The Effect of Cost Fluctuation on the Waste Trade and Recycling between China and Japan*†

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Abstract

Combining the increase of the generation of wastes, the surge in the demand of recyclables in the developing countries and the disappearance of the dumping option in the developed countries, the potential demand for waste trade is now exceptionally high in the history. In fact, the total waste trade in the world has been rapidly growing and reached about 200 million tons (Kellenberg (2013)), which is much bigger than the debris generated by the earthquake and the Tsunami in Japan on March 11, 2011. This paper analyze the waste trade data between Japan and China, the largest importer of the waste. Through this research, it is shown that the transportation cost of the waste is more related to the 1st grade natural resource prices at world markets compared to the export price of the scrap materials. Furthermore, the impact of the fluctuated price of the world market price affect the scrap prices in the different way. This type of the heterogeneous feature makes it difficult to apply appropriate policy for policy makers and the careful implementation is inevitable.

1 Introduction

There is no doubt that the trade between two or more countries increases the welfare among them. This advantage of the trade has been shown by many literatures in economics for a long time both by theoretical and empirical points of view. It seems, however, that the analysis has been rather limited within the trade of "goods" and the literature has not discussed the welfare improvement through trading "bads", or wastes.

Indeed, the waste in the world trade was trivial until very recently. Two things make the volume of the waste traded larger and larger. First, the per capita consumption level has been

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getting higher and higher in the last several decades. It has been remarkable especially in the emerging countries in the last decades and this leads to not only more generation of wastes but also more demand for natural resources which could be substituted by the recyclables out of the waste. The second is the ever strengthened regulation against environmental pollution mainly in the developed countries. The more wastes has been losing its final destination because the strict regulation restrains wastes from being dumped nearby.

Combining the increase of the generation of wastes, the surge in the demand of recyclables in the developing countries and the disappearance of the dumping option in the developed countries, the potential demand for waste trade is now exceptionally high in the history. In fact, the total waste trade in the world has been rapidly growing and reached about 200 million tons (Kellenberg (2013)). It is easy to understand how much it is when we compare it with the total debris created by massive Tsunami attack in Japan in March 11, 2011, which is 26.7million tons[1], and 1.6 million tons by September 11, 2001 in New York (Kellenberg (2013)).

Despite such a strong presence in the international trade, economists have not been paying enough attention to this issue. There are plenty of previous research in the field of natural resource and its trade (ex. Li *et. al* (2012), Agostini (2006), Slade (1991)). Not so much in the area of the waste trade and recycling except the seminal work by Slade (1980) or Goméz *et. al*(2007). Only recently, Baggs (2009) and Kellenberg (2013) considers the waste trade from the perspective of international trade. They are based on so called a "gravity model".

In the next section, we describe the data we use. Section 3 analyzes if the data is stationary with the special attention to the existence of a structural break and considers the cointegration among the transportation cost and the resource prices. Section 4 provides some policy implications

[1] `http://eprc.kyoto-u.ac.jp/saigai/report/2011/03/001341.html`

and summarizes the discussion.

2 Data

Following the motivation above, waste trade between Japan and China is targeted in this study. All the waste data are derived from the famous *World Trade Atlas*. The data is monthly and is from 2000/01 to 2012/09. Note that this paper is only considering ferrous waste, copper waste, aluminum waste due to data continuity problem. The data contains the value in the US dollars as well as the tonnage. Dividing the value by the weight, we can get the price data of the transaction. Since the data is registered twice, at the timing of export and the import of the same transaction, with the different definition, we can derive a generalized transportation cost. When it is exported, the value does not include the insurance and transportation cost while these are included when it is imported. We define the transportation cost index (hereafter TCI) by dividing the import price by the export price.

Figure 1 shows the changes of the value for three scraps since January 2000. As is shown, the export of the ferrous scrap and the copper scrap from Japan to China is continuously increasing despite the economic slump in 2008. Although it decline very sharply in October 2008, the price level of the scraps shown in Figure 2 steadily increases. In fact, the prices in 2012 are in the level before the economic crisis in 2008. These facts simply tell us how important the scrap trade is.

/////////// Figure 1 and 2 around here. //////////////

In this paper, the 1st grade resource are also used for the comparison purpose. The data for the 1st graded commodity prices are from IMF's *Primary Commodity Price Report*. At the world market for the 1st graded (or virgin) resource, the price are stagnated except the price of the iron ore at the first glance.

/////////// Figure 3 around here. //////////////

Our purpose here is to analyze these fluctuation more precisely with the time series analysis technique.

3 What Causes the Fluctuation in Waste Trades?

3.1 The Structural Break and the Unit Root Test

The first step is to check whether the series are stationary, which can be done by applying the unit root test such as Dickey -Fuller test, for example. According to Perron (1989) and others, the Dickey - Fuller type test is unreliable in the case of potential structural break. Zivot and Andrew (1992) proposed to choose the date of the structural shift that gives the least favorable result against the null hypothesis, say a random walk with drift.

/////////// Table 1 around here. //////////////

Table 1 is the summary of the Zivot - Andrew test conducted for the export price from Japan to China and the TCI. Note that the date of the suggested structural breaks are different between the export price and the TCI in the same scrap, which implies that the fluctuation of the two variables are based on the different mechanism.

Along with the Zivot-Andrew type test, the ADF test and the KPSS test are also conducted for the robustness[2]. From Table 1, it is fair enough to conclude the original data is not stationary. Thus, the naive use of the regression creates the problem of the spurious regression. Since we know that taking the first difference excludes the unit root for all the data we are interested in, we need to check, to avoid the spurious regression problem, if there is any cointegration vectors among the variables.

[2]Note that the null hypothesis of the ADF test and the KPSS are opposite.

3.2 Cointegration Test

It is well known that the Johanson Test is to test if there is a cointagration between two (or more) time series data. Again, there is a little concern that the structural breaks creates some critical noise against the test results. Lütkepohl, H., Saikkonen, P. and C. Trenkler (2004) proposed a new way to do Johanson test with robustness against a structural break, which we call here the extended Johanson test[3].

/////////// Table 2 around here. //////////////

Table 2 is the summary of the cointegration test. At the first glance, it is clear that the copper scrap has a different move compared to other two because it has 'n.s. (not significant)' sign in most of them.

It is intuitive that the TCI is cointegrated with the WTI oil price, which is one of the world-wide index for the oil. It is straight forward to understand that the TCI increases if the cost of the transportation goes up. What astonished myself is the non - existence of the cointegration vector between the 1st grade resource price at the world market and the export prices of the scraps. None of the three scraps has the statistical significance to give up the null hypothesis that there is no con integration vector. This means that the fluctuation of the export price of these scraps do not depend upon the world resource market, which is, I assume, against the intuition for most of us.

On the other hand, the TCI for the ferrous and aluminum scrap has significant results with 1st grade resource price. Although the export prices are not correlated with the world resource price, the transportation cost for the scraps have correlation with the world price. We will discuss

[3]See Pfaff (2008) for computational issues.

this point in the next section.

4 Policy Implication

It is often said that the scrap price fluctuates if the world market for the resource soars. From the empirical result in Table 2, it is unlikely that the price of the scrap coincides with the world resource price. The real price that the recycler faces is, however, the total price of the scrap which include the transportation cost and the insurance. We will see how these relationship affect each other by using the impulse response function, which is based on the Vector Error Correction Model (VECM)[4].

First, we check the relationship between the world oil price and the TCI. Stated in the previous section, these two are cointegrated. Figure 4 shows the impact of the change in the world oil price against the TCI. As expected, the shock in the first term for the oil price causes huge increase in the TCI for a long time[5].

/////////// Figure 4 around here. //////////////

Second, the impact of the world resource price against the TCI is examined. Figure 5 is the result of the impulse response function for the two scraps. After a little bit of fluctuation at the beginning, the TCI remains with the positive effect in the both panel. This means that the increase in the world resource price increases the transportation cost. The reason that the domestic recyclers face the higher price when the world resource prices soar is not because the export price of the scrap goes up but the increase in the transportation cost. This difference should be understood and be examined more precisely for the better policy decision.

[4]For computation, the `vars` package for `R` language is used. See Pfaff(2008b) for the details.

[5]The result for copper scrap is omitted because it is not significant in the cointegration test shown in Table 2.

/////////// Figure 5 around here. //////////////

/////////// Figure 6 around here. //////////////

Another look of the impulse response function in Figure 6 provides us with the very interesting insight. It is the impulse response from the change of the TCI to the export price. We understand that the TCI rises when the natural resource price increases. How the increase of the TCI affect to the export price of the scrap. The answer is that it depends. For the ferrous scrap, the increase in the transportation cost leads to the decrease in the export price of the material while the export price would increase for the aluminum scrap as the TCI increases. The time series analysis developed here is powerful enough to reveal these facts between the transportation cost and the material price, but not enough to examine the reason this type of different impact occurs. Exploring this puzzle would be our next task.

The importance of the waste for the substitutes of the natural resources is now recognized by most of the policy makers as well as the benefit of the international trade. Considering the serious pollution at some part of China, it might be better to keep some of the electronic waste (E-waste) within Japan so that our E-waste contaminate other countries anymore. Stopping the flow of the market is a real difficult task and we need to know much more about how the international trade works if we wish to control the waste trades.

5 Conclusion

This paper analyze the waste trade data between Japan and China. Through this research, it is revealed that the structural changes are different among three scraps. The structural change of the scrap price and its transport cost happen in different timing for each material. Furthermore, it is shown that the transportation cost of the waste is more related to the 1st grade natural resource prices at world markets compared to the export price of the scrap materials. There is a cointegration between transportation cost index and export price. The impact of the fluctuated price of the world market price affect the scrap prices in the different way. The policy makers should be aware of this type of difference during the decision making of the waste management policy.

References

Agostini, C. (2006) "Estimating market power in the US copper industry," *Review of Industrial Organization*, vol. 28, pp. 17-39.

Cuñado, J., and F. Pérez de Gracia (2003) " Do oil price shocks matter? Evidence for some European countries," *Energy Economics*, vol. 25, pp. 137-154.

Furióa, D. and H. Chuliáb (2012) "Price and volatility dynamics between electricity and fuel costs: Some evidence for Spain," *Energy Economics*, vol.34, pp. 2058-2065.

Goméz, F., Guzmán, J. and J. Tilton (2007) "Copper recycling and scrap availability," *Resource Policy*, vol. 32, pp. 183-190.

Kellenberg, D. (2013) "Trading wastes, " *Journal of Environmental Economics and Management*, vol. 64, pp. 68-87.

Li, S., Zhu, H. and K. Yu (2012) "Oil prices and stock market in China: A sector analysis using panel cointegration with multiple breaks," *Energy Economics*, vol. 34, pp. 1951-1958.

Lütkepohl, H., Saikkonen, P. and C. Trenkler (2004) "Testing for the Cointegrating Rank of a VAR Process with Level Shift at Unknown Time," *Econometrica*, vol. 72, pp. 647-662.

Mansanet-Batallera, M., Chevallierd, J., Hervé-Mignuccic, M. and E. Alberolac (2011) "EUA and sCER phase II price drivers: Unveiling the reasons for the existence of the EUA-sCER spread," *Energy Policy*, vol. 39, pp. 1056-1069.

Miller, I. and R. Rattib (2009) "Crude oil and stock markets: Stability, instability, and bubbles," *Energy Economics*, vol. 31, pp. 559-568.

Perron, P. (1989) "Trends and random walks in macroeconomic time series," *journal of Economic Dynamics and Control*, vol. 12, pp. 297-332.

Pfaff, B. (2008a) *Analysis of integrated and cointegrated time series with R*, 2nd edition, Springer.

Pfaff, B. (2008b) " VAR, SVAR and SVEC Models: Implementation within `R` package `vars`," *Journal of Statistical Software*, vol. 27, pp. 1-32.

Slade, M. (1980) "An Econometric model of the US secondary copper industry: recycling versus disposal, " *Journal of Environmental Economics and Management*, vol. 7, pp. 123-141.

Watkins, C. and M. McAleer (2006) "Pricing of non-ferrous metals futures on the London Metal Exchange," *Applied Financial Economics*, vol. 16, pp. 853-880.

Watkins, C. and M. McAleer (2004) "Econometric Modelling of non-ferrous metal prices, " *Journal of Economic Surveys*, vol. 18, pp. 651-701.

Xiarchos, I. and J Fletcher (2009) " Price and volatility transmission between primary and scrap metal markets," *Resource, Conservation and Recycling*, vol. 53, pp. 664-673.

Zeileis, A., Leisch, F., Hornik, K. and C. Kleiber (2002) " `strucchange`: An `R` package for testing for structural change in linear regression models, " *Journal of Statistical Software*, vol. 7, pp1-38.

Zivot, E. and D. Andrew (1992) "Further evidence on the Great Crash, the oil price shock and the unit root hypothesis," *Journal of Business and Economic Statistics*, vol. 10, pp. 251-270.

A Tables

Table 1: Summary of ZA Test

	structural break	ZA	ADF	KPSS
Ferrous				
Export Price	2008/09	5%	n.s.	1%
Transport Cost Index	2006/10	1%	1%	1%
Copper				
Export Price	2005/12	n.s.	n.s.	1%
Transport Cost Index	2009/08	1%	1%	1%
Aluminum				
Export Price	2008/09	n.s.	n.s.	1%
Transport Cost Index	2009/10	1%	1%	1%

Table 2: Summary of Johanson Test

	1st grade price	WTI oil price	TCI
Ferrous			
Export Price (EP)	n.s.	-	1%
Transport Cost Index (TCI)	10%	1%	-
Copper			
Export Price (EP)	n.s.	-	n.s.
Transport Cost Index (TCI)	n.s.	n.s.	-
Aluminum			
Export Price (EP)	n.s.	-	1%
Transport Cost Index (TCI)	1%	1%	-

Note: Test type is trace statistic with linear trend in shift correction.

B Figures

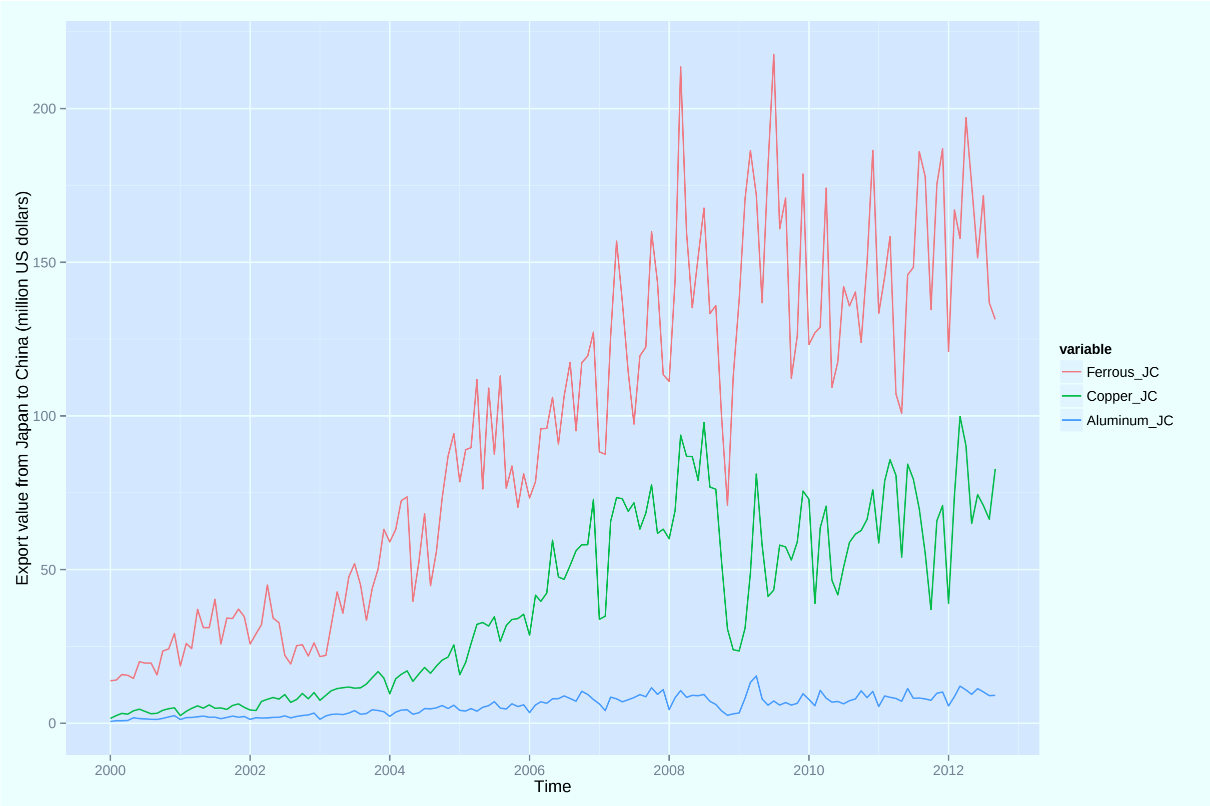


Figure 1: Changes in Japanese export to China

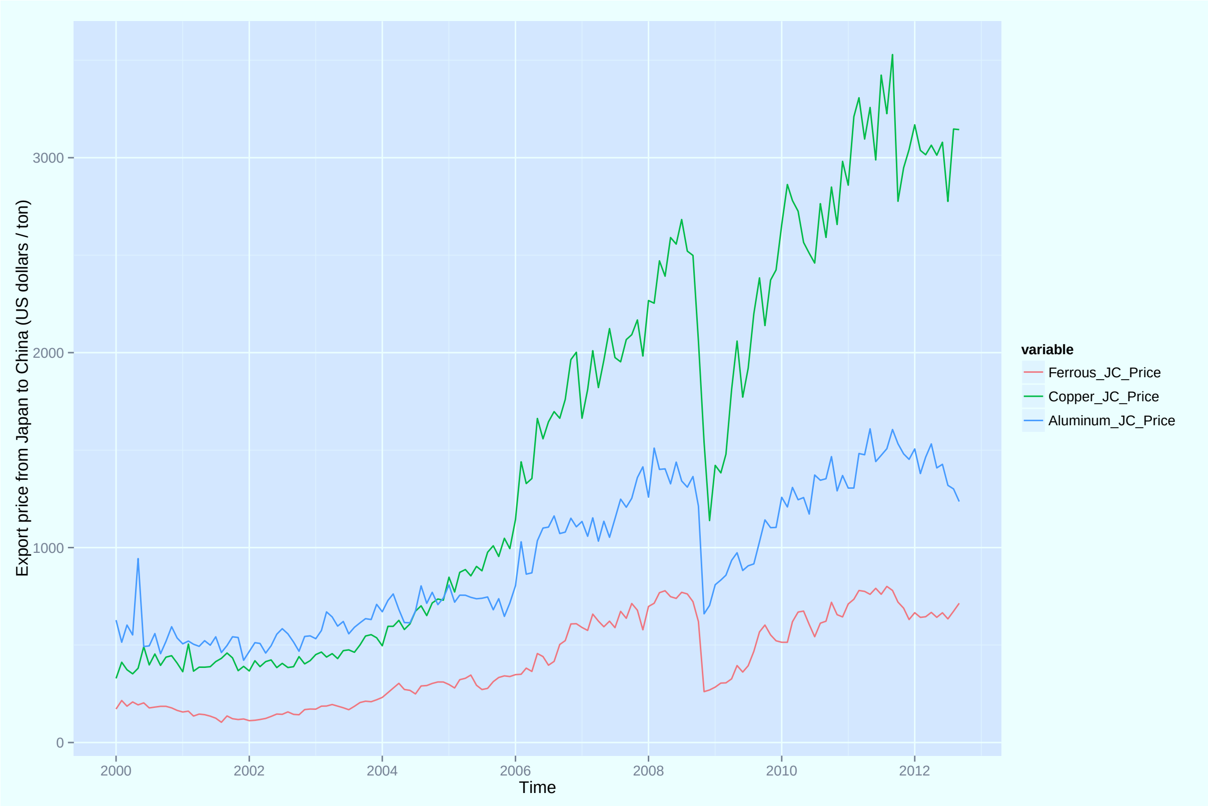


Figure 2: Price Changes in Japanese export to China

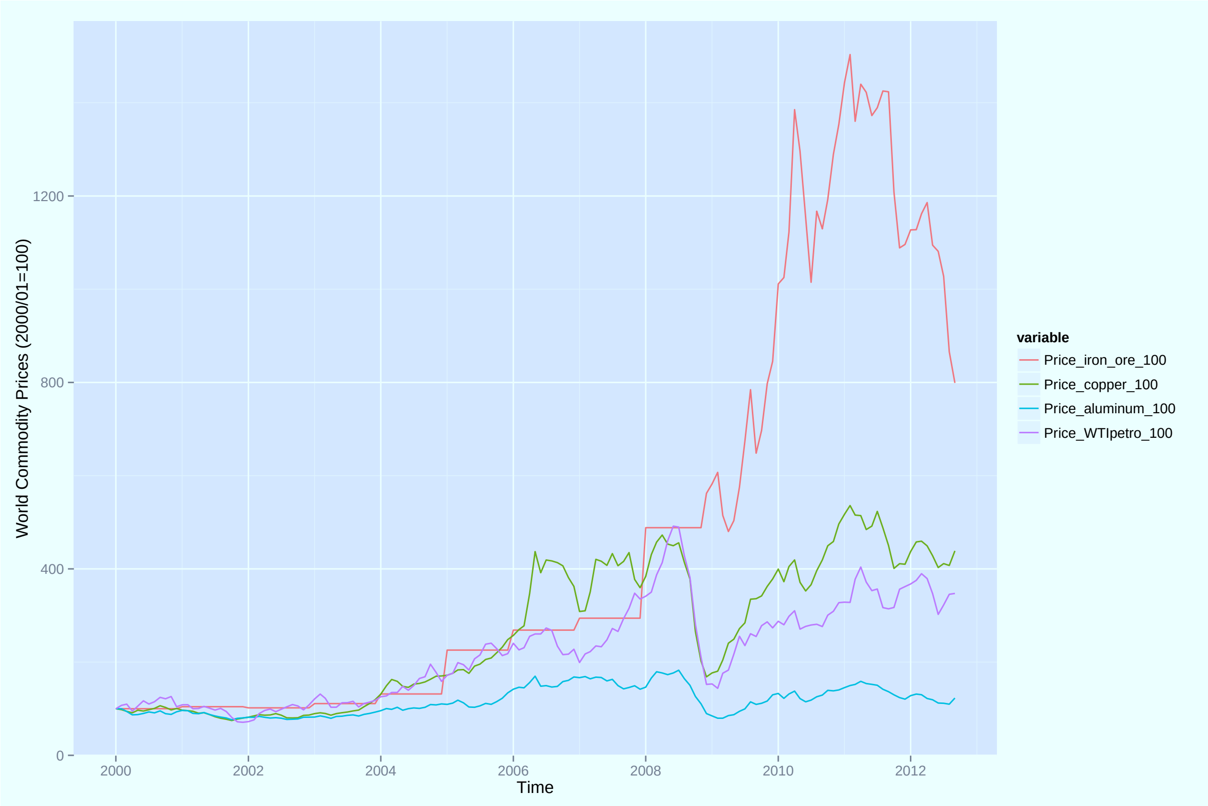
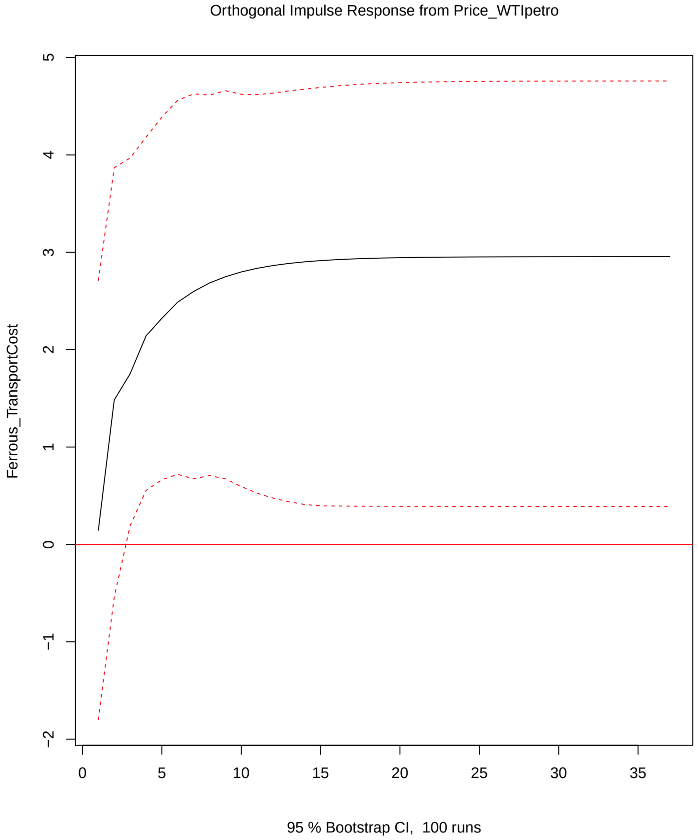


Figure 3: Changes in World Commodity Price Index



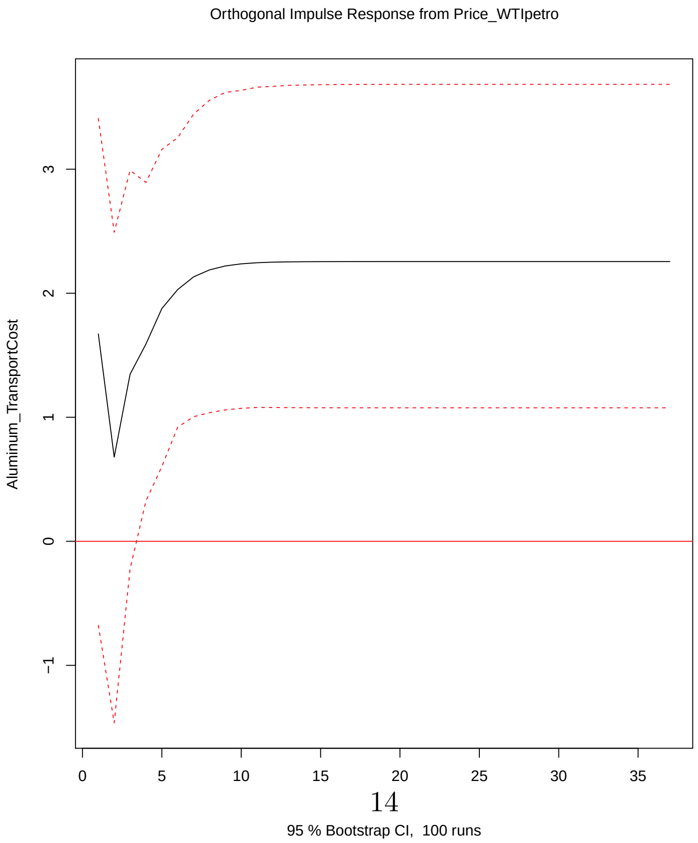
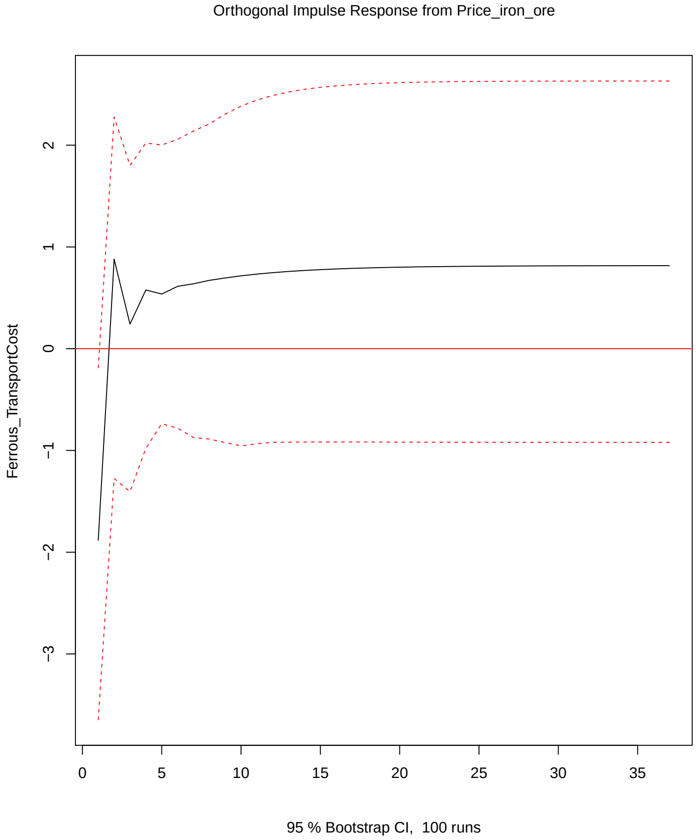


Figure 4: Impulse Response Function for changes from world oil prices



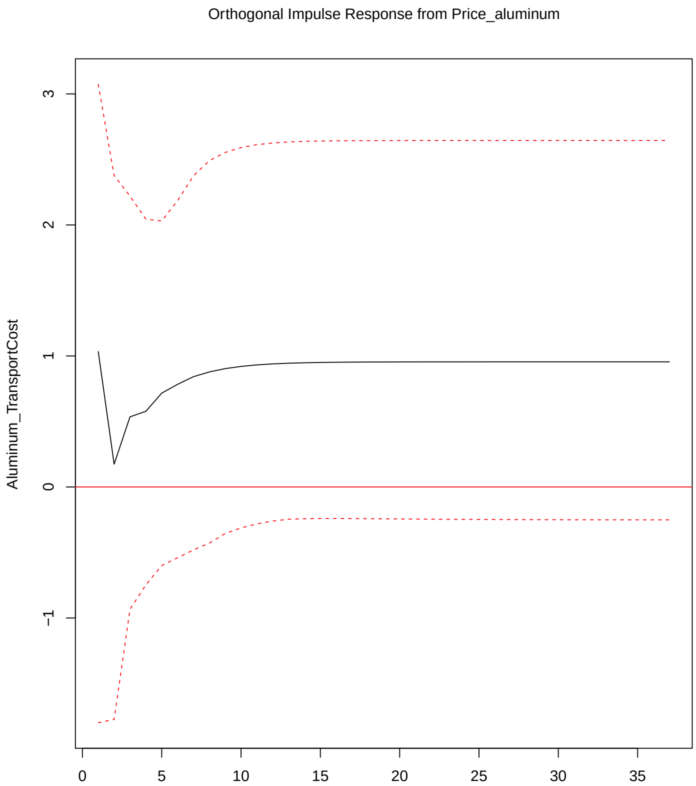
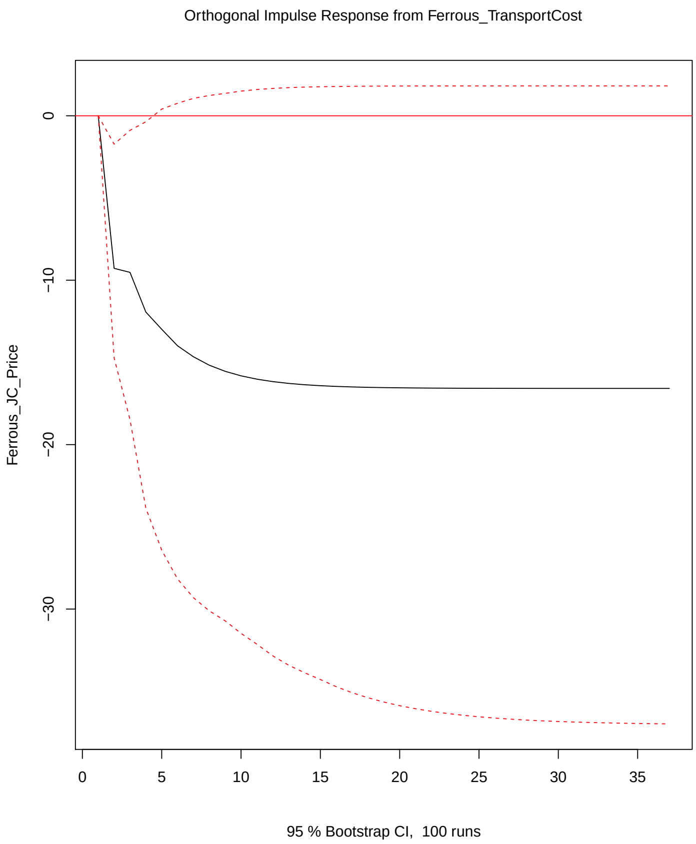


Figure 5: Impulse Response Function for changes from world 1st grade resource prices



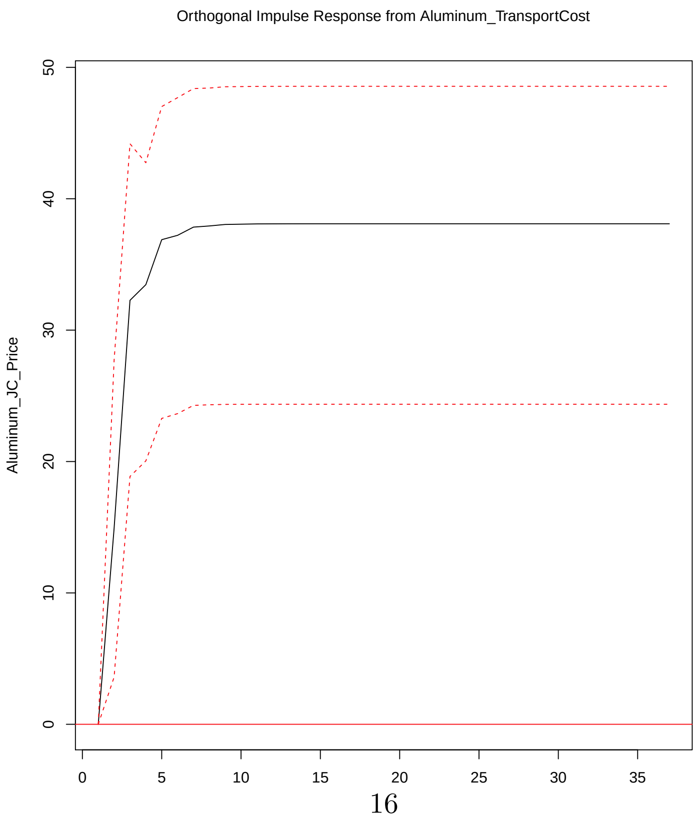


Figure 6: Impulse Response Function for changes from TCI to export price