Is the gold fever too high?

The effect of the mining commodity price shocks on the export in Australia's sectors

Abstract

As the metal, mineral and fossil fuels prices seem to be more volatile in the new millennium, the global economy is affected in many ways. As most of Australia's main export products originate from the mining sector, shifts in the real exchange rate and other macroeconomic variables occur because of the commodity price shocks and in their turn affect the exports of unrelated sectors. Because little empirical research has been conducted on this topic, an interesting approach would be to first test these effects by an 'one fit for all' Vector Error Correction Model on three sectors, instead of making a sector specific model for each sector. For the best performing shock definition we will run a deterministic dynamic simulation for a base model and an alternative model with an artificial shock to determine the effects of both a negative and a positive shock. While there is room for improvement in the used methodology, in two out of three cases the model with the best performing shock definition was robust and the effect is in line with the literature. After an initial period of uncertainty which causes a negative effect, a positive shock will have a negative effect on the real exports, while a negative shock will have an positive effect.

Author: Simon Baltussen

Student number: 349986

Supervisor: Dr. B.S.Y Crutzen

Master thesis International Economics

Erasmus School of Economics

Erasmus University, Rotterdam

Contents

Introduction

Once it was known as one of Australia's largest export sectors and a significant contributor to its economy, however the momentum has turned for the Australian car export sector which has been decreasing rapidly over the last four years. This sector is best described as a specialized sector concentrating around large rear-wheel-drive passenger cars (DITR,2007 ,p.23-30). The reason for the downward trend in the car export sector can be attributed to rising gasoline prices causing the demand to shrink (DITR, 2007,p.23-30). As a result exports are just a fraction of what they used to be (source: see Appendix 1). The specialization of this part of the machinery sector suffered from increasing fuels costs and a subsequent change in demand.

But there is also a more underlying trend in Australia. A large part of the miscellaneous articles sector, a good example is photographic equipment, saw their exports increase in the eighties and nineties but decline in the new millennium mainly due to the high real exchange rate and the ability of the mining sector to draw away skilled labour (Parkinson, 2010, p.17-18). In contrary some businesses and sectors adapt, innovate, move into niche markets or a new place in a supply chain and are successful in the changing environment (Parkinson, 2010, p.17-18). For example scientific instruments for medical, geo-science and other similar advanced applications became one of the top dogs in the Australian 'Miscellaneous Article' sector.

This paper will take a closer look at these current developments and how the price development in the mining sector is influencing the exports of the other sectors, answering the following question: *"What effect have commodity price shocks on the exports of other sectors in Australia?"*

We will answer this question by using a 'one fit for all' model. The reason for the use of this methodology is the lack of empirical research on the subject. As the unit root tests showed we are looking for cointegration to validate the use of a Vector Error Correction model (VECM). To answer the research question we not only search for a significant effect in a robust model but we will also simulate the effect over time, as the theory suggest that some structural effects take places over a longer time span. A 'simple' deterministic dynamic simulation within our sample period is used to estimate the deviations of the 'alternative' model with an artificial commodity price shock from the 'base' model.

Turning to our results, we should first state that we had to make some assumptions regarding data problems. The ‘one fit for all’ model, the (oil) price shock definitions from another research area and other simple methods have the consequence that the robustness of the models is not always optimal and further study with more sector specific models and data, shock definitions and more elaborate estimation methods should gain better results. But results were exciting and the models with the best performing shock are robust in two out of three sectors, the third has some (small) serial correlation issues. The initial price shock has a negative effect on the exports in the first few months for most regressions, originating predominately from an shock in the exchange rate, after a few months the effect converge back to smaller monthly loss or profit as a result of more structural changes in demand and competitiveness. In accordance with the theory, after a short initial period in most cases a negative shock will increase exports in other sectors, while a positive shock will have a negative effect the exports of the Australian sectors.

In the first chapter the theoretical influence of the developments in the mining sector on the other merchandise export sectors is studied. Next there is a general description of the used commodity basket, the developments in the mining sector and a few important Australian macroeconomic variables are analyzed. In the third chapter we will explain the model and methodology for examining the effects on the real exports across sectors. The fourth chapter will elaborate on the used data and the composition of the used variables. The fifth chapter contains the outcomes and discussion. For clarity the metals, mineral, fossil fuels and their products will be referred to as the commodities, natural resources or raw materials. The extraction, basic treatment and simple derivative products will be referred to as the mining sector and its products.

1. Theory

Price shocks of natural resources might seem unrelated to the exports of other Australian sectors for an outsider. So it is important to bear in mind that the price shocks affect the sectoral exports through other parts of the (global) economy, which in turn affect the exports. These price shocks are influencing decisions of consumers, companies and other actors all over the world. Next to this, a resource exporting country is also influenced by the price shocks in a different way than a resource importing country, an example is given by the Dutch disease theory by Cordon (1984).
This chapter will outline the main theoretical effects of the price change in the mining sector on the exports of other Australian industries which produce merchandise goods. This chapter is divided

into a section that will outline some transmission mechanisms through which these effects occur all over the world. The second part is focussed on the transmission mechanism behind the Dutch disease, where competitiveness loss occurs because of real exchange rate appreciation.

1.1. Input and operating effect of natural resources

The effect of oil price shocks on the production or income at different levels economy has been a popular topic for research papers. These papers are important suppliers of theory and methodology for our research. The next section summarizes some of the main transmission mechanisms in the literature through which natural resources affect the economy in resource importing (and exporting) countries. Oil as well as the other energy sources are used for countless final services in almost every part of the economy. This also accounts for the other raw materials, although to a lesser extent.

One of the transmission mechanisms is the input-cost effect, where an increase in the price of a fossil fuel will lead to a reduction in the fossil fuel's consumption and thus to a reduction in the productivity of capital and labour (Lee& Ni, 2004, p.824-825). The classical income effect states that the increase in the oil price will reduce the disposable income of a household reserved for other goods. Another factor is that oil price peaks increase the operating cost of durable goods like cars or the heating of houses, this reduces the demand for durable goods and investments (Lee& Ni, 2004, p.824-825). A third mechanism is David Lilien's dispersion hypothesis, where exogenous disturbances are causing unemployment because the reallocation of specialized labour, as a consequence of sectoral shifts in demand, will require some time (Jones & Leiby, 1996, p.17).
Next to these more obvious channels, oil price shocks are also influencing foreign exchange markets, inflation and other macroeconomic factors, which can lead to monetary and other political responses to stimulate the economy (Jiménez-Rodríguez & Sánchez, 2004, p.7). An important example is the effect of exchange rate volatility, the belief in this research area is that an increase in volatility creates uncertainty about the future profits on international transactions, and this leads to hesitation from actors to conduct business (Arize & Malindretos ,1998, p.43-45). In most major mining countries the exported natural resources have a major influence on the exchange rate (Djoudad, Murray, Chan & Daw, 2000, p.169-172), we will elaborate on the effect on these commodity currencies further on in the paper. The exchange rate volatility originating from the commodity price shocks might thus create uncertainty and reduce the real exports. Further research about the volatility is outside the scope of this research.

In a similar way to the above mentioned (micro- and) macroeconomic effects, effects occur at the industry level. An increase in the oil price will increase the production, transportation and input cost of the sectoral goods. The automobile industry also faces these costs but is also a good example of the effect of higher operating cost for the consumer, during the oil price spikes in the seventies car sales plummeted as a result of these increased costs (Lee & Ni, 2004, p828-831). Bresnahan & Ramey (1992) found that during these spikes small car production plants operate at a high capacity while large car production plummeted (in Jones & Leiby, 1996, p.20-21), showing that there are adjustment mechanisms active in the sectors beyond the Standard International Trade Classification (SITC) one and two digit level (Jones & Leiby, 1996, p.20-21).

The observation that the ’73-’74, ’79-’80 and ’90 oil price spikes were followed by a global recession, but an oil price collapse in ’86 did not produce a economic boom along with the diversity of the channels described above, gave rise to the belief that shocks had asymmetric and nonlinear impacts (Jones & Leiby , 1996, p.3-5). Over the years some of these asymmetric and nonlinear shock approaches yielded a stable oil-price GDP relationship after the second World War (Jones, Leiby & Paik, 2004, p. 3-28). We will further outline these shock variables in Chapter 3.

1.2. Terms of trade forces

Next to the above mentioned demand and supply mechanisms there is another important force at work which primarily affects resource exporting countries. In traditional economic theory the (real) exchange rate problems of countries caused by a large resource stock can make other national sectors less competitive. Cordon (1984, p.359-363) refers to the origin of the term ‘Dutch disease’ as the adverse effects of the natural gas discovery and exploitation on the Dutch manufacturing sector, caused by real appreciation of the Dutch Guilder. Next to the exploitation of one or more natural resources, a ‘boom’ in Cordon’s theoretical ‘booming sector’ model can also happen by an exogenous price increase of the sector’s product in the world market relative to the country’s imports (Cordon, 1984, p.359-363).

One effect of a boom is the spending effect: As a result of an increase in the price and/or quantity exported the demand for the currency is increased (Cordon, 1984, p. 359-363). The owners of the mining firms and the government spent more because of the increased income which leads to a relative price increase of nontradables because the latter’s income elasticity of demand is positive, and thus to a real appreciation of the exchange rate (Cordon, 1984, p. 359-363).

The other effect is the resource movement effect: The boom in the commodity sector attracts labour from the nontradable sector and the industrial sector. The first channel through which this occurs is called direct de-industrialization where the mining sector's increased demand for labour directly attracts labour from the industrial sector, without a real exchange rate appreciation (Cordon, 1984, p. 359-363). The indirect de-industrialization appears because the movement of labour out of the nontradable sector which causes the supply curve to shift upwards, and next to the increased demand for nontradable goods by the spending effect, this causes extra appreciation of the exchange rate through a price level increase in the nontradable sectors (Cordon, 1984, p. 359-363).

1.3. Concluding remarks

To conclude we can state that the price shocks initiate more mechanisms that influence the exports than initially might be apparent. And it is easy to lose track of how the effect on sectoral exports arises because of the many economic variables that are influenced by commodity price shocks. Important is to bear in mind the two main variables, that is the overall demand for a sector's good in the world. Change in production cost, employment, income and operating cost all reduce or increase the demand for a good, which in turn affect the export of this good in any country. The other variable is competitiveness. The natural resource exports affect the real exchange rate and the prices of a sector's goods, making the price of a national sectoral good on the world market cheaper or more expensive than the same good produced in a country that does not have the same effect on their real exchange rate.

2. Australia and its mining sector

As described in the previous chapter, in countries exploiting a large natural resource stock unrelated sectors can have problems with rising labour costs and an appreciating real exchange rate. In the following chapter we will take a quick look at Australia's mining sector, the used commodity basket and look at some variables related to the Dutch Disease and the export.

2.1. Australia's natural resource basket

Australia has one of the biggest and most diverse mining sectors in the world. On this continent not only fossil fuels and the more familiar metals, like gold, iron and bauxite, are present. Australia is also a major supplier of many materials for modern technologies like lithium and manganese (used in electric and hybrid car batteries), tantalum and titanium (used for jet engines and spaceflight) (Mélanie et al., 2010, p.106). Table 1 shows the selected commodities used in this research and their average weight in the commodity basket. Figure 1 shows the average monthly price of the basket of natural resources. The weights are determined by an indexed average of the quarterly export of the commodities in the period ’98 to ’10. The selected resources account for 40.14 % of Australia’s goods and services export and for 91.33 % of the total mining export between ’98 and ’09 (source: see Appendix 1).

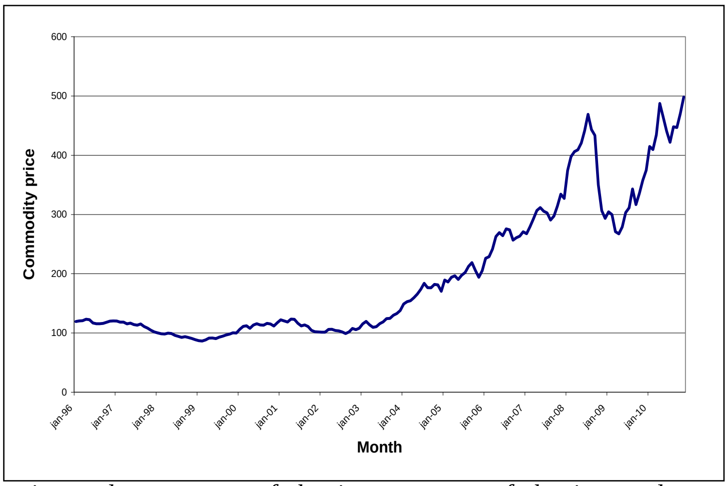
$$com_t = \sum p_{n,t} * w_n$$

$$w_n = \frac{1}{t}\sum \frac{ex_{n,t}}{ex_{total,t}}$$

com_t is the ‘average commodity price’ in period t, p is the average monthly commodity price of raw material n. w, is the weight of raw material n showed in Table 1, these are determined by the average of commodity n’s monthly share of the value of the total exports of the basket (ex_{total}) in each quarter. $ex_{n,t}$ is the value of the exports of commodity n at time t.

Table 1 and Figure 1. Commodity weights & commodity price, base month January 1st 1998

Raw material	Weight, percentage
Aluminium (ingot)*	13.7
Coal	25.4
Copper	4.8
Gold, refined	11.2
Iron	16.5
Lead	1.5
Nickel	4.6
Oil	11.8
Gas	6.4
Silver, refined	0.3
Tin	0.1
Uranium oxide	0.8
Zinc	2.9

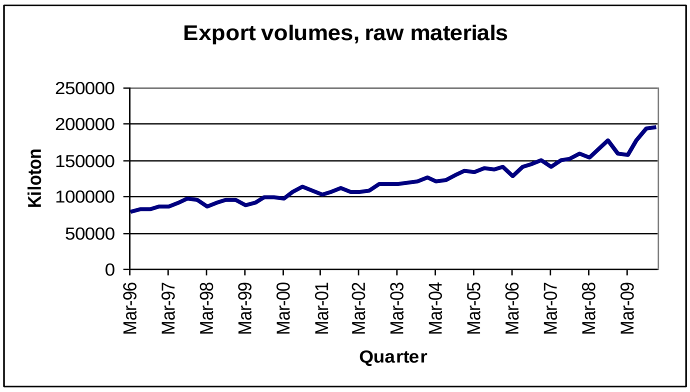


*Sources: see Appendix 1, * two parts of bauxite produce one part of alumina, two parts of alumina produce one part of aluminium. Volatility in terms of Standard deviations/average: 0.102 for 1996-2003 and 0.325 for 2004-2010.*

Figure 1 shows a relatively stable commodity price in the period 1996 until 2003. One of the main reason for the rising price after this period is the increased demand for the raw materials, mainly driven by the economic growth in China and India (Avendaño, Reisen & Santiso, 2008, p.10-11). The demand is not the only reason for the price movements, the slow supply response to changes in demand, the supply chain that has become increasingly complex and an increasing codependency of the actors in the chain all led to an increase in the volatility of the market (Peeling, Stothart, Toms & Mcllveen, 2010, p.156-160). Another characteristic is that conflicts and corruption occur more frequently in resource rich countries and on the transport routes of the raw materials (Peeling et al., 2010, p.156-160). The geographical concentration and the lack of substitutes for some of these materials result in a high dependency of importing countries on (quasi-) monopolies (Korinek & Kim, 2010, p. 120-121). In a study on export restrictions on 21 strategic metals and minerals from Korinek & Kim (2010, p.123-129) they found that 13 of these had one or more export restrictions in at least one year since the late nineties and 50 of the 102 known restrictions were imposed between 2006 and 2008. Finally, on the background there is an underlying supply trend lingering in some markets, for example in the oil market most large oil fields are slowly getting exhausted and most conventional large fields have been found (Bruggink, 2011).

Figure 2 shows the growth of the Australian export volume of the basket. It follows a more stable trend in comparison to its price, as the difference in the increase in volatility of both show. The volatility in the total revenue of the raw material export is thus mainly determined by the price, and quantities seem to react to price fluctuations gradually.

Figure 2. Quarterly mining export volumes of Australia, in kiloton



Source: Appendix 1, Volatility in terms of Standard deviations/average: 0.124 for 1996-2003 and 0.134 for 2004-2010.

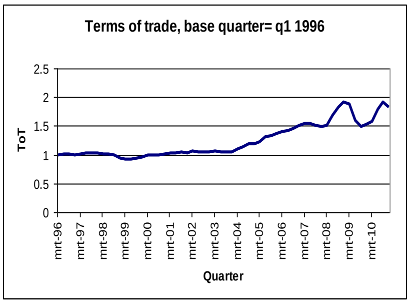
For the calculation of the basket and the weights the same methodology was used as in Djoudad et al. (2000), Chen, Rogoff & Rossi (2003) and Chen (2004). In line with these researches, the argument behind the basket is that it ‘prevents’ Australia from influencing the average commodity price, since Australia’s share in global production is relatively small if all raw materials are combined. Shocks are thus largely exogenous to Australia’s economy. Other arguments for this statement are that in Australia conflicts occur to a lesser extent than in most other mining countries, transport routes are mainly through international waters and Australia has no export restrictions on its resources (ACS, 2010, p.78), except for uranium and some other strategic resources (ATC,?).

2.2. The rest of Australia's economy

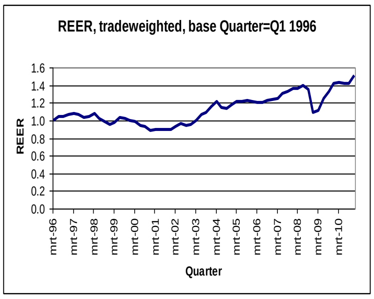
In the theoretical part it became apparent that the export of other sectors is influenced through different mechanisms, some of these are working in an indirect way, for example the Dutch disease. In this part we will look at some important macroeconomic variables that are affected by the Dutch disease and in their turn affect the real export of other sectors. We will look at the exchange rate, the terms of trade and the Consumer Prices Index, then the employment in some different tradable and nontradable sectors. Finally we briefly analyse the growth of the exports of the Australian sectors.

Figure 3a shows that the terms of trade (export prices divided by import prices) is relatively stable from 1996 until 2004 and changes into an upward trend and the volatility increases. The change shows some similarity with the change in the commodity price. The terms of trade is also steadily rising in the first half of the 00's and collapsed and recovered at the same time the commodity price did, during the financial crisis. This is a signal that Australia has symptoms of the Dutch disease. This also is the case for Figure 3b, which shows the real exchange rate of the Australian Dollar against a basket of currencies (basket currency/Aus$). Although in the period 1998 until 2002 the terms of trade and the Real exchange rate do not move together, after 2002 the two graphs begin to show more similarities. Finally, the Consumer Price Index (Figure 3c), seem to be relatively unaffected by the developments in the Australian mining sector.

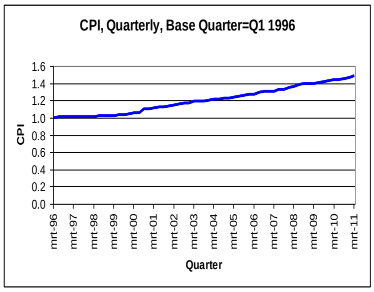
Figure 3a. Terms of trade



3b. Real exchange rate



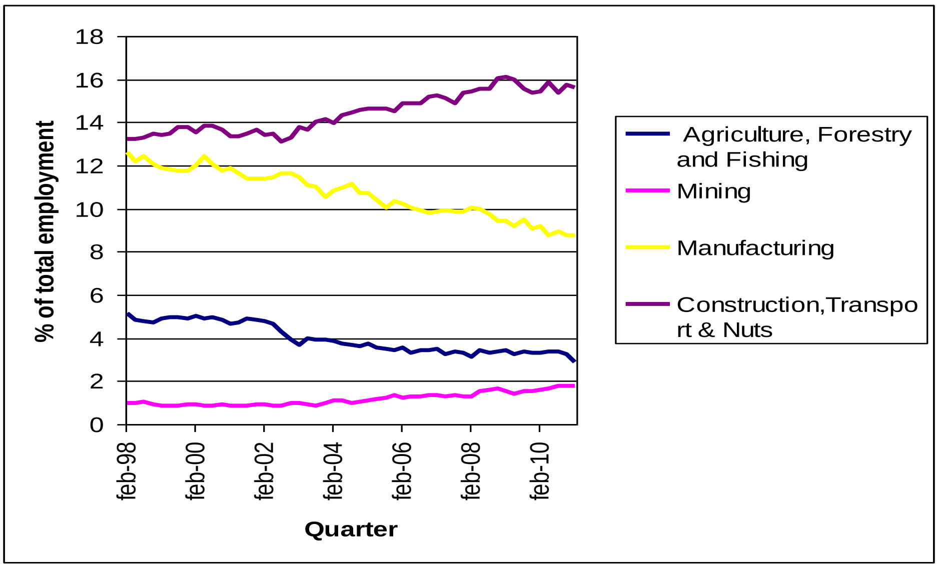
3c.Consumer Price Index



Source: see Appendix 1, Volatility in terms of Standard deviations/average: ToT, 0.037 for 1996-2003 and 0.145 for 2004-2010, REER , 0.066 for 1996-2003 and 0.085 for 2004-2010, CPI, , 0.064 for 1996-2003 and 0.057 for 2004-2010.

The effect of commodity prices is also pointed out in the papers of Djoudad et al. (2000), Chen, Rogoff & Rossi (2003) and Chen (2004), the main finding of these papers is that there is a significant and robust relationship between commodity prices and the exchange rate of some developed commodity exporting countries' currencies. Other examples of these commodity currencies are the Canadian Dollar, the New Zealand Dollar and the South African Rand. For these commodity currencies the real exchange rate appreciates as a result of this exogenous shock in the terms of trade and results in a higher demand for the currency, caused by an increase in the commodity price (Chen, 2004, p. 2-4).

Figure 4. Employment in different sectors of both services and manufacturing, as a percentage of the total labour force (first quarter from November '97-February'98 and so on).



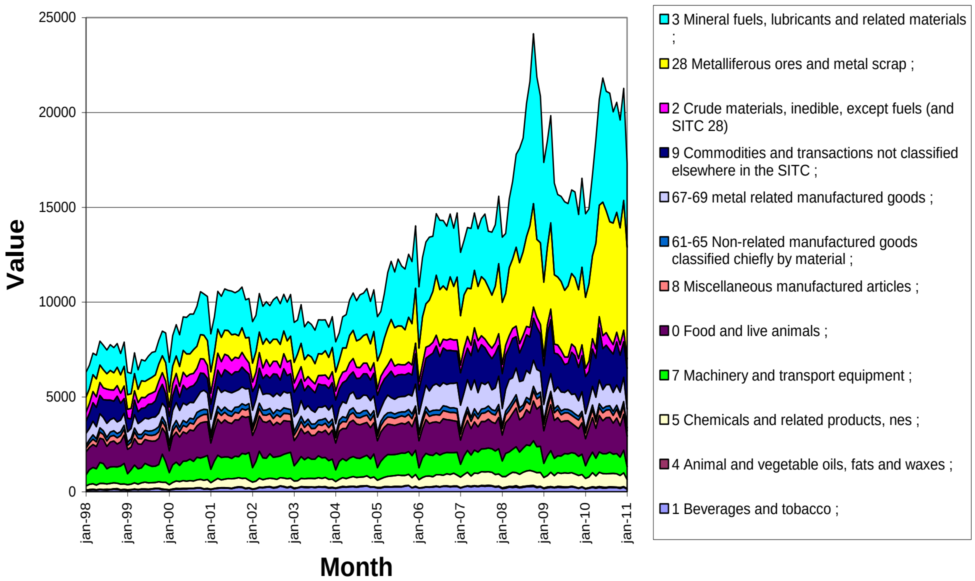
Source: see Appendix 1.

Figure 4 shows the share of total labour force for some selected sectors (not the SITC definition). Before 2002 the labour distribution was relatively stable, the mining sector's share and the labour force share in the supporting sectors started growing after 2002 at the costs of the manufacturing and 'soft' commodity sectors, that is 'natural growing' products. Next to the rise of competition of the low cost countries, the 'soft' commodity and the manufacturing sector could not compete for the labour force with the mining sector and the construction, transport and nuts sectors, which are important supporting sectors for mining activities. The rest of the labour force is active in other service sectors, their share increased relatively stable from 68.08% in the first quarter of 1998 to 70.54% in the last quarter of 2010 (source: see Appendix 1). This stable labour share can be explained by both the spending effect, the indirect de-industrialization effect and a part of the employment is in sectors which are largely unaffected by any problem in the economy, for instance education and the army.

Figure 5 shows that the total exports, in terms of millions of Australian Dollars, have been booming in the last 6 years, but are also very volatile in a similar way as Figure 1, where there has been an upward trend and increased volatility.

While total exports in millions are booming in a similar trend as the commodity price, most to the mining sector unrelated sectors have only shown moderate growth. Machinery and to the mining sector unrelated manufactured goods only grew annually by respectively 1.112% and 0.057% from 1998 to 2010. Crude materials without metal ores and scrap of metal had an annual growth of 0.29% in the same period. Manufactured articles and the agricultural sector showed a moderate growth rate, while the good performers are the chemical sector and the small beverage and tobacco sector with an export growth of 6.996% and 7.273% during these 13 years. But it is not comparable to the export of metalliferous ores and scrap with an annual growth of 18.269 % and the fossil fuel or mineral fuels sector with an annual growth of 10.674%. Noticeable in Figure 5 is similarity with the commodity price in Figure 1, this leads to a suspicion that the export growth in terms of Australian Dollars is mainly price-driven and originates from the mining sector.

Figure 5. Nominal sectoral exports, in million Australian Dollars, classified by SITC sector



Source: see Appendix 1. Volatility in terms of Standard deviations/average: Total exports, 0.149 for 1996-2003 and 0.251 for 2004-2010

2.3. Concluding remarks

The chapter has shown some remarkable similarities between the behaviour of the commodity price, the real exchange rate, employment and the terms of trade of Australia. These similarities and the upward trend of the variables over time indicate that the country has symptoms of the

Dutch disease. The variables also showed the opposite effects when the price collapsed during the financial crisis.

The small growth rate of some of the sectoral export cannot only be explained by the Dutch disease theory and the resulting loss in competitiveness. As Chapter 1 has shown there are many other mechanism at work in the economy which are influenced by changing commodity prices on a national and global level, apart from any other ‘unrelated’ forces in the world economy.

3. Model and Methodology

This chapter will outline the model and methodology used to estimate the effect of commodity basket’s price on the real exports of the other sectors. First we will give a short description of the theoretical model used, followed by the estimation method through which we hope to answer the null hypothesis: "Is the effect of a commodity price shock on the real exports (significantly) different from zero." Only if this hypothesis is not rejected in a robust model we can look at the effects of the commodity price shocks.

The choice for a VECM was based on several arguments. As the previous chapter has shown there are many dynamics which are influenced by the price shocks. One of the main criticisms on many ‘Ordinary Least Square based’ methods, whether or not adapted for cointegration, is that they insufficiently represent the dynamics within a model even with a large number of equations or variables (Lütkepohl & Krätzig, 1999, p.1). In modern literature that studies shocks vector autoregressive models (VAR) and VECM’s are used because they capture the dynamics better and their effect over a longer time period (Lütkepohl, 1999, p.1). Of these two models a VECM seems more appropriate because many of the variables probably have an unit root, and not taking this into account can lead to spurious results. A first difference VAR model does not take into account any effect of the levels of the variables and will only look at the effect of the shocks on the change in real export from one period to another instead of taken into account the levels, so if cointegration exist a cointegrated model is preferred (Lütkepohl, 1999, p.1). Another argument in favour for the VECM is that the effect of an shock can have permanent effects, where the effect of a shock in a VAR will converge to zero (Lütkepohl, 1999, p. 21).

3.1. Model

In the economic literature the traditional specification for export is a demand and supply function. There are several variations to the basic model, used to test different hypotheses (for example:

Muscatelli, Stevenson & Montagna 1995 and Arize & Malindretos ,1998). However, the impact of the price changes in the mining sector on the exports of other sectors is relatively untouched yet. Therefore, we will use a variation of the traditional demand model used in most researches and adapt it to test the null hypothesis on the sectoral level and answer the research question .

$$\log(ex_{y,t}) = c_0 + c_1 * \log(trade_{y,t}) + c_2 * \log(p_{y,t}^{Aus} / (e_t \times p_{y,t}^{world}))$$

where $ex_{y,t}$ is the ‘real’ export in Australian Dollars, t is time, y is one of the sectors, $trade_{y,t}$ is the representative variable for the (world) demand, e_t is the exchange rate, $p_{y,t}^{Aus}$ and $p_{y,t}^{world}$ are the export prices of Australia and the world. Chapter 4 will further explain the variables.

3.2. Estimation technique

First of all, many of the studies which used this long run model assumed stationary variables, but many of the variables probably have an unit root, and not taking this into account can lead to spurious results. We will test for unit roots in the variables at an I(0) and I(1) level using the Augmented Dickey-Fuller test. The nonstationarity of the endogenous variables is essential for the use of a VEC Model. To test for cointegration a Johansen cointegration test is used.

$$\begin{aligned}
\Delta Y_{1,t} &= \alpha_1 (Y_{1,t-1} - \delta_2 Y_{2,t-1} - \delta_3 Y_{3,t-1} - c) \\
&+ \gamma_{1,1}\Delta Y_{1,t-1} + \gamma_{1,2}\Delta Y_{1,t-2} + \gamma_{1,3}\Delta Y_{1,t-3} + \gamma_{2,1}\Delta Y_{2,t-1} + \gamma_{2,2}\Delta Y_{2,t-2} + \gamma_{2,3}\Delta Y_{2,t-3} + \gamma_{3,1}\Delta Y_{3,t-1} + \gamma_{3,2}\Delta Y_{3,t-2} + \gamma_{3,3}\Delta Y_{3,t-3} \\
&+ \Phi_1 S_t^+ + \Phi_2 S_{t-1}^+ + \Phi_3 S_{t-2}^+ + \Phi_4 S_t^- + \Phi_5 S_{t-1}^- + \Phi_6 S_{t-2}^- + \Phi_7 \Delta Y_{1,t-12} + \Phi_8 \Delta Y_{2,t-12} + \Phi_9 \Delta Y_{3,t-12} + u_{1,t}
\end{aligned}$$

$$\begin{aligned}
\Delta Y_{2,t} &= \alpha_2 (Y_{1,t-1} - \delta_2 Y_{2,t-1} - \delta_3 Y_{3,t-1} - c) \\
&+ \gamma_{4,1}\Delta Y_{2,t-1} + \gamma_{4,2}\Delta Y_{2,t-2} + \gamma_{4,3}\Delta Y_{2,t-3} + \gamma_{5,1}\Delta Y_{1,t-1} + \gamma_{5,2}\Delta Y_{1,t-2} + \gamma_{5,3}\Delta Y_{1,t-3} + \gamma_{6,1}\Delta Y_{3,t-1} + \gamma_{6,2}\Delta Y_{3,t-2} + \gamma_{6,3}\Delta Y_{3,t-3} \\
&+ \Phi_{10} S_t^+ + \Phi_{11} S_{t-1}^+ + \Phi_{12} S_{t-2}^+ + \Phi_{13} S_t^- + \Phi_{14} S_{t-1}^- + \Phi_{15} S_{t-2}^- + \Phi_{16} \Delta Y_{1,t-12} + \Phi_{17} \Delta Y_{2,t-12} + \Phi_{18} \Delta Y_{3,t-12} + u_{2,t}
\end{aligned}$$

$$\begin{aligned}
\Delta Y_{3,t} &= \alpha_3 (Y_{1,t-1} - \delta_2 Y_{2,t-1} - \delta_3 Y_{3,t-1} - c) \\
&+ \gamma_{7,1}\Delta Y_{3,t-1} + \gamma_{7,2}\Delta Y_{3,t-2} + \gamma_{7,3}\Delta Y_{3,t-3} + \gamma_{8,1}\Delta Y_{1,t-1} + \gamma_{8,2}\Delta Y_{1,t-2} + \gamma_{8,3}\Delta Y_{1,t-3} + + \gamma_{9,1}\Delta Y_{2,t-1} + \gamma_{9,2}\Delta Y_{2,t-2} + \gamma_{9,3}\Delta Y_{2,t-3} \\
&+ \Phi_{10} S_t^+ + \Phi_{11} S_{t-1}^+ + \Phi_{12} S_{t-2}^+ + \Phi_{13} S_t^- + \Phi_{14} S_{t-1}^- + \Phi_{15} S_{t-2}^- + \Phi_{16} \Delta Y_{1,t-12} + \Phi_{17} \Delta Y_{2,t-12} + \Phi_{18} \Delta Y_{3,t-12} + u_{3,t}
\end{aligned}$$

The system of equations above is implemented to calculate our results. As an example the version with three endogenous lags is used, with no dummies (which are added as exogenous variables). The three endogenous variables which are determined within the system are the ones in the long run equation, which is between brackets: Y_1 is the Australian real export, Y_2 is the world demand conditions variable, Y_3 is the competitiveness variable. $Y_{1,t-1} - \delta_2 Y_{2,t-1} - \delta_3 Y_{3,t-1} - c$ captures the long run cointegrated relationship described in Paragraph 3.1, and α represent the adjustment coefficients which capture the per period correction towards the cointegrated relationship. In the second row of each equation, γ shows the effect that past short run changes in the endogenous variables have on the present change of variable Y_x. The last row of each equation represent the variables not determined within the system (exogenous), S^+ represents a positive commodity price shock, S^- is a negative shock and the change in the three endogenous variables Y of the same month in the previous year. These are treated as exogenous due to software problems. Φ show the effect of the exogenous variables on the change in variable Y. The variables showed no trend, so only a constant is used in the long run equation. Finally u is the white noise process.

Table 2. Endogenous and exogenous variables

Endogenous Variables, Y_t	**Exogenous**
Real Export, $ex_{y,t}$, $Y_{1,t}$	Positive commodity shock (3 lags), S_t^+
World demand conditions, $trade_{y,t}$, $Y_{2,t}$	Negative commodity shock (3 lags), S_t^-
Competitiveness, $p_{y,t}^{Aus} / (e_t * p_{y,t}^{world})$, $Y_{3,t}$	the first difference of the t-12 lag of the endogenous variables ($Y_{1,t-12}, Y_{2,t-12}, Y_{3,t-12}$)
	Dummy for outliers (only for Articles)

3.3. Estimation choices

The following section describes the main issues concerning the use of the model and we will elaborate on the choice made. These main issues are, next to the unit root and cointegration, related to the time-span of the data, omitted variables and lags, seasonality and endogeneity.

An important choice in the estimation of a cointegrated model is the choice of the time span. Hakkio & Rush (1991, p. 579) show that increasing frequency from annual to quarterly or monthly barely decreases the false rejection of the null hypothesis of cointegration because of a lack of power. Still, not reject the cointegration may be a strong conclusion because this can be relying on the chosen time period used (Hakkio & Rush, 1991, p. 579). Cushman, Lee & Thorgeirsson (1996, p.349) showed that a minimum of 12 years must be adopted to detect a cointegration relationship in their exchange rate model. In this research the period between January 1996 and November 2010 is used. The reason that a model with a wider time span is not used is mainly because of the fear of structural breaks, which require a different technique than a normal VECM, and the availability of data in early parts of the research before the regressions where executed.

Another important choice is the use of a demand model, which in case of a cointegrated model for exports is biased downward (Orcutt (1950) in Behar,2004, p.3). The use of a single equation long run model is chosen because of carefulness of including too much and too inaccurate variables on sectoral level. Since this paper investigates a relatively unexplored subject, we think it is better to first try to find evidence in the same established model for all sectors were the stability, outcomes and problems are more predictable than in a more complicated sector-specific model. Also the used software has some shortcomings.

Related to this is the choice for the number of lags. Because of the exogeneity of the shocks, the assumption is made that the shocks have the current and the two previous months as lags. For the endogenous variables the number of lags is determined by the Akaike Information Criterion between 3 and 6 months plus the 12 months lag. The reason is that under three lags, serial correlation is strong in every regression, whereas beyond 6 lags the amount of coefficients to estimate is getting large. After observing all individual monthly data we came to the conclusion that in some of the endogenous variables seasonality occurs, Figure 5 shows indications of seasonality as well. To adjust for seasonality the 12^{th} lag of the change in the endogenous variables are included as exogenous variables, since the used software did not allow seasonal dummies or an endogenous 12^{th} lag.

An important factor in a VECM is the assumption of which variables are endogenous and which are exogenous. The reliance on these endogeneity assumptions is one of the main criticisms against this method and a solid theoretical model is important, again a good argument to aim for simplicity. Although the choice of endo- or exogenous variables can sometimes come across as a bit counterintuitive, it is also important that some channels through which the effect of the commodity shock occurs are included as endogenous variables. The strength of the assumption might also differ per sector, and one can even argue that commodity price shocks can be viewed as endogenous in the materials and manufactured goods sector, since ores and direct products like steel are part of those sectors. The endogeneity of the endogenous variables will be tested.

3.4. Estimation procedure regarding the shocks

To estimate the effect of the price shocks, the following steps are taken. First Augmented Dickey-Fuller tests are performed on all variables, with lag determination by the AIC. Then a cointegration test (Johansen procedure) is performed and the VECM is estimated with a constant in the long-run equation. After this, the model is tested for robustness where the ideal situation is that the model passes all robustness tests, but in this research we will focus on the skewness test (Urzua), serial correlation (LM) and stability (AR roots), since the statistical inference is somewhat robust to heteroskedasticity (White, no cross-terms) and kurtosis (Urzua) in the distribution of the errors (Uctum, ?, p.15). Another important condition for the VECM is the endogeneity of the model's cointegrated relationship, represented by significant adjustment coefficients as well as a significant long run equation represented by significant (level) coefficients in this equation.

To test the null hypothesis: "The effect of a commodity price shock on the real export is significantly different from zero," a likelihood ratio test is performed. The best performing shock is selected on the amount of 'important' tests it passed.

If this null hypothesis is not rejected in a robust model, a 'simple' deterministic dynamic simulation is run to plot the effect of a commodity shock. Again with the argument of simplicity, where behaviour is more predictable than using more elaborate (stochastic) techniques which are still subject of discussion. First a base model is estimated by an one-step forecast over the entire sample period, using the system of equations and their estimated coefficients in Section 3.2. The values of the endogenous variables before the first period that is forecasted are the actual value from the sample, all other endogenous values are estimate by the one-step forecast, that is twelve months after the start of our sample (i.e. February 1997). Where the value of the exogenous shocks in t are assumed to be known in period $t-1$ so that their actual values are used in contrary to the endogenous variables and all their lags. The errors are assumed to be unbiased and generated by an independent process, and thus have an expectation of 0:

$$\mathrm{E}(u_{1,t})=\mathrm{E}(u_{2,t})=\mathrm{E}(u_{3,t})=0$$

As an example the equation for Y_1 is used, but the same accounts for the other two equations in the system. The expected change of one of the three endogenous variables in period t-1, becomes:

$$E_{t-1}(\Delta Y_{1,t}) = \alpha_1(Y_{1,t-1} - \delta_2 Y_{2,t-1} - \delta_3 Y_{3,t-1} - c) + \gamma_{1,1}\Delta Y_{1,t-1} + \gamma_{1,2}\Delta Y_{1,t-2} + \gamma_{1,3}\Delta Y_{1,t-3} + ... + \Phi_1 S_t^+ + \Phi_2 S_{t-1}^+ + ...$$
$$+ \Phi_7 \Delta Y_{1,t-12} + \Phi_8 \Delta Y_{2,t-12} + \Phi_9 \Delta Y_{3,t-12}$$

Then ‘alternative’ model is simulated, with the difference that an artificial shock is implemented in one of the two exogenous shock variables S in a ‘random’ period. So in each sector one separate ‘alternative’ simulation is run for a positive shock and one for a negative shock. We will plot cumulative effect of the shock, that is the deviation of real exports in the alternative scenario from the base scenario for a period of 12 months in a graph and put the per period deviation in a table. For Hamilton’s shock a 20% increase is used for both negative and positive shocks, for Lee the shock implemented is of unity, because Lee’s shock is not a ‘direct’ price difference but the value is also determined by the volatility. Both shocks are implemented at the first of January. A side note is that the values of the shocks in the other periods are not adapted to this artificial shock.

4. Data

This chapter will outline the choices made during the construction of some of the variables, the selection of the data and the choices made to construct the variables.

4.1 Competitiveness

The competitiveness is, in line with Bredin & Cotter (2008, p.543-545), captured as the sectoral Australian export price index to the world export price index, both expressed in the Australian dollar. The used variable in our research is:

$$prices_{y,t} = p_{y,t}^{Aus} \big/ (e_t * p_{y,t}^{world})$$

Where $prices_{y,t}$ is a representative of the competitiveness forces at work, $p_{y,t}^{Aus}$ is the export price of the industry and $e_t * p_{y,t}^{world}$ is the world export price in the sector times the exchange rate of the Australian Dollar per an indexed basket of currencies.

The exchange rate and world price are weighted averages of export prices and the exchange rates of the China, the U.S.A and the E.U. The Chinese/ Asian prices are represented by the Taiwanese export prices, while the volume is China’s export volume. *This choice was made on the availability of data in Asian countries, not on anything else and I am refraining from any political views.* The E.U. export prices and volumes are those of Germany and the U.K.

$$p_{y,t}^{world} = \sum \exp ortprice_{y,c,t} * \exp ortshare_{y,c}$$

$$\exp ortshare_{y,n} = \frac{1}{t} \sum \frac{\exp orts_{y,c,t}}{world \exp orts_{y,t}}$$

The calculation of the world price is shown in the equations above, where $p_{y,t}^{world}$ is world price, n is the sector, and c is one of the four countries, $\exp orts_{n,c,t}$ and $world \exp orts_{n,t}$ are in volumes.

In contrary to the exchange rate, the frequency of the prices used in the ratio and to construct real export and world demand is quarterly instead of a monthly one. No interpolation method is used to transform the frequency, the same level is adapted for each month in the quarter. First of all there is no most favoured technique and is difficult to adjust to seasonal data and can lead to distortions, as a result interpolation techniques based on a single series will not add any informational content (Lütkepohl, 2004, p.4). The downside is that the bias in stationary variables is opposite to the bias in random walk series, making inference for an unit root suspect (Dezhbakhsh & Levy, 1994, p.8). Smith (1998, from Zhou (2001, p. 917-920)) showed that this does not create a bias in estimating the cointegrating vectors and with one linear interpolated variable in a sample of 80 quarter the bias does not create a problem in the cointegration rank test.

The choice of export price is also disputed, but this will include the shift to and from higher-quality or higher-value goods more accurately than unit values (Mahdavi (2000) in Behar, 2004, p.3). This also led to the choice of real exports rather than export volume in our model. An obvious example in favour of this choice comes from the mining sector, where iron ore would be represented disproportionally to pure gold in the export volume. Appendix 1 specifies which export prices are used and which adjustments are made.

There are some debatable choices made for this variable, but an important argument for them is that this research is in a field that is relatively unexplored yet and solidness and simplicity seemed more important to us than making it more complicated in an attempt to instantly find the ‘golden formula.’

4.2. World demand conditions

$$trade_{y,t} = \frac{RWX_{y,t}}{ISF_t}$$

$trade_{y,t}$ is a representative of the world trade and the economic situation in the world. ISF_t are the transport prices, $RWX_{y,t}$ is real world exports in terms of the calculated basket of currencies, in sector n of some OECD countries.

$$RWX_{n,t} = \sum \frac{e_t^{us/world} * \exp ort_{c,y,t}}{priceworld_{y,t}}$$

The equation above shows the decomposition of the real world exports ($RWX_{n,t}$), $p_{y,t}^{world}$ is the world price, $e_t^{us/world}$ is the exchange rate of the calculated world currency in terms of US dollar, $\exp ort_{c,y,t}$ is the nominal exports of the OECD countries (c) in U.S. Dollars.

Some sectors countries are excluded from $RWX_{n,t}$ because of missing data or have a large SITC 66-69 or SITC 28 trade, see Appendix 1 for more detailed information.

In most papers world demand conditions are modelled by real GDP (Reidel, 1988, p.147), real import (Muscatelli et al. 1995, p.148) and export volumes (Arize and Malindretos,1998, p.56). We will focus on 'real' world exports, but the remoteness of Australia’s economic heart and the Oceania area in the global trade network led to the decision to adjust for this geographical disadvantage, so the New Zealand’s International Sea Freight price index is used (ISF_t).

4.3. Commodity shocks

Chapter 2 has shown that the price level of commodities affecting different parts of the economy through different channels. Because there is not much research on the effect of price shocks in the mining sector on the export of other sectors, the oil price shock definitions designed to estimate the effect on macroeconomic variables are used. In the following section we describe the three main definitions of an oil price shock that are used to research oil price shocks, next to a normal first difference.

Mork (1989, p.740-745) considers an asymmetric definition of the oil price shocks, because a negative shock may have different effects on the economy than a positive shock.

$$Mork+_t = \begin{cases} \log(com_t) - \log(com_{t-1}), if \log(com_t) > \log(com_{t-1}) \\ 0 if \log(com_t) < \log(com_{t-1}) \end{cases}$$
$$Mork-_t = \begin{cases} \log(com_t) - \log(com_{t-1}), if \log(com_t) < \log(com_{t-1}) \\ 0 if \log(com_t) > \log(com_{t-1}) \end{cases}$$

We will define Mork's asymmetric shocks as two variables, the positive shock $Mork+_t$ and the negative shock $Mork-_t$, which is either the positive/ negative logarithmic change or zero.

In an attempt to explain the unsatisfying results obtained by Mork, Hamilton (1996, p. 215-218) argues that in most cases oil price changes are just responses according to a business cycle, and that shocks are unexpected and move outside this cycle.

$$Hamilton+_t = \begin{cases} \log(com_t) - \log(\max((com_{t-1}, \ldots, com_{t-12}), if \log(com_t) > \log(com_{t-1}) \\ 0 if \log(com_t) < \log(\max((com_{t-1}, \ldots, com_{t-12})) \end{cases}$$
$$Hamilton-_t = \begin{cases} \log(com_t) - \log(\min((com_{t-1}, \ldots, com_{t-12}), if \log(com_t) \langle \log(com_{t-1}) \\ 0 if \log(com_t) > \log(\max((com_{t-1}, \ldots, com_{t-12})) \end{cases}$$

In this paper we define a Hamilton's positive shock ($Hamilton+_t$) as the positive percentage change from the maximum price in the previous 12 months, but there is discussion on the exact period. com_t is the commodity price in month *t*, $Hamilton-_t$ a negative price deviation from the 12 month minimum.

Lee, Ni & Ratti (1995, p. 5-6) stated that the gravity of a shock not only lies in the change but also in the volatility in the period. A large shock in a period with low volatility is more unexpected and creates more uncertainty than a shock in a volatile period, where it is more expected to occur (Lee, Ni & Ratti,1995, p. 5-6). They developed and tested an AR(4) with a GARCH(1,1) function of the oil price shock and used this scaled oil price in a estimation so it takes into account the time-varying conditional probability, which goes in line with the oil price changes over time where there are mostly small shocks and the occasional sizeable shock (Jiminez-Rodriguez, 2004, p.10-12).

$$\sigma_t = b_0 + b_1\sigma_{t-1} + b_2 e_{t-1}^2$$
$$com_t = a_0 + a_1 com_{t-1} + ... + a_{12} com_{t-12} + e_t$$
$$Lee_t = e_t / \sqrt{\sigma_t}$$
$$Lee+_t = \begin{cases} (Lee_t) if Lee_t \rangle 0 \\ 0 if Lee_t < 0 \end{cases}$$
$$Lee-_t = \begin{cases} (Lee_t) if Lee_t < 0 \\ 0 if Lee_t \rangle 0 \end{cases}$$

Lee_t is an asymmetrical shock in time *t*, the plus indicates the positive asymmetrical shock and the minus for the negative shock. σ_t is the volatility in period *t* and e_t the error term. The shock variable in our regression is of an Ar (12) with a Garch(1,1) form.

4.4. Sectors

For this research we conduct the general model on three different sectors specified by the SITC.

'Crude materials, inedible, except for fuels' (SITC2, minus SITC 28)
'Manufactured goods classified chiefly by material' (SITC 6, minus SITC66-69)
'Miscellaneous manufactured articles' (SITC 8)

To analyse the effect of shocks on these three categories we use two different techniques. For Articles we look what the effect is on the whole sector. While for Goods and Materials we look at the impact on a few subsectors using the world demand and competitiveness variables of the whole sector. A part of the last two sectors consists of raw materials, for example SITC 28 consists of metal scrap and metal ores. Because we could not find a good monthly representative of world prices and world export on a two digit SITC level we felt that use of the prices and world exports of the whole sectors is justified, we excluded the countries with a high annual SITC 28 exports from world demand in the materials sector and did the same for countries with high SITC 66-69 exports for the manufactured goods sector, so that the assumption of exogeneity of the shocks is more viable.
For Australia the main export product in the crude materials sector is by far wool, it is one of the main suppliers in the world (see: Appendix 1). In this sector employment is falling gradually and is projected to keep falling (MSA, 2011, p.4). The future outlook for the sector is not great, the main reasons for this are the real exchange rate and the rise of production in low cost countries (Dixon,

May & Rimmer,2003, p.2-3).

The (to the mining sector unrelated) manufactured goods which mainly consists of textile, leather and paper manufactures (SITC61-65) is one move up the supply chain of most products in the crude materials sector, where the crude materials are treated and transformed, for example animal skins are used to produce leather. The developments are similar to the ones in the crude materials sector.

'Miscellaneous manufactured articles' is the most diverse sector of the three, it mainly consist of products which are used every day by consumers and companies. For Australia the main export products of this sector in the last decade are medical, research and scientific appliances and instruments. The less innovative parts of this sector see a reduction of the export because of foreign competition, while the successful parts/ companies are active in the development of new technologies and focus on niche-markets (Parkinson, 2010, p.17-18).

5. Results

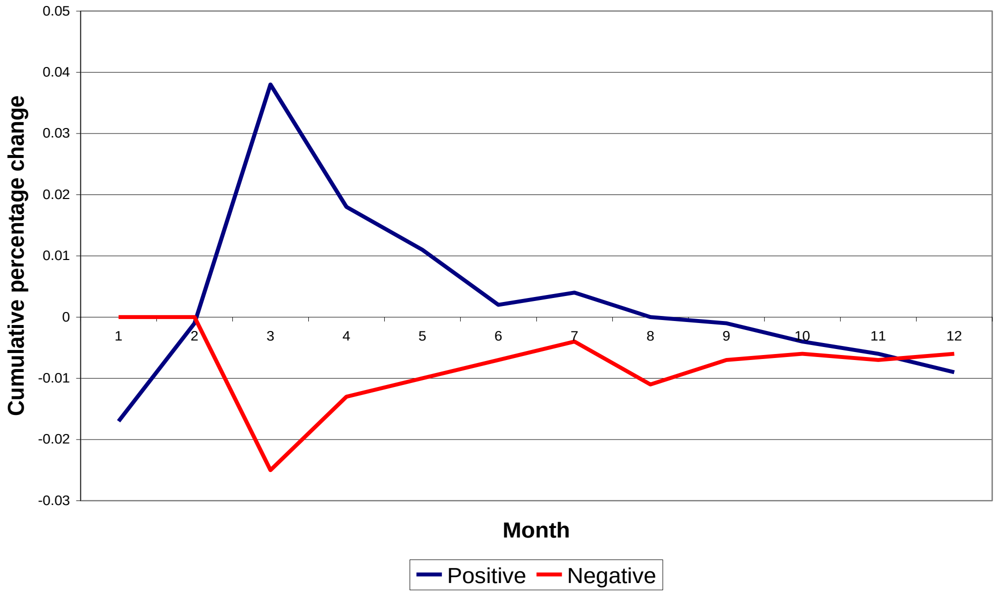
In the next section we will look at the manufactured goods sector, the crude materials sector and then the miscellaneous articles sector. For each sector we will look effect of a shock on the real exports of the sector and check the most important tests for the robustness of the statistical inference. The unit roots are tested with an Augmented Dickey Fuller test. For *export, trade* and *prices*, at a 5% significance and only a constant all are nonstationary in I(0) and stationary in a I(1), the shock variables are only done in levels, because they are jointly a sort of (first) difference and are all stationary in a test with a constant and with both a constant and a trend. The results of all regressions and tests are added in Appendix 2.

5.1. Materials

For materials all three models are stable and have 1 cointegrated relation, but there are problems with the significance of the adjustment coefficients and the coefficients in the long run equation. The best performing shock variable for materials is Lee's, as all adjustment coefficients and the long run equation coefficients are significant. It passed all the important robustness tests with a 5 % significance. Only the long-run coefficient of prices is significantly different from 0 at a 10% level.

The effects are shown in Figure 6 and Table 3. In the first month a positive shock has a negative effect, followed by two months of high growth rates as a result of the shock. While a negative shock has zero effect in the first two months and real exports decreases a month later. This changes in the third month as the negative shock starts to have an positive effect and vice versa.

Figure 6. Cumulative effect of a shock on Materials, 12 periods, % change



Shock implemented at the 1st of January 1998. For Lee an unit shock is used.

Table 3. effect of shock per period on Materials, % change

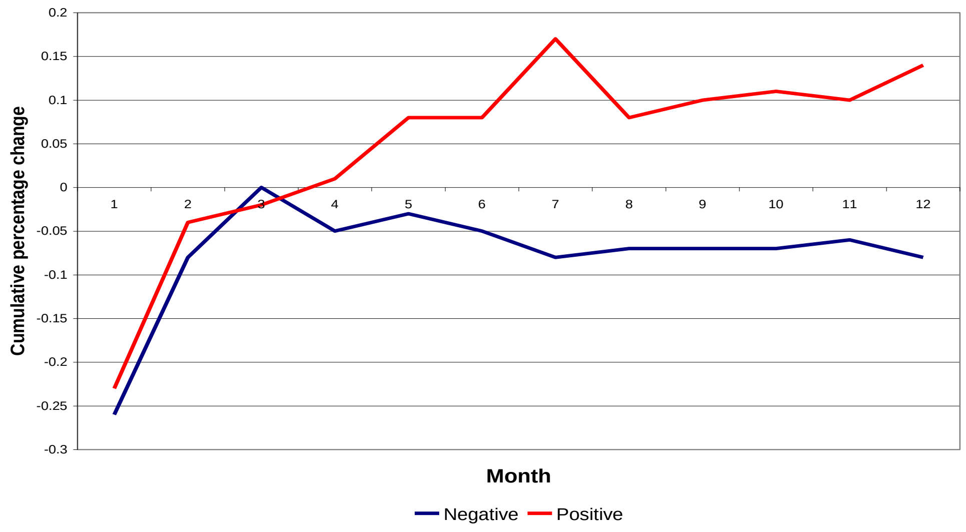
Period	1	2	3	4	5	6	7	8	9	10	11	12
Materials Lee, positive	*-0.017*	*0.016*	*0.039*	*-0.02*	*-0.007*	*-0.009*	*0.002*	*-0.004*	*-0.001*	*-0.003*	*-0.002*	*-0.003*
Materials, Lee, negative	*0*	*0*	*-0.025*	*0.012*	*0.003*	*0.003*	*0.003*	*-0.007*	*0.004*	*0.001*	*-0.001*	*0.001*

5.2. Manufactured goods

All the variables in the long rung equation are endogenous and significant in the long run, except trade in the regressions with Lee's and Mork's shocks. The best performing shock definition is Hamilton's shock, everything is in accordance with robustness and significance requirements at a 5% level, except serial correlation and the skewness of the residuals which are only rejected at a significance level of 1% level.

The effect of the price shock on manufactured goods in the first months has a large negative effect on both the negative and the positive Hamilton's shock, in the following months the exports recovers. After this initial period a negative shock will have a positive effect on the real exports of manufactured goods and a positive shock a negative effect.

Figure 7. Cumulative effect of a shock on Goods, 12 periods, % change



Shock implemented at the 1st of January 1998. For Hamilton an shock of 0.2 is implemented, that is an 20 percent increase the highest price in the last 12 months.

Table 4. effect of shock per period on Goods, % change

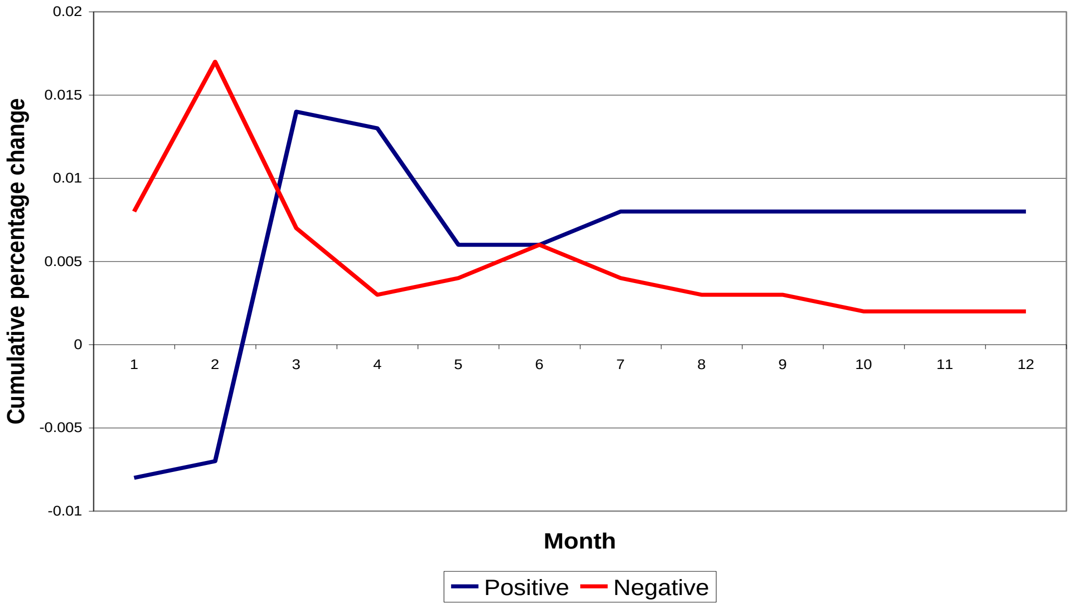
Period	1	2	3	4	5	6	7	8	9	10	11	12
Goods, Hamilton, positve	-0.26	0.18	0.08	-0.05	0.02	-0.02	-0.03	0.01	0	0	0.01	-0.02
Goods, Hamilton. Negative	-0.23	0.19	0.02	0.03	0.07	0	0.09	-0.09	0.02	0.01	-0.01	0.04

5.3. Articles

Of the three sectors the miscellaneous articles sector is the worst performing sector in terms of the models robustness. Lee's shock passed almost all tests but the null hypothesis of no serial correlation is still rejected at a 1% significance level. A dummy for two visible outliers, improved the robustness a bit, but not to a satisfying level. The other regressions have even more severe problems.

In the case of Articles Lee's positive shock has a negative effect in the first month, but as time progresses the effect is more positive, the negative shock has the opposite effect. Strangely both have a positive cumulative effect after a 12 months, but a negative shock is still decreasing if the horizon is expanded. But with the presence of serial correlation, we must be careful drawing conclusions from the results.

Figure 8. Cumulative effect of a shock on Articles, 12 periods, % change



Shock implemented at the 1st of January 1998. For Lee an unit shock is used, interpretation is harder because of the inclusion of the volatility.

Table 5. effect of shock per period on goods, % change

Peroid	1	2	3	4	5	6	7	8	9	10	11	12
Articles, Lee, positive	*-0.008*	*0.001*	*0.021*	*-0.001*	*-0.007*	*0*	*0.002*	*0*	*0*	*0*	*0*	*0*
Articles, Lee, negative	*0.008*	*0.009*	*-0.01*	*-0.004*	*0.001*	*0.002*	*-0.002*	*-0.001*	*0*	*-0.001*	*0*	*0*

Non-technical discussion

There can be more discussion about the used methodology as we pointed out in Chapter 3 an 4, but this section will focus on the interpretation and discussion of our results. In our two robust models both positive and negative shocks have an negative or zero effect in the first months (and sometimes second), this might be an indication of uncertainty created by the commodity prices and the basket's effect on the real exchange rate. As actors might hesitate to execute international transactions in the first months. The recovery in the following months increased our suspicion of this process even more. After the third/ fourth month the exports seem to converge slowly to a more stable path towards a new long run equilibrium, even when looked at the results in the period after the first twelve months. This is in accordance with the theoretical transmission mechanisms of chapter 1. Another observation is that the coefficients of the competitiveness and the world demand variable sometimes not have the expected coefficient sign. This might be a possible indication of a large influence of the mining sector in world demand and prices in the two sectors, since the mining part could not be properly separated in these variables and we must be careful with making other statements with it. This said, it might also indicate the problems the sectors face with the rise of the low labour cost countries. The adaptation of the sectors in the new business environment, the move towards more exchange rate resistant markets and the production of some goods is relatively immobile can be used as argument for supporting the competitiveness coefficients.

Another observation is that asymmetric 'first difference' of Mork is in none of the three sectors the best performing shock, this leads us to conclude that we made the right call in looking for alternative shock definitions.

Conclusion

The recent developments in the mining sector bring back a strange mixture of the stories of the gold rushes and oil crises in the past for Australia. All around the world the economy is affected by the price shocks of metals, fossil fuels and other minerals. If the price of the commodities rise, production, transportation and operating costs of many products will rise. But resource exporting countries are affected in a more complicated way, Australia sees its export value grow rapidly, because it is dominated by the mining sector. This success story brings back the same problems as the gold rushes of the past. As the real exchange rate rises and labour is drawn towards the mining sector, other sectors lose competitiveness relative to their foreign competitors. The opposite happens when commodity prices plummet.

One of the most affected parts of a sector is its export. This research tried to find the effects of the commodity price shocks on the real exports of other sectors, we found robust results for 2 out of 3 sectors in a VECM model, the third suffered from some serial correlation. Considering there is much room for improvement in these sector specific models, the used definition of a shock and other parts of the methodology, the results were exciting in this relatively unexplored part of international economics. But we must be careful with drawing conclusions, since our model and VEC models in general can be criticized.

For the two robust models it seems that in the first months the impact of a shock is the largest and mostly negative for a positive shock as well as a negative shock, and the two shocks that include some form of volatility or business cycle gave a robust model. These are indications that uncertainty created by a price shock has some effect on export in Australia. After these initial months the export seems to recover and behave as the theory predicts, that is a cumulative loss/ profit in real export after a positive/ negative shock.

Sources

Arize, A.C. & Malindretos, J. (1998) 'The long-run and short-run effects of exchange-rate volatility on exports: the case of Australia and New Zealand.' *Journal of Economics and Finance*, 22 (2-3), 43-56.

Australian Custom Services (?) 'Manual: Export control: Volume 12.' Australian Government, retrieved from: http://www.customs.gov.au/site/page4226.asp

Australian Trade Commission (?) 'List of goods subject to export prohibition or restriction.' Australian Government, retrieved from: http://www.austrade.gov.au/What-can-I-export-from-Australia/default.aspx

Avendaño, R., Reisen, H. and Santiso, J. (2008) 'The macro management of commodity booms: Africa and Latin America's response to Asian demand.' OECD Development Center Working paper 270

Behar, A. & Edwards, L. (2004) 'Estimating elasticities of demand and supply for South African manufactured exports using a Vector Error Correction Model.' Centre for the Study of African Economies, Working paper series 2004-04.

Bredin, D. & Cotter, J. (2008) 'Volatility and Irish exports.' *Economic Inquiry*, 46(44), 540-560.

Bruggink, J. (2011) 'Towards a sustainable world energy system.' IVM, Lecture at Erasmus university, Course: World Development, 7 April 2011.

Chen, Y., Rogoff, K. & Rossi, B. (2003) 'Can exchange rates forecast Commodity Currencies.' National Bureau of Economic Research, Working paper 13901.

Chen, Y. (2004) 'Exchange rates and fundamentals: evidence from commodity economies.' University of Washington, Washington, Nov 2004.

Cordon, W.M. (1984) 'Booming sector and Dutch Disease economics: survey and consolidation.' *Oxford Economic Papers*, 36 (3), 359-380.

Cushman, D.O., Lee S.S. & Thorgeirsson, T. (1996) 'Maximum likelihood estimation of cointegration in exchange rate models for seven inflationary OECD countries.' *Journal of International Money and Finance*, 15(3), 337-368.

Department of Industry, Tourism and Resources (2007) 'Background Paper 2; Australian Manufacturing Sector Trends.' Australian Government, Department of Industry, Tourism and Resources, May 2007, retrieved from: http://www.innovation.gov.au/Industry/ReportsandStudies/Documents/AustralianManufacturingSectorTrends2007.pdf

Dezhbakhsh, H., and Levy, D. (1994) 'Periodic Properties of Interpolated Time Series.' Department of Economics, Emory University, Economics Letters, Elsevier.

Dixon, P.B., Mai, Y. and Rimmer, M.T. (2003) 'The Textile, Clothing and Footwear Sector from 1997 to 2020 and the Effects of Reductions in Assistance.' Monash university, Centre of Policy Studies.

Djoudad, R., Murray, J., Chan, T. & Daw, J. (2000) 'The role of chartists and fundamentalists in currency markets: the experience of Australia, Canada, and New Zealand.' retrieved from: http://www.bankofcanada.ca/publications/working.papers/2000/murray.pdf

Hakkio, C. S. and Rush, M. (1991) 'Cointegration: how short is the long run?' *Journal of International Money and Finance*, 1991, 10, 571-581.

Hamilton J.D. (1996) 'This is what happened to the oil price-macroeconomy relationship.' *Journal of Monetary Economics*, 38, 215-220.

Jiménez-Rodríguez, R. & Sánchez, M. (2004) 'Oil price shocks and real GDP growth; Empirical evidence for OECD countries.' European Central Bank, Working paper 362.

Jones D.W. & Leiby, P.N. (1996) 'The macroeconomic impacts of oil price shocks: a review of literature and issues.' draft version, Oak Ridge National Laboratory, January 5, 1996.

Jones D.W., Leiby, P.N. & Paik, I.K. (2004) 'Oil price shocks and the macroeconomy: what has been learned since 1996.' *The Energy Journal,* 25(2), 1-32.

Korinek, J. & Kim, J (2010) 'Export restrictions on strategic raw materials and their impact on trade and global supply.' Chapter 4 in OECD (2010), 'The economic impact of export restrictions on raw materials.' p.103-130, OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9789264096448-en

Lee, K., Ni, S. & Ratti, R. (1995), 'Oil shocks and the macroeconomy: the role of price variability.' *Energy Journal,* 16(4), 39-56.

Lee, K. & Ni, S. (2002) 'On the dynamic effects of oil price shocks: a study using industry level data.' *Journal of Monetary Economics,* 49(4), 823-852.

Lütkepohl, H. (1999) 'Vector autoregressions.' Institut für Statistik und Ökonometrie, Hümboldt Universität, January 12, 1999.

Lütkepohl, H. and Krätzig, M. (2004) 'Initial tasks and overview.' Chapter 1 in Lütkepohl, H. and Krätzig, M. (2004) 'Applied Time Series Econometrics.' p. 1-7, Cambridge University press.

Manufacturing Skills Australia (2011) 'Statistics for the Textiles, clothing and footwear industries.' August 2011, retrieved from: http://www.mskills.com.au/DownloadManager/downloads/Textiles,%20clothing%20and%20footwear%20in%20Australia.pdf

Mélanie, J. Curtotti, R., Saunders, M., Schneider, K., Fairhead, L. & Qiang, Y. (2002) 'Global coal markets: prospects to 2010.' ABARE Research report 02.2, retrieved from: http://adl.brs.gov.au/data/warehouse/pe_abarebrs99000763/PC12286.pdf

Mork, K.A. (1989) 'Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results.' *The Journal of Political Economy*, 97(3), 740-744.

Muscatelli, V.A., Stevenson, A.A. & Montagna, C. (1995) 'Modelling aggregate manufactured exports for some Asian Newly Industrialized Economies.' *The Review of Economics and Statistics*, 77(1), 147-155.

Parkinson, M., (2011) 'The implications of global economic transformations for Australia.' Chapter 2 in Australian Government Department of the Treasury (2011) 'Economic roundup, 2011, issue 4.' p.15-32, Commonwealth of Australia

Peeling, G., Stothart, P., Toms, B. & Mcllveen, N. (2010) 'Increasing demand for and restricted supply of raw materials.' Chapter 6 in OECD (2010) 'The economic impact of export restrictions on raw materials.' p.155-170, OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9789264096448-en

Péridy, N. (2003) 'Exchange rate volatility, sectoral trade, and the aggregation bias.' *Review of World Economics / Weltwirtschaftliches Archiv*, 139(3), 389-418.

Riedel, J. (1988) 'The demand for LDC exports of manufactures: estimates from Hong Kong.' *The Economic Journal*, 98(389), 138-148.

Uctum, M (?) 'Vector Error Correction Models Johansen FIML Approach.' CUNY, retrieved from: http://userhome.brooklyn.cuny.edu/economics/muctum/EconometricsG/Multivariate%20Models II-Johansen.doc

Zhou, S. (2001) 'The Power of Cointegration Tests versus Data Frequency and Time Spans.' *Southern Economic Journal*, 67(4), 906-921.

Appendix 1. Data Sources

Commodity Prices

International Monetary Funds, IFS-online/ now e-library (http://www.imf.org/external/data.htm)

Database	Seriescode	Descriptor
IFS	15676DRDZF...	ALUMINUM CANADA/UK
IFS	19976CODZF...	COAL SOUTH AFRICA INDEX
IFS	11276C.DZF...	COPPER UK (LONDON)
IFS	11276KRDZF...	GOLD LONDON AV 2ND FIX
IFS	22376GADZF...	IRON ORE BRAZIL (N.SEA.PORTS)
IFS	11176RGDZF...	GASOLIN GULF COAST REGULAR UNLEADED
IFS	92276NGDZF...	NATURAL GAS INDEX RUSSIA
IFS	11176Y.DZF...	SILVER U.S.(NEW YORK)
IFS	11276Q.DZF...	TIN ALL ORIGINS(LONDON)
IFS	00176UMDZF...	URANIUM INDEX
IFS	21874T.DZF...	ZINC
Primary commodity prices	PLEAD	LEAD UNIT
IFS	15676PTDZF...	NICKEL CANADA CAN/PORTS

Export Value and Volumes of Australia's Natural Resources

Australian Bureau of Agricultural and Resource Economics, Abare.gov.au (changed in abares.gov.au)

Australian mineral statistics, 3. export summary, exports (metal, minerals, fossil fuels, volumes and value, also of total merchandise goods and total merchandise goods and services, Quarterly)

Export price, Export value, CPI and Labour Force of Australia

Australian Bureau of Statistics, ABS.gov.au

5368.0 International Trade in Goods and Services, Australia

- Table 12a. Merchandise exports, Standard International Trade Classification (1 and 2 digit), FOB Value
- Table 12b. Merchandise exports, Standard International Trade Classification (3 digit), FOB Value

6457.0 International Trade Price Indexes, Australia

- Tables 7 and 9. Export Price Index by SITC, Index Numbers and Percentage Changes
- Tables 1, 3 and 12. Import Price Index by SITC, Index Numbers and Percentage Changes

6401.0 - Consumer Price Index, Australia, Jun 2011

- Tables 1 and 2. CPI: All Groups, Index Numbers and Percentage Changes

6291.0 - Labour Force, Australia

- Labour Force, Australia, Detailed, Quarterly

Real Exchange rate

Reserve Bank of Australia (rba.gov.au)

- F15 Real exchange rate, trade-weighted averages, index

Transport

Producer Price Index; International Sea Freight (Ppiqsc90)

World export

Oecd (OECD iLibrary)

- Trade in value classified by sections of SITC, DOI: 10.1787/data-00280-en

Countries to represent World exports are: France, Germany, Japan, New Zealand, Turkey, United Kingdom and the United States. Other OECD member countries were not included due to data problems or fear of a unrepresentative sample of world export, like intra EU trade.

Materials: Turkey, New Zealand, South Korea and Japan are excluded because of a relatively high share of Metal ores, slag or scrap (SITC28) compared to the other exports in SITC 2

Manufactured Goods: Germany is excluded due to a high export in to the mining industry related manufactured goods (SITC 66-69) compared to other exports in SITC 6

World export price:

- Weights per sector: UNCTAD,UNCTADSTAT, export in value US$, period 1998-2010

- Exchange rate: IFS, average, indexed, for Germany with both Bundesmark and Euro, index= 100 at march 1998

- Export Price (all are indexed at December 2005 due to the U.S. change in system note that US):

U.S.A: U.S. Census Bureau (census.gov)
The U.S. changed systems in December 2005 from SITC to NAICS, the following codes were used as replacement from that date per SITC sector

Articles SITC 8: EIUIDXX
Goods SITC 6: EIUIY32
Materials SITC2: EIUIY32
(note that for SITC2 and SITC 6 the same export price is used, since the materials (SITC) used in the production of the manufactured goods (SITC 6) are placed in the same sector under the NAICS system.

Taiwan: National Statistics Export Price Indices by S.I.T.C. on N.T.D. Basis-Monthly by Period, Type and S.I.T.C.
Due to language problems a direct link, hopefully it works:
http://ebas1.ebas.gov.tw/pxweb/Dialog/varval.asp?ma=PR0404A1M&ti=Export Price Indices by S.I.T.C. on N.T.D. Basis-Monthly&path=../PXfileE/PriceStatistics/&lang=1&strList=L

UK: (www.statistics.gov.uk/statbase)

Materials: EHFB

Manufactured goods: BQLK

Articles: EHFW

Germany: Statistisches Bundesamt (*www.destatis.de*)

Ausfuhrpreise: Deutschland, Monate, SITC 1-2-steller hierarchie: 61421-0004

Appendix 2. Results

Appendix 2.1. Unit Root

Unit Root: Augmented Dickey-Fuller, lag determination by AIC

	I(0)		**I(1)**	
	Constant	Constant+ trend	None	Constant
Export				
Articles	*-1.511*	*-1.640*	*-3.616****	*-4.792****
Machinery	*-1.939*	*-2.604*	*-3.178****	*3.223****
Materials	*0.136*	*-2.553*	*-4.078****	*-5.233****
Manufactures	*-1.024*	*-2.192*	*-2.834****	*-2.940***
World Demand				
Articles	*-0.520*	*-2.944*	*-2.630****	*-3.029***
Machinery	*-1.142*	*-3.166**	*-3.209****	*-3.421***
Materials	*-0.860*	*-3.088*	*-3.044****	*3.199***
Manufactures	*-1.594*	*-3.382**	*-3.044****	*-3.187***
Competitiveness				
Articles	*-2.196*	*-1.924*	*-13.069****	*13.112****
Machinery	*-0.687*	*-3.129*	*-13.09****	*-13.098****
Materials	*0.198*	*-1.461*	*-5.585****	*-5.838****

Manufacturers	*-1.684*	*-2.549*	*-5.506****	*-5.510****
Shocks	*None*	*Constant*	*Constant & trend*	
Hamilton +	*-4.233****	*-8.848****	*9.469****	
Hamilton -	*-3.759****	*-14.740****	*14.827****	
Mork +	*-1.513*	*-5.366****	*-12.619****	
Mork -	*-2.259***	*-9.395****	*9.481****	
Lee +	*-0.923*	*-14.740****	*-14.827****	
Lee -	*-3.421****	*-12.252****	*12.247****	

*Unit root is tested by an Augmented Dickey-Fuller test, with a constant and a constant plus trend, in both level and first differences. Lag length is determined by Akaike Information Criterion. H0: unit root is rejected at *=10%, **=5% and ***=1%*

Appendix 2.2. Materials

Cointegration results for Materials

		Cointegration Null: (at most)	Trace	P-value	Eigenvalue	P-value
Materials	Hamilton	0	45.095	0.0032	33.579	0.0009
		1	11.516	0.4931	7.582	0.5982
		2	3.934	0.4221	3.934	0.4221
	Lee	0	43.289	0.0054	33.269	0.0010
		1	10.020	0.6379	9.945	0.3394
		2	0.0743	1.0000	0.074	1.0000
	Mork	0	47.093	0.0017	37.514	0.0002
		1	9.579	0.681	9.349	0.3972
		2	0.230	0.9999	0.230	0.9999

The trace statistic is for the Trace test, the Eigenvalue statistic is for the maximum eigenvalue test. Constant in long-run equation, none in the short run equations

VECM results for Materials

Materials	Long run equation		Adjustment coefficients					
	Trade	Prices	Export	Trade	Prices			
Hamilton	1.394***	-0.261	-0.196***	-0.160	0.057***	Wald	8.197	0.0514
5 lags						AIC	-6.954	
	[5.843]	[-0.692]	[-3.415]	[-4.283]	[2.566]	White	358.718	0.0112
						Jarque-Bera	59.924	0.0001
						skewness	5.583	0.1338
						kurtosis	21.703	0.0001
						Likehood-ratio	327.911	0.0000
			stable, endogenous, some serial correlation L7 p0.152					
Lee	1.764***	-0.792*	-0.106***	-0.099***	0.053***			
5 lags						Wald	10.054	0.346
	[6.614]	[-1.718]	[-2.719]	[-3.955]	[3.578]	AIC	-6.996	
						White	388.741	0.0004
						Jarque-Bera	72.510	0.0000
						skewness	6.721	0.0814
						kurtosis	28.194	0.0000
						Likehood-ratio	334.878	0.0000
			stable, endogenous, L7 p.0.021					
Mork	1.511132***	-0.51028	-0.15009***	-0.13939***	0.062646***			
5 Lags						Wald	32.729	0.000
	[6.40060]	[-1.38404]	[-3.10047]	[-4.51219]	[3.40901]	AIC	-7.009	
						White	368.046	0.0044
						Jarque-Bera	73.561	0.0000
						skewness	7.688	0.0529
						kurtosis	25.847	0.0000
						Likehood-ratio	270.276	0.0000
			stable, endogenous, no serial correlation					

*H0 is rejected at *=10%, **=5% and ***=1%. Between [ ] is the t-statistic. For the trade variable Japan and South Korea are excluded for their large share of metal scrap export.*

Appendix 2.3. Manufactured goods

Cointegration results for Manufactured goods

		Cointegration Null: (at most..)	Trace	P-value	Eigenvalue	P-value
Goods	Hamilton	0	37.553	0.0273	31.919	0.0017
		1	5.634	0.9638	4.314	0.9395
		2	1.319	0.9045	1.319	0.9045
	Lee	0	30.445	0.1487	26.197	0.0136
		1	4.248	0.9934	2.977	0.9912
		2	1.271	0.9123	1.271	0.9123
	Mork	0	38.499	0.0212	31.282	0.0021
		1	7.217	0.883	4.338	0.9380
		2	2.879	0.6036	2.879	0.6036

The trace statistic is for the Trace test, the Eigenvalue statistic is for the maximum eigenvalue test. Constant in long-run equation, none in the short run equations

VECM results for Manufactured Goods.

Goods	Long run equation		Adjustment coefficients					
	Trade	Prices	Export	Trade	Prices			
Hamilton	*0.481***	*1.188****	*-0.128****	*-0.114****	*-0.06019****	Wald	22.003	0.0090
6 lags						AIC	*-9.093*	
	[2.486]	*[5.823]*	*[-2.763]*	*[-2.938]*	*[-2.518]*	White	*395.319*	*0.0142*
						Jarque-Bera	*66.574*	*0.0000*
						skewness	*10.673*	*0.0136*
						kurtosis	*13.534*	*0.0036*
						Likehood-ratio	*270.276*	*0.0000*
	stable, endogenous, some serial correlation l1 p.0.0187 l3 0.0110							
Lee	*0.534***	*1.039****	*-0.126****	*-0.133****	*-0.016*			
4 lags						Wald	*15.974*	*0.0670*
	[2.339]	*[4.026]*	*[-2.979]*	*[-4.051]*	*[-0.78436]*	AIC	*-9.094*	
						White	*285.992*	*0.1684*
						Jarque-Bera	*172.856*	*0.0000*
						skewness	*11.068*	*0.0114*
						kurtosis	*55.743*	*0.0000*
						Likehood-ratio	*259.851*	*0.0000*
	stable, prices not endogenous, some serial correlation l1 p.0.0024 l6 0.0170							
Mork	*0.339*	*1.086****	*-0.139****	*-0.164****	*-0.021*			
4 lags						Wald	*32.729*	*0.000*
	[1.518]	*[5.044]*	*[-3.103]*	*[-4.523]*	*[-0.968]*	AIC	*-9.13167*	
						White	*269.1283*	*0.4010*
						Jarque-Bera	*132.3433*	*0.000*
						skewness	*8.3145*	*0.0399*
						kurtosis	*44.11785*	*0.000*
						Likehood-ratio	*266.1802*	*0.0000*
	stable, prices not endogenous, some serial correlation l3 0.0062 l6 0.0099							

*H0 is rejected at *=10%, **=5% and ***=1%. Between [ ] is the t-statistic.*

Appendix 2.4. Articles

Cointegration results for Articles.

		Cointegration Null: (at most..)	Trace	P-value	Eigenvalue	P-value
Articles	Hamilton	*0*	*49.949*	*0.0007*	*30.935*	*0.0024*
		1	*19.013*	*0.0735*	*11.124*	*0.2428*
		2	*7.889*	*0.0868*	*7.890*	*0.0868*
	Lee	*0*	*34.647*	*0.0572*	*24.597*	*0.0235*
		1	*10.050*	*0.6350*	*7.615*	*0.5943*
		2	*2.435*	*0.6905*	*2.435*	*0.6905*
	Mork	*0*	*37.024*	*0.0314*	*20.328*	*0.0921*
		1	*16.696*	*0.1443*	*11.180*	*0.2388*
		2	*5.516*	*0.2316*	*5.516*	*0.2316*

The trace statistic is for the Trace test, the Eigenvalue statistic is for the maximum eigenvalue test. Constant in long-run equation, none in the short run equations

VECM results for Articles

Articles	Long run equation		Adjustment coefficients					
	Trade	Prices	Export	Trade	Prices			
Hamilton	*-0.35222****	*1.651899****	*-0.33584****	*0.05531*	*-0.06018****	Wald	21.400	0.011
3 Lags						AIC	*-8.706*	
	[-8.50439]	*[8.47502]*	*[-4.13981]*	*[0.68338]*	*[-2.20562]*	White	*311.070*	*0.0006*
						Jarque-Bera	*44.695*	*0.0091*
						skewness	*5.801*	*0.1217*
						kurtosis	*11.225*	*0.0106*
						Likehood-ratio	*30.177*	*0.0000*
stable, trade not endogenous, strong serial correlation								
Lee								
3 Lags	*-0.35109****	*1.598435****	*-0.24559****	*0.154766***	*-0.06194***	Wald	*10.895*	*0.283*
						AIC		
	[-8.28208]	*[7.38994]*	*[-2.81758]*	*[1.96037]*	*[-2.24387]*	White	*284.447*	*0.0134*
						Jarque-Bera	*45.063*	*0.0082*
						skewness	*5.998*	*0.1117*
						kurtosis	*13.124*	*0.0044*
						Likehood-ratio	*32.721*	*0.0000*
stable, endogenous, some serial correlation l1 p. 0.0032 l3 p0.0241								
Mork	*-0.3367****	*1.609798****	*-0.3198****	*0.127692**	*-0.04472**			
6 lags						Wald	*5.984*	*0.7420*
	[-7.15855]	*[7.52393]*	*[-3.07406]*	*[1.31124]*	*[-1.32642]*	AIC	*-8.741*	
						White	*397.351*	*0.0208*
						Jarque-Bera	*56.959*	*0.0003*
						skewness	*5.332*	*0.1491*
						kurtosis	*7.953*	*0.0470*
						Likehood-ratio	*48.1996*	*0.0000*
stable, endogenous, some serial correlation l1 0.0018 l3 0.0093								

*H0 is rejected at *=10%, **=5% and ***=1%. Between [ ] is the t-statistic.*