

The Commodity and Industrial Sector in the Brazilian Economy

A thesis presented to
the faculty of
the Center for International Studies of Ohio University

In partial fulfillment
of the requirements for the degree
Master of Arts

Barbara Persilva Fernandes

May 2015

© 2015 Barbara Persilva Fernandes. All Rights Reserved.

This thesis titled
The Commodity and Industrial Sector in the Brazilian Economy

by
BARBARA PERSILVA FERNANDES

has been approved for
the Center for International Studies by

Roberto Duncan
Associate Professor of Economics

Mariana Dantas
Director, Latin American Studies

Lorna Jean Edmonds
Vice Provost for Global Affairs

ABSTRACT

PERSILVA FERNANDES, BARBARA, M.A., May 2015, Latin American Studies

The Commodity and Industrial Sector in the Brazilian Economy

Director of Thesis: Roberto Duncan

For the last ten years, Brazilian commodity share in its exports has grown due to the commodity boom in the 2000s. Nowadays, Brazil is one of the biggest producers of commodities in the world. However, the growth of the commodity sector in the economy has not been followed by the industrial sector, suggesting that the decrease of industrial production might be caused by a deindustrialization happening in Brazil. This thesis aims to study the interrelationship between these sectors using the variables: industrial production, petroleum export value, iron ore export value, coffee export value and the Gross Domestic Product (GDP) of Brazil. The econometric model was used and it confirmed the interrelationship of the variables, however with surprise results. Commodity export do affect industrial production, but in a positive manner and GDP also, however mainly in a negative way.

ACKNOWLEDGMENTS

I would like to thank all my committee and Ohio University faculty members that helped and guided me through this process. An especial thank you to Dr Ariaster B. Chimeli that spent time and effort teaching and helping me. Finally, I would like to thank my family back home that has always supported me; my friends in Brazil for always be there even if it is from afar; and my friends/family that I found in Athens, without them everything would have been impossible.

TABLE OF CONTENTS

	Page
Abstract.....	3
Acknowledgments.....	4
List of Tables	7
List of Figures	9
Introduction.....	10
Literature Review.....	13
Chapter 1: The Commodity Boom.....	16
1.1 The rise of the price	16
Chapter 2: Commodity and Industry in Brazil.....	21
2.1 The historical background of the oil market.....	21
2.2 The historical background of the iron ore market.....	23
2.3 The historical background of the coffee market	25
2.4 The historical background of the industry in Brazil	26
Chapter 3: Brazilian Economy.....	29
3.1 Innovation in the industrial sector	29
3.2 The development of the Brazilian economy	30
3.3 The Brazilian industry and the commodities markets	34
Chapter 4: Econometric Analysis	38
4.1 Expected relationships	39
4.2 Methodology and data	40
Chapter 5: VEC and VAR Models and their Results.....	42
5.1 Vector Error-Correction Model (VEC) and Vector Autoregression Model (VAR).....	42
5.2 Impulse response function	45
Conclusion	50
Epilogue	55
References.....	59
Appendix A: Test for Unit Roots.....	65
Appendix B: Test for Lags.....	71

Appendix C: Test for Cointegration	74
Appendix D: Test for Residuals.....	79
Appendix E: VAR Estimation results	82

LIST OF TABLES

	Page
Table A1 Augmented Dickey-Fuller Test for Petroleum Export Values	65
Table A2 Augmented Dickey-Fuller Test for Iron Ore Export Values	66
Table A3 Augmented Dickey-Fuller Test for Coffee Export Values	67
Table A4 Augmented Dickey-Fuller Test for GDP	68
Table A5 Augmented Dickey-Fuller Test for Industrial Production	69
Table B1 Test for Industrial Production and GDP Model	71
Table B2 Test for Industrial Production and Petroleum Export Values Model	71
Table B3 Test for Industrial Production and Iron Ore Export Values Model	72
Table B4 Test for Industrial Production and Coffee Export Values Model	73
Table C1 Johansen-Procedure for Petroleum export values and Industrial Production Model	74
Table C2 Johansen-Procedure for GDP and Industrial Production Model	75
Table C3 Johansen-Procedure for Iron Ore Export Values and Industrial Production Model	76
Table C4 Johansen-Procedure for Coffee Export Values and Industrial Production Model	77

Table D1 Portmanteau Test (adjusted) for Petroleum Export Values and Industrial Production Model	79
Table D2 Breusch-Godfrey LM test for Petroleum Export Values and Industrial Production Model	79
Table D3 Portmanteau Test (adjusted) for GDP and Industrial Production Model	79
Table D4 Breusch-Godfrey LM test for GDP and Industrial Production Model	80
Table D5 Portmanteau Test (adjusted) for Iron Ore Export Values and Industrial Production Model	80
Table D6 Breusch-Godfrey LM test for Iron Ore Export Values and Industrial Production Model	80
Table D7 Portmanteau test (adjusted) for Coffee Export Values and Industrial Production Model	80
Table D8 Breusch-Godfrey LM test for Iron Ore Export Values and Industrial Production Model	81
Table E1 VAR Estimation for Petroleum Export Values and Industrial Production Model	82
Table E2 VAR Estimation for GDP and Industrial Production Model	83

LIST OF FIGURES

	Page
<i>Figure 1: Indices of Primary Commodity Prices</i>	17
<i>Figure 2: Impulse Response from l.val.dollar_p and Industry</i>	46
<i>Figure 3: Impulse Response from l.val.dollar_r and Industry</i>	47
<i>Figure 4: Impulse Response from l.val.dollar_c and Industry</i>	48
<i>Figure 5: Impulse Response from GDP and Industry</i>	49

INTRODUCTION

Brazil has been a player in the international trade of primary goods since it was a Portuguese colony. It has experienced high economic growth due to exports of commodities in many periods of time, such as the 1879-1912 rubber boom and the 1880s-1930s coffee boom (Topik, 1985). However, growth due to commodities exports was not sustainable and as soon as the demand for these goods decreased or the supply increased in the international market the Brazilian economy was highly affected. After the 1929 economic crisis the Brazilian government, trying to industrialize and to become less dependent on primary goods, implemented the Import Substitution Industrialization (ISI) program (dos Santos Junior, 2004). The goal of ISI was to encourage the creation of an environment for the development of a national industry and make the importation of manufactured products from other countries more difficult.

After the program to stimulate industrialization in Brazil, its economy was more diversified and less dependent on commodities trade. However, in the beginning of the 2000s the prices of commodities (or basic goods) started rising in the international market and Brazil started exporting more of these goods. The high demand for commodities and the increase in the exports of these goods caused the Brazilian economy to grow significantly and fast. According to government data in 1990, the shares of the products the country exported were: 27.9% for basic goods, 54.2% for manufactured goods and 16.3% for semi-manufactured goods (Ministry of Development, Industry and Foreign Trade). However this scenario has changed over time and in 2013 the shares of the

products the country exported were: 47.7% for basic goods, 38.7% for manufactured goods and 12.6% for semi-manufactured goods.

This thesis aims to find if there is a connection between the commodity boom that started in the 2000s and industrial production in Brazil. Furthermore, I hope to estimate how strong this relation was, if it in fact existed. It is important to find if there is a connection between these variables because of the importance the industrial sector has in the sustained growth of the Brazilian economy. On the one hand, growth in the exports of commodities can draw investments from industry, reduce diversification of the economy and increase its vulnerability to external shocks. On the other hand, increasing exports of commodities can strengthen the local industry through internal demand by producers and consumers and increase the diversification and resiliency of the Brazilian economy. To investigate this connection and to measure its strength, econometrics will be used. The variables chosen to represent the commodities are petroleum export value, iron ore export value and coffee export value. The others variables are industrial production from semi manufactured and manufactured industries and the Gross Domestic Product (GDP). Each one has the goal of representing two different sectors of the economy and the economic growth and to better understand how they are connected after using econometrics.

However, at first it is important to explain how the commodity boom happened and how each sector has developed in Brazil. At first, I explain the reasons behind the commodity boom in the 2000s and how the commodity (or primary) sector in Brazil gained more space in the balance of trade in such a short period of time. In the second part, I give the historical backgrounds of the variables used in this thesis. This section

shows how historically the Brazilian economy has been connected to commodities and how they are connected to the development of the national industry. In the third part, I briefly explain how the Brazilian economy has become one of the biggest in the world. In the same section, I explain the relationship between the commodities (especially petroleum, iron ore and coffee), industry, and economic development. The next part I explain the methodology that I used in the econometric models. And finally, in the conclusion I analyze the results I obtained with the econometric models and I offer some recommendations for future researches.

LITERATURE REVIEW

The causes behind the commodity boom are debated in the literature. Authors such as Prates (2007) and Baffes and Hanriotis (2010) state that low investments in the primary sector around the world and the El Nino phenomenon are some of the reasons for the increase of the prices of commodities in the international trade market. However, others argue that the main reason for the boom in the commodities market is the Chinese economic growth. Data from the Ministry of Development, Industry and Foreign Trade show that the main trade partner of Brazil in 2006 was the United States, Argentina and China. In 2013, however, China was the largest consumer of Brazilian exports. This shift was likely the result from China's increase of demand for commodities (Gallagher; Porzecanski, 2009).

Also, it is crucial to understand the reason behind the importance of the industrial sector in an economy, thus understanding the relevance of this research. According to Matleena (2008) the importance of the industrial sector in an economy is due to the long-term benefits it brings to the economy in general. The investments made in the sector create more skilled jobs, improve local income, and develop other sectors (like services). The industrial sector makes higher investments in innovation and technology, which generates the production of goods with a higher aggregate value and increases GDP.

Due to the fact that the industrial sector has decreased its participation in the Brazilian exports and balance of trade in the last ten years scholars have debated whether a deindustrialization is happening in Brazil, and if it could be the resource curse. Some authors argue that the cause can be the overvalue of the Real, liberalization in the

financial and commercial sector and the lack of a plan of strategic development in Brazil (Palma, 2007; Loures, Oreiro and Passos, 2006; Bresser-Pereira, 2008; Bresser-Pereira and Marconi, 2009; Oreiro and Feijó, 2010; Marconi and Rocha 2012; Cano, 2012).

Thus, the national product has to compete with more competitive foreign ones, since the high value of Real increases importation and the liberalization open the national market to international products. However, Silva (2014) argues that competition is not only based in the price, there are other factors such as quality that affects it.

Another reason given for the deindustrialization is the Dutch disease (Silva, 2014): an increase in the exports of primary goods, causes the appreciation of the currency in the exchange rate which damages the industrial sector and decreases its participation in the country GDP (Bresser-Pereira, 2008; Frankel, 2010). Verissimo (2010) also debates whether there is a Dutch disease happening in Brazil, the main argument being that the export products between 2000 and 2006 became mainly basics goods rather than manufactured ones. Also, because this change affected the economic growth, the rise of the prices increased the Brazilian GDP as well. Finally, the increase of exportation of commodities increased the national currency value in the exchange rate, leading to the importation of more manufactured goods (they became cheaper) and the decrease of investments made in the industrial sector nationally.

The deindustrialization could also be happening due to the lack of domestic economic policies that help the development of the sector. There is a high cost to produce and it is often called “Brazilian cost”. Silva (2014) argues that workers’ wages paid have increased, but the productivity has not followed it, which decreases the competitiveness

of the domestic products. According to the Institute of Research in Applied Statistics ([IBGE] 2012) the productivity in less productivity sectors (agricultural and services) has increased, while in the industrial sector it has decreased.

This research will analyze the link between the commodity boom in the 2000s and manufactured production in Brazil. It uses export and industrial production data to connect these variables and to measure the impact one has on the other. Without using econometric analysis and only comparing the numbers and variation between commodities exports and manufactured production it can be agreed that the former increased and the latter decreased, leading to a conclusion that the rise in one led to the decrease in the other (Verissimo, 2010). This analysis is not rigorous, however, as it does not account for common trends determining both variables and internal mechanisms that determine variability in the indicators of interest. To address these issues econometrics is used in this research.

CHAPTER 1: THE COMMODITY BOOM

In this chapter I will explore the reasons behind the commodity boom in the 2000s. I discuss how the prices of commodities changed between 2001 and 2003 going from very low prices to very high ones. I aim to give a background information that helps explain the increase in the exportation of commodities from Brazil.

1.1 The rise of the price

In 2001, commodities reached their lowest prices in decades (see Figure 1). Two reasons given for the low prices of commodities were: the increase in the demand for manufactured products, which was not followed by the demand for primary products, especially agricultural ones; and technological development for the final products and in the primary sector, which improved efficiency and productivity in the sector (Prates, 2007). Technological developments caused the substitution of synthetic products for some natural minerals for final products. This lowered the price of mineral commodities. In the agricultural sector, technological progress made this sector more efficient and productive. These developments, allied with a low demand, made the agricultural products cheaper at the end of the 1990s and beginning of 2000s (Prates, 2007).

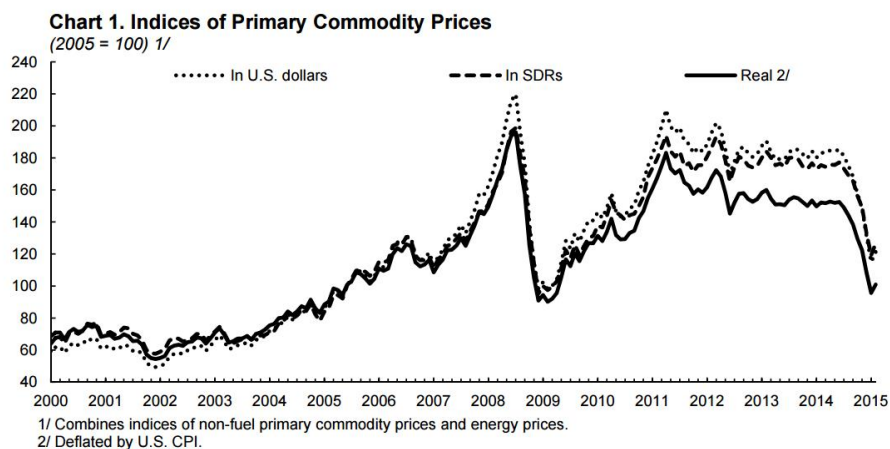


Figure 1: Indices of Primary Commodity Prices

Source: International Monetary Fund Website

In addition to these, the trends in the trade after World War II showed an increase in trade rates; however the sectors with growing rates were the manufactured and technological ones. The primary goods experienced a negative growth rate, due to a weak demand. However, some processed agricultural, like meat, dairy, vegetables, fruits and oils, goods had some sustainable demand because of some aspects that give them some characteristics of manufactured goods, like security methods, quality control and delivery (Prates, 2007).

Before early 2000s the market structure was different between manufactured and primary goods. While the manufactured goods had the market controlled by some big companies that could keep track of their products' prices (oligopoly), the primary market had its prices controlled by the market itself. The more competitive a product is, the cheaper it becomes. However, this market structure changed over time and now the

structure of these two markets are more alike, with big companies in the primary sector controlling a large part of the sector and the prices as well (Prates, 2007).

In 2002, because of the El Niño phenomenon some regions in the world were affected by a serious drought and others were affected by floods. The change in the weather affected the agricultural production worldwide, the offer of these products decreased even more and their prices increased. In the following years, because of some other climate changes, some agricultural products had their prices affected. Not only had climate variability affected the commodities prices, the demand for some of these products also increased (Bafes, Haniotis, 2010). China had a big role in the increase in the demand for commodities, especially for soy and meat in the early 2000s. The increase in the prices of metals began later, in the beginning of 2004, with the growing prices of petroleum, which made the production costs and prices of iron and aluminum higher. (Political Economy Research Institute [PERI], 2009).

The fast growth of the Chinese economy can be pointed as the main reason for the increase of the commodities prices after 2002 (Bentley, 2003; International Monetary Fund [IMF], 2004; Roach, 2004; The Economist, 2003, 2004; Unctad, 2005). After 2001, China became a member of the World Trade Organization and had to make some structural changes in its economy. To become a part of the organization the Chinese government had to accelerate the process of liberalization of its economy, and decrease the tariff and nontariff barriers for imported goods and services. With these changes China became one of the biggest economies in the world and its participation in international trade grew (PERI, 2009).

Due to the development of its industrial sector, especially the automotive, metallurgic, and construction the demand for minerals increased. And due to the population growth and the rise in their income the demand for agricultural goods also increased in China. According to the IMF (2004), the impact of the Chinese economy in the prices of commodities can last until 2020.

Some other reasons behind the commodity boom are: the weak price of the dollar; the low interests of this currency; the low investment made by governments in the primary sector because of the low prices, which led to a low inventory of some primary goods; and the growth of the world economic rate after some low growth, for example because of the Asian Crises in the late 1990s, which increase the demand for these products (Bafes, Haniotis, 2010).

The trade of commodities is done in the futures markets, where buyers and sellers make contracts for the delivery of some commodity in the future, but with the present price. These deals are made in US dollars, so when the dollar price is weak the exports of these products rise. The growth in the world economy is reflected in the international trade, when the first one has a positive growth so has the second one.

However, since the financial crises in 2008 the prices of commodities have been decreasing. The crises and the decrease of the global growth are some reasons for the sharp decrease in prices in some commodities sectors (Baffes, Haniotis, 2010). Also, as the main reason for the increase of the prices was the Chinese growth the deceleration of the Chinese economy has caused the decrease in the prices. The Chinese economy grew 10.4% in 2010, but in 2013 it slowed down to 7.7%, according to the World Bank. Some

other reasons for the decrease in the commodities prices would be the increase of the supply of these products and the stronger price of the dollar in the world market (Baffes; Haniotis; 2010).

CHAPTER 2: COMMODITIES AND INDUSTRY IN BRAZIL

In this chapter I will address the historical background of the oil, iron ore, and coffee markets in Brazil. I will also address the development of the Brazilian industrial sector. I aim to explain how important they are for the economy and how they are connected.

2.1 The historical background of the oil market

It was known that there was petroleum in Brazil since the imperial era (Brasil Escola). At that time the Marquis of Olinda gave Jose Barros de Pimentel permission to extract the oil by the River Marau (Bahia). It was not until 1930, however, that the extraction of petroleum was successfully achieved by the engineer Manoel Inacio de Basto, before that all other attempts failed to dig a hole for the extraction. In 1932 the engineer gave to the then President Getulio Vargas a report with his findings. In 1938, National Oil Council (CNP) was created, which gave directions for the use and exploration of the Brazilian underground and its resources. The Council decided that all petroleum reserves were owned by the Union (the country). The first hole was made in Lobato (Salvador, Bahia).

After that, the Brazilian government started to look for new reserves and in 1941 it established the oil well in Candeias, Bahia. Even though the findings were small, in 1953 the stated-owned company “Petroleo Brasileiro SA” (Petrobras) was created, which made petroleum extraction and production an official monopoly of the State. The company started to increase its actions and by 1968 it started developing innovative technologies, such as deep and ultra-deep water oil extraction (Petrobras). And in 1974

the reserve of Campos Basin was found, which was the biggest reserve in the country. The technological developments associated with deep water oil extraction made Brazil one of the few countries in the world to be able to extract petroleum in deep and ultra-deep waters.

The Fernando Henrique Cardoso administration (1997) extinguished the law that made the exploration of petroleum in Brazil a state monopoly (Blog do Planalto). The goal was to make it possible for private companies to explore oilfields and thus to increase the production and use of petroleum. In 2000, 31.7% of Petrobras stocks were sold in the market, especially in the New York Stock Market (Universidade Federal do Rio de Janeiro [UFRJ]). And in 2003 it was announced by Petrobras that new reserves were found, which increased the possibilities of the sector in the Brazilian economy, the capacity of production matched 90% of the demand of the product and its derivatives domestically (UFRJ).

Self-sufficiency was reached for the first time in 2006, when the production of petroleum was greater than the domestic demand. It meant that production had been increasing greatly, making the country less dependent on imports of the product and able to export it. In 2007, Petrobras announced the discovery of a new deep water oilfield in a geological formation called pre-salt. The pre-salt oil is in ultra-deep waters (between five and seven thousand meters below sea level) and it is an enormous well-preserved reserve. According to the estimates, the new oilfield could double oil production in Brazil (Petrobras). The discovery of these reserves made Brazil one of the ten countries with the biggest oilfields in the world (Petrobras).

In 2008 oil was extracted for the first time from the pre-salt layer, in the Campos Basin (Rio de Janeiro), and production in the oilfield of Tupi, also in the pre-salt layer, started in 2009. The production of the pre-salt layer oil is nowadays eight times greater than it was in 2010 having a bigger than 90% index of success (Petrobras).

2.2 The historical background of the iron ore market

When the Portuguese arrived in Brazil they expected to find gold, silver and bronze, it was the mercantilist period in Europe. However they did not find these metals at first, and the iron used in the colony came from Europe (Acobrasil). The first report of gold and iron found in Brazil was in 1554 by a Jesuit priest. In 1587 the first factory of iron in the colony was founded. The factories worked until the death of its owner, in 1616, after that the iron industry in Brazil did not grow until basically the next century.

The gold mines found in Minas Gerais were important for the development of the iron sector in Brazil and started what became known as the cycle of gold (between the seventeenth and eighteenth century) (Historia do Brasil). However, it was forbidden for the colony to have any kind of factory, thus the iron industry did not developed until 1795. That year the new king of Portugal authorized the construction of new foundries in Brazil and after 1808 many others were built. In 1808 the Portuguese royal family ran away from Napoleon to Brazil. Before the development of an iron industry all of the iron was imported from Europe, mainly from Germany, Sweden and Spain (Acobrasil).

Even with the construction and development of an iron industry in Brazil, during the nineteenth century there was a decrease in production. England had trade agreements with Portugal, in which it benefited English products with low import taxes, thus the iron

products imported from there had a competitive price (Acobrasil). Besides, there was a lack of workers for the sector that went to sugar and coffee plantations.

The first decades of the nineteenth century were characterized by the focus of the government on coffee and not on the development of the industry (Acobrasil). However it was different for the iron industry and during these decades important companies were created for the extraction and production of iron in Brazil. The government gave fiscal benefits for the industries in the sector and in the 1930s it had an increase in production. Even though the industry was growing, the country was still dependent on the importation of iron.

In the 1940s, during the Vargas administration the focus changed. He wanted to develop the basic industry in Brazil and to end the dependence on the importation of basic goods. In 1946 the “Companhia Siderúrgica Nacional” (CSN) was created and it marked the beginning of Brazilian self-sufficiency of iron production. In the next decades the demand for iron increased in the international trade and the National Steel Plan (1971) was created in Brazil. The goal was to increase production four times. During the 1980s, Brazil was going through an economic crises and the domestic demand for steel decreased, the solution found was to export. The country found itself as an iron exporter instead of an importing country (Acobrasil).

In the 1990s the state started to intervene less in the economy, it was one of the conditions for the IMF (International Monetary Fund) to lend money to Brazil. Due to the conditions given by the IMF the government sold most of the stated-owned companies. The privatizations brought more capital to be invested in the companies and they

increased production. Nowadays, Brazil has the fifth largest reserve of iron ore in the world and is the second biggest producer in the world (Vale).

2.3 The historical background of the coffee market

The first Brazilian coffee plant was established in 1727 in Belem (north of the country) (Revista Cafeicultura). At the time, coffee already experienced a high demand in the international market and had a high commercial value. Due to the weather and soil conditions, the cultivation of the plant spread out to other regions in Brazil and the grains were sold in the domestic market only at first. Rapidly, it became an important product for the Brazilian economy and in 1825 it started a new economic cycle in the country. In the late eighteenth century Brazil started to export more coffee, thanks in part to the Haitian revolution which disrupted coffee production in the island – then one of the main coffee producers in the world. But Brazil only started to have an expressive volume in the beginning of the following century.

Coffee was really important for the economic development of Brazil and its rise as a big export country in the international scenario. The coffee economy promoted the development of certain regions and the implementation of railways to transport the commodity instead of animal traction. Immigrants came to work in the farms and the domestic trade intensified. The coffee economy played an important role in shaping the Brazilian society and economy for over a century. It was also important to finance the national industry and the banking sector with its high profits (Revista Cafeicultura).

At the highest point of the coffee cycle, Brazil was the biggest supplier of coffee in the world and could control prices in the international trade (Infoescola). However, it

relied on the population growth of consumer countries, especially European ones. As the supply began to increase more than demand, prices started to fall and, in 1929, the economic crises in the United States brought prices even lower. The Great Depression ended the coffee cycle in Brazil. However, with the increase of demand and price, production grew and nowadays Brazil is the biggest producer of coffee in the world and the second biggest consumer (Ministry of Agriculture of Brazil).

2.4 The historical background of the industry in Brazil

The development of the Brazilian industry did not really start until its independence (Cavalcante, 2009). Before that Portugal prohibited any kind of manufacture in the colony and promoted monoculture, such as sugar plantations. The process of industrialization started in the middle of the nineteenth century with the coffee cycle, because the high profits made it possible for resources to be invested in other sectors. However, it had a slow start and between the nineteenth and the twentieth century it did not have a big participation in the Brazilian economy. Until the half of the twelfth century Brazil depended completely on the importation of manufactured goods, especially from Europe. Its exports boiled down essentially to agricultural goods.

The 1929 crisis showed how fragile the economy was. Thus during the President Getulio Vargas government important policies were created to develop the national industry, namely the implementation the Import Substitution Industrialization (ISI) program (dos Santos Junior, 2007). Some of the actions taken were investments in infrastructure, labor laws, and rights and protectionist measures (tax on import goods, for example). It was during the first and second Vargas mandates that important companies

were created such as Vale do Rio Doce (1942) and Petrobras (1953). At the time, World War II had ended and Europe was importing industrial goods from other countries, because the European industry was destroyed during the war, which was beneficial to the development of the Brazilian industry.

This economic strategy was constructed around what is called “Theory of dependency”. This theory stated that there was an International Labor Division where core countries (developed and industrialized) exported manufactured goods and peripheral countries (in development and agricultural) exported and specialized in primary goods. According to the theory peripheral countries provide natural resources to core ones which they manufacture products out of them and export them back to peripheral countries. Due to the fact that manufactured goods are much more expensive than commodities, peripheral countries would never be able to pay off their debts, which leads to their underdevelopment and the flow of capital to core nations (Hage, 2013). Only protectionist policies could lead to development and self-sufficiency of peripheral countries.

Another important development in the industrial sector happened during the Juscelino Kubitschek presidential administration (dos Santos Junior, 2007). He opened the country for foreign investment and the settlement of multinationals, especially the ones in the automobile sector (Ford, General Motors, Volkswagen and Willys). He focused on the development of industries in the energy and transport sectors.

Throughout the next decades the Brazilian industry developed even more and nowadays it has industries in the sector of airplanes, automobiles, textile, machines, etc.

However, the high technological sector is not developed and the country has to import from other ones. Also, the industrial sector has not really developed and analyzing the historical background it is possible to see a pattern where the economy has high economic growth during commodities boom, which was followed by low growth.

CHAPTER 3: BRAZILIAN ECONOMY

This chapter has the purpose of exploring the connection between commodities and industry in the Brazilian economy. I first give a theoretic explanation of the importance of the industry in an economy, then an overview of the Brazilian economy and policies adopted by the state regarding the development of the national industrial sector, and finally I discuss the relationship between industry, commodities, and economic growth.

3.1 Innovation in the industrial sector

According to Schumpeter, innovation leads to “creative destruction”, a scenario where a more productive and profitable sector of the economy replaces a less productive and profitable one increasing the aggregate productivity in the economy. Technological change is a driving force for economic growth. Technological change happens mostly in the industrial sector, especially through research and development (R&D) investments in developed countries and technology diffusion in the international trade in developing countries (Kniivilä, 2008).

The industrial sector is a dynamic one, where firms try to keep up with one another and by always innovating and making investments. Innovation is important for productivity, decrease of costs and the increase of profits. Industrial goods have more added value and are more expensive than primary goods. According to Cornwall (1976, 1977), the development of some manufacturing sectors can create productivity growth in many others.

Due to the technological changes in the industrial sector, most of the people employed by the sector are skilled and educated. The development of the sector increases wages and investment in education. Better income means more consumers, thus more demand for domestic goods and more employment and production. It creates a productivity cycle that promotes sustained economic growth (Kniivilä, 2008).

However, commodities prices are too sensitive to the change in demand and/or supply in the international market. Over time they do not sustain a high price and have short-time fluctuations. Specialization in the primary sector is a risky strategy for a country pursuing long term sustained growth (Kniivilä, 2008). Also, it tends not to generate a large number of jobs nor does it tend to demand large numbers of skilled workers. Often, when an economy is based on the trade of commodities it is due to comparative advantages it has with the others, like natural resources, which does not lead to the stimulation of investment in innovation.

3.2 The development of the Brazilian economy

Brazil experienced some fast and high growth in its economy because of the increased demand for some primary goods over the last centuries (Werner, 2001). In the 1920s Brazil had an economic boom with the trade of coffee, but the competition for this market grew with the introduction of Vietnam in the trade and the end of the boom came with the Great Depression in 1929.

The Brazilian government introduced the Import Substitution Industrialization (ISI) in the 1930s to refocus the economy away from the primary sector. Some policies adopted as part of this plan were the creation of State Owned Enterprises (SOEs) in

strategic sectors, like Petrobras (oil), Vale (mining), National Steel Company (steel) and National Motors Factory (auto). The country also had a protected economy, based on the creation of tariffs and non-tariff barriers (like quotas) for imported goods. Finally, the state subsidized companies to develop the industrialized sector with “cheap polities” (cheap electricity, cheap food, cheap transportation); and the government also controlled the exchange rate, having it overvalued (Silva, 2013). During this time the government had a great control over the economy and its sectors.

During the 1970s, Brazil had a military government and it didn't have any accountability. It borrowed large amounts of money from international banks with low interest rates. The low prices of petroleum in the countries that produced it were overloading with money and investing it in western banks, thus these banks had a large amount of money to borrow with low rates. However, in the period of 1979-1982, there was a Global recession because of the high prices of oil (the oil price shock). Banks started rising the interests of their loans and the Brazilian government ended having a much bigger debt. The 1980s are known as “The lost decade” and in 1985 the military government fell. To try to pay the loans the Brazilian government started printing money, but this only led to a hyper inflations crises, social problems, and the increase in inequality in the population (Leandro, 2012).

Due to its debt, Brazil had to turn to the International Monetary Fund for loans. At the time, almost all Latin American countries were having the same problem with their debt and they all turned to the IMF or to the World Bank for loans. These institutions made some structural changes requirements for these countries' economies -- these were

known as the neoliberal restructuring. Brazil had to privatize most of its SOEs, agrees to a free exchange rate, a more open economy for foreign investments, a fiscal reform, and a reduced state. Part of the Brazilian plan to follow these criteria was the Real Plan (“Plano Real”) in 1993 and the Fiscal Responsibility Law, which had a great impact on the stabilization of the economy (Leandro, 2012).

Inflation in Brazil before this plan was about 80% a month, the prices of goods were constantly going up and the real value of the wages was declining - it could not keep up with inflation (Leandro, 2012). Because of such high inflation the purchasing power of the population was not high, and the ones who had a minimum wage income were the most harmed. Inflation was due to the monetary plan implemented by the government; it didn’t have enough money to pay its debts and ordered the Central Bank to print more money so it could pay its debt. Between 1980 and 1992 the average annual inflation was of 694%.

The “Plano Real” had the objective of having the currency value close to the US dollar. It had five basics pillars: (1) elimination of the public debt, the main reason of the money printing ordered by the government. Because of that there was an increase of 5% in federal taxes and the privatization of state owned companies, especially of state owned banks. (2) The end of the automatic corrections of prices and salaries based on the previous inflation rate. (3) Making prices and salaries vary according to the US dollar value. (4) Reducing the import tax to have cheaper products and reducing the rise of products prices with the creation of a competitive environment. (5) Increasing the international reserves of the government, so the international investors could have more

trust in the new currency and decrease the chances of having speculative attack and capital flight (Leandro, 2012).

In 1993, the currency changed its name from Cruzeiro to Cruzeiro Real and it had a three-zero cut in its face value. The most important change was made in the beginning of 1994, with the implementation of the URV (“Unidade Real de Valor” – Real Value Unit), it was calculated based on dollar value from the day before, so all prices in Cruzeiro Real had to be divided by this value and that would be the price in Real (Leandro, 2012). It had the objective of making the transition between the Cruzeiro Real and the Real a smooth one, so the prices wouldn’t change from one day to another. The Real was implemented on July 1, 1994 and the exchange value of the new currency for that day was US\$ 1. A floating rate was also implemented. The inflation rate was 47.43% in June, after the Real it was 6,84% in July, 1.86% in August, 1.53% in September, 2.62% in October, 2.81 in November and 1.71% in December.

After the “Plano Real”, another important action taken by the Brazilian government to stabilize the economy was the Fiscal Responsibility Law. It was established in 2000 and according to it every federal entity (states and municipalities) had to have all their budgets balanced by the end of each mandate. This law was established to avoid great spending by these entities (Leandro, 2012).

These were two major monetary and fiscal reforms made by the Brazilian government that could stabilize the economy. With the inflation in control the government could raise the minimum wage above annual inflation. With the economy stabilized and the rise of the commodities in the early 2000s, the Brazilian economy

experienced great growth as well as better social indicators, like unemployment and income inequality (IBGE database).

After the program to stimulate the industrialization of the Brazilian economy, its economy was more diversified and less depending on commodities trade. But, with the high commodity prices the Brazilian economy started becoming more focused on the trade of primary goods, and China's growing role in the international trade also affected the Brazilian trade structure (Ministry of Development, Industry and Foreign Trade database).

3.3 The Brazilian industry and the commodities markets

At the beginning of the 1950s, coffee still accounted for over 70% of all Brazilian exports (Alvim, Fantini, 2008). The Brazilian government adopted economic models focusing on the development of the national industry and the diversification of domestic production. As mentioned before, as a reaction to the crisis in the 1930s the local government adopted the ISI model. First implemented during the Getulio Vargas administration, ISI was consolidated during the Juscelino Kubitschek administration and was maintained during the military regime (1930 - 1985). Some of the accomplishments of the economic strategy was the development of the industry in Sao Paulo, the national steel industry, and Petrobras. However, the protectionism implemented for the development of the industry led to the limitation of the sector because it did not face external competition and became dependent on foreign technology (Alvim, Fantini, 2008). In the 1980s the model was dropped and throughout the 1990s the process of

liberalization of the economy occurred, with privatizations and the ending of protectionist policies.

According to governmental data, between 2005 and 2014 primary goods went from 29.3% of export shares to 48.7%, which shows a significant increase in the share of these goods in the balance of trade in almost ten years. Also, industrial goods had their share decreased from 55.1% (2005) to 35.6%. Even though basic goods have increased their share in the Brazilian exports, it is still less than it was in the early 1960s, according to Alvim and Fantini (2008).

During the 1970s and the petroleum shock generated a large supply of dollars (petrodollars) in the international market, which led to loans with very low interests. The investments made in the decade in Brazil were made especially in commodity production and the infrastructure to produce them, because at that time the commodities prices were high (Alvim, Fantini, 2008). That led to a decrease in capital production, since primary goods are labor intensive.

Brazil has one of the biggest iron ore reserves in the world and it has the best iron ore concentration in the world (67% according to Vale), which gives a high comparative advantage to export the product. According to governmental data (IBGE), the mining industry in 2013 had more than doubled the participation in the Brazilian GDP, between 1991 and 2001 its participation was 1.1%, but between 2002 and 2012 it went to 2.9%. Also, Brazil is one of the top ten countries regarding investments made in the mining sector. To keep growing, investments in R&D must be done, thus new technology for production can be developed and new reserves can be found (Vale).

Petrobras had the largest oil production in the world among publicly traded companies in 2014 (Petrobras). The company makes large investments in research and development to develop new technologies for the extraction and production of energy. It was a pioneer in the development of extracting oil from deep and very deep waters and due to that Brazil is today self-sufficient in petroleum and one of the biggest producers with the discovery of the pre-salt layer. The company has partnerships with universities for the development of new technologies and new energy resources. The production of oil and the development of technologies are intertwined.

The coffee sector, however, is not as technologically intensive and investments are not geared towards R&D. Most of technological development made is regarding genetically modified plants to improve resiliency against diseases and/or natural hazards (Ministry of Agriculture). In 2014, Brazil was the biggest producer and exporter of coffee grounds in the world and the second biggest consumer. Coffee has been important to the Brazilian economy since the nineteenth century and it was due to its high profits that investments were made in infrastructure and financing of the beginning of the industrial sector.

These three commodities are examples of how the sector can take advantage in investments with the profits made with the high profits made due to exports. However, most of the investments made are usually towards the increase of production or infrastructure connected to it. The industrial sector could benefit from these profits when they are made towards industry that will aggregate value to basic goods and that are more competitive in the global market. Profits made in the oil production could be invested in

the second and third generation of the petrochemical sector, which is a very important one - it is the basis of many other sectors (Petrobras). Also, profits from iron ore (mining) could be invested in the transformation of the mineral into steel or production of aluminum.

CHAPTER 4: ECONOMETRIC ANALYSIS

This study investigates the potential relationship between the value of Brazilian exports of selected commodities, GDP, and industry. After the economic crises in 1929 the Import Substitution Industrialization (ISI) program was implemented to industrialize the Brazilian economy that at the time was largely commodities dependent. In the 2000s the demand for commodities increased and their prices went up, which promoted an increase in the exports of these products from Brazil and caused them to become more expressive in the national balance of trade. Three of the main commodities exported from Brazil are the ones used in the study: petroleum, iron ore, and coffee. During this period, Brazilian GDP increased and the country had one of the highest GDP growth rates in the world due to the commodities export boom. Meanwhile, the participation of the local industry in the Brazilian exports decreased with the increase of the primary sector. Thus, when analyzing the impact of the commodities boom in the Brazilian industry, we focus on industrial production.

Greater participation of commodities or primary goods in the Brazilian balance of trade can mean increased dependence of the country on these products and a less diversified economy. This means the country may become more sensitive to changes in the international trade of commodities, which is a very volatile one. The relation between exports of commodities and industry can be shown in how the latter has less participation in the balance of trade. However, this study wants to analyze the quantitative relation between commodities exports and industrial production.

What is important in the study is the concern about the deindustrialization that might be happening in the country. Industry is an essential sector for an economy, it brings innovation, capital, and development. Therefore, it is important to answer questions such as how this increase in commodities exportation has affected the industrial sector. Also, how can the GDP be affected by the industrial sector and/or commodities? Therefore, this thesis aims to analyze, through econometric models, the relationships between the variables: the value in US dollars of petroleum exportations in logarithms (l.val.dollar_p), the value in US dollar of iron ore exportations in logarithms (l.val.dollar_{ir}), the value in US dollar of coffee exportations in logarithms (l.val.dollar_c), GDP (gdp) and industrial production indices. Before analyzing these variables it is important to state that other factors may influence each sector, but they are not the focus of this thesis. I will consider all other factors as constant to evaluate the interrelationship between these variables.

4.1 Expected relationships

First, I expect the industrial production to be affected by the commodities exportations and by the GDP. The effects of them could be negative or positive. Negative if with the commodity boom the investments shift from the manufactured sector to the primary one, or positive if with the commodity boom the production in the manufactured sector increases to support the growth in the primary sector. Also, I expect the industry to be affected by GDP growth. If the country is not growing economically, then industrial production will decrease because the domestic demand will also decrease.

Secondly, I expect GDP to increase with an increase in the exports of commodities, because, as stated before, commodities exports play a dominant role in the Brazilian balance of trade, thus any alteration in them will affect the Brazilian growth rate. It is also expected that if industrial production changes it will also affect GDP. That would happen due to the fact that industry is a very important sector in an economy, a change in it affects other sectors, such as services.

Lastly, I do not expect a change in commodities exports if industrial production increases, because it is affected mostly by international demand and trade.

4.2 Methodology and data

This study aims to analyze the interrelationship between five variables: petroleum export values, coffee export values, iron ore export values, GDP, and industrial production. I first collected monthly export values of petroleum, coffee, and iron ore from January 2001 to November 2014 from a governmental website called AliceWeb. From the Brazilian Institute of Geography and Statistics (IBGE) I collected monthly data for industrial production and from the Serasa Experian, a firm specialized in databases, I collected monthly data for GDP. The commodities export values had to be adjusted according to the inflation using a producer pricing index and the month five of 1986 as the base year, thus the monetary values are in constant terms. Next, the new prices were converted to logarithms.

Following, I had to check the desired models. I had to first check whether these variables had unit roots or not (see tables A1, A2, A3, A4 and A5 in Appendix A), I did this test conducting an Augmented Dickey-Fuller Test on the R software. This test helps

to find if there is any series correlation in the errors and if there are any unit roots in the series under consideration. I found evidence of unit roots by at least 5% in all the variables: GDP, iron ore export values, coffee export values, petroleum export values, and industrial production.

The choice of the best model had to take into account their residual autocorrelation. I used a test to find lagged values in the determination of current values and whether or not the series have unit roots. The test for unit roots showed evidence of them in all variables, thus I had to test for cointegration between all of them using the Johansen-Procedure. Next, I used a function to transform the Vector Error-Correction (VEC) model in a Vector Autorregression (VAR) one involving these variables, pairing one variable with the industrial production one. Since all variables showed unit roots I used this model to test all of them.

Once the models were chosen, I ran the following tests using the R software, having a five percent critical value: (1) a VEC2VAR model with industrial production and petroleum export value; (2) a VEC2VAR model with industrial production and iron ore export value; (3) a VEC2VAR model with industrial production and coffee export value; and (4) a VEC2VAR model industrial production and GDP. To choose the best lag model I used AIC (Akraike Info Criterion), HQ (Hannan Quinn Info Criterion), SC (Schwartz Bayesian Criterion), and FPE (Final Prediction Error). I tested the lags as all the criteria tests showed for each model, choosing the one with the best results and the minimum number of lags.

CHAPTER 5: VEC AND VAR MODELS AND THEIR RESULTS

This chapter analyzes the results of the VEC and VAR models.

5.1 Vector Error-Correction Model (VEC) and Vector Autoregression Model (VAR)

As mentioned before, because of the evidence of unit root in the time series for the variables studied here, I had to test for cointegration between the variables in the chosen models using the Johansen-Procedure (see tables C1, C2, C3, and C4 in Appendix C). This test showed that in all models I do not reject the hypothesis of having a maximum of one relation of cointegration ($r \leq 1$). The model GDP and industry showed no evidence of cointegration at 5% and the model coffee and industry showed no cointegration at 1%. However, they showed at 10% evidence of cointegration for $r \leq 1$, thus I chose to test these models as being cointegrated. After I estimated models that took into consideration the cointegration between the variables I tested them using the Portmanteau adjusted test (PT) and Breusch-Godfrey LM test (BG) (see tables D1, D2, D3, D4, D5, D6, D7 and D8 in Appendix D). They tested if the estimated models exhibit no autocorrelation between the residues, which is a necessary property for a valid VEC or VAR model.

After testing the model using the variables petroleum and industry I do not reject the hypothesis of no correlation at 7% ($p\text{-value} = 0.0716$) in the PT adjusted test. Ideally a good $p\text{-value}$ would be above 0.1. I consider this model valid because in the BG test I do not reject the hypothesis at 70% ($p\text{-value} = 0.7032$).

In the model using the variables iron ore and industry I do not reject the hypothesis of no correlation at 50% ($p\text{-value} = 0.5151$) in the PT adjusted test. And for

the BG test I do not reject the hypothesis at 40% (p-value = 0.4452). Again, this model seems to satisfy the basic properties of a VAR or VEC model.

For the coffee and industry model I also do not reject the hypothesis of no correlation. In the PT adjusted test at 10% (p-value = 0.1364) and in the BG test I do not reject the hypothesis at 30% (p-value = 0.3502). These results make this model to fit into the statistical conditions for a VAR or VEC model.

The model with the variables GDP and industry I did not reject the hypothesis of no correlation even though in the PT adjusted test the p-value was below 1% (p-value = 0.003825). I did not reject the no-autocorrelation hypothesis, because in the BG test the p-value was high enough at 70% (p-value = 0.7007). Thus, all the models seem to have been according to the statistical property of no autocorrelation between the residues, which fit them to a VAR or VEC model.

As I mentioned before I used the R software and transformed the VEC models into VAR ones, I used the results of these models to analyze the relationship between the variables. They look at whether two variables are positively or negatively related and whether there is a significant relationship between them in the data set at 0.05 significance level. As the p-value is much less than 0.05 I reject the null hypothesis and argue that they have a significant relationship. A variable that has a low p-value is likely to be a meaningful addition to the model as a change in the predictor's (X) value are related to changes in the response variable (Y). Also, for statistical significance I expect the absolute value of the t-value to be greater than two, which means it is statistically

significant. That is, I can be confident that the true relationship between X and Y is positive if the t-statistic is greater than two or negative if it is below negative two.

In the model including industrial production and GDP (see Table E2 in Appendix E), it is reasonable to say that there is a significant relationship between the variables. Their p-values are much lower than 0.05, with the GDP coefficient exhibiting a lower figure ($p\text{-value} = 2.2e-16$). That could mean that the GDP is more influenced by industry than the opposite. One reason for that could be that industry is very important for the economic growth of Brazil. Since industry has a big contribution to the GDP, any changes in it will affect growth. And the industry has the domestic market and the international market to rely on, so if there is a change in the GDP it can adjust its exportations. The t value is greater than two in different times, showing a positive relation between the variables, however they influence each other in different levels and times. The p-value of the coefficients ($\Pr(>|t|)$) and the significance codes (asterisks) show the same.

Surprisingly, the results of the model using the variables petroleum price exports and industrial production (see Table E1 in Appendix E) showed that even though there is a significant relationship between them ($p\text{-value}$ below 0.05), industry is not influenced as much by petroleum as the opposite. The industry is influenced once by one past value of petroleum exports and once by its own past value. Petroleum, on the other hand, is influenced by two past values of industrial production and one of its own past values. The reason for petroleum being more dependent on the industry could be that the extraction of oil relies a lot on the national industry and the development of technological development

for extracting oil in deep waters, which is developed by Petrobras. And even though the industry of petroleum is very important in Brazil, there are other important sectors, such as aircraft, automobiles, textile, food, etc and the industrial sector imports a lot of the needed inputs. The t value is greater than two in different times and I can state that there is a significant relationship between the variables, but they happen in different periods of time. I can state the same by looking at the p -value of the coefficients ($\Pr(>|t|)$) and the significance codes (asterisks).

5.2 Impulse response function

To explore the relationship between the commodities export values and GDP with the Brazilian industrial production I plotted “impulse-response functions”. The idea behind this graph is: if there is a sudden shock (an increase) in one of the variables, what would happen to the industry? In other words, how would industrial production respond to the sudden increase of the others variables. In the graphs, the dot lines are confidence intervals at 95%, which I compared to the red horizontal line (equal to zero). If the red line is between the dot lines it means that I cannot be confident enough (at 95% of the times) that the response of industrial production is not going to be null.

The response of industry to a sudden increase in the price of petroleum exports would be a positive one starting in the month four, where the horizontal line is not between the dotted lines. This means that I have a 95% level of confidence that the industry will also increase production due to a shock in the petroleum export value. Before month four, I cannot say with 95% of certain that the shock will not have a null effect in industrial production (see Figure 2).

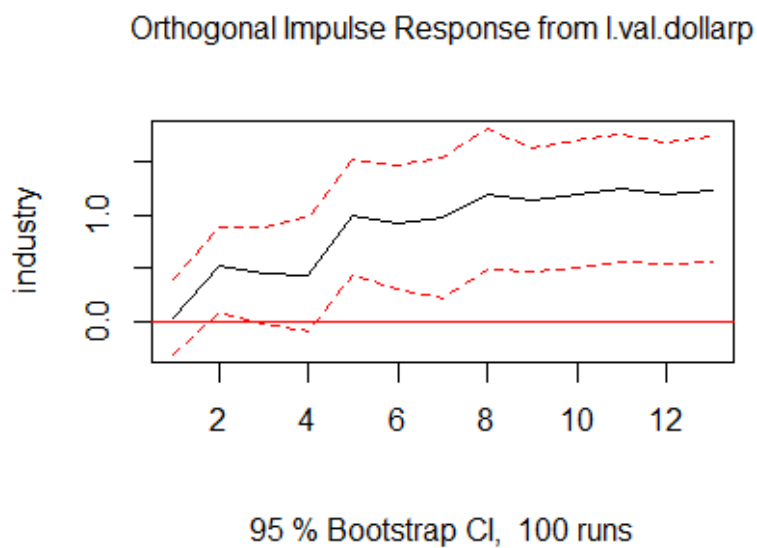


Figure 2: Impulse Response from l.val.dollarp and Industry

It seems that a sudden increase in the iron ore export values will cause an increase in industrial production starting in month four. From month four and on I can be 95% confident that the shock will have an impact in industrial production, which in this case was a positive one as well (see Figure 3).

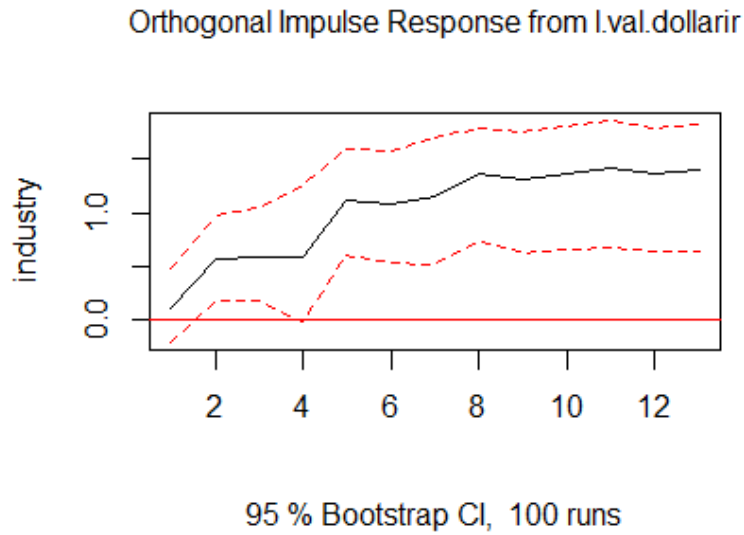


Figure 3: Impulse Response from l.val.dollarir and Industry

Testing the model using the variables coffee export values and industrial production for an impulse-response I can expect with 95% of confidence that a sudden increase in the price of coffee export price would have a positive effect at first in the industrial production. Between months two and six I cannot affirm that it will have any effect on industrial production, because the interval between the dotted lines includes the red line. However, after month six it seems industrial production will have an increase and it will continue to increase for the following six months (see Figure 4).

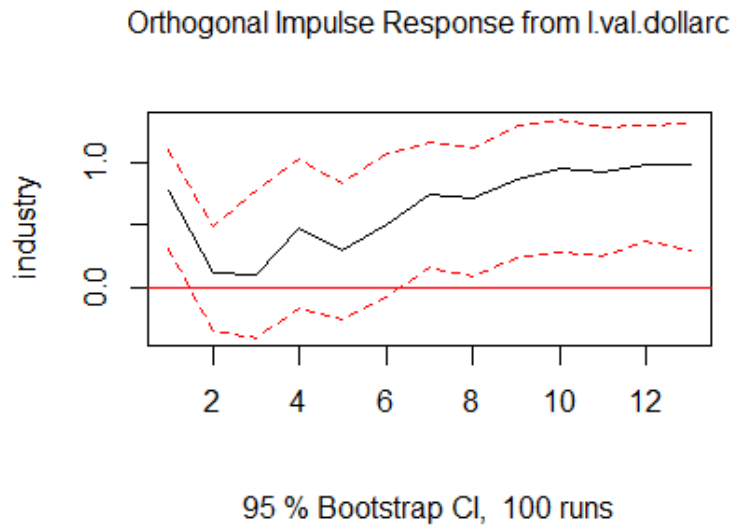


Figure 4: Impulse Response from l.val.dollarc and Industry

And the last model tested using the variables GDP and industrial production shows that the response of a sudden increase in the GDP would lead to increases that become smaller after the initial one. Between months two and four there would be a significant increase in production, however there would be a sharp decrease in the magnitude of the increases. From months eight and beyond I cannot affirm with 95% of certainty that GDP will have an impact in the industry (see Figure 5).

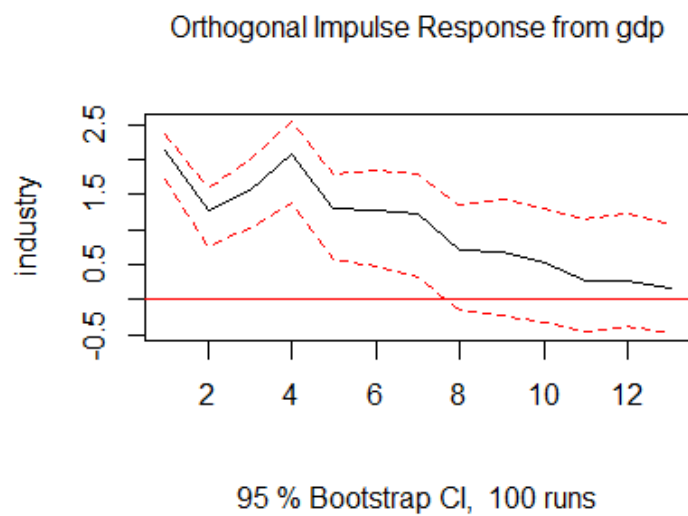


Figure 5: Impulse Response from GDP and Industry

CONCLUSION

The commodity boom had a great impact on the Brazilian economy and the primary sector has since then increased its share in the Brazilian exports. Due to natural conditions and investments made in the past ten years, today the country has a high comparative advantage in the production of agricultural and mineral goods. The primary sector has expanded its importance to the national economy, which generated concerns with respect to the fact that industrial production has lost relative importance. The commodity boom has generated not only the increase of commodity production but it has also increased the Brazilian economic growth. However, the economic growth connected to the commodity boom was not a sustainable one, since that is a sector that is highly influenced by exogenous causes, such as domestic policies in another country that impacts the international market (China, for example). And the industrial sector might be impacted by the commodity boom, since commodities become more important to the economy.

Even though industrial production and commodity exports are related, little is known about the extent and duration of this relationship. The comparison made between commodity export and industrial production suggests the possibility that an increase in one results in a decrease of the other. An analysis that only compares numbers, moreover, does not give the exact relation between them. This thesis sought to analyze the role played by the commodity sector in the industrial sector. I also analyzed the relationship between economic growth and the industrial sector. This was done using econometric analysis of the interrelationship between five variables: petroleum export value, iron ore export value, coffee export value, GDP, and industrial production. At first, I gave a

historical perspective of each variable and how they are doing today in the Brazilian economy. After a theoretical analysis, I collected monthly data from a governmental website called AliceWeb for the commodity export values. From the Brazilian Institute of Geography and Statistics (IBGE) I collected monthly data for industrial production and from the Serasa Experian, a firm specialized in databases, I collected monthly data for GDP. The range of the monthly data collected for all the variables was from 2001 to 2014 and I ran econometric models to estimate the relationship between the variables of interest.

The three analyzed commodity sectors (petroleum, iron ore, and coffee) showed that Brazil has improved its production of all these products in the last decade. In 2006 self-sufficiency in petroleum was announced, meaning that the exports of oil outnumbered the imports and with the discovery of the pre-salt layer Brazil has the potential of being one of the biggest oil producers in the world. Also, Brazil is the fifth country in investments made in the mining sector, having the second largest production in the world and the best iron concentration. Those two products accounted for almost one quarter of the Brazilian exports in 2014, showing how concentrated the balance of trade has been on primary goods. The coffee sector is also very important in Brazil, it does not only have economic value but historical and political as well. Last year, Brazil was the biggest coffee producer and the second biggest coffee consumer in the world. Coffee accounted for almost 3% of total exports in the same year.

According to the literature, it is expected that the industrial production in the economy decreases if there is an increase in the commodities export and production. This

might be the case if resources and investments are made in the more profitable sectors and with more chances of success, such as the commodities sector. Thus, we can expect investors to allocate more resources to the commodities production sector and less to the industrial sector as the demand for commodities in the world market increases causing their higher prices to rise. Also, it is expected that the increase in the GDP growth would have an impact on the industrial production. GDP growth tends to lead to growing purchasing power of the population and demand for consumer goods. Thus an increase in economic growth means an increase in industrial production and more investments in the sector. However, if most of the growth is happening in the primary sector and investments are returned to that sector, the importation of industrial goods would increase since the domestic industry cannot supply the internal demand. This could cause a decrease in industrial production. The commodity sector might not be as influenced by industrial production since it is more influenced by the international market.

I ran VAR and VEC models after performing necessary statistical tests to guarantee its applicability. Some of the results obtained for a five percent critical value were different from what the literature described and some were similar. I estimated that the four variables are interrelated, however some of the expectations were not confirmed. First, petroleum, iron ore, and coffee export values have a positive effect in the industrial production: the increase in commodity export increases industrial production. That is not surprising, most economic sectors in the Brazilian economy grew during the commodities boom.

Also, GDP at first has a positive effect in the industrial production, however its positive impacts decreases overtime. That might be the case because this short-term growth might have not translated in long-term growth as investments in other sectors may not have happened. That is a speculation, since I do not have enough data to prove that. Since the commodity boom in 2003, Brazil experienced high economic growth rates, which could lead to the conclusion that one caused the other. Thus, an increase in the GDP means an increase in commodity exports and in industrial production.

Ultimately, I argue that the commodity boom in Brazil had a positive immediate impact on the country's industrial production. However, it seems that this boom did not translate into long term investment in other sectors of the economy. It means that perhaps growth in industrial production might have occurred due to expansion of production but without expansion in production capacity. Perhaps the profits from the commodity boom did not translate into investment into the industrial sector, like in the case of coffee in the past. This might explain why the commodity boom was followed by the slowing down of the Brazilian economy after the boom was over.

This thesis aimed to analyze the interrelationship between the primary and industrial sectors in Brazil during the commodity boom in the 2000s. The results of the tests proved that there were unexpected results, such as positive effect of commodity exports on the industrial production. I suggest that further researches taking into consideration different industrial sectors when developing this analysis. I used the data of general industrial production, which is formed by manufactured and semi manufactured goods, as well as products with low, medium and, high technology. Framing my analysis

in this manner might have limited my results, because an increase in the industrial production does not mean the improvement and development of the whole sector.

EPILOGUE

According to the International Monetary Fund (IMF), during the Commodities boom in the 2000s the economic growth of the countries in Latin America increased. Comparing the extra income that was originated due to the improvement in trade during this latest boom and the one that occurred in the 1970s it is possible to say that the recent boom brought more capital to Latin America, a factor perhaps of the greater liberalization of the economy and the longer duration of the boom (Adler and Magud, 2013). National income increased in 15% per year in the region compared to a scenario without the boom. Income increased was particularly noteworthy in Bolivia (20%), Venezuela (30%) and Chile (20%). Brazil, however, experienced a much lower increase. Also, it seems that this income has been invested more in internal physical capital than in external savings. The economic growth of the region during the Commodities boom, between 2002 and 2010, was 4.1%; Brazil grew 4% while Colombia grew 4.6% and Argentina 7.6%.

The Commodities boom affected the industry in all countries, according to the Community of Latin America and Caribbean States. China's economic growth increased demand for basics goods and the countries of Latin America became an important supplier to the Chinese market. Peru and Chile supply copper and Brazil and Argentina supply soy, for example. The main products exported to China are primary goods, however the main products imported from China by Latin American countries are manufactured goods of low, medium and high technology. Not only that, but imports have increased more than exports, meaning a negative payment balance for these

countries, an increase in its debts, and less capital to make investments in their economies.

Comparing the Brazilian case to other cases in Latin America it is possible to say that the Commodities boom in the 2000s had a positive effect in its economy, however it might not be a sustainable one. As before in the region's history, as the boom gives signs of slowing down so does the regional economy. According to the World Bank, in 2013 Latin America and the Caribbean grew 2.5%, but in 2014 the regional economy only grew 0.8%, mainly because of the slowing down of the Chinese economy.

As argued in this thesis, the Brazilian economy has historically followed a pattern of economic growth due to an increase in commodities exports followed by weak economic growth when such exports decrease. Since 2010, 2011 the GDP has decreased fast, while between 2004 and 2009 it had showed high economic growth rates. However during these period of time, the rates were increasing but the industrial production did not follow it, having negative growth rates in 2012 (IBGE). Since the industrial production has not increased it is possible to affirm that the Brazilian economic growth relied greatly in the increase of the commodities prices in the international market and when they decreased the economy did not continue to grow. During the boom the investments made by the government were only of 20%, which did not prepare the country for the expansion of its capacity of production (Mueller, 2013). As mentioned before, the growth was based on the export of commodities and internally the government adopted artificial policies to increase the consumption, with easy credit and lower interest.

For a more sustainable growth the economy needs more investments to expand its production capacity, this means it needs capital and more savings, which is a problem in Brazil where there is a culture of low savings rates. Also, without investments the industrial productivity cannot improve, which is a very important key for economic development and innovation. To have a sustainable growth the government should adopt a long-term plan for industrial and economic development, with less bureaucracy, a reform in taxes, investments in infrastructure, and a major improvement in the education system.

Not only does low investments in the industrial sector affects the economic growth but so does the corruption factor. After the Petrobras scandal the role that corruption has in the economy became more exposed. According to Al-Sadig (2009), corruption has a negative impact in the flux of foreign direct investment (FDI) in a country. However, strong institutions and law enforcement changes the scenario and flux becomes positive. Corruption affects the cost of conducting business in a country and threatens profits. Thus, taking into account the corruption factor and the Petrobras scandal it is possible to say that if there is no prosecution of the people that were charged with corruption, the trust of investors will decrease and so will the investments made not only in the company but also in others sectors of the Brazilian economy. It is important that this case serve as an example to show the political stability and strong institutions capable of dealing with corruption in Brazil. The corruption factor should also be taken into account in future research about the Brazilian economy and its growth. It is

important because it can show if investments have not increased due to the perception of a rising of corruption in the country or it could show the opposite.

REFERENCES

- Adler, G.; and Magud, N. (2013, May 14). *Poupar a renda extraordinária sem precedentes da América Latina*. International Monetary Fund. Retrieved April 6, 2015, from <http://www.imf.org/external/lang/portuguese/np/vc/2013/051413p.pdf>
- Alexandre Athayde Hage, J. (2013). *A Teoria da Dependência: Uma Contribuição aos Estudos de Relações Internacionais*. *Revista Política Hoje*, 22(1), 106-136. Retrieved March 10, 2015, from <http://www.revista.ufpe.br/politica/hoje/index.php/politica/article/download/218/137>
- Alice Web Database. Ministry of Development, Industry and Foreign Trade. Retrieved September 1, 2014, from <http://aliceweb.mdic.gov.br/>
- Alves Cardoso, F. (2013). *Crescimento econômico e restrição externa da economia brasileira: Uma análise do padrão das exportações em relação ao BRIC e do Sistema de Inovação do Brasil (1980-2012)* (Masters Dissertation). Retrieved from Universidade Federal do Rio Grande do Norte database. Accessed on March 1, 2015, from <http://repositorio.ufrn.br:8080/jspui/handle/123456789/14097>
- Araújo, F. *Ciclo do Café - História do Brasil*. Retrieved February 18, 2015, from <http://www.infoescola.com/historia/ciclo-do-cafe/>
- Baffes, J.; and Haniotis, T. (2010). Placing the 2006/2008 Commodity Price Boom into Perspective. The World Bank Prospects Group. Access on October 14th, 2013, from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1646794

Balança Comercial Brasileira: dados consolidados. Ministerio do Desenvolvimento

Database. Access on October 14th, 2013, from

<http://www.mdic.gov.br/sitio/interna/interna.php?area=5&menu=571>

Banco Central do Brasil Database. Access September 9th, 2014, from

<http://www.bcb.gov.br/?INDECO>

Bevan, A.; and Wengrow, D. (2010). *Cultures of commodities branding*. Publications of the Institute of Archaeology, University College London. Eletronic resource.

Cavalcante, N. (2009). *40 anos do IEL na trajetoria da industria brasileira* (1st ed., Vol. 1, p. 177). Brasilia, DF: Confederação Nacional da Industria.

Eustaquio Diniz Alves, J. (2015). *A China e a reprimarização da América Latina: Novo imperialismo?* Ecodebate - Cidadania E Meio Ambiente. Retrieved April 6, 2015, from <http://www.ecodebate.com.br/2015/02/25/a-china-e-a-reprimarizacao-da-america-latina-novo-imperialismo-artigo-de-jose-eustaquio-diniz-alves/>

Ferreira, M. (2013, September 24). *As perspectivas de mineração no Brasil*. Retrieved March 5, 2015, from http://www.vale.com/PT/investors/Presentation-webcasts/Presentations/PresentationDocs/130924As_perspectivas_da_mineracao_no_Brasil_PRMF.pdf

Instituto Brasileiro de Geografia e Estatistica Database. Access September 10th, 2014, from www.seriesestatisticas.ibge.gov.br

Instituto Brasileiro de Mineração (2012). Informações e análises da economia mineral brasileira (7th ed.). Brasília, DF. Retrieved February 20, 2015, from <http://www.ibram.org.br/sites/1300/1382/00004035.pdf>

International Monetary Fund Database. IMF Webpage. Access on December 15, 2014,
from <http://www.imf.org/external/data.htm>

José de Souza Pires, M.; and Rosa dos Santos, G. (2013). *Modelo agroexportador, política macroeconômica e a supremacia do mercado: Uma visão do modelo brasileiro de exportação de commodities* (1st ed., Vol. 1, p. 38). Brasília, Distrito Federal: IPEA. . Accessed on March 1, 2015, from
http://repositorio.ipea.gov.br/bitstream/11058/970/1/TD_1817.pdf

Kniivilä, M. (2007). Industrial development and economic growth: Implications for poverty reduction and income inequality. *Industrial Development for the 21st century: sustainable development perspectives*. United Nations. 404.

Messenberg, R.; Hamilton Matos dos Santos, C.; Augusto Mansor de Mattos, F.; Jose da Silva Paiva Ribeiro, F.; Eduardo de Luna e Almeida Santos, F.; De Medeiros Braga, J.; ... and Carvalho Silva, R. (2012, March). *Desindustrialização no Brasil: Apontamentos para um Debate em Favor do Desenvolvimento Econômico. Conjuntura Em Foco - IPEA, 1-10*. Accessed on March 2, 2015, from
http://www.ipea.gov.br/agencia/images/stories/PDFs/conjuntura_em_foco/120315_conjunturaemfoco_marco.pdf

Ministry of Development, Industry and Foreign Trade & Secretariat of Foreign Trade. (2014). *Balança comercial brasileira –2013*. Brasília, DF. Retrieved December 1, 2014, from http://www.mdic.gov.br/arquivos/dwnl_1388692200.pdf

Monteiro Martins, R.; and Polline Veríssimo, M. (2013, July). *Exportações brasileiras de petróleo e a especialização da economia em bens intensivos em recursos naturais*

no período 2000-2012. Perspectiva Econômica, 115-130 Accessed on March 1, 2015, from
http://www.revistas.unisinos.br/index.php/perspectiva_economica/article/view/pe.2013.92.04/4054

PERI (“Political Economy Research Institute”). (2009). China and Latin America Commodities Boom: A critical assessment. University of Massachusetts Amherst site. Access on October 14th, 2013, from
http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1161&context=peri_workingpapers&sei-

Petrobras Webpage. Access on February 20, 2015, from www.petrobras.com.br

Polline Veríssimo, M.; Lourenço Xavier, C.; and Vilela Vieira, F. (2012, January). *Taxa de Câmbio e Preços de Commodities: Uma Investigação sobre a Hipótese da Doença Holandesa no Brasil*. *Revista Economia*, 93-130. Retrieved February 20, 2015, from https://anpec.org.br/revista/vol13/vol13n1p93_130.pdf

Polline Veríssimo, M. 2010. “*Doença holandesa no Brasil: ensaios sobre taxas de câmbio, perfil exportador, desindustrialização e crescimento econômico*”. “Dutch disease in Brazil: essays about exchange rate, export profile, deindustrialization and economic growth”. Universidade Federal de Uberlândia.

Portal da Indústria: Tudo sobre CNI, SESI, SENAI, IEL. (n.d.). Retrieved March 11, 2015, from <http://www.portaldaindustria.com.br/>

- Prates, D. (2007). *A alta recente dos preços das commodities. Revista de economia politica* , vol. 27, n 03 (107) pages 323 – 344. Retrieved October 14th, 2013.
<http://www.scielo.br/pdf/rep/v27n3/v27n3a01.pdf>
- Roque, L. 2012. “*Uma breve história do Plano Real, aos seus 18 anos*”. “A brief story of the Real Plan at its 18 years anniversary”. Instituto Ludwig Von Mises Brasil Webpage. Retrieved March 10, 2015, from
<http://www.mises.org.br/Article.aspx?id=1294>
- Santos, F. *O início da industrialização brasileira. Industrialização no Brasil - Brasil Escola*. Retrieved February 19, 2015, from
<http://www.brasilecola.com/historiab/industrializacao-brasileira.htm>
- Santos, T. (2008, January 1). *Raízes do café no Brasil*. Retrieved February 18, 2015, from
<http://www.brasilecola.com/historia/o-cafe-no-brasil-suas-origens.htm>
- Serasa Experian Database. Retrieved December 15, 2014, from
http://www.serasaexperian.com.br/release/indicadores/atividade_economica.htm
- Siderurgia no Brasil. Retrieved March 1, 2015, from
<http://www.acobrasil.org.br/site/portugues/aco/siderurgia-no-brasil--desenvolvimento.asp>
- Soriano, T. (2009, December 20). *Ciclo do Ouro - Brasil Colônia*. Retrieved March 1, 2015, from <http://www.historiabrasileira.com/brasil-colonia/ciclo-do-ouro/>
- The World Bank Database. World Bank Webpage. Retrieved November 10, 2014, from
<http://data.worldbank.org/>

Topik, S. (1985). *State and economy: Brazil under the empire and the republic*. Austin:

Office for Public Sector Studies, Institute of Latin American Studies, University
of Texas at Austin.

Vale Webpage. Retrieved February 20, 2015, from www.vale.com.br

Werner, B. (2001). *The Brazilian Economy: Growth and Development*. Greenwood

Publishing Group: Library of Congress. Ebook.

Wooldridge, J. (2003). *Introductory Econometrics – a modern approach*. Thomson,

South-Western. 2nd edition.

APPENDIX A: TEST FOR UNIT ROOTS

Table A1

Augmented Dickey-Fuller Test for Petroleum Export Values

Test regression trend

#####

Augmented Dickey-Fuller Test Unit Root Test

#####

Call:

lm (formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:

Min	1Q	Median	3Q	Max
-1.08186	-0.09523	0.02981	0.13820	0.74920

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	3.9088702	0.6927139	5.643	7.43e-08 ***
z.lag.1	-0.4972774	0.0884352	-5.623	8.17e-08 ***
tt	0.0036999	0.0007908	4.679	6.11e-06 ***
z.diff.lag	-0.2356194	0.0771753	-3.053	0.00265 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2448 on 160 degrees of freedom

Multiple R-squared: 0.3618, Adjusted R-squared: 0.3498

F-statistic: 30.24 on 3 and 160 DF, p-value: 1.534e-15

Value of test-statistic is: -5.6231 10.6531 15.856**Critical values for test statistics:**

1pct 5pct 10pct


```
tau3  -3.99 -3.43 -3.13
phi2   6.22  4.75  4.07
phi3   8.43  6.49  5.47
```

Table A2

Augmented Dickey-Fuller Test for Iron Ore Export Values

Test regression trend

```
#####
```

```
# Augmented Dickey-Fuller Test Unit Root Test #
```

```
#####
```

Call:

```
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-0.54099 -0.09654   0.00537  0.10691  0.54060
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	3.1094750	0.6371819	4.880	2.54e-06 ***
z.lag.1	-0.3783746	0.0777952	-4.864	2.73e-06 ***
tt	0.0021219	0.0005268	4.028	8.67e-05 ***
z.diff.lag	-0.2375965	0.0771710	-3.079	0.00245 **

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.1628 on 160 degrees of freedom

Multiple R-squared: 0.2893, Adjusted R-squared: 0.2759

F-statistic: 21.71 on 3 and 160 DF, p-value: 7.582e-12

Value of test-statistic is: -4.8637 7.992 11.8752

Critical values for test statistics:

	1pct	5pct	10pct
tau3	-3.99	-3.43	-3.13
phi2	6.22	4.75	4.07
phi3	8.43	6.49	5.47

Table A3

Augmented Dickey-Fuller Test for Coffee Export Values

Test regression trend

#####

Augmented Dickey-Fuller Test Unit Root Test

#####

Call:

lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:

Min	1Q	Median	3Q	Max
-0.159208	-0.041847	-0.000528	0.041090	0.243287

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	1.3955747	0.3785907	3.686	0.000311 ***
z.lag.1	-0.1768656	0.0481637	-3.672	0.000327 ***
tt	0.0006609	0.0002126	3.108	0.002227 **
z.diff.lag	-0.0556365	0.0790209	-0.704	0.482411

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06499 on 160 degrees of freedom

Multiple R-squared: 0.09669, Adjusted R-squared: 0.07976

F-statistic: 5.709 on 3 and 160 DF, p-value: 0.0009744

Value of test-statistic is: -3.6722 4.7881 6.7502

Critical values for test statistics:

	1pct	5pct	10pct
tau3	-3.99	-3.43	-3.13
phi2	6.22	4.75	4.07
phi3	8.43	6.49	5.47

Table A4

Augmented Dickey-Fuller Test for GDP

Test regression trend

#####

Augmented Dickey-Fuller Test Unit Root Test

#####

Call:

lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:

Min	1Q	Median	3Q	Max
-6.425	-1.901	-0.250	1.775	9.059

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	36.25968	5.94356	6.101	7.66e-09 ***
z.lag.1	-0.33726	0.05576	-6.049	9.96e-09 ***
tt	0.13809	0.02340	5.902	2.08e-08 ***
z.diff.lag	0.26767	0.07651	3.499	0.000606 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.822 on 160 degrees of freedom

Multiple R-squared: 0.1938, Adjusted R-squared: 0.1786

F-statistic: 12.82 on 3 and 160 DF, p-value: 1.505e-07

Value of test-statistic is: -6.0487 13.0813 18.302

Critical values for test statistics:

	1pct	5pct	10pct
tau3	-3.99	-3.43	-3.13
phi2	6.22	4.75	4.07
phi3	8.43	6.49	5.47

Table A5

Augmented Dickey-Fuller Test for Industrial Production

Test regression trend

#####

Augmented Dickey-Fuller Test Unit Root Test

#####

Call:

lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:

Min	1Q	Median	3Q	Max
-14.7331	-4.6215	0.1096	4.8307	12.6499

Coefficients:

Estimate	Std. Error	t value	Pr(> t)
----------	------------	---------	----------

(Intercept)	35.43273	6.20173	5.713	5.27e-08 ***
z.lag.1	-0.33837	0.05927	-5.709	5.38e-08 ***
tt	0.09147	0.01872	4.885	2.49e-06 ***
z.diff.lag	0.16264	0.07792	2.087	0.0385 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.727 on 160 degrees of freedom

Multiple R-squared: 0.1693, Adjusted R-squared: 0.1537

F-statistic: 10.87 on 3 and 160 DF, p-value: 1.545e-06

Value of test-statistic is: -5.709 11.0582 16.2999

Critical values for test statistics:

	1pct	5pct	10pct
tau3	-3.99	-3.43	-3.13
phi2	6.22	4.75	4.07
phi3	8.43	6.49	5.47

APPENDIX B: TEST FOR LAGS

Table B1

Test for Industrial Production and GDP Model

\$selection

AIC(n) HQ(n) SC(n) FPE(n)

4 4 1 4

\$criteria

	1	2	3	4	5	6	7	8
AIC(n)	1.596584	1.568910	1.501558	1.388956	1.406184	1.398207	1.443097	1.489682
HQ(n)	1.836896	1.841264	1.805954	1.725393	1.774662	1.798727	1.875659	1.954286
SC(n)	2.188198	2.239406	2.250936	2.217216	2.313325	2.384230	2.508002	2.633470
FPE(n)	4.942263	4.810097	4.500035	4.024398	4.098766	4.071464	4.264898	4.476226
	9	10	11	12				
AIC(n)	1.523555	1.551259	1.543087	1.462865				
HQ(n)	2.020200	2.079946	2.103815	2.055635				
SC(n)	2.746224	2.852810	2.923520	2.922180				
FPE(n)	4.639946	4.781489	4.755221	4.401851				

Table B2

Test for Industrial Production and Petroleum Export Values Model

\$selection

AIC(n) HQ(n) SC(n) FPE(n)

4 4 1 4

\$criteria

1 2 3 4 5 6

AIC(n)	-0.7289192	-0.74956865	-0.78904750	-0.90332172	-0.85813461	-0.8815219
HQ(n)	-0.4886071	-0.47721485	-0.48465207	-0.56688467	-0.48965594	-0.4810016
SC(n)	-0.1373051	-0.07907262	-0.03966958	-0.07506192	0.04900708	0.1045017
FPE(n)	0.4830283	0.47342497	0.45542676	0.40660927	0.42586521	0.4165596
	7	8	9	10	11	12
AIC(n)	-0.8370219	-0.8784193	-0.8504302	-0.8347542	-0.8037842	-0.8160389
HQ(n)	-0.4044599	-0.4138158	-0.3537850	-0.3060674	-0.2430558	-0.2232689
SC(n)	0.2278836	0.2653680	0.3722391	0.4667970	0.5766488	0.6432759
FPE(n)	0.4361798	0.4192360	0.4320206	0.4398767	0.4549226	0.4507335

Table B3

Test for Industrial Production and Iron Ore Export Values Model

\$selection

AIC(n)	HQ(n)	SC(n)	FPE(n)
4	4	1	4

\$criteria

	1	2	3	4	5	6	7
AIC(n)	-1.4578555	-1.4982807	-1.4986444	-1.6039169	-1.5602280	-1.5851415	-1.5517478
HQ(n)	-1.2175433	-1.2259269	-1.1942490	-1.2674799	-1.1917494	-1.1846212	-1.1191859
SC(n)	-0.8662414	-0.8277847	-0.7492665	-0.7756571	-0.6530864	-0.5991179	-0.4868424
FPE(n)	0.2330234	0.2239183	0.2239982	0.2017960	0.2110362	0.2061100	0.2134342
	8	9	10	11	12		
AIC(n)	-1.5458146	-1.5160432	-1.5041641	-1.4757385	-1.44893862		
HQ(n)	-1.0812111	-1.0193981	-0.9754773	-0.9150101	-0.85616858		
SC(n)	-0.4020273	-0.2933740	-0.2026130	-0.0953055	0.01037627		
FPE(n)	0.2150862	0.2220406	0.2252215	0.2323333	0.23936191		

Table B4

Test for Industrial Production and Coffee Export Values Model

\$selection

AIC(n)	HQ(n)	SC(n)	FPE(n)
4	4	2	4

\$criteria

	1	2	3	4	5	6
AIC(n)	-3.57275279	-3.68874657	-3.73798139	-3.83063533	-3.7946838	-3.76588462
HQ(n)	-3.33244061	-3.41639277	-3.43358597	-3.49419829	-3.4262051	-3.36536433
SC(n)	-2.98113865	-3.01825054	-2.98860348	-3.00237553	-2.8875421	-2.77986105
FPE(n)	0.02811327	0.02504854	0.02386233	0.02177014	0.0225915	0.02328168
	7	8	9	10	11	12
AIC(n)	-3.75468335	-3.73274623	-3.73672402	-3.72046706	-3.69805642	-3.66654246
HQ(n)	-3.32212143	-3.26814268	-3.24007886	-3.19178027	-3.13732801	-3.07377243
SC(n)	-2.68977790	-2.58895888	-2.51405479	-2.41891595	-2.31762342	-2.20722758
FPE(n)	0.02357986	0.02414572	0.02409922	0.02455171	0.02517509	0.02605925

APPENDIX C: TEST FOR COINTEGRATION

Table C1

Johansen-Procedure for Petroleum Export Values and Industrial Production Model

#####

Johansen-Procedure

#####

Test type: trace statistic , with linear trend in cointegration

Eigenvalues (lambda):

[1] 1.355249e-01 6.124686e-02 1.110223e-16

Values of teststatistic and critical values of test:

	test	10pct	5pct	1pct
r <= 1	10.24	10.49	12.25	16.26
r = 0	33.83	22.76	25.32	30.45

Eigenvectors, normalised to first column:

(These are the cointegration relations)

	l.val.dollarp.l4	industry.l4	trend.l4
l.val.dollarp.l4	1.000000000	1.000000000	1.00000000000
industry.l4	-0.051916826	0.029444469	-0.0005757891
trend.l4	0.006950494	-0.01436531	-0.0222696856

Weights W:

(This is the loading matrix)

	l.val.dollarp.l4	industry.l4	trend.l4
l.val.dollarp.d	-0.2606851	-0.1412993	-3.854217e-15
industry.d	3.7175451	-1.5490246	1.748358e-13

Table C2

Johansen-Procedure for GDP and Industrial Production Model

#####

Johansen-Procedure

#####

Test type: trace statistic , with linear trend in cointegration

Eigenvalues (lambda):

[1] 1.183360e-01 1.824713e-02 -1.032703e-17

Values of teststatistic and critical values of test:

	test	10pct	5pct	1pct
r <= 1	2.98	10.49	12.25	16.26
r = 0	23.39	22.76	25.32	30.45

Eigenvectors, normalised to first column:

(These are the cointegration relations)

gdp.l4 industry.l4 trend.l4


```

gdp.l4      1.000000  1.0000000  1.0000000
industry.l4 -3.852082 -0.4790972 -0.3765929
trend.l4     0.629676 -0.2779322 -0.6228527

```

Weights W:

(This is the loading matrix)

```

                gdp.l4    industry.l4    trend.l4
gdp.d      0.01897253  -0.07589913  -1.395054e-15
industry.d 0.06325149  -0.07840781  -7.620577e-15

```

Table C3

Johansen-Procedure for Iron Ore Export Prices and Industrial Production Model

```
#####
```

```
# Johansen-Procedure #
```

```
#####
```

Test type: trace statistic , with linear trend in cointegration

Eigenvalues (lambda):

```
[1] 0.12777635 0.06045787 0.00000000
```

Values of teststatistic and critical values of test:

```

                test  10pct  5pct   1pct
r <= 1 |  10.10  10.49  12.25  16.26
r = 0  |   32.25  22.76  25.32  30.45

```


Eigenvectors, normalised to first column:

(These are the cointegration relations)

	l.val.dollarir.l4	industry.l4	trend.l4
l.val.dollarir.l4	1.000000000	1.000000000	1.000000000
industry.l4	-0.044554076	0.011755758	0.001473399
trend.l4	0.006378859	-0.008570503	-0.029928343

Weights W:

(This is the loading matrix)

	l.val.dollarir.l4	industry.l4	trend.l4
l.val.dollarir.d	-0.1907717	-0.1668555	4.622501e-15
industry.d	5.3099951	-1.9944161	-1.931385e-13

Table C4

Johansen-Procedure for Coffee Export Prices and Industrial Production Model

#####

Johansen-Procedure

#####

Test type: trace statistic , with linear trend in cointegration

Eigenvalues (lambda):

[1] 1.325931e-01 2.876568e-02 5.637851e-18

Values of teststatistic and critical values of test:

	test	10pct	5pct	1pct
$r \leq 1$	4.73	10.49	12.25	16.26
$r = 0$	27.77	22.76	25.32	30.45

Eigenvectors, normalised to first column:

(These are the cointegration relations)

	l.val.dollarc.l4	industry.l4	trend.l4
l.val.dollarc.l4	1.000000000	1.000000000	1.000000000
industry.l4	-0.030221379	0.009348391	0.02616565
trend.l4	0.004340711	-0.006030064	-0.03569044

Weights W:

(This is the loading matrix)

	l.val.dollarc.l4	industry.l4	trend.l4
l.val.dollarc.d	-0.08524612	-0.06139896	3.784980e-17
industry.d	6.00473360	-2.65773352	-1.430294e-14

APPENDIX D: TEST FOR RESIDUALS

Table D1

Portmanteau Test (adjusted) for Petroleum Export Values and Industrial Production

Model

Portmanteau Test (adjusted)
data: Residuals of VAR object
var.vec.coint.pet.ind.l4.r1
Chi-squared = 65.3215, df = 50, p-value = 0.0716

Table D2

Breusch-Godfrey LM Test for Petroleum Export Values and Industrial Production Model

Breusch-Godfrey LM test
data: Residuals of VAR object
var.vec.coint.pet.ind.l4.r1
Chi-squared = 29.9715, df = 20, p-value = 0.07032

Table D3

Portmanteau Test (adjusted) for GDP and Industrial Production Model

Portmanteau Test (adjusted)
data: Residuals of VAR object
var.vec.coint.gdp.ind.l4.r1
Chi-squared = 80.7344, df = 50, p-value = 0.003825

Table D4

Breusch-Godfrey LM Test for GDP and Industrial Production Model

Breusch-Godfrey LM test
data: Residuals of VAR object
var.vec.coint.gdp.ind.l4.r1
Chi-squared = 16.2549, df = 20, p-value = 0.7007

Table D5

Portmanteau Test (adjusted) for Iron Ore Export Values and Industrial Production Model

Portmanteau Test (adjusted)
data: Residuals of VAR object
var.vec.coint.iro.ind.l4.r1
Chi-squared = 48.9599, df = 50, p-value = 0.5151

Table D6

Breusch-Godfrey LM Test for Iron Ore Export Values and Industrial Production Model

Breusch-Godfrey LM test
data: Residuals of VAR object
var.vec.coint.iro.ind.l4.r1
Chi-squared = 20.205, df = 20, p-value = 0.4452

Table D7

Portmanteau Test (adjusted) for Coffee Export Values and Industrial Production Model

Portmanteau Test (adjusted)

data: Residuals of VAR object

var.vec.coint.cof.ind.l4.r1

Chi-squared = 61.0319, df = 50, p-value = 0.1364

Table D8

Breusch-Godfrey LM Test for Coffee Export Values and Industrial Production Model

Breusch-Godfrey LM test

data: Residuals of VAR object

var.vec.coint.cof.ind.l4.r1

Chi-squared = 21.8232, df = 20, p-value = 0.3502

APPENDIX E: VAR ESTIMATION RESULTS

Table E1

VAR Estimation for Petroleum Export Values and Industrial Production Model

VAR Estimation Results:

=====

Endogenous variables: l.val.dollar, industry

Deterministic variables: none

Sample size: 161

Log Likelihood: -495.984

Roots of the characteristic polynomial:

0.7561 0.7561 0.7523 0.7523 0.6218 0.6218 0.5726 0.5726

Call:

VAR(y = diff(tslogcom2[, c("l.val.dollar", "industry")]), p = 4,
type = "none")

Estimation results for equation l.val.dollar:

=====

l.val.dollar = l.val.dollar.l1 + industry.l1 + l.val.dollar.l2 +
industry.l2 + l.val.dollar.l3 + industry.l3 + l.val.dollar.l4 +
industry.l4

	Estimate	Std. Error	t value	Pr(> t)
l.val.dollar.l1	-0.7241122	0.0784578	-9.229	< 2e-16 ***
industry.l1	0.0038928	0.0029087	1.338	0.182768
l.val.dollar.l2	-0.5482315	0.0938483	-5.842	3e-08 ***
industry.l2	0.0078948	0.0028934	2.729	0.007107 **
l.val.dollar.l3	-0.3231986	0.0913346	-3.539	0.000533 ***
industry.l3	0.0003026	0.0029555	0.102	0.918588
l.val.dollar.l4	-0.1553133	0.0740057	-2.099	0.037489 *
industry.l4	0.0074276	0.0029847	2.489	0.013898 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2263 on 153 degrees of freedom

Multiple R-Squared: Adjusted R-squared:

0.4016, 0.3703

F-statistic: 12.84 on 8 and 153 DF, p-value: 4.798e-14

Estimation results for equation industry:

```
=====
industry = l.val.dollarp.l1 + industry.l1 + l.val.dollarp.l2 +
industry.l2 + l.val.dollarp.l3 + industry.l3 + l.val.dollarp.l4
+ industry.l4
```

	Estimate	Std. Error	t value	Pr(> t)
l.val.dollarp.l1	-0.17143	2.06280	-0.083	0.934
industry.l1	-0.01092	0.07647	-0.143	0.887
l.val.dollarp.l2	1.88165	2.46745	0.763	0.447
industry.l2	0.08000	0.07607	1.052	0.295
l.val.dollarp.l3	4.60447	2.40136	1.917	0.057 .
industry.l3	-0.09450	0.07771	-1.216	0.226
l.val.dollarp.l4	1.44036	1.94575	0.740	0.460
industry.l4	-0.33305	0.07847	-4.244	3.79e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.95 on 153 degrees of freedom

Multiple R-Squared: Adjusted R-squared:

0.1281, 0.08256

F-statistic: 2.811 on 8 and 153 DF, p-value: 0.006189

Covariance matrix of residuals:

	l.val.dollarp	industry
l.val.dollarp	0.05091	0.1139
industry	0.11388	35.3256

Correlation matrix of residuals:

	l.val.dollarp	industry
l.val.dollarp	1.00000	0.08492
industry	0.08492	1.00000

Table E2

VAR Estimation for GDP and Industrial Production Model

VAR Estimation Results:

=====

Endogenous variables: gdp, industry

Deterministic variables: none

Sample size: 161

Log Likelihood: -755.541

Roots of the characteristic polynomial:

0.8036 0.8036 0.802 0.802 0.7927 0.7927 0.5363 0.1061

Call:

VAR(y = diff(tslogcom2[, c("gdp", "industry")]), p = 4, type = "none")

Estimation results for equation gdp:

=====

gdp = gdp.l1 + industry.l1 + gdp.l2 + industry.l2 + gdp.l3
+ industry.l3 + gdp.l4 + industry.l4

	Estimate	Std. Error	t value	Pr(> t)	
gdp.l1	-0.37263	0.14721	-2.531	0.01238	*
industry.l1	0.20293	0.06622	3.064	0.00258	**
gdp.l2	-0.53150	0.12834	-4.141	5.69e-05	***
industry.l2	0.25152	0.06192	4.062	7.74e-05	***
gdp.l3	0.30374	0.12476	2.435	0.01606	*
industry.l3	-0.30283	0.05967	-5.075	1.11e-06	***
gdp.l4	0.54634	0.12735	4.290	3.15e-05	***
industry.l4	-0.46106	0.06517	-7.075	5.03e-11	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.354 on 153 degrees of freedom

Multiple R-Squared: Adjusted R-squared:

0.4601, 0.4319

F-statistic: 16.3 on 8 and 153 DF, p-value: < 2.2e-16

Estimation results for equation industry:

=====

industry = gdp.l1 + industry.l1 + gdp.l2 + industry.l2
+ gdp.l3 + industry.l3 + gdp.l4 + industry.l4

	Estimate	Std. Error	t value	Pr(> t)
gdp.l1	-0.3481	0.3475	-1.002	0.31808
industry.l1	0.1295	0.1563	0.828	0.40884

gdp.l2	-0.5515	0.3029	-1.820	0.07067	.
industry.l2	0.3607	0.1462	2.468	0.01469	*
gdp.l3	0.6125	0.2945	2.080	0.03924	*
industry.l3	-0.3646	0.1408	-2.589	0.01056	*
gdp.l4	0.9113	0.3006	3.032	0.00286	**
industry.l4	-0.7963	0.1538	-5.176	7.03e-07	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.558 on 153 degrees of freedom
 Multiple R-Squared: 0.2395, Adjusted R-squared: 0.1997
 F-statistic: 6.022 on 8 and 153 DF, p-value: 1.009e-06

Covariance matrix of residuals:

	gdp	industry
gdp	5.343	11.14
industry	11.144	30.85

Correlation matrix of residuals:

	gdp	industry
gdp	1.0000	0.8679
industry	0.8679	1.0000



OHIO
UNIVERSITY

Thesis and Dissertation Services