United States International Trade Commission
Journal of International Commerce and Economics

Measuring Shifts in Brazil's Trade Using International Input-Output Tables

Web Version:
April 2014

Authors[1]:
Jeffrey Horowitz and David Riker

Abstract

In this paper, we use information from the World Input-Output Database (WIOD) and a method for decomposing the value-added contributions of each country in international trade flows to measure shifts in Brazil's exports between 1995 and 2009. The database allows us to separate gross trade flows into intermediate and final products and to trace Brazil's value added to the country of final use. Over the fifteen year period covered by WIOD, there was a shift in Brazil's exports of intermediate and final goods away from services and other manufactured products toward greater specialization in the country's traditional areas of comparative advantage, agricultural and mineral products. There was also a shift in Brazil's exports toward East Asia and developing countries and away from the European Union and the United States. However, the redirection of Brazil's exports to East Asia does not reflect a significant shift in the ultimate destination of Brazil's value added from its traditional markets. According to our calculations of trade in value added, Brazil's exports of intermediate goods and services to East Asia have been increasingly incorporated into East Asia's exports to the United States and the European Union.

Suggested citation: Horowitz, Jeffrey and David Riker. "Measuring Shifts in Brazil's Trade Using International Input-Output Tables." *Journal of International Commerce and Economics*. Published electronically April 2014. *http://www.usitc.gov/journals*.

[1] This article is the result of the ongoing professional research of ITC staff and is solely meant to represent the opinions and professional research of the authors. It is not meant to represent in any way the views of the U.S. International Trade Commission or any of its individual Commissioners. Please direct all correspondence to David Riker, Office of Economics, U.S. International Trade Commission, 500 E Street, SW, Washington, DC 20436, or by email to *David.Riker@usitc.gov.*

INTRODUCTION

In this article, we use information from the World Input-Output Database (WIOD) and a method for calculating the value added of each country in international trade flows to examine shifts in Brazil's exports between 1995 and 2009. This rich data set separates trade in intermediate products from trade in final products. With this additional information, we calculate the value-added components of Brazil's output and trade flows. We examine trends in the data, establish a set of stylized facts, and document patterns in Brazil's trade flows.

Overall, we find that during the fifteen years for which WIOD provides data, Brazil's exports shifted toward greater specialization in the country's traditional areas of comparative advantage: agricultural and mineral products. At the same time, the exports shifted toward East Asia and developing countries. However, the redirection of Brazil's exports to East Asia does not reflect a significant shift in the ultimate destination of Brazil's value added from its traditional export markets. According to our calculations of trade in value added, Brazil's exports to East Asia have been increasingly incorporated into East Asia's exports to the United States and the European Union.

Our analysis contributes to a small but growing literature on how Brazil participates in global value chains.[2] It is closest to the branch of the literature that takes the macroeconomic approach, such as Chen (2012).[3] Chen's study examines sector-level trade flows between 2000 and 2010. It finds that Brazil is the least trade-dependent of the emerging BRIC countries, and that its export growth has been dominated by resource-based manufactures and primary products.

The article is organized into the following sections. Section 2 introduces key economic concepts relevant to this analysis. Section 3 provides details about WIOD and discusses its strengths and limitations. Section 4 describes the method that we used to calculate Brazil's exports of value added. Sections 5 and 6 document the shifts in Brazil's exports across products and destination markets. Finally, Section 7 offers concluding remarks.

[2] The term *global value chain* describes the international staging of vertically integrated production: final products are the result of a series of production stages, and the final and intermediate stages can be located in different countries and connected by international trade.

[3] A second branch of the literature focuses more narrowly on the specific firms and industries. Examples of this microeconomic approach include Filho et al. (2006) in Brazil's metalworking industry, Gomes (2006) in Brazil's fresh fruit industry, and Strachman and Pupin (2011) in Brazil's sugar and alcohol sectors.

ECONOMIC CONCEPTS

In our analysis of the shift in Brazil's exports, we distinguish between final products and intermediate products. Final products are goods and services that are consumed or are invested as capital goods. Intermediate products are goods and services that are used in the production of downstream products, including final products and other intermediates.

Gross exports are a traditional measure of a country's trade flows. Gross exports are defined as the total value of all of the goods and services that the country sells to foreign nationals. They include the value of any intermediates that are used in production, even if these intermediates are imported from another country. A common criticism of gross exports as a measure of trade is that it overstates the value that a country contributes to its exports.[4]

To address this issue, economists have developed methods and data sets to better estimate the value that a country contributes to international trade flows. Exports of value added is defined as the value of a country's factors of production that is incorporated into goods and services that are ultimately consumed or invested as capital in another country.

The easiest way to explain the difference between gross exports and exports of value added is to use a hypothetical numerical example. Suppose that Brazil produces an intermediate mineral product valued at $10 million and exports the product to China. In China, this intermediate import is used to produce $15 million in final products by adding $5 million in Chinese value. The final product is then exported from China to the United States, where it is consumed.

As a result of this series of international trades, China's gross exports to the United States are $15 million, but its exports of value added to the United States are $5 million. Brazil's gross exports to China are $10 million, but this $10 million is consumed in the United States, so it is classified as a Brazilian export of value added to the United States. This simple example illustrates the distinction between the gross and value-added measures of exports when some of the value of the final product is exported more than once (from Brazil to China, then from China to the United States). It also illustrates the distinction between direct exports and indirect exports. Brazil is exporting $10 million of the mineral product directly to China, and Brazil is exporting the same $10 million of the mineral product indirectly to the United States by way of China. The value that originated in Brazil enters consumption in the United States, though there is no direct trade between the two countries in the example.

[4] Koopman, Wang, and Wei (2014) discuss this issue and a related concern about "double counting" in gross exports.

DATA SOURCES

Our calculations of exports of value added are based on the international input-output (IIO) tables in the recently published WIOD.[5] An IIO table reports how the output of each sector in each country is distributed across intermediate and final uses in different countries. The WIOD tables also provide information on the direct value added in each sector in each country. The tables are disaggregated into 35 sectors and 40 countries, including Brazil, plus an aggregate of the Rest of the World. We compare data for the first and final years that are available in WIOD, 1995 and 2009.[6] In order to simplify our graphical analysis of the data below, we combine the WIOD sectors into four product groups (agriculture and food products, mining and petroleum products, other manufactures, and services), and we combine the WIOD countries other than Brazil into four destination regions (the United States, the European Union, East Asia, and the Rest of the World). Table 1 lists the WIOD sectors and countries that are included in each of these product groups and regions.

The WIOD IIO table is valuable because it is comprehensive: it covers all global trade and all of the sectors in each country's national income accounts, and it disaggregates inter-industry and international shipments by use. However, it is important to keep in mind that the trade data by use are not based on direct observations. The IIO tables, like many national economic statistics, are approximations that are constructed by allocating aggregate values across sectors and uses.

TABLE 1 Aggregation of WIOD Sectors and Countries

Product Groups	WIOD Sectors Included
Agriculture and Food Products	Agriculture, Hunting, Forestry and Fishing; Food, Beverages and Tobacco
Mining and Petroleum Products	Mining and Quarrying; Coke, Refined Petroleum and Nuclear Fuel
Other Manufacturing	Textiles and Textile Products; Leather, Leather Products, and Footwear; Wood and Products of Wood and Cork; Pulp, Paper, Paper Products, Printing and Publishing; Chemicals and Chemical Products; Rubber and Plastics; Other Non-Metallic Mineral Products; Basic Metals and Fabricated Metal; Machinery NEC; Electrical and Optical Equipment; Transport Equipment; Manufacturing NEC
Services	All Other WIOD sectors

[5] Timmer et al. (2012) explains how this database was constructed. The data are publicly available online at *www.wiod.org.*

[6] These years represent the starting and ending dates of the data available in WIOD. However, 2009 may not be a representative year due to the global recession. It will be informative to extend the analysis as the data become available for subsequent years.

TABLE 1 Aggregation of WIOD Sectors and Countries (cont'd)

Regions	WIOD Countries Included
United States	United States
European Union	Austria; Belgium; Bulgaria; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Great Britain; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden
East Asia	China; Japan; Korea; Taiwan
Rest of the World	Australia; Canada; India; Indonesia; Mexico; Russia; Turkey; WIOD's Rest of World aggregated

CALCULATING EXPORTS OF VALUE ADDED

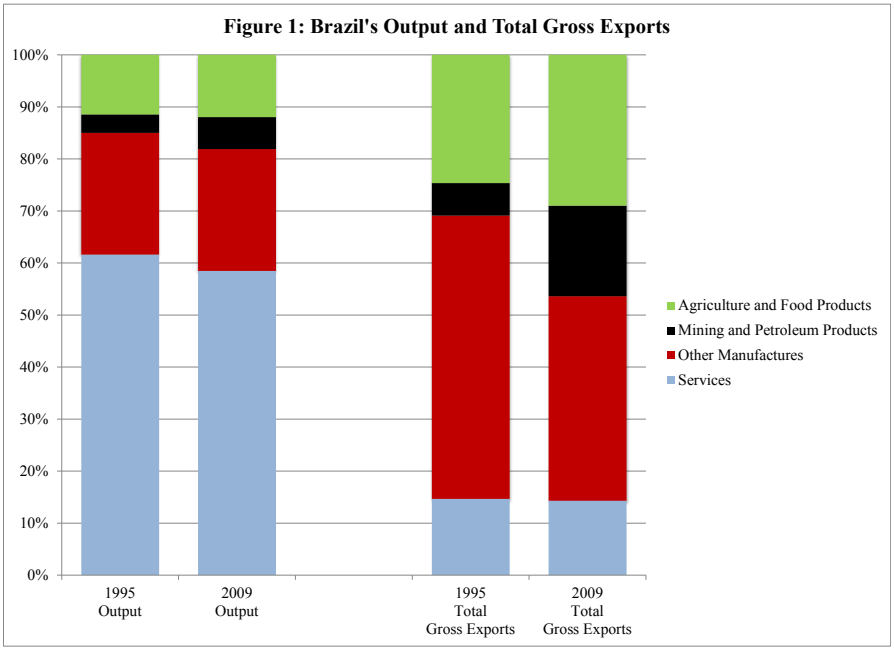
We calculate the exports of value added based on the WIOD IIO tables and a methodology developed in Johnson and Noguera (2012), Powers (2012), and Koopman, Wang, and Wei (2014). First, we used the tables to calculate the direct value added in the final stage of production of each sector in each country. We repeated this calculation of value added for the imported and domestic intermediate products that were used in this final stage of production, and then for the intermediate products that were used in each prior stage of production, until the full value of the final products was allocated among all of the countries of origin. The Appendix provides a technical description of these calculations. In the remaining sections, we present the results of these calculations.

SHIFTS IN THE PRODUCT SHARE OF EXPORTS

The data from the WIOD suggests that the Brazilian economy has increased its participation in global trade over the fifteen-year period, and the types of products exported have shifted as well. Table 2 and figure 1 report WIOD-based estimates of the value of Brazil's output and gross exports for the four product groups in 1995 and 2009 (in 2009 U.S. dollars). According to the WIOD data, Brazil exported 4.4 percent of its output in 1995, and this share rose to 6.3 percent by 2009. Additionally, there were modest changes in the product shares of Brazil's output but more significant shifts in the product shares of the country's gross exports. Mining and petroleum products rose as a share of Brazil's output (from 3.6 to 6.1 percent) and as a share of Brazil's exports (from 6.3 to 17.4 percent). There was also a significant increase in the share of agriculture and food products in gross exports (from 24.6 to 29.0 percent) and a decline in the share of the other manufactures product group exports, but there was little change in the two groups' shares of total output. There were only small changes in the output and export shares of services.

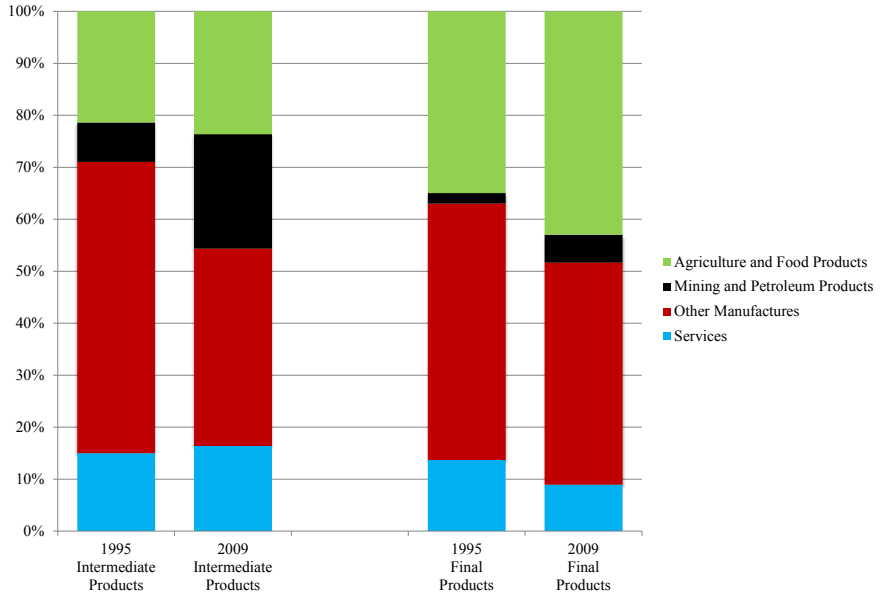
TABLE 2 Brazil's Output and Gross Exports by Sector

Output (Billions of 2009 US Dollars)	Agriculture and Food Products	Mining and Petroleum Products	Other Manufactures	Services
Value in 1995	193.9	60.1	395.7	1,043.1
Value in 2009	337.9	172.9	661.1	1,650.4
Average Annual Growth Rate	5.0	12.5	4.5	3.9
Gross Exports of Intermediate Products (Millions of 2009 US Dollars)	**Agriculture and Food Products**	**Mining and Petroleum Products**	**Other Manufactures**	**Services**
Value in 1995	12.2	4.3	31.9	8.5
Value in 2009	30.2	28.2	48.6	20.9
Average Annual Growth Rate	9.88	36.65	3.48	9.68
Gross Exports of Final Products (Millions of 2009 US Dollars)	**Agriculture and Food Products**	**Mining and Petroleum Products**	**Other Manufactures**	**Services**
Value in 1995	6.3	0.4	8.9	2.5
Value in 2009	21.1	2.6	21.0	4.4
Average Annual Growth Rate	15.7	41.6	9.1	5.2



The growing importance of Brazil's exports of intermediate mining and petroleum products becomes more apparent as we further disaggregate the gross export data into exports of intermediate and final products (figure 2).[7] The largest gains in product shares were in the country's exports of intermediate mining and petroleum products (from 7.6 to 22.0 percent) and its exports of final agriculture and food products (from 35.0 to 42.7 percent). The largest declines in product shares were in Brazil's exports of intermediate and final manufactures.

Figure 2: Brazil's Gross Exports of Final and Intermediate Products



SHIFTS IN THE REGIONAL SHARE OF EXPORTS

There were also large shifts in the regional shares of Brazil's exports over the fifteen years. Table 3 reports the shifts in the shares of the four destination regions for Brazil's gross exports and its exports of value added.[8] The combined share of the European Union and the United States declined according to both of these measures, while the combined share of East Asia and the Rest of the World rose. The largest shift was in Brazil's gross exports of final products: the share exported to the United States declined by 15.1 percentage points and the share exported to the European Union declined by 10.1 percentage points. In contrast, the share exported to

[7] Overall, intermediate products account for approximately three-fourths of Brazil's gross exports.

[8] The export values in this table are aggregates of the four product groups.

the Rest of the World countries rose by 26.2 percentage points.[9] This reflects the higher growth rates in the final expenditures in the Rest of the World.[10]

TABLE 3 Regional Shares of Brazil's Gross and Value-Added Exports

Gross Exports Final Goods and Services	European Union	United States	East Asia	Rest of the World
Percentage in 1995	34.15	23.69	7.97	34.18
Percentage in 2009	24.05	8.63	6.91	60.40
Percentage Point Change	-10.10	-15.06	-1.06	+26.22

Gross Exports Intermediate Goods and Services	European Union	United States	East Asia	Rest of the World
Percentage in 1995	33.70	14.94	12.35	39.00
Percentage in 2009	28.69	10.63	24.59	36.08
Percentage Point Change	-5.01	-4.31	+12.24	-2.92

Value-Added Exports	European Union	United States	East Asia	Rest of the World
Percentage in 1995	33.87	18.80	12.04	35.28
Percentage in 2009	27.30	12.81	17.46	42.43
Percentage Point Change	-6.57	-5.99	+5.42	+7.15

Brazil's integration into the upstream part of global value chains has also increased over the period. The share of Brazil's intermediate product exports shipped to East Asia rose by 12.2 percentage points, while the shares of the other three regions declined. This reflects the significant shift in global manufacturing to East Asia during that period, as the region became the preferred assembly location in many global value chains.[11]

When measured in terms of exports of value added, the shifts in the shares of the regions were less dramatic. The Rest of the World countries' share of Brazil's exports of value added rose (reflecting the large increase in gross exports of final products), as did the East Asian share of Brazil's exports of value added (reflecting the increase in East Asia's share of Brazil's gross

[9] Due to the limitations of the country detail in WIOD, the Rest of the World region includes Brazil's trade partners in South America. The trade flows to these countries are not reported separately in WIOD.

[10] Appendix table 1, based on WIOD data, reports that the share of the Rest of the World countries in global final expenditures (outside of Brazil) rose from 20.4 percent in 1995 to 27.1 percent in 2009, while the shares of the other three regions declined.

[11] Appendix table 2, also based on WIOD data, reports that East Asia's share of global manufacturing output (outside of Brazil) rose from 29.5 to 38.0 percent. The measure of manufacturing output in this table includes all of the sectors in the Other Manufactures product group in table 1 as well as the food, beverage, and tobacco sectors and the coke, refined petroleum and nuclear fuel sectors.

exports of intermediate products). However, the magnitude of each of these shifts in shares of value-added exports was smaller than the shift in final exports in the case of the Rest of the World and the shift in intermediate exports in the case of East Asia. This suggests that the re-direction of Brazil's exports to East Asia had only a limited effect on the ultimate destination of value added in Brazil. These exports have been increasingly incorporated into East Asia's exports to the United States and the European Union.

Another way to summarize the shifts in Brazil's exports of value added is to examine the path that they traveled to reach consumers in the United States. Table 4 focuses on exports of value added from Brazil that were used to produce final goods and services that were ultimately consumed or were invested as capital goods in the United States. The table reports the shares of Brazil and the four regions. Over the fifteen-year period, the largest decline was in the share of final product exports from Brazil, which declined by 11.8 percentage points. The share of final product exports from East Asia rose by 4.7 percentage points, while the share of domestic final product shipments in the United States rose by 4.4 percentage points.[12] The combined share of the other two regions rose by 2.7 percentage points.

TABLE 4: Value Added in Brazilian Production That is Consumed in the United States

Share of Brazil's Value Added By the Region of Final Stage Production for Final Use in the United States	Percentage in 1995	Percentage in 2009	Percentage Point Change
U.S. Imports from Brazil	30.04	18.29	-11.75
U.S. Domestic Shipments	58.94	63.30	+4.36
U.S. Imports from East Asia	1.90	6.57	+4.67
U.S. Imports from the European Union	2.20	3.09	+0.89
U.S. Imports from the Rest of the World	6.92	8.74	+1.82

CONCLUSION

Over the fifteen years covered by WIOD, Brazil's exports shifted toward mineral and agricultural products and away from services and other manufactured products, further reinforcing the country's traditional areas of comparative advantage. By disaggregating the trade flows into intermediate and final products and then into the value-added contributions of each country of origin, we have been able to document the shifts in Brazil's exports across products and

[12] However, the share from U.S. producers remained much larger.

destination regions.[13] While Brazil's exports shifted to greater specialization in its traditional areas of comparative advantage, they shifted away from Brazil's traditional markets in the United States and European Union. The shift in the share of Brazil's gross exports to East Asia is more than twice the shift in the share of its exports of value added to East Asia.

Now that we have documented these shifts in Brazil's trade flows, the next step is to investigate the underlying economic causes of these shifts. We leave that for future research.

[13] It is also possible to analyze flows of value added on the import side, though that has not been the focus of this paper. The foreign share of value added in Brazil's output measures the share of Brazil's costs of production that accrue to factors of production in other countries through the purchase of imported intermediate products. Appendix table 3 reports the foreign shares of the value added in each of the product groups. The other manufactures group recorded the largest increase in share. Its foreign share of value added rose from 9.7 percent in 1995 to 13.1 percent in 2009. The foreign share of value added rose in the agriculture and food products group and in the services group but declined slightly in the mining and petroleum products group. On average across the four product groups, the foreign share of value added in Brazil's output rose from 5.5 percent in 1995 to 7.4 percent in 2009. In comparison, the foreign share of value added in the output of the East Asian countries was higher and increased more: it rose from 7.3 percent in 1995 to 16.2 percent in 2009.

BIBLIOGRAPHY

Chen, Lurong. "The BRICs in the Global Value Chain: An Empirical Note." *Cuadernos de Economía* 31, no. 27 (August 2012): 221–239.

Filho, Arlindo Villaschi, José Eduardo Cassiolato, and Helena Lastres. "Local Production and Innovation Systems in Brazil: The Metalworking Cluster in Espirito Santo." In *Upgrading to Compete: Global Value Chains, Clusters, and SMEs in Latin America*, edited by Carlo Pietrobell and Roberta Rabellotti, 175–189. Inter-American Development Bank and David Rockefeller Center for Latin American Studies at Harvard University, 2006.

Gomes, Raquel. "Upgrading without Exclusion: Lessons from SMEs in Fresh Fruit Producing Clusters in Brazil." In *Upgrading to Compete: Global Value Chains, Clusters, and SMEs in Latin America*, edited by Carlo Pietrobell and Roberta Rabellotti, 71–107. Inter-American Development Bank and David Rockefeller Center for Latin American Studies at Harvard University, 2006.

Johnson, Robert C. and Guillermo Noguera. "Accounting for Intermediates: Production Sharing and Trade in Value Added." *Journal of International Economics* 86, no. 2 (March 2012): 224–236.

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. "Tracing Value-Added and Double Counting in Gross Exports." *American Economic Review* 104, no. 2 (February 2014): 459–94.

Powers, William. "The Value of Value Added: Measuring Global Engagement with Gross and Value-Added Trade." *World Economics* 13, no. 4 (2012): 19–38.

Strachman, Eduardo and Gustavo Milan Pupin. "The Brazilian Sugar and Alcohol Sector: Evolution, Productive Chain and Innovations." *CEPAL Review* 103 (April 2011): 167–185.

Timmer, Marcel P., ed. "World Input-Output Database (WIOD): Contents, Sources, and Methods." WIOD Working Paper 10, April 2012.

APPENDIX

This technical appendix describes the method for calculating a country's exports of value added using the WIOD IIO tables. The tables report how the output of each sector in each country is allocated across many alternative uses, including use as an intermediate input in each sector in the same country, as exports to other countries, and as final goods or services in private consumption, government consumption, and capital formation in each country. WIOD provides estimates of the intermediate use columns of the table, which are represented by the *NC* by *NC* matrix *A*. *N* represents the number of sectors, and *C* represents the number of countries. The *NC* by *C* matrix *X* represents the value of output in each sector and country in a year. Given these definitions, the value of output in each sector and country is the sum of its intermediate uses, *AX*, and its final uses.

$$X = AX + F \qquad (1)$$

The *NC* by *N* matrix represents *F* the final use in each country of the output of each sector and country. Equation (2) is the solution for *X*.

$$X = (I - A)^{-1} F \qquad (2)$$

The matrix *I* is an *NC* by *NC* identity matrix. $(I-A)^{-1}$ is commonly called Leontief's Inverse. The matrix *X* is converted into a measure of the value added in each country of origin in the final use category of the destination country by multiplying by a *C* by *NC* matrix *V* that contains the shares of direct value added in the output of the sectors in each country. Equation (3) focuses specifically on value added that enters final use in destination country *d*.

$$M_d = V(I - A)^{-1} F_d \qquad (3)$$

The *C* by 1 vector M_d is the direct and indirect value added of each country in the final use of goods and services in country *d*, and the *NC* by 1 vector F_d is the final use expenditures of country *d*. The vector M_d includes domestic shipments of value added in the final use expenditures of country *d* as well as exports of value added from other countries to country *d*.

APPENDIX TABLES

APPENDIX TABLE 1 Regional Share of Final Expenditures Outside of Brazil

Regional Share of Final Expenditures	Percentage in 1995	Percentage in 2009	Percentage Point Change
East Asia	23.71	19.31	-4.40
European Union	30.21	28.08	-2.13
United States	25.72	25.53	-0.19
Rest of the World	20.37	27.07	+6.70

APPENDIX TABLE 2 Regional Share of Manufacturing Output Outside of Brazil

Regional Share of Manufacturing Output	Percentage in 1995	Percentage in 2009	Percentage Point Change
East Asia	29.52	38.03	+8.51
European Union	30.24	24.78	-5.46
United States	20.81	14.56	-6.25
Rest of the World	19.42	22.62	+3.20

APPENDIX TABLE 3 Foreign Share of Value Added in Brazil's Output

Foreign Share of Value Added in Brazil's Output	Percentage in 1995	Percentage in 2009	Percentage Point Change
Agriculture and Food Products	5.28	7.54	+2.26
Mining and Petroleum Products	14.84	13.45	-1.39
Other Manufactures	9.70	13.11	+3.41
Services	3.35	4.51	+1.16