rises in one sector were translated to other parts of the economy, reducing relative wage flexibility and increasing the inflationary impact of shocks.

Similar to the IMF (2005) are comments by Clark (1995), who highlighted the ineffectiveness of monetary targeting, lack of productivity growth and an over-reliance on fiscal policy. These factors led to the change of policy focus to microeconomic reform in the 1980s, which sought to improve the efficiency of selected sectors, in particular the non-traded and import-competing sectors, as a reduction in tariff protection had opened the economy to external competition. Other microeconomic reforms included the commercialisation and privatisation of government business enterprises, along with reforms of the financial, communications, energy, and transportation sectors (IMF, 2005; Thompson *et al.*, 2012).

Along a similar line, MacFarlane (2006) highlighted other policy reforms directed towards improving efficiency including the deregulation of the financial sector that allowed a more efficient allocation of financial capital; a decoupling of fiscal and monetary policy; the float of the Australian dollar that assisted structural improvement of the economy through the free play of comparative advantage and increased international trade; reduced government protection of inefficient industries; and reduced government ownership of major firms and enterprises. Thompson *et al.* (2012) also highlighted the importance of the deregulation of the exchange rate as a catalyst for wider economic reform.

In summary since European settlement, the Australian economy has been reliant on a handful of primary commodities for export and has imported manufactured goods and capital. The late 1970s and early 1980s were a period of great change triggered by world inflation, the collapse of the Bretton Woods Agreement, deregulation of markets and increased trade openness.

3.3 Sectoral Contribution in the Australian Economy

The previous section provided background on several factors that were impacting the Australian economy in the 1970s and 1980s. This section examines changes at a sectoral level within the wider economy. Table 3.1 summarises the contributions of agriculture, mining and manufacturing to real Australian GDP since 1982/83. Clearly agriculture and manufacturing have declined as a proportion of real GDP, while mining has expanded.

Table 3.1

Agriculture, Mining and Manufacturing Sectors as Proportion of Real Australian GDP from 1982/83 to 2010/11

	1982/83[a] (%)	1987/88[b] (%)	1992/93[c] (%)	1997/98[d] (%)	2002/03[e] (%)	2006/07[f] (%)	2010/11[f] (%)
Agriculture	3.0	4.5	4.0	3.0	2.0	1.0	2.1
Mining	3.5	4.5	5.0	4.0	6.9	7.2	7.3
Manufacturing	23.0	26.0	23.0	20.0	9.1	9.0	8.2
Three Sectors	29.5	35.0	32.0	27.0	18.0	17.2	17.6

Source: a: ABS (1985, p558); b: ABS (1989, p775); c: ABS (1996, p 685), d: ABS (1999, p 750), e: ABS (2005, p 834), f: ABS 5206 National Income, Expenditure and Product

An important insight concerns the contribution of the manufacturing sector to real Australian GDP. Table 3.1 suggests that the contribution is now only approximately one-third (i.e. in 2010/11) of the sector's contribution in 1982/83. There may also be some form of structural break in the economy between 1997/98 and 2002/03. During this five-year period there were significant changes to both the contribution of mining and manufacturing to real Australian GDP. This structural break coincides with the last peak in the traded goods and services balance and a structural break in the net income balance as discussed in relation to Figure 3.1. Further discussion on this is provided in Chapter 5. Notwithstanding this, it is noted that the total contribution of agriculture, mining and manufacturing to real Australian GDP was 17.6 percent in 2010/11, which is in line with the contribution recorded in 2002/03 and approximately one half of the peak of 35 percent recorded in 1987/88.

Table 3.2 highlights the contribution of other sectors to real Australian GDP. While data for 1982/83 are not provided, the summary suggests that there are several sectors that contribute to real Australian GDP in a similar manner to each other, with no particular sector dominating. It is likely that there are linkages between the various sectors, for example, mining-based activities may be included in construction and finance and insurance, while manufacturing is also linked with both retail and wholesale trade.

Table 3.2

Selected Sectors as Proportion of Real Australian GDP from 1993/94 to 2010/11

	1993/94[a] (%)	2002/03[b] (%)	2010/11[c] (%)
Retail Trade	5.0	3.5	4.5
Wholesale Trade	4.7	3.5	4.2
Construction	5.5	4.1	7.7
Finance & Insurance	7.0	5.2	9.7
Professional & Technical Services	8.8	7.2	6.6
Ownership Dwellings	8.4	5.8	8.0
Total	39.4	29.3	40.7

Source: a: ABS (1996, p 685); b: ABS (2005, p 834): c: ABS 5206 National Income, Expenditure and Product

Comparison of Tables 3.1 and 3.2 show that in 2010/11 Finance and Insurance was the largest single contributor to real Australian GDP at 9.7 percent. Grouped together around a 7 – 8 percent contribution are Manufacturing (8.2 percent), Ownership Dwellings (8.0 percent), Construction (7.7 percent), Mining (7.3 percent) and Professional & Technical Services (6.6 percent). The total contribution of agriculture is not as substantial, at 2.1 percent.

As per Table 3.1 and Table 3.7, the growth in the mineral export sector has seen large increases in the contribution to total exports. However, while the contribution to Australian GDP has also increased, the overall contribution of the mining (mineral) sector in 2010/11 is only approximately seven per cent, and in line with the contribution of the manufacturing, finance and construction sectors to Australian GDP. Thus, while it dominates total exports, if measured by GDP it is largely in line with a number of other sectors of the economy.

3.4 Sectoral Contribution to Total Australian Employment

The contribution of various sectors to the wider economy can also be examined through their relative contribution to total employment. As suggested in Chapter 2, this is of particular use as any response to structural change within an economy from a booming sector is often transmitted through the relative demand for labour. Table 3.3 summarises the three key exports sectors from an employment perspective.

Table 3.3

Sectoral Contribution of Agriculture, Mining and Manufacturing to Total Australian Employment from 1982/83 to 2010/11

	1982/83 (%)	1987/88 (%)	1992/93 (%)	1997/98 (%)	2002/03 (%)	2006/07 (%)	2010/11 (%)
Agriculture	5.9	5.2	4.7	4.5	3.4	2.9	2.7
Mining	1.5	1.4	1.1	1.0	0.9	1.3	1.8
Manufacturing	18.4	16.1	14.3	13.3	12.0	9.8	8.7
Other	74.2	77.3	79.9	81.2	83.7	86.0	86.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: ABS 6291 Labour Force Statistics

The agricultural sector now contributes to total employment less than half of its contribution in 1982/83. As will be seen later in this chapter this is consistent with the results evidenced in contribution to total exports and Australian GDP.

The contribution of manufacturing to total employment is also less than half of its 1982/83 contribution, which is consistent with its relative contribution to Australian GDP over the same period. While mining has seen an increase in contribution to Australian GDP, it still only represents less than two per cent of total employment.

While there have been some movements in contribution of employment within the agricultural, mining, and manufacturing sectors, it is noted that some 86.8 percent of Australian employment is domiciled in other sectors.

In short the relative contributions of agriculture and manufacturing to total employment have decreased, while the relative contribution of mining has increased, but is still less than two percent of total employment. This increase is not commensurate with its relative increase in contribution to real Australian GDP, and suggests substantial productivity growth in this sector. Some of the changes, such as a transfer of labour from manufacturing to the non-traded sector, are supportive of Dutch Disease theory, and some, such as the small change in employment in the mining sector, are not.

3.5 Sectoral Contribution to Real Private Capital Expenditure

It is also important to consider the changes in real private real capital expenditure related to structural change in the economy. Table 3.4 examines the relative contributions of key sectors to total private capital expenditure (capex). Public Administration and Education are not included given their expenditure is considered public expenditure.

Private capital expenditure in mining has been variable since 1987/88, but increased significantly since 2002/03. In contrast manufacturing capex has decreased since 1992/93. Substantial proportional decreases are seen in Finance & Insurance and Wholesale Trade.

Table 3.4

Sectoral Contribution of Selected Industries to Total Australian Real Annual Private Capital Expenditure from 1987/88 to 2010/11

	1987/88 (%)	1992/93 (%)	1997/98 (%)	2002/03 (%)	2006/07 (%)	2010/11 (%)
Mining	14.8	20.4	22.6	16.3	27.0	39.3
Manufacturing	25.0	26.7	20.7	18.7	13.8	10.3
Retail Trade	5.3	5.6	4.8	5.4	4.7	3.5
Wholesale Trade	6.4	7.6	5.8	3.9	3.4	2.7
Construction	5.4	5.1	3.9	4.4	3.8	4.6
Finance & Insurance	9.8	8.0	5.3	5.4	4.1	2.4
Professional & Technical	4.3	4.9	5.6	4.3	3.8	3.1
Other	29.0	21.7	31.3	41.6	39.4	34.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: ABS 5206 National Income, Expenditure and Product

At first glance the decrease in real manufacturing capex is commensurate with the declines in its relative contribution to real Australian GDP and total Australian employment. Similarly the increase in mining capex is commensurate with the increase in its contribution to real Australian GDP, albeit with the impact of employment not as great. This will be discussed later in this chapter. Suffice it to say here that these labour and capital expenditure trends are indicative of an increasing capital-to-labour ratio in the mining sector.

Figure 3.1 further highlights the relative movements of mining and manufacturing capex over the same time period. It shows more clearly the movements in the respective relative contributions of mining and manufacturing to Total Real Quarterly Private Capital Expenditure over the period 1987 to 2011. For the majority of the period from June 1987 to October 2003, total quarterly manufacturing capex was higher than that of mining capex. However since that time mining capex has increased at such a rate that it comprised around 42 percent of total private capex in June 2011. This is nearly three times its contribution in June 1987, and double its contribution since October 2003. In contrast manufacturing capex comprised only 10 percent of total capex in June 2011, that is, half of its contribution in October 2003 and much lower than the 25 percent contribution for most of the 1990s. These observations are supportive of Dutch Disease theory.

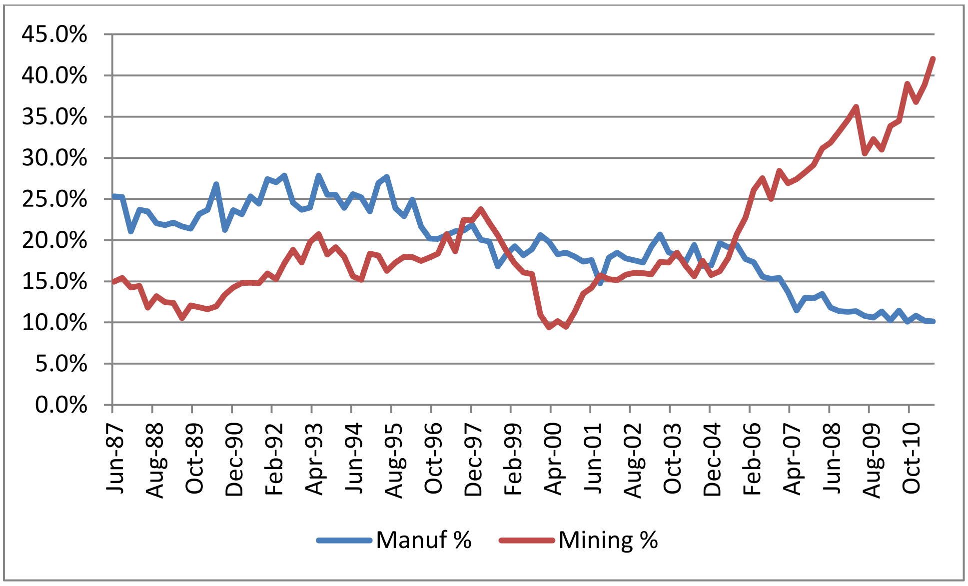

Figure 3.1. Relative Contribution to Real Quarterly Private Capital Expenditure from June 1987 to June 2011. (Data Source: ABS 5206.03 Australian National Accounts)

3.6. Role of the Traded Sector

Microeconomic reform delivered a substantial fall in protection of the domestic economy in the 1980s, and this is another factor responsible for a rising trade share in GDP over that time at the expense of the non-traded sector (Gruen & Shuetrim, 1994). The following analysis highlights the key structural changes within the Australian traded sector.

3.6.1 Role of the Traded Sector within the Economy

A common measure of the role of trade in an economy is that of trade intensity (i.e., total exports plus total imports as a percentage of GDP). Trade intensity measures that total influence of traded sector to an economy. In contrast the balance of trade nets the two sectors against each other to estimate the net value flow to the economy. Traditionally this figure has been low in Australia. However, the Productivity Commission (2005) suggests that Australia's trade intensity rose from 20 percent in the mid-1980s to around 40 percent by 2010/11. Table 3.5 supports this and also shows that more recently the traded sector has remained largely around 40 percent of Australian GDP.

Trade intensity nearly tripled in size from 1983/84 to 2010/11, that is, from 14.1 percent of real Australian GDP to 40.3 percent. The real traded sector (as represented by import values plus export chain volume measures) has increased 5.36 times in volume terms from 1983/84 to 2010/11. Within the traded sector exports have increased 4.28 times and imports 6.97 times over the corresponding period. In contrast real Australian GDP has increased 2.45 times. While this is still strong in its own right, the higher relative growth of the traded sector would suggest there has been some underlying structural change in the Australian economy, and that the economy is more open, with the traded sector now being an important factor.

Table 3.5

Real Australian Trade as a Proportion of Real Australian GDP from 1983/84 to 2010/11

$A m Chain Volume	1983/84	1988/89	1993/94	1998/99	2003/04	2008/09	2010/11
Total Real Exports	65,260	94,261	141,297	191,913	229,395	266,095	279,772
Total Real Imports	(44,088)	(67,909)	(80,011)	(123,211)	(177,563)	(261,838)	(307,251)
Total Real Trade	109,348	162,170	221,308	315,124	406,951	527,933	587,023
Real Aust. GDP	595,297	735,082	824,044	1,014,357	1,197,295	1,394,226	1,456,210
Total Trade as % GDP	14.1	22.0	26.8	31.0	33.9	37.9	40.3

Source: ABS 5206 National Income, Expenditure and Product.

Another consideration is the net trade balance. Table 3.5 highlights the summation of export and imports as a measure of trade intensity within the economy. However, the net balance (i.e., exports less imports) shows that until 2010/11, exports were greater than imports in each five-year period. There should be care in making more detailed conclusions at this stage given the structured five-year time period utilised. The annual balance is discussed below in Section 3.6.4.

3.6.2 Traded Goods

Parallel to the increasing role of the traded sector is the underlying composition of export and import goods. Table 3.6 highlights the top 10 export and import goods for 2010/11.

Table 3.6

Australia's Top 10 Exports and Imports Goods as a Proportion of Real Total Exports and Real Total Imports Respectively for 2010/11

Exports	%	Imports	%
Iron Ore	19.7	Petroleum (i)	11.2
Coal	14.8	Passenger Vehicles	5.3
Gold	4.8	Pharmaceuticals	3.0
Petroleum (i)	4.6	Telecom Equipment	2.9
Natural Gas (LNG)	3.5	Computers	2.4
Aluminium (ii)	3.4	Transport Vehicles	2.0
Copper	3.1	Gold	1.8
Wheat	1.9	Engineering Equip.	1.2
Beef	1.5	Furniture	1.0
Pharmaceuticals	1.1	Tools - Measuring / Analysing	1.0
	58.4		31.8

Source: DFAT (2011, p23-24)
(i) Includes crude petroleum and refined petroleum
(ii) Includes aluminium, alumina, and related ores

The export sector is dominated by the top 10 export commodities, which comprise some 58 percent of total exports. In contrast, the top 10 imports only comprise 32 percent of total imports. Furthermore the first 7 of the top 10 export goods are resource sector commodities, while the next two export goods are agricultural commodities.

The composition of the top ten export and import goods have not significantly changed over the last few years. However, there have been some changes in their underlying value and subsequent ranking. A key issue is that the total contribution of the top ten exports has increased from 40.3 percent in 2006/07 to 58.4 percent in 2010/11. In contrast, the contribution of the top ten import goods is largely unchanged.

In addition to this increase in the overall contribution of the top ten exports there have been some minor changes in their individual contribution and ranking. For example, in 2006/07 coal was the largest export good comprising 9.5 percent of total exports (versus 14.8 percent in 2010/11). Iron ore was the second highest with 7.5 percent of total exports (versus 19.7 percent in 2010/11). Gold is largely unchanged in percentage terms, while both natural gas and petroleum have increased their contribution (from 2.3 percent and 3.6 percent respectively). In contrast the ranking and contribution of the top ten import goods is largely unchanged over the same period.

Also shown in Table 3.6 is that exports are dominated by commodity-based goods while imports are dominated by manufactured goods, except for gold and petroleum. In effect, Australia exports one group of goods and imports another separate group. While there are some examples of intra-industry trade (e.g., import, value add and then export of the good), this is only in limited circumstances and largely related to local and smaller trading partners. This is consistent with the earlier observation that Australia has always relied on a few primary commodity exports and has imported manufactured goods and capital.

In summary Australia has an inter-industry traded sector, with largely commodity-based exports and largely manufactured imports. This is an important consideration. It has important linkages to the theory included in Chapter 2 related to the Prebisch-Singer Hypothesis and Dutch Disease.

3.6.3 Sectoral Composition of the Export Sector

The growing contribution of resource commodities to total exports has implications on other export sectors and within the wider economy. Table 3.7 provides an overview of the relative contribution of the key sectors within the Australian export sector.

From the previous discussion the relative contribution of resource exports significantly increased over the last four years, increasing from 37 percent to 56 percent. Over the same period agriculture has remained steady at around 10 percent, although about half of its contribution as at 1982/83. Surprisingly, service exports while lower over the four years to 2010/11, still broadly contribute to total exports at levels similar to those in 1982/83.

Manufacturing exports have decreased their contribution from 20 percent to 14 percent over this four-year period to be broadly in line with their contribution in 1982/83. In effect the relative contribution of manufacturing exports to total exports is unchanged compared to declines in the manufacturing sector's contribution to real Australian GDP, total employment and real Private Capital Expenditure.

Table 3.7

Sectoral Composition of Real Australian Total Exports from 1982/83 to 2010/11

	1982/83[a] (%)	1987/88[b] (%)	1992/93[c] (%)	1997/98[d] (%)	2002/03[e] (%)	2006/07[f] (%)	2010/11[f] (%)
Agriculture	18	20	21	20	18	10	9
Mining	39	39	39	36	37	37	56
Total Commodities	57	59	60	56	55	47	66
Manufacturing	13	12	12	20	22	20	14
Services	17	19	22	22	21	22	18
Other Goods	13	10	2	2	2	11	2
Total	100	100	100	100	100	100	100

Source: a: ABS (1985, p 834); b: ABS (1989, p 775); c: ABS (1996, p685); d: ABS (1999, p 750); e: ABS (2005, p 834); f: ABS 5368 International Trade in Goods and Services

In contrast the increase in the contribution of mining exports to total exports is consistent with the increase in the sector's contribution to real Australian GDP and Private Capital Expenditure. It is noted that the levels of contributions significantly differ, namely 56 percent of total exports, 7 percent of real Australian GDP, less than 2 percent of total employment and 39 percent of real Private Capital Expenditure.

3.7 The Increasing Role of the Income Balance

As detailed in Chapter 2, the Australia economy has always been reliant on foreign capital inflows to expand investment. As shown above, the last 30 years has seen the role of trade increase within the Australian economy, associated with the lowering of import tariffs and encouragement of foreign investment.

The impact of this is evidenced in Table 3.8, which summarises the contributions of the goods and services balance, the trade balance and the income balance to the overall current account balance. Income balance is the balance of financial-related transactions in current account balance. It covers transactions such as interest payments, dividends, and other monetary-related transactions. Furthermore, a comparison of the size of the current account balance against Australian GDP is also provided.

Table 3.8

Breakdown of the Real Current Account Balance and Real Current Account as a Proportion of Real GDP from 1983/94 to 2010/11

$m	1983/84[a]	1988/89[b]	1993/94[c]	1998/99[d]	2003/04[e]	2006/07[f]	2010/11[f]
Goods Balance		-5,397	-503	-13,528	-20,489	-11,040	19,609
Services Balance		-3,505	-2,196	-2,137	429	1,414	-4,805
Trade Balance	-6,023	-8,902	-2,699	-15,665	-20,060	-9,626	14,804
Income Balance	-7,520	-14,179	-15,345	-18,076	-20,585	-37,400	-38,328
Total Current Account	-13,543	-23,081	-18,044	-33,741	-40,645	-47,026	-23,524
Income Balance % CAD	56	61	85	54	51	80	163
Current Account % GDP	-1.6	-3.3	-2.7	-4.4	-5.3	-4.7	-2.4

Source: a: ABS (1985, p 579); b: ABS (1989, p 789); c: ABS (1996, p 665); d: ABS (1999, p 718); e: ABS (2005, p 819); f: ABS 5302 Balance of Payments and International Investment Position

As shown in Table 3.5 Australian trade intensity has increased approximately three-fold, from 14 percent in 1983/84 to around 40 percent in 2010/11, and at that same time real Australian GDP only increased 2.45 times.

However, as per Table 3.8 the underlying trade balance has recorded a recent surplus balance after sustained deficit balances. However, the income balance has consistently recorded a deficit balance (i.e., more income related transfers being paid than being received). The net deficit in the income balance has more than offset the variability in the traded goods and services balance. This is highlighted in the relatively high contribution of the income balance as a percentage of the current account balance. The size of the current account balance as a percentage of real Australian GDP has remained around three to five percent.

One key highlight of Table 3.8 is the increasing contribution of the income balance to the current account balance. While recording a contribution of 56 percent in 1983/84 the income balance reduced to around 50 percent until 2006/07, since which time it has progressively increased.

Figure 3.2 highlights the trend for the annual Australian current account balance, and within that the contribution of the annual net traded goods and services balance and the annual net income balance. Since 1983/84 the annual deficit on net income balance has been increasing and in 2003/04 there seemed to be some form of structural break such that the deficit on income has been increasing more rapidly.

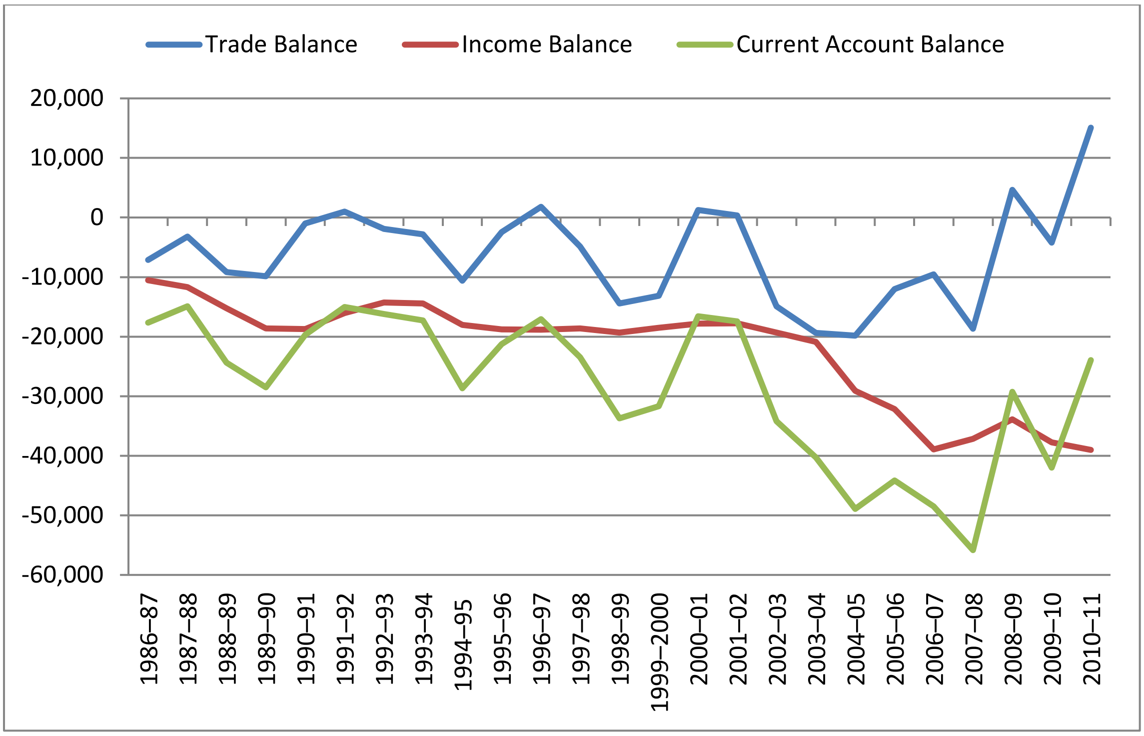

Figure 3.2. Real Annual Australian Current Account Balance from 1983/84 to 2010/11. (Data Source: ABARES, 2012)

The annual net traded goods and services balance was also increasing into deficit with more sustained periods between peaks and troughs. Over the period 1983/84 to 2000/01 the trade balance fluctuated into deficit and peaked at around a net zero balance. The trend seemed largely stationary although the variation between peaks and troughs was increasing gradually.

The period 2000/01 to 2008/09 saw a deficit net trade balance, which was the largest length of time in deficit since 1983/84. However, since 2008/09 net trade has recorded a positive balance, with a similar improvement also reflected in the underlying current account balance.

3.8 Summary

The chapter has provided a detailed overview of the relative contributions of selected sectors to real Australian GDP, total Australian employment, real private capital expenditure and real Total Exports.

In real values (at 2000 prices), Australian GDP has increased 2.45 times over the period 1983/84 to 2010/11. At the same time the traded sector (as measured by trade intensity) has increased by 3.5 times. This has been caused by an increase in both total real exports and total real imports.

Similarly the role of the real income balance in the wider real current account is also growing. Figure 3.2 suggests that prior to 2002/03 the real income balance was steady and that annual fluctuations in the real trade balance impacted the annual real current account balance. Over the five-year period 2002/03 to 2007/08 there was an increase in the real income deficit. This could be related to an increase in real private capital expenditure over the same period. The real income balance has now stabilised such that annual movements in the real current account balance largely mirror movements in the real annual trade balance.

The contribution of the mining sector seems to reflect that of a booming export sector in Dutch Disease theory as highlighted in Chapter 2. Of particular note is the large increase in contribution to real total exports and real private capital expenditure since 2002/03. For example mining in 2010/11 contributed 39 percent or real private capital expenditure and 56 percent of total Australian exports. Notwithstanding this, mining still only contributes some 7 percent of total real Australian GDP and less than 2 percent of total employment.

In contrast the respective contributions of agriculture and manufacturing to the Australian economy do reflect those of lagging sectors as suggested in Dutch Disease theory. The role of agriculture within the wider economy is now not considered significant, with contributions to real Australian GDP and total employment around 2 to 3 percent and total Australian exports of around 9 percent.

The contribution of manufacturing is a little more complex. The relative contribution to real Australian GDP has decreased from 23 percent to 8.2 percent since 1983/84, to total employment has decreased from 18 percent to 8.7 percent, and of capex from 25 percent to 10.3 percent. Notwithstanding this its contribution to total exports remains around 14 percent and the relative contribution to real Australian GDP is commensurate with mining and other sectors such as education and finance.

In summary, between 2002/3 and 2010/11, there has been a series of associated events, starting with a mineral export boom, some apparent Dutch Disease effects throughout the economy, a balance of trade surplus, capital investment in mining, income payments abroad, and a deficit on the income balance. Hence, there appears to be some evidence of Dutch Disease related structural change in the Australian economy that was triggered by a booming mineral sector between 2002/03 and 2010/11. However this is in a context of wider structural change that has been occurring in the economy since the early 1980s.

The next chapter describes the hypotheses and the methods that were utilised to study them.

Chapter 4 – Research Questions and Methods

4.1 Introduction

The last two chapters provided an overview of literature related to structural change created by a booming commodity export sector and linked this literature to the Australian economy since the 1980s. This chapter integrates the ideas of these two chapters into common themes to formulate the three research hypotheses of this thesis.

This chapter is structured as follows. The next section summarises Chapters 2 and 3 and highlights overlap or differences that require investigation. From this summary three research hypotheses were identified.

The final section details the methods and data utilised to investigate the three hypotheses. This includes an overview of relevant literature, the key themes, methods and data utilised and then concludes with a summary of the techniques that came to be utilised in each of the three hypotheses. These methods and data are introduced to establish the context and detail the framework for testing of each hypothesis.

4.2 Reconciling Dutch Disease Theory and the Australian Economy

While Dutch Disease has been covered in detail by authors such as Corden and Neary (1982), Corden (1984), Jones and Neary (1985), Fardmanesh (1991), Davis (1995) and Sachs and Warner (2001), there have been few empirical studies completed in an Australian context (Hambur & Norman 2012). Furthermore there are differences in approaches to what constitutes Dutch Disease and the impact it has on the economy in question. Corden and Neary (1982) detail the expected deindustrialisation of a traded manufacturing sector from a booming energy sector, while the net impact on the non-traded sector is dependent on the balance between the initial resource effect in the lagged export sector and non-traded sector and the pending effect on the non-traded sector from increased national income. Moreover the roles of relative factor intensities as well as mixed sectors (that comprise both traded and non-traded components) have been raised by Gregory (1976; 2011), Corden and Neary (1982), Corden (1984), Fardmanesh (1991) and Davis (1995). Finally Gregory (2011) also suggested that the impact of the then current mineral price boom may not have been as great as expected as significant factor reallocation may have taken place in response to the earlier mineral booms and wider economic restructuring from deregulation.

Chapter 2 concluded that the impact of a booming export mineral sector on the Australian economy remains an important consideration given the potential structural changes that could eventuate in the non-traded, import and non-mineral export sectors. However, the response to the mineral export price boom of the 2000s may be different from earlier responses to a volume-driven expansion. For example, de-industrialisation may not be as predicted because of factors such as the resource effect being small.

To progress this further Chapter 3 provided a detailed overview of the relative contributions of selected sectors to real Australian GDP, total Australian employment, real private capital expenditure and real total exports. Particular attention was directed towards the mineral and manufacturing sectors. In this context it was shown that there was a series of linked events between 2002/03 and 2010/11. These were a mineral export boom, a balance of trade surplus, capital investment in mining, income payments abroad, and a deficit on the income balance.

Real Australian GDP has increased 1.45 times over the period 1983/84 to 2010/11. At the same time the traded sector (as measured by trade intensity) has increased by 4.36 times. This has been caused by an increase in both total real exports (3.30 times) and total real imports (6.00 times). These measures are in chain volume terms and signify the impact of volume-related growth in these sectors rather than price-related growth.

Similarly the role of the real income balance in the real current account is also growing. Figure 3.2 suggested that prior to 2002/03 the real income balance was steady and that annual fluctuations in the real trade balance impacted the annual real current account balance. Over the five year period 2002/03 to 2007/08 there was an increase in the real income deficit. This is related to an increase in real private capital expenditure over the same period. The real income balance has now stabilised such that annual movements in the real current account balance largely mirror movements in the real annual trade balance.

More specifically important linkages are as follows:

- Dutch Disease theory suggests that a booming commodity export sector can be triggered by technological improvement, a price rise, or new reserves. In the Australian context the expansion of the mineral sector as highlighted by Gregory (1976) was triggered by new reserves resulting from foreign investment, while Gregory (2011) suggested that the more recent expansion in mineral commodity exports has been export price driven.

- Dutch Disease suggests that the lagging export sector will have resources drawn away from it and towards the booming export sector. Traditionally this has been considered to be manufacturing and this process has been known as the "de-industrialisation" of the economy as labour and capital factors are drawn towards the booming export sector. In an Australian context the contribution of Australian manufacturing to real Australian GDP, total Australian employment and real private capital expenditure has decreased over the period 1983/84 to 2010/11. The contribution of Australian manufacturing exports to total Australian exports has largely remained unchanged at around 14 percent, although it did peak around 20 percent in the 1990s.

- The mineral export sector dominates total Australian exports (i.e. contributing around 56 percent for 2010/11), as well as real private capital expenditure (contributing around 39 percent for 2010/11). In contrast the contribution of mining to total real Australian GDP is modest in comparison at 7.3 percent in 2010/11, which places it alongside the manufacturing, construction, financial, and education sectors. Similarly the mineral sector only contributes about two percent of total Australian employment.

In summary there appears to be some evidence of Dutch Disease related structural change in the Australian economy that was triggered by a booming mineral sector between 2002/03 and 2010/11. However, these responses to the price boom have in a context of wider structural change that has been occurring in the economy since the early 1980s. Moreover this is complicated by the long-term structural change that has also been occurring in the economy in response to the earlier mineral boom as discussed in Gregory (1976), wider structural change in the world economy that has seen increased international trade and capital mobility, as well as subsequent deregulation of the Australian economy since the 1980s.

The next few sections detail the research questions that seek to disentangle the effects of the export price boom since 2002/03 and the earlier structural changes.

4.3 Hypotheses

4.3.1 Hypothesis 1

As detailed above the impact of “de-industrialisation” in response to a price-led mineral export boom has provided conflicting results as predicted by Dutch Disease theory. Manufacturing as a percentage of real GDP has decreased as has its contribution to total employment and real private capital expenditure. In contrast Table 3.7 highlights that its contribution to total Australian exports has decreased from a peak of 22 percent in 2002/03 to 18 percent in 2010/11, which is consistent with its level of contribution in 1982/83 and 1987/88.

There are different explanations of these events in the literature. On one hand authors such as Gregory (1976), Corden and Neary (1982), Corden (1984), Lindert (1991), Ismail (2010) and Sachs and Warner (2001) would suggest that the impact of de-industrialisation in the manufacturing sector from a mineral export boom was to be expected. On the other hand authors such as Fardmanesh (1991), Davis (1995), McKissak *et al.* (2008) and Gregory (2011) would suggest that the impact is more complex and less clear cut. Various reasons are suggested ranging from the impact of previous export booms (Gregory 2011), the manufacturing sector simply performing better than expected (McKissak *et al.* 2008), or the impact was negated through other sectors and / or due to the different intensity of relative factors (Davis 1995).

The first hypothesis is designed to disentangle the impact of the mineral export price boom on the Australian manufacturing sector from long-term and existing structural change that the sector was responding to.

Hypothesis 1 (H1) – That the mineral export price boom between March 2003 and June 2008 did not impact the Australian manufacturing sector as Dutch Disease theory suggests.

4.3.2 Hypothesis 2

The first hypothesis above is designed to examine the impact of the mineral export price boom on the aggregated manufacturing sector. As detailed above the response of Australian manufacturing is mixed and requires further investigation. Two recent studies have highlighted the need to also consider the impact of worldwide changes in the relative contribution of manufacturing to developed countries as well as the role of different factor intensities within disaggregated manufacturing sub-sectors.

A study in the Canadian context by Beine *et al.* (2012) disentangled the impact of Dutch Disease on the Canadian manufacturing sector into international manufacturing sector evolution (i.e. industrialised nations such as members of the OECD) and that felt in response to the booming Canadian oil-sector. Furthermore the study highlighted different impacts at the disaggregated level within Canadian manufacturing to the latter. In a similar vein, Hambur and Norman (2013) confirmed mixed evidence of de-industrialisation in Australian manufacturing from the price-led mining boom, and this mixed evidence was more obvious when examining manufacturing at the disaggregated level. The authors concluded this was possible evidence of a two-speed economy, which is consistent with the conclusions of Gregory (2011).

The second hypothesis is designed to investigate this further, namely the role of the sub-sectors of Australian manufacturing in the price-led mineral export boom. This investigation may also explain why the contribution of manufacturing exports to total exports is steady while other relative contributions of manufacturing to real Australian GDP, total employment and total real Private Capital Expenditure has decreased. Also related to this is the contribution of total imports to the increase in trade intensity.

The second hypothesis is as follows:

Hypothesis 2 (H2) –That the mineral export-price boom between March 2003 and June 2008 did impact the sub-sectors of the Australian manufacturing as Dutch Disease theory suggests.

4.3.3 Hypothesis 3

Australia has long been considered a commodity-based economy, with a strong correlation identified between movements in Australia's terms of trade and the real exchange rate. Most studies of this relationship have been at an aggregate level, where exogenous shocks to the terms of trade are assumed and then the impacts are tested empirically.

Two early Australian-based studies provided a theoretical foundation for much of the subsequent work on the real Australian exchange rate (Blundell-Wignall & Gregory, 1990; Gruen & Wilkinson, 1991). Both studies utilised the terms of trade and real-interest rate differential as determinants of the real Australian exchange rate, where the terms of trade represented the long-term equilibrium relationship and the real-interest rate differential (and other variables) as the driver of short-term deviations from equilibrium. Other Australian exchange rate studies that have utilised this "hybrid" model of exchange rate determination include Sjaastad (1990), Blundell-Wignall *et al.* (1993), Bullock *et al.* (1993), Bleaney (1996), Gruen and Kortian (1996), Webber (1997), Swift (1998; 2001; 2004), Rankin (1999), Chen and Rogoff (2003), Bagchi *et al.* (2004), and Hatzinikolaou and Polasek (2005).

In the Australian context the variables considered have typically been the real exchange rate, the terms of trade (or its proxy) and the real interest rate differential. The terms of trade are considered to represent the goods and service determinant of the real exchange rate, while the real interest rate differential is considered to represent the income/money determinant.

Blundell-Wignall and Gregory (1990) examined the role of the real exchange rate on monetary policy settings and the role of official intervention in the foreign exchange market. They developed a theoretical model using commodity prices as exogenous shocks to the terms of trade and money demand function. The study examined two constructs within a model that derived long-term equilibrium - the first related to deviations in measured purchasing power parity (where purchasing power parity was defined as the ratio of commodity prices to manufacturing prices), and the second being deviations in the terms of trade. Blundell-Wignall and Gregory concluded that there was co-integration between the terms of trade and the real exchange rate, but no significant co-integration between real interest rate differentials and the real exchange rate.

Gruen and Wilkinson (1991) utilised a similar model where shocks to the real exchange rate were considered temporary, with the real exchange rate expected to move back towards its long-run equilibrium. This study examined the relationships between the real exchange rate and the terms of trade and between the real exchange rate and the real interest rate differential – individually and collectively. They concluded that there was evidence of a co-integrating relationship between the real exchange rate and the terms of trade over the sample period and mixed evidence of a co-integrating relationship between the real exchange rate and the real interest rate differential.

At first glance these early studies would still be suitable to be utilised in the current setting. However the increased role of the traded sector in the Australian economy (as measured by trade intensity) as well as the greater importance of the income balance within the current account balance suggest that additional factors may be influencing the real exchange rate. While the terms of trade measure price effects on the real exchange rate, increased volumes of trade, and particularly import volumes, may now also influence real exchange rates. As a consequence, trade intensity and income balance are introduced as additional variables in the current study.

Trade intensity as a determining variable has not been utilised previously, but is proposed in this study. As highlighted in Chapter 2 the role of the traded sector within the Australian economy has increased such that it now measures some 41 percent of Australian GDP. While the terms of trade capture any variations in traded prices, the introduction of a measure of trade intensity is proposed to capture possible variations in volume of traded goods and services, given that the interaction of export and import values and volumes could have implications on the value of the real exchange rate. Similarly, trade intensity is measured as total export value plus total import value as a percentage of Australian GDP. An increase in trade intensity could occur from either an increase in imports or exports. Therefore, the nature and magnitude of the co-efficient could provide some useful insights. For example, a negative/positive co-efficient may imply an import/export dominated influence on the real exchange rate.

The introduction of an income balance measure is proposed by the author in place of foreign indebtedness. While the latter was consistent with previous studies such as Blundell and Wignall (1993), the size of foreign debt has been broadly steady around 50 percent of Australian GDP since 2003/04. In contrast, the role of the income balance in the Australian current account has increased significantly since 2000/01 and, as shown in Figure 3.1, is now largely offsetting any improvement in the traded goods and services balance within the Australian current account. Given this, income balance is included as a variable in explaining the value of the real exchange rate.

Similarly real-interest rate differentials are considered suitable to measure the role of monetary considerations in the determination of the real exchange rate. Notwithstanding this, recent trade balance surpluses and the offset role of income balance deficits suggest that the while real-interest rate differentials adequately measure the flow of capital, the size of these flows and their contribution on the income balance is not adequately measured.

The longer term variables of trade intensity and income balance were included to provide reference to the longer-term structural change, as they are becoming more important. It is possible that the variation in these variables determines changes in the real exchange rate and that are often overlooked in the literature.

The third and final hypothesis of this thesis is as follows:

Hypothesis 3 (H3) The increased role of the income balance in the Australian Current Account Balance has resulted in the Real Australian Exchange Rate being less responsive to changes in the Australian Terms of Trade and more responsive to monetary variables.

4.4 Research Methods

As detailed above, this section provides an overview of relevant literature, key themes, methods, data and techniques utilised in the analysis of the three hypotheses detailed above.

4.4.1 Hypothesis 1 & 2 Methods

Given the overlapping nature of the first and second hypotheses, the methods utilised are similar and for the sake of brevity are described together in this section. That is, similar methods were utilised in examining the impact of the mineral export price boom from 2002/03 on the aggregated manufacturing sector in the first hypothesis and eight manufacturing sub-sectors in the second hypothesis.

These hypotheses examine the contradiction between the maintenance of the contribution of manufacturing exports to total Australian exports while at the same time seeing a decline in the contribution of the manufacturing sector to real Australian GDP, total Australian employment and real private capital expenditure.

Hambur and Norman (2013) suggest that Dutch Disease literature tends to fall into two broad categories – theoretical dominant research with limited evidence or empirical work at an aggregate economy level across limited time spans. They also add that many Dutch Disease models are based on over-simplified assumptions and overly aggregated sectors within the target economy.

Dutch Disease related literature that falls into the first category includes Gregory, 1976; 2011), Corden and Neary (1982), Corden (1984), Davis (1995), Sachs and Warner (2001), and Hart (2011). All of these contributions contain detailed theoretical constructs and support this with descriptive analysis on important economic ratios and / or graphical representations.

Alternatively aggregated empirical based literature includes Fardmanesh (1991), Ismail (2010), Acharya and Coulombe (2009), Beine *et al.* (2012), Hambur and Norman (2013), and Coulombe (2013). A common thread of this literature is that it includes detailed empirical analysis at an aggregate economic level, either at a country level or cross-country level.

Fardmanesh (1991) completed a five-country study to measure the impact of an oil price boom on the respective manufacturing and agricultural sectors as part of a reduced form three-sector model. The model measured the impact of the oil price boom on the relative contributions of manufacturing and agriculture to non-oil GDP. OLS techniques analysing annual data across the time period 1966 to 1986 were utilised. The study concluded that an oil price boom saw a decrease in the agriculture contribution to GDP and an increase in the traded component of the manufacturing sector. This latter finding is of particular relevance to this thesis because of the extent to which manufacturing exports from Australia have been maintained.

Ismail (2010) conducted extensive empirical cross-country and cross-sector analysis that included 90 countries (of which 15 were oil producing), and 81 different sectors across these countries. The purpose of this study was to identify possible shortfalls to Dutch Disease related structural change, e.g. factor immobility, factor productivity, international capital mobility and under-utilised capacity. The model utilised an oil price boom as the initial shock and then sought to measure the impact on output, with dummy variables utilised to account for the different combinations of industry, country and time. Annual data for the period 1990 to 2004 were utilised.

Beine *et al.* (2012) completed a bilateral study of Dutch Disease in Canada. That is, given the strong bilateral trade relationship between these two countries the study focussed on the bilateral United States / Canadian dollar exchange rate, relative manufacturing price indices, and manufacturing trade between the two countries. They disentangled the role of US manufacturing and the value of the United States dollar from the response of the Canadian dollar and Canadian manufacturing to Dutch Disease created by an oil resources boom. The strong bilateral relationship between Canada and the United States saw a need to distinguish the impact on structural changes in the Canadian manufacturing sector caused from the booming Canadian oil sector and those changes translated from the United States (their free trade partner). The model was based on the employment share of Canadian manufacturing with variables including lagged employment share, the lagged share of US manufacturing employment, industry (dummy) variables and the Canadian exchange rate. Quarterly data for 21 industries from 1987 to 2006 were utilised.

Beine *et al.* (2012) draw on the unpublished work of Acharya and Coulombe (2009). This latter work referred to changes in commodity prices and exchange rates as the "new global order" and concluded that Canadian industrial employment was shifting from trade-exposed manufacturing to the primary and service sectors. Their study examined annual data for 38 Canadian industries across the primary, manufacturing and service sectors for the time period 1987 to 2006. The model utilised had a time series component as well as industry dimensions, including variables such as the real Canadian exchange rate, energy prices, and the nominated industry share of total Canadian employment as well as the respective same sector share of total US employment.

Coulombe (2013) studied the relative evolution of regional terms of trade to the Canadian resource boom from 2002 to 2008. Terms of trade are an important consideration given the larger role of exports in the Canadian economy when compared to an economy such as the United States. The study used labour productivity as a tool to measure the regional response of Dutch Disease within Canada. The focus of this study was on regional labour productivity disparity, where this disparity was the cause of provincial terms of trade disparity in response to the oil price boom. Data for ten provinces for the period 2002 to 2008 were analysed using OLS regression.

Of all Dutch Disease studies, Hambur and Norman (2013) provide the most comprehensive study to date. This study utilised an industry specific model that included the aggregate Australian manufacturing sector as well as seven sub-manufacturing sectors. Vector Autoregressive (VAR) Techniques were utilised on quarterly data from 1985 to 2012. Importantly the authors note that VAR techniques were utilised to allow the data to reveal the appropriate relationships rather than test a theory based model. Another consideration is that income variables were utilised rather than chain volume measures given that the recent Australian export boom is price-driven, and income based variables allow the impact of price in income variables to be identified. Income and deflated current variables have been utilised in this thesis along similar lines.

Hypothesis 1

The models utilised in testing Hypothesis 1 are largely based on Beine *et al.* (2012), albeit modified to suit the Australian context. The models seek to disentangle the response of the Australian manufacturing sector to the mineral export-price boom of

2002/03 from that of longer-term structural change in the Australian economy, with a component of such structural change being related to manufacturing sector changes generally in the developed economies worldwide.

The process requires two steps. The first step is designed to identify the role of the real Australian exchange rate, the mineral export price boom, manufacturing production and the manufacturing producer price to changes in Australian manufacturing income.

The first model states that quarterly manufacturing income is determined as follows:

$$\ln Y_t = Ƀ_0 + Ƀ_1 \ln TWI_t + Ƀ_2 \ln Q_t - Ƀ_3 \ln Q_{t-1} + Ƀ_4 \ln P_t - Ƀ_5 \ln P_{t-1} + Ƀ_6 \ln Y_{t-1} + Ƀ_7 (Dutch \times \ln TWI_{t-1}) + U_t$$

Equation 4.1

where;

Y_t is quarterly Australian manufacturing income. Data have been sourced from *ABS 5676.25 Business Indicators, Australia; Manufacturing Subdivision, Table 25 Income from Sales of Goods and Services (Current Prices)*. Data have been deflated and indexed to June 2000 price levels.

TWI_t is the contemporaneous real Australian Exchange Rate as measured by the Real Trade Weighted Index published by RBA (2015). Data have been indexed to June 2000 levels.

Q_t is the value of quarterly Australian manufacturing production as sourced from *ABS5206.41 Australian National Accounts: National Income,* *Expenditure and Product, Table 41 Industrial Production*. Seasonally adjusted data have been indexed to June 2000 price levels.

Q_{t-1} is the one-quarter lagged value of quarterly Australian manufacturing production as sourced from *ABS5206.41 Australian National Accounts: National Income, Expenditure and Product, Table 41 Industrial Production*. Seasonally adjusted data have been indexed to June 2000 price levels.

P_t is the quarterly manufacturing producer price index as sourced from *ABS6427.12 Producer Prices Indexes, Table 12 Output of the Manufacturing Industries, Division, Subdivision, Class, Group*. Data have been adjusted to June 2000 price levels.

P_{t-1} is the one-quarter lagged value of manufacturing producer price index as sourced from *ABS6427.12 Producer Prices Indexes, Table 12 Output of the Manufacturing Industries, Division, Subdivision, Class, Group*. Data have been adjusted to June 2000 price levels.

Y_{t-1} is the one-quarter lagged value of Australian manufacturing income. Data has been sourced from *ABS 5676.25 Business Indicators, Australia; Manufacturing Subdivision, Table 25 Income from Sales of Goods and Services (Current Prices)*. Data have been deflated and indexed to June 2000 price levels.

$(Dutch \times lnTWI_{t-1})$ is a dummy variable to measure the mineral export price shock over the period March 2003 to June 2008. A 0/1 dummy variable has been utilised against the Real Exchange Rate (X_1) to represent the contemporaneous shock of the mineral export price boom that is transmitted through the real exchange rate to the lagging (manufacturing) sector.

U_t standard residual term.

This equation was designed to identify the influence of the real exchange rate, quarterly changes in manufacturing production and prices, and the mineral export-price boom on changes in quarterly manufacturing income. A percentage change in manufacturing income, production and producer price is defined as a change in value from the previous quarter to the current quarter.

Neither capital expenditure nor employment data were included in this equation as these were not considered to be determinants of manufacturing income. Rather they could be considered determinants of manufacturing production. Furthermore, the purpose of this equation is to establish if an export-price shock has an impact on the aggregate manufacturing sector as measured through manufacturing income.

Dutch Disease theory suggests that the lagging manufacturing sector will respond directly to the price-driven mineral export boom (i.e. the resource effect as labour and capital resources are re-directed to the booming sector), and also to changes in resource allocation from increased national income (i.e. the spending effect where increased income sees increased demand for imports in response to an appreciating exchange rate caused by higher terms of trade generated by the export price boom). The real exchange rate and export-price boom variables are included to capture the resource-effect, and the manufacturing production and manufacturing producer price are included to capture the spending-effect. Manufacturing production will help to identify volume changes from changing domestic demand while the producer price variable will capture changes transmitted through relative prices of the manufacturing sector.

The previous quarter real exchange rate was utilised on the assumption that there are sticky prices in this sector, such that any changes in the real exchange rate will not be transmitted to prices until the following period as contracts are re-negotiated. Production and price variables were included to disaggregate their respective roles in determining manufacturing income. A dummy variable was included to estimate the role of the mineral export-price boom from 2002/03. Logged quarterly data from September 1987 to June 2014 were utilised.

The second equation related to the first hypothesis was as follows:

$$\text{Ln } Y_t = Ɓ_0 + Ɓ_1 \ln TWI_{t-1} + Ɓ_2 \ln ExP_t + Ɓ_3 \ln GDP_{t-1} + Ɓ_4 \ln USManEm_{t-1} + U_t$$

Equation 4.2

Where

Y_t is the change in the quarterly contribution (ratio) of Australian manufacturing employment to total Australian employment. Data were sourced from *ABS 6291.0.055 Labour Force Australia, Detailed, Quarterly, Table 6 Employed Persons by Industry Subdivision.* The contribution is measured as the ratio on an annualised calendar year basis. Given the nature of the data there is no distinction between full-time and part-time employees.

TWI_{t-1} is the one-year lagged value of the average annual real Australian Exchange Rate as measured by the Real Trade Weighted Index published by RBA. The lagged value has been utilised to allow for price-stickiness associated with manufacturing sales contracts. Data have been indexed to June 2000 levels.

ExP_t is the booming quarterly export mineral price index measured by the Australian Iron Ore Export Price index that has been averaged to a calendar year. Data have been sourced from *ABS 6457 International Trade Prices Indexes, Australia Tables 7 and 9. Export Price Index by SITC, Index and Percentage Changes*. Data have been indexed to June 2000 levels.

GDP_{t-1} is the one-year lagged value of annual real Australian GDP. Data have been sourced from *ABS 5206.03 Australian National Accounts: National Income, Expenditure and Product, Table 3 Expenditure of Gross Domestic Product (GDP) Current Prices*. Annual data have been deflated and indexed to June 2000 price levels. This calculation has been utilised instead of chain volume measures to capture both the price and volume impact within real Australian GDP. The lagged value has been utilised to allow time for the transmission of GDP changes to the manufacturing employment.

$USManEm_{t-1}$ this is the quarterly contribution of United States (US) manufacturing employment to total US employment. The US has been utilised to represent the worldwide role of the manufacturing sector in developed economies. The structure and nature of the US economy is different from that of Australia and is considered a proxy of structural change in developed industrial economies worldwide. Data were sourced from the *United States Department of Labour, Bureau of Labour Statistics, Non-Farm Payrolls.* The contribution is measured as the ratio on an average annualised calendar year basis. Given the nature of the data there is no distinction between full-time and part-time employees.

U_t standard residual term.

This equation disentangled the role of Dutch Disease related triggers such as the real Australian Exchange rate and the booming mineral export price from the longer-term structural change forces such as underlying real Australian GDP and worldwide trends in manufacturing employment (for which US Manufacturing Employment was used as a proxy). Logged annual data from 1989 to 2014 were utilised.

These two equations, related to manufacturing income and manufacturing employment are important in disentangling various effects. As explained in Chapter 3 there are some contradictions in the response of the manufacturing sector to a mineral export-price driven boom: In particular the continued stronger than expected contribution of manufacturing exports to total Australian exports when compared to the relative contributions of the manufacturing sector to total real Australian GDP, total Australian employment and real Australian private capital expenditure.

Hypothesis 2

The second hypothesis seeks to draw on the work of Beine *et al.* (2012), but utilising the manufacturing sub-sectors in the manner described in Hambur and Norman

(2013). The inclusion of eight sub-sectors in this model allows for more detailed analysis into the various contributions of each sub-sector to total manufacturing income, employment and private capital expenditure. Identification of re-allocation of resources within the manufacturing sector may also assist in clarifying the contradictions identified in the previous paragraph.

The model for this hypothesis was the same as equation 4.1, except that eight sub-sectors of manufacturing were included, namely:

- Metal Manufactures (MM);
- Textile Clothing and Footwear (TCF);
- Food and Beverage (F&B);
- Chemicals, Rubber and Petroleum (CRP);
- Wood, Paper and Furniture (WFP);
- Machinery and Equipment (M&E);
- Non Ferrous Metals (NFF); and
- Print and Media (P&M).

With separate equations for each sub-sector, the model can be summarised as follows:

$$\ln Y_t = B_0 + B_1 \ln TWI_t + B_2 \ln Q_t - B_3 \ln Q_{t-1} + B_4 \ln P_t - B_5 \ln P_{t-1} + B_6 \ln Y_{t-1} + B_7 (Dutch \times \ln TWI_{t-1}) + U_t$$

Equation 4.3

where;

Y_t is quarterly income of eight sub-sectors of Australian manufacturing. Data have been sourced from *ABS 5676.25 Business Indicators, Australia; Manufacturing Subdivision, Table 25Income from Sales of Goods and Services (Current Prices)*. Data have been deflated and indexed to June 2000 price levels.

TWI_t is the contemporaneous real Australian Exchange Rate as measured by the Real Trade Weighted Index published by RBA (2015). Data have been indexed to June 2000 levels.

Q_t is the value of quarterly production of the manufacturing sub-sectors, sourced from *ABS5206.41 Australian National Accounts: National Income, Expenditure and Product, Table 41 Industrial Production*. Seasonally adjusted data have been indexed to June 2000 price levels.

Q_{t-1} is the one-quarter lagged value of production of the eight sub-sectors, as sourced from *ABS5206.41 Australian National Accounts: National Income, Expenditure and Product, Table 41 Industrial Production*. Seasonally adjusted data have been indexed to June 2000 price levels.

P_t is the quarterly producer price index of each eight sub-sectors of manufacturing, as sourced from *ABS6427.12 Producer Prices Indexes, Table 12 Output of the Manufacturing Industries, Division, Subdivision, Class, Group*. Data have been adjusted to June 2000 price levels.

P_{t-1} is the one-quarter lagged producer price index of each of the eight sub-sectors of manufacturing, as sourced from *ABS6427.12 Producer Prices Indexes,*

Table 12 Output of the Manufacturing Industries, Division, Subdivision, Class, Group. Data have been adjusted to June 2000 price levels.

Y_{t-1} is the one-quarter lagged value of income of the eight sub-sectors of manufacturing. Data have been sourced from *ABS 5676.25 Business Indicators, Australia; Manufacturing Subdivision, Table 25Income from Sales of Goods and Services (Current Prices)*. Data have been deflated and indexed to June 2000 price levels.

Dutch x $\ln TWI_{t-1}$ is a dummy variable to measure the mineral export price shock over the period March 2003 to June 2008. A 0/1 dummy variable has been utilised against the Real Exchange Rate (X_1) to represent the contemporaneous shock of the mineral export price boom that is transmitted through the real exchange rate to the lagging (manufacturing) sector.

U_t standard residual term.

The purpose of retaining the same equation is to provide further insights into disaggregated levels of the manufacturing sector to identify different responses by the sub-sector to the booming mineral export sector and longer-term structural change, and then compare these results to those of the aggregated manufacturing sector. Given the diverse nature of Australian manufacturing with varying utilisation of labour and capex, the export-price related boom could generate different responses at the disaggregated level within the manufacturing sector.

All three equations (4.1-4.3) utilised Ordinary Least Squares (OLS) regressions for empirical analysis. This is consistent with previous studies identified earlier in this chapter. VAR techniques such as those in Hambur and Norman (2013) were not utilised as this analysis is seeking to test established Dutch Disease theoretical relationships rather than identifying possible relationships. Similarly Least Square Dummy Variable techniques of Coulombe (2013) were not utilised as the industry analysis is being confined to separate estimation of eight sub-sectors of manufacturing.

4.4.2 Hypothesis 3 Methods

This hypothesis is largely a re-examination of the well documented co-integrated relationship between the real Australian exchange rate, terms of trade and the real interest rate differential. With the introduction of two new variables concerned with trade intensity and the income balance, the purpose was to identify if there have been any changes in the nature and strength of the relationship in response to the structural changes within the Australian economy and traded sector that were highlighted in Chapter 3.

Exchange rate economics was revitalised after the introduction of floating exchange rate regimes after the collapse of the Bretton Woods Agreement, which generated large fluctuations in currency values which in turn impacted on other macroeconomic aggregates such as prices, wages, interest rates, employment and production (Frankel & Rose, 1995; Isard, 1995).

Early literature in the decade after 1973 focused on the development and estimation of empirical models to estimate floating exchange rates with purchasing power parity as the key determinant (Frankel & Rose, 1995). Two early studies have provided a foundational model for the majority of subsequent real exchange rate studies. The first was Dornbusch (1976) and was published some three years after the collapse of the Bretton Woods Agreement in 1973. While not specified by the author, subsequent volatility in floating exchange rates after 1973 saw the development of a theory of exchange rate determination that included a component for "overshooting" to highlight different adjustment speeds from various markets. The study was theoretical in nature, but could be considered the first study where short-term dynamics were introduced into exchange rate modelling.

The second definitive study was by Meese and Rogoff (1983) who compared the predictive powers across time periods of one to twelve months of various models, and concluded that none could outperform the random walk hypothesis. Their empirical testing included structural models such as flexible good and asset prices, a sticky-price monetary model and balanced current account models. Testing also examined univariate time series models utilising variables from the various structural models. Ordinary least squares and generalised least squares were applied, although there was no differentiation between short-term adjustment periods and long-term horizons.

Bagchi *et al.* (2004) suggested that while few issues in international finance attract more attention than the determination of the real exchange rate, theoretical frameworks do not connect easily with empirical practice. For example, the early empirical literature considered either large developed economies or small developing countries, and ignored mid-range countries such as Australia, Canada, Austria and

Finland (the focus of their study). They also suggest that empirical studies usually perform better at longer horizons. In contrast many studies, including the study by Meese and Rogoff (1983), sought to quantify short-term exchange rate volatility and overshooting.

Seminal work by Engle and Granger (1987) provided a framework that effectively combined the work of Dornbusch (1976) and Messe and Rogoff (1983), that is, their model captured a long-term equilibrium model together with the short-term deviations and subsequent adjustment within this longer-term equilibrium model (Fisher 1996).

Economic theory proposes that forces keep certain variables together, for example, income and consumption, short-term interest rates and long-term interest rates. Two or more variables may share a common stationary trend with finite variance. There is potentially dual causality (or co-integration), which has economic management implications. The model allows long-term equilibrium constraints to be linked with short-term dynamic movements from this equilibrium, where these dynamic short-run movements tend to automatically self-correct towards the long-term equilibrium. This self-correcting "error correction model" will typically utilise lagged residuals of the co-integrating long-term relationship (Bagchi *et al.*, 2004).

Error-correction models are a variant of partial adjustment models, where it is assumed that any change in the dependent variable in the current time period is a combination of:

- the partial closing of the discrepancy between the current value and previous values of the dependent variable; and
- responding to changes in the current value of the independent variable (Dougherty 2011).

While different forms of error-correction models have been around since the 1960s, Engle and Granger (1987) were the first to link error-correction models with co-integrated variables. A major benefit of error correction modelling is that it estimates both short-term and long-term elasticities. However it requires a large number of observations and stationary data (Alemu *et al.*, 2003).

For error-correction techniques to hold there are three underlying assumptions. The first is that endogeneity is assumed between variables (i.e. the two variables must have theoretical link and they can impact on each other). Household consumption and income are examples of such variables. The second is that individual variables must be co-integrated to the same order. This suggests that their theoretical link must be at the same level, in the case of household consumption and income at nominal amount: first differences. The third is that their linear combination must be integrated at an order less than that of the original variables. Thus, if variables are integrated at first order differences then the error term for the co-integrating relationship must be to order zero. This allows you to infer that any drift between variables is short term and thus temporary and the equilibrium holds in the long term. If the drift is not short term then potentially the two variables can drift apart indefinitely, thereby violating the theoretical relationship (Dougherty 2011; Enders, 2003).

Tests for co-integration are performed on the predicted residuals as a proxy for the disturbance term. It should be noted that on its own a co-integrated relationship does not shed any light on short-run dynamics. However, the existence of a short-run variation from the long-term relationship suggests that there must be both short-term dynamics within the wider relationship (Engle & Granger, 1987). This is an important consideration as it allows for the concept of overshooting in asset price markets, which was a limitation of early empirical exchange rate studies. It also allows for the introduction of variables that may have a short-term impact on the independent variable and allow for estimation of the adjustment back towards long-term equilibrium. Similarly, as detailed below it also allows for secondary impacts from changes in dependent variables.

This was an important development as traditionally Australia had been considered a small open economy, with a close relationship between the terms of trade and the real exchange rate, i.e. changes in the terms of trade impact the real exchange rate and vice versa.

The relationship between the real exchange rate and the terms of trade has been well documented. Two early Australian-based studies provided a theoretical foundation for much of the subsequent work on the real Australian exchange rate (Blundell-Wignall & Gregory, 1990; Gruen & Wilkinson, 1991). Both studies utilised the terms of trade and real-interest rate differential as determinants of the real Australian exchange rate, where the terms of trade represented the long-term equilibrium relationship and the real-interest rate differential (and other variables) as the cause of short-term deviations from equilibrium. Other Australian exchange rate studies that have utilised this "hybrid" model of exchange rate determination include Sjaastad (1990), Blundell-Wignall *et al.* (1993), Bullock *et al.* (1993), Bleaney (1996), Gruen and Kortian (1996), Webber (1997), Swift (1998; 2001; 2004), Rankin (1999), Chen and Rogoff (2003), Bagchi *et al*. (2004), and Hatzinikolaou and Polasek (2005).

These studies are not considered a definitive list, rather they are provided to show how a dual purchasing power parity–monetary model of exchange rate determination has dominated Australian exchange rate studies. A common theme of the majority of studies is that they utilise error correction modelling techniques. In the Australian context the variables have typically been the real exchange rate, the terms of trade (or its proxy) and the real interest rate differential. The terms of trade are considered to represent the goods and service determinant of the real exchange rate, while the real interest rate differential is considered to represent the income/money determinant.

As discussed in Section 4.3.3, Blundell-Wignall and Gregory (1990) concluded that there was co-integration between the terms of trade and the real exchange rate, but no significant co-integration between real interest rate differentials and the real exchange rate. Similarly, Gruen and Wilkinson (1991) concluded that there was evidence of a co-integrating relationship between the real exchange rate and the terms of trade over the sample period.

Gruen and Wilkinson (1991) have provided an error-correction template that has been utilised in the majority of subsequent Australian exchange rate studies. For univariate analysis Ordinary Least Square techniques (OLS) were utilised, while for the multivariate relationships Maximum Likelihood (ML) techniques were utilised. The latter allowed for a vector autoregressive system of equations, at both nominal levels and first differences, in line with Johansen (1988).

Some Australian exchange rate studies that utilise these error correction techniques include:

- Sjaastad (1990) – This study examined the interaction between the Australian price, foreign prices and the exchange rate levels on a logged quarterly basis from 1972 to 1989, largely using the OLS technique, given that most of the analysis was univariate. Rather than utilising the terms of trade, the study utilised the foreign price to domestic price index as a proxy for exchange rate determination. In line with Blundell-Wignall & Gregory (1990) the study concluded that there is little relationship between the Australian price level, external prices (i.e., purchasing power parity) and the exchange rate. The study concluded that the Australian exchange rate had a stronger relationship with the terms of trade after it was floated than before.

- Blundell-Wignall *et al.* (1993) – This RBA Discussion Paper was part of a series of papers at the 10-year anniversary of the float. The study utilised a similar framework to Gruen & Wilkinson (1991) in that its commentary provides background discussion of various historical issues, graphical representations of underlying variables and exchange rate volatility, and then utilises an error correction model based on the real exchange rate, terms of trade, real interest rate differential and foreign indebtedness. Foreign indebtedness was introduced as Australia's emerging foreign debt was considered an issue at the time. This study utilised both univariate and multivariate techniques, similar to Gruen & Wilkinson (1991).

- Bleaney (1996) – Unlike the majority of recent studies that have modelled largely post-float developments, this study examined the annual exchange rate, relative export price and terms of trade over the period 1900-1991, with a goal of quantifying the elasticity of the annual real exchange rate and the annual relative price of Australian exports. Utilising error correction modelling techniques the study concluded that there is evidence that the Australian exchange rate is a function of both the terms of trade and underlying value of the exchange rate in the previous year.

- Gruen and Kortian (1996) – This study was an RBA Discussion Paper that utilised error correction techniques and assumed that the terms of trade was the sole explanator of the real exchange rate and that deviations from the long-term equilibrium relationship were temporary.

- Webber (1997) – This study was one of the first to examine the effects of changes in the exchange rate on commodity export prices, whereas most studies up until this time had tested the other way around. It focussed on the top six commodity exports (at the time) that accounted for 40 per cent of total

Australian exports. The study assumed that changes in the real exchange rate were exogenous, and utilised error correction modelling techniques.

- Swift (1998; 2001; 2004) – These three studies expanded on the work by Webber (1997), albeit with more focus on the destination prices of Australian exports. Multivariate co-integration techniques developed by Johansen (1988) were utilised to quantify the changes. The 1998 study was on selected differentiated manufactured exports, while the subsequent studies in 2001 and 2004 were undertaken into non-ferrous metals, aluminium, copper and lead, as well as dairy and livestock agricultural exports. A common theme across all three studies is that all export products are either first stage or later stage processed, thereby retaining some form of manufacturing across all exports analysed.

- Chen and Rogoff (2003) - This study examined Australia, New Zealand and Canada as commodity currencies. Utilising univariate techniques within error correction modelling, they concluded that the world price of the commodity exports has a strong and stable influence on the Australian exchange rate.

- Bagchi *et al.* (2004) – This study compared the effects of the terms of trade and the interest rate differential on the real exchange rate in nine small open economies – Australia, Austria, Canada, Finland, Italy, New Zealand, Norway, Portugal and Spain. These economies were considered similar given there is a high degree of openness in the financial markets and goods markets. The authors considered that the terms of trade would capture the goods market effect while interest rate differentials capture effects in the financial markets. Both forms of error correction techniques were used, and the study concluded that, in an Australian context, the overall impact of the terms of trade on the real exchange rate is more consistent and stronger than the real interest rate differential. The study also concluded that the speed of adjustment in the error correction model is quantitatively larger for interest rate differentials. Notwithstanding this, the study is similar to that initially undertaken by Gruen and Wilkinson (1991).

- Hatzinikolaou and Polasek (2005) - This study tested the relationship between commodity prices and the real Australian exchange rate and found that a 10 percent increase in the terms of trade is associated with a real appreciation by about 8 percent. Commodity prices were utilised as a proxy for the terms of trade as the authors assumed that the terms of trade correlate highly with the world commodity price cycle. The study concluded that an increase in the commodity price index of one percent will see a currency appreciation of 0.67 percent in the same quarter, a further 0.44 percent in next quarter and a final 0.37 percent in the third and final quarter. Both univariate and multivariate techniques were utilised in this study. While most studies assumed multi-variable co-integrated relationships within the exchange rate, terms of trade and real interest rate differential (and some other variables), this study assumed a co-integrated relationship between the terms of trade and the real exchange rate as well as between the terms of trade and world commodity prices. The latter is due to the fact that commodity price changes deliver external shocks to the exchange rate. This study is also similar to the terms of trade component of that undertaken by Gruen and Wilkinson (1991).

The studies listed above are not considered a definitive list, but rather are provided to show how error correction techniques have been utilised under the common assumption of co-integration between the variables. The discussion also highlights a commonality of econometric techniques that have been utilised in previous Australian exchange rate studies.

Hypothesis 3 – Model

In line with existing literature univariate and multivariate error correction techniques were used to examine these relationships: in particular, Ordinary Least Squares for the univariate component of the analysis and Maximum Likelihood analysis for the multivariate component of the analysis. Furthermore, it is considered that there are parallels between the proposed analysis and that undertaken by Gruen and Wilkinson (1991), Blundell-Wignall *et al.* (1993) and Bagchi *et al.* (2004).

The error correction model that was developed had the Australian real exchange rate determined over the longer term by the Australian terms of trade, the five-year real interest rate differential, the level of trade intensity within the economy and the level of income balance within the economy. This represents additional variables from the studies of Gruen and Wilkinson (1991), Blundell-Wignall *et al.* (1993) and Bagchi *et al.* (2004).

The variables considered by Gruen and Wilkinson (1991) included a goods and services terms of trade, a commodity-based terms of trade, short-term real interest rate differentials and long-term differentials. While not stated explicitly, the commodity-based terms of trade and short-term real interest rate differentials were utilised to assist the authors to undertake analysis at both monthly and quarterly data intervals as these variables were considered more easily measurable and considered to have greater short-term impact than the quarterly generated goods and services terms of trade and long-term interest rate differential. The study concluded that there was evidence of a relationship between the terms of trade and real exchange rate, while there was no significant relationship between the real exchange rate and real interest rate differentials (either long-term or short-term). Notwithstanding this, Gruen and Wilkinson suggested that there may be additional variables not included in their study.

Blundell-Wignall *et al.* (1993) appeared to heed this advice as they included the terms of trade, real long-term interest rate differential and a measure of foreign indebtedness as possible determinants of the real exchange rate. Foreign indebtedness was measured in relative terms as a percentage of Australian GDP, which was also considered to represent the cumulative current account balance. The study also utilised both a real trade-weighted index and real bilateral $A/$US exchange rate as measures of the real exchange rate. Blundell-Wignall *et al.* (1993) concluded that there was an error correcting relationship between the terms of trade and real exchange rate.

The proposed model is to include four independent variables, that is, the terms of trade; real interest rate differential; trade intensity; and income balance within the current account. It is noted that the inclusion of the terms of trade and the five-year interest rate differential is consistent with previous studies. Similarly, the previous use of a real exchange rate (e.g. Bagchi *et al.* 2004) is also applicable to the longer-term horizon of this study.

Trade intensity as a determining variable has not been utilised previously, but is proposed in this study. As highlighted in Chapter 2 the role of the traded sector within the Australian economy has increased such that it now measures some 41 percent of real Australian GDP. While the terms of trade capture any variations in traded prices, the introduction of a measure of trade intensity is proposed to capture possible variations in volume of traded goods and services, given that the interaction of export and import values and volumes could have implications on the value of the real exchange rate. Similarly, trade intensity is measured as total export value plus total import value as a percentage of real Australian GDP. An increase in trade intensity from one period to the next could occur from either an increase in imports or exports. Therefore, the nature and magnitude of the co-efficient could provide some useful insights. For example, a negative/positive co-efficient may imply an import/export dominated influence on the real exchange rate.

The introduction of an income balance measure is proposed in place of foreign indebtedness. As discussed in Section 4.3.3, this variable may be more reflective of the value of the real exchange rate than is a measure of total foreign indebtedness.

From this discussion the following error correction model was proposed:

$$\text{Ln TWI}_t = B_0 + B_1 \ln \text{TOT}_t + B_2 \text{IntDiff}_t - B_3 \ln \text{TradeInt}_t + B_4 \ln \text{IncBal}_t - B_5 \ln \text{ECM}_{t-1} + U_t$$

Equation 4.4

where:

TWI_t is the Australian real exchange rate as measured by the Real Trade Weighted ndex published by the RBA (2015).

TOT_t is the Australian terms of trade and measured as the Real Export Price Index divided by the Real Import Price Index and multiplied by 100 to put into index form. Data are sourced from the Australian Bureau of Statistics (2012).

$IntDiff_t$ is the five-year interest rate differential between the real Australian five-year interest rate and an arithmetic average of the USA, UK, Japan and Germany real interest rates over time periods five years (or seven years if a five-year interest rate was not available). Nominal interest rates are deflated by the Australian CPI and an arithmetic average of the CPIs of the four countries, respectively. Data were sourced from IMF International Financial Statistics (2012) and ABS Catalogue *6457 International Trade Prices* and Catalogue *6401 CPI Australia*.

$TradeInt_t$ represents trade intensity within the Australian economy. This is measured as (total value Australian exports plus total value Australian imports) divided by total value Australian GDP and multiplied by 100. Data are sourced from ABS Catalogue *5206 Australian National Accounts: National Income, Expenditure and Product*; ABS Catalogue *5368 International Trade in Goods and Services;* and ABS Catalogue *5465 International Trade Australia*.

$IncBal_t$ represents the income balance component of the current account balance. This is expressed in index form and measured as a ratio of the Income Balance to the Australian Current Account Balance. Data are sourced from ABS *Catalogue 5302 / 5303 Balance of Payments Australia*.

ECM_{t-1} measures the divergence from long-term equilibrium in time period (t-1). This is calculated according to error-correction techniques detailed below and represents the divergence from the long-term equilibrium. It is calculated from the projected residual from time period t-1.

U_t standard residual term.

The proposed model in Equation 4.4 looks to measure the short-term and long-term dynamics of the relationship between the real exchange rate and the terms of trade, real interest rate differential, trade intensity and the income balance within the current account balance. The longer-term dynamics are measured through the coefficients β_1 through to β_4 and the corresponding independent variables X_1 through to X_4. Short-run dynamics are measured through the coefficient β_5 and variable X_5 is generated from the error correction techniques detailed below. This variable is important as it can provide an insight into the timing of self-correction towards the long-term equilibrium.

Table 4.1 compares and contrasts the model of this study with those of the three studies detailed above.

Table 4.1 *Error Correction Variable Comparison*

Variables	G&W 1991	BW 1993	Bagchi 2004	This Study
Real Exchange Rate	Self-calculated trade-weighted exchange rate to 22 major trade partners	ABS real TWI	$AUD / USD deflated by relative CPI	ABS real TWI
Terms of Trade	Self-calculated utilising export and import price deflators from ABS	Calculated from ABS real export price index / ABS real import price index	IMF international stats - Australian terms of trade	Calculated from ABS real export price index / ABS real import price index
Real Interest Rate Differential	Self-calculated by real Aust Long-term bond less arithmetic average of real bond rates for US, UK, Japan and Germany	Real Aust interest rate less Average real world rate	Bilateral Aust / USA differential deflated by respective CPI-	Self-calculated by Real Aust long-term bond less arithmetic average of real bond rates for US, UK, Japan and Germany (EU after 1993)
Foreign Indebtedness	n/a	RBA bulletin foreign debt as % of Australian GDP (ABS)	n/a	n/a
Trade Intensity (Traded Sector as a percentage of Aust GDP)	n/a	n/a	n/a	(Total exports plus total imports) / Australian GDP x 100
Income Balance of the Current Account as a percentage of Aust GDP)	n/a	n/a	n/a	Income balance / Australian GDP x 100
Logged Data	Yes	Yes	Yes	Yes
Quarterly Data	Yes	Yes	Yes	Yes
Period	1969:4 - 1990:4	1973:2 - 1992:3	1973 to 1995	1984:1 - 2010:1
No. Of Observations	88	77	88	105

Source: Gruen & Wilkinson, 1991; Blundell-Wignall et al., 1993; Bagchi et al., 2004.

The analysis used logged quarterly data, which is consistent across all four studies. Logged data are utilised as they allow calculated elasticities to be easily compared. Similarly, indexed data were utilised for consistency, although real interest rate differentials were at their nominal value given they vary between negative and positive values.

The time period (Quarter 1 1984 to Quarter 1 2010) provided quarterly data over 26 years. This compares favourably with the previous studies.

Error Correction Techniques

As detailed above, error correction modelling techniques were first developed by Engle and Granger (1987) and have been utilised extensively in Australian exchange rate studies. Alemu *et al.* (2003) highlighted that there are two important conditions that must be satisfied for error correction techniques to be utilised:

1. All individual variables are integrated to the same order. This is tested using Augmented Dicky Fuller techniques and implies that all variables are integrated at the same level (i.e. nominal values, first differences, second differences, etc.).

2. The subsequent linear combination of the variables must be integrated at an order less than the original variables. For example, if the variables are integrated at first differences then the linear combination must be integrated at zero order. This is critical as it implies that the short-term drift between variables is temporary, residuals are stationary over time, and longer-term equilibrium should exist. It is tested by

using lagged residuals from the co-integrating regression as the error correction term in the model (Engle & Granger 1987).

There are two commonly used techniques that can be employed to establish the linear combination in Step 2. Engle and Granger (1987) utilised ordinary least squares regression (OLS) to establish the linear combination. However, a limiting feature of OLS is that it only allows for one co-integrating relationship within the variables, in effect it is utilised in univariate co-integration analysis. Studies that have utilised OLS have been discussed in Section 4.4.2.

However, a weakness of utilising OLS for multivariate equations is that the t statistic from ordinary least squares regression analysis does not have an asymptotic distribution. This suggests that the coefficients are consistent, but the standard errors are not. Furthermore, only predicted residuals are known and not the actual error, such that predicted errors are fitted to minimise the residual sum of squares (Dougherty 2011; Enders, 2003).

Johansen (1988) developed a procedure that captures the underlying time series properties of the data and estimates all co-integrating vectors that may exist within a vector of variables. The procedure highlights whether the system consists of a unique co-integrating vector or a linear combination of several co-integrating vectors. This procedure utilises maximum likelihood co-integration techniques rather than ordinary least squares. In effect, there are a series of co-integrating vectors hypothesised, and usually from zero to one less than the number of independent variables in the model (Alemu *et al.*, 2003; Bagchi *et al.*, 2004; Blundell-Wignall *et al.*, 1993; Chowdhury, 1993; Dougherty, 2011; Enders, 2003; Gruen & Wilkinson, 1991; Johansen, 1988; Swift, 1998).

The majority of Australian studies detailed previously used a combination of OLS and maximum likelihood techniques. Following Gruen and Wilkinson (1991) and Blundell-Wignall *et al.* (1993) both techniques were applied in the current analysis.

The critical steps in the analysis were:

1. Test if all variables are integrated to the same order;

2. If so, undertake either the OLS or Maximum Likelihood techniques utilising data at their nominal level and test that the resultant residuals are stationary; and

3. If so, estimate Equation 4.4 using the nominal values of variables X_1 through to X_4, utilise the residuals from Step 2 as X_5.

From the subsequent model detailed in Equation 4.4, coefficients β_1 through to β_4 provided the elasticity around the long-term equilibrium while short-run dynamics were measured through the coefficient β_5 as this represents the adjustment speed from previous time periods.

4.5 Summary

This chapter has summarised the three research hypotheses and accompanying methods that were utilised in this dissertation. A common theme across all three hypotheses and four equations is the recognition that empirical analysis of the mineral export price boom also needs to also consider the longer-term structural change that has been occurring within the Australian economy and traded sector.

Chapter 5 details the results of this empirical analysis and discussion around the key implications of these results.

Chapter 5 Results

5.1 Introduction

This chapter contains the results from investigation of the three hypotheses introduced in Chapter 4. It also discusses their implications with particular reference to the background information provided in Chapters 2 and 3. This chapter follows each hypothesis in turn and provides the relevant results, followed by a discussion of their linkages and implications from the broader contexts from Chapters 2 and 3.

5.2 Hypothesis 1

From Chapter 4 the first hypothesis (H1) was:

Hypothesis 1 (H1) – That the mineral export price boom between March 2003 and June 2008 did not impact the Australian manufacturing sector as Dutch Disease theory suggests.

In short this hypothesis suggested that the Australian manufacturing sector did not respond to the mineral export-price boom as suggested by Dutch Disease theory due to (a) the underlying long-term structural change that has been occurring in response to previous mineral booms and (b) the transmission of a declining trend of the OECD manufacturing sector.

Equation 4.1

Analysis of the first hypothesis was undertaken through equations 4.1 and 4.2 and corresponding estimating equations. Equation 4.1 measured the determinants of Australian manufacturing income through the variables: the real Australian exchange rate, a change in the value of Australian manufacturing production, a change in the value of Australian manufacturing producer prices, the previous value of Australian manufacturing income and a mineral export-price boom dummy variable. Correlation of these variables showed:

Table 5.1

Correlation of Real Australian Exchange Rate, Total Australian Manufacturing Production, Australian Manufacturing Producer Price Index and Mineral-Export Price Boom September 1987 to June 2014

	RER	Production	Producer Price	Export-Price Boom
RER	1.000	0.577	0.798	0.151
Production	0.577	1.000	0.864	0.531
Producer Price	0.798	0.864	1.000	0.271
Export-Price Boom	0.151	0.531	0.271	1.000

High correlation co-efficient (unadjusted for degrees of freedom) were recorded between the real Australian exchange rate and the manufacturing producer price index and also between the value of manufacturing production and its producer price. It is noted that chain volume measures are not utilised and the high correlation suggest a price influence on the value of manufacturing production. Given the high correlations, it is important to be aware of the problem of multicollinearity in the regression equations. The mineral export-price boom is measured as a dummy variable from March 2003 to June 2008, where this 5-year period compares to the 27-year period of the total analysis. Accordingly the low correlation recorded between these two variables is expected. Regression results for are:

Table 5.2

Summary Regression Results for Quarterly Manufacturing Income September 1987 to June 2014

C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	$\check{R}^2$	DW
0.063	-0.029	0.559	0.472	0.393	0.369	0.903	0.001	0.993	1.93
$p < 0.05$	*	*	*	*	*	*	*		

Detailed results for the equation are provided in Appendix 1. Except for the real exchange rate (RER) (only significant at 5.3 percent) all coefficients are significant at five percent. The negative co-efficient for the real exchange rate supports Dutch Disease theory. That is, an appreciation in the real exchange rate would be associated with a decrease in manufacturing income; through either manufactured exports being less competitive or import-competing manufactures being crowded out as a result of lower imported-goods prices.

The coefficients for manufacturing production (Prod) and the manufacturing producer price index (PPI) variables are as were expected. An interesting result is the positive coefficient for the mineral export-price boom dummy (Boom), which is significant at 3.5 percent. This suggests that for the time period of the mineral-export price boom there was a positive relationship between the boom and total Australian manufacturing income. At first glance this contradicts Dutch Disease theory, namely the opposite should occur and that manufacturing income could decrease as the economy "de-industrialises". This contradiction is explored further in the results for Hypothesis 2 detailed later in this chapter, which is when eight sub-sectors of manufacturing are analysed. Suffice it to say here that the variable only lessens the effect of the real exchange rate variable over the boom period, so that in combination these two variables still result in a negative relationship with manufacturing income.

It is possible that the results for Table 5.2 could be spurious given the high correlations recorded between the variables detailed in Table 5.1. To investigate this prospect, two further additional partial regressions were conducted. The first equation in Table 5.3 omitted the two manufacturing producer price indices from the equation while second equation omitted the real exchange rate. Results for these regressions were as follows:

Table 5.3

Summary of Partial Regression Results for Quarterly Manufacturing Income September 1987 to June 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	Ř²	DW
(i)	0.008	-0.013	0.611	0.509	n/a	n/a	0.908	0.002	0.992	1.99
		*	*	*			*	*		
(ii)	-0.013	n/a	0.583	0.511	0.311	0.326	0.942	0.001	0.993	1.91
			*	*	*	*	*	†		

NB. * $p < 0.05$ † $p < 0.10$

Results for these equations are also located in Appendix 1. For both equations all independent variable coefficients retain their same sign and remain significant at five percent, except for the mineral export-price boom in the second equation which is only significant at ten percent.

The removal of the manufacturing price index from first equation in Table 5.3 sees the size of the coefficient of the real exchange rate decrease, and vice versa when the real exchange rate is removed in the second equation. This suggested there is some link between the producer price index and the real exchange rate, both directly and indirectly with total Australian manufacturing income. This three-way interaction is an important conclusion from this analysis. The other important observation is the sign of the coefficient of the mineral-export price boom, which suggests that this boom did see manufacturing income increase. As noted above, this can be regarded as partially offsetting the negative effect of the real exchange rate.

Equation 4.2

Equation 4.2 measured the determinants of the share of Australian manufacturing employment of total Australian employment through the variables: the real Australian exchange rate, the real export price, real Australian GDP, the previous period value of the share of Australian manufacturing employment, and lagged share of US manufacturing employment of total US non-farm payrolls.

As discussed in Section 4.4.1 this equation disentangles the impact of Dutch Disease triggers from longer-term structural changes such as the underlying real Australian GDP and OECD trends in the manufacturing sector. This analysis mirrors that utilised in a Canadian context (Acharya & Coulombe 2009). The inclusion of this analysis is supported by the following.

Figure 5.1 summarises the role of annual Australian manufacturing employment to total annual Australian employment and annual US manufacturing employment to annual US Non-Farm Payrolls over the period 1987 to 2014. It shows that the relative employment contribution of both manufacturing sectors has declining on a steady and similar pattern over the entire period. In both cases the total number of persons employed in the respective manufacturing sectors has been steady against an expanding total workforce – hence the declining contribution overall. This is consistent with the observation in Section 3.4

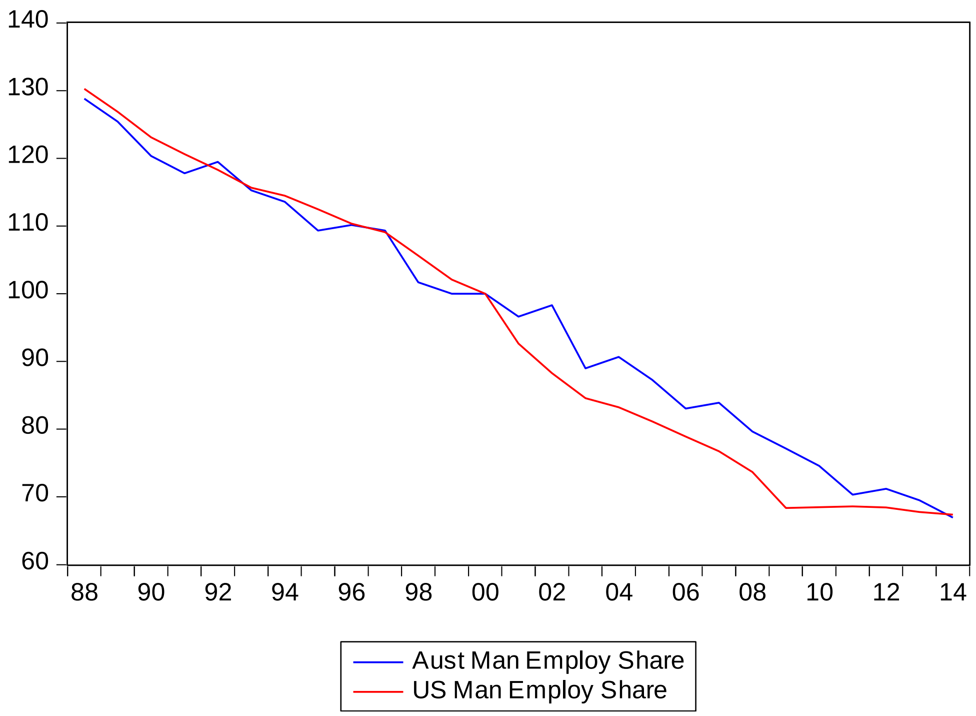

Figure 5.1 Index of Annual Manufacturing Employment and US Manufacturing Employment to Total Employment in Australia and the US respectively for the period 1987 to 2014, Year 2000 = 100

Similarly Figure 5.2 summarises annual manufacturing output in Australia and OECD against their corresponding annual GDP measures over the period 1984 to 2014. Nominal figures have been utilised as the OECD measures are an average of participating economies. Notwithstanding this, the figure highlights that manufacturing output has grown steadily in both the OECD and Australia over the whole period. However GDP, in both the OECD and Australia, has been growing at a faster rate than underlying manufacturing over the whole time period, and more particularly so since 2003. The figure also highlights that Australian GDP has grown at a much faster rate than the wider OECD since 2003 – which partly corresponds with the mineral export-price boom.

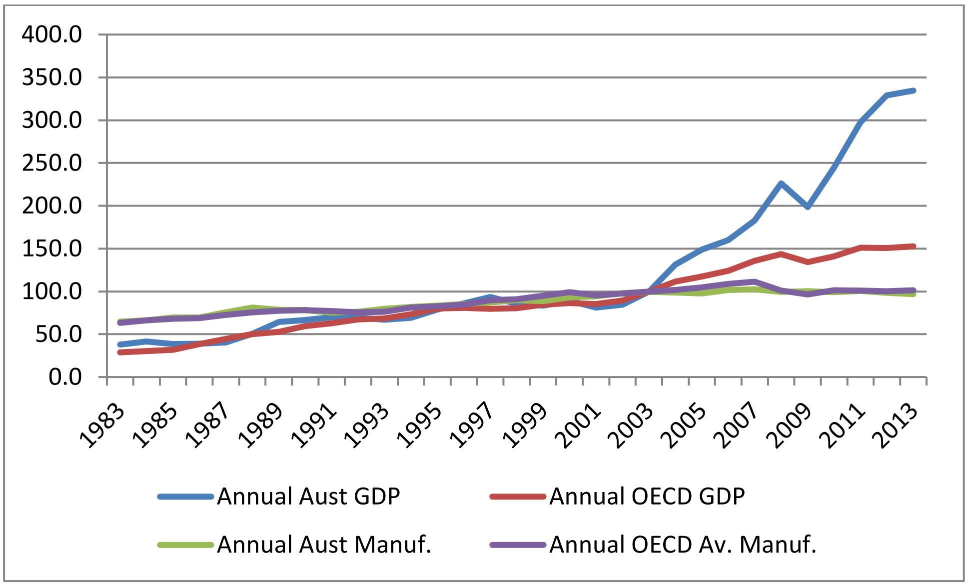

Figure 5.2 Index of Annual Manufacturing and GDP Output in Australia and the OECD Average in Nominal terms from 1983 to 2014. 2000 = 100

Figures 5.1 and 5.2 highlight that OECD manufacturing has been undergoing longer-term structural change – both in its contribution to total employment and also GDP. In both cases

Australian manufacturing was mirroring what was occurring in other industrial economies. Equation 4.2 was designed to disentangle this longer-term structural change from other impacts such as a mineral-export price boom. Table 5.4 provides the estimation for equation 4.2.

Table 5.4

Summary Regression Results for Annual Australian Manufacturing Employment 1987 to 2014

	C	Aust. Man Employ (-1)	RER	Export Price	Aust. GDP	US Man Employ	Ř²	DW
(i)	3.93	-0.638	-0.027	0.019	-0.34	0.131 (a)	0.37	2.61
	p < 0.05	*						
(ii)	2.53	-0.80	n/a	n/a	-0.20	0.45 (b)	0.48	2.11
	p < 0.05	*				*		

(a) Lagged one period (b) Lagged two periods

Results are provided in Appendix 1. The first set of results provides the estimation for all variables. Of the independent variables only the previous Australian manufacturing employment contribution to total employment (Aust. Man Employ) is significant at five percent, while lagged Australian GDP (Aust GDP) is only significant at nine percent. Unlike the Canadian results in Acharya and Coulombe (2009) the coefficients for the real exchange rate, the mineral export price (Exp Price), or the share of US manufacturing employment (US Man Employ) are not significant at five percent.

US manufacturing employment was utilised as a proxy variable for OECD employment as it is a large industrialised economy that would not be impacted by a booming mineral export sector.

Appendix 2 also shows additional regressions where the real exchange rate (RER) and the real export price index (Exp Price) are individually removed and then both removed from the analysis. In each case there is no major change to the coefficients of the retained variables or the value of the R Square or Durbin Watson statistics. While only significant to nine percent, the negative co-efficient of the Australian GDP does support the earlier conclusion that the decline in manufacturing is relative to the wider economy. That is, manufacturing output and employment have remained static in an economy growing through other sectors.

At first glance the role of structural change in OECD manufacturing sectors compared to the wider economy to changes in the role of Australian manufacturing is not significant in these equations. Interestingly an additional lag period to two calendar years in this variable (i.e. USMan) and the elimination of the exchange rate and export price variables provides the second set of estimations in Table 5.4. Results for this equation are also provided in Appendix 2. The Australian GDP variable coefficient remains negative, although it is no longer significant at five percent. However the coefficient of the share of US manufacturing is much stronger and now significant at five percent.

Discussion

The first hypothesis is that the Australian manufacturing sector did not react to the mineral export-price boom as suggested in Dutch Disease literature. The analysis above confirmed that this statement is supported, albeit with reservations.

The first set of equations confirmed that there is a negative relationship between the real exchange rate and manufacturing income as expected in Dutch Disease theory. However rather than reinforcing this relationship, the results suggested that the mineral export-price boom may have slightly negated the strength of the relationship between the real exchange rate and manufacturing income. At an aggregate level the reasons for this are unclear. However the disaggregated analysis in Hypothesis 2, to be considered in Section 5.3, provides more detailed insights.

These results around the real exchange rate, the mineral export-price boom and the manufacturing price index suggest additional layers of transmission and possible collinearity between variables. For example an increase in the real exchange rate could impact the Australian manufacturing prices index as well as manufacturing production, as production may utilise imported inputs. Further analysis could seek to disentangle these relationships within manufacturing as well.

It is also important to note that over the period 1987 to 2014 there has been a medium-term structural change in the contribution of both Australian manufacturing employment and output to total Australian employment and output that are consistent to that happening in wider industrialised economies. That is, separate to the mineral export price boom there appears a tendency towards medium-term “deindustrialisation” that has only been more evident since the large growth in Australian GDP since 2003 that is associated with the mineral export-price boom.

The results from Equation 5.4 suggest that the model utilised in Acharya and Coulombe (2009) may have some relevance in an Australian context, although the underlying results are not as clear cut as the Canadian-based results. The influence of worldwide manufacturing trends does have a role in the Australian context, as does the general impact of an expanding economy. This is represented by the consistent results for the variables around Australian GDP and US manufacturing employment (particularly the two year lag). However the limitations on the explanatory ability of these variables suggest that other variables may also influence changes in manufacturing employment. This is an important consideration that requires further investigation as changes in relative employment levels are an indicator of changes in factor utilisation and hence structural change. Additional research that identifies change triggered by mineral price changes apart from longer-term sector evolution would have significant policy implications.

Finally this analysis has been undertaken on an aggregate manufacturing sector basis. The next step was to search for further insights by examining the manufacturing sector at a disaggregated level. Section 5.3 provides some analysis in this regard as the second hypothesis is examined.

5.3 Hypothesis 2

This hypothesis examined the manufacturing sector at a disaggregated level to discover any evidence that could shed light on the positive relationship between the aggregate manufacturing sector and the mineral price boom of 2003 to 2008. The analysis would also allow for differentiation between (a) the effect of the underlying long-term structural change that has been occurring in response to the previous mineral booms and (b) structural change consistent with the wider Australian economy and worldwide manufacturing.

The following eight sub-sectors of Australian manufacturing were utilised:

- Metal Manufactures (MM);
- Chemical, Rubber and Petroleum (CRP);
- Machinery and Equipment (M&E);
- Non Ferrous Metals (NFM);
- Textile, Clothing and Footwear (TCF);
- Printing and Media (P&M);
- Food and Beverage (F&B); and
- Wood, paper and Furniture (WPF).

These sub-sectors are recorded in *ABS 5206.41 Australian National Accounts: National Income, Expenditure and Product, Table 41 Industrial Production* and also consistent with the sub-sectors utilised in Hambur and Norman (2013).

Figures 5.3 and 5.4 show the annual relative contribution of each sub-sector income to total manufacturing income over the period 1985 to 2014.

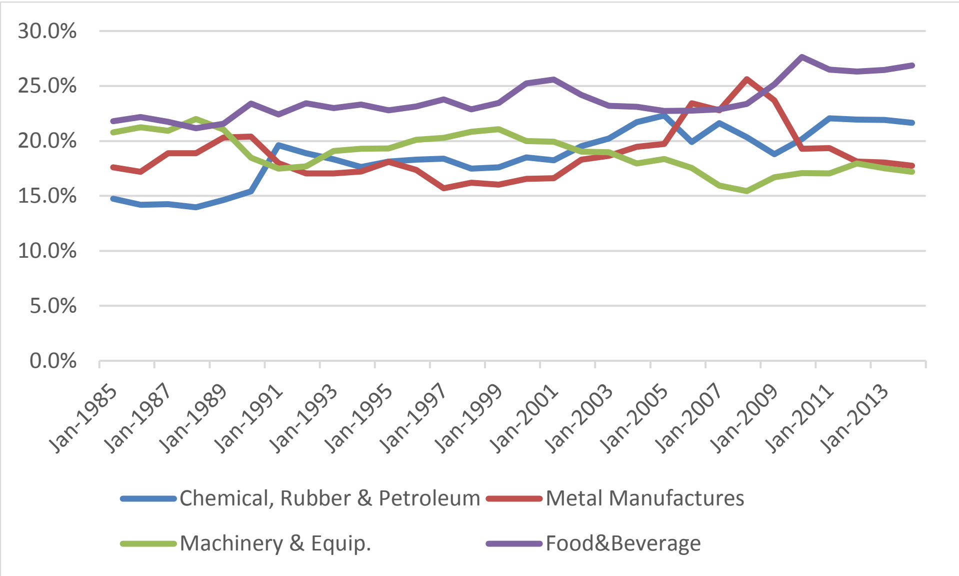

Figure 5.3 Relative Annual Contribution of Sub-Sector Income to Total Manufacturing Income 1985 to 2014

The first four sub-sectors, namely Chemical Rubber and Petroleum, Metal Manufactures, Machinery and Equipment and Food and Beverage are the largest sub-sector contributors within total manufacturing income. Food and beverage was steady around 22 percent until 2008, where it has since increased to 26 percent. Machinery and equipment declined in the 1985 to 2007 but has increased since then, where a lagged response to the mineral export price boom from June 2003 is a possible explanation. Metal manufactures also showed a large increase around the same time as the mineral export-price boom, although since a peak of 25 percent in 2006 has gradually declined to 15 percent in 2014. Chemical, rubber and petroleum contributed 15 percent of total manufacturing income in 1985 and peaked at 20 percent in 1991. It stayed at this broad level of relative contribution since then.

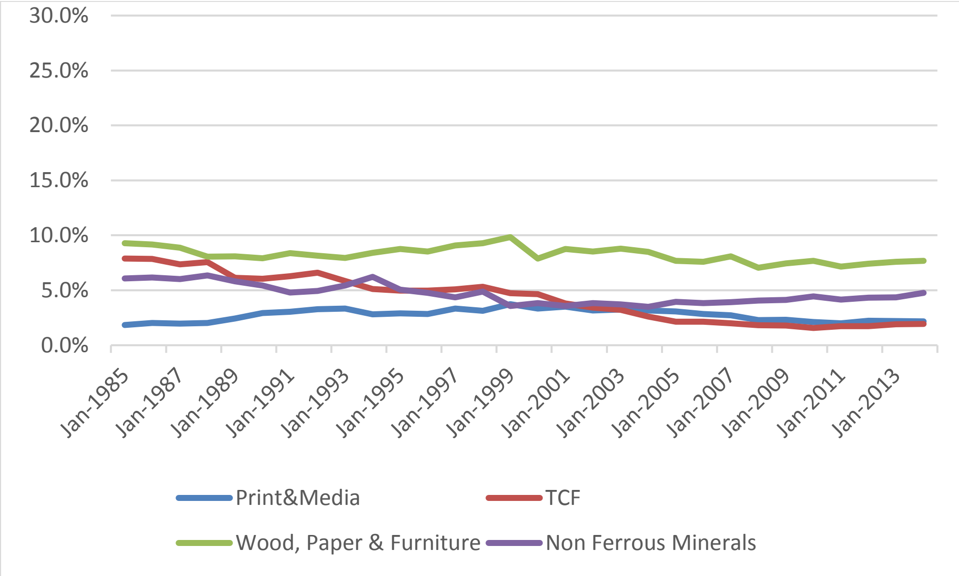

Figure 5.4 Relative Annual Contribution of Sub-Sector Income to Total Manufacturing Income 1985 to 2014

In contrast the next four sub-sectors in Figure 5.4 have individually contributed less than ten percent of total manufacturing income. The Wood, Paper and Furniture sub-sector has remained steady across the time period with a relative contribution of around eight percent. The contribution of the Print and Media sub-sector has also been steady around three percent. Similarly the relative contribution of Non Ferrous Metals sub-sector has been steady around five percent. In contrast the relative contribution of Textile, Clothing and Footwear sub-sector has more than halved from an eight percent relative contribution in 1985 to a three percent contribution in 2014.

In summary the relative contributions of Metal Manufacture, Chemical Rubber and Petroleum and Food and Beverage sub-sector income to total manufacturing income have increased over the period 1985 to 2014. In contrast the relative contribution of the Textile, Clothing and Footwear sub-sector has declined, while the other four sub-sectors have remained steady. It is noted that the relative contribution of the machinery and equipment sub-sector has been more variable over the period than the other three steady sub-sectors.

Regressions similar to Equation 4.1 utilised in the aggregated manufacturing sector have been utilised and are summarised below for all sub-sectors. Detailed analysis and commentary is located in Appendix 3. Throughout the analysis, multicollinearity was considered an issue as evidenced by the same strong correlations between the independent variables. Table 5.5 provides the estimation results for the eight sub-sectors of manufacturing.

Table 5.5

Summary Regression Results for Eight Sub-Sectors of Manufacturing Income September 1987 to June 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	$\check{R}^2$	DW
MM	0.065	-0.048	0.443	0.44	1.66	1.57	0.944	0.002	0.991	1.97
			*	*	*	*	*			
CRP	-0.719	0.448	0.558	0.391	0.109	-0.071	0.91	0.002	0.997	1.66
			*	*	*	*	*			
M&E	-0.193	-0.049	0.556	0.422	0.572	0.527	0.913	-0.001	0.995	1.52
		†	*	*	†	†	*			
NFM	-0.185	0.022	0.71	0.576	-0.008	0.029	0.925	-0.002	0.986	1.43
			*	*			*			
TCF	-0.2	0.009	0.451	0.359	-0.314	-0.029	0.886	-0.004	0.973	1.91
			*	*	†	*	*	†		
P&M	-0.346	0.445	0.708	0.678	0.129	0.079	0.95	0.002	0.973	1.91
			*	*			*			
F&B	-0.198	0.004	0.58	0.5	0.336	0.331	0.96	0.001	0.997	1.99
			*	*			*			
WPF	-0.195	-0.032	0.384	0.345	0.164	0.048	0.918	0.003	0.992	1.82
			*	*			*			

NB. * $p < 0.05$ † $p < 0.10$

Results are included in Appendix 3 together with additional commentary and analysis on each of the eight sub-sectors. Table 5.2 estimated that at an aggregate level Australian manufacturing income had a significant relationship with all determining variables. While the mineral-export price boom dummy did partially offset the impact of the real exchange rate, the combined relationship with manufacturing was still negative.

Table 5.5 shows that at a disaggregated level there are mixed results between the variables. Considering the signs of the real exchange rate variable and the boom dummy variable, only metal manufacturing (MM), machinery and equipment manufacturing (M&E), and wood, paper and furniture (WPF) resemble the aggregate results of a negative relationship between manufacturing income and the real exchange rate, tempered by the boom period. The estimation for metal manufacturing (MM) income confirmed that metal manufacturing income has a significant relationship with both production and producer price indexes, while neither the real exchange rate nor the mineral export-price boom dummy has a significant relationship. This suggests that any change in metal manufacturing income from these latter variables is partially transmitted through either the metal manufacturing production or producer price index.

Similar results are also observed in the estimation results for chemical, rubber and petroleum (CRP) manufacturing income. This does not show a significant relationship with the real exchange rate or the mineral export-price boom. However, there are significant relationships with both production and producer prices. This is somewhat surprising given that petroleum is an energy commodity and other energy commodity prices such as coal have been associated with the mineral export-price boom. A possible explanation of this is the structural composition of the Australian petroleum industry that generates strong exports and well as significant imports. Nonetheless it is also concluded that impact of changes in the real exchange rate and / or mineral export-price boom dummy variable are transmitted through the production and producer price indexes.

The results for machinery and equipment manufacturing income (M&E) are a little more complicated in that there is a significant relationship (i.e. at a five percent level of significance) with production and also with producer prices and the real exchange rate (albeit at a ten percent level of significance). While only significant to ten percent, the results do suggest that the real exchange rate does inversely impact machinery and equipment manufacturing income. Namely where the negative coefficient links an increase in the real exchange rate with a decrease in this sub-sector income. An appreciation of the exchange rate would see decreased import prices of import substitutes, which would then lead to decreased production and ultimately income.

The estimation results for textile, clothing and footwear (TCF) manufacturing income show a relationship with the mineral export-price boom dummy and lagged producer price indexes at a ten percent level of significance and with the current producer price and production variables at a five percent level of significance. These results are consistent with the assumption that this sub-sector is undergoing longer-term structural change as manufacturing is moved to other countries and as a result the longer-term decline in the relative contribution to total manufacturing income is related to this. Notwithstanding this, the significance of the mineral export-price boom also suggests that while income was not impacted by the underlying real exchange rate, additional real exchange rate variability created by the boom did increase this longer-term trend decline.

The estimation results for non-ferrous metal (NFM) manufacturing income; print and media (P&M) manufacturing income; wood, paper and furniture (WPF) manufacturing income; and food and beverage (F&B) manufacturing income all suggest that their respective income values are more responsive to production related variables than the price related variables. That is, their respective producer price indexed, the real exchange rate or the mineral export-price boom. This suggested that longer-term structural change that impacts production are the important consideration rather than the mineral export-price boom (and thus Dutch Disease) implications.

Appendix 3 provides information on additional estimation that was conducted that utilised different combinations of the variables included in the original analysis. While there are some interesting results, they are not considered material enough to impact the above analysis or the discussion in the next section. Notwithstanding this they do highlight that the sub-sector analysis is an important area to consider when examining the role of Dutch Disease theory on the Australian manufacturing sector.

The results at a disaggregated level highlight the complexity of the Australian manufacturing sector and the resultant response to the mineral export-price boom. This complexity includes the longer-term structural change that each sub-sector is undergoing, the resultant impact on the sub-sector contribution to the aggregate Australian manufacturing sector and ultimately any response to the mineral export-price boom. Suffice it to say that results for three sub-sectors have similar coefficient signs as the manufacturing sector in aggregate, and two of these, metal manufacturing and machinery and equipment manufacturing have links to mining. Also the sign of the coefficient for the boom dummy variable is positive (though insignificant) for all sub-sectors, and also positive in the aggregate model.

Discussion

Section 5.2 concluded the aggregate Australian manufacturing income has a significant relationship with manufacturing production, producer prices, the real exchange rate and the mineral export-price boom. Section 5.3 highlighted that the share of Australian manufacturing employment to total Australian employment and the contribution of Australian manufacturing output to total Australian GDP has mirrored worldwide trends in the United States and OECD respectively.

The analysis across the eight sub-sectors of manufacturing has provided some additional results. Figures 5.3 and 5.4 show the relative contribution of each manufacturing sub-sector income to total manufacturing income over the period 1985 to 2014. The relative contributions of food and beverage as well as chemical, rubber and petroleum have increased over the time. The relative contribution of metal manufacturing in 2014 was relatively unchanged as compared with 1985, although it did peak in 2008, which is near the end of the mineral export-price boom. The relative contribution of the three sub-sectors wood, paper and furniture; non-ferrous metals; and print and media have all remained at the same levels and were steady across the whole time period. In contrast the relative contributions of textile, clothing and footwear as well as machinery and equipment have declined. Figure 5.4 shows that the relative contribution of machinery and equipment was at its lowest in 2008, coincidentally around the same time metal manufacturing peaked. It has since increased marginally since that time. A possible explanation for this is investment in the mineral sector resulting from the sustained nature of the export-price boom.

The regression analysis in Table 5.5 has provided mixed results across the eight sub-sectors of manufacturing. Unlike the aggregate level analysis in Section 5.2, at a disaggregated level only the textile, clothing and footwear manufacturing sub-sector has a significant relationship with the mineral export-price boom dummy variable, albeit at a ten percent level of significance. Similarly the machinery and equipment manufacturing sub-sector income has a significant relationship with the real exchange rate, again at the ten percent level of significance.

These two sectors, as well as metal manufactures and chemical rubber and petroleum have significant relationships with their respective production and price indexes. This suggests that these sectors may see real exchange rate and mineral export-price index changes transmitted through the producer price indexes rather than direct to the respective sub-sector income levels.

In contrast the remaining four sectors of (i) textile, clothing and footwear, (ii) non-ferrous metals, (iii) food and beverage, and (iv) print and media all have significant relationships with their respective production related variables. This suggests that longer-term structural changes have a more significant relationship than changes in the real exchange rate or the producer price.

The analysis in Appendix 3 highlighted possible multicollinearity between the real exchange rate and respective producer price indexes. This is evidenced where the omission of various price indexes in estimation sees a change in the level of significance of the retained variables. Additional research at a disaggregated level would need to address these various elasticities as part of the analysis.

In summary the results suggest that aggregate manufacturing income does have a significant relationship with the real exchange rate, production, producer prices and the mineral export-price boom. However this relationship does not exist in a straight-forward manner across the eight sub-sectors of manufacturing. Each sub-sector has an individual relationship with their respective variables. The mineral export-price boom has assisted some sectors, increased / decreased the rate of structural change in others, or alternatively has had no impact in other sub-sectors. It is concluded that the mineral export-price boom (i.e. Dutch Disease) has had mixed impact at the disaggregated level of manufacturing.

5.4 Hypothesis 3

The third and final hypothesis (H3) involves an examination of the income balance in the Australian current account and the responsiveness of the real exchange rate to the terms of trade and monetary variables. From Section 4.3.2 the proposed model includes four independent variables, that is, the terms of trade (TOT), real interest rate differential (INTDIFF), trade intensity (TRADEINT) and income balance within the current account (INCBAL), and is summarised in Equation 4.1.

Step 1

Table 5.6 summarises the results of the Augmented Dicky Fuller test (ADF) to measure the stationarity of the variables. None of the variables records a critical value of 10 percent or better at their nominal value. However, all record a 1 percent critical level at first differences. This satisfies Step 1 of the error-correction techniques as detailed in Section 4.5.1 - that all variables are integrated at the same order, namely I(1). The analysis was completed using E Views and the output reports are contained in Appendix 5.

Table 5.6

Summary Augmented Dicky Fuller Tests for Stationarity

	RER	TOT	INTDIFF	TRADEINT	INCBAL
Nominal value	-2.12	-0.1	-2.32	-1.87	-3.1
First Differences	*-7.57*	*-6.34*	*-8.26*	*-8.87*	*-9.59*
1% Critical Value	-3.49	-3.49	-3.49	-3.49	-3.49
5% Critical Value	-2.89	-2.89	-2.89	-2.89	-2.89
10% Critical Value	-2.58	-2.58	-2.58	-2.58	-2.58

From this an OLS regression was conducted utilising the nominal values of these variables and residuals were generated. These residuals were also tested for stationarity utilising ADF techniques, and results are attached in Appendix 5. Analysis shows an ADF critical value at their nominal level of -5.34, which makes it significant at the 1 percent level utilising the critical values as detailed in Table 5.8. This satisfies Step 2 of the error-correction techniques as detailed above, namely that the residuals are integrated at a higher order than the variables, in this case I(0) versus I(1) for the variables in the equation.

Step 2.1 – OLS Regression

OLS Regression utilising the nominal values of the variables and the residuals generated above were conducted utilising E Views and the results are attached in Appendix 5. Log values for all variables were utilised except the real interest rate differential. The time period adopted is first quarter 1984 to first quarter 2010. Table 5.7 summarises this analysis. The results are all considered significant given the strong t statistics for each variable and the F statistic. The Durbin-Watson measure also suggests that there is no auto-correlation problem within the residuals of this equation.

The results suggest that a 1 percent change in the terms of trade leads to a 0.82 percent change in the real exchange rate on the average.

It is noted that the real interest rate differential is not a log value as the differential has recorded positive and negative figures over the time period in question. Care is required when interpreting the results as a differential value of 0.01 represents a one percent real interest rate differential. Therefore a one percent change in the real interest rate differential in this example is in effect 1/100 of 1 percent, or one basis point (e.g. 1 percent to 1.01 percent). The results suggest that a one percent movement in the underlying interest rate differential has only a minor impact on the real exchange rate.

Table 5.7

Results Error Correction OLS Regression Q1 1984 to Q1 2010

	Co-efficient	Value	t Stat
Constant	β_0	2.73	*31.9*
TOT	β_1	0.82	*29.8*
INTDIFF	β_2	0.0001	*6.5*
TRADEINT	β_3	-0.25	*-16.1*
INCBAL	β_4	-0.04	*-4.1*
ERRORCOR	β_5	-0.6	*-7.4*
Adjusted R Square		0.925	
F Statistics		257.6	
Durbin-Watson		1.943	

In contrast a one percent change in trade intensity leads to a negative 0.25 percent change in the real exchange rate. This provides valuable insight as an increase in trade intensity can be triggered by either a growth in exports or a growth in imports as a percentage of Australian GDP. The negative sign suggests a small devaluation in the exchange rate from any increase in trade intensity, suggesting that the growing role of the traded sector is having an overall negative impact on the real exchange rate, and that import value growth may offset the role of export value growth in setting the value of the real exchange rate. This is consistent with the role of import prices in the determination of the terms of trade, as well as Gregory (1976).

The role of the income balance in exchange rate determination is also surprising, where the results suggest that a 1 percent increase in the income balance (as a percentage of the current account deficit) leads to a negative 0.04 percent change in the real exchange rate. Given the role of the income balance in the current account deficit the value of this co-efficient is lower than expected, although it is consistent with the lower than expected role of the real interest rate differential as well.

The error correction term shows that 60 percent of any short-term variation from the longer-term equilibrium corrects in the same quarter.

Step 2.2 – Johansen Technique

In addition to the OLS regression, Johansen's (1988) maximum likelihood techniques can also be utilised in error correction analysis. As discussed in Section 4.5.1 Johansen (1988) developed a procedure that captures the underlying time series properties of the data and estimates all co-integrating vectors that may exist within a vector of variables. This may be a unique co-integrating vector or a linear combination of several co-integrating vectors. In effect, there are a series of co-integrating vectors hypothesised - usually from zero to one less than the number of independent variables in the model (Alemu *et al.*, 2003; Bagchi *et al.*, 2003; Blundell-Wignall *et al.*, 1993; Chowdhury, 1993; Dougherty, 2011; Enders, 2003; Gruen & Wilkinson, 1991; Johansen, 1988; Swift, 1998).

The standard procedure utilising the Johansen (1988) procedure is to commence at a null hypothesis of nil co-integrating relationships and then proceed until there is a failure to reject the null hypothesis. The results are tested utilising two blocks of results – trace statistics and maximum Eigen value statistics. All four exogenous variables are considered - terms of trade, real interest differential, trade intensity and the income balance, and the Real TWI is nominated as an endogenous variable.

Johansen's Test for Co-integration was undertaken over the time period June Quarter 1994 to March Quarter 2010 utilising E Views. A summary of output is provided in Appendix 5. Table 5.8 provides a summary of both the trace statistics and the maximum Eigen statistic. Both provide a rejection of the null hypothesis of zero co-integrated relationships, but then fail to reject any higher number of relationships. Based on this the test, the conclusion is that there is one co-integrated relationship among the five variables (i.e. between the real exchange rate and one of the four exogenous variables).

Table 5.8

Summary Results for Johansen Testing for Co-integrating Relationship Q21984 to Q12010

Null Hypothesis (no. of co-integrating equations)	Trace Statistic	Critical Value	Prob.** (0.05)	Max-Eigen Statistic	Critical Value	Prob ** (0.05)
None *	*71.956*	*69.819*	*0.033*	*34.094*	*33.877*	*0.047*
At most 1	37.862	47.856	0.308	19.764	27.584	0.358
At most 2	18.098	29.797	0.559	10.396	21.132	0.707
At most 3	7.702	15.495	0.498	7.683	14.265	0.412
At most 4	0.019	3.841	0.891	0.019	3.841	0.891

* Rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Normalised coefficients for each variable are also generated from the analysis and expressed in the format:

RER – TOT – INTDIFF – TRADEINT – INCBAL = 0 **Equation 5.1**

Normalised coefficients (with levels of significance in italics) are as follows:

RER – 0.73*TOT -0.0002*INTDIFF + 0.16*TRADEINT + 0.5*INCBAL = 0 **Equation 5.2**

(0.05) ***(-0.00004)*** ***(0.03)*** ***(.02)***

Rewriting this sees the following equation developed:

RER = 0.73*TOT + 0.0002*INTDIFF - 0.16*TRADEINT - 0.5*INCBAL **Equation 5.3**

All coefficients are statistically significant. The results from the Johansen (1988) technique are broadly in line with those from the OLS regression in Step 2.1 above.

Table 5.9

Comparison OLS and Johansen Regression Coefficients

	OLS	Johansen
Terms of Trade	0.83	0.73
Real Interest Differential	0.000135	0.000176
Trade Intensity	-0.26	-0.16
Income Balance	-0.05	-0.05

Table 5.9 compares the respective coefficients that have been generated for each exogenous variable from the OLS regression and the Johansen technique. There is broad agreement between the two estimates. There are small discrepancies in the coefficient on the terms of

trade and trade intensity, while the real interest rate differential and income balance are similar. All coefficient signs are the same.

One final issue remaining from the Johansen technique is consideration of which exogenous variable has a co-integrating relationship with the real exchange rate. This variable is not easily identified from the Johansen (1988) technique. However, it can be established by undertaking a series of single equation OLS regressions between the real exchange rate and each exogenous variable.

As detailed in Table 5.6 all variables are integrated at first differences (i.e. the same order). As discussed above, a co-integrated relationship will generate stationary residuals from OLS regressions at a higher order - in this case at their nominal value.

A series of univariate OLS regressions have been conducted between the Real TWI and terms of trade, real interest rate differential, trade intensity and income balance individually, and the residuals from the previous time period. The time period and data utilised are the same as previous testing (Q1 1984 to Q1 2010). This analysis has been conducted through E Views and summary output is attached in Appendix 4. The respective residuals are tested for stationarity using Augmented Dicky Fuller Tests to confirm if the equation exhibits error correction tendencies (Table 5.10).

Table 5.10

Augmented Dicky Fuller Test Statistics on Residuals on Selected Univariate Regressions

Univariate Regression between Real TWI and	Residual Stationarity	1% Critical value	5% critical value	10% Critical value
Terms of Trade	-4.078	-3.493	-2.889	-2.582
Real Interest Differential	-2.198	-3.493	-2.889	-2.582
Trade Intensity	-2.472	-3.493	-2.889	-2.582
Income Balance	-1.549	-3.493	-2.889	-2.582

Table 5.10 summaries the Augmented Dicky Fuller test statistics on the series of univariate OLS regressions, and shows that the co-integrating relationship is between the real exchange rate and the terms of trade. While there is a significant relationship between the real exchange rate and real interest differential, trade intensity and income balance respectively, the terms of trade maintains its co-integrated and dominant relationship. Furthermore, this is statistically significant at the one percent level. This result is consistent with previous studies such as Gruen and Wilkinson (1991), Blundell-Wignall *et al*. (1993) and Bullock *et al*. (1993).

Discussion

The results from the error correction modelling techniques are in line with previous studies. Both models confirm that there is a long-term co-integrating relationship between the real exchange rate and the terms of trade - a 1 percent change in the terms of trade leads to a 0.73 to 0.83 change in the real exchange rate. This is consistent with previous studies such as Gruen and Wilkinson (1991), Blundell-Wignal *et al.* (1993), Bleaney (1996), Wren-Lewis

(2004) and Hatzinikolaou and Polasek (2005), who all found similar co-integrating relationships of between 0.5 to 1.08.

Similarly, the error correction value of 0.6 is also broadly in line with the 0.67 established by Hatzinikolaou and Polasek (2005). This suggests that 60 percent of any deviation from the long-term equilibrium occurs in the same quarter, 24 percent the second (i.e. 60 percent of the remaining 40 percent), and 10 percent the third quarter (i.e. 60 percent of the remaining 16 percent) and so forth. Accordingly, these results can be considered to be in line with the previous studies detailed above. Notwithstanding this there are two areas that merit further discussion.

The first relates to the distribution of results from the modelling, that is, the trade related exogenous variables record strong results whereas the monetary related exogenous variables do not. For example, the coefficients for the terms of trade and trade intensity are 0.83 and minus 0.26 respectively compared to the real interest rate differential of 0.000135 (which is not directly comparable with the size of the other coefficients, which are elasticities, but actually is the smallest of the elasticity values) and the income balance within the current account deficit of minus 0.05. While all four results are considered significant (as per their respective test statistics), the size of the coefficients for the trade related variables is much greater and suggests a much stronger influence on the real exchange rate.

The lower role of the monetary related variables could relate to discussion in Section 3.6.1 about Australia being reliant on foreign capital and the importance of inter-temporal considerations with this importation of foreign capital. That is, Australia imports foreign capital on a long-term basis and then utilises income from its commodity exports to repay this capital.

The second issue relates to the Australian economy being essentially a segregated economy. While the traded sector has increased relative to Australian GDP, the role of the key export commodity sectors of mining cannot be considered dominant to the wider economy. For example Tables 3.1 and 3.3 shows mining contribute some 7 percent to Australian GDP and 2 percent to total Australian employment, respectively. In contrast Table 3.9 shows that mining contributes in excess of 50 percent of total exports. Furthermore, the relative contribution of manufactured exports to total exports is largely unchanged while the relative contribution of the manufactured sector to Australian GDP and employment has declined.

This suggests that the Australian economy may have two segregated components. The first is a specialised export sector that almost exclusively exports its annual production, and the second a largely separate domestic economy that relies on manufactured imports, but at the same time has non-export related activities as well.

Therefore a real exchange rate that has a stronger relationship with the terms of trade and trade intensity as highlighted in the error correction model is understandable.

Chapter 6 Conclusions

6.1 Introduction

This chapter concludes the thesis and brings together the key themes, issues and findings. The contribution to knowledge is also discussed, together with possibilities for future research. Finally some limitations of the findings are provided.

Australia has long been considered a commodity-based economy, with a commodity- driven exchange rate. The literature showed that trade has always been an important component of the Australian economy, where exports have largely consisted of primary products, imports have consisted of manufactured goods, and there is an underlying reliance on the importation of foreign labour and capital (Kriesler 1995; Promfert 1995). It also highlighted that, in addition to the mineral export price-boom of 2003 to 2008, the Australian economy had been undergoing long-term structural change in response to two critical influences. The first was the collapse of the Bretton Woods Agreement in 1973 that has seen the world economy become more open in both trade and capital movement, as well as the associated deregulation of world financial markets. The second was the Australian mineral boom commencing in the early 1970s.

An overriding theme from the perspective of trade theory (the Heckscher-Ohlin theory, the Prebisch-Singer hypothesis, Gregory thesis, Dutch Disease) as well as Australian exchange rate studies was the expected decline in the manufacturing sector resulting from a booming mineral export sector. This process of "de-industrialisation" was where the booming export sector draws labour and capital away from the lagging (manufacturing) export sector. However recent literature such as Ismail (2010), Gregory (2011), Thompson *et al.* (2012), Hambur and Norman (2013) concluded that a mineral export boom could have implications different from expectations given the differences in factor utilisation, the economy undergoing structural change and differential impact at a disaggregated levels within an economy. Furthermore Gregory (2011) suggested that the Australian economy may have already restructured in response to the previous mineral boom (i.e. as detailed in Gregory 1976).

Chapter 3 discussed developments in the Australian economy and traded sector in the 30 years since the 1980s. The chapter provides a detailed overview on the sectoral composition of the Australian economy, including discussion on the various sectoral contributions to GDP, total employment and real private capital expenditure. The chapter also detailed the growing role of the Australian traded sector, key export and import goods, and the growing role of the income balance within the current account. The important conclusions from Chapter 3 included:

- That the contribution of the manufacturing sector to Australian GDP had declined from 23 percent in 1982/83 to 8 percent in 2010/11. Similarly the sector's contribution to total Australian employment has declined from 18 percent to 9 percent over the same period;
- Across the same time period the contribution of the mineral sector increased from 3.5 percent to 7 percent, which placed it around the same contribution levels as finance and insurance, construction, and ownership of dwellings. Notwithstanding this, the sector still accounted for less than 2 percent of total Australian employment as at 2010/11;

- Movements in the contribution these sectors to real private capital expenditure were also as expected. The mineral sector accounted for 39 percent of expenditure in 2010/11 against 15 percent in 1987/88. In contrast manufacturing accounted for 10 percent of expenditure in 2010/11 against 25 percent in 1987/88;
- Real Australian GDP (as measured by chain volumes) has increased by 2.45 times over the period 1983/84 to 2010/11. In contrast the traded sector has increased by 5.36 times over the same period, with exports increasing 4.28 times and imports increasing 6.97 times. This highlighted the growing role of the traded sector within the broader economy; and,
- The contribution of manufacturing to total exports was 14 percent in 2010/11, which is broadly in line with its contribution in 1983/84, although lower than its 22 percent contribution in 1997/98.

When linked with the Dutch Disease literature these conclusions saw the development of the three research questions of this thesis: did the mineral export price boom of 2003 to 2008 impact on the Australian manufacturing sector as Dutch Disease theory suggests? Have there been substantial changes at a disaggregated level in the Australian manufacturing sector in response to that price boom? Has the increased role of the income balance resulted in the real exchange rate being less responsive to changes in the Australian terms of trade and more responsive to monetary variables?

6.2 Findings

The major findings of this research are summarised below together with a discussion on how findings have contributed to the wider understanding of the field of study.

6.2.1 Aggregate Manufacturing

The first hypothesis was that at an aggregate level the manufacturing sector would not be impacted by the mineral export-price boom of 2003 to 2008 in the manner as suggested by Dutch Disease theory. This was based on the premise from both Gregory (2011) and Acharya and Coulombe (2009). That is, the impact of Dutch Disease would be softened by the fact that the Australian economy was already undergoing structural change from the previous mineral boom and also in response to worldwide economic changes.

At an aggregate level the mineral export-price boom from 2003 to 2008 did have an impact on manufacturing income, although neither as strong nor as expected by Dutch Disease literature. The findings (summarised in Tables 5.2, 5.3 and 5.4) suggest that total Australian manufacturing income had a significant relationship with the real exchange rate, the level of Australian manufacturing production and manufacturing prices. The significance and nature of the respective relationships were as expected. However the results related to the impact of the mineral export-price boom suggest that additional real exchange rate variability triggered by the boom partially offset the existing relationship with the real exchange rate. That is, aggregate manufacturing income increased when the mineral export-price boom triggered an increase in the real exchange rate and vice versa. This suggests that the impact of the mineral export-price boom may be more complex than that suggested by Dutch Disease theory, as highlighted by Gregory (2011) and Hambur and Norman (2013). This is an important finding of this thesis.

Further analysis at the aggregate level sought to disentangle the impact of the mineral export-price boom from longer-term structural change as suggested by Acharya and Coulombe (2009) and Beine *et al*. (2010). Figures 5.1 and 5.2 showed that the employment share of Australian manufacturing to total Australian employment as well as Australian manufacturing output against Australian GDP have been similar to those recorded in the United States and the OECD respectively. In both cases the underlying value of manufacturing employment and manufacturing output have remained steady in absolute terms against an expanding aggregate employment and growing GDP. As a result the relative contributions of manufacturing have declined.

Furthermore Equations 5.4 and 5.5 sought to disentangle the impact of the mineral export-price boom from that of longer-term structural change. The results in the Australian context have not been as conclusive as the Canadian studies that this analysis was based on. Notwithstanding this there is some evidence that worldwide trends in manufacturing employment have impacted on the contribution of Australian manufacturing to employment.

The longer-term structural change in manufacturing and its contribution to the wider economy is suggested by the relative decline in the respective contributions to total Australian employment and GDP. In contrast real private capital expenditure is being drawn towards the mineral export sector as evidenced by Table 3.5 and discussed above. The mineral export-price boom between 2003 and 2008 is a likely reason for this increase in real private capital expenditure within the mineral sector.

The overall impact of the mineral export-price boom is that it assisted aggregate manufacturing income, by partly offsetting the underlying negative impact of the real exchange rate. This suggested that the boom may have slowed down a process of "deindustrialisation" that was already occurring rather than triggering a further reallocation of resources away from the manufacturing sector.

These results are an important finding of this thesis as they suggest that any analysis of structural change triggered by a mineral export-price boom also needs to take into account longer-term structural change that may be already occurring. It highlights that microeconomic analysis may be useful when considering the impact of any structural change, given the sub-sectoral complexities surrounding utilisation rates of labour and capital as well as the differing role of the exports of different manufactured products. It is consistent with Hambur and Norman (2013) who suggested the potential for a two-speed economy and the need for disaggregated industry analysis. Similarly Gregory (2011) suggested that longer-term trends needed to be included in any analysis of the reallocation of resources within the economy.

6.2.2 Disaggregated Manufacturing

In addition to analysis of the manufacturing sector at the aggregate level, further analysis was undertaken at a disaggregated level. Eight sub-sectors of manufacturing income were examined with some differing outcomes. Metal manufacturing income increased in its relative contribution to total manufacturing income over the period 1995 to 2014. Regression results confirmed that this sub-sector had a significant relationship with the real exchange rate, its production and producer price indices as well as a positive relationship with the mineral export-price boom (the boom). In effect this sub-sector was increasing its role with the aggregate manufacturing sector as part of longer-term structural change and the boom added to this relative increase. This is not surprising given the linkage between the metals manufactured in this sub-sector and the mineral sector. The timing of the boom from 2003 to 2008 also coincides with the peak contribution of the metal manufactures to GDP.

Similar to metal manufacturing income, the relative contribution of chemical, rubber and petroleum sub-sector income to total manufacturing income has increased between 1985 and 2014. Its initial peak contribution was around 22 percent in 2006 at it has stayed steady since that time. Regression results in Table 5.4 confirmed that neither real exchange rate nor the mineral export-price boom had a significant relationship with this sub-sector's income. This is somewhat surprising given that petroleum is a major export commodity and it would be expected that both the real exchange rate and / or boom would have an impact. A possible explanation of this is the complex nature of the petroleum sector, where this good is both a major imported good as well as an exported good. Furthermore different categories of petroleum are imported and refined against those that are exported. In these circumstances longer-term factors producer price are more influential on this sub-sector than the shorter-term factors of real exchange rate and mineral export-price boom.

Similar longer-term structural issues are also more significant for the non-ferrous metal, print and media, and wood, paper and furniture sub-sectors of manufacturing income. None of these sub-sectors saw a significant relationship between their respective income levels and either the real exchange rate or the mineral export-price boom. In contrast there was significant regression results with their production and producer price indexes. Similar to the previous sub-sector, these results suggest that longer-term structural forces are more important. It is noted that these three sub-sectors have all maintained a steady contribution to total manufacturing over the period 1985 to 2014.

The relative income contribution of the food and beverage sub-sector has increased from 22 percent to 27 percent. However the regression results in Table 5.4 show that the boom achieved mixed results as a determinant of food and beverage manufacturing income. When all variables are included there is no significant relationship between the mineral export-price boom and income.

Textile, clothing and footwear manufacturing income is the inverse of metal manufacture income. That is, over the period 1985 to 2014 the relative contribution of this sector has been declining, and the regression results suggest that the boom period enhanced the decline in contribution. The textile, clothing and footwear manufacturing sub-sector can also be considered to have been impacted as predicted by Dutch Disease theory.

The final sub-sector is machinery and equipment manufacturing income, which is arguably the most variable of all sub-sectors as shown in Figures 5.3 and 5.4. The regression results in Table 5.4 suggest that this sub-sector is more influenced by production and the real exchange rate rather than the mineral export-price boom or producer prices.

In short of the eight sub-sectors of manufacturing income, results suggest that five sub-sectors have not been impacted at all. Of the remaining three sectors, only the textile, clothing, and footwear sub-sector evidenced responses to income that are consistent with Dutch Disease theory. The final sector, metal manufactures (which has important linkages to mining) saw an increase in income from the mineral export-price boom. It is noted that this is the largest sub-sector in relative contribution to total manufacturing income and that increases in this sub-sector may have more than offset declines in textile, clothing, and footwear income.

The conclusion that the mineral export-price boom has had a mixed and varying impact on the various sub-sectors of Australian manufacturing is an important one. This is for two reasons. The first is that Australian manufacturing is quite diverse in scope and will utilise different combinations of factors depending on the nature of the good as well as the geographic location. For example print and media manufacturing will utilise different technology and labour-capital ratios than machinery and equipment manufacturing or food and beverage manufacturing.

The second is that it requires significant change to amend underlying structural change in the economy. This change can relate to change that is translated from worldwide trends to that taking place within particular industries (e.g. technology and globalisation within print and media). While the mineral export-price boom of 2003 to 2008 was long compared with historical boom periods, the underlying structural change in the Australian economy and manufacturing sector has been occurring for nearly 30 years. Perhaps a six-year boom was still not long enough to alter these longer-term structural changes. This is another important finding of this thesis.

6.2.3 Australian Exchange Rate

Section 5.4 considered the growing role of the income balance in the current account balance and the growing role of the traded sector within the economy, and whether monetary considerations are an important component of the determination of the Australian real exchange rate. Error correction modelling of the relationship between the real exchange rate and the terms of trade, real interest rate differential, trade intensity and income balance confirm that there is a co-integrated relationship between the real Australian exchange rate and the terms of trade, and that any deviations from this relationship correct themselves at approximately 60 percent per quarter. These findings are in line with previous literature and suggest that the Australian exchange rate still has a long-term co-integrated relationship with the terms of trade. While other variables such as the real interest rate differential, trade intensity and the income balance have significant relationships with the real Australian exchange rate, the dominant variable remains the terms of trade.

This result is a little surprising given the increased role of the income balance within the current account and the increased size of the traded sector. Both of these factors could be expected to alter the long established relationship between the real Australian exchange rate and the Australian terms of trade.

6.3 Contribution of Research

This research project has had the objective of measuring the impact of the mineral export-price boom from 2003 to 2008 on the structural change of the Australian economy over the last 30 years. While in boom terms this was considered lengthy and sustained, perhaps it is not so long when compared with the length of impact of this longer-term structural change. Moreover, the impact of the mineral export price boom has not been as large as Dutch Disease theory would suggest. These mixed findings confirm the conclusion from Hambur & Norman (2013), who suggested that any changes would be felt at the disaggregated level, in terms of different responses in different sub-sectors of manufacturing rather than the aggregated level. The findings also support their comment that the impact of Dutch Disease-like symptoms is often over-simplified when examining an economy at the aggregated level.

In addition to issues such as different speeds in different sectors within an economy, the findings also suggest that different factor utilisation between sub-sectors also need to be considered.

Also identified are some differences within the eight sub-sectors of manufacturing and any research on the impact of Dutch Disease needs to be at a disaggregated level. It has also identified what sub-sectors of manufacturing are more responsive to shorter-term variables such as the real exchange rate and mineral export-price boom, from the longer-term fundamentals such as production and producer prices.

The findings of this research project are not consistent with those in Beine *et al.* (2011), who disentangled the commodity price and real exchange rate impact on the share of Canadian manufacturing to total Canadian employment with structural factors. In an Australian context the wider impact of structural change on the role of Australian manufacturing to total employment is not as defined or clear as the Canadian based study. Similarly the findings of this research project do not mirror the results of Acharya and Coulombe (2009), who highlighted the role of a booming commodity price and real exchange rate in the restructuring of Canadian employment from trade-exposed manufacturing to the primary and service sectors.

The re-examination of the co-integrated relationship between the terms of trade and the real exchange rate is the final contribution of this thesis. The results are largely in line with previous studies, and suggest that the terms of trade is still the main determinant of the real exchange rate despite recent growth in the income balance and role of the traded sector within the Australian economy. The co-integrated relationship between the real exchange rate and terms of trade is still in existence.

6.4 Future research

Several areas for future research have been thrown-up while conducting this project. The first of these is to investigate further the impact of the mineral export-price boom on the disaggregated sub-sectors of the manufacturing sector. Investigation into employment and capital expenditure utilisation within these sub-sectors and how they respond to price triggers and impact income would be useful to micro-economic and industry-based policy makers. Similarly deeper analysis of production changes based on chain volume measures would also provide insight for policy makers, as this would further differentiate between price impacts and volume impacts.

Similarly further analysis to disentangle longer-term structural change from mineral export-price boom (or other short-term triggers) would also be useful. Co-integration techniques could be utilised to highlight possible relationships between sub-sectors of manufacturing that could include suitable lagged periods as well.

It is also noted that much of this thesis has focused on the manufacturing sector. Possible future research could also examine other sectors in the economy that have export components and that are also more sensitive to exchange rate changes. For example sectors such as agriculture (aggregated and disaggregated), education, and financial services may all be worth considering suitable for future investigation given their importance to the economy and the export sector.

A final area of research is further analysis on the real exchange rate and the relationship between the terms of trade, real interest rate differential, trade intensity and income balance. While a long-term co-integrated relationship exists between the real exchange rate and terms of trade, additional modelling into the impact of the other three variables on the short-term dynamics of the error-correction modelling could provide worthy of further investigation.

6.5 Limitations

Dutch Disease related techniques such as those utilised in Acharya and Coulombe (2009), Beine *et al.* (2011), and Hambur and Norman (2013) all provide an opportunity to examine the impact of Dutch Disease within the wider economy as well as the manufacturing sector. Notwithstanding this, the findings of this research have identified possible areas for future investigation that could utilise these techniques. That is, this thesis sought to differentiate the impact on the Australian economy between longer-term structural change and the mineral export-price boom.

Another limitation of this research is that additional analysis on employment and capital expenditure utilisation between and within the eight sub-sectors was not covered as the focus was on manufacturing income. Additional analysis utilising chain volume measures may be more appropriate when considering the impact on demand for labour and capital. This is the next stage of research that could provide some useful insights. Also important would be the consideration of different factor intensities in the different sub-sectors of manufacturing.

Notwithstanding this this thesis has highlighted that the impact of the mineral export-price boom on the Australian economy is more complex than initially thought. The short-term nature of the boom when compared to longer-term structural change requires consideration in the development of any further studies. The development of a cross sector and sub-sector model that includes these longer-term dynamics as well as shorter-term, Dutch-Disease-related variables would provide valuable insights for policy makers.

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Appendix 1

Total Manufacturing Income – All Variables

Dependent Variable: LOG(TOTALMANINC)
Method: Least Squares
Date: 07/09/15 Time: 17:20
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(TOTALMANINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)
*LOG(TOTALMANPROD)+C(4)*LOG(TOTALMANPROD(-1))+C(5)
*LOG(TOTALMANPPI)+C(6)*LOG(TOTALMANPPI(-1))+C(7)
LOG(TOTALMANINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.062799	0.110468	0.568485	0.5710
C(2) RER(-1)	-0.029177	0.014956	-1.950885	0.0538
C(3) Prod	0.559819	0.078974	7.088631	0.0000
C(4) Prod(-1)	-0.472475	0.086767	-5.445349	0.0000
C(5) PPI	0.392936	0.110473	3.556852	0.0006
C(6) PPI (-1)	-0.369144	0.104166	-3.543814	0.0006
C(7) Income (-1)	0.903976	0.040349	22.40372	0.0000
C(8) Boom	0.001904	0.000894	2.131314	0.0355

R-squared	0.993123	Mean dependent var	4.550903
Adjusted R-squared	0.992651	S.D. dependent var	0.155030
S.E. of regression	0.013291	Akaike info criterion	-5.733580
Sum squared resid	0.018017	Schwarz criterion	-5.537182
Log likelihood	323.3469	Hannan-Quinn criter.	-5.653920
F-statistic	2104.150	Durbin-Watson stat	1.928010
Prob(F-statistic)	0.000000		

Total Manufacturing Income – No PPI

Dependent Variable: LOG(TOTALMANINC)
Method: Least Squares
Date: 08/03/15 Time: 15:30
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(TOTALMANINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)
*LOG(TOTALMANPROD)+C(4)*LOG(TOTALMANPROD(-1))+C(7)
LOG(TOTALMANINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.008255	0.096910	0.085186	0.9323
C(2) RER	-0.013040	0.009978	-1.306880	0.1941
C(3) Prod	0.611619	0.081253	7.527328	0.0000
C(4) Prod (-1)	-0.509172	0.090478	-5.627598	0.0000
C(7) Income (-1)	0.908459	0.036626	24.80354	0.0000
C(8) Boom	0.002395	0.000819	2.922201	0.0043

R-squared	0.992263	Mean dependent var	4.550903
Adjusted R-squared	0.991891	S.D. dependent var	0.155030
S.E. of regression	0.013961	Akaike info criterion	-5.652142
Sum squared resid	0.020270	Schwarz criterion	-5.504843
Log likelihood	316.8678	Hannan-Quinn criter.	-5.592397
F-statistic	2667.479	Durbin-Watson stat	1.997439
Prob(F-statistic)	0.000000		

Total Manufacturing Income – No RER

Dependent Variable: LOG(TOTALMANINC)
Method: Least Squares
Date: 08/03/15   Time: 15:35
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(TOTALMANINC)=C(1)+C(3)*LOG(TOTALMANPROD)+C(4)
*LOG(TOTALMANPROD(-1))+C(5)*LOG(TOTALMANPPI)+C(6)
*LOG(TOTALMANPPI(-1))+C(7)*LOG(TOTALMANINC(-1))+C(8)
*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.013584	0.104695	-0.129745	0.8970
C(3) Prod	0.583383	0.079101	7.375166	0.0000
C(4) Prod (-1)	-0.511671	0.085551	-5.980923	0.0000
C(5) PPI	0.314440	0.104277	3.015427	0.0032
C(6) PPI (-1)	-0.326005	0.103169	-3.159921	0.0021
C(7) Income (-1)	0.942033	0.035798	26.31522	0.0000
C(8) Boom	0.001560	0.000888	1.756994	0.0819

R-squared	0.992866	Mean dependent var	4.550903
Adjusted R-squared	0.992450	S.D. dependent var	0.155030
S.E. of regression	0.013470	Akaike info criterion	-5.715128
Sum squared resid	0.018689	Schwarz criterion	-5.543279
Log likelihood	321.3320	Hannan-Quinn criter.	-5.645425
F-statistic	2389.122	Durbin-Watson stat	1.908033
Prob(F-statistic)	0.000000		

Appendix 2

Manufacturing Employment – All Variables

Dependent Variable: LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHA
RE(-1))
Method: Least Squares
Date: 02/28/16 Time: 12:39
Sample (adjusted): 1989 2014
Included observations: 26 after adjustments
LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHARE(-1))=C(1)+C(2)
*LOG(AUSTMANEMPSHARE(-1))+C(3)*LOG(REALTWI)+C(4)
*LOG(REALAUSTEXPPRICE)+C(5)*LOG(REALAUSTGDP)+C(6)
*LOG(USMANEMPSHARE(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.930998	2.132923	1.843009	0.0802
Aust Man Employ (-1)	-0.638245	0.190569	-3.349147	0.0032
Real Exchange Rate	-0.026803	0.056992	-0.470294	0.6432
Real Aust Export Price	0.018803	0.062102	0.302783	0.7652
Aust GDP	-0.341113	0.193937	-1.758885	0.0939
US Man Employ (-1)	0.131091	0.230074	0.569775	0.5752

R-squared	0.370259	Mean dependent var	-0.025170
Adjusted R-squared	0.212824	S.D. dependent var	0.029267
S.E. of regression	0.025967	Akaike info criterion	-4.264826
Sum squared resid	0.013485	Schwarz criterion	-3.974496
Log likelihood	61.44274	Hannan-Quinn criter.	-4.181222
F-statistic	2.351818	Durbin-Watson stat	2.612557
Prob(F-statistic)	0.078203		

Manufacturing Employment – No RER

Dependent Variable: LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHA
RE(-1))
Method: Least Squares
Date: 02/28/16 Time: 12:42
Sample (adjusted): 1989 2014
Included observations: 26 after adjustments
LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHARE(-1))=C(1)+C(2)
*LOG(AUSTMANEMPSHARE(-1))+C(4)*LOG(REALAUSTEXPPRICE)
+C(5)*LOG(REALAUSTGDP)+C(6)*LOG(USMANEMPSHARE(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.459745	1.847645	1.872516	0.0751
Aust Man Employ (-1)	-0.625226	0.185019	-3.379259	0.0028
Real Aust Export Price	0.005863	0.054631	0.107323	0.9156
Real Aust GDP	-0.308641	0.177837	-1.735525	0.0973
US Man Employ (-1)	0.173382	0.207808	0.834340	0.4135

R-squared	0.363295	Mean dependent var	-0.025170
Adjusted R-squared	0.242018	S.D. dependent var	0.029267
S.E. of regression	0.025481	Akaike info criterion	-4.330751
Sum squared resid	0.013635	Schwarz criterion	-4.088810
Log likelihood	61.29977	Hannan-Quinn criter.	-4.261081
F-statistic	2.995576	Durbin-Watson stat	2.594107
Prob(F-statistic)	0.042064		

Manufacturing Employment – No Boom

Dependent Variable: LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHA
RE(-1))
Method: Least Squares
Date: 02/28/16 Time: 12:44
Sample (adjusted): 1989 2014
Included observations: 26 after adjustments
LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHARE(-1))=C(1)+C(2)
*LOG(AUSTMANEMPSHARE(-1))+C(3)*LOG(REALTWI)+C(5)
*LOG(REALAUSTGDP)+C(6)*LOG(USMANEMPSHARE(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.825666	2.058349	1.858609	0.0772
Aust Man Employ (-1)	-0.633366	0.185735	-3.410054	0.0026
Real Exchange Rate	-0.019158	0.049976	-0.383335	0.7053
Real Aust GDP	-0.326470	0.183704	-1.777154	0.0900
US Man Employ (-1)	0.145654	0.220071	0.661848	0.5153

R-squared	0.367372	Mean dependent var	-0.025170
Adjusted R-squared	0.246872	S.D. dependent var	0.029267
S.E. of regression	0.025399	Akaike info criterion	-4.337176
Sum squared resid	0.013547	Schwarz criterion	-4.095234
Log likelihood	61.38329	Hannan-Quinn criter.	-4.267505
F-statistic	3.048722	Durbin-Watson stat	2.620754
Prob(F-statistic)	0.039670		

Manufacturing Employment – No Boom or RER

Dependent Variable: LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHA
RE(-1))
Method: Least Squares
Date: 02/28/16 Time: 12:45
Sample (adjusted): 1989 2014
Included observations: 26 after adjustments
LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHARE(-1))=C(1)+C(2)
*LOG(AUSTMANEMPSHARE(-1))+C(5)*LOG(REALAUSTGDP)+C(6)
*LOG(USMANEMPSHARE(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.471032	1.802732	1.925429	0.0672
Aust Man Employ (-1)	-0.624774	0.180768	-3.456229	0.0022
Real Aust GDP	-0.306553	0.172753	-1.774514	0.0898
US Man Employ (-1)	0.174352	0.202894	0.859327	0.3994

R-squared	0.362946	Mean dependent var	-0.025170
Adjusted R-squared	0.276075	S.D. dependent var	0.029267
S.E. of regression	0.024902	Akaike info criterion	-4.407126
Sum squared resid	0.013642	Schwarz criterion	-4.213573
Log likelihood	61.29264	Hannan-Quinn criter.	-4.351390
F-statistic	4.177982	Durbin-Watson stat	2.602354
Prob(F-statistic)	0.017472		

Manufacturing Employment – No RER, No Boom, US Man 2 lags

Dependent Variable: LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHA
RE(-1))
Method: Least Squares
Date: 02/28/16 Time: 12:46
Sample (adjusted): 1990 2014
Included observations: 25 after adjustments
LOG(AUSTMANEMPSHARE)-LOG(AUSTMANEMPSHARE(-1))=C(1)+C(2)
*LOG(AUSTMANEMPSHARE(-1))+C(5)*LOG(REALAUSTGDP)+C(6)
*LOG(USMANEMPSHARE(-2))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	2.538045	1.615471	1.571086	0.1311
Aust Man Employ (-1)	-0.806643	0.186127	-4.333836	0.0003
Real Aust GDP	-0.201211	0.154155	-1.305247	0.2059
US Man Employ (-2)	0.451548	0.201182	2.244478	0.0357

R-squared	0.480395	Mean dependent var	-0.025111
Adjusted R-squared	0.406166	S.D. dependent var	0.029869
S.E. of regression	0.023017	Akaike info criterion	-4.559492
Sum squared resid	0.011126	Schwarz criterion	-4.364472
Log likelihood	60.99365	Hannan-Quinn criter.	-4.505402
F-statistic	6.471768	Durbin-Watson stat	2.113375
Prob(F-statistic)	0.002836		

Appendix 3

Appendix 3.1 – Regression Results

Metal Manufacturing

All Variables

Dependent Variable: LOG(MMINC)
Method: Least Squares
Date: 06/22/15 Time: 14:43
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(MMINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(MMPROD)+C(4)
*LOG(MMPROD(-1))+C(5)*LOG(MMPPI)+C(6)*LOG(MMPPI(-1))+C(7)
LOG(MMINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.065184	0.304074	0.214369	0.8307
C(2) RER(-1)	-0.048021	0.044427	-1.080896	0.2823
C(3) Prod	0.443302	0.110202	4.022626	0.0001
C(4) Prod (-1)	-0.440911	0.118270	-3.728009	0.0003
C(5) PPI	1.660758	0.459287	3.615948	0.0005
C(6) PPI (-1)	-1.572347	0.403670	-3.895125	0.0002
C(7) Income (-1)	0.944525	0.043970	21.48095	0.0000
C(8) Boom	0.002966	0.002764	1.073177	0.2857

R-squared	0.991004	Mean dependent var	4.778851
Adjusted R-squared	0.990387	S.D. dependent var	0.424437
S.E. of regression	0.041614	Akaike info criterion	-3.450795
Sum squared resid	0.176639	Schwarz criterion	-3.254396
Log likelihood	197.7937	Hannan-Quinn criter.	-3.371134
F-statistic	1605.252	Durbin-Watson stat	1.966755
Prob(F-statistic)	0.000000		

No RER

Dependent Variable: LOG(MMINC)
Method: Least Squares
Date: 07/27/15 Time: 10:23
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(MMINC)=C(1)+C(3)*LOG(MMPROD)+C(4)*LOG(MMPROD(-1))+C(5)
*LOG(MMPPI)+C(6)*LOG(MMPPI(-1))+C(7)*LOG(MMINC(-1))+C(8)
*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.271217	0.316762	-0.856217	0.3939
C(3) Prod	0.437135	0.104344	4.189365	0.0001
C(4) Prod (-1)	-0.399742	0.114690	-3.485405	0.0007
C(5) PPI	1.558786	0.409000	3.811208	0.0002
C(6) PPI(-1)	-1.432796	0.371483	-3.856958	0.0002
C(7) Income (-1)	0.894363	0.042283	21.15159	0.0000
C(8) Boom	0.008954	0.002953	3.031727	0.0031

R-squared	0.991595	Mean dependent var	4.778851
Adjusted R-squared	0.991106	S.D. dependent var	0.424437
S.E. of regression	0.040028	Akaike info criterion	-3.536939
Sum squared resid	0.165033	Schwarz criterion	-3.365090
Log likelihood	201.5317	Hannan-Quinn criter.	-3.467236
F-statistic	2025.358	Durbin-Watson stat	1.925665
Prob(F-statistic)	0.000000		

No Prod, or RER

Dependent Variable: LOG(MMINC)
Method: Least Squares
Date: 08/03/15 Time: 15:46
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(MMINC)=C(1)+C(5)*LOG(MMPPI)+C(6)*LOG(MMPPI(-1))+C(7)
LOG(MMINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.081791	0.197153	-0.414859	0.6791
C(5) PPI	1.302840	0.418676	3.111808	0.0024
C(6) PPI (-1)	-1.196076	0.386067	-3.098104	0.0025
C(7) Income (-1)	0.911073	0.042171	21.60428	0.0000
C(8) Boom	0.009494	0.003114	3.048502	0.0029

R-squared	0.990024	Mean dependent var	4.778851
Adjusted R-squared	0.989644	S.D. dependent var	0.424437
S.E. of regression	0.043193	Akaike info criterion	-3.401865
Sum squared resid	0.195896	Schwarz criterion	-3.279116
Log likelihood	192.1026	Hannan-Quinn criter.	-3.352078
F-statistic	2604.965	Durbin-Watson stat	1.969122
Prob(F-statistic)	0.000000		

Chemical, Rubber & Petroleum

All Variables

Dependent Variable: LOG(CRPINC)
Method: Least Squares
Date: 07/09/15 Time: 17:12
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(CRPINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(CRPPROD)+C(4)
*LOG(CRPPROD(-1))+C(5)*LOG(PETROLPPI)+C(6)
*LOG(PETROLPPI(-1))+C(7)*LOG(CRPINC(-1))+C(8)*(LOG(RERTWI(
-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.719217	0.268946	-2.674201	0.0087
C(2) RER (-1)	0.044846	0.029635	1.513312	0.1333
C(3) Prod	0.557970	0.065997	8.454507	0.0000
C(4) Prod(-1)	-0.391867	0.063656	-6.155980	0.0000
C(5) PPI	0.108566	0.033458	3.244894	0.0016
C(6) PPI(-1)	-0.071271	0.033497	-2.127690	0.0358
C(7) Income (-1)	0.909864	0.019091	47.65836	0.0000
C(8) Boom	0.001784	0.001693	1.053401	0.2946

R-squared	0.996787	Mean dependent var	4.725400
Adjusted R-squared	0.996566	S.D. dependent var	0.476250
S.E. of regression	0.027908	Akaike info criterion	-4.249883
Sum squared resid	0.079442	Schwarz criterion	-4.053484
Log likelihood	241.7435	Hannan-Quinn criter.	-4.170222
F-statistic	4520.152	Durbin-Watson stat	1.660008
Prob(F-statistic)	0.000000		

No RER

Dependent Variable: LOG(CRPINC)
Method: Least Squares
Date: 07/27/15 Time: 10:45
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(CRPINC)=C(1)+C(3)*LOG(CRPPROD)+C(4)*LOG(CRPPROD(-1))
+C(5)*LOG(PETROLPPI)+C(6)*LOG(PETROLPPI(-1))+C(7)
LOG(CRPINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.431486	0.191402	-2.254344	0.0263
C(3) Prod	0.535299	0.064675	8.276725	0.0000
C(4) Prod(-1)	-0.399986	0.063826	-6.266850	0.0000
C(5) PPI	0.127530	0.031216	4.085410	0.0001
C(6) PPI(-1)	-0.079462	0.033263	-2.388885	0.0187
C(7) Income (-1)	0.913829	0.019029	48.02343	0.0000
C(8) Boom	0.001745	0.001704	1.024144	0.3082

R-squared	0.996715	Mean dependent var	4.725400
Adjusted R-squared	0.996523	S.D. dependent var	0.476250
S.E. of regression	0.028082	Akaike info criterion	-4.245861
Sum squared resid	0.081225	Schwarz criterion	-4.074012
Log likelihood	240.5223	Hannan-Quinn criter.	-4.176158
F-statistic	5207.898	Durbin-Watson stat	1.643409
Prob(F-statistic)	0.000000		

Machinery and Equipment

All Variables

Dependent Variable: LOG(M_EINC)
Method: Least Squares
Date: 07/09/15 Time: 17:08
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(M_EINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(M_EPROD)+C(4)
*LOG(M_EPROD(-1))+C(5)*LOG(M_EPPI)+C(6)*LOG(M_EPPI(-1))
+C(7)*LOG(M_EINC(-1))+C(8)*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.192531	0.240908	-0.799190	0.4260
C(2) RER(-1)	-0.049052	0.026624	-1.842399	0.0683
C(3) Prod	0.555555	0.061659	9.010116	0.0000
C(4) Prod(-1)	-0.421708	0.073080	-5.770515	0.0000
C(5) PPI	0.572340	0.338708	1.689775	0.0941
C(6) PPI(-1)	-0.527532	0.315150	-1.673910	0.0972
C(7) Income (-1)	0.912649	0.047762	19.10817	0.0000
C(8) Boom	-0.001216	0.001316	-0.923906	0.3577

R-squared	0.995609	Mean dependent var	4.505443
Adjusted R-squared	0.995308	S.D. dependent var	0.306207
S.E. of regression	0.020974	Akaike info criterion	-4.821089
Sum squared resid	0.044872	Schwarz criterion	-4.624691
Log likelihood	273.1599	Hannan-Quinn criter.	-4.741429
F-statistic	3304.252	Durbin-Watson stat	1.518229
Prob(F-statistic)	0.000000		

No PPI

Dependent Variable: LOG(M_EINC)
Method: Least Squares
Date: 07/27/15 Time: 11:42
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(M_EINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(M_EPROD)+C(4)
*LOG(M_EPROD(-1))+C(7)*LOG(M_EINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.045265	0.107074	-0.422748	0.6734
C(2) RER (-1)	-0.037868	0.022787	-1.661876	0.0995
C(3) Prod	0.543302	0.061362	8.854089	0.0000
C(4) Prod(-1)	-0.417803	0.072032	-5.800244	0.0000
C(7) Income (-1)	0.923092	0.039495	23.37235	0.0000
C(8) Boom	-0.000931	0.001279	-0.727636	0.4685

R-squared	0.995486	Mean dependent var	4.505443
Adjusted R-squared	0.995269	S.D. dependent var	0.306207
S.E. of regression	0.021061	Akaike info criterion	-4.829772
Sum squared resid	0.046131	Schwarz criterion	-4.682473
Log likelihood	271.6375	Hannan-Quinn criter.	-4.770027
F-statistic	4587.318	Durbin-Watson stat	1.503045
Prob(F-statistic)	0.000000		

No RER

Dependent Variable: LOG(M_EINC)
Method: Least Squares
Date: 07/27/15 Time: 11:48
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(M_EINC)=C(1)+C(3)*LOG(M_EPROD)+C(4)*LOG(M_EPROD(-1))
+C(5)*LOG(M_EPPI)+C(6)*LOG(M_EPPI(-1))+C(7)*LOG(M_EINC(-1))
+C(8)*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.071779	0.195772	0.366648	0.7146
C(3) Prod	0.520259	0.059285	8.775612	0.0000
C(4) Prod (-1)	-0.492707	0.062811	-7.844253	0.0000
C(5) PPI	0.402853	0.329743	1.221717	0.2246
C(6) PPI(-1)	-0.423920	0.313675	-1.351463	0.1795
C(7) Income (-1)	0.978583	0.031997	30.58373	0.0000
C(8) Boom	-0.000574	0.001284	-0.446741	0.6560

R-squared	0.995463	Mean dependent var	4.505443
Adjusted R-squared	0.995199	S.D. dependent var	0.306207
S.E. of regression	0.021217	Akaike info criterion	-4.806534
Sum squared resid	0.046365	Schwarz criterion	-4.634685
Log likelihood	271.3594	Hannan-Quinn criter.	-4.736831
F-statistic	3766.827	Durbin-Watson stat	1.564294
Prob(F-statistic)	0.000000		

No PPI, RER or Boom

Dependent Variable: LOG(M_EINC)
Method: Least Squares
Date: 07/27/15 Time: 11:56
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(M_EINC)=C(1)+C(3)*LOG(M_EPROD)+C(4)*LOG(M_EPROD(-1))
+C(7)*LOG(M_EINC(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.017340	0.094638	0.183230	0.8550
C(3) Prod	0.512095	0.057621	8.887292	0.0000
C(4) Prod (-1)	-0.482022	0.061023	-7.899025	0.0000
C(7) Income (-1)	0.966666	0.029440	32.83471	0.0000

R-squared	0.995366	Mean dependent var	4.505443
Adjusted R-squared	0.995235	S.D. dependent var	0.306207
S.E. of regression	0.021137	Akaike info criterion	-4.839889
Sum squared resid	0.047358	Schwarz criterion	-4.741690
Log likelihood	270.1939	Hannan-Quinn criter.	-4.800059
F-statistic	7589.777	Durbin-Watson stat	1.534136
Prob(F-statistic)	0.000000		

Non-Ferrous Metals

All Variables

Dependent Variable: LOG(NONFMINC)
Method: Least Squares
Date: 07/09/15 Time: 17:18
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(NONFMINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(NMMPROD)
+C(4)*LOG(NMMPROD(-1))+C(5)*LOG(NFMPPI)+C(6)*LOG(NFMPPI(
-1))+C(7)*LOG(NONFMINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.184905	0.121972	-1.515963	0.1326
C(2) RER (-1)	0.021628	0.032839	0.658616	0.5116
C(3) Prod	0.709567	0.053961	13.14966	0.0000
C(4) Prod(-1)	-0.575559	0.063109	-9.120045	0.0000
C(5) PPI	-0.007654	0.051912	-0.147432	0.8831
C(6) PPI(-1)	-0.028939	0.049567	-0.583842	0.5606
C(7) Income (-1)	0.925063	0.031992	28.91534	0.0000
C(8) Boom	-0.001939	0.001966	-0.986622	0.3262

R-squared	0.986298	Mean dependent var	4.730997
Adjusted R-squared	0.985357	S.D. dependent var	0.259609
S.E. of regression	0.031415	Akaike info criterion	-4.013138
Sum squared resid	0.100662	Schwarz criterion	-3.816740
Log likelihood	228.7226	Hannan-Quinn criter.	-3.933478
F-statistic	1048.848	Durbin-Watson stat	1.432665
Prob(F-statistic)	0.000000		

No PPI

Dependent Variable: LOG(NONFMINC)
Method: Least Squares
Date: 07/27/15 Time: 12:17
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(NONFMINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(NMMPROD)
+C(4)*LOG(NMMPROD(-1))+C(7)*LOG(NONFMINC(-1))+C(8)
*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.077709	0.090299	-0.860570	0.3915
C(2) RER(-1)	0.000643	0.028693	0.022417	0.9822
C(3) Prod	0.695958	0.052872	13.16308	0.0000
C(4) Prod (-1)	-0.591609	0.061730	-9.583832	0.0000
C(7) Income (-1)	0.915723	0.031154	29.39342	0.0000
C(8) Boom	-0.001845	0.001943	-0.949099	0.3448

R-squared	0.986059	Mean dependent var	4.730997
Adjusted R-squared	0.985389	S.D. dependent var	0.259609
S.E. of regression	0.031381	Akaike info criterion	-4.032227
Sum squared resid	0.102416	Schwarz criterion	-3.884929
Log likelihood	227.7725	Hannan-Quinn criter.	-3.972482
F-statistic	1471.181	Durbin-Watson stat	1.413866
Prob(F-statistic)	0.000000		

No RER or Boom

Dependent Variable: LOG(NONFMINC)
Method: Least Squares
Date: 07/27/15 Time: 12:22
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(NONFMINC)=C(1)+C(3)*LOG(NMMPROD)+C(4)*LOG(NMMPROD(-1))
+C(5)*LOG(NFMPPI)+C(6)*LOG(NFMPPI(-1))+C(7)*LOG(NONFMINC(
-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.089251	0.072004	-1.239532	0.2179
C(3) Prod	0.702630	0.053470	13.14068	0.0000
C(4) Prod(-1)	-0.594872	0.060946	-9.760622	0.0000
C(5) PPI	-0.010022	0.051034	-0.196369	0.8447
C(6) PPI(-1)	-0.015765	0.048312	-0.326317	0.7448
C(7) Income (-1)	0.941054	0.029172	32.25844	0.0000

R-squared	0.986084	Mean dependent var	4.730997
Adjusted R-squared	0.985415	S.D. dependent var	0.259609
S.E. of regression	0.031352	Akaike info criterion	-4.034064
Sum squared resid	0.102228	Schwarz criterion	-3.886765
Log likelihood	227.8735	Hannan-Quinn criter.	-3.974318
F-statistic	1473.923	Durbin-Watson stat	1.444840
Prob(F-statistic)	0.000000		

No PPI or RER

Dependent Variable: LOG(NONFMINC)
Method: Least Squares
Date: 07/27/15 Time: 12:26
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(NONFMINC)=C(1)+C(3)*LOG(NMMPROD)+C(4)*LOG(NMMPROD(-1))
+C(7)*LOG(NONFMINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.076343	0.066361	-1.150421	0.2526
C(3) Prod	0.696087	0.052309	13.30720	0.0000
C(4) Prod(-1)	-0.591564	0.061404	-9.634036	0.0000
C(7) Income (-1)	0.915920	0.029749	30.78830	0.0000
C(8) Boom	-0.001851	0.001913	-0.967604	0.3355
R-squared	0.986059	Mean dependent var		4.730997
Adjusted R-squared	0.985528	S.D. dependent var		0.259609
S.E. of regression	0.031231	Akaike info criterion		-4.050404
Sum squared resid	0.102416	Schwarz criterion		-3.927655
Log likelihood	227.7722	Hannan-Quinn criter.		-4.000617
F-statistic	1856.650	Durbin-Watson stat		1.414151
Prob(F-statistic)	0.000000			

Textile Clothing Footwear

All Variables

Dependent Variable: LOG(TCFINC)
Method: Least Squares
Date: 07/09/15 Time: 17:11
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(TCFINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(TCFPROD)+C(4)
*LOG(TCFPROD(-1))+C(5)*LOG(TEXTILEPPI)+C(6)*LOG(TEXTILEPPI(
-1))+C(7)*LOG(TCFINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.019924	0.551191	-0.036147	0.9712
C(2) RER	0.008973	0.048328	0.185664	0.8531
C(3) Prod	0.450678	0.064660	6.969975	0.0000
C(4) Prod (-1)	-0.358820	0.066519	-5.394222	0.0000
C(5) PPI	-0.313524	0.169051	-1.854606	0.0665
C(6) PPI (-1)	0.329478	0.159858	2.061061	0.0418
C(7) Income (-1)	0.885639	0.046728	18.95305	0.0000
C(8) Boom	-0.004371	0.002638	-1.656950	0.1006

R-squared	0.973045	Mean dependent var	4.316214
Adjusted R-squared	0.971195	S.D. dependent var	0.209400
S.E. of regression	0.035539	Akaike info criterion	-3.766402
Sum squared resid	0.128831	Schwarz criterion	-3.570003
Log likelihood	215.1521	Hannan-Quinn criter.	-3.686741
F-statistic	526.0081	Durbin-Watson stat	1.907175
Prob(F-statistic)	0.000000		

No RER

Dependent Variable: LOG(TCFINC)
Method: Least Squares
Date: 07/27/15 Time: 13:12
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(TCFINC)=C(1)+C(3)*LOG(TCFPROD)+C(4)*LOG(TCFPROD(-1))+C(5)
*LOG(TEXTILEPPI)+C(6)*LOG(TEXTILEPPI(-1))+C(7)*LOG(TCFINC(
-1))+C(8)*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.060864	0.336752	0.180739	0.8569
C(3) Prod	0.448468	0.063256	7.089744	0.0000
C(4) Prod(-1)	-0.359087	0.066191	-5.424992	0.0000
C(5) PPI	-0.314480	0.168179	-1.869912	0.0643
C(6) PPI(-1)	0.328460	0.159014	2.065610	0.0414
C(7) Income (-1)	0.881511	0.040907	21.54895	0.0000
C(8) Boom	-0.004342	0.002621	-1.656594	0.1006

R-squared	0.973036	Mean dependent var	4.316214
Adjusted R-squared	0.971465	S.D. dependent var	0.209400
S.E. of regression	0.035372	Akaike info criterion	-3.784246
Sum squared resid	0.128875	Schwarz criterion	-3.612397
Log likelihood	215.1335	Hannan-Quinn criter.	-3.714543
F-statistic	619.4774	Durbin-Watson stat	1.901490
Prob(F-statistic)	0.000000		

Print and Media

All Variables

Dependent Variable: LOG(P_MINC)
Method: Least Squares
Date: 07/09/15 Time: 17:06
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(P_MINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(P_MPROD)+C(4)
*LOG(P_MPROD(-1))+C(5)*LOG(MEDIAPPI)+C(6)*LOG(MEDIAPPI(-1))
+C(7)*LOG(P_MINC(-1))+C(8)*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.346018	0.374611	-0.923672	0.3578
C(2) RER (-1)	0.044898	0.032081	1.399514	0.1647
C(3) Prod	0.707932	0.051871	13.64789	0.0000
C(4) Prod (-1)	-0.678047	0.053176	-12.75090	0.0000
C(5) PPI	0.128966	0.156059	0.826391	0.4105
C(6) PPI (-1)	-0.079772	0.152083	-0.524533	0.6010
C(7) Income (-1)	0.950214	0.015261	62.26283	0.0000
C(8) Boom	0.002496	0.002322	1.075269	0.2848

R-squared	0.994037	Mean dependent var	4.324856
Adjusted R-squared	0.993628	S.D. dependent var	0.376498
S.E. of regression	0.030054	Akaike info criterion	-4.101688
Sum squared resid	0.092131	Schwarz criterion	-3.905290
Log likelihood	233.5929	Hannan-Quinn criter.	-4.022028
F-statistic	2429.118	Durbin-Watson stat	1.656943
Prob(F-statistic)	0.000000		

No PPI or Boom

Dependent Variable: LOG(P_MINC)
Method: Least Squares
Date: 07/27/15 Time: 16:31
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(P_MINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(P_MPROD)+C(4)
*LOG(P_MPROD(-1))+C(7)*LOG(P_MINC(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.080143	0.141729	-0.565463	0.5730
C(2) RER (-1)	0.025548	0.020023	1.275886	0.2048
C(3) Prod	0.717319	0.049539	14.47980	0.0000
C(4) Prod (-1)	-0.676798	0.051495	-13.14286	0.0000
C(7) Income (-1)	0.951186	0.012809	74.25740	0.0000

R-squared	0.993867	Mean dependent var	4.324856
Adjusted R-squared	0.993633	S.D. dependent var	0.376498
S.E. of regression	0.030042	Akaike info criterion	-4.128078
Sum squared resid	0.094762	Schwarz criterion	-4.005329
Log likelihood	232.0443	Hannan-Quinn criter.	-4.078290
F-statistic	4253.764	Durbin-Watson stat	1.622207
Prob(F-statistic)	0.000000		

No PPI or RER

Dependent Variable: LOG(P_MINC)
Method: Least Squares
Date: 07/27/15 Time: 16:36
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(P_MINC)=C(1)+C(3)*LOG(P_MPROD)+C(4)*LOG(P_MPROD(-1))
+C(7)*LOG(P_MINC(-1))+C(8)*(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.177568	0.104392	1.700977	0.0919
C(3) Prod	0.691159	0.049514	13.95878	0.0000
C(4) Prod (-1)	-0.691285	0.051911	-13.31671	0.0000
C(7) Income (-1)	0.960845	0.011045	86.99188	0.0000
C(8) Boom	0.003091	0.002114	1.462348	0.1466

R-squared	0.993896	Mean dependent var	4.324856
Adjusted R-squared	0.993664	S.D. dependent var	0.376498
S.E. of regression	0.029970	Akaike info criterion	-4.132855
Sum squared resid	0.094311	Schwarz criterion	-4.010106
Log likelihood	232.3070	Hannan-Quinn criter.	-4.083067
F-statistic	4274.258	Durbin-Watson stat	1.593926
Prob(F-statistic)	0.000000		

No RER, PPI or Boom

Dependent Variable: LOG(P_MINC)
Method: Least Squares
Date: 08/03/15 Time: 15:55
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(P_MINC)=C(1)+C(3)*LOG(P_MPROD)+C(4)*LOG(P_MPROD(-1))
+C(7)*LOG(P_MINC(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.072540	0.076164	0.952417	0.3431
C(3) Prod	0.705444	0.048801	14.45551	0.0000
C(4) Prod (-1)	-0.679839	0.051592	-13.17710	0.0000
C(7) Income (-1)	0.959490	0.011065	86.71215	0.0000

R-squared	0.993772	Mean dependent var	4.324856
Adjusted R-squared	0.993595	S.D. dependent var	0.376498
S.E. of regression	0.030130	Akaike info criterion	-4.130875
Sum squared resid	0.096231	Schwarz criterion	-4.032675
Log likelihood	231.1981	Hannan-Quinn criter.	-4.091045
F-statistic	5637.747	Durbin-Watson stat	1.598803
Prob(F-statistic)	0.000000		

Food and Beverage

All Variables

Dependent Variable: LOG(F_BINC)
Method: Least Squares
Date: 07/09/15 Time: 17:03
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(F_BINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(F_BPROD)+C(4)
*LOG(F_BPROD(-1))+C(5)*LOG(BEVPPI)+C(6)*LOG(BEVPPI(-1))+C(7)
LOG(F_BINC(-1))+C(8)(LOG(RERTWI(-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.197947	0.227304	-0.870847	0.3859
C(2) RER(-1)	0.004549	0.025373	0.179293	0.8581
C(3) Prod	0.580137	0.077739	7.462672	0.0000
C(4) Prod(-1)	-0.504190	0.080684	-6.248916	0.0000
C(5) PPI	0.336046	0.228264	1.472182	0.1441
C(6) PPI(-1)	-0.331430	0.223602	-1.482230	0.1414
C(7) Income (-1)	0.960010	0.033849	28.36160	0.0000
C(8) Boom	0.000876	0.001297	0.674999	0.5012

R-squared	0.997568	Mean dependent var	4.577314
Adjusted R-squared	0.997401	S.D. dependent var	0.409447
S.E. of regression	0.020872	Akaike info criterion	-4.830837
Sum squared resid	0.044437	Schwarz criterion	-4.634438
Log likelihood	273.6960	Hannan-Quinn criter.	-4.751176
F-statistic	5977.549	Durbin-Watson stat	1.991720
Prob(F-statistic)	0.000000		

No PPI

Dependent Variable: LOG(F_BINC)
Method: Least Squares
Date: 07/27/15 Time: 16:49
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(F_BINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(F_BPROD)+C(4)
*LOG(F_BPROD(-1))+C(7)*LOG(F_BINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.169989	0.226121	-0.751762	0.4539
C(2) RER(-1)	0.009867	0.017862	0.552394	0.5819
C(3) Prod	0.566588	0.075785	7.476261	0.0000
C(4) Prod(-1)	-0.501126	0.080356	-6.236361	0.0000
C(7) Income (-1)	0.964085	0.021144	45.59577	0.0000
C(8) Boom	0.001150	0.001177	0.976506	0.3311

R-squared	0.997516	Mean dependent var	4.577314
Adjusted R-squared	0.997396	S.D. dependent var	0.409447
S.E. of regression	0.020893	Akaike info criterion	-4.845780
Sum squared resid	0.045399	Schwarz criterion	-4.698481
Log likelihood	272.5179	Hannan-Quinn criter.	-4.786035
F-statistic	8351.388	Durbin-Watson stat	1.948547
Prob(F-statistic)	0.000000		

No RER or Boom

Dependent Variable: LOG(F_BINC)
Method: Least Squares
Date: 07/27/15 Time: 16:52
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(F_BINC)=C(1)+C(3)*LOG(F_BPROD)+C(4)*LOG(F_BPROD(-1))+C(5)
*LOG(BEVPPI)+C(6)*LOG(BEVPPI(-1))+C(7)*LOG(F_BINC(-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.217966	0.186926	-1.166052	0.2463
C(3) Prod	0.582237	0.074459	7.819599	0.0000
C(4) Prod(-1)	-0.496434	0.079283	-6.261530	0.0000
C(5) PPI	0.377152	0.216767	1.739896	0.0848
C(6) PPI(-1)	-0.372401	0.216079	-1.723448	0.0878
C(7) Income (-1)	0.959370	0.032287	29.71341	0.0000

R-squared	0.997553	Mean dependent var	4.577314
Adjusted R-squared	0.997435	S.D. dependent var	0.409447
S.E. of regression	0.020736	Akaike info criterion	-4.860912
Sum squared resid	0.044717	Schwarz criterion	-4.713613
Log likelihood	273.3501	Hannan-Quinn criter.	-4.801166
F-statistic	8479.039	Durbin-Watson stat	1.989242
Prob(F-statistic)	0.000000		

Wood, Paper and Furniture

All Variables

Dependent Variable: LOG(WPFINC)
Method: Least Squares
Date: 07/09/15 Time: 17:14
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(WPFINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(WPFPROD)+C(4)
*LOG(WPFPROD(-1))+C(5)*LOG(WOODPPI)+C(6)*LOG(WOODPPI(
-1))+C(7)*LOG(WPFINC(-1))+C(8)*(LOG(RERTWI(-1))
*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.195167	0.420092	-0.464583	0.6432
C(2) RER(-1)	-0.032294	0.032536	-0.992556	0.3233
C(3) Prod	0.384354	0.068452	5.614953	0.0000
C(4) Prod(-1)	-0.345056	0.068757	-5.018483	0.0000
C(5) PPI	0.164365	0.296474	0.554400	0.5805
C(6) PPI(-1)	-0.047513	0.290928	-0.163316	0.8706
C(7) Income (-1)	0.918670	0.040811	22.51031	0.0000
C(8) Boom	0.002881	0.002190	1.315371	0.1913

R-squared	0.992643	Mean dependent var	4.407382
Adjusted R-squared	0.992138	S.D. dependent var	0.332561
S.E. of regression	0.029487	Akaike info criterion	-4.139797
Sum squared resid	0.088686	Schwarz criterion	-3.943398
Log likelihood	235.6888	Hannan-Quinn criter.	-4.060136
F-statistic	1966.109	Durbin-Watson stat	1.822748
Prob(F-statistic)	0.000000		

No PPI

Dependent Variable: LOG(WPFINC)
Method: Least Squares
Date: 07/27/15 Time: 17:21
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(WPFINC)=C(1)+C(2)*LOG(RERTWI(-1))+C(3)*LOG(WPFPROD)+C(4)
*LOG(WPFPROD(-1))+C(7)*LOG(WPFINC(-1))+C(8)*(LOG(RERTWI(
-1))*DUTCHDISEASE)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.165364	0.340286	0.485956	0.6280
C(2) RER (-1)	-0.009214	0.028856	-0.319314	0.7501
C(3) Prod	0.366882	0.067790	5.412038	0.0000
C(4) Prod (-1)	-0.374910	0.064870	-5.779444	0.0000
C(7) Income (-1)	0.982331	0.011115	88.37650	0.0000
C(8) Boom	0.001966	0.002126	0.924792	0.3572

R-squared	0.992445	Mean dependent var	4.407382
Adjusted R-squared	0.992081	S.D. dependent var	0.332561
S.E. of regression	0.029593	Akaike info criterion	-4.149524
Sum squared resid	0.091080	Schwarz criterion	-4.002225
Log likelihood	234.2238	Hannan-Quinn criter.	-4.089779
F-statistic	2732.209	Durbin-Watson stat	1.876883
Prob(F-statistic)	0.000000		

No RER or Boom

Dependent Variable: LOG(WPFINC)
Method: Least Squares
Date: 07/27/15 Time: 17:24
Sample (adjusted): 9/01/1987 12/01/2014
Included observations: 110 after adjustments
LOG(WPFINC)=C(1)+C(3)*LOG(WPFPROD)+C(4)*LOG(WPFPROD(-1))
+C(5)*LOG(WOODPPI)+C(6)*LOG(WOODPPI(-1))+C(7)*LOG(WPFINC(
-1))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.460785	0.368614	-1.250046	0.2141
C(3) Prod	0.410879	0.065469	6.275895	0.0000
C(4) Prod (-1)	-0.330747	0.067949	-4.867602	0.0000
C(5) PPI	0.078547	0.280378	0.280148	0.7799
C(6) PPI(-1)	0.005387	0.282536	0.019068	0.9848
C(7) Inc (-1)	0.937655	0.038409	24.41238	0.0000

R-squared	0.992504	Mean dependent var	4.407382
Adjusted R-squared	0.992144	S.D. dependent var	0.332561
S.E. of regression	0.029476	Akaike info criterion	-4.157454
Sum squared resid	0.090361	Schwarz criterion	-4.010155
Log likelihood	234.6599	Hannan-Quinn criter.	-4.097708
F-statistic	2754.126	Durbin-Watson stat	1.832150
Prob(F-statistic)	0.000000		

Appendix 3.2 Additional Commentary

This appendix details the analysis of the eight sub-sectors of the Australian manufacturing sector. The analysis was undertaken in conjunction with that of the second hypothesis but was not included in Chapter 5 of the thesis. It provides an overview of the series of regressions that were undertaken for each sub-sector. The results discussed below provide additional coverage to the key results and conclusions in Chapter 5 and are provided here for information purposes.

A3.2.1 Metal Manufacturing

Summary regression results for metal manufacturing income are detailed below in Table A3.1 Details of the regressions are provided at the conclusion of this appendix. Income (Inc), production (Prod) and producer price indexes (PPI) are those for the metal manufacturing sub-sector.

Table A3.1

Summary Regression Results for Quarterly Metal Manufacturing Income 1987 to 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc(-1)	Boom	RSq	Durbin Watson
(i)	0.065	-0.048	0.443	0.44	1.66	1.57	0.944	0.002	0.991	1.97
	p < 0.05		*	*	*	*	*			
(ii)	-0.271	n/a	0.437	0.4	1.56	1.43	0.89	0.009	0.991	1.93
	p < 0.05		*	*	*	*	*	*		

The first equation includes all variables. All variables are significant at five precent except the real exchange rate (RER) and the mineral export-price boom (Boom). To account for possible transmission influences between the real exchange rate and the metal manufacturing producer price index, the second equation removed the real exchange rate from analysis. The removal of the real exchange rate now sees all variables significant at five percent.

These results suggest that the mineral export-price boom did have an impact on metal manufacturing income. The coefficient confirms that this is a positive relationship, namely that the boom did lead to an increase in metal manufacturing income. However the relationship between metal manufacturing income and the real exchange rate is not significant. This may suggest that normal real exchange rate movements (i.e. across the 27-year time period) are translated to metal manufacturing income either through the production or producer price variables. However the mineral export-price boom related exchange rate prices (i.e. from 2003 to 2008) did impact metal manufacturing income.

These results are not surprising as metal manufacturing production would evidence some price-stickiness due to lagged contractual arrangements and production lead times. Similarly real exchange rate changes would impact competitiveness are arguably reflected in the underlying price changes rather than directly to income. Furthermore boom related increases in mineral commodity prices would be expected to have an impact on this sector given it concerns metal-related commodities.

A3.2.2 Chemical, Rubber and Petroleum

Summary regression results for metal manufacturing income are detailed below in Table A3.2. Details of the regressions are provided in at the conclusion of this appendix. Income (Inc), and production (Prod) indexes are for the chemical, rubber and petroleum sub-sector, while the Petrol Producer Price index has been utilised given it was available for the whole time series.

Table A3.2

Summary Regression Results for Quarterly Chemical, Rubber and Petroleum Manufacturing Income from 1987 to 2014

	C	**RER**	**Prod**	**Prod (-1)**	**PPI**	**PPI (-1)**	**Inc (-1)**	**Boom**	**RSq**	**DW**
(i)	-0.719	0.448	0.558	0.391	0.109	-0.071	0.91	0.002	0.997	1.66
	p < 0.05		*	*	*	*	*			
(ii)	-0.43	n/a	0.535	0.4	0.128	-0.079	0.914	0.002	0.996	1.64
	p < 0.05		*	*	*	*	*			
(iii)	-0.522	n/a	0.543	0.388	0.131	0.08	0.911	n/a	0.997	1.63
	p < 0.05		*	*	*	*	*			

The first equation includes all variables and shows that all variables except the real exchange rate (RER) and the mineral export-price boom (Boom) are significant at five percent. The second equation removes the real exchange rate from analysis and showed that the impact of the mineral export-price boom was still insignificant. Exclusion of both variables in the third and final equation does not change the previous results of production, price or lagged income.

These results suggest that chemical, rubber and petroleum income is not significantly impacted by the real exchange rate or the mineral export-price boom. This is surprising given that the petrol producer price index was utilised and that this sub-sector would be considered to be more closely aligned with the commodity sector than other manufacturing sub-sectors.

As with metal manufacturing income, this sub-sector may have structural and operational considerations that see the impact of real exchange rate changes transmitted through either the production or price indices.

A3.2.3 Machinery and Equipment

Summary regression results for machinery and equipment income are detailed below in Table A3.3. Details of the regressions are provided at the conclusion of the appendix. Income (Inc), production (Prod) and producer price indexes (PPI) are those for the machinery and income manufacturing sub-sector.

The first equation includes all independent variables and shows that all variables are significant except for the mineral export-price boom (Boom). The production (Prod) variables and lagged income (Inc) variable are significant at five percent, the real exchange rate (RER) variable significant at seven percent and the two producer price (PPI) index variables are significant at ten percent.

Table A3.3

Summary Regression Results for Quarterly Machinery and Equipment Income from 1987 to 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	RSq	DW
(i)	-0.193	-0.049	0.556	0.422	0.572	0.527	0.913	-0.001	0.995	1.52
	p < 0.05	†	*	*	†	†	*			
(ii)	0.071	n/a	0.52	0.49	0.403	0.423	0.979	-0.001	0.995	1.56
	p < 0.05		*	*			*			
(iii)	-0.045	-0.038	0.543	0.418	n/a	n/a	0.923	-0.001	0.995	1.5
	p < 0.05	†	*	*			*			
(iv)	0.017	n/a	0.512	0.482	n/a	n/a	0.967	n/a	0.995	1.53
	p < 0.05		*	*			*			

NB. * $p < 0.05$ † $p < 0.10$

Unlike the other sub-sectors to date the production and producer price indexes record coefficients of similar strength. The respective Durbin Watson statistics suggest auto-correlation in the residuals.

The second equation omits the real exchange rate and the results of the producer price index are no longer significant. Similarly the third equation saw the real exchange rate retained and the producer price indexes omitted. As a result all other values revert to similar levels recorded in the first equation. Neither of these equations see the export mineral-price boom values change, nor the underlying performance indicators. The fourth and final equation sees all price related variables omitted with little change in results.

The lack of a strong relationship between the mineral export-price boom and machinery and equipment income is not surprising. Machinery and income production should be responsive to a sustained mineral-export price boom that triggers demand for mineral related machinery and equipment as production increases in response to sustained higher mineral export prices. The mineral export-price boom could be transmitted through the real exchange rate and the producer price index that increases production, and ultimately income.

Additional analysis utilising longer lags is beyond the scope of this analysis but could provide an opportunity for additional research.

A3.2.4 Non Ferrous Metals

Summary regression results for non-ferrous metal (NFM) income are detailed below in Table A3.4. Details of the regressions are provided at the conclusion of the appendix. Income (Inc), production (Prod) and producer price indexes (PPI) are those for the non-ferrous metal manufacturing sub-sector. Non-ferrous metals are classified as precious metals not containing iron such as zinc and copper and their manufacturing related to processing and refining that was undertaken within Australia.

Table A3.4 *Quarterly Non Ferrous Metal Manufacturing Income from 1987 to 2014*

	C	RER	Prod	Prod(-1)	PPI	PPI (-1)	Inc (-1)	Boom	RSq	DW
(i)	-0.185	0.022	0.71	0.576	-0.008	0.029	0.925	-0.002	0.986	1.43
	p < 0.05		*	*			*			
(ii)	-0.089	n/a	0.703	0.595	-0.01	0.016	0.941	n/a	0.986	1.45
	p < 0.05		*	*			*			
(iii)	-0.078	0.001	0.696	0.592	n/a	n/a	0.916	-0.001	0.986	1.41
	p < 0.05		*	*			*			
(iv)	-0.077	n/a	0.696	0.592	n/a	n/a	0.916	-0.001	0.986	1.41
	p < 0.05		*	*			*			

The first equation shows that only non-ferrous metal production and lagged income variables are significant at five percent. The low Durbin Watson statistic suggests auto-correlation in the residuals from the analysis. The second equation excludes both the real exchange rate and the boom related variables with little change in underlying equation results. The third equation includes the boom related variable but again underlying results are largely unchanged. The fourth and final equation omits all price related variables, namely the real exchange rate, the producer price indexes and the mineral export-price boom index from analysis. Again the impact on the results of the regression analysis is minimal.

The stronger relationship with production related variables rather than price related variables seems somewhat surprising, until you consider the changes taking place in this sub-sector. A lower proportion of these metals is now manufactured in Australia, as multinational firms have relocated to overseas smelters. An example is aluminium that was originally refined in Australia but now has been replaced by bauxite production and exporting to overseas aluminium smelters. Any mineral export-price boom impact is translated through additional production rather than prices.

A3.2.5 Textile, Clothing and Footwear

Summary regression results for textile, clothing and footwear income are detailed below in Table A3.5. Details of the regressions are provided later in the appendix. Income (Inc) and production (Prod) indexes are those for textile, clothing and footwear manufacturing sub-sector. The textile producer price index (PPI) has been utilised as it covers the time period utilised.

The first equation includes all variables and provides two interesting results. The negative sign of both producer price index coefficients is interesting as this suggests that textile clothing and footwear manufacturing increase with a price index decrease, which seems counter-intuitive. It is noted that the contemporaneous value of the price index is only significant at six percent.

Table A3.5 *Summary Regression Results for Quarterly Textile, Clothing and Footwear Manufacturing Income from 1987 to 2014*

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	RSq	DW
(i)	-0.2	0.009	0.451	0.359	-0.314	-0.029	0.886	-0.004	0.973	1.91
	p < 0.05		*	*	†	*	*	†		
(ii)	0.06	n/a	0.448	0.359	-0.314	-0.328	0.881	-0.004	0.973	1.9
	p < 0.05		*	*	†	*	*	†		
(iii)	-0.078	0.001	0.696	0.592	n/a	n/a	0.916	-0.001	0.986	1.41
	p < 0.05		*	*			*	†		
(iv)	0.138	n/a	0.432	0.361	n/a	n/a	0.897	-0.004	0.972	1.98
	p < 0.05		*	*			*	*		

NB. * p < 0.05 † p < 0.10

Although only significant at ten percent, the results also suggest that (unlike other manufacturing sub-sectors to date), the mineral export-price boom did have an impact on income as suggested by Dutch Disease theory.

The second equation omits the real exchange rate variable and sees no material change to the results when compared to the first equation. The third equation omits the producer price indexes and includes the real exchange rate as well as retaining the mineral export-price boom index. These results are interesting in that the real exchange rate index remains insignificant even at ten percent, and the strength of the coefficient of the mineral-export price boom reduced. The level of significance did not.

The fourth equation omits the real exchange rate and the producer price indexes from the equation but retained the mineral export-price boom index. This provides the strongest results as all variables are significant at five percent and the Durbin Watson statistics is also satisfactory.

The linkage of these results confirm analysis from Figure 5.4, which highlighted that the relative contribution of textile, clothing and footwear manufacturing income to total income was in a steady trend decline over the period 1985 to 2014. This decline would be reflected through the production related variable this longer-term structural change was taking place. Over this longer-term period movements in the real exchange rate did not impact the income of this sub-sector. However the impact of the mineral-export price boom did impact textile, clothing and footwear income as the related real exchange appreciation decreased the import price of competitors and expedited the decline in the local income of this sub-sector. This is reflected in Figure 5.4 over the period 2003 to 2008.

A3.2.6 Print and Media

Summary regression results for print and media manufacturing income are detailed below in Table A3.6. Details of the regressions are provided later in this appendix. Income (Inc) and production (Prod) indexes are those for the print and media manufacturing sub-sector. The media producer price index (PPI) has been utilised as it covers the time period utilised.

Table A3.6

Summary Regression Results for Quarterly Print and Media Manufacturing Income from 1987 to 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	RSq	DW
(i)	-0.346	0.445	0.708	0.678	0.129	0.079	0.95	0.002	0.973	1.65
	p < 0.05		*	*			*			
(ii)	0.137	n/a	0.691	0.692	0.1	0.09	0.963	0.003	0.993	1.61
	p < 0.05		*	*			*			
(iii)	0.178	n/a	0.691	0.691	n/a	n/a	0.961	0.003	0.993	1.59
	p < 0.05		*	*			*			
(iv)	-0.08	0.026	0.717	0.678	n/a	n/a	0.952	n/a	0.994	1.62
	p < 0.05		*	*			*			

The first equation includes all variables, namely the real exchange rate, print and media production, the media producer price index, lagged print and media income and the mineral export-price boom. The second equation omitted the real exchange rate while the third equation omitted both the real exchange rate and the media producer price index. The final equation omitted both the media producer price index and the mineral export-price boom.

All four equations provide similar results in that production and lagged income related variables have a strong coefficient as well as significant at five percent. The similarity of results across all four equations suggest that production related influences are the main determinant of print and media manufacturing income. Technological gains and globalisation of ownership in this sub-sector could be a reason for this.

A3.2.7 Food and Beverage

Summary regression results for food and beverage manufacturing income are detailed below in Table A3.7. Details of the regressions are provided later in the appendix. Income (Inc) and production (Prod) indexes are those for the food and beverage manufacturing sub-sector. The beverage producer price index (PPI) has been utilised as it covers the time period utilised.

Table A3.7

Summary Regression Results for Quarterly Food and Beverage Manufacturing Income from 1987 to 2014

	C	RER	Prod	Prod (-1)	PPI	PPI (-1)	Inc (-1)	Boom	R Sq	DW
(i)	-0.198	0.004	0.58	0.5	0.336	0.331	0.96	0.001	0.997	1.99
	p < 0.05		*	*			*			
(ii)	-0.218	n/a	0.582	0.496	n/a	n/a	0.959	n/a	0.997	1.99
	p < 0.05		*	*	†	†	*			
(iii)	0.178	n/a	0.432	0.361	n/a	n/a	0.897	-0.004	0.972	1.98
	p < 0.05		*	*			*	*		

NB. * $p < 0.05$ † $p < 0.10$

The first equation includes all variables and show that the real exchange rate, the beverage producer price index or the mineral export-price boom have a significant relationship with food and beverage manufacturing income.

The second equation omits the real exchange rate and mineral export-price boom and shows that the producer price index variable is now significant at eight percent. The size of the coefficients of the remaining variables are largely unchanged.

Alternatively the third equation includes the mineral export-price boom variable and omits the real exchange rate and the producer price index. The mineral export-price boom variable now has a significant relationship with food and beverage manufacturing income. The negative relationship between the mineral export-price boom and income.

Figure 5.3 shows that the relative contribution of food and beverage income to total manufacturing income declined shortly after 2000 and remained steady over the period 2003 to 2008 before increasing after 2008. A possible explanation is while overall real exchange rate movements did not impact food and beverage manufacturing income, exchange rate movements relating to the mineral export-price boom did influence income during the boom (i.e. dummy variable) period but slowing down the underlying structural change within the sub-sector. Notwithstanding this the main determinants of food and beverage income are more production related than price related.

A3.2.8 Wood, Paper and Furniture

Summary regression results for wood, paper and furniture manufacturing (WPF) income are detailed below in Table A3.8. Details of the regressions are provided later in the appendix. Income (Inc) and production (Prod) indexes are those for the wood, paper and furniture manufacturing sub-sector. The wood producer price index (PPI) has been utilised as it covers the time period utilised.

Table A3.8

Summary Regression Results for Quarterly Wood, Paper and Furniture Manufacturing Income from 1987 to 2014

	C	**RER**	**Prod**	**Prod (-1)**	**PPI**	**PPI (-1)**	**Inc (-1)**	**Boom**	**R Sq**	**DW**
(i)	-0.195	-0.032	0.384	0.345	0.164	0.048	0.918	0.003	0.992	1.82
	p < 0.05		*	*			*			
(ii)	0.137	n/a	0.411	0.331	0.08	-0.005	0.94	n/a	0.993	1.61
	p < 0.05		*	*			*			
(iii)	0.178	-0.009	0.367	0.375	n/a	n/a	0.982	n/a	0.992	1.88
	p < 0.05		*	*			*			

The first equation includes all variables and confirms that the production and income variables are significant at five percent and that the Durbin Watson statistic is satisfactory. The removal of the real exchange rate and mineral export-price boom variables in the second equation sees change in the coefficients of the producer price indexes, although they do not record significant levels. Alternatively the inclusion of the real exchange rate and mineral export-price and omission of the producer price index variables sees an improvement in the Durbin Watson statistic but not a significant relationship in these variables.

The poor results of any of the price related variables suggest that wood, paper and furniture manufacturing income remains dependent on production related variables rather than price related variables.

Appendix 4

LN TWI		Current	First Differences
Augmented Dickey-Fuller test statistic		-2.12585	-7.579479
Test critical values:	1% level	-3.49375	**-3.494378**
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

LN QTRLYTOT

		Current	First Differences
Augmented Dickey-Fuller test statistic		-0.10624	-6.342925
Test critical values:	1% level	-3.49375	**-3.493747**
	5% level	-2.8892	-2.8892
	10% level	-2.5816	-2.581596
	Yes / No	No	Stationary at 1%

REAL 5YR DIFF		Current	First Differences
Augmented Dickey-Fuller test statistic		-2.32825	-8.25998
Test critical values:	1% level	-3.49568	-3.495677
	5% level	-2.89004	-2.890037
	10% level	-2.58204	-2.582041
	Yes/No	No	Stationary at 1%

LN TRADE INTENSITY		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-1.87176	-8.870994
Test critical values:	1% level	-3.49375	**-3.494378**
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

LN INCOME BALANCE		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-3.1019	-9.587408
Test critical values:	1% level	-3.49375	**-3.494378**
	5% level	**-2.8892**	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	At 5%	Stationary at 1%

Ordinary Least Squares - Single Equation

Method: Least Squares - Single Equation
Date: 10/01/12   Time: 10:55
Sample Q4 1983 to Q1 2010
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.743643	0.107743	25.46459	0
LNQTRLYTOT	0.836134	0.033941	24.63511	0
REAL5YRINTDIFF	0.000159	2.45E-05	6.487429	0
LNTRADEINTENSITY	-0.261727	0.018864	-13.87476	0
LNINCOMEBALANCE	-0.048341	0.014265	-3.388712	0.001

R-squared	0.886352	**Residuals**		**t - statistic**
Adjusted R-squared	0.881851	Augmented Dickey-Fuller test statistic		-5.342532
S.E. of regression	0.041751	Test critical values:	1% level	**-3.493747**
Sum squared resid	0.176055		5% level	-2.8892
Log likelihood	188.8136		10% level	-2.581596
F-statistic	196.927	Stationary at 1%		
Prob(F-statistic)	0			
Durbin Watson	0.79975			

Dependent Variable: LNTWI
Method: Least Squares
Date: 10/01/12 Time: 11:00
Sample (adjusted): 1984Q1 2010Q1
Included observations: 105 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	**2.737925**	0.085585	31.99083	0
LNQTRLYTOT	**0.82949**	0.02784	29.79509	0
REAL5YRINTDIFF	**0.000135**	2.07E-05	6.530286	0
LNTRADEINTENSITY	**-0.256817**	0.015927	-16.12413	0
LNINCOMEBALANCE	**-0.045851**	0.011395	-4.023651	0.0001
RESIDTOTRIDTRADEINTYBAL(-1)	**0.604973**	0.081722	7.402851	0

R-squared	0.928619	Mean dependent var	4.711245
Adjusted R-squared	0.925014	S.D. dependent var	0.120793
S.E. of regression	0.033077	Akaike info criterion	-3.924485
Sum squared resid	0.108318	Schwarz criterion	-3.77283
Log likelihood	212.0354	Hannan-Quinn criter.	-3.863031
F-statistic	257.5859	Durbin-Watson stat	1.943109
Prob(F-statistic)	0		

Johanssen - Maximum Likelihood

Date: 11/11/12   Time: 15:24

Sample Q2 1984 to Q1 2010

Included observations: 104 after adjustments

Trend assumption: Linear deterministic trend

Series: LNTWI LNQTRLYTOT REAL5YRINTDIFF LNTRADEINTENSITY LNINCOMEBALANCE

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.279513	71.95573	69.81889	0.0334
At most 1	0.17307	37.86168	47.85613	0.3081
At most 2	0.09513	18.09804	29.79707	0.5588
At most 3	0.071212	7.70181	15.49471	0.4978
At most 4	0.000181	0.018828	3.841466	0.8907

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05		
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	
None *	0.279513	**34.09405**	**33.87687**	0.0471	Yes
At most 1	0.17307	19.76364	27.58434	0.3577	No
At most 2	0.09513	10.39623	21.13162	0.7068	No
At most 3	0.071212	7.682982	14.2646	0.4118	No
At most 4	0.000181	0.018828	3.841466	0.8907	No

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

1 Cointegrating Equation(s): Log likelihood 94.38252

Normalized cointegrating coefficients

LNTWI	**LNQTRLYTOT**	**REAL5YRINTDIFF**	**LNTRADEINTENSITY**	**LNINCOMEBALANCE**
1	**-0.727826**	**-0.000176**	**0.155721**	**0.047547**
	-0.05708	**-4.40E-05**	**-0.03252**	**-0.02493**

Wrtiiten by system as: LNTWI - LNTOT - REALDIFF - LNTRADEINTEN - LN Y Bal = 0

Thus reworking algebra and inserting co-efficients becomes: LNTWI = 0.73 LNTOT + 0.000176 REAL DIFF + 0.16 LN TRADE Inten - 0.048 LN Y Bal

1. TWI and Terms of Trade

LN QTRLYTOT		t-Statistic	
		Current	**First Differences**
Augmented Dickey-Fuller test statistic		-0.10624	-6.342925
Test critical values:	1% level	-3.49375	-3.493747
	5% level	-2.8892	-2.8892
	10% level	-2.5816	-2.581596
	Yes / No	No	Stationary at 1%

LN TWI		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-2.12585	-7.579479
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

Dependent Variable: LNTWI				Date: 09/16/12 Time: 15:11
Method: Least Squares				Sample: 1983Q4 2010Q2
				Included observations: 107
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.676374	0.187996	14.23636	0
LNQTRLYTOT	0.480843	0.04429	10.8566	0

R-squared	0.528864	**Residual**		t-Statistic
Adjusted R-squared	0.524377	Augmented Dickey-Fuller test statistic		**-4.07785**
S.E. of regression	0.085222	Test critical values:	1% level	**-3.49375**
Sum squared resid	0.762596		5% level	-2.8892
Log likelihood	112.6698		10% level	-2.5816
F-statistic	117.8658	Residuals stationary at 1%, co-integration holds		
Prob(F-statistic)	0			
Durbin Watson	0.257			

2. TWI and Real Interest Differential

LN TWI		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-2.12585	-7.579479
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

REAL 5YR DIFF		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-2.32825	-8.25998
Test critical values:	1% level	-3.49568	-3.495677
	5% level	-2.89004	-2.890037
	10% level	-2.58204	-2.582041
	Yes / No	No	Stationary at 1%

Dependent Variable: LNTWI
Method: Least Squares
Date: 10/03/12 Time: 07:13
Sample: 1983Q4 2010Q2
Included observations: 107

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.681061	0.014898	314.2172	0
REAL5YRINTDIFF	0.000242	6.82E-05	3.555016	0.0006

R-squared	0.107432	**Residual**		**t-Statistic**
Adjusted R-squared	0.098932	Augmented Dickey-Fuller test statistic		-2.19829
S.E. of regression	0.117301	Test critical values:	1% level	-3.49313
Sum squared resid	1.444741		5% level	-2.88893
Log likelihood	78.48567		10% level	**-2.58145**
F-statistic	12.63814	Residuals not stationary, Co-integration does not hold		
Durbin Watson	0.175			

3. TWI and Trade Intensity

LN TWI		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-2.12585	-7.579479
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

LN TRADE INTENSITY		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-1.87176	-8.870994
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

Dependent Variable: LNTWI
Method: Least Squares
Date: 10/03/12 Time: 07:17
Sample (adjusted): 1983Q4 2010Q1
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.427927	0.181528	24.39255	0
LNTRADEINTENSITY	0.053726	0.034148	1.573317	0.1187

R-squared	0.023248				
Adjusted R-squared	0.013856		**Residuals**		t-Statistic
S.E. of regression	0.12062		Augmented Dickey-Fuller test statistic		-2.47262
Sum squared resid	1.51311		Test critical values:	1% level	-3.49438
Log likelihood	74.80394			5% level	-2.88947
F-statistic	2.475325			10% level	-2.58174
Prob(F-statistic)	0.118683		Residuals not stationary, co-integration does not hold		
Durbin Watson	0.152644				

4. TWI and Income Balance

LN TWI		**Current**	**First Differences**
Augmented Dickey-Fuller test statistic		-2.12585	-7.579479
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	No	Stationary at 1%

LN INCOME BALANCE		Current	First Diff
Augmented Dickey-Fuller test statistic		-3.1019	-9.587408
Test critical values:	1% level	-3.49375	-3.494378
	5% level	-2.8892	-2.889474
	10% level	-2.5816	-2.581741
	Yes / No	At 5%	Stationary at 1%

Dependent Variable: LNTWI
Method: Least Squares
Date: 10/03/12 Time: 07:22
Sample (adjusted): 1983Q4 2010Q1
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.038258	0.163446	30.82514	0
LNINCOMEBALANCE	-0.075875	0.038024	-1.99548	0.0486

R-squared	0.036876	**Residuals**			**t-Statistic**
Adjusted R-squared	0.027615	Augmented Dickey-Fuller test statistic			-1.54921
S.E. of regression	0.119775	Test critical values:		1% level	-3.49375
Sum squared resid	1.491998			5% level	-2.8892
Log likelihood	75.54862			10% level	-2.5816
F-statistic	3.981923	Residuals not stationary, co-integration does not hold			
Prob(F-statistic)	0.048606				
Durbin Watson	0.14144				