FUNDAÇÃO GETÚLIO VARGAS
ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO

CLAUDIA BAUMGART

THE EFFECTS OF COMMODITY DEPENDENCE ON THE BRAZILIAN ECONOMY: A TEST OF THE DUTCH DISEASE HYPOTHESIS

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Dissertation presented to Escola de Administração de Empresas de São Paulo of Fundação Getúlio Vargas, as condition to obtain the Master title in Business Administration.

Field of Knowledge:
Economia Brasileira e Doença Holandesa

Supervisor: Prof. Dr. Julia von Maltzan Pacheco

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“Sucesso não é a chave para a felicidade; felicidade é a chave para o sucesso. Se você ama o que faz, você será bem sucedido.”

“Success is not the key to happiness. Happiness is the key to success. If you love what you are doing, you will be successful.”

Albert Schweitzer

RESUMO

A doença holandesa tornou-se amplamente conhecida na década de 1960, quando a descoberta repentina de reservatórios de gás natural em território holandês, na região do mar do norte, transformou o país em uma economia rica em recursos. A desagradável consequência que proveio da recém-adquirida abundância de *commodities* foi o declínio da próspera indústria holandesa, que perdeu sua competitividade devido à valorização do florim holandês, como consequência do aumento do influxo de capital estrangeiro no país. Desde então este fenômeno tem sido observado em diversos países que possuem abundância de *commodities.* O objetivo desta tese é aplicar o modelo da doença holandesa ao Brasil, já que a maior economia da América latina poderá também ter de encarar a ameaça de se tornar prisioneira da "armadilha das *commodities*", devido à sua abundância de recursos naturais. O autor revisa a bibliografia básica abordando o tema geral da doença holandesa e dá enfoque a estudos realizados anteriormente no Brasil. Além disso, os quatro maiores sintomas que caracterizam a doença holandesa são testados: (1) valorização das taxas de câmbio do real, (2) declínio do setor industrial, (3) crescimento do setor de serviços, e (4) aumento dos salários. Todos estes sintomas foram observados e podem ser comprovados através das abordagens de cointegração ou de correlação, com exceção do sintoma número dois. Ainda que estes resultados sejam significativos, há muito outros fatores determinantes que influenciam o desenvolvimento dos sintomas examinados, motivo pelo qual futuros estudos serão necessários para se obtiver conclusões definitivas sobre como o Brasil é afetado pela doença holandesa.

Palavras-chave: doença holandesa, Brasil, desindustrialização, cointegração, modelo de BEER.

ABSTRACT

The Dutch disease became generally known in the 1960s, when the sudden discovery of gas deposits in the Dutch territory in the North Sea turned the country into a resource-abundant economy. The displeasing disadvantage that stemmed from this newly acquired commodity wealth was the decline of the previously prosperous Dutch industries, which lost their competitiveness due to the appreciation of the Dutch guilder resulting from the increased inflow of foreign currencies. Since that time, this phenomenon has been observed in many commodity-rich countries. The intention of this thesis is to apply the Dutch disease to Brazil, as Latin America's biggest economy might also face the threat of being stuck in a so-called commodity trap owing to its vast natural resource wealth. The author reviews the fundamental literature regarding the general topic of the Dutch disease, while focusing on the previous research on Brazil. Furthermore, the four major features that are symptomatic of the Dutch disease are tested: (1) real exchange rate appreciation, (2) industry sector decline, (3) service sector growth, and (4) wage growth. All of these symptoms were found and can be proven via a cointegration or correlation approach, with the exception of symptom two. Even if these results are significant, there are many other driving factors that also impact the development of the examined symptoms, which is why further research needs to be conducted in order to draw final conclusions as to whether Brazil is afflicted with the Dutch disease.

Key Words: Dutch disease, Brazil, deindustrialization, cointegration, BEER model.

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List of Abbreviations

ABIQUIM	Associação Brasileira da Indústria Química
ABIT	Associação Brasileira da Indústria Têxtil
ADF	Augmented Dickey Fuller
BEER	Behavioral equilibrium exchange rate
BRIC	Brazil Russia India China
CA	Current account
COR	Corruption
CP	Commodity prices
CPI	Consumer price index
DD	Dutch disease
FR	Foreign reserves
GC	Government consumption
GDP	Gross domestic product
IBGE	Instituto Brasileiro de Geografia e Estatística
IEDI	Instituto de Estudos para o Desenvolvimento Industrial
IMF	International Monetary Fund
IFS	International Financial Statistics
IPEA	Instituto de Pesquisa Econômica Aplicada
MIKT	Mexico Indonesia Korea Turkey
NFA	Net foreign assets
OICA	International Organization of Motor Vehicle Manufacturers
OPED	Organization of the Petroleum Exporting Countries
PD	Productivity differential
R&D	Research and development
REER	Real effective exchange rate
RER	Real exchange rate
U.S.	United States
VAR	Vector autoregression
VECM	Vector error correction model

1 Introduction

Brazil first took center stage in 2001, when Jim O'Neill coined the acronym *BRIC* in a paper he wrote for his employer, Goldman Sachs. Ever since, Brazil has been in the spotlight as a promising emerging economy, along with China, India and Russia. Whereas China and India are expected to become leading producers of manufactured goods and services, Russia and Brazil are esteemed as global commodity providers (O'Neill, 2001). Brazil commands a number of natural resources and, thus, is a major exporter of iron ore, sugar, ethanol, soybeans, beef, coffee, tobacco, and orange juice, to name but a few (Alfaro, 2001). As commodity prices have peaked in the last few years, inter alia owing primarily to China's accelerating demand (Cashin, McDermott & Scott, 2002; Roache, 2012), Brazil was able to benefit well from its export-oriented economy. Nevertheless, the emerging giant has also been struggling against the overvaluation of the Brazilian real as a consequence of the influx of foreign exchange (Almeida, Feijó & Carvalho, 2005; Bresser-Pereira & Marconi, 2008; Nakahodo & Jank, 2006; Palma, 2005; Ueno, 2010). This raises the question of whether Brazil's already comparatively weak industry will be harmed in the long-term, putting the country in jeopardy of deindustrialization. This phenomenon, known in academic literature as *Dutch disease* (DD) or *curse of natural resources*, was initially observed in the Netherlands in the 1960s, when the discovery of oil and gas reserves led to an appreciation of the real exchange rate and, hence, to a temporary decrease in manufacturing exports. If Brazil desires to maintain its auspicious position or even aspires to become the 5th largest economy in the world, a diversified and strong economy is needed. Therefore, it is crucial for Latin America's biggest country to avoid getting stuck in a commodity trap in order to promote healthy growth rates in the long run (Ascher, 1999; Birdsall & Hamoudi, 2002).

1.1 Purpose of the Thesis

The objective of the underlying thesis is to detect whether Brazil is really at risk of suffering from the so-called Dutch disease and consequently has to improve its industry competitiveness. The author formulates the research question as follows:

Is Brazil afflicted with the Dutch disease and does its commodity abundance have the potential to be a long-term threat to the domestic industry?

It is believed that the symptoms of the Dutch disease are present, but only in a weaker form. Therefore the research hypothesis can be expressed in this way:

Brazil is afflicted with the Dutch disease to a certain extent, which is elucidated by the existence of characteristic symptoms. Nevertheless, the country's incentives and respective government measures to further build and promote domestic industry will prevent the country from experiencing a severe commodity trap and, thus, deindustrialization.

1.2 Relevance for Scholars and Professionals

This thesis fills a gap in research insofar as it responds to the call of scholars for evidence on the Dutch disease in Brazil. More specifically, it is the first analysis of Brazil that focuses on statistical evidence by applying the behavioral equilibrium exchange rate (BEER) model, a vector error correction model (VECM).[1] Hence, this thesis can be viewed as a starting point, which sheds light on this research area from a totally different angle. Therefore, hitherto existing literature on Brazil and the Dutch disease will hereby be enhanced by an additional piece of research portraying the topic from a new perspective. Beyond that, the author adds to the discussion by providing a contribution in English with respect to the case of Brazil, which has been lacking to date.[2] From the point of view of professionals, this thesis aims to determine whether or not Brazil has the capacity to become an attractive investment vehicle in the future, and whether the symptoms of the Dutch disease may potentially harm the investment environment, especially for foreign investors who are exposed to exchange rate fluctuations or the like. Furthermore, this research is of interest in regard to Brazil's current position as an ascending economy, which could have respectable influence on world markets in the long-

1 For an application of the BEER model see Oomes and Kalcheva (2007) for Russia, Chen (2010) for China, and Hasan and Dridi (2008) for Syria.

2 Ueno (2010) has delivered one of the very few contributions in English to date with respect to the examined topic.

term. Is the allocation among the BRICs therefore justified? Does Brazil have the ability to manage its resource wealth in such a way that profits are reaped wisely and capital is protected?[3] The intention of the author is to at least partially answer these questions for practitioners in order for them to be able to participate in recent discussions that evaluate Brazil's economic potential from a global perspective.

1.3 Chapter Outline

After introducing the topic, the author will first review the theoretical framework of the Dutch disease provided by Corden and Neary (1982). In doing so, the focus will be set on resource movement, spending, and the combined effect of such, which also forms the basis for discussion in the methodology chapter. Thereafter, the original concept will be expanded upon by presenting Gelb's (1988) resource curse theory and further research extensions of the Dutch disease model. Examples from developed and developing countries will thereby support the analysis. Subsequently, an overview of the literature on Brazil and the Dutch disease will shed light on the status quo of particular research contributions. Afterwards, structural changes in the Brazilian economy and the macroeconomic background will be explained so as to gain further insights into the particular situation of Brazil and its commodity dependence. To test whether the Dutch disease is indeed present or not, the author will employ the methodology in the style of Oomes and Kalcheva (2007) by examining (1) the drivers of the exchange rate, (2) the reasons for industry decline, (3) the comparatively high service sector growth, and (4) the overall wage growth. Limitations of the approach and recommendations for further research will be considered. The thesis closes by offering some final conclusions.

3 Norway is one of the very few paradigms that is able to deal with its oil and gas wealth in an appropriate way. Similar regulatory procedures could be an option for Brazil so as to profit from its resource abundance.

2 Theoretical Framework

Whether resource wealth is considered a blessing or a curse has been debated by various social scientists. The majority of these studies (Auty, 1993; Corden & Neary, 1982; Gelb, 1988; Sachs & Warner, 1997), particularly those examining developing countries, reveal a negative correlation between commodity abundance and economic growth.[4] Research began to take notice of this relationship in the 1960s, when oil and gas discoveries in the Netherlands led to an inflow of foreign capital, which was accompanied by the appreciation of the Dutch guilder. As a consequence, manufactured goods became too expensive to export, which ignited the deindustrialization process. After *The Economist* coined the term *Dutch disease* in the 1970s, Corden and Neary (1982) were the first to create an explicit macroeconomic model expounding the phenomenon. In the following sections, the concept of the Dutch disease, in addition to the theoretical fundaments of the resource curse is presented. Beyond that, examples from developed and developing economies are examined so as to better understand the phenomenon in practice before looking at the specific case of Brazil.

2.1 Original Concept of the Dutch Disease

Corden and Neary's (1982) article on the Dutch disease can be considered as one of the most contributory works in the examined research field and forms the basis for discussion in this chapter. Their framework pictures a small, open economy, in which three types of goods are produced. Two of these goods, X_E = energy and X_M = manufactured goods, are traded at exogenously determined world market prices, and the third non-traded good, X_S = services, adjusts its price according to local supply and demand. Furthermore, Corden and Neary (1982) assume the following:

- Consideration of relative prices (monetary effects are disregarded).
- The real exchange rate is defined as the price of non-traded goods in relation to traded goods.

4 Before the occurrence of the Dutch disease, Prebisch and Singer (1950) independently generated the thesis that countries, which mainly export primary goods, suffer from the deterioration of the terms of trade, as the quantity of imported manufactured goods is lower relative to the given level of commodity exports. For further information, see chapter three.

- GDP is equal to total expenditure, which implies balanced trade at any time.
- No bias in commodity or factor markets.
- Full employment, which guarantees an increase in welfare during periods of boom.
- Each of the three sectors possesses a sector-specific factor (capital), which is only applicable in the particular sector, in addition to a mobile factor (labor), which is versatile between sectors in order to balance their performance.

Corden and Neary (1982) suppose the occurrence of a boom in the extractive sector (energy), which provokes an increased flow of external rents and thus an appreciation of the real exchange rate. This development, in turn, browbeats the performance of the manufacturing sector as a result of a lack of competitiveness and, hence, puts the country at risk of deindustrialization. There are many reasons for a boom, but Corden and Neary (1982) limit their examination to a Hicks-neutral improvement in technology. This condition means that the factor intensities, and thus the balance of labor and capital in the production function, remain unchanged (Heiduk, 2004).

Corden and Neary (1982) suggest splitting the analysis, dividing the explanations into the *resource movement effect* and *spending effect*.

2.1.1 Resource Movement Effect

The resource movement effect can be explained by neoclassical arguments. Mobile factors tend to shift to the booming sector (Sec_E), as a consequence of the greater marginal productivity of the capital deployed there. Factor prices adapt accordingly and thus incite a real exchange rate appreciation (Ueno, 2010).

The following macroeconomic sequence summarizes the distinctive processes occurring during the resource movement effect:

$$Boom\ in\ Sec_E \rightarrow MPL\ in\ Sec_E \uparrow \rightarrow w_E \uparrow Labor\ from\ Sec_M\ and\ Sec_S\ to\ Sec_E \rightarrow Y_E \uparrow \&\ Y_M \downarrow,\ Y_S \downarrow\ (direct\ deindustrialization) \rightarrow P_S \uparrow \rightarrow RER \uparrow$$

A boom in the energy sector (Sec_E) increases the marginal productivity (MPL) of mobile factors, which allows wages (w_E) to surge in the respective prospering sector. Labor switches correspondingly, causing an output rise in the energy sector (Y_E) and an output decline in the rest of the economy (Y_M, Y_S) (direct deindustrialization). The decreased output in the services sector causes an excess of demand and hence a price rise of non-tradable goods (P_S). Because prices of tradable goods are determined on world markets, the increase in the price of services induces an appreciation of the real exchange rate (RER) (Brahmbhatt, Canuto, & Vostroknutova, 2010; Corden & Neary, 1982; Oomes & Kalcheva, 2007; Stijns, 2003; Ueno, 2010).

If there are only a few resources (labor, capital) to draw from the manufacturing and services sectors, the resource movement effect is negligible, and only the spending effect can be considered to be of major relevance.

2.1.2 Spending Effect

Spending effect analysis delivers varying outcomes. According to the spending effect, a boom in the energy sector (Sec_E) accompanies a rise in real income. This rise, in turn, leads to an increase in the demand for services. As a supply lag probably occurs in the short run, the disparity is compensated through higher prices in the services sector. The necessary price adjustment is regarded as the other channel that causes the exchange rate to appreciate (Ueno, 2010).

As illustrated above for the resource movement effect, the following sequence outlines the procedures taking place during the spending effect:

$$Boom\ in\ Sec_E \rightarrow Y \uparrow \rightarrow Demand \uparrow for\ X_E,\ X_M\ \&\ X_S \rightarrow P_S \uparrow \rightarrow RER \uparrow \rightarrow Demand \uparrow for\ Labor\ in\ Sec_S \rightarrow w_S \uparrow \rightarrow Labor\ from\ Sec_M\ \&\ Sec_E\ to\ Sec_S \rightarrow w_M\ \&\ w_E \uparrow \rightarrow Y_S \uparrow\ \&\ Y_M \downarrow,\ Y_E \downarrow (indirect\ deindustrialization)$$

The higher real income (Y) arising from the boom in the energy sector (Sec_E) engenders a higher aggregate demand and tempts the public and private sectors to indulge on services, natural resources, and manufactured goods (X_E, X_M & X_S). The increased demand for non-tradable goods causes a price augmentation (P_S),

which then leads to an appreciation of the real exchange rate (RER). Thereafter, the demand for labor in the services sector (Sec_S) increases so as to cope with the additional demand for services emerging from the population. A subsequent pay increase in the services sector (w_S) entails workers to leave the energy and manufacturing sectors (Sec_M & Sec_E), and hence reallocate their skills to the services industry (Sec_S). This shift puts pressure on the energy and manufacturing sectors and forces them to also increase wages (w_M & w_E). Since the energy and manufacturing sectors are not able to compensate for the supplementary expenditures via higher prices, a decline in their profits and output, at least in the manufacturing sector (Y_M), is the natural consequence (indirect deindustrialization). In contrast, the labor conglomeration in the services sector promotes a rise in the output of services (Y_S) (Brahmbhatt et al., 2010; Corden & Neary, 1982; Oomes & Kalcheva, 2007; Stijns, 2003; Ueno, 2010).

2.1.3 Combined Effect

A joint contemplation of the resource movement and spending effect, when infected with the Dutch disease, allows for the prediction of four major features. First of all, the real exchange rate appreciates as the relative prices of services rise. Second, one of the main characteristics is a definite decrease in manufacturing output and employment, reverberating deindustrialization in the direct and indirect sense. Third, the impact on the services and energy sectors with respect to output and employment is unclear, as the spending and resource movement effects arrive at contradictory conclusions. If labor mobility is low, and only a few people are employed in the energy sector, the spending effect prevails. Fourth, the overall wage level increases (Oomes & Kalcheva, 2007). These findings are detailed in Table 1.

Table 1: Summary of Resource Movement, Spending, and Combined Effects

	Output	Employment	Wage	Price
Resource movement effect				
Energy sector	+	+	+	Given
Manufacturing sector	-	-	+	Given
Services sector	-	-	+	+
Spending effect				
Energy sector	-	-	+	Given
Manufacturing sector	-	-	+	Given
Services sector	+	+	+	+
Combined effect				
Energy sector	Not ascertainable	Not ascertainable	+	Given
Manufacturing sector	-	-	+	Given
Services sector	Not ascertainable	Not ascertainable	+	+

Source: The author's illustration, based on the work of Oomes and Kalcheva (2007).

2.2 Resource Curse Theory and Further Research Extensions of the DD Model

The original Dutch disease model is based on restrictive assumptions and limitations, which loosened and partially vanquished over time as economists further appended dynamics and included learning-by-doing, in addition to monetary effects. Following the contributions made by Corden and Neary (1982) and Corden (1984), those of Gelb (1988), Auty (1993), and Sachs and Warner (1997) can be regarded as the major literature references, delivering connotative extensions of the studied topic.

Only a few years after the first academic article on the Dutch disease was published, Gelb (1988) coined the term *resource curse theory*, which also counter-intuitively affirmed that commodity richness impedes economic development. Gelb (1988) focuses on the examination of oil windfalls and discusses the implications of the 1970s oil shocks for six oil-abundant countries. By means of a self-compiled index, Gelb (1988) is able to measure the effects on the respective economies and places particular emphasis on the development of the manufacturing sector and the alteration of the exchange rate. His outcomes are diverse and vary according to each country. Yet, he reasons that well-endowed economies should concentrate on measures that stimulate economic progress, instead of merely relying on the abundance of resources.

Auty (1993) also expands upon Corden and Neary (1982) applying the Dutch disease model to larger economies. He basically argues that a large country size is favorable, as a vast domestic market creates incentives for industrialization. All the same, Auty (1993) does not deliver a definite corollary of how large economies are affected by natural resource prosperity and, therefore, acknowledges only that mineral-exporting economies underperform non-resource-rich countries in terms of growth.

Later, Sachs and Warner (1997) confirmed the aforementioned conjectures, finding an inverse relationship between natural resource intensity and economic growth when considering data from 1970-1990. According to their research results, the observed stagnation in resource-abundant countries from the beginning of the 1970s cannot be explained by alternative variables, such as geographical or climate features. Other unobserved growth repellents also cannot be held responsible for distorting the countries' economic performance. Pursuant to Sachs and Warner (1997), it is the resource abundance itself and its mismanagement that inhibits export-led growth and other possibilities that promote industrial sector development.[5]

2.3 Examples from Developed Countries

The Dutch disease has been subject to research since the 1960s, when oil and gas discoveries placed the Netherlands in an unexpected situation. All at once, the country had to deal with its sudden resource wealth and faced major challenges in regard to the development of the manufacturing sector. Ever since, several developed countries have been studied in connection with the Dutch disease, and research on the matter has tried to determine whether or not they are suffering from the consequences. In the following section, some of the most prominent examples are discussed. The Netherlands, Norway, and the United Kingdom are examined within the context of oil and gas deposits in the North Sea. Furthermore, a very recent example is provided by investigating the case of Australia. The latest

5 For recent research extensions, which confirm the findings of Sachs and Warner (1997), see Isham, Pritchett, Woolcock, and Busby (2005). For a research contribution with focus on political economy, see Ross (1999).

mining boom harmed the country's industrial sector and, thus, might place it in danger of deindustrialization.

2.3.1 The Netherlands

The Dutch disease phenomenon has its roots in the late 1950s, when vast natural gas discoveries in the North Sea of the Netherlands pursued the Western European country with alleged natural resource wealth. Further exploration began in 1963, and, a decade later, the previous energy importer turned into an energy exporter (Stijns, 2003). At first glance, the sudden domestic energy abundance appeared to be promising for the comparatively small economy, but, upon closer inspection, it had a controversial impact on the Netherlands. As the guilder significantly appreciated against the U.S.-Dollar and the major European currencies in the 1970s, the Dutch manufacturing sector took a considerable hit. Textile production, metal fabrication, mechanical engineering, the vehicles and shipping industries, and construction businesses almost disappeared. Furthermore, a conspicuous increase in the Dutch service sector was observed at this particular time (Ellman, 1981). Even if the above-mentioned facts are undeniable, Corden (1984) questions the gas discoveries as the sole cause of the distressed circumstances. He argues that the inappropriate use of the booming sector's revenues exacerbated the economically unfavorable situation, as they were employed to fund high unemployment and extra benefit levels. The consequence was premeditated unemployment, which on the other hand decreased labor supply, and thus, increased the real wage and brought about a contraction of profits and output in the manufacturing sector. Moreover, Stijns (2003) notes a significant inverse relationship between real energy prices and real manufacturing exports, not only for the Netherlands, but also for its major trading partners: Germany, the United Kingdom, and France. As Germany and France are net energy importers and display the same features as the Netherlands at that point in time, meaning that their manufacturing exports received a setback, it is debatable whether the gas deposits can be held solely responsible for the substantial decline in the Dutch industrial sector.

2.3.2 Norway

Norway is regarded as one of the very few resource-abundant countries that was able to deal appropriately with its commodity wealth and, hence, it has thus far managed to avoid the Dutch disease in the classical sense. When oil and gas deposits were found in the Norwegian territory of the North Sea in the 1960s, the country was already a stable democracy with mature institutions and a sophisticated economy. Ever since, the Norwegian government has adopted expedient measures so as to take advantage of the resource prosperity (Obodzinskiy, 2010). Development areas are divided among Norwegian and international oil companies; however, a tax rate of 78% allows the Norwegian state to keep a significant amount of the revenues within the country (Seifert & Werner, 2005). A further major contribution is made by the state-owned oil funds, called *Petroleumsfondet*, which increased their value by 20 times between 1996 and 2004. Proceeds from exports are invested in foreign securities, and only about 4% of the return is used to cover government spending. Such institutional constraints help deal with the profits, avoid unnecessary expenses, diminish corruption, and alleviate the danger of inflation (Bardt, 2005). Aside from these factors, the country hedges itself by producing a lion's share of energy through hydroelectric facilities and wind turbines (Seifert & Werner, 2005). Norway succeeds in eluding oil dependency, despite major exports, and will probably be able to maintain affluence and power supply in an oil-poor future. Neither a crucial dependency on energy supply nor a domestic dependency on oil and gas profits exists. Therefore, the likelihood of the Dutch disease manifesting itself in the Scandinavian oil nation appears to be very improbable in the long-term (Obodzinskiy, 2010).[6, 7]

6 It may be argued that Norway still does not meet the requirements of a perfect escape from the Dutch disease, as its manufacturing sector, in particular the shipping industry, shrank significantly after the discovery of the deposits and only compiles about 1% of GDP nowadays. Nevertheless, for example Norway's aluminum industry sticks out, since it is considered the world's largest producer of primary aluminum, generating 1000 metric tons per year. This delivers the necessary evidence that Norwegian manufacturing, even if very focused, is successful. Moreover, much of the success is ascribable to the many foreign-owned manufacturing companies in Norway, which contribute 28% of the total production value in manufacturing (Larsen, 2004; Nations Encyclopedia, 2012).

7 Akram (2004) also disproves a Dutch disease-like overvaluation of the Norwegian real exchange rate by employing the BEER, FEER and PPP approach. He argues that despite some fluctuations (e.g. in 2002) the currency tends to level out at the equilibrium level in the long-term.

2.3.3 United Kingdom

Yet another example associated with the discoveries of oil and gas resources in the North Sea is provided by the United Kingdom. According to Greenspan (2007), the insular state suffered from the Dutch disease in the 1970s and 1980s, when sudden energy abundance turned the country into an oil net exporter. As a result, the British pound appreciated over 50% between 1977 and 1980 (Ross, 1986) and, hence, made it very difficult for industrial export goods to compete in the world markets (Greenspan, 2007). However, the literature does not deliver a clear view on the incidents in the United Kingdom. For example, Stijns (2003) and Krugman (1997) argue that the above-mentioned real exchange rate appreciation can also be related to the tight monetary policy pursued by then Prime Minister Margaret Thatcher.[8] Buiter and Miller (1981, 1983) highlighted a rapid rise in productivity, particularly in the manufacturing sector, within the examined timeframe, which can be considered as a counter-intuitive observation in conjunction with the Dutch disease.

2.3.4 Australia

Australia is one of the most lately discussed cases in the context of the Dutch disease. Very recently, Corden (2012) related the classical framework from 1982, outlined in chapter two, to the mining boom in Australia. As in his previous works, Corden (2012) differentiates among the booming, lagging, and non-tradable goods sectors. He considers the booming sector as represented by the Australian mining industry, which grew about 85% within the last six years. Additionally, he observes a 41% increase in the GDP in the same time frame and a 100% value rise in exports of mining industry products. These impressive growth rates, especially for iron ore and coal, are ascribable to the insatiate demand of China during the last decade. Nevertheless, the mining boom comes with an enormous increase in prices;

8 Margaret Thatcher was considered an adherent of monetarism, as her monetary policy goal was to reduce the growth of the money supply. In literature, this is known as the *"monetary experiment"* that first aimed at the disciplining of the government and second had the obligation to control inflation, which had reached an 18% level in the beginning of the 1980s in the United Kingdom as a consequence of the oil shocks in the 1970s (Diehl, 2010).

Corden (2012) estimates a 41% increase for Australia in terms of trade. Consequentially, the Australian dollar appreciated more than 30% in real terms against major currencies between 2005 and 2011 and, thus, negatively influenced import-competing and non-mining industries, the so-called lagging sector. Even though Corden (2012) does not deliver empirical evidence in his paper concerning whether Australia is suffering from the Dutch disease or not, he clearly points out that Australia is a paradigm of a three-speed economy. The fastest moving part is embodied by the mining sector, the slowest or even declining sector is constituted by industry, and the non-tradable goods sector receives net gains from this constellation. Therefore, it can be deduced that Australia currently finds itself in a Dutch disease-like situation at the very least, and thus must attempt to deal with it in an adequate manner, possibly by imposing certain government measures.

2.4 Examples from Developing Countries

Numerous case studies have been conducted on developing nations and whether their industrial underdevelopment can be attributed to a certain type of resource wealth or not. Nevertheless, most of the academic literature examines the Dutch disease in second and third-world countries in relation to sudden oil windfalls or the 1970s surge in oil prices. So does, for example, Gylfason (2001), who compares the growth rates of OPEC to those of non-OPEC lower- and middle-class countries. He draws the conclusion that the yearly average GNP per capita for OPEC economies declined by 1.3% from 1965-1998, whereas the same for non-OPEC lower- and middle-class nations grew by 2.2% in the same timeframe.[9] This observation implies that, at least to some extent, OPEC nations seem to grow slower than non-OPEC nations, which could be interpreted as a hint to the Dutch disease. Furthermore, Gylfason (2001) emphasizes that his results can be explained by the fact that countries without resource abundance are exposed to a smaller error margin and are less likely to commit blunders. As opposed to this, commodity-rich nations tend to overlook the risks involved in resource

9 Förster (2007) also presents detailed research on the Dutch disease and OPEC countries and suggests elaborate control strategies.

abundance, and therefore lose awareness. The following section is dedicated to examining the Dutch disease in developing countries. Although there are plenty of considerable articles on this topic, the author has decided to present the research of only four interesting cases. Indonesia and Russia serve as examples of petroleum abundance, and Chile and Botswana illustrate the case of copper wealth and diamond prosperity, respectively.[10]

2.4.1 Indonesia

Indonesia became the focus of international attention about two decades ago. The Southeast Asian country holds impressive resources in abundance, inter alia, substantial petroleum deposits. Lipscomb, Ramakrishnan, Adler, Budina, and Li (2010), in addition to Usui (1996), examined the case of the promising MIKT[11]-nation before and after the global financial crisis and arrived at similar conclusions. Characteristically for the Dutch disease, the country had to deal with a real exchange rate appreciation once commodity exports ballooned. This situation led to doubts about whether the manufacturing sector would be harmed in the long-term and whether the country faced an increasing vulnerability owing to the unpredictability of commodity prices. Lipscomb et al. (2010) infer that there is no strong evidence of the Dutch disease and that the poor performance of some industrial sectors cannot be associated with the resource boom and should rather be attributed to infrastructure bottlenecks and labor market frictions. They also observe steady terms of trade, from which it can be concluded that vulnerability to export price volatility is limited. Usui (1996) emphasizes that altered policy decisions, such as the investment of oil revenues in the tradable goods sector, were key to promoting further development of the Indonesian industry.

10 Aizenman and Marion (1999) specifically focused on the Dutch disease in developing countries and the involved investment risk. For further general contributions with respect to developing countries, see Hjort (2006). For the social impact of commodity dependence, see Carmignani and Avom (2010) and Estrades and Terra (2011).

11 MIKT stands for Mexico, Indonesia, Korea, and Turkey. These countries are considered to be the next BRICs, as they display promising economic features.

2.4.2 Russia

Russia is one of the most prominent examples that studies continuously link to the phenomenon of the Dutch disease, as about 40% of its revenues are derived from the oil business. The study of Oomes and Kalcheva (2007) delivered the most meaningful results regarding Russia and is therefore discussed when evaluating the case of the BRIC country. The four major symptoms of the Dutch disease: (1) an appreciation of the real exchange rate, (2) a drop in manufacturing growth, (3) a rise in the service sector growth, and (4) a gain in wage growth, are tested. The authors deduce that the real exchange rate has almost always been in line with the equilibrium level, if not even undervalued, since 2002. While symptom one cannot be verified, Oomes and Kalcheva (2007) provide evidence for the existence of the remaining three symptoms. However, the economists underscore that the occurring symptoms may also be the result of other major factors that influenced the structures of the Russian economy, especially after the collapse of the Soviet Union.[12]

2.4.3 Chile

Chile is one of the very few examples that is related to the context of the Dutch disease by virtue of its copper wealth and not due to massive oil reserves. Ruehle and Kulkarni (2011) scrutinized the Chilean case and found that the country has indeed contracted the Dutch disease over the last 20 years, especially after the copper boom in 2003. An eight-fold increase of the copper price was observed between 2003 and 2007. This impressive upsurge also had a significant impact on the Chilean economic situation; the exports of the copper industry boosted and the exports of the agricultural and manufacturing sector became less important. Being significantly dependent on its copper exports, Chile experienced real exchange rate appreciation, after the influx of an increased amount of foreign currency, and inflation peculiar to the Dutch disease. Also the demand for domestic non-tradable

12 It has to be underlined that the four symptoms Oomes and Kalcheva (2007) mention are crucial in order to determine the status of the affliction. The more symptoms exist, the likelier is the presence of the Dutch disease.

goods, represented by the services sector, augmented suddenly. Nonetheless, Chile, known for its efforts to fight political unrest, somehow managed to keep the negative effects under control through fiscal and monetary discipline.[13] Nowadays, the South American country is considered to be one of the most developed and prosperous nations on the continent, despite its position as a rather minor, open economy with a thriving commodity sector (Ruehle & Kulkarni, 2011).[14]

2.4.4 Botswana

According to Pegg (2010), Botswana ranks among the top three diamond producers in the world. The deposits, extraction, and production have allowed the country to grow about 9% on annual average throughout the last 30 years. Not only in contrast to other African countries, but also on a global level, Botswana has done very well in terms of GDP per capita. Aside from tourism and agriculture, diamond production is definitely the major foreign exchange earner, which is why many describe the economic structure of the country as relatively one-sided. This circumstance also raises the question of whether Botswana's mineral-dependency might expose the country to the risk of being troubled with the Dutch disease. Pegg (2010), who mainly contributes to the discussion, highlights that Botswana suffers from the symptoms of the Dutch disease. Apart from the overvaluation of the currency, Pegg (2010) notes that Dutch disease effects became noticeable through the explosion of wages and their relation to labor productivity. However, the resource movement and spending effect are kept within limits, as most of the diamond revenues are invested in foreign capital markets. It is challenging to draw precise conclusions with regard to the specific circumstances in Botswana, but

13 Chile's political past plays a determining role when it comes to the economy of the country. After the nationalization programs of Salvador Allende in the beginning of the 1970s, Chile suffered from a deep recession, as foreign direct investment disappeared. After the tremendous exodus of foreign capital, Augusto Pinochet's government followed a radical neoliberal economic model so as to spur on the Chilean economy and integrate the hitherto lagging sectors. However, even if overall growth was promoted with this method, it also bolstered up the already strong copper industry. Ever since, copper revenues have been the most important source of income for the Chilean government, as they comprise about 10% of their total earnings. In order to reduce this significant dependency and thereby the risks of a Dutch disease, the Chilean government fosters diversification programs (Ruehle & Kulkarni, 2011).

14 For further specific research on the Dutch disease in mineral-dependent economies, see Davis (1995).

Pegg (2010) concludes that diamond revenues and the symptoms of the Dutch disease are hardly the only rationales behind the country's lack of diversification, as especially the bloated government sector obstructs investments in miscellaneous industries.

3 Literature on Brazil and the Dutch Disease

The hitherto existing literature on whether Brazil is at risk of suffering from the Dutch disease and the resulting fears of a possible deindustrialization is wide-ranging. Neoclassical approaches, which question the existence of a real disease, and Keynesian attitudes, which clearly detect specific symptoms as a consequence of market liberalization, can be found in extant research efforts. In the following section, the author outlines the most contributive opus with respect to the studied topic, which serve as an orientation for the further examination of the particular case of Brazil.

One of the pioneer inputs is delivered by Bresser-Pereira and Marconi (2008), who are profoundly convinced that Brazil has found itself in the dilemma of deindustrialization since 1990 due to the abolishment of neutralizing policy mechanisms[15] and the introduction of the free market economy model[16]. Furthermore, they observe a significant appreciation of the Brazilian real after 2003, hampering the former positive export development and, thus, the trade surplus. The reasons that Bresser-Pereira and Marconi (2008) give for valorization are straightforward: Additional foreign capital, which entered the country as a result of increasing commodity exports, provoked the alteration in the Brazilian currency's value. The lower current account then reflected the explosive growth of imported goods, in particular within the manufacturing sector. That is why the intention of promoting the production of manufactured goods and industry buildup declined and, hence, put the country at risk of deindustrialization. The problem worsened once commodity prices rose and the Brazilian real reached its peak in value. Bresser-Pereira and Marconi (2008) admit that, in comparison to other emerging economies, Brazil faces a lower risk of suffering heavily from the Dutch disease, as their commodity export portfolio is well diversified.

15 Since the 1930s, Brazil had used neutralizing policy mechanisms, which aimed at promoting their own industry sector, and therefore, increasing the production of manufactured goods. This phenomenon, also known as import substitution industrialization, is a trade policy, which was mainly pursued by many developing countries until the 1990s in order to boost own domestic production, reduce industrial dependence from the first world, and diversify from the vast commodity abundance. For further details, see Prebisch and Singer (1950).

16 The free market economy model is defined by QFinance (2012) as the follows: "an economic system in which the government does not intervene or unduly regulate business activity".

Consequently, Brazil does not have a one-sided income at command; therefore, it avoids a unilateral concentration of its natural resource-rich economy. Nevertheless, Bresser-Pereira and Marconi (2008) highlight the significantly higher contribution of commodities to GDP and the improvement of the commodities' balance of trade in contrast to the decline on the manufacturing side. Besides, they affirm that the increase of the commodities' balance of trade evolved irrespective of the exchange rate, meaning that other external factors influenced their supply and demand. In contrast, manufactured goods are considerably connected to the exchange rate and, thus, are dependent on the Brazilian real so as to perform well. All in all, Bresser-Pereira and Marconi (2008) see the solution in promoting the participation of technology-strong sectors to achieve sustainable long-term growth per capita.

In comparison to Bresser-Pereira and Marconi's (2008) rather reserved opinion concerning the subject, Nassif (2008) holds the view that deindustrialization cannot necessarily be considered an undesirable phenomenon. From his perspective, specialization can aid long-term growth with respect to the societal well-being. Moreover, he casts doubts over the occurrence of deindustrialization in Brazil, following the implementation of economic and political reforms in the 1990s. He argues that the worst decline of industry participation in GDP occurred in the late 1980s, before the structural reforms. Nassif (2008) holds the low labor productivity at that point in time, hyperinflation, and the general economic grievance of the lost decade responsible for the industry decrease. Furthermore, he points out that from 1990 on the industry share of GDP has only deteriorated slightly and still comprises almost 30%. Such being the case, he comes to the conclusion that there is no definite evidence for deindustrialization. Palma (2005), in contrast, blames the transition from import substitution to trade liberalization, accompanied by institutional changes, for the appearance of Dutch disease symptoms. His hypothesis is strengthened by the fact that the Brazilian real has substantially appreciated since 2004 and that the relative prices of Brazil's principal export commodities have noticeably increased within the last decade. Additionally, Palma (2005) observes a decrease in the manufacturing sector work force vis-à-vis other sectors, in particular the service

sector. Nassif (2008) does not agree with this line of argument; he justifies the trend, as new technologies, advanced capital access, and innovative products have replaced manpower.

Lopes de Souza Júnior's (2009) contribution can be allocated among the rather Keynesian thoughts of Bresser-Pereira and Marconi (2008). He is of the conviction that especially the recent growth of the biofuel sector and the pre-salt oil discoveries heavily contributed to the Brazilian industry's loss of competitiveness in external markets. Furthermore, Lopes de Souza Júnior (2009) agrees with Bresser-Pereira and Marconi (2008) with regard to government interference, which took place until 1990. From his point of view, the measures had neutralizing effects and were necessary protection mechanisms in order to prevent an overvaluation of the Brazilian real. Beyond that, he puts emphasis on the declining share of manufacturing in GDP. According to his research, the share shrank from 33% in 1991-1995 to 22% in 2001-2005. In compliance with his preceding ideas, Lopes de Souza Júnior (2009) also highlights Brazilian export data, which display an explicit increase in the export of primary goods. Therefore, he concludes that Brazil finds itself in a position of high-level deindustrialization and suggests an improvement in domestic political decisions, which should promote technology-focused rearrangements. So, as to enhance international competitiveness, Brazil must learn not only to extract resources, but also to sharply apply them. For Lopes de Souza Júnior (2009), these recommendations are essential in order for Brazil to profit from its enormous commodity abundance in the future.

The research carried out by the *Instituto de Estudos para o Desenvolvimento Industrial* (IEDI) (2005) contemplates the issue from a different perspective. Scholars diagnose the Dutch disease in Brazil, but advise to regard the degree in relative terms. The IEDI (2005) points out that all of Latin America and the Caribbean are suffering from the symptoms, but that the transformation industry, which primarily converts raw materials into intermediary or final goods, grew at least 1.6% on annual average between 1990 and 2003. Nonetheless, Asian market players were able to achieve double-digit growth rates in the transformation sector within that same timeframe. With regard to this connection, one must also

take into account the fact that Asia's emerging economies followed the model of industrialization right after opening up to the world markets. Latin American countries, including Brazil, instead complied with the natural resource course and concentrated on commodity exports. The IEDI (2005) suggests some remedial measures so as to keep the relative deindustrialization within limits. First of all, an adequate reintegration of natural resource-intensive industries, such as chemistry, metallurgy, or ironworks, is recommended so as to foster the Brazilian business portfolio. Second, traditional sectors, such as the textile or electronics industries, have to be revitalized, as their potential currently appears to be underdeveloped. Third, the IEDI (2005) also favors policies that promote industrialization, modernization, and the development of advanced technologies.

The paper by Nakahodo and Jank (2006) concerning the fear of Dutch disease in Brazil approaches the topic from a different angle. Nakahodo and Jank (2006) blame the high commodity prices, which rose by virtue of the high demand in Asia, for Brazil's miserable situation. The subsequent export boom provoked the appreciation of the Brazilian real and, thus, changes in the balance of payments. Moreover, Nakahodo and Jank (2006) call attention to the circumstance that much of the research on Brazil and the Dutch disease is based on impressions rather than on profound analytical data. Just as Bresser-Pereira and Marconi (2008) and Lopes de Souza Júnior (2009), Nakahodo and Jank (2006) also believe in the promotion of high-technology sectors to boost industry export dynamics.

Oreiro and Feijó (2010) basically summarize the previous research results and consider the positive in addition to the negative sides of a possible Dutch disease in Brazil. On one hand, there are the *new developmentalists* that defend the thesis of the occurrence of deindustrialization in Brazil. On the other hand, there are the *orthodox economists* that highlight the positive side of cheap imports, such as extended access to new technologies. Notwithstanding, as most results in the Brazilian case show, Oreiro and Feijó (2010) also find the balance of trade data and the low contribution of the industry sector to the GDP alarming.

Ueno (2010) focuses on the discovery of the oil fields in the pre-salt layer and delivers a contribution in English with respect to the particular case of Brazil. Similar to the suggestions of Oreiro and Feijó (2010), Ueno (2010) also

distinguishes between neoclassical and Keynesian approaches. From one perspective, a boom of natural resources changes endowments and, accordingly, the comparative advantage of an economy. From another perspective, a commodity pattern of specialization could be the source of chronic slow growth of non-oil exports. Nevertheless, Ueno (2010) accentuates the hazard that Brazil encounters by building up further foreign exchange reserves and, hence, overvaluing the Brazilian real. That is why he esteems exchange rate interventions and argues for investments in R&D and high technology in order to compensate for the high share of commodities in the export portfolio.

On balance, one can deduce that many of the previous research results on Brazil and the Dutch disease phenomenon lean in the same direction. Most of the economists come to the conclusion that Brazil exhibits features of the Dutch disease, but it is not as infected as many assume. Concordantly, all researchers criticize the appreciation of the Brazilian real, which impedes the desired exports of manufacturing goods and industry products. In this context, many researchers mention the declining share of manufactures' contribution to the Brazilian GDP. Moreover, almost all of the examined papers suggest investments in technology so as to keep up with international standards and ameliorate production facilities. An overview of the aggregated previous findings is presented in Table 2. Even if the topic appears to be processed in research literature, two major drawbacks exist: First, the majority of the literature is in Portuguese, which complicates international research contributions. Second, most of the papers have not applied statistical tests; instead they have solely focused on data analysis and interpretation. Therefore, it is essential to deliver statistical evidence so as to draw meaningful conclusions on the subject.

Table 2: Literature Review on the Particular Case of Brazil

Author	Macro-economic school	DD	Cause	Symptoms	Solution
Bresser-Pereira & Marconi (2008)	Keynesian	√	Neutralizing policy mechanisms abolished → free market economy	↑ international demand for commodities → ↑ Brazilian commodities exports → ↑ foreign capital → ↑ BRL → ↑ manufacturing imports → ↓ domestic manufacturing → DD	Promotion of technology-strong sectors
Nassif (2008)	Neo-classical	X	Specialization not necessarily undesirable	Can be neglected, instead introduction of new technologies, advanced capital access, innovative products	Not ascertainable
Palma (2005)	Keynesian	√	Trade liberalizations & institutional changes	- ↑ BRL - ↑ prices of Brazilian export commodities - ↓ workforce in manufacturing - ↑ workforce in service sector	Not ascertainable
Lopes de Souza Jr (2009)	Keynesian	√	Neglect of government interference & protection mechanisms	- ↑ of biofuel and petroleum sector - ↓ GDP share of manufacturing - ↑ exports of primary goods	Technology investments
IEDI (2005)	Rather Keynesian	√ (relatively)	Abandonment of policy measures & concentration on commodity exports after opening up	- Symptoms are present, but only in relative terms (comparison to Asian countries), but slight growth of transformation industry	Reintegration of natural resource intensive industries & revitalization of traditional sectors
Nakahodo & Jank (2006)	Rather neutral	√	↑ commodity demand in Asia → ↑ commodity prices	- ↑ BRL - Changes in balance of payments	Promotion of high-technology sectors
Oreiro & Feijó (2010)	Rather neutral	√ x	*New developmentalists:* DD due to governmental alterations *Orthodox economists:* No DD due to advantages of new import products	- Alarming balance of trade data - ↓ contribution of industry sector to GDP	Not ascertainable
Ueno (2010)	Rather Keynesian	√	Neoclassical: changes of natural resource endowments & comparative advantage of economy Keynesian: specialization leads to chronic slow growth of non-oil exports	- ↑ foreign exchange reserves → ↑ BRL - ↑ share of commodities in export portfolio	Exchange rate interventions & investments in R&D and high-technology

Source: The author's illustration.

4 Structural Changes and Macroeconomic Background

After opening itself up to world markets in the early 1990s, particularly after the introduction of the Real Plan by Fernando Henrique Cardoso in 1994, Brazil was transformed into an open economy with the potential to succeed in international markets. The stabilization program cut inflation from nearly 40% a month to 2%, encouraging long-desired price stability. Afterwards, privatization, deregulation, and trade liberalization were high on Brazil's agenda (Alfaro, 2001; Rigolon & Giambiagi, 1999). This section aims to understand these structural changes, which occurred mainly during the past two decades, and to relate them to the potential threat of the Dutch disease. GDP composition, development of the exporting sector, industry alterations, employment distribution, and fluctuations in the exchange rate play a major role in this investigation. This chapter can be understood as an extension of the review of the literature on Brazil, because most of the Brazilian economists employed the following or similar macroeconomic data to draw conclusions on whether the country's resources can be considered a blessing or a curse.

4.1 GDP Composition and Labor Force Evolution

First of all, GDP composition, displayed in Figure 1, is analyzed. The chart features the percentage of value added of the agricultural, industrial, and services sectors. According to the World Bank (2012), agriculture incorporates forestry, hunting, fishing, crop cultivation, and livestock production. Industry is comprised of manufacturing, construction, electricity, water, gas, and mining. The services sector encompasses wholesale and retail trade (including restaurants and hotels), transportation, government, and financial, professional, and personal services, such as health care, education, and real estate. Value added is composed of the sum of all outputs, with all intermediary inputs subtracted. Unfortunately, this method does not allow for a clear separation of commodities or natural resources, as they are included in the first two sectors. This widely recognized and applied classification, though, serves as an indicator for detecting trends in the respective sectors and helps identifying significant alterations.

Figure 1 basically highlights two major trends. Firstly, a massive decline in the industry sector can be observed, as its contribution shrank by 11%, from 39% to 28%, over the past 21 years. As ascertained in the previous section, Palma (2005), Lopes de Souza Júnior (2009), Bresser-Pereira and Marconi (2008), Ueno (2010), and the IEDI (2005) hold trade liberalization and the elimination of tariff barriers responsible for the change. Especially after the introduction of the new currency, a rather stagnant period in industry is witnessed. One possible explanation is the overvaluation of the Brazilian real, as a result of long-lasting monetary tightening, which reduced the competitiveness of domestically produced goods and enabled foreign-manufactured goods to enter the local markets to an increased extent (Ueno, 2010). Secondly, the services sector has risen sharply, by 17%, since 1994 and now contributes 67% of valued added to the Brazilian GDP. In contrast to the matter of the industry, the liberalization of some particular service-focused sectors, such as finance, energy, and telecommunications, promoted a rapid surge in their added value, especially in the first two years after the implementation of the Real Plan. Further reasons Ueno (2010) attributes to this development are the growth in the public sector and increased demand for low-skill services.

It can also be observed that the decline of the industry sector und the increase in the services sector basically occurred right after the enactment of structural changes in 1994. This leads to the conclusion that the composition of the Brazilian economy adapted itself relatively fast to the then introduced free market economy model[17].

Moreover, one can deduce that the agricultural sector's contribution remained consistent to a greater or lesser extent over the past two decades, meaning that this sector is not significantly prone to substantial trade alterations.[18]

17 However, taking into consideration the degree of trade openness, which is represented by the average of exports and imports as a percentage of GDP, Brazil takes the 41st place, meaning that still nowadays Brazil can be considered a rather closed economy (OECD, 2009).

18 In this context, it is important to also note the contestability hypothesis, which first gained attention in 1982, when Baumol et al. presented their theory on contestable markets and industry structure. Since Brazil's opening up to foreign countries, local industrial companies had to deal with the market entrance of many international competitors and adapt their strategy accordingly.

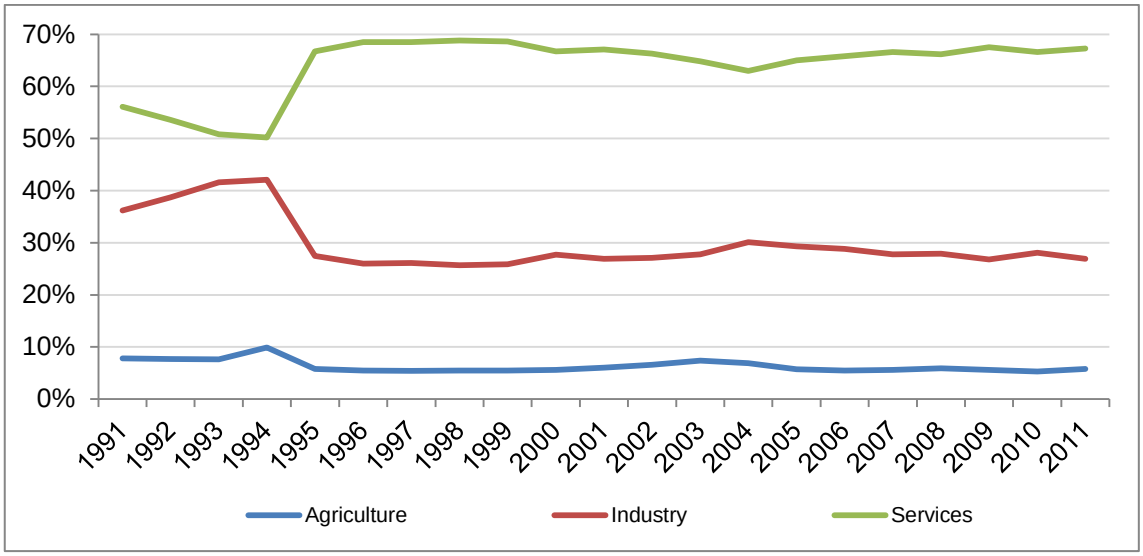

Figure 1: GDP composition (percentage of value added)
Source: The author's illustration, based on the work of Ueno (2010), data retrieved from the World Bank.

Figure 2 shows the distribution of the labor force and its evolution with respect to the three different sectors. As expected from the economic trends analyzed in Figure 1, employment in the services sector grew continuously and now accounts for more than 60% of the total labor force. Interestingly, the labor force employed in the industry sector has remained almost constant since 1990 and covers about 20% of the working population. Although the value added to GDP of the agricultural sector has almost remained constant during the observed time frame, employment in the agricultural sector decreased slowly from 23% to 16%. This development is most likely attributable to the technical improvements and the advanced automation processes the sector underwent during the last two decades (Ueno, 2010).

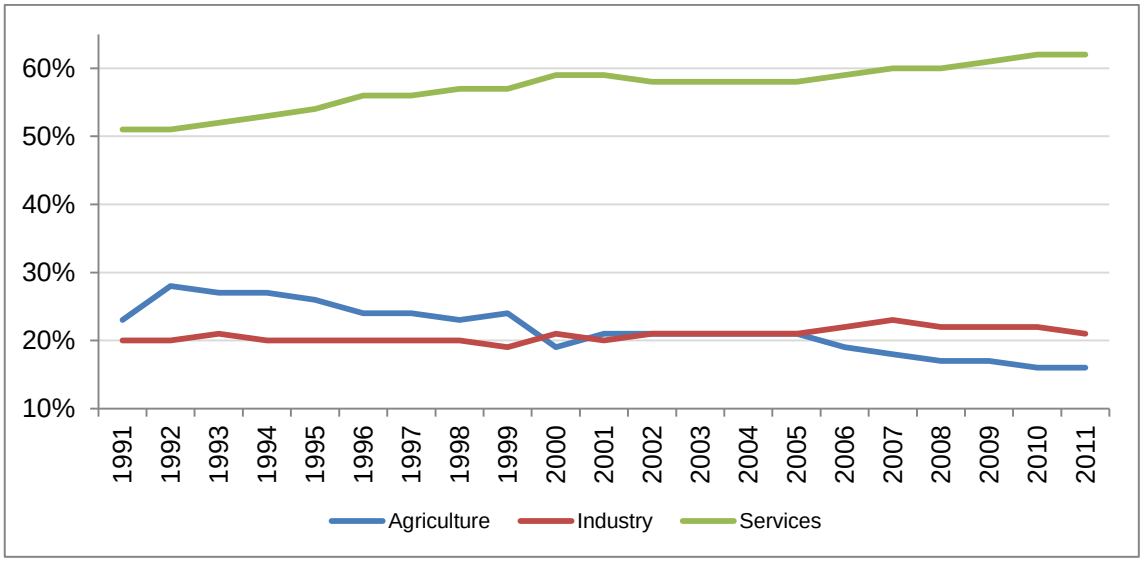

Figure 2: Labor Force by Sector

Source: The author's illustration, based on the work of Ueno (2010), data retrieved from the World Bank.

4.2 Industry Development and Export Alterations

As Nassif (2008) and Ueno (2010) brought to mind in their contributions, it is vital to also include the structure of the industry and the development of sector-specific exports in a discussion of this type. Appendices 1 and 2, respectively, display the composition of the Brazilian industry and its export data. It can be deduced that particularly natural resource-based industries, particularly the oil sector, have performed increasingly well over the last few years. Petroleum, gas, and metallic minerals extraction have grown significantly. Work-intensive industries, such as the textiles and shoe sectors, have declined over the past decades and contribute only about 10% of value added to the industry as a whole. Scale-intensive, differentiated, and science-based industries show stagnation or even gradual slowdowns. Regarding the export development, one can observe that natural resources-based exports have increased their share considerably, and that scale-intensive, differentiated, and science-based exports have augmented only slightly. On the contrary, labor-intensive exports have declined sharply since the liberalization of the Brazilian markets.

Also Figure 3 highlights the previously deliberated changes in the export evolution of the Brazilian industry. It becomes clear that natural resources have

overtaken manufactured products in regards to exports and are increasing at a noticeably faster pace.

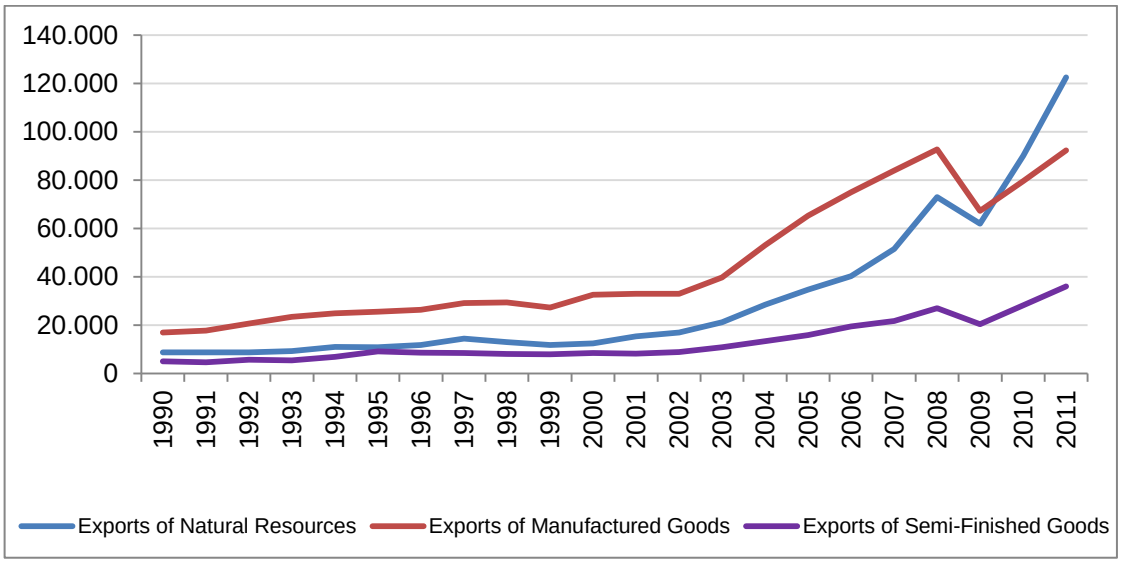

Figure 3: Export Development
Source: The author's illustration, data retrieved from IBGE.

Furthermore, the opus of Bresser-Pereira and Marconi (2008) and Ueno (2010) reveal a significant rise in imported manufactured goods, without an accumulation of further capital stock. Usually, an addition of fixed assets is used for land improvements, equipment purchases, and infrastructure construction. As this does not appear to be the case for Brazil due to declining gross capital formation data, one can only deduce that a crowding out of the domestic industry is at hand.

4.3 Monetary Criteria

As mentioned in previous paragraphs, Brazil has followed a tight monetary policy over the past 20 years so as to avoid inflationary pressures. Using high nominal interest rates as a tool of control, the government succeeded in accomplishing the intended purpose, but had to deal with the crucial disadvantage of the permanent overvaluation of the Brazilian real (Ueno, 2010). This overvaluation considerably hit the competitiveness of the manufacturing industry, as Brazilian manufacturing products lost their appeal on international markets due to comparatively high

prices, resulting from the strong real (Segura-Ubiergo, 2012). The development of the exchange rate with respect to the U.S.-Dollar is illustrated in Figure 4. Particularly since 2003, the Brazilian real has constantly gained in value, making it difficult for exchange rate-dependent export products, which are primarily found in the manufacturing sector, to be successful in markets outside Brazil.

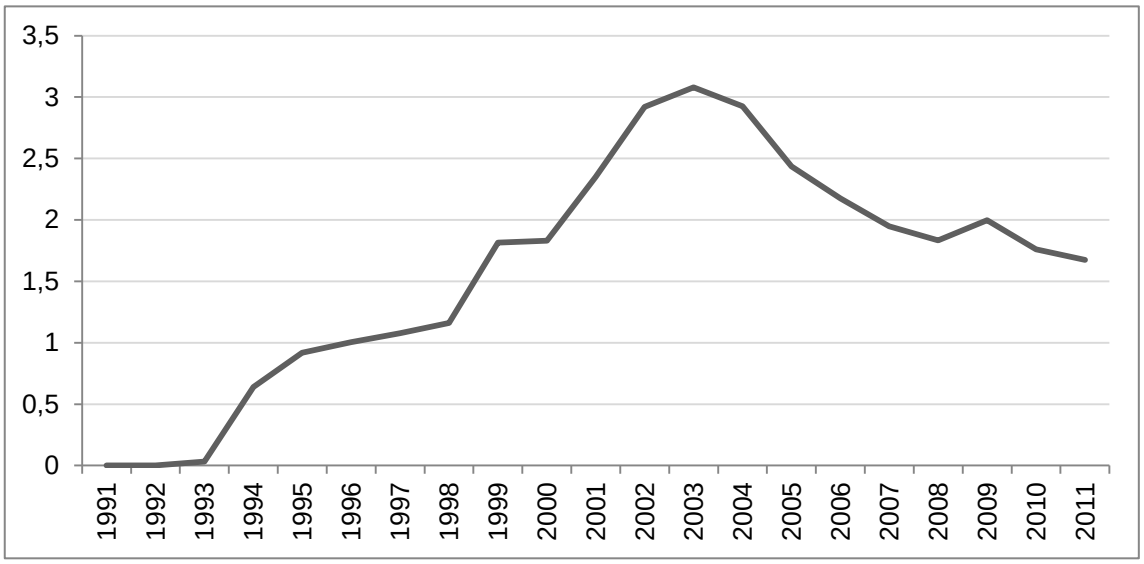

Figure 4: Nominal Exchange Rate Development BRL/USD
Source: The author's illustration, data retrieved from Bloomberg.

4.4 Summary

It is apparent from the data analyzed above that Brazil displays a multitude of symptoms of the Dutch disease. The most obvious of these symptoms are outlined in the following: At first, the GDP contribution shares of the industry and services sectors fit the concept of the Dutch disease phenomenon, as the stake of industry decreases and the impact of services grows. Even if, at first glance, the data appears to be relatively constant, a trend of declining industry after the stabilization of the currency in 2003 is still discernible. A similar observation can be made in regard to the development of employment. The services sector records continuous growth in its labor force, while the working population in the industry areas remains constant. Taking the composition of Brazilian industry into consideration, suspicion of Dutch disease arises once again. Resource-based industries denote incremental growth, while scale-intensive, differentiated, and

science-based industries stagnate, and work-intensive industries diminish. Moreover, the composition of exports offers valuable clues for this investigation, since resources-focused exports overtook the exports of manufactured goods in 2010. Additionally, increased imports of manufactured goods, without a significant accumulation of further capital stock, indicate the presence of the Dutch disease. Above all, the high interest rates and the chronic overvaluation of the Brazilian real also portend the earlier suppositions about the occurrence of deindustrialization. Looking at the data, as almost all previous Brazilian research on the Dutch disease does, it seems uncontested that Brazil is infected. The results of this section with respect to the original literature, setting the focus on the resource movement and spending effect, are outlined and displayed in Table 3.

Table 3: Summary of the Dutch Disease Symptoms in Brazil according to Existing Literature

Dutch disease symptoms according to structural development	Relation to Resource Movement Effect	Relation to Spending Effect	Relation to Combined Effect
Contribution of industry to GDP ↓	√ Labor shift to energy sector causes industry output to decline	√ Labor shift to services sector causes industry output to decline	√ Labor shift to either energy or services sector causes industry output to decline
Contribution of services to GDP ↑	x Labor shift to energy sector causes services output to decline	√ Labor shift to services sector causes services output to rise	? Labor shift direction unclear; therefore no unambiguous statement possible
Industry employment ↓	√ Higher wages in energy sector cause industry employment to decline	√ Higher wages in services sector cause industry employment to decline	√ Higher wages in either energy or services sector cause industry employment to decline
Services employment ↑	x Higher wages in energy sector cause services employment to decline	√ Higher wages in services sector cause services employment to rise	? Sector of higher wages unclear; therefore no unambiguous statement possible
Composition of the industry (resource-based ↑; scale-intensive, differentiated, science-based →; work-intensive ↓)	? The original model of Corden and Neary (1982) does not make any statement about the composition of the industry.	? The original model of Corden and Neary (1982) does not make any statement about the composition of the industry.	? The original model of Corden and Neary (1982) does not make any statement about the composition of the industry.
Resources-focused exports ↑ Manufactured exports ↓	? Export development is not directly considered in the basic DD model of Corden and Neary (1982).	? Export development is not directly considered in the basic DD model of Corden and Neary (1982).	? Export development is not directly considered in the basic DD model of Corden and Neary (1982).
Imports of manufactured goods ↑	? Import development is not directly considered in the basic DD model of Corden and Neary (1982).	? Import development is not directly considered in the basic DD model of Corden and Neary (1982).	? Import development is not directly considered in the basic DD model of Corden and Neary (1982).
EXR ↑	√ Price increase of services causes the exchange rate to appreciate	√ Price increase of services causes the exchange rate to appreciate	√ Price increase of services causes the exchange rate to appreciate

Source: The author's illustration.

5 Methodology and Test for Evidence of Dutch Disease in Brazil

As previously summarized in Chapter Two, the combined consideration of the resource movement and spending effect allows for the identification of four substantial symptoms, when suffering from the Dutch disease: (1) real exchange rate appreciation, (2) industry output and employment decline, (3) services sector growth, and (4) an elevation of the real wage level. The aim of this section is to test for these four symptoms and to enrich the existing literature about the presence of the Dutch disease in Brazil with statistically significant results. To do so, the author adopts the approach of Oomes and Kalcheva (2007), who have delivered vital insights on Russia and the Dutch disease phenomenon. According to them, it is obvious that the real exchange rate appreciated in Russia, but there is still no evidence about the actual trigger causing the overvaluation. The question, therefore, is whether high commodity prices can really be held responsible for the unequivocal appreciation. This is why, it is important to control for other main exchange rate determinants, comprising government consumption, foreign exchange reserves, productivity differential, and corruption so as to detect further possible currency appreciation drivers. In a similar manner, the industry sector decline is tested. The effect of commodity prices on three big industries in Brazil sheds light on whether the country deindustrializes or not. Pairwise correlation coefficients between Brazil and various Latin American countries in regard to the services sector growth give indications about the rather ambiguous third assertion. Determinants that account for real wage growth are difficult to assess, but nevertheless, a suggestion of how to approach this issue is presented at the end of this chapter.

5.1 Test for Real Appreciation

In both effects, the resource movement and the spending effect, an appreciation of the real exchange rate is the logical consequence of a price rise in the services sector, as the exchange rate is defined as the price of non-traded goods in relation to traded goods. Hence, a currency overvaluation is considered one of the major

symptoms of a Dutch disease infection. Nevertheless, it is not enough to discern the matter from pure data observation, since a simple analysis does not provide information on the components that drive the exchange rate behavior. In the following, the influence of selective determinants, including commodity prices, is explained and tested. Their impact is expressed in terms of elasticities in order to draw unambiguous and precise conclusions.

5.1.1 Determinants of the Real Exchange Rate

Many variables are perceived to be of influence when determining exchange rate behavior. However, the decision to focus on only a few important variables facilitates and specifies the analysis. The selection of the determinants is based on their disposability, relevancy for Brazil, and previous economic significance in hitherto studies. The author takes up the suggestions of Oomes and Kalcheva (2007) for Russia, Chen (2007) for China, and Hasan and Dridi (2008) for Syria, as they employed similar variables when testing for currency misalignment.[19] It is important to accentuate that the following selection makes no claim to be complete.[20]

5.1.1.1 Commodity Prices

Many previous studies, such as the works of MacDonald and Ricci (2003) and Zalduendo (2006), have identified a positive correlation between oil prices or exports and the behavior of the effective real exchange rate. Even though Brazil tempestuously improved its position in regard to the amount of oil reserves after the recent discoveries in the pre-salt layer, it would probably not be appropriate to

19 A similar approach was used by Kutan and Wyzan (2005), who also related the real exchange rate to the Dutch disease in the case of Kazakhstan. For a general impression on how currencies affect trade, see Engel (1993), Glick and Rose (2002), and Rose (2000).

20 The real interest rate, which is also considered one of the major determinants of the real effective exchange rate, is not included in the following analysis. One substantial reason can be mentioned in this regard: Real interest rate data are only available from 1997, according to the World Bank (2012). The data of all other determinants are available from 1992. As the dataset is already very small, it would not be advantageous to exclude another five years, making the dataset even smaller. For a similar reason, Oomes and Kalcheva (2007), Hasan and Dridi (2008), and Chen (2007) did not include the real interest rate either.

only consider the effect of the oil price on the exchange rate for the particular examination of Brazil. The Brazilian natural resource extraction and production portfolio includes a lion's share in soft as well as hard commodities[21], which is why a consideration of a broader approach appears to be more suitable. Therefore the author applies a far-reaching commodity index, provided by the IMF, which considers a wide variety of energy and non-energy commodities. This commodity index serves as the major variable in this section so as to detect whether the presumed causal relationship exists between high commodity prices and currency appreciation.

5.1.1.2 Government Consumption

Opinions are divided about the impact of government consumption on currency trends. On the one hand, Oomes and Kalcheva (2007) claim that a positive correlation exists, unless the government decides to focus on the consumption of import merchandise. They refer to the spending effect, in which a general demand rise causes the exchange rate to appreciate by virtue of the relative price surge of non-tradables. On the other hand, Hasan and Dridi (2008) argue that an increase in government consumption is likely to lead to a diminishment of the fiscal balance. This, in turn, weakens the current account (CA) position and promotes downward pressure on the currency, particularly if the market is distorted towards tradables. In contrast to the classical spending effect, they reference to the restricted trade system and administrative prices that prevail for non-tradables in reality. From their point of view, there exists a clear negative relation between the exchange rate and a large CA and fiscal deficit.

21 The main difference between soft and hard commodities is the following: a hard commodity is an expression for commodities, which are extracted or mined, as for example oil, natural gas, or metals. Soft commodities on the other hand, are produced or cultivated in the agricultural industry, such as soy beans, coffee, sugar, and corn (FinancialWeb, 2012).

5.1.1.3 Foreign Exchange Reserves

According to Chen (2007), this variable has a positive impact on the value of the currency. A CA deficit implies a decline in the net foreign assets (NFA) position, which is only compensable through the buildup of a larger trade surplus. The creation of such a surplus is likely to succeed once the exchange rate depreciates. That is why a setback of the NFA position induces a devaluation of the exchange rate. On the contrary, a further accumulation of NFA brings forth an appreciation of the exchange rate. In spite of the positive relation Chen (2007) describes, Oomes and Kalcheva's (2007) research results display a negative association between the accumulation of foreign reserves and the value of the real effective exchange rate.[22]

5.1.1.4 Productivity Differential

The productivity differential can be explained by the Balassa-Samuelson hypothesis, (Balassa, 1964; Samuelson, 1964), which assumes a productivity rise in the tradable goods sector and thus, a sectorial pay increase. This wage elevation is also denoted in the non-tradable sector, as labor mobility is presumed to be high. If productivity in the non-tradable goods sector does not improve in line with the wage rise, inflation, and hence exchange rate appreciation, occur. Therefore, a positive effect in regard to the productivity differential and the exchange rate can be observed (Bonelli & Fonseca, 1998; Chen, 2007; Égert, 2002).[23]

5.1.1.5 Corruption

The foreign direct investment (FDI) hype since the 1990s has encouraged scholars to research its determinants. Lately, the level of corruption has become an important factor with respect to FDI location. In general, investors consider a corrupt business environment as undesirable, as instability negatively impacts

22 The argument Oomes and Kalcheva (2007) offer for their deviating coefficient is the following: even if augmented government savings resulting from the oil stabilization funds rose in conjunction with the international reserves, and therefore reduced inflationary pressures, the massive dollar purchases and ponderous rubble sales put downward on the Russian currency.

23 Van Ark, Inklaar, and McGuckin (2003) give an overview on how to define the productivity differential by explaining the differences between the U.S. and Europe.

financial return (Al-Sadig, 2009). While corruption is probably the least common determinant, it is still very important for research on Brazil, as only slight improvements concerning the corruption perception index have been observed over the last 15 years (Transparency International, 2012). Intuitionally, the correlation should not be positive, since an investment climate surrounded by corruption encourages an exodus of capital and thus raises the chance of currency depreciation (Wei & Wu, 2001). On the other hand, this negative correlation could neutralize the effects of the Dutch disease at least to a certain extent (Oomes & Kalcheva, 2007).

5.1.2 Data Description and Sources

The data for this section is taken from IMF, World Bank and IFS databases. As the applied commodity price index was only introduced in 1992, data thenceforth is taken into account. The following Table 4 gives an overview of the origin, frequency of such data and goes towards providing respective explanations.

Table 4: Data Summary for Testing Real Appreciation

Variable/Determinant	Data Origin	Frequency	Explanation
Real Effective Exchange Rate	IFS	Annually	2005=100, based on CPI
Commodity Prices	IMF	Annually	2005=100, energy and non-energy commodities
Government Consumption	World Bank	Annually	Government final consumption expenditure
Foreign Exchange Reserves	World Bank	Annually	Total reserves (holdings of monetary gold, special drawing rights, IMF reserves, holdings of foreign reserves)
Productivity Differential	World Bank	Annually	Ratio of Brazilian labor productivity to U.S. labor productivity (labor productivity = GDP/total labor force* labor participation rate)
Corruption	Transparency International	Annually	Perception-based index

Source: The author's illustration, based on the work of Oomes and Kalcheva (2007).

5.1.3 Empirical Approach and Econometric Methods

The author bases her approach on the Behavioral Equilibrium Exchange Rate (BEER) model, which has been applied in previous topic-related works by Oomes and Kalcheva (2007), Chen (2007), and Hasan and Dridi (2008). It estimates "the empirical long-run relationship between the real exchange rate and its determinants, after which we interpret the error correction term as the deviation from the long run equilibrium, i.e., as the extent of exchange rate misalignment." (Oomes & Kalcheva, 2007). Beyond, Zhang (2001) argues that this approach fits well when applied to developing countries, as models that are too large and complex are not reasonable due to data limitations. The following information is based on the hitherto deliberations of Chen (2007) and Clark and Macdonald (1998). An estimated reduced-form equation is applied to elucidate the behavior of the real effective exchange rate (REER) in conjunction with its economic fundamentals:

$$\boldsymbol{q_t} = \boldsymbol{\beta}' \boldsymbol{Z_t} + \boldsymbol{\tau}' \boldsymbol{T_t} + \boldsymbol{\varepsilon_t} \quad (1)$$

where

$\boldsymbol{Z}$ *is a vector of economic fundamentals, which are presumed to have an impact on the real exchange rate (RER) in the medium and long-term.*
$\boldsymbol{T}$ *is a vector of transitory factors influencing the RER in the short-term.*
$\boldsymbol{\beta}, \boldsymbol{\tau}$ *are vectors of reduced-form coefficients.*
$\boldsymbol{\varepsilon_t}$ *is considered to be a random disturbance term.*
$\boldsymbol{q_t}$ *is assumed to be the actual, observed REER.*

Equation (1) allows for the conclusion that the actual REER can be explained through a set of long-run fundamental variables, short-run transitory variables, and a random disturbance term. The current equilibrium exchange rate is based on the current value of the economic fundamentals and is defined as follows:

$$\boldsymbol{q_t'} = \boldsymbol{\beta}' \boldsymbol{Z_t} \quad (2).$$

Then, $\boldsymbol{mis\_cur_t}$ can be regarded as the disparity between the actual rate and the RER as determined by the current value of the economic fundamentals:

$$\boldsymbol{mis\_cur_t = q_t - q'_t = \tau' T_t + \varepsilon_t} \quad (3).$$

However, it is probable that the current values and fundamentals diverge from their long-term sustainable level, which is why a total misalignment, $\boldsymbol{mis\_per_t}$, also ought to be defined. $\boldsymbol{mis\_per_t}$ is considered to be the difference between the actual rate and the real rate, which is driven by the long-term economic fundamental values that are represented by $\overline{\boldsymbol{Z}}_{\boldsymbol{t}}$:

$$\boldsymbol{mis\_per_t = q_t - \beta' \overline{Z}_t} \quad (4).$$

Subtracting equation (2) from equation (4) permits the decomposition of the total misalignment into two fragments:

$$\boldsymbol{mis\_per_t = (q_t - q'_t) + \beta'(Z_t - \overline{Z}_t)} \quad (5).$$

It is apparent that the total misalignment is compiled of the current misalignment and the effect of the deviations of the current fundamentals from their long-term figures. Applying equation (3) allows for equation (5) to be rewritten in the following way:

$$\boldsymbol{mis\_per_t = \tau' T_t + \varepsilon_t + \beta'(Z_t - \overline{Z}_t)} \quad (6).$$

Hence, the total exchange rate misalignment can at all times be segmented into the transitory factors effect, random disturbances, and the magnitude to which economic fundamentals drift from their equilibrium values. As mentioned above, in the present thesis, the author has chosen to work with five economic fundamentals, which are regarded as the variables in vector $\boldsymbol{Z_t}$. Thus, the current equilibrium exchange rate can be seen as a function of the following determinants:

$$\boldsymbol{\hat{q}_t = f(CP, GC, FR, PD, cor)} \quad (7)$$

where

CP *are the commodity prices.*
GC *represents government final consumption expenditure*[24]*.*
FR *encompasses foreign exchange reserves.*
PD *reflects the productivity differential.*
cor *comprises corruption.*

Therefore, only a single equation must be estimated:

$$\boldsymbol{BEER} = (\boldsymbol{CP}, \boldsymbol{GC}, \boldsymbol{FR}, \boldsymbol{PD}, \boldsymbol{cor}) \quad (8).$$

Before assessing the cointegrating vectors, it is important to test for stationarity. For this purpose, the Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979) is applied. The idea of this test is to ascertain whether a time series is non-stationary or not ($H_0 =$ non-stationary, $H_1 =$ stationary). If the null hypothesis of a unit root in levels cannot be rejected, it is possible to convert the variables into a stationary time series by differentiation so as to fulfill the qualifications for a cointegration relationship (Hadeler, Winter, Arentzen, Sellien, & Sellien, 2000). Afterwards, the trace and Max-Eigenvalue statistics after Johansen (1995) are used to prove the existence of a cointegration relationship and to determine the amount of cointegrating vectors ($H_0 =$ no cointegration; $H_1 =$ cointegration) (Oomes & Kalcheva, 2007). Finally, a vector autoregression (VAR) model, respectively a vector error correction model (VECM), which is a special case of the VAR for variables that are only stationary in their differences, is applied in order to define the elasticities, and thus the conclusive cointegrating vector/vectors (Cottrell and Lucchetti, 2012).[25, 26]

24 "General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation." (World Bank, 2012).

25 For an application of the cointegration approach, see also Gregory (1994) and Rautava (2004).

26 The application of the Durbin-Watson test has shown that 1.66 < d < 1.98, implying that autocorrelation issues can be neglected (Cottrell & Lucchetti, 2012).

5.1.4 Estimation Results and Analysis

5.1.4.1 Stationarity

The results of the ADF unit root tests for each variable are presented in Table 5. When taking a closer look at the second and third columns, it becomes clear that it is impossible to reject the null hypothesis on the level. That is why the first differences are considered (see columns four and five), which deliver the necessary stationarity to conduct further research. Moreover, one can deduce that all variables are integrated with the same order one I(1) and that it therefore stands to reason to seek after a cointegration relationship.

Table 5: Results of ADF Unit Root Tests[27]

Variable	Ln Levels		Ln First Differences		Classification I(0), I(1)
	Test statistics	P-Value	Test statistics	P-Value	
REER	0,46	0,80	-3.51**	0,00	I(1)
CP	1,44	0,96	-3.93**	0,00	I(1)
GC	2,27	0,99	-2.28*	0,03	I(1)
FR	1,14	0,93	-2.18*	0,03	I(1)
PD	-0,76	0,39	-2.43*	0,02	I(1)
Cor	0,14	0,76	-2.35*	0,02	I(1)

Source: The author's illustration, based on computing results in gretl[28]*.*

5.1.4.2 Cointegration Analysis

The two cointegration tests suggested by Johansen (1995) yield the same results with respect to the presence of a cointegration relationship and the amount of existing cointegrating vectors. Both, the trace and the Max-eigenvalue test, show that there is a unique cointegration relation between various combinations of these variables at the 1% significance level. Detailed evidence is outlined in Table 6.

27 Lag length selected automatically based on the Bayesian and Akaike information criteria. The symbols ** and * connote the significance at the 1% and 5% level, respectively.

28 "gretl is a cross-platform software package for econometric analysis, written in the C programming language." (Cottrell & Lucchetti, 2012).

Table 6: Results of Johansen Cointegration Tests[29]

Rank	Eigenvalue	Trace Statistic	P-Value
None (r=0)**	0,97	119,900	0,00
At most 1 (r<=1)**	0,86	61.600	0,00
At most 2 (r<=2)	0,66	27.699	0,08
At most 3 (r<=3)	0,30	9,2538	0,35
At most 4 (r<=4)	0,17	3,0873	0,08
		Max- Eigen Statistic	
None (r=0)**	0,97	58.302	0,00
At most 1 (r<=1)**	0,86	33.901	0,00
At most 2 (r<=2)	0,66	18.445	0,11
At most 3 (r<=3)	0,30	6,1665	0,60
At most 4 (r<=4)	0,17	3,0873	0,08

Source: The author's illustration, based on computing results in gretl.

5.1.4.3 Results and Implications

Table 7 sheds light on the required cointegrating vectors, which are estimated with respect to four and five explanatory variables. The coefficients are statistically significant with the exception of foreign reserves and corruption, possess the anticipated algebraic signs, and thus display consistence with the hypothetical relationship underlying the REER.

29 Lag length selected automatically based on the Bayesian and Akaike information criteria. The symbols ** and * connote the significance at the 1% and 5% level, respectively.

Table 7: Estimated Cointegrating Vectors

	Vector not including corruption (1)	Vector including corruption (2)
Ln (CP)	**1,44***	**1,41***
Standard error	(0.18)	(0.13)
Ln (GC)	**1,65***	**1,80***
Standard error	(0.14)	(0.15)
Ln (FR)	-1,91	-1,78
Standard error	(0.13)	(0.16)
Ln (PD)	**0,01****	**0,02***
Standard error	(0.10)	(0.13)
Ln (Cor)		-0,80
Standard error		(0.16)

Source: The author's illustration, based on computing results in gretl.

The subsequent equilibrium relationship illustrates the obtained coefficients for the selected determinants in gretl.

$$REER = 1.41 * CP \ + \ 1.80 * GC \ - (1.78 * FR) \ + \ 0.02 * PD \ - (0.80 * Cor)$$

As all variables have been converted to logs (see Oomes & Kalcheva, 2007), it is possible to construe the coefficients as long-term elasticities.

With reference to the first term, it becomes obvious that there is indeed evidence for the existence of the Dutch disease in the Brazilian data, since higher commodity prices imply a real exchange rate appreciation. In this case, a 1% rise in the commodity index price entails an approximate 1.41% appreciation of the Brazilian real. Another main source for the appreciation of the currency is the increase of government consumption as a share of GDP. According to the second term of the above mentioned equation, a 1% rise in government consumption leads to a 1.80% appreciation of the exchange rate. The data (World Bank, 2012) shows that Brazil's general government final consumption expenditures level out at about 20% per year of the accomplished GDP. An elaborated reduction could probably help in counterbalancing the effects of the Dutch disease in the long-run. When looking at the third term of the equation, the coefficient is not significant, as the R^2 value is only 0.2. Otherwise foreign reserves accumulation would have had a negative impact on the exchange rate. In this instance, a 1% increase in foreign

reserves would connote a 1.78% depreciation of the Brazilian real. Oomes and Kalcheva (2007) also illustrate a negative association concerning the international reserves coefficient and justify their outcome with the short examination period, which is accurate for the present thesis, too. Furthermore they allude to the long-run neutrality of money that is impossible to obtain within such a short time frame. The productivity differential seems to have a rather small impact on the exchange rate, as the coefficient only adds up to 0.01-0.02. This implies a 0.01-0.02% appreciation of the exchange rate, if the productivity differential increases by 1%. Jones' (2010) contributions with respect to the low degree of labor mobility within Brazil may provide a probable explanation for only the partial compliance of the Balassa-Samuelson hypothesis. Last but not least, the corruption coefficient is negative, which would imply a reduction of the real appreciation pressures, once corruption increases. In this case, a 1% surge in corruption would cause the currency to depreciate by 0.80%. As Wei and Wu (2001) have affirmed in their main contribution, an increase in corruption encourages the exodus of foreign investor's capital, which then leads to the depreciation of the local currency. As in the present case the R^2 for corruption is only 0.15, the observation can be neglected.

All in all, one can say that the Brazilian real exchange rate was subject to significant fluctuations. With the exception of the 1998/1999 currency crisis and the subsequent recovery, the real was almost permanently overvalued, especially from 2002 onwards.[30] This can be somewhat explained by the increase in commodity prices, as the above conducted research shows. Nevertheless, commodity prices are by far not the only substantial factor influencing appreciation, since the government consumption coefficient exceeds the elasticity of the commodity prices. However, the existence of the first symptom of the Dutch disease according to the spending and resource movement effect is undeniable and has been proved in this section.

30 This can partly be explained by the "Lula Effect", which gives reference to former Brazilian president Luiz Inácio Lula da Silva. He was able to get millions of people out of poverty and strengthened Brazil's economic image on a global basis, impacting positively the exchange rate (Baer, 2008).

Figure 5 provides an additional overview of the development of the exchange rate and its determinants.

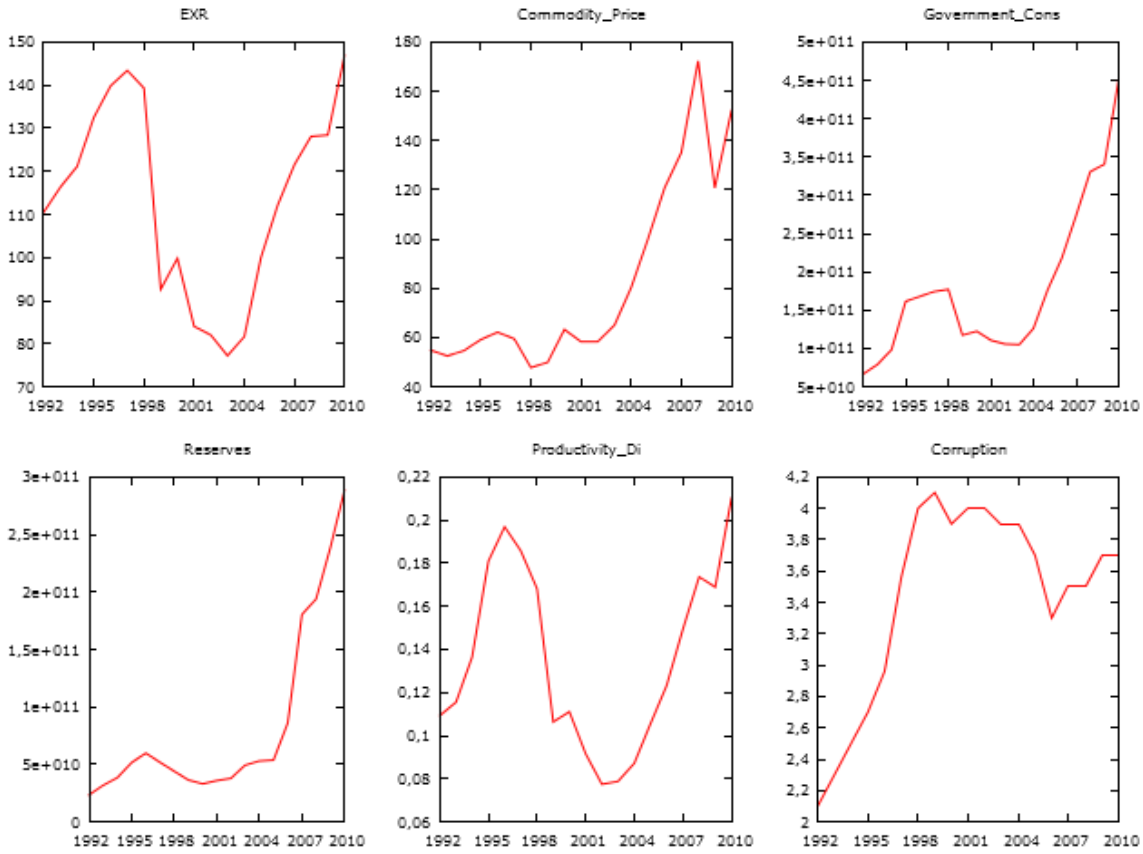

Figure 5: The REER and its Determinants
Source: The author's illustration, based on its depiction in gretl.

5.1.5 Possible Shortcomings of the Approach

Even though most of the results appear plausible, there are a variety of shortcomings that have to be taken into account. The first point of criticism is probably the approach to apply a broad commodity index, which is not seasonally adjusted and denoted in nominal terms. Besides, the weighting of the commodities might not suit exactly the particular case of Brazil. Instead, a customized index that reflects the major commodity extraction and exports of Brazil would be the appropriate approach. Furthermore the question arises of whether it might not even be adequate to consider the oil price in the future, depending on the further development of the resources in the pre-salt layer. The next crucial shortcoming is the lack of monthly data for all of the examined determinants. Beyond that, one

could only consider data from 1994 on, when the Brazilian real came into being. Another option would be to include dummies for the period of the currency crisis, in order to control for the large depreciation. Above all, it could be advantageous to contemplate further determinants that have an impact on the exchange rate in the long-run, such as the degree of openness and terms of trade, to achieve even more detailed results.

5.2 Test for Industry Sector Decline

The purpose of this section is to examine symptom two, the decline of the industry sector, which both, resource movement and spending effect, infer, be it in the direct or indirect sense. To begin with, it is worthwhile to look at the *absolute* and *relative* deindustrialization that Brazil could suffer from, just as Oomes and Kalcheva (2007) did for the circumstances in Russia. At first glance, there does not seem to be evidence for *absolute* deindustrialization, when considering Figure 6, since both, industry output and employment have grown more than they declined within the period from 1991 to 2011. *Absolute* deindustrialization, in contrast, would insinuate negative industry output and employment growth. As this does not appear to be the case for Brazil, at least for most of the observed years, one could conclude that this symptom is not present.

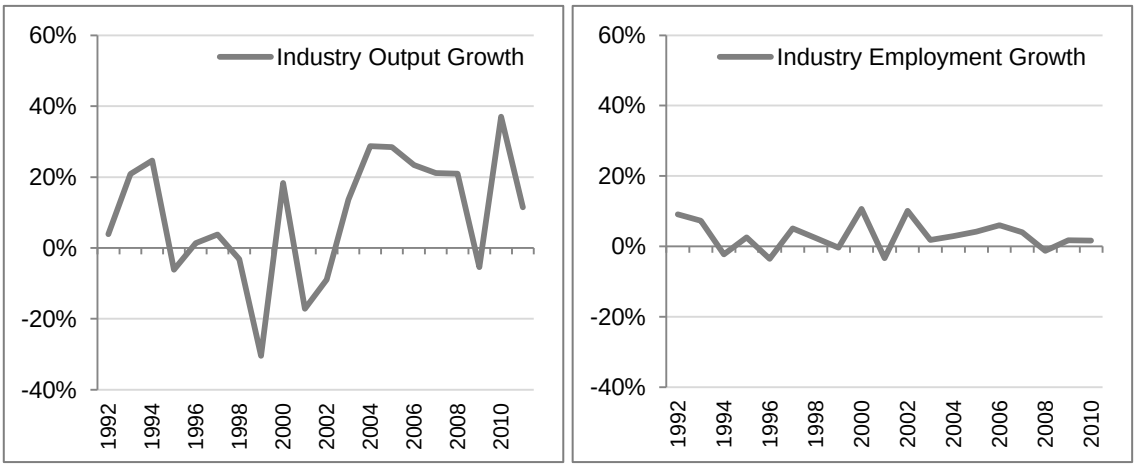

Figure 6: Absolute Industry Output and Employment Growth
Source: The author's illustration, data retrieved from the World Bank.

However, it cannot be ruled out that certain growth determinants or other variables exist that have a positive impact on industry growth, and which therefore offset the effects of the Dutch disease. This does not necessarily imply that the present data is inconsistent with the Dutch disease model, but it is undoubtedly advantageous to also include *relative* deindustrialization in the discussion (Oomes & Kalcheva, 2007). Figure 7 summarizes the relative industry output and employment growth by contrasting it with the agriculture and services output and employment growth. If the above-mentioned growth determinants and other variables, such as technological improvements, affected all sectors equally, the *relative* version of the Dutch disease would imply a slower growth in the industry sector in comparison with the other sectors.

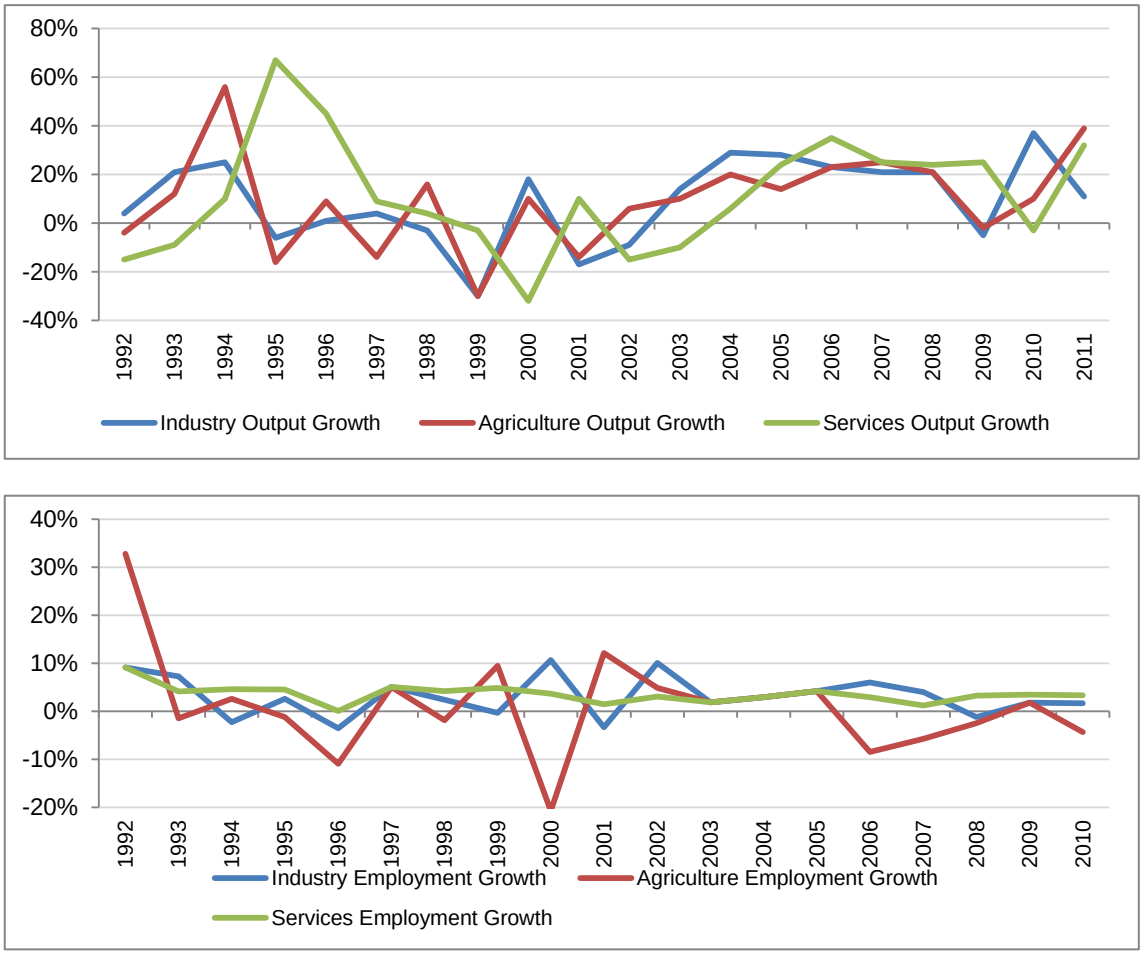

Figure 7: Relative Industry Output and Employment Growth
Source: The author's illustration, data retrieved from the World Bank.

From Figure 7 it can be inferred that neither relative industry output growth nor relative employment growth suggest the existence of the Dutch disease. With respect to output growth, one can definitely discern the aftermath of the 1998/1999 currency crisis and the ensuing recovery, with the exception of 2009. However, it becomes clear that there is no evidence for a relative slowdown of industry output growth. The same interpretation almost applies to the relative industry employment growth. When ignoring some outliers in the agricultural sector, which may be the cause of technological improvements and advanced automating processes, it seems as if the employment growth in the three, respectively two, sectors occurred congruently. Moreover, one can observe comparatively small employment growth within the last several years, which probably arises from an increase in productivity and a surge in capacity utilization (Oomes & Kalcheva, 2007). Notwithstanding, this trend is identifiable for all sectors, and therefore cannot be regarded as an indication for the Dutch disease. All in all, one can say that also in the relative sense the data is not consistent with the Dutch disease hypothesis.

Even if the pure data analysis does not militate in favor of the Dutch disease, it is not possible to completely exclude the possibility that symptom two exists. Therefore, it appears to be appropriate to approach the deindustrialization discussion from a statistical angle. Additionally, one must keep in mind that the considered timeframe was characterized by significant changes, such as the opening up to world markets, the introduction of a new currency, and privatization that had an impact on the development of the Brazilian economy. Furthermore, the classification itself is questionable, as there is no clear separation of commodities from the industry sector. That is why it is more suitable to contemplate another perspective so as to draw final conclusions on whether symptom two is present or not.

5.2.1 Data Sources

The data for this section are retrieved from various databases. The sector-level data, which is used above to characterize absolute and relative deindustrialization,

is provided by the World Bank. The sources of industry-specific data vary according to area of specialization. For example, detailed automotive production data is available from the *International Organization of Motor Vehicle Manufacturers* (OICA). Chemicals production data can be found through the *Associação Brasileira da Indústria Química* (ABIQUIM). Precise textiles production data is accessible through the *Associação Brasileira da Indústria Têxtil* (ABIT). Table 8 provides an overview of this data, which is used in the following discussion to test the industry sector decline.

Table 8: Data Summary for Testing Industry Sector Decline

Variable	Data Origin	Frequency	Observed Timeframe
Industry, Agriculture, and Services Output	World Bank	Annually	1990-2011
Industry, Agriculture, and Services Employment	World Bank	Annually	1990-2011
Automotive Production	OICA	Annually	1999-2010
Chemicals Production	ABIQUIM	Annually	1999-2010
Textiles Production	World Bank, ABIT	Annually	1999-2010
Industry Output in General	World Bank	Annually	1999-2010

Source: The author's illustration.

5.2.2 Empirical Approach and Econometric Methods

The empirical approach, which was applied for the real exchange rate appreciation, must be adjusted to assertion two, industry decline. This means that calculated cointegrating vectors serve as elasticities, which helps to determine their relationship to commodity prices. The difficulty lies within choosing appropriate variables that reflect the situation of the industry/manufacturing sector in Brazil. In the style of Oomes and Kalcheva (2007), the author selected three major industries: automotive, chemicals, and textiles. Each can be considered a non-commodity industry, plays a major role in the Brazilian economy, and has accessible data. The key disadvantage of this approach is that somehow all industries depend on the development of commodity prices, even if only in an indirect sense. Therefore, it is hardly possible to deliver unbiased and unaffected

results. Furthermore, seasonality issues and changes in foreign demand could have an undesirable impact on the conducted research.

5.2.3 Estimation Results and Analysis

After controlling for autocorrelation, stationarity and conducting the cointegration analysis, the VECM delivers the following results:

Table 9: Estimated Cointegrating Vector

	Vector
Ln (Automotive industry production)	**-2.64***
Standard error	(0.01)
Ln (Chemicals production)	**2.23***
Standard error	(0.02)
Ln (Textiles industry production)	**- 3.10***
Standard error	(0.03)
Ln (Industry production in general)	**2.92***
Standard error	(0.04)

Source: The author's illustration, based on computing results in gretl.

The outcomes of the cointegrating vector calculations, displayed in Table 9, are heterogeneous. On one hand, the automotive and textiles industries are negatively correlated to commodity prices, meaning that a rise in commodity prices causes these industries to decline. In detail, this means that a 1% increase in commodity prices leads to a 2.64% decrease in the automotive industry and to a 3.10% decrease in the textiles industry. On the other hand, the coefficient of the chemical industry and the industry in general is positive, implying a favorable impact with respect to an increase in commodity prices. In this case, a 1% rise in commodity prices would cause a 2.23%, respectively 2.92%, surge in the chemicals industry and the industry in general.

The positive effect on the industry in general can be explained by the fact that the major part of the Brazilian industry is based on the extraction and processing of natural resources (IBGE, 2012). A price increase is therefore beneficial for the involved companies. In contrast, the automotive and textiles

industries heavily depend on the price of natural resources, as they are regarded as their major inputs. Hence, it is not conspicuous that high commodity prices negatively affect these industries, since expensive input factors either lead to a mark-up for the end costumer or to revenue cut for the company. Surprisingly, the chemical industry is not affected in the way one would expect. A possible explanation could be the small data-set, which is limited to a very small amount of observations. Moreover, it is undeniable that the chemical industry is very much connected to commodities.

On balance, one can deduce that the hypothesis of the Dutch disease cannot be confirmed, when considering the evaluation of the results concerning the assumed downward movement of the industry. The fact that the industry as a whole is positively correlated to commodity prices particularly allows for the rejection of the notion that a deindustrialization is occurring. Nevertheless, the results have to be treated with caution, as a multitude of industries are directly or indirectly connected to natural resources.

5.3 Test for Services Sector Growth

Although the resource movement and spending effect deliver miscellaneous outcomes regarding the commodity boom's effect on the services sector, it is worthwhile to consider it briefly. Oomes and Kalcheva (2007) accentuate that whether the resource movement or the spending effect preponderates is a question of labor mobility. If labor mobility is low, the spending effect dominates the resource movement effect, and vice versa. Several studies have been conducted on Brazil and its degree of labor mobility. Even though Castillo's, Novick's, Rojo's, and Yoguel's (2005), Paz's (2003), and Guimaraes' (2004) research display high labor mobility for Brazil and Argentina, particularly in the second half of the 1990s, it is more likely to act on the assumption of lower labor mobility. Jones (2010) highlights that Brazil's low degree of labor mobility can be regarded as one of the major causes for the humble wage level and the prevalent poverty in Latin America's biggest economy. Furthermore, the World Bank (2012) places responsibility on the unbending occupational safety principles and the pathetic

income protection systems to decelerate the development of labor mobility in Brazil. On top of this, the transition between jobs diminishes when transferability of social insurance benefits is limited. All in all, one can deduce that labor mobility appears to be comparatively low in Brazil, which is why the author presumes the spending effect to prevail in this case and thus proceeds on the assumption of services sector growth.

5.3.1 Data Sources

The data for the following analysis is taken from the World Bank. For each of the countries the services percentage share of nominal GDP is considered from 1990 to 2011.

5.3.2 Empirical Approach and Choice of Comparison Countries

The author constitutes her approach for this section based on the suggestions of Oomes and Kalcheva (2007), who recommend calculating pairwise correlation coefficients for the services sector share of the nominal GDP between the examined country and similar economies. The idea of this method is to discern whether the Brazilian services sector grew more rapidly than the services sectors in other Latin American countries in the last two decades. If this were confirmed, this would imply a connection to the rapidly escalating commodity prices, and hence evidence for the existence of the Dutch disease. Argentina, Mexico, Chile, Peru, Colombia, and Venezuela have been chosen as comparison countries, since these six states, together with Brazil, compose the biggest economies in Latin America with respect to their GDP (World Bank, 2012). Moreover, these countries can look back on a comparable history, which began with the colonization mainly by the Spanish and Portuguese that was determined by dictatorships and oppression in the middle of the twentieth century and is now dedicated to the persistence of stable democracies, the reduction of poverty, and economic advancement. In addition, most of the selected countries exhibit similar economic features in the presence and the past, such as the switch from import substitution to liberal markets,

natural resource abundance, instability in currency values, high inflation rates, and national bankruptcy (Baer, 2008; Hay, 2001; Rigolon & Giambiagi, 1999; Willumsen & Fonseca, 1997).

5.3.3 Estimation Results and Analysis

Bivariate correlation coefficients are computed for Brazil and each chosen country. The separate contemplation of several periods allows for the construction of sub-periods of six and four years, respectively. Calculation results are displayed in Table 10 below:

Table 10: Correlation Matrix Services Sector Share of GDP

	1990-1995	1996-2001	2002-2007	2008-2011
Brazil (Services share 1990: 53%, 2011: 67%)	1.00	1.00	1.00	1.00
Mexico (Services share 1990: 64%, 2011: 57%)	-0.13	-0.88	-0.22	0.43
Argentina (Services share 1990: 56%, 2011: 65%)	0.21	-0.76	0.85	0.40
Chile (Services share 1990: 50%, 2011: 62%)	0.13	0.00	0.48	0.00
Peru (Services share 1990: 64%, 2011: 58%)	-0.30	-0.71	-0.42	0.43
Venezuela (Services share 1990: 34%, 2007: 42%)	0.42	0.00	0.33	na
Colombia (Services share 1990: 45%, 2011: 62%)	0.31	-0.96	0.43	0.82

Source: The author's illustration, based on computing results in gretl.

According to the obtained correlations between Brazil and the comparison countries, it becomes clear that in most of the cases, with the exception of Argentina and Colombia, there is little, none or even a negative connection. This infers that the share of services in Brazil must have increased at a more rapid pace than in most of the other Latin American countries. Whereas Mexico and Peru have cut back their services share, Brazil, Argentina, Chile, and Venezuela have augmented their services contribution with respect to the GDP. The period from

1996 to 2001 is especially peculiar in that almost all of the countries displayed an opposite trend to that of Brazil. One can derive that Brazil's comparatively rapid growth in recent years could allude to the presence of the Dutch disease. Notwithstanding, this approach should be regarded with caution, as it does not deliver definite evidence as to whether the services growth is attributable to the surge in commodity prices. On the other hand, the relatively high services sector growth rates cannot be ignored, which as a matter of fact could indeed be a hint to the existence of the Dutch disease in the case of Brazil.

5.4 Test for Wage Growth

General wage growth is perceived to be the fourth symptom a country suffers from when afflicted with the Dutch disease. Both, resource movement and spending effect lead to the conclusion that it is impossible to avoid a real wage increase. From the resource movement perspective, the wage level first rises in the energy sector as a consequence of a commodity boom. As labor is assumed to be mobile, the working population then shifts from the services and manufacturing sector to the energy sector, which is why the services and manufacturing sector are thus incentivized to similarly raise their wage levels. From the spending effect perspective, on the other hand, the wage level first rises in the services sector, owing to the fact that a general income enhancement calls forth a demand increase of non-tradable goods. Labor then moves to the services sector, which is why the energy and manufacturing sectors also increase their wage level. On these grounds, it is essential to incorporate wage discussion in the analysis.

5.4.1 Data Sources

The general availability of time series of Brazilian wage data is limited. Several databases, such as the *Instituto Brasileiro de Geografia e Estatística* (IBGE) or the *Instituto de Pesquisa Econômica Aplicada* (IPEA), provide insights into the development of the wage level in Brazil. However, hardly any data address the sector-specific evolution of wages when distinguishing between energy, services,

and industry. Therefore, a broader approach must be considered so as to still deliver at least some results with respect to symptom four of the Dutch disease. The author decided to use an IBGE data series called *Total dos salários* (Total salaries), which embraces salaries for the extractive and transformation industries, using yearly data from 1996 to 2007. Hence, at any rate the manufacturing and energy sectors are somewhat comprised in the examination.

5.4.2 Empirical Approach

As it appears to be very difficult to test the wage drivers in an exact manner due to missing data and clear distinction between the sectors, the author is geared to adapt part of the approach used by Oomes and Kalcheva (2007). They principally display growth rates of the respective sectorial wages within the last years and attempt to draw parallels to the Dutch disease. On this basis, the author calculated the nominal and real growth rates for the total salaries data series, illustrated below in Figure 8.

5.4.3 Estimation Results and Analysis

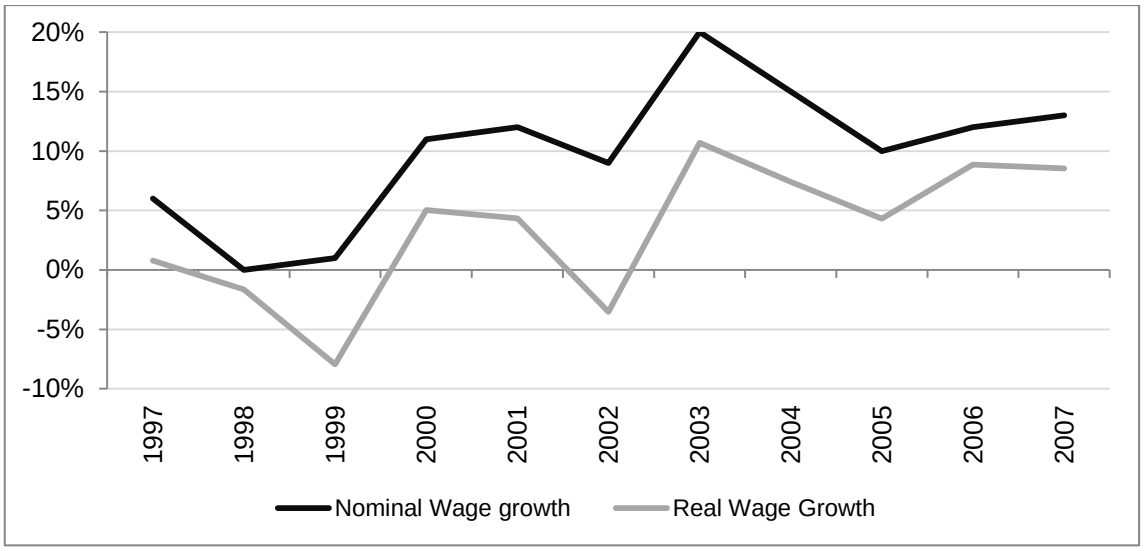

Figure 8: Wage Growth for Total Salaries
Source: The author's illustration, data retrieved from IBGE.

Even if this representation does not allow for the identification whether in the case of Brazil it is a matter of the spending or resource movement effect, one can still deduce that nominal and real wages grew after the currency crisis of 1998/1999. The only year that breaks from this growth pattern is 2002, when inflation outpaced growth. It seems as if there is explicit evidence that at least after 2002 wages grew about 4 to 11% per year when considering real terms, which suggests indications for the presence of the Dutch disease. Nevertheless, the wage increase could well be explained by other factors, such as the "de-shadowization" of wages, implying that formerly unregistered wages have recently started to emerge in official statistics, meaning that only a reported real wage growth rather than an actual real wage growth is present (Oomes & Kalcheva, 2007). Therefore it is hard to draw a final conclusion and to judge whether the observed real wage growth in the data can be attributed to the existence of the Dutch disease.

6 Conclusion, Limitations, and Further Research Suggestions

The underlying thesis aimed at examining whether Brazil's sectorial development structure and the rising commodity prices trigger Dutch disease effects on Latin America's biggest emerging economy. Based on the research findings in section five, one can deduce that a multitude of Dutch disease symptoms are present in the case of Brazil. With the exception of the second symptom, all symptoms can be verified and, hence, are suggestive of the natural resource curse. Regarding the first symptom, there is no doubt that commodity prices indeed have a significant impact on the real exchange rate and that the Brazilian real was continuously overvalued in the examined timeframe, excluding the currency crisis of 1998/1999. By adapting cointegration methodology, the author was able to express a selection of exchange rate determinants in the terms of elasticities. Commodity prices were among the most influential drivers of the currency transition rate; however, they were by far not the only factor that boosted the appreciation of the Brazilian real. Even if this result indicates the existence of the Dutch disease, it is vital to keep in mind the just addressed further determinants, in this case particularly government consumption, which have a bearing on the value of the exchange rate.

When perusing the second symptom of the Dutch disease, it becomes explicit that the outcomes are rather heterogeneous and do not offer exact clues on the progression of the Brazilian industry. Also for this investigation cointegration technique was suitable, as cointegration vectors, respectively elasticities, were required for the analysis after Oomes and Kalcheva (2007). The author observed a positive correlation between the industry data in general and the commodity prices, implying a rejection of the Dutch disease hypothesis and the concomitant deindustrialization. All the same, one cannot neglect that natural resources contribute a tremendous amount to industry in the case of Brazil, which is why also this result has to be interpreted with caution.

The third symptom, services sector growth, could also be proved by calculating correlation coefficients between Brazil and other Latin American economies. Brazil's services sector grew at a noticeably more rapid pace than the

equivalent of most examined countries, indicating the presence of the Dutch disease. Nevertheless, the question still arises whether this approach really delivers the necessary evidence that the services sector growth can mainly be explained by the increase of commodity prices and that no other features played a determining role in this structural development. Considering the fourth symptom, similar observations can be made. On the one hand, nominal and real wage growth is denoted, but, on the other hand, it is debatable whether this development is attributable to the Dutch disease. As mentioned in section five, other components, such as the "deshadowization of wages" may also be responsible for the results. However, hypothesis four is at hand in reality, which confirms once again the infection with the Dutch disease.

Altogether, the initial research question, which had the purpose to detect whether Brazil suffers from the Dutch disease and therefore faces the threat of deindustrialization, cannot be answered with a simple yes or no. The central hypothesis, stating that Brazil is indeed afflicted with the Dutch disease, but only to a certain extent, cuts right to the chase of the matter. Three out of four symptoms can be identified, showing that it is not so far off to associate Brazil in conjunction with the natural resource curse. Despite this rough affirmation of the initial research question, one has to ponder on the missing evidence of symptom two, which at the end of the day is the most essential for the overall context. Consequently, one cannot refer to the term deindustrialization in the present case of Brazil. Therefore, two major conclusions of this work can be drawn: first, Brazil is displaying a plethora of Dutch disease symptoms. Second, deindustrialization is nothing of the sort. Notwithstanding, it is advisable for Brazil to further diversify its industry sector so as to gain more independence from commodities. Technology investments, which have the potential to bring about the required competitive advantage Brazil's industry is in need of should be focused on. As a consequence, the country would not only be noticed as a raw-material supplier, but also appreciated as a pioneer in specific industries. Granted that the government and the companies are able to implement and consider these recommendations, Brazil

really has the chance to assert itself globally and remain/become an attractive investment target for investors.[31]

Further research is needed in order to definitely confirm the diagnosis of the Dutch disease. Expanded data, a specific commodity index for Brazil, consideration of additional exchange rate drivers and examination of more industries are some ideas that could be taken into account and elaborated in the future. Over and above, an econometric approach to appropriately test symptom four is desirable so as to also deliver significant statistical evidence with regard to real wage growth.

31 For investment decisions, see also Ramey and Ramey (1995) who find that high volatility in data is not beneficial for sustainable growth.

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Appendix 1: Composition of Value Added to the Brazilian Industry per Technology Type

Tabela 1: Composição do valor adicionado na indústria brasileira por tipo de tecnologia no período 1996-2004 (em %)

	Valor adicionado setorial (participação em %)								
Setores industriais com tecnologia	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Baseada em recursos naturais	32,70	32,09	33,36	36,79	38,32	39,15	40,05	42,47	40,10
Extração de carvão mineral	0,07	0,08	0,08	0,07	0,08	0,06	0,06	0,06	0,07
Extração de Petróleo, gás e serviços relacionados	0,03	0,03	0,05	0,04	0,05	0,09	0,25	0,32	0,34
Extração de minerais metálicos	1,46	1,55	1,87	2,28	2,07	2,21	2,28	2,22	2,52
Extração de minerais não-metálicos	0,68	0,62	0,65	0,62	0,58	0,58	0,56	0,56	0,52
Alimentos e bebidas	17,22	17,53	17,69	16,45	14,05	16,09	16,26	16,20	15,22
Produtos do fumo	1,10	1,03	0,95	1,04	0,80	0,87	0,85	0,78	0,73
Preparação do couro	0,30	0,28	0,23	0,25	0,22	0,31	0,36	0,33	0,34
Produtos de madeira	1,11	1,13	1,10	1,39	1,20	1,26	1,41	1,68	1,69
Fabricação de papel e outras pastas para fabricação de papel	0,67	0,52	0,44	0,82	1,16	0,90	1,08	1,02	0,67
Fabricação de coque e refino de pertróleo	5,45	4,48	5,60	9,20	13,27	11,93	12,16	14,32	13,50
Produção de álcool	1,53	1,36	0,81	0,64	0,77	0,60	0,49	0,80	0,55
Metalurgia de não-ferrosos	1,25	1,48	1,38	1,80	1,78	1,73	1,77	1,79	1,92
Cimento e outros produtos minerais não metálicos	1,83	2,00	2,51	2,19	2,29	2,52	2,52	2,39	2,03
Intensiva em trabalho	**13,56**	**12,56**	**12,90**	**12,15**	**11,50**	**11,22**	**10,69**	**9,88**	**9,69**
Têxteis	3,26	2,86	2,93	3,06	2,84	2,54	2,45	2,21	2,17
Vestuário	2,30	2,09	2,15	1,95	1,76	1,69	1,48	1,37	1,30
Artigos para viagem e artefatos de couro	0,11	0,11	0,11	0,11	0,14	0,13	0,11	0,08	0,08
Calçados	1,83	1,52	1,46	1,55	1,52	1,63	1,64	1,62	1,52
Fabricação de produtos de metal (exceto máquinas e equipamentos)	3,81	3,75	3,87	3,39	3,11	3,29	3,15	2,89	3,05
Móveis e indústrias diversas	2,25	2,23	2,38	2,09	2,13	1,94	1,86	1,71	1,57
Intensiva em escala	**35,78**	**36,91**	**35,79**	**33,80**	**33,19**	**31,69**	**32,64**	**33,15**	**35,61**
Produtos cerâmicos para construção civil e para usos diversos	0,97	1,00	1,00	0,89	0,80	0,73	0,77	0,69	0,68
Fabricação de produtos e artefatos de papel e papelão	3,07	2,90	3,07	3,20	3,13	2,95	3,43	3,31	3,18
Edição, impressão e reprodução de gravações	4,92	5,25	5,25	4,18	4,08	3,69	3,22	2,92	2,92
Produtos químicos	9,24	9,36	9,01	10,33	9,02	9,03	8,53	8,38	8,81
Artigos de borracha e plástico	4,06	4,05	3,99	3,79	3,64	3,17	3,23	3,84	3,47
Vidro e produtos de vidro	0,61	0,65	0,55	0,60	0,59	0,58	0,60	0,56	0,60
Metalurgia básica	4,15	4,34	4,21	4,21	4,58	4,44	5,22	5,34	7,40
Veículos automotores	8,12	8,65	8,00	6,01	6,83	6,49	6,97	7,37	7,69
Equipamentos de transporte ferroviário, naval e outros (exceto aeronáuticos)	0,64	0,71	0,71	0,59	0,52	0,61	0,67	0,74	0,86
Diferenciada	**12,98**	**13,03**	**12,02**	**11,20**	**11,18**	**11,82**	**11,18**	**9,60**	**10,00**
Máquinas e equipamentos	6,81	6,94	6,40	5,75	5,28	5,92	6,07	5,71	5,82
Máquinas, aparelhos e materiais elétricos	2,12	2,19	2,30	2,06	2,03	2,17	1,92	1,69	1,65
Material eletrônico, aparelhos e equipamentos de comunicação	3,55	3,39	2,78	2,88	3,36	3,28	2,73	1,75	2,12
Equipamentos de instrumentação médico-hospitalares	0,29	0,29	0,31	0,30	0,30	0,25	0,29	0,28	0,27
Instumentos ópticos, cronômetros e relógios	0,21	0,22	0,23	0,21	0,21	0,20	0,17	0,17	0,14
Baseada em ciência	**4,96**	**5,33**	**5,89**	**6,02**	**5,75**	**6,06**	**5,40**	**4,82**	**4,54**
Produtos farmacêuticos	3,42	3,49	3,68	3,64	2,88	2,54	2,62	2,45	2,32
Máquinas de escritório e equipamentos de informática	0,49	0,54	0,56	0,76	1,11	1,34	0,72	0,60	0,47
Equipamentos de distribuição de energia elétrica	0,51	0,63	0,85	0,41	0,39	0,42	0,35	0,54	0,40
Aparelhos e instrumentos de medida, teste e controle	0,26	0,25	0,26	0,25	0,28	0,27	0,25	0,18	0,22
Máquinas e aparelhos de automação industrial	0,08	0,08	0,09	0,08	0,08	0,07	0,08	0,06	0,06
Equipamentos de transporte aeronáuticos	0,20	0,34	0,45	0,88	1,01	1,42	1,38	0,99	1,07

Nota 1: Os totais podem ser ligeiramente superiores ou inferiores a 100% por problemas de aproximação.
Fonte: Elaboração própria com base nos dados do IBGE, Pesquisa Industrial Anual.

Appendix 2: Brazilian Industry Exports per Technology Type

Tabela 2: Exportações industriais brasileiras por tipo de tecnologia
Taxas de crescimento médias anuais e participação setorial (em %)

	Taxas de crescimento médias anuais (em %)					Participação setorial (%)				
Setores industriais com tecnologia	**1989-1994**	**1994-1999**	**1999-2004**	**2004-2005**	**1989-2005**	**1989**	**1994**	**1999**	**2004**	**2005**
Baseada em recursos naturais	3,12	4,34	12,03	18,35	7,14	39,68	39,72	44,27	45,80	46,93
Extração de carvão mineral	-13,66	-5,56	-1,62	2,48	-6,51	0,00	0,00	0,00	0,00	0,00
Extração de Petróleo, gás e serviços relacionados	-	505,42	326,89	53,59	-	0,00	0,00	0,00	2,94	3,91
Extração de minerais metálicos	-1,09	2,37	9,05	42,58	5,46	8,19	6,66	6,74	6,10	7,53
Extração de minerais não-metálicos	-5,17	9,50	10,97	-1,24	4,45	0,61	0,40	0,57	0,56	0,48
Alimentos e bebidas	3,04	5,57	10,49	10,08	6,55	17,44	17,39	20,55	19,84	18,91
Produtos do fumo	35,96	-13,87	1,66	-1,09	5,53	0,29	1,15	0,49	0,31	0,27
Preparação do couro	12,05	4,56	12,95	0,85	9,21	0,81	1,23	1,38	1,49	1,30
Produtos de madeira	18,96	4,70	13,76	-7,00	11,00	1,37	2,80	3,17	3,54	2,85
Fabricação de papel e outras pastas para fabricação de papel	2,89	7,00	3,45	10,09	4,78	2,31	2,28	2,89	2,00	1,91
Fabricação de coque e refino de pertróleo	-3,06	7,10	19,28	42,68	9,31	2,85	2,10	2,66	3,77	4,65
Produção de álcool	33,76	-6,19	44,90	43,15	23,27	0,06	0,24	0,16	0,58	0,72
Metalurgia de não-ferrosos	0,80	2,35	5,95	6,48	3,22	5,44	4,86	4,92	3,85	3,55
Cimento e outros produtos minerais não metálicos	17,86	5,81	13,33	20,39	12,72	0,32	0,62	0,74	0,81	0,85
Intensiva em trabalho	4,31	-3,69	8,49	0,74	2,77	10,42	11,05	8,25	7,26	6,34
Têxteis	0,22	-5,31	10,08	-1,15	1,30	3,07	2,66	1,83	1,73	1,48
Vestuário	4,40	-15,95	12,40	-5,65	-0,79	0,94	1,00	0,38	0,40	0,32
Artigos para viagem e artefatos de couro	2,24	14,47	17,06	-2,39	10,17	0,06	0,06	0,11	0,14	0,12
Calçados	2,89	-4,52	3,89	-2,83	0,46	4,40	4,36	3,12	2,21	1,86
Fabricação de produtos de metal (exceto máquinas e equipamentos)	9,03	-2,60	9,00	16,82	5,70	1,17	1,55	1,22	1,10	1,12
Móveis e indústrias diversas	16,26	4,57	12,48	-1,38	10,18	0,78	1,42	1,60	1,69	1,44
Intensiva em escala	2,49	-1,04	12,09	14,72	4,99	36,04	34,98	29,92	31,03	30,82
Produtos cerâmicos para construção civil e para usos diversos	5,68	-0,75	10,28	3,09	4,85	0,62	0,70	0,61	0,58	0,52
Fabricação de produtos e artefatos de papel e papelão	7,62	-1,68	1,81	9,60	2,94	2,02	2,50	2,07	1,33	1,26
Edição, impressão e reprodução de gravações	17,15	3,73	7,95	-11,50	8,02	0,07	0,14	0,15	0,13	0,10
Produtos químicos	3,53	2,08	8,18	14,31	5,15	6,59	6,72	6,71	5,83	5,77
Artigos de borracha e plástico	12,66	0,61	6,45	12,64	6,84	1,40	2,18	2,02	1,62	1,58
Vidro e produtos de vidro	11,49	6,71	5,38	-3,16	7,10	0,23	0,35	0,43	0,33	0,28
Metalurgia básica	-2,73	-6,11	14,24	19,04	2,44	14,80	11,06	7,27	8,30	8,55
Veículos automotores	3,31	2,87	12,67	25,61	7,31	9,98	10,09	10,47	11,14	12,12
Equipamentos de transporte ferroviário, naval outros (exceto aeronáuticos)	34,67	-31,15	76,99	-57,81	10,61	0,33	1,25	0,17	1,77	0,65
Diferenciada	5,26	0,70	11,54	21,23	6,65	10,06	11,15	10,41	10,53	11,05
Máquinas e equipamentos	6,56	-1,67	12,36	3,18	5,44	6,61	7,80	6,46	6,78	6,06
Máquinas, aparelhos e materiais elétricos	11,61	-0,13	10,34	31,16	8,51	1,11	1,64	1,47	1,41	1,60
Material eletrônico, aparelhos e equipamentos de comunicação	-2,77	10,29	10,35	73,51	9,10	2,00	1,49	2,19	2,10	3,16
Equipamentos de instrumentação médico-hospitalares	15,88	9,00	12,53	14,51	12,56	0,07	0,13	0,18	0,19	0,19
Instumentos ópticos, cronômetros e relógios	-17,88	5,37	-5,84	16,37	-5,31	0,27	0,09	0,10	0,04	0,04
Baseada em ciência	-1,05	20,72	5,10	4,37	7,66	3,80	3,10	7,16	5,38	4,86
Produtos farmacêuticos	11,45	15,36	1,20	20,20	9,83	0,28	0,41	0,75	0,47	0,49
Máquinas de escritório e equipamentos de informática	-3,31	15,57	-9,56	33,52	2,16	0,81	0,59	1,09	0,39	0,45
Equipamentos de distribuição de energia elétrica	11,10	0,05	5,14	8,26	5,51	0,22	0,32	0,29	0,22	0,20
Aparelhos e instrumentos de medida, teste e controle	15,42	4,48	-1,16	10,53	6,30	0,24	0,42	0,47	0,26	0,25
Máquinas e aparelhos de automação industrial	-	-	-	-	-	0,00	0,00	0,00	0,00	0,00
Equipamentos de transporte aeronáuticos	-6,78	29,95	8,69	-0,85	8,92	2,26	1,36	4,55	4,05	3,48
Total da Indústria	3,10	2,10	11,28	15,49	6,02	86,69	85,57	89,72	89,05	89,97

Nota: 1. Para o cálculo das taxas de crescimento médias anuais, o valor das exportações foi deflacionado com base no Producer Price Index - Wholesale (PPI - Wholesale) - dos E.U.A, a preços de 1994.
2. O total não corresponde a 100%, porque os dados restringem-se à indústria (incluíndo a extrativa mineral)
Fonte: Elaboração própria com base nos dados da SECEX.

Statutory Declaration

I hereby declare

- that I have written this thesis without any help from others and without the use of documents and aids other than those stated above,
- that I have mentioned all used sources and that I have cited them correctly according to established academic citation rules.

Date	Signature