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# Product Space Analysis of the Exports of Brazil

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**ABSTRACT**

*This paper applies several of the product space tools of Hausmann, Klinger, and Hidalgo to explain and predict the pattern of Brazil's exports. First, we calculate an annual measure of distance between moderately disaggregated products. Then we fit an econometric model that predicts the next products in which each country will gain comparative advantage, based on this distance measure, domestic resource constraints, and the extent of international competition. We evaluate the model's success in explaining the changes in the pattern of Brazil's exports between 1998 and 2008. Then we use the model to predict the products in which Brazil will gain a comparative advantage over the next decade. These products are concentrated in primary commodities like agricultural and mineral products rather than manufactures like machinery and equipment. Finally, we find that the model's predictions change significantly when we refocus the analysis on Brazil's exports to the United States rather than its exports to the entire world.*

*Key words*: Revealed Comparative Advantage, Product Space, Brazil, and Model Validation.

*JEL Codes*: F10, F17, O20, O54

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## 1 Introduction

Brazil is a natural resource rich country that has rapidly expanded its exports to the United States and to the rest of the world. In 1998, Brazil recorded $51 billion in exports, approximately one percent of world exports. That placed Brazil in 24th place among exporting countries. Ten years later, Brazil advanced to 21st place with total exports of $198 billion, approximately 1.3 percent of world exports. In 2011, Brazil advanced to 15th place with approximately 1.8 percent of world exports. In 1998, Brazil's largest market, the United States, accounted for almost 20 percent of its exports. In 2008, the United States continued to be Brazil's top market, but its share declined to 14 percent. In 2009, China overtook the United States as Brazil's top export destination.

The product mix of Brazil's exports has shifted over time, but not significantly. In 1998, Brazil's top exports were coffee, soy beans and soy bean oil, iron ore and concentrates, iron ore agglomerates, blooms, billets, slabs and sheet bars of iron or steel, pig iron, oil-cake and other residues, and motor vehicles and parts and accessories. A decade later in 2008, Brazil's top exports were petroleum, iron ore and concentrates, soy beans, poultry, iron ore agglomerates, motor vehicles and parts, aircraft, oil-cake and other residues, coffee, meat of bovine animals, blooms, billets, slabs and sheet bars or iron or steel, chemicals wood pulp, and sugar.

Table 1 reports the value of Brazil's exports to the world by sector in 2008. The table also reports whether Brazil had a revealed comparative advantage in the sector's products in 2008. We measure revealed comparative advantage (RCA) as the ratio of a product's share of a country's total exports to the product's share in the combined exports of all countries. Table 2 identifies the ten largest export products of Brazil in 2008. For several of these products, including petroleum oils, Brazil recorded a relatively large value of exports but did not have a revealed comparative advantage. The last column of Table 2 indicates that more than half of Brazil's ten exports products in 2008 were also among its top ten export products in 1998.

To analyze the changes in Brazil's comparative advantage over time, and to predict the next products in which it may gain a comparative advantage, we apply and extend the product space analysis of Hausmann, Hidalgo, and Klinger. In a series of recent papers, these authors have developed a framework for analyzing data on international trade flows. Different products are related to each other by a network of proximities. When countries add new products to the set of products in which they have comparative advantage, they tend to be products that are closer in the product space to those that they already export. Hausmann, Hidalgo, and Klinger interpret the product space as reflecting similarities in the products' specific input requirements.

There are two economic issues that are fundamental to modeling international trade but are not been addressed in the product space literature (to our knowledge). The first is the importance of resource constraints within each country. The second is international competition. We attempt to extend the product space analysis to incorporate these factors in a simple way and also to incorporate product complexity concepts from related work by Hausmann, Hidalgo, and Klinger.

We use the extended model to explain the past, current, and future exports of Brazil. First, we measure the product space for 1998 based on a data set of the exports of 121 countries, and then we estimate an econometric model of the changes in the countries' RCA between 1998 and 2008, at a moderately disaggregated product level. Next, we evaluate how well the model predicted the changes in RCA for the 121 countries as a whole, and we also assess the model's predictions for one specific country, Brazil. Then we construct a different product space for 2008 and use the estimated parameters of the econometric model, along with export values in 2008, to estimate the probability that Brazil will gain RCA after 2008 in each of the products in which it did not have an RCA in 2008.

In the final step in our analysis, we also reshape the product space by focusing on each country's exports to a specific national market, the United States, rather than defining the product space based on each country's exports to the entire world. This focus changes the estimated product space in a significant way, and so it changes the model's predictions about the products in which the countries will gain RCA in the future. By redefining the product space, we generate predictions for the changes in international trade that will most directly affect consumers and domestic producers within the United States.

The rest of the paper is organized as follows. In the second section, we introduce the product space framework by briefly reviewing related studies, explaining the measures of product space distance and RCA, and identifying the data requirements of the analysis. In the third section, we report the parameter estimates for our econometric model of the changes in RCA between 1998 and 2008. In the fourth section, we report the model's predictions for the products in which Brazil will gain RCA after 2008. In the fifth section, we refocus the analysis on exports to the United States and repeat the many steps of the data analysis. In the concluding section, we summarize the strengths and limitations of the product space analysis and discuss its potential policy implications.

## 2 Overview of the Product Space Framework

### *Related Literature*

Recent research suggests that what a country exports matters. Hausmann, Hwang, and Rodrik (2007) find that the level of sophistication of a country's exports has important implications for economic growth. More sophisticated exports tend to accelerate economic growth. The determinants of the evolution of a country's export sophistication have been studied by Hausmann and Klinger (2006, 2007) and Hidalgo, et al. (2007). They found that the process of structural transformation reflects the similarity in the specific input requirements of products. They call the network of relatedness among products the product space. According to Hausmann (2009), the similarity in input requirements includes everything from particular skills, institutional and infrastructural requirements, and technology.

Hausmann and Klinger (2006, 2007) suggest that changes in the revealed comparative advantage of countries can be predicted by where the countries' output lies within the product space. When countries change the product mix of their exports, they tend to add products that are closely related to the products in which they currently have an RCA. To illustrate the point, Klinger (2007) notes that the infrastructure, institutions, human capital, and inputs that are required by the garment industry can be more easily reemployed in the harness industry than in the call center industry.

Hausmann and Klinger (2006, 2007) develop a measure of relatedness between pairs of products using annual export data for a cross-section of countries. They find that the product space is highly heterogeneous: there are very dense parts of the product space with highly inter-connected products and very sparse parts.[2] They conclude that a "product's proximity to existing areas of comparative advantage is one of the most significant determinant of whether a country will develop an advantage in that product over time." In addition, Hidalgo and Hausmann (2009) provide evidence that countries with more capabilities will be more diversified and will export a wider range of products. They also demonstrate that products that require more capabilities will be produced by fewer countries. The products will be less ubiquitous as fewer countries will have all of the capabilities needed to make the products. They conclude that a country's diversification (the number of products in which it has an RCA) is a reliable indicator of the number of capabilities that the country has.

The structural transformation and product space methodology have been applied to analyze the pattern of trade of a number of specific countries and regions. Hausmann and Klinger (2006b, 2007a, 2008, and 2009) studied structural transformation in South Africa, Chile, Colombia, and several Caribbean nations. The Inter-American Development Bank (2008) used the methodology to study diversification from energy in Trinidad and Tobago. The United Nations Economic and Social

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[2] Hausmann and Klinger (2006, 2007) construct a map of possibilities for export diversification at the SITC 4-digit level, with approximately 800 traded products. As an analogy, they describe the product space as a forest (the country) with trees (the products) occupied by monkeys (the firms). In this analogy, income-enhancing diversification will occur when monkeys jump to additional trees with additional fruit, and they are more likely to jump to nearby trees.

Commission for Asia and the Pacific analyzed 13 of the least developed countries in the Asia and the Pacific. Jankowska, Nagengast and Perea (2012) compared Asian and Latin American export experiences. Hausmann, Klinger, and López-Cálix (2008 ) studied export diversification in Algeria. Hidalgo (2011) studied the industrial opportunities of five countries in eastern and southern Africa. Abdon and Felipe (2011) studied the opportunities for growth and structural transformation in Sub-Saharan Africa. Felipe, Kumar, and Abdon (2010) applied the methodology to exports and industrial policy in India, and Felipe, Kumar, Usui, and Abdon (2010) applied the methodology to China.

***The Product Space and Measures of Revealed Comparative Advantage***

We calculate the product space proximity for fairly disaggregated (SITC4) products, based on how many countries export each pair of products in a given year. We can summarize our measures of RCA and distance in the product space using the following five equations from Hausmann, Hidalgo, et al. (2011). Equation (1) is their definition of RCA, for country $c$ and product $p$.

$$RCA_{cp} = \left(\frac{X_{cp}}{\sum_j X_{cj}}\right) \Big/ \left(\frac{\sum_i X_{ip}}{\sum_j \sum_i X_{ij}}\right) \qquad (1)$$

The variable $X_{cp}$ is the total value of product $p$ exports from country $c$. The variable $i$ is an index of countries, and the variable $j$ is an index of products. Equation (2) is the cut-off rule that Hausmann, Hidalgo, et al. (2011) use to define whether country $c$ has a revealed comparative advantage in product $p$.

$$M_{cp} = 1 \text{ if } RCA_{cp} > 1; \text{ otherwise } M_{cp} = 0 \qquad (2)$$

Equation (3) defines the ubiquity of product $p$ as the number of countries that have a revealed comparative advantage in product $p$.

$$k_{0,p} = \sum_i M_{ip} \qquad (3)$$

Equation (4) represents the proximity of distinct products $p$ and $p'$ within the product space.

$$\phi_{pp'} = \frac{\sum_i M_{ip}\, M_{ip'}}{max\left(k_{0,p}\, ,k_{0,p'}\right)} \tag{4}$$

Finally, equation (5) is the measure of distance from the products in which country $c$ currently has a comparative advantage to product $p$ in which it does not.

$$D_{cp} = \frac{\sum_{p'} \left(1 - M_{cp'}\right) \phi_{pp'}}{\sum_{p'}\ \phi_{pp'}} \tag{5}$$

This distance measure from Hausmann, Hidalgo, et al. (2011) is inversely related to the density measure in Hausmann and Klinger (2007b).

We use the product space distance in (5) to predict the next products in which a country will gain comparative advantage. To clarify timing, we add a time subscript to the variables introduced in equations (1) through (5). Equation (6) defines an indicator variable that is equal to one if country $c$ gains a revealed comparative advantage in product $p$ in period $t$ that it did not have in period $t-1$ and is equal to zero otherwise.

$$A_{cpt} = 1 \text{ if } M_{cpt} = 1 \text{ and } M_{cp,t-1} = 0 \tag{6}$$

We calculate the probability of gaining an RCA in product $p$ based on an econometric model with the logit functional form in equation (7).

$$E_{t-1}A_{cpt} = \frac{exp\left(Z_{cp,t-1}\right)}{1+exp\left(Z_{cp,t-1}\right)} \tag{7}$$

$$Z_{cp,t-1} \equiv \alpha + \beta \ln\left(D_{cp,t-1}\right) \tag{8}$$

$E_{t-1}$ represents expectations in period $t-1$. We expect that $\beta < 0$.

One limitation of the models (in Hausmann and Klinger (2007), Hausmann, Hidalgo et al. (2011), and our equations (7) and (8)) is that they do not account for resource constraints within the countries of origin. The probability that a country will gain an RCA in a particular product should depend not only on the distance to that product but also on the distance to the country's other potential new RCA products, to the extent that they compete for some of the same scarce resources.

A second limitation of the models is that they do not take into account the extent of international competition. A simple way to do this is to include the number of countries that already have an RCA in product $p$ in period $t-1$ as an additional explanatory variable. This is measured by $k_{0,p,t-1}$ in equation (3). If this is a reasonable proxy for the number of international competitors, then it should have a negative effect on $E_{t-1}A_{cpt}$. On the other hand, if this variable indicates a lack of product complexity, as in Hausmann, Hidalgo et al. (2011), then it could have a positive effect on $E_{t-1}A_{cpt}$. In this case, the country would be more likely to gain an RCA in products that require simple and ubiquitous production capabilities, for a given product space distance.

Equation (9) extends the model to address these concerns. It replaces equation (8).

$$Z_{cp,t-1} \equiv \alpha + \beta \ln\left(D_{cp,t-1}\right) + \gamma\, ln\left(\overline{D_{c\cdot,t-1}}\right) + \delta\, ln\left(N_{c,t-1}\right) + \theta\, ln\left(k_{0,p,t-1}\right) \qquad (9)$$

The variable $N_{c,t-1}$ is the number of products in country $c$ that are potential entrants after period $t-1$, and the variable $\overline{D_{c\cdot,t-1}}$ is the average distance of products in which country $c$ does not have comparative advantage in period $t-1$.

The econometric model in Hausmann and Klinger (2007b) does not include the additional terms in equation (9), but it does include a set of country fixed effects and a set of product fixed effects. While these fixed effects would absorb the additional terms in equation (9), they would only be appropriate in our forecast model if the factors that they represent were *fixed over time*. That is not the case. The country effects in equation (9) include the number of potential new RCA products, which we define as the number of products in which the country does not currently have an RCA, as well as the average distance associated with these products. We know that these factors are not fixed over time; in fact, they change in an observable way. Likewise, the product effect $k_{0,p,t-1}$ changes over time. There is a different set of potential new RCA products in 1998 than in 2008. For this reason, it would not be correct to use a set of product fixed effects estimated for the potential new RCA products in 2008 to forecast the set of new RCA products after 2008.

#### *Data Requirements*

One of the greatest appeals of the product space analysis is its limited data requirements. We analyze annual exports from each country at the four-digit level of the SITC revision 2 product classifications. These are the product classifications used in Hausmann, Hidalgo, et al. (2011). We analyze data for 121 countries for 1998 and 2008. The trade data are from COMTRADE, available through the World Banks' WITS data base. The various terms in equation (9), representing the country-average distance, product-average distance, and product ubiquity, are all constructed from these trade data.

## 3 Econometric Model of Change in Brazil's Revealed Comparative Advantage

Before estimating the econometric models, we look for basic evidence that there is a negative relationship between the measure of distance in product space and the set of products in which Brazil gained an RCA between 1998 and 2008. We separate the potential new RCA products into two groups based on the ex-post outcomes: the products in which the country gained an RCA between 1998 and 2008 and the products in which it did not.

Figure 1 represents the distance of the potential new RCA products along the horizontal axis, and the share of potential new RCA products in each group along the vertical axis. The distribution for the products that did gain an RCA over the time period is shifted to the left of the distribution of the products that did not gain an RCA. These data for Brazil indicate that product space distance helps to predict whether Brazil gained an RCA in a particular product.

Table 3 reports four alternative econometric models based on equations (7) and (9). The dependent variable in all of the models is $A_{cp,2008}$. This variable is define in equation (6). All of the explanatory variables in the models are observable ex ante, in 1998. We estimated the parameters of the models using the two-dimensional panel of ten-year differences, which varies across the countries and four-digit products. Model 1 is the least restrictive of the four models, while Model 4 is the most restrictive. According to Table 3, the Akaike Information Criterion (AIC) and the sum of absolute deviations are both lower for Model 1, though these diagnostic statistics are very close across the models. The purpose of these statistics is to measure the gain in model fit from adding explanatory variables. In the case of the AIC, there is also a penalty for reducing the degrees of freedom. Model 1 is the preferred model by these criteria. We find that the coefficients on the proxies for domestic resource constraints, $N_{c,t-1}$ and $\overline{D_{c\cdot,t-1}}$, have the expected sign and are statistically significant. The ubiquity measure, $k_{0,p,t-1}$, has a positive effect that is statistically significant. This suggests that the positive effect from less product complexity dominates the negative effect of more international competitors.

Table 4 provides an evaluation of the econometric models for two groups of products, potential new RCA products that were added between 1998 and 2008 and potential new RCA products that were not added during that time period. The top panel of Table 4 reports the group average over all 121 countries of origin. Based on the export data for 1998, Model 1 predicts that each country will gain an RCA in approximately 9% of all of the potential new RCA products. The average estimated probability was 16.4% higher among the products in which the countries did in fact gain an RCA by 2008. The difference in group means is statistically significant at the 1% level for all four models, but the largest difference is in the predictions of Model 1. This comparison provides in-sample validation of the predictions of the model. The bottom panel of Table 4 looks more narrowly at the performance of the models in predicting changes in exports from Brazil. The models are constructed to fit the data on average for the full set of 121 countries. They are not necessarily a good fit for each individual country in the sample. Nevertheless, the outcomes for Brazil help to validate the models. For Model 1, the average *estimated* probability was 30.3% higher among products in which Brazil *actually* gained an RCA by 2008.

## 4 Predictions of Brazil's New RCA Products after 2008

In this section, we use the econometric model that we fit to the historical changes in comparative advantage to identify products in which Brazil is likely to gain an RCA in the future. In our opinion, the model is more reliable as an estimate of the relative probabilities across the potential new RCA products, rather than as an estimate of the average magnitude of the probabilities. The reason is that the average magnitude depends on the assumption that the constant of the econometric model, which we estimate from the historical sample, will continue to apply going forward. While this assumption underlies our estimates of the average magnitude of the probabilities, it is irrelevant to the estimates of the relative probabilities. Therefore, we focus our discuss on the relative probabilities.

Table 5 reports the sector average of the probability that Brazil will gain an RCA in each product after 2008. The top panel of the table reports the mean and standard deviation of the estimated probability of gaining an RCA in each product, by SITC one-digit sector. The average estimated probability for food products (SITC 0) is almost twice as high as the average estimated probability for machinery and equipment (SITC 7). The bottom panel of the table differentiates the products by whether the United States has an RCA in the product in 2008. The average probability of Brazil gaining an RCA in a product in which the United States already has an RCA is 0.073, compared to 0.070 for products in which the United States did not have an RCA in 2008.

Figure 2 graphs the estimated probability that Brazil will gain an RCA after 2008 in each four-digit product after 2008. The horizontal axis of the graph represents the four-digit SITC codes of the potential new RCA products. The height of the vertical bars represents the estimated probability of gaining RCA after 2008. The graph uses color to group the products into three categories: primary commodities other than fuels, mineral fuels, chemicals, machinery, transportation equipment, and all other manufactures. There is substantial variation in the estimate probabilities across the categories. They range from 2% to 15%. There is also substantial variation within the six categories. Nevertheless, the estimated probabilities are generally higher for primary commodities and lower for machinery and equipment. This reflects the shorter average distance of the primary commodities from Brazil's RCA products in 2008 and the fact that these products are typically more ubiquitous.

Finally, Table 6 lists the ten SITC four-digit products in which Brazil is most likely to gain an RCA after 2008. The table demonstrates that the model can generate fairly detailed product predictions, even though our discussion has focused for the most part on sector-level summary statistics. Most of these four-digit products are agricultural or mineral commodities. None is in the machinery or equipment sectors.

## 5 Estimation of the Models for Brazil's Exports to the United States

In this section, we reformulate the model using a different set of trade data to define each country's revealed comparative advantage. We reshape the product space by focusing on each country's exports to a specific national market of interest, in our case the United States, rather than defining the product space based on the countries' total exports. This change in the estimated product space alters the model's predictions for the pattern of Brazil's future exports. The new model predictions address more directly how changes in the country's pattern of exports will affect consumers and domestic producers in the United States. With these new data, we repeat the prior analysis, using the same steps to calculate RCA, estimate distances in the relevant product space, estimate an econometric model of new RCA products, and use the model to predict Brazil's new RCA products after 2008.

Table 7 reports the new set of parameter estimates for Model 1, using the data on each country's exports to the United States. The table also repeats the parameter estimates from Table 3 for the sake of comparison. It is difficult to compare the two models, because they describe fundamentally different data sets. There are different numbers of observations, because the definition of the potential new RCA products of each country of origin varies with the geographic scope of the export market. Nevertheless, the models have the same signs for the effects of each of the explanatory variables. The greatest difference is that the measure of ubiquity is not significantly different from zero for the model based on exports to the United States. Also, the coefficient that measures the sensitivity of the probabilities to product space distance is smaller in absolute value in the model based on exports to the United States.

Figure 3 graphs the estimated probability that Brazil will gain an RCA in each of the four-digit products in which it does not have an RCA in 2008. Like Figure 2, there is substantial variation in the estimated probabilities across all of the products and even within the three categories of products. Unlike Figure 2, the primary commodity category is not significantly higher than the other product categories, and the machinery and equipment sectors are not significantly lower. This reversal of the model's predictions is also clear in Table 8, which compares the two sets of sector averages of the estimated probabilities. The greatest difference is in the probabilities for the manufacturing sectors (SITC 5, 6, 7, and 8). The sector averages in Table 8 are 18% to 36% higher than the comparable sector averages in Table 5. When we focus on the countries' exports to the United States, the potential new RCA products in the manufacturing sectors are much closer to Brazil's pattern of RCA in 2008, and therefore they are more likely to gain an RCA in these products after 2008.

## 6 Concluding Remarks

We draw several conclusions from our product space analysis of the exports of Brazil. First, the measures of distance in the product space are significant determinants (and predictors) of changes in each country's pattern of comparative advantage. Second, it is important to allow for resource constraints and measures of product ubiquity in the econometric specification. Third, the data validate the model's predictions for the 121-country data set overall but also for Brazil in particular. Fourth, the model assigns a specific probability that Brazil will gain an RCA in each product after 2008. Fifth, Brazil's predicted new RCA products are concentrated in the primary commodity sectors like agriculture and minerals rather than manufactured products like machinery and equipment. Finally, these predictions about new RCA products change significantly when we refocus our analysis on the countries' exports to the United States rather than their exports to the entire world.

In this paper, we have not analyzed the impact of specific trade policies on Brazil's pattern of trade; however, but the model's predictions about the products in which they are likely to gain an RCA as part of a general export expansion have some broad policy implications. For example, liberalization of a country's barriers to imports will generally free domestic resources that had been dedicated to import substitution, and we expect that these resources will be reallocated to products in which the country has (or can gain) a comparative advantage. The specific path of this expansion of exports will likely be shaped to some extent by distances in the product space. Of course, if the trade policies narrowly promote specific industries, then this targeting may dominate the changes predicted by the product space analysis. In an economy in which each industry employs specific factors of production, the specific set of products in which Brazil gains an RCA can have a significant impact on the returns to competing specific factors within the United States.

The greatest limitation of the product space framework, in our opinion, is that the econometric specification is not explicitly derived from a general equilibrium model with specific functional forms, and for this reason it is outside of the mainstream of empirical international trade models, like Anderson and van Wincoop (2003) and Helpman, Melitz, and Rubinstein (2008). Careful consideration in the context of a general equilibrium model of international trade may help to refine the econometric specification by identifying omitted variables and appropriate functional forms.

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**Table 1: Exports of Brazil by Sector in 2008**

| SITC rev 2 Sectors | Description | Value of 2008 Exports in billions of US$ | Share of SITC Four-Digit Products with RCA > 1 in 2008 |
|---|---|---|---|
| 0 | Food and Live Animals | 37.4 | 0.38 |
| 1 | Beverages and Tobacco | 2.9 | 0.36 |
| 2 | Crude Materials, Inedible, Except Fuel | 39.3 | 0.30 |
| 3 | Mineral Fuels | 13.9 | 0.00 |
| 4 | Animal and Vegetable Oils | 3.0 | 0.28 |
| 5 | Chemicals | 12.5 | 0.19 |
| 6 | Non-Machinery Manufactured Goods | 30.6 | 0.21 |
| 7 | Machinery and Equipment | 41.8 | 0.19 |
| 8 | Miscellaneous Manufactured Goods | 5.4 | 0.06 |

**Table 2: Brazil, Ten Four-Digit Products with Most Exports from Brazil in 2008**

| SITC rev 2 Product Code | Product Description | Value of 2008 Exports in billions of US$ | RCA > 1 in 2008? | Top Ten Export Product in 1998? |
|---|---|---|---|---|
| 3330 | Petroleum Oil and Crude Oils Obtained from Bituminous Minerals | 13.70 | No | No |
| 2815 | Iron Ore and Concentrates, Not Agglomerated | 11.10 | Yes | Yes |
| 2222 | Soy Beans | 11.00 | Yes | Yes |
| 114 | Poultry, Dead and Edible Offals | 6.01 | Yes | No |
| 2816 | Iron Ore Agglomerates (Sinters, Pellets, Briquettes) | 5.48 | Yes | Yes |
| 7810 | Passenger Motor Cars, for Transportation of Passengers and Goods | 4.92 | No | Yes |
| 7924 | Aircraft Exceeding an Unladen Weight of 15000 kg | 4.39 | Yes | No |
| 813 | Oil Cake and Other Residues (Except Dregs) | 4.36 | Yes | Yes |
| 711 | Coffee, Whether or Not Roasted or Freed of Caffeine | 4.17 | Yes | No |
| 111 | Meat of Bovine Animals, Fresh, Chilled or Frozen | 4.01 | Yes | Yes |

**Table 3: Logit Models of the Probability of New RCA Products in 2008**

Dependent Variable: $A_{cp,2008}$

| Explanatory Variables | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| $ln\ D_{cp,1998}$ | -9.679<br>(0.371)* | -11.210<br>(0.348)* | -1.889<br>(0.102)* | -1.992<br>(0.101)* |
| $ln\ \overline{D}_{c,1998}$ | 8.943<br>(0.422)* | 10.665<br>(0.404)* | | |
| $ln\ N_{c,1998}$ | -0.623<br>(0.043)* | -0.648<br>(0.042)* | | |
| $ln\ k_{0p,1998}$ | 0.348<br>(0.033)* | | 0.662<br>(0.032)* | |
| Constant | 0.349<br>(0.282) | 1.509<br>(0.262)* | -4.523<br>(0.091)* | -2.675<br>(0.025)* |
| Number of Observations | 63,101 | 63,101 | 63,101 | 63,101 |
| Sum of the Absolute Deviations | 10,120 | 10,136 | 10,238 | 10,313 |
| AIC | 36,824 | 36,938 | 37,419 | 37,920 |

Note: Robust standard errors in parentheses.

**Table 4: Group Averages of the Estimates Probabilities**

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| All Countries | | | | |
| Products in which the country gained an RCA | 0.0959 | 0.0928 | 0.1081 | 0.1020 |
| Products in which the country did not gain an RCA | 0.0824 | 0.0811 | 0.0981 | 0.0995 |
| P-Value of Difference in Group Means | 0.0005 | 0.0001 | 0.0211 | 0.0001 |
| Brazil Only | | | | |
| Products in which Brazil gained an RCA | 0.1149 | 0.1135 | 0.1046 | 0.0980 |
| Products in which Brazil did not gain an RCA | 0.0882 | 0.0883 | 0.0896 | 0.0899 |
| P-Value of Difference in Group Means | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**Table 5: Sector Averages of the Estimated Probabilities**

| SITC rev 2 Sectors | Description | Mean | Standard Deviation |
|---|---|---|---|
| 0 | Food and Live Animals | 0.101 | 0.019 |
| 1 | Beverages and Tobacco | 0.083 | 0.018 |
| 2 | Crude Materials, Inedible, Except Fuel | 0.087 | 0.025 |
| 3 | Mineral Fuels | 0.081 | 0.028 |
| 4 | Animal and Vegetable Oils | 0.078 | 0.020 |
| 5 | Chemicals | 0.064 | 0.022 |
| 6 | Non-Machinery Manufactured Goods | 0.073 | 0.020 |
| 7 | Machinery and Equipment | 0.055 | 0.013 |
| 8 | Miscellaneous Manufactured Goods | 0.067 | 0.019 |
| Products in which the United States had RCA in 2008 | | 0.073 | 0.024 |
| Products in which the United States did not have RCA in 2008 | | 0.070 | 0.023 |

**Table 6: Products with the Ten Highest Probabilities That Brazil Will Gain an RCA After 2008**

| Rank | SITC Revision 2 Division | Product Description | Estimated Probability of Gaining an RCA After 2008 |
|---|---|---|---|
| 1 | 3330 | Petroleum Oils and Crude Oils | 0.1522 |
| 2 | 2225 | Sesame Seeds | 0.1421 |
| 3 | 360 | Crustaceans and Mollusks, Fresh | 0.1393 |
| 4 | 342 | Fish, Frozen (Excluding Fillets) | 0.1385 |
| 5 | 5721 | Propellant Powders and Other Preparations | 0.1343 |
| 6 | 2879 | Ores and Non-Ferrous Minerals | 0.1339 |
| 7 | 459 | Buckwheat, Millet, Canary Seed | 0.1339 |
| 8 | 542 | Beans, Peas, Lentils | 0.1327 |
| 9 | 6612 | Portland Cement | 0.1310 |
| 10 | 615 | Molasses | 0.1309 |

**Table 7: Comparison of Logit Models with Different Export Data**

Dependent Variable: $A_{cp,2008}$

| Explanatory Variables | Using Total Exports (from Table 3) | Using Exports to the United States |
|---|---|---|
| $ln\ D_{cp,1998}$ | -9.679 | -6.830 |
| | (0.371)* | (0.420)* |
| $ln\ \overline{D}_{c,1998}$ | 8.943 | 5.648 |
| | (0.422)* | (0.506)* |
| $ln\ N_{c,1998}$ | -0.623 | -0.479 |
| | (0.043)* | (0.034)* |
| $ln\ k_{0p,1998}$ | 0.348 | 0.001 |
| | (0.033)* | (0.034) |
| Constant | 0.349 | 0.452 |
| | (0.282) | (0.201)* |
| Number of Observations | 63,101 | 33,472 |
| Sum of the Absolute Deviations | 10,120 | 6,601 |
| AIC | 36,824 | 23,113 |

Note: Robust standard errors in parentheses.

**Table 8: Probability of Gaining an RCA after 2008 for Brazil, by Sector**

| SITC rev 2 Sectors | Description | Average Probabilities for Model of Total Exports (from Table 5) | Average Probabilities for Model of Exports to the United States |
|---|---|---|---|
| 0 | Food and Live Animals | 0.101 | 0.093 |
| 1 | Beverages and Tobacco | 0.083 | 0.094 |
| 2 | Crude Materials, Inedible, Except Fuel | 0.087 | 0.086 |
| 3 | Mineral Fuels | 0.081 | 0.080 |
| 4 | Animal and Vegetable Oils | 0.078 | 0.082 |
| 5 | Chemicals | 0.064 | 0.087 |
| 6 | Non-Machinery Manufactured Goods | 0.073 | 0.086 |
| 7 | Machinery and Equipment | 0.055 | 0.080 |
| 8 | Miscellaneous Manufactured Goods | 0.067 | 0.081 |

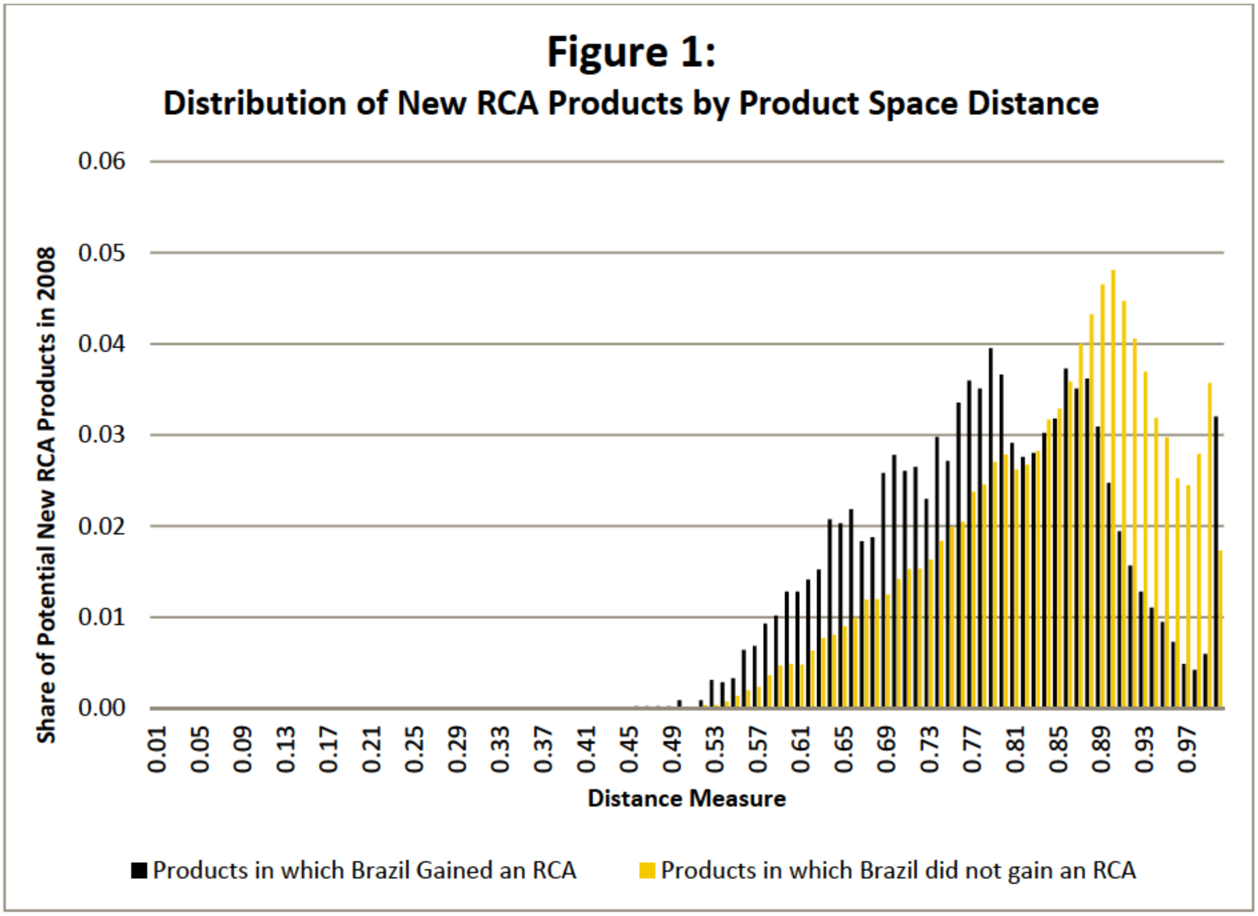
Figure 1:
Distribution of New RCA Products by Product Space Distance
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Share of Potential New RCA Products in 2008
0.01 0.05 0.09 0.13 0.17 0.21 0.25 0.29 0.33 0.37 0.41 0.45 0.49 0.53 0.57 0.61 0.65 0.69 0.73 0.77 0.81 0.85 0.89 0.93 0.97
Distance Measure
Products in which Brazil Gained an RCA
Products in which Brazil did not gain an RCA

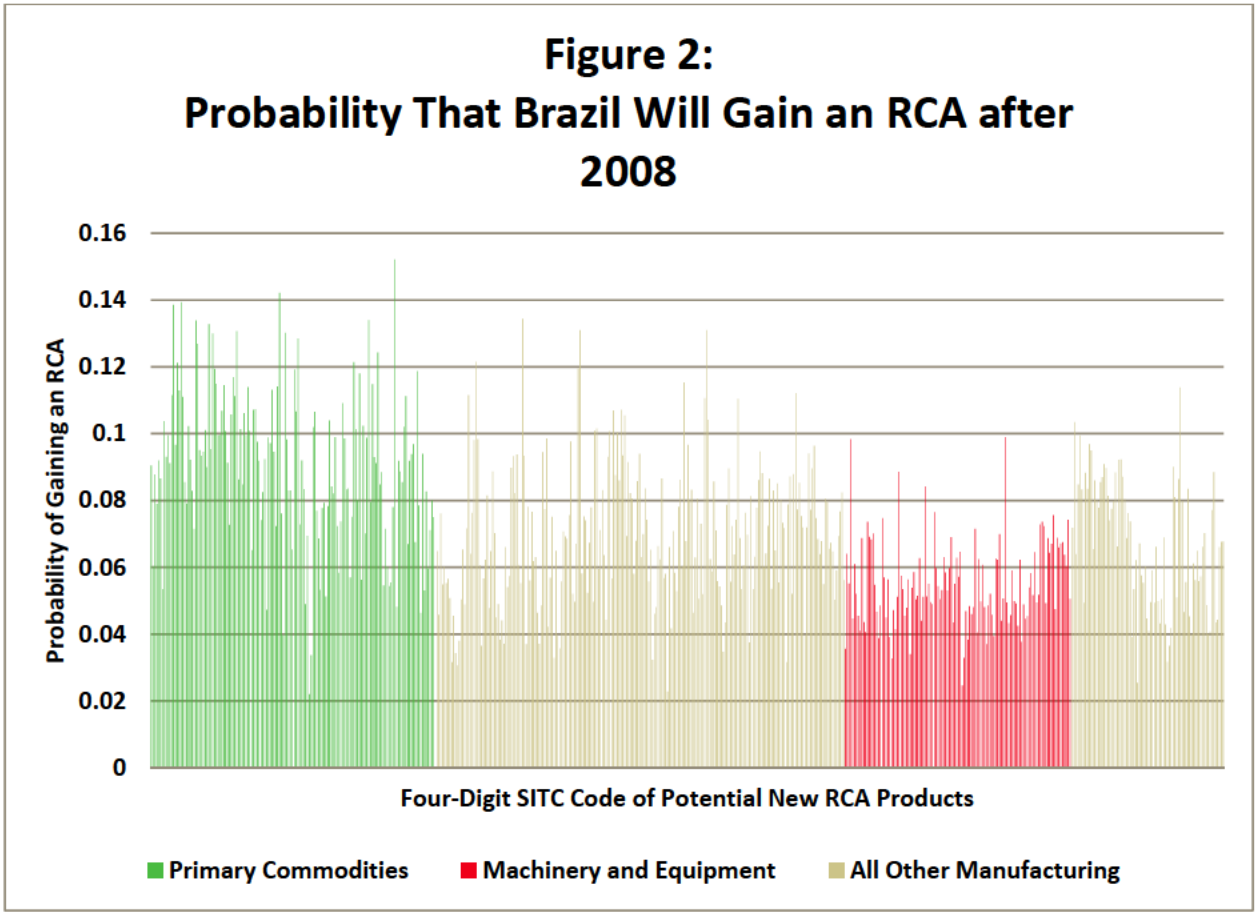

Figure 2:
Probability That Brazil Will Gain an RCA after 2008
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Probability of Gaining an RCA
Four-Digit SITC Code of Potential New RCA Products
Primary Commodities
Machinery and Equipment
All Other Manufacturing

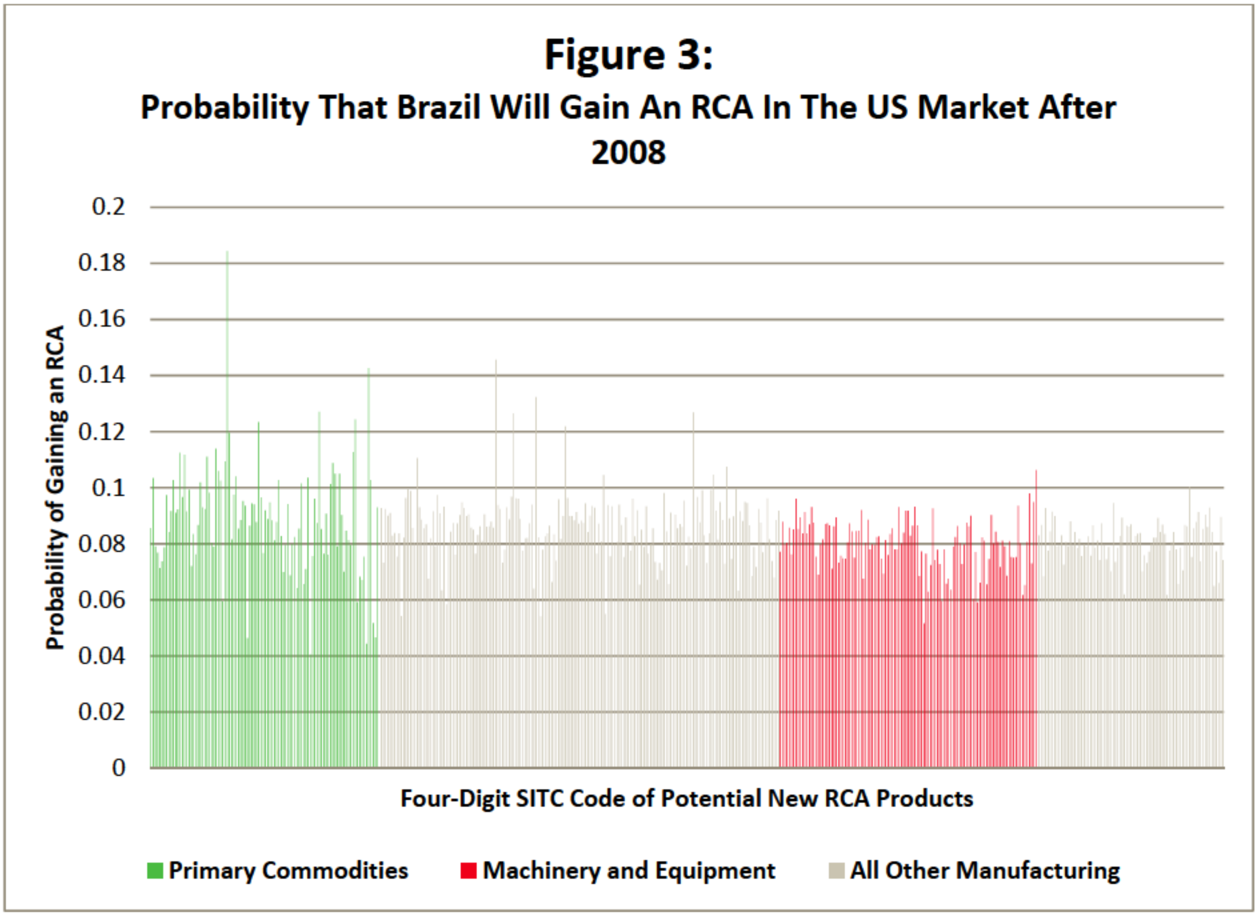
Figure 3:
Probability That Brazil Will Gain An RCA In The US Market After 2008
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Probability of Gaining an RCA
Four-Digit SITC Code of Potential New RCA Products
Primary Commodities
Machinery and Equipment
All Other Manufacturing