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THE POTENTIAL IMPACTS OF THE PORT OF SALVADOR IMPROVEMENTS ON THE BRAZILIAN COTTON INDUSTRY

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Abstract

A spatial price equilibrium model of the international cotton sector was used to analyze the impacts of the Port of Salvador improvements on the Brazilian cotton industry and world cotton trade. The port of Salvador is undergoing relevant improvements in its facilities and physical structure. As a result of these improvements, the port of Salvador is expected to become more competitive and attract ocean shipping companies which are willing to export products directly to Asian importing markets. Scenarios with different reduction in export cost for the port of Salvador were examined. For all scenarios, the new direct ocean shipping lines were found to be important for the cotton exporters in Brazil, especially for the producers in the state of Bahia. In addition, results suggested that the state of Bahia would have the potential of becoming the largest cotton exporting state in Brazil.

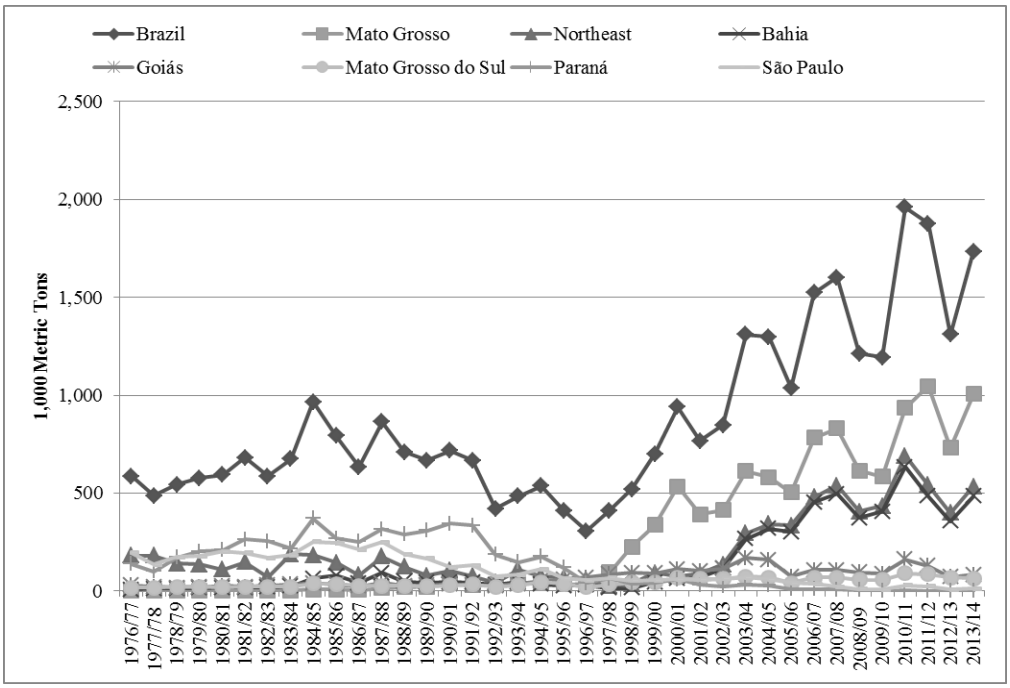
Keywords: *Cotton, international trade, Brazil, spatial equilibrium model, transportation*

1. Introduction and Background

In the 18th century, cotton was introduced in Brazil in the Northeastern region of the country. As the Southeastern region of the country started to industrialize in late 1800's, the textile industry followed and eventually cotton cultivation was solidified in the states of São Paulo and Paraná. In the early 1980's, the states of São Paulo and Paraná was shown to represent the majority of the Brazilian production (Figure 1).

However, from 1984/85 to 1996/97, national cotton production decreased substantially from nearly 1,000 to 300 thousand metric tons (Figure 1). The principal factors for the decline were (Buainain & Batalha, 2007): (i) the boll weevil, especially in the Northeast; (ii) high production costs; (iii) low international prices; and (iv) less expensive cotton imports. Under these circumstances, cotton cultivation migrated to the *Cerrado*[1] region, more specifically to the states of Mato Grosso, Goiás, Mato Grosso do Sul and western region of the state of Bahia. The expansion of cotton production in the *Cerrado* was strongly affected by the following factors: (i) large scale production; (ii) advanced technology with respect to

planting and harvesting; (iii) local government support regarding research and development; and (iv), although small, investment in transportation infrastructure in these portions of the *Cerrado* (Buainain & Batalha, 2007).



Source: Companhia Nacional de Abastecimento (CONAB/MAPA, 2015).

Figure 1. Historical Series Of Cotton Production By State And Region, 1976/1977 – 2011/12

As noted in Figure 1, in the 1997/98 marketing year, cotton production for the state of Mato Grosso began to rise significantly. By 2000/01, the production share by the state of Mato Grosso reached 57 percent (534 thousand metric tons) of the Brazilian production (938 thousand metric tons). Three years later, the state of Bahia started to play a major role by increasing its cotton production to 317 thousand metric tons, which is almost five times the level of 2000/01 harvest. In 2009/10, these two states represented more than 80 percent (990 thousand metric tons) of the Brazilian production (1,194 thousand metric tons), with the state of Mato Grosso accounting for nearly 50 percent (583 thousand metric tons). Currently, Mato Grosso continues as the number one producing state followed by Bahia, Goiás, and Mato Grosso do Sul. Overall, these four states accounts for more than 90 percent of the Brazilian cotton production.

Brazil's total cotton exports are disaggregated to state and region levels as shown in Table 1. Brazil's total cotton exports rose from 758.33 thousand metric tons in 2011 to 1,052.81 thousand metric tons in 2012, which is a record level. South Asia and Southeast Asia are large importers of Brazilian cotton (SECEX/MDIC, 2014). Lately, China, Indonesia and South Korea represents more than half of Brazil's cotton exports. The remaining cotton exports are evenly distributed with most of the exports having final destinations in the Southern and Southeastern parts of Asia.

Table 1. Cotton Exports by State/Region in Brazil (thousand metric tons), 2011 - 2013

State	2011	2012	2013
Mato Grosso	362.69	553.69	341.10
Bahia	304.32	348.27	163.13
Goiás	41.35	63.31	16.97
São Paulo	8.36	19.67	5.84
Mato Grosso do Sul	16.20	28.73	15.64
Maranhão	17.77	18.67	17.64
Minas Gerais	3.92	10.35	5.23
Subtotal	754.60	1,042.69	565.55
Rest of Brazil	3.73	10.12	7.36
Total	758.33	1,052.81	572.91

Source: SECEX/MDIC (2014).

Table 1 also shows the distribution of exports by state. From 2011 to 2013, the states of Mato Grosso, Bahia, and Goiás accounted for, on average, more than 90 percent of Brazil's total quantity exported. The state of Mato Grosso average exports for the analyzed period was 419.2 thousand metric tons, a 52 percent share of total exports (794.7 thousand metric tons). As for Bahia and Goiás, their participation with respect to the total exports was an average of 34 (271.9 thousand metric tons) and 5 (40.5 thousand metric tons) percent, respectively.

Historically, the average share of transportation by mode (truck, rail, barge) of Brazilian total cargo has been largely concentrated on roads (60 percent) followed by rail (20 percent) and waterway (17 percent). With respect to agricultural cargo, this truck reliance increases drastically to 81 percent, as most production is located in remote and underdeveloped areas such as Mato Grosso and Western Bahia (ANUT, 2008). As for cotton, the trucking modal share increases to approximately 100 percent of the total cotton transported to ports (Caixeta Filho & Gameiro, 2001).

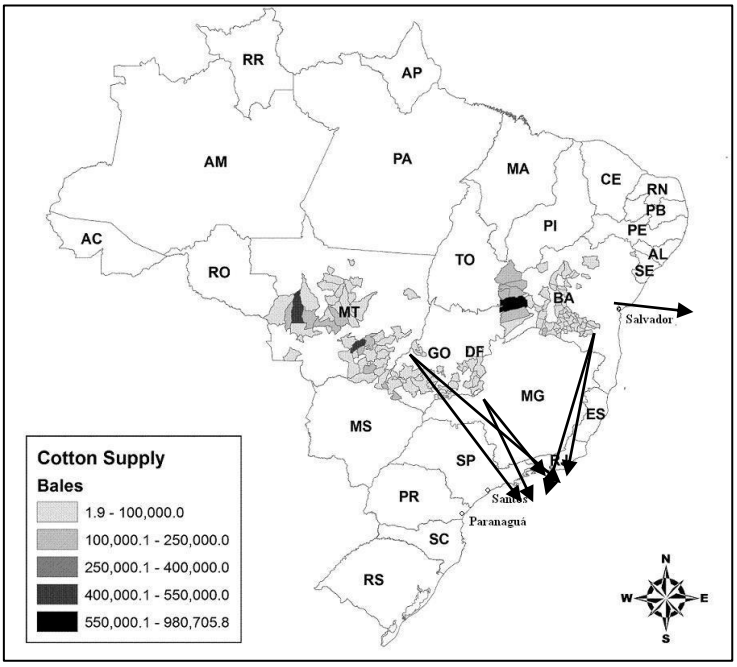
One can argue that trucks prevail in Brazil due to highway improvements, but this is not the case. It is important to note that the highway systems in developed areas of Brazil are very inefficient, and it is even worse in remote agricultural areas. A survey conducted by the Confederação Nacional do Transporte (CNT) shows that 58.8 percent of Brazil's paved highways are considered unsatisfactory (CNT, 2011). Furthermore, due to the poor conditions of the paved roads, estimates are that the Brazilian operational costs of cargo trucks are almost one third higher than they would be on paved roads under optimal conditions (AMS/USDA, 2011). The main reasons for reliance on truck transportation for cotton are: (i) lack of railroad to link producing areas to exporting ports; (ii) railways have multiple gauges thereby requiring costly transhipment stops when transporting across different-gauged tracks; (iii) most of the Brazilian railroads lack sufficient locomotives and railcars to keep up with transportation demand; and (iv) environmental constraints hinder the development of major waterways (Schnepf, Dohlman, & Bolling, 2001; ANUT, 2008). Santos is the leading cotton exporting port with an average share of 74 percent of the total cotton exports (Table 2). Paranaguá port comes in second and represents on average 22 percent of cotton exports. For the 2011-2013 period, these two ports combined represented approximately 96 percent of Brazilian cotton shipments. The port of Salvador (Bahia) had an average of less than one percent of the total Brazilian exports.

Table 2. Cotton Exports by Ports in Brazil (thousand metric tons), 2011 - 2013

Port	2011	2012	2013
Santos	553.26	810.58	413.72
Paranaguá	163.06	219.59	146.45
Foz do Iguaçu	6.49	9.63	4.66
Salvador	10.67	3.87	6.27
Subtotal	733.48	1,043.67	571.10
Others	24.85	9.14	1.81
Total	758.33	1,052.81	572.91

Source: SECEX/MDIC (2014).

In summary, the Brazilian cotton transportation network from supply area to exporting ports is heavily concentrated in three major producing states (Mato Grosso, Bahia, and Goiás). Figure 2 below depicts the supply locations (municipality level) for the three states and the two main exporting ports. It is interesting to note the distance between these locations. For example, the average distances from the farm location in Mato Grosso to the ports of Santos and Paranaguá are equal to 1,800 and 2,000 kms, respectively. As for the producing areas in the state of Goiás, the average truck haul distances to the ports of Santos and Paranaguá are 1,000 and 1,400 kms, respectively. Cotton producers in the state of Bahia rely heavily on exports via the port of Santos where the average distance is 1,600 kms. The port of Salvador, which is on average 850 kms away, has a minor role in Western Bahia cotton exports.



Source: Constructed with data from IBGE/MPOG (2011).

Figure 2. Main export routes for the cotton producing states of Mato Grosso (MT), Bahia (BA), and Goiás (GO)

As Figure 2 depicted, instead of shipping cotton to the closer port of Salvador, farmers located in Western Bahia deliver most of their cotton via the port of Santos, which is on average 830 kms further than the port of Salvador. Currently, there are no direct maritime routes from the port of Salvador to Asia and the only way for cotton to be exported is via transshipments (Lomanto, 2011). In other words, ocean vessels first have to come from major importing ports in Brazil (such as the port of Santos) then load the cargo in Salvador and eventually head to Asia. Hence, this indirect transhipment route becomes very expensive for the cotton exporters. Estimates suggest that ocean freight rates from the port of Salvador to Asia are double the charges from the port of Santos and the transit time is on average 20 days longer (Lomanto, 2011).

Furthermore, when contrasting the trucking costs from same origin in Western Bahia (i.e. Barreiras municipality) to the ports of Santos and Salvador, the latter is found to be a lower cost route. By using data from CEPEA (2011), estimates indicate that the inland truck cost to ship a metric ton from Barreiras municipality in Western Bahia to the port of Santos ($102.37/metric ton) is nearly 50 percent greater than the truck cost to the port of Salvador ($70.08/metric ton). Regarding port capacity, the port of Salvador handled 262,000 TEUs in 2010 (CODEBA, 2011a). This amount is greater than what would be required to handle the total cotton exports for the state of Bahia[2]. Therefore, based on inland cost advantages and current port capacity, one can argue that the most appropriate exporting route for the producers in Western Bahia would be utilizing the port of Salvador.

However, as discussed previously, the port of Salvador is practically not utilized for exporting cotton. In lieu of this situation, recently, Wilson Sons maritime company, which runs the container terminal in the port of Salvador (Tecon Salvador), along with the Brazilian government both agreed on cooperating to improve the port infrastructure vis-à-vis attracting direct shipping lines from the port to Asian markets and competing against other major ports for both vessel calls and container availability (CODEBA, 2011b).

According to Lomanto (2011), in order to draw interest from ocean shipping companies to consider direct shipments from the port of Salvador to Asian markets with very affordable ocean freight rates, Tecon Salvador is undergoing the following improvements: (i) structural reinforcement and expansion of the current terminal berth from 210 to 377 meters; (ii) dredging of all the extension of the berth from the current 40 to a 50 feet draft; (iii) purchase of three super Post-Panamax Ship-to-Shore (STS) cranes and six rubber-tire gantry (RTGs) cranes; and (iv) expansion of terminal retro-area from 74 thousand to 118 thousand square meters.

When the aforementioned improvements are expected to be completed, Tecon Salvador will be able to allow efficient access of Post-Panamax ships that can measure in excess 300 meters in length and are capable of transporting 10,000 TEU. According to CODEBA (2011b), several shipping lines have recently shown interest in the port of Salvador. Ocean freight charges for the direct shipment from the port of Salvador to East Asia were quoted to be 27 percent lower than the current rate, but still 44 percent higher than the port of Santos (Lomanto, 2011).

By assuming that all these improvements will take place in the near future, export cost competitiveness between the ports of Santos and Salvador is analyzed. Table 3 shows that inland trucking costs for cotton originating in Barreiras to the port of Salvador is $35.45/metric ton cheaper than to the port of Santos. When the port charges are taken into consideration, the total logistics costs for the port of Salvador equals $111.29/metric ton, which is 28.9 percent lower than the costs for the Santos port. Such low logistics costs for the port of Salvador generates a cotton price at the port (FOB) of $1,379.63/metric ton, which is approximately 3.1 percent lower than the FOB cotton price at the port of Santos.

Table 3. Cotton Export Cost Competitiveness between the Ports of Santos and Salvador after Introduction of New Ocean Shipping Lines from the Port of Salvador to Asian Markets, 2008/09 Market Year

Cost Item	Santos	Salvador
	$/metric ton	
Farm Price[1] (Barreiras, Bahia)	1,265.35	1268.35
Distance to Port (kms)	1046	530
Inland Truck Cost	105.54	70.09
Port Charges[2]	51.03	41.19
Total Logistics Cost	156.57	111.28
Price at the Port (FOB)	1,424.92	1,379.63
Freight Costs to Asia3	35.82	51.99
Price at Asia (CIF)	1,460.74	1,431.62

Source: [1] CEPEA (2011). [2] Mello (2010) and Lomanto (2011). [3] Lomanto (2011).

With respect to shipping charges to Asian importing markets (China, Indonesia, South Korea, etc.) after improvements, Table 3 points out that the new shipping lines will offer a competitive ocean freight rate for the port of Salvador. The ocean freight costs from the port of Salvador to Asian importing markets are expected to be $51.99/metric ton, still higher than the rates from the port of Santos by $16.67/metric ton. However, in CIF price terms, estimates indicate that the cotton price in Asian countries for the port of Santos and Salvador are $1,460.74 and $1,431.62/thousand ton, respectively, which gives an advantage to the port of Salvador with respect to export competitiveness.

In summary, as the improvements in the port facilities and infrastructure take place at the port of Salvador, it is expected that direct ocean shipping lines will play a major role in enhancing the port's export competitiveness. For Asian importing countries, buying cotton from the port of Salvador is expected to be two percent cheaper than its largest port competitor[3]. As a result, producers located in the state of Bahia are expected to shift exports to the port of Salvador and eventually gain in competitiveness. On the other hand, the port of Santos is expected to decrease its participation, not only in the state of Bahia's total cotton exports, but also in the total Brazilian exports.

To assess the impacts of the introduction of direct ocean shipping lines from the Port of Salvador to Asian importing countries, a spatial, intertemporal equilibrium model of the international cotton trade for the 2008/09 market year is used. Three scenarios were examined. The first scenario evaluates the effects of introducing the Port of Salvador as a viable option for Western Bahia cotton exporters into the model by reducing the export cost for the port of Salvador by two percent. The second scenario examines the effects of assuming equal ocean freight costs for both the Santos and Salvador ports to Asian importing countries (export cost from Salvador to Asian countries is reduced by 3.1 percent). Last, scenario three assumes an optimistically large reduction in export costs from the port of Salvador to Asian countries by introducing a 10 percent decrease.

2. Methodology

The model used to accomplish the research objectives is a spatial, intertemporal equilibrium model of the international cotton trade for the 2008/09 market year. A quadratic

programming model generates interregional trade flows and prices. The objective function specifies the maximization of producer and consumer surplus minus cotton handling, storage, and transportation costs (Samuelson, 1952; Takayama & Judge, 1971). The model includes considerable detail on regional excess supplies and demands as well as transportation, storage, and cotton handling costs in both the U.S and Brazil. Other cotton trading countries are considered as either excess supply or excess demand regions.

The model in this analysis includes 567 excess supply regions and 46 excess demand regions. Cotton excess supply regions include 410 U.S. regions (warehouses), 152 Brazilian regions (farm level) and 5 foreign regions (Australia, India, Sub-Sahara Africa, Uzbekistan, and all other exporting countries). Included in excess demand are 11 U.S. regions (domestic mills), 21 Brazilian regions (domestic mills), and 15 foreign demand regions (Bangladesh, China, EU-27, Hong Kong, Indonesia, Japan, Mexico, Pakistan, Rest of South America, South Korea, Taiwan, Thailand, Turkey, Vietnam, and all other importing countries).

The U.S model component represents a transportation network that links excess supply regions with excess demand regions and ports via truck and rail. Excess supply regions are connected to excess demand regions within the U.S. via truck. There are 15 U.S. ports linked to excess supply regions by truck or truck to 5 intermodal sites by rail. The ports are linked to the excess demand regions via vessels. The exception is Mexico where land border port crossings are used exclusively. A representative port in each of the foreign excess supply regions is also linked by ocean freight to each of the foreign excess demand regions.

The Brazilian model consists of 152 excess supply sub-regions/states and 21 excess demand regions (mills). The 152 excess supply regions were at the municipality level for Mato Grosso, Bahia, and Goiás. The remaining excess supply regions were modeled at the state level. The excess demand regions in Brazil were represented at the state level by determining their physical location within the primary cotton consuming states. Excess supply regions are connected to excess demand regions within Brazil by truck. Five ports are linked to the excess supply regions by truck. These five ports are linked to the excess demand regions via vessels.

3. Model Data

The spatial model was constructed with estimates of cotton production and consumption in excess supply and excess demand regions for the U.S. and Brazil as well as other major exporting and importing countries. Estimated excess supply and demand locations for the U.S. were based on the optimal solution generated by a cost minimizing mathematical programming model developed by Fraire et al. (2011). This approach minimizes the total cost of shipping, handling, and storing cotton that originates at 811 gins and flows to 415 warehouses in the U.S. The model allows routing cotton shipments from originating gins to warehouses and then to sixteen U.S. ports, eleven domestic mill regions, or four major intermodal facilities and then by rail to major West Coast, Gulf and South Atlantic ports.

The optimum solution to the least cost model is used to represent the excess supply and demand locations in the intertemporal, spatial price equilibrium. Excess supply locations are warehouses that receive cotton shipments from gins. Excess demand locations are domestic mills. The solution to the least cost model indicated that there are 410 optimal warehouses and 11 domestic mills within the United States.

Using the optimal solution of the least cost model to indicate the location of the warehouses and their cotton supply, the share of each warehouse is estimated relative to total supply. Each warehouse supply was utilized to estimate the ending stock and surplus for each excess supply region (FAS/USDA, 2011). Domestic mill locations and cotton demand were used to calculate the consumption by mill. Multiplying total consumption to the calculated consumption share, mill demand of each excess demand region was quantified.

Surplus/deficits were calculated by subtracting the total consumption and ending stocks from the total supply. If the final value is positive, the region has a surplus and thus an excess supply. If the final value is negative, the region has a deficit and thus has an excess demand.

To estimate production and consumption of cotton in excess supply (demand) regions in Brazil, several efforts were made based on data from IBGE/MPOG (2011), RAIS/MTE (2011), and FAS/USDA (2011). For exporting and importing countries, the data for exports and imports were sourced from FAS/USDA (2011).

An estimated region/country excess supply elasticity in combination with exports or estimated region surplus and region/country price facilitated the estimation of the slope and intercept parameters of inverse excess supply functions for each region/country. An inverse demand equation was estimated for each region/country with estimated excess demand elasticity, imports, or estimated region deficit and price.

Supply elasticities for U.S. cotton producing regions were acquired from Pan, Mohanty, Etheridge, & Fadiga (2006). The cotton price supply elasticities were 0.18 and 0.16 for the warehouses located in the Delta (Arkansas, Missouri, Tennessee, Louisiana, and Mississippi) and Southeast (Alabama, Georgia, Florida, North Carolina, South Carolina, and Virginia) regions, respectively. As for the Southwest (Texas, Kansas, Oklahoma, and New Mexico) and West (California and Arizona) producing regions, the supply elasticities were assumed to be 0.34 and 0.42, respectively. As for the Brazilian regions, for simplicity, the supply elasticity was equal to 0.62 and was assumed to be equal across the country (Shepherd, 2006).

As in the case of the excess supply regions, for both the U.S. and Brazilian excess demand regions (mills), each mill had quantity produced equal to zero. Thus, the excess demand elasticity was equal to its own-price demand elasticity. Domestic own-price elasticity for the U.S. mills was equal to -0.24 and was also taken from Pan et al. (2006). For the Brazilian mills, the source for the own-price elasticity is Poonyth, Sarris, Sharma, & Shui (2004) and is equal to -0.60.

Cotton handling and storage data for the U.S. portion of the model were acquired from Fraire et al. (2011). In the Brazilian cotton industry, virtually all cotton shipment from the farm to either demand (mills) or ports occurs by truck. Truck costs in this study were calculated based on the monthly data from CEPEA (2011) for the years 2007 to 2009. The port charges for the Brazilian exporting ports were based on estimations from Mello (2010) and Lomanto (2011).

The estimates of ocean freight rates from U.S. and Brazilian ports to different foreign excess demand regions were estimated based on the difference between the cotton export price (FOB-free on board) and the import price (CIF-cost insurance and freight). The difference between the CIF and FOB cotton prices for trading pairs was used as a proxy for the ocean freight rate for all countries. These international cotton ocean freight rates were compiled based on the data from FAO (2011).

Efforts were made to validate the model before performing the analysis. Historic flow patterns of cotton were compared to flows associated with the base model. Validation involved a comparison between historic export flows by U.S. and Brazilian ports and model-generated flows.

4. Results

4.1. Cotton Flow Patterns and Exports by State

As the new direct ocean shipping lines from the port of Salvador are available for cotton exporters located in the state of Bahia, it is expected that a shift of exports from the port of

Santos to the more export cost competitive port of Salvador will occur. A two percent decrease in export costs for the Port of Salvador to Asian cotton importing countries increases cotton exports via the port of Salvador (Table 4). The absolute change in exports was a positive 22.51 thousand metric tons. On the other hand, the port of Santos decreased shipments modestly by reducing total exports approximately 22.12 thousand metric tons, which in relative terms is equal to a 5.8 percent decrease. The route via the port of Santos reduces its share of total Brazil cotton exports by nearly four percentage points (from 67.4 to 63.4 percent).

As expected, cotton flow patterns resulting from the analysis of scenario two (3.1 reduction) are similar to scenario one in direction, but larger in magnitude. The port of Salvador increased cotton exports to 95.39 thousand metric tons, which in absolute value is equal to an increase of 93.99 thousand metric tons (Table 4). This increase generates a share of total Brazilian exports for the port of Salvador of almost 17 percent, up 13 percentage points when compared to scenario one. The port of Santos undergoes a decline in exports, going from 378.60 thousand metric tons to 285.35 thousand metric tons, which is in relative terms is a drop of nearly 25 percent. In scenario 3, as it was expected, the change in exports by ports is accentuated. The port of Salvador increased cotton exports to 270.48 thousand metric tons (Table 4). With a participation in the country's total exports of 46.9 percent, the port of Salvador becomes Brazil's largest cotton exporting port. In contrast, the port of Santos reduces its exports to 123.65 thousand metric tons, which represents a decrease of 67.3 percent when compared to the base model. This positions the port of Santos with a share of 21.4 percent of the Brazilian cotton exports.

Table 4. Estimated Change in Brazilian Cotton Flows Resulting from Reducing Export Cost from the Port of Salvador to Asian Importing Countries Due to Direct Ocean Shipping Lines (1,000 metric tons)

Port	Base Model	2% Reduction	Change (%)	3.1% Reduction	Change (%)	10% Reduction	Change (%)
Santos	378.6	356.48	-5.84	285.35	-24.63	123.65	-67.34
Paranaguá	127.02	127.02	0	127.02	0	126.93	-0.06
Salvador	1.39	23.91	1,616.40	95.39	6,745.61	270.48	19,316.11
Subtotal	507.02	507.41	0.08	507.76	0.15	521.06	2.78
Others	54.65	54.65	0	54.65	0	54.65	0
Total Brazil	561.67	562.06	0.07	562.41	0.13	575.71	2.51

Similar to the analysis of the changes in exports by ports, changes in exports by state are presented in Table 5. For scenario one and two, the changes in export levels by state were not significant. Scenario three induced the largest increase in exports for the state of Bahia. Table 5 indicates that the state of Bahia increased its exports by 119.95 thousand metric tons, which represent a gain of 82.6 percent. Furthermore, the state of Bahia is shown to become the leading cotton exporting state in Brazil. As for the state of Mato Grosso, cotton exports are reduced to 239.33 thousand metric tons, down 27.2 percent from the base model. This amount leaves the state of Mato Grosso as the second largest exporter of cotton in Brazil. The state of Goiás also loses its share in exports as it reduces its total by 53.3 percent (from 40.91 to 19.09 thousand metric tons). As for the share of exports, the state of Bahia would

account for 46 percent of the nation's total (up 21 percentage points when compared to the base model).

Table 5. Estimated Change in Brazilian Cotton Exports by State Resulting from Reducing Export Cost from the Port of Salvador to Asian Importing Countries Due to Direct Ocean Shipping Lines (1,000 metric tons)

State	Base Model	2% Reduction	Change (%)	3.1% Reduction	Change (%)	10% Reduction	Change (%)
Mato Grosso	328.72	328.83	0.04	328.98	0.08	239.33	-27.19
Bahia	145.25	145.44	0.14	146.01	0.53	265.19	82.62
Goiás	40.91	41	0.15	40.63	-0.69	19.09	-53.32
Subtotal	514.88	515.29	0.07	515.62	0.15	523.61	1.71
Others	46.79	46.79	0	46.79	0	52.1	11.37
Total Brazil	561.67	562.06	0.07	562.41	0.13	575.71	2.51

Although cotton flows are altered with the introduction of the direct ocean shipping lines from the port of Salvador to Asian importing markets, total Brazilian cotton exports are only modestly impacted. The largest increase in total Brazilian cotton exports is found in scenario three. This result was expected since with greater reduction in export costs for the port of Salvador, the cotton exporting producers in Bahia gain the most as they have less costly shipping options than before. The total cotton exports for this scenario was equal to 575.71 thousand metric tons, which is equal to a growth of 14.11 thousand metric tons when compared to the base model (2.51 percent increase).

4.2. Changes in Producer Prices and Revenues in Brazil

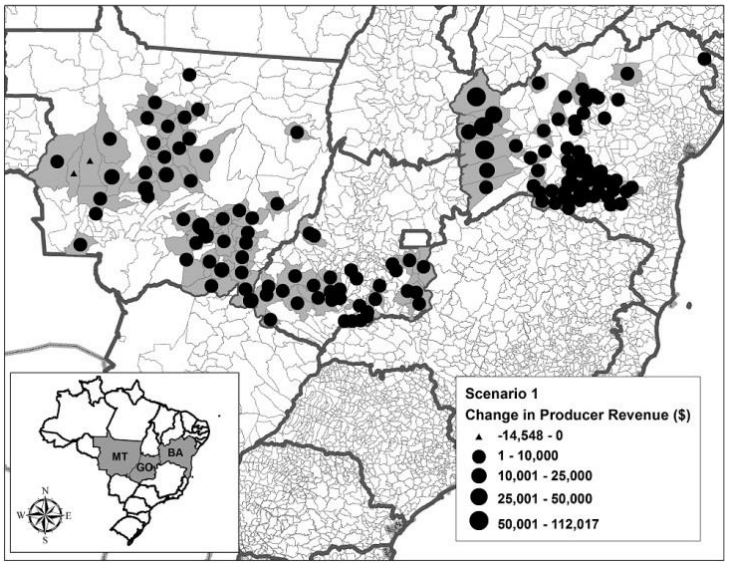
As the new direct shipping lines from the port of Salvador to Asia are in place, there would be an anticipated reduction in transportation costs linking the producers in Brazil to importers in the Asian importing countries. This increases price and production in producing areas in Brazil that ship via the port of Salvador. For example, in scenario one, by comparing the gain in prices of the top three exporting states (Mato Grosso, Bahia and Goiás), the state of Bahia experiences the largest increase in price $0.41/metric ton (Table 6). The states of Mato Grosso and Goiás also have gains in prices with an increase of $0.18/metric ton for both states.

Regarding the gains and losses in producer revenue, in scenario one, the state with the largest gain in revenue was Bahia (Table 6). The increase in producer revenues for that state was equal to $298.6 thousand. Taking into account the relatively small change in price that occurs in Bahia ($0.41/metric ton), model estimates indicate that the main reason for such increase in producer revenue is the expansion of cotton production. Figure 3 below shows the changes in producer revenue by municipality for the states of Mato Grosso, Bahia, and Goiás. The state of Bahia accrues the most benefits of the export cost reduction of the port of Salvador whereas the gains in producer revenue were concentrated in the west side of the state.

Table 6. Estimated Annual Increase in Brazilian Cotton Producer Revenues (thousand dollars) and Farm Price ($/metric ton) for Different Reductions in Export Cost of the Port of Salvador

State	2% Reduction		3.1% Reduction		10% Reduction	
	Revenue	Price	Revenue	Price	Revenue	Price
Alagoas	4.15	0.73	12.89	2.25	206.16	35.60
Bahia	298.66	0.41	1,135.75	1.70	24,860.13	34.49
Ceará	1.68	0.73	5.24	2.25	83.91	35.64
Goiás	34.74	0.18	(7.17)	(0.05)	74.59	0.69
Maranhão	26.25	0.73	81.65	2.25	1,306.48	35.60
Mato Grosso	195.62	0.18	(13.89)	(0.05)	(1,237.95)	(1.06)
MS[1]	16.58	0.18	(3.42)	(0.05)	(98.69)	(1.15)
Minas Gerais	6.41	0.18	(1.32)	(0.05)	(38.12)	(1.15)
Paraíba	8.83	0.73	27.46	2.25	439.13	35.60
Paraná	2.17	0.23	(0.11)	(0.05)	(10.50)	(1.06)
Pernambuco	2.51	0.73	7.82	2.25	125.10	35.60
Piauí	25.02	0.69	81.01	2.25	1,296.19	35.60
RN[2]	10.08	0.73	31.34	2.25	501.26	35.60
São Paulo	7.38	0.23	(1.33)	(0.05)	(38.23)	(1.15)
Tocantins	5.85	0.69	18.93	2.25	302.91	35.60
Total Brazil	645.92	0.37	1,374.85	0.87	27,772.38	3.61

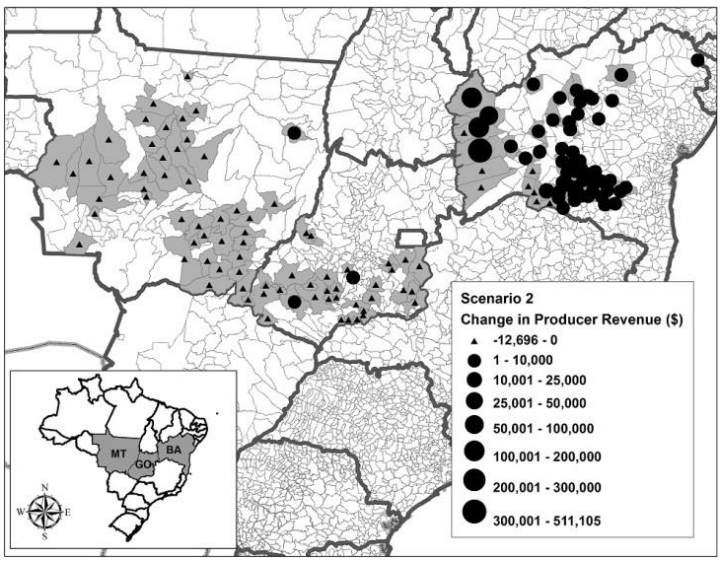
[1] Mato Grosso do Sul. [2] Rio Grande do Norte.



Note: Scenario 1 is 2 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

Figure 3. Model-estimated Changes in Cotton Producer Revenues by Municipalities for the States of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for Scenario 1

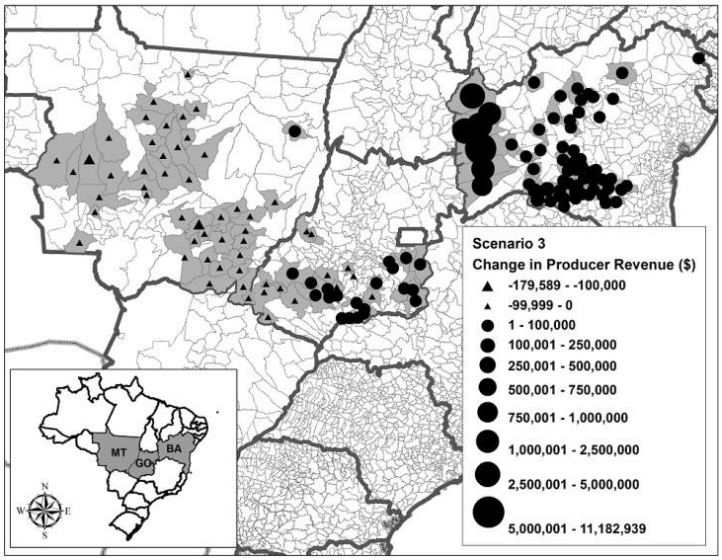
In scenario two, the 3.1 percent reduction in export cost for the port of Salvador to Asian markets is estimated to increase annual producer revenues for the state of Bahia by $1,135.75 thousand (Table 6). For the state of Bahia, the increase in cotton price of $1.70/metric ton was the greatest of all the top three producing states. As discussed earlier, Bahia is a special case since most of the gain in revenue is due to increased cotton production and not higher prices. By losing competitiveness relative to the producers in the state of Bahia, the states of Mato Grosso and Goiás undergo decreases in producer revenues of $13.89 and $7.17 thousand, respectively. As Figure 4 indicates, the municipalities located in western Bahia experience the largest increases in revenues as their cotton is mostly shipped through the port of Salvador.



Note: Scenario 2 is a 3.1 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

Figure 4. Model-Estimated Changes in Cotton Producer Revenues by Municipalities for the States of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for Scenario 2

As Table 6 shows, scenario three also estimates that Bahia is the state with the largest increase in producer revenue. With the 10 percent reduction in export cost for the port of Salvador to Asian countries, the state of Bahia increases its producer revenue by $24.8 million. On the other hand, the state of Mato Grosso decreases its producer revenue by $1.2 million. The states of Maranhão and Piauí had increases in producer revenue of $1.30 and $1.29 million, respectively. These values are worth mention since these gains are due to supplying local domestic consumption with higher prices. In other words, these regions gained because the domestic mills were previously supplied by the state of Bahia. Since the production from Bahia started to be more exported, these states gained by offering their cotton to local mills at a higher price. The municipalities located in the state of Bahia experienced the largest increases in revenues (Figure 5). For the state of Bahia, the municipality of São Desidério is shown to increase its producer revenue by $11.2 million, which represents almost half of the gains for that state ($24.8 million). Furthermore, the Western Bahia region, which is composed of six municipalities[4], accounted for almost 90 percent ($22.3 million) of the gains for the state.



Note: Scenario 3 is a 10 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

Figure 5. Model-estimated Changes in Cotton Producer Revenues by Municipalities for the States of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for Scenario 3

In summary, the producer revenue for cotton increased in all scenarios (Table 6). The largest gain in producer revenue for Brazil takes place in scenario three. As expected, the total increase in producer revenue is equal to $27.77 million, which is, in relative terms, an increase of 1.79 percent.

4.3. Brazilian Cotton Competitiveness in the World Market

The impact of the reduction in export cost for the port of Salvador to Asian importing countries on the competitiveness of exporting countries is evaluated with the focus on exports, prices, and revenue (Table 7). With the exception of scenario one, all scenarios indicate that the U.S., India, Sub-Sahara Africa, Uzbekistan and the Rest of the World Exporters all experience lower exports, prices, and revenues. Among these countries/regions, the Rest of the World Exporters were the most affected followed by India.

The U.S. is an interesting case since the results indicate that in scenario one there is a gain with respect to competitiveness in global cotton trade. A potential explanation is that the two percent reduction in the export cost for the port of Salvador does not affect a large country cotton producer such as the U.S. Nonetheless, in scenario three, when the reduction is considered to be 10 percent, the U.S. is the competing exporting country that accrues the most losses ($5.72 million). Overall, for all analyzed scenarios, these losses in exports, prices, and revenues are very modest in relative terms. For example, in scenario three, U.S. exports, price, and revenue declined by 0.03, 0.11 and 0.14 percent, respectively.

Table 7. Estimated Effects of Export Cost Reduction in the Port of Salvador to Asian Importing Countries on Exports, Prices, and Revenue for Selected Exporting Countries

Exports (1,000 metric tons)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	0.39	0.74	14.04
United States	0.14	-0.03	-0.98
Australia	-0.01	-0.01	-0.11
India	-0.15	-0.11	-1.85
Sub-Sahara Africa	-0.04	-0.03	-0.46
Uzbekistan	-0.03	-0.02	-0.39
Rest of the World	-0.16	-0.11	-1.81
Prices ($/metric ton)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	$0.37	$0.87	$16.58
United States	$0.09	$(0.05)	$(1.29)
Australia	$(0.14)	$(0.09)	$(1.19)
India	$(0.14)	$(0.09)	$(1.24)
Sub-Sahara Africa	$(0.14)	$(0.09)	$(1.24)
Uzbekistan	$(0.14)	$(0.09)	$(1.24)
Rest of the World	$(0.14)	$(0.09)	$(1.19)
Revenues (thousand $)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	$645.92	$1,374.85	$27,772.38
United States	$457.89	$(198.22)	$(5,720.89)
Australia	$(45.17)	$(35.17)	$(493.23)
India	$(714.15)	$(204.03)	$(3,240.53)
Sub-Sahara Africa	$(176.61)	$(102.95)	$(1,491.16)
Uzbekistan	$(151.49)	$(86.58)	$(1,250.89)
Rest of the World	$(727.86)	$(224.45)	$(3,416.51)

As the export cost from the port of Salvador to Asian markets is reduced due to new direct ocean shipping lines, there are gains in competitiveness for Brazilian cotton producers (Table 7). There are increases in exports, price, and revenue for Brazil. The largest impacts were in scenario three due to the larger reduction in export cost for the port of Salvador. The increases in exports, price, and revenue were equal to 14.04 thousand metric tons, $16.58/metric ton, and $27.77 million, respectively. However, in relative terms, the Brazilian cotton exporting industry is slightly better off. The percentage increases in export, price, and producer revenue were only 2.50, 1.54, and 1.79 percent, respectively.

5. Conclusions

The port of Salvador is undergoing major improvements in port facilities and other important basic infrastructure such as dredging of the main canal. As a result, this port is

expected to become more competitive and attract ocean shipping companies which are willing to export products directly to Asian markets. One of the industries that is expected to benefit from these direct shipping lines is the cotton located in the state of Bahia. To evaluate these expected benefits, a spatial, temporal equilibrium model was used to examine three scenarios.

The first scenario evaluates the effects of introducing the Port of Salvador as a viable option for Western Bahia cotton exporters into the model by reducing the export cost at Asian importing countries by two percent. The second scenario examines the effects of assuming equal ocean freight costs for both the Santos and Salvador ports at Asian importing countries (export cost from Salvador to Asian countries is reduced by 3.1 percent). Last, scenario three assumes an optimistically large reduction of export cost from the port of Salvador to Asian countries by introducing a 10 percent decrease.

For the 10 percent reduction scenario, the cotton flows and exports had substantial changes. Cotton exports via the port of Salvador increased substantially. This scenario indicated the port of Salvador as the leading cotton exporting port in Brazil. The port of Santos would decrease its participation in total cotton exports considerably. Overall, in scenario three, the percentage of cotton exported via the port of Salvador relative to the country's total cotton exports increased from 0.24 to 46.9 percent. Further, total Brazilian cotton exports were estimated to increase by 14.04 thousand metric tons, which is equivalent to a 2.51 percent rise.

With respect to the export share by states, in scenario three, the state of Mato Grosso is shown to decrease its participation in the export total for Brazil by 16.9 percentage points. On the other hand, the port of Salvador makes the producers in the state of Bahia more export competitive which boosts their exports to 265.19 thousand metric tons. This increase in cotton exports would place Bahia as the leading cotton exporting state in the country.

A 10 percent reduction in export cost for the port of Salvador is projected to annually increase revenues of Brazilian cotton producers by $27.77 million, with the state of Bahia accruing the most gains ($24.86 million). On the other hand, the largest decrease in producer revenue occurred in the state of Mato Grosso. Since these producers ship most of their exports to the ports of Santos and Paranaguá, they lose competitiveness and undergo losses in producer revenue of $1.23 million. With respect to the world cotton trade, the modest increase in exports due to a more efficient port of Salvador made Brazil's cotton industry more competitive.

In summary, the new direct ocean shipping lines from the port of Salvador are important for the cotton exporters in Brazil, especially for the producers in the state of Bahia. As the port improvements are completed and the ocean shipping carriers introduce new shipping lines, the analysis indicates a shift in Brazil cotton export flows from the port of Santos to the port of Salvador as well as an increase in exports and producer revenues. In addition, this study suggests that the state of Bahia has the potential of becoming the largest cotton exporter in Brazil. As for other competing export countries, modest declines in exports, prices, and revenues are expected to occur.

References

Associação Nacional dos Usuários de Transporte de Cargas (ANUT) (2008). Transporte – Desafio ao Crescimento do Agronegócio Brasileiro. Rio de Janeiro, Brazil. Accessed September, 2011, available at http://www.anut.org.br/estudos_trabalhos.asp.

Buainain, M.A., & Batalha, M.O. (2007). Cadeia Produtiva do Algodão. Brasília: Ministério da Agricultura, Pecuária e Abastecimento.

Caixeta Filho, J.V., & Gameiro, A. H. (2001). Transporte e Logística em Sistemas Agroindustriais. São Paulo: Atlas Editora, São Paulo, Brazil.

Centro de Estudos Avançados em Economia Aplicada (CEPEA) (2011). Análise Mensal do Algodão. São Paulo, Brazil. Accessed August, 2011, available at http://www.cepea.esalq.usp.br/.
Companhia das Docas do Estado da Bahia (CODEBA) (2011a). Estatística Portuária. Salvador, Brazil. Accessed October, 2011, available at http://www.codeba.com.br/.
Companhia das Docas do Estado da Bahia (CODEBA) (2011b). Algodão baiano começa a ser exportado pelo porto de Salvador. Salvador, Brazil. Accessed October, 2011, available at http://www.codeba.com.br/.
Confederação Nacional do Transporte (CNT) (2011). Pesquisa CNT de Rodovias 2010. Brasília, Brazil. Accessed October, 2011, available at http://www.sistemacnt.org.br/pesquisacntrodovias/2010/.
Fraire, F., Fuller, S., Robinson, J., & Vadali, S. (2011). Feasibility of Containerized Transport in Rural Areas and its Effect on Roadways and Environment: A Case Study. Department Agricultural Economics, *AFCERC Commodity Market Research Report*, No. CP-03-11, Texas A&M University.
Lomanto, J. (2011). Infra-Estrutura do TECON Salvador. Terminal de Contaneires de Salvador (TECON – Salvador). Salvador, Bahia, Brazil. Personal email communication on September 28, 2011.
Mello, F. (2010). Mecanismos de Redução de Custos Logísticos de Exportação Algodão. *7º Seminário Internacional de Logística Agroindustrial*, Piracicaba, São Paulo.
Ministério da Agricultura, Pecuária e Abastecimento, Companhia Nacional de Abastecimento (CONAB/MAPA) (2015). Safras Históricas – Algodão. Brasília, Brazil. Accessed February, 2015, available at http://www.conab.gov.br/conabweb/.
Ministério do Desenvolvimento, Indústria e Comércio Exterior, Secretaria de Comércio Exterior (SECEX/MDIC) (2014). Aliceweb. Brasília, Brazil. Accessed August, 2014, available at http://aliceweb.desenvolvimento.gov.br/default.asp.
Ministério do Planejamento, Orçamento e Gestão, Instituto Brasileiro de Geografia e Estástica (IBGE/MPOG) (2011). Produção Agrícola Municipal – PAM. Brasília, Brazil. Accessed August, 2011, available at http://www.ibge.gov.br/home/estatistica/economia/pam/.
Ministério do Trabalho e Emprego (RAIS/MTE) (2011). Relação Anual de Informações Sociais – RAIS. Brasília, Brazil. Accessed August, 2011, Available at http://www.rais.gov.br/.
Pan, S., Mohanty, S., Etheridge, D., & Fadiga, M. (2006). The impacts of U.S. cotton programs on the world market: an analysis of Brazilian WTO petition. *Journal of Cotton Science*, 10, 180-92.
Poonyth, D., Sarris, A., Sharma, R., & Shui, S. (2004). The Impact of Domestic and Trade Policies on the World Cotton Market. Working Paper, FAO Commodity and Trade Policy Research No. 8, Rome, Italy.
Samuelson, P.A. (1952). Spatial Price Equilibrium and Linear Programming. *American Economic Review*, 42, 283-303.
Schnepf, R.D., Dohlman, E., & Bolling, C. (2001). Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops. Washington D.C.: Department of Agriculture, Economic Research Service, Agriculture and Trade Report, WRS-01-3, December.
Shepherd, B. (2006). Estimating Price Elasticities of Supply for Cotton: a Structural Time-series Approach. Working Paper, FAO Commodity and Trade Policy Research No. 21, Rome, Italy.
Takayama, T., & Judge, G.G. (1971). *Spatial and Temporal Price and Allocation Models.* Amsterdam, North Holland Publishing Co.

United Nations, Food and Agriculture Organization (FAO) (2010). Summary of World Food and Agricultural Statistics. Prepared by the Statistics Division, Food and Agriculture Statistics, Rome. Accessed: October, 2010. available at: http://www.fao.org/trade/stats_en.asp.

U.S. Department of Agriculture, Foreign Agriculture Service (FAS/USDA) (2011). Production, Supply, and Demand (PS&D) online database. Washington D.C. Accessed August, 2011, available at http://www.fas.suda.gov/psd/.

U.S. Department of Agriculture, Agricultural Marketing Service (AMS/USDA) (2011). Soybean Transportation Guide: Brazil 2011. Washington D.C. Accessed August, 2011, available at www.ams.usda.gov/tmdtsb/grain.

Footnotes

[1] The Cerrado area is comprised of a large heterogeneous tropical savanna which occupies more than 2 million hectares, approximately 20 percent of the land area in Brazil. It includes areas from the Amazon complex, most of the Central-West of Brazil, and part of Southeast and Northeast of Brazil.

[2] If the total cotton exports from the state Bahia was equal to 163.13 thousand metric tons in 2013 and one 1 TEU (20 foot container) fits approximately 10 metric tons, then it would be required 16,313 TEUs (20 foot containers) to export the total state's cotton exports.

[3] For importing countries in Asia, the CIF prices for cotton exported via the ports of Santos and Salvador are $1,460.74 and $1,431.62/metric ton, respectively, which indicates that the port of Salvador is two percent more efficient.

[4] Barreiras, Correntina, Formosa do Rio Preto, Luís Eduardo Magalhães, Riachão das Neves, and São Desidério.