Transportation Infrastructure in Brazil: Impacts and Implications for Global Cotton Trade

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CNAS 2012-01

http://cnas.tamu.edu/

May 2012

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Cotton Industry in Brazil

Cotton was introduced into Brazil in the Northeastern region of the country in the 18th century. 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 represented the majority of Brazilian cotton production (figure 1).
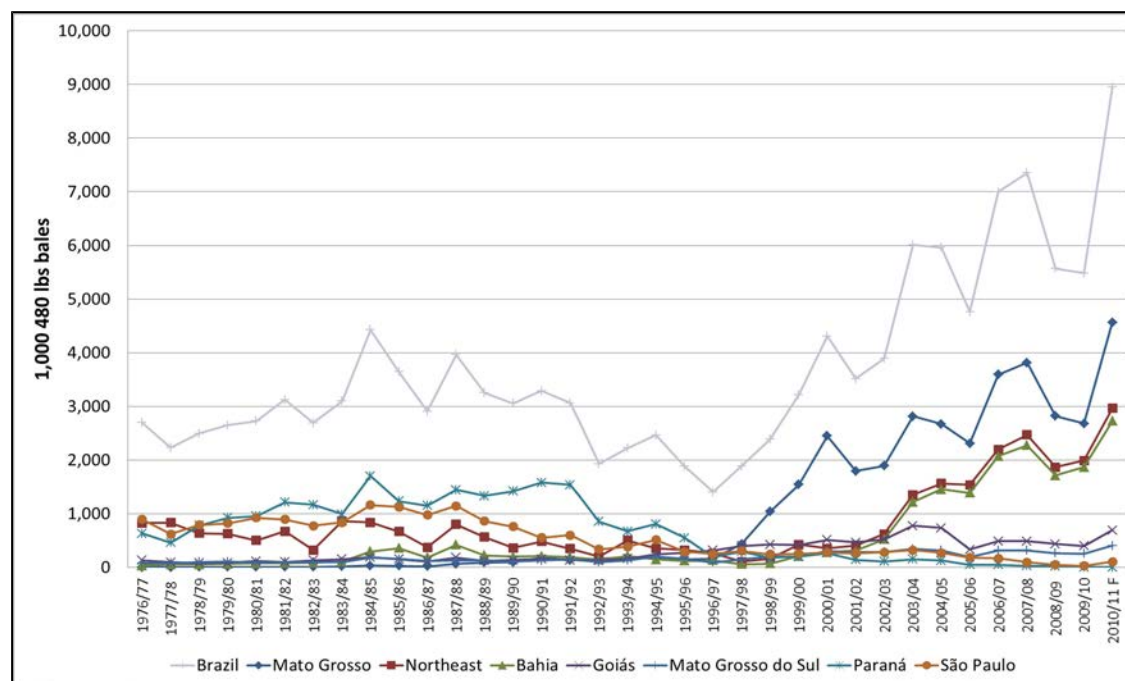

Figure 1. Historical series of cotton production by state and region, 1976/1977 – 2010/11
Source: Companhia Nacional de Abastecimento (CONAB/MAPA 2011a).

From 1987/88 to 1996/97 cotton production decreased substantially from four million bales to 1.5 million bales (figure 1). According to Buainain and Batalha (2007), the principal factors for the decline were: (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[2] 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

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[2] 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, most of the Central-West of Brazil, and part of Southeast and Northeast.

cotton production in the Cerrado was strongly affected by the following factors: (i) large scale production; (ii) advanced technology for planting and harvesting; (iii) local government support for research and development; and (iv), although small, investment in transportation infrastructure (Buainain and Batalha 2007).

In the 1997/98 marketing year, cotton production for the state of Mato Grosso began to rise significantly (figure 1). By 2000/01, the production share for the state of Mato Grosso reached 57 percent (2.45 million bales). Three years later, Bahia started emerged by increasing its cotton production to 1.22 million bales, which represented an increase of almost one million bales when compared to 2000/01. In 2009/10, these two states represented more than 80 percent (4.55 million bales) of Brazilian production (5.48 million bales), with the state of Mato Grosso accounting for 50 percent (2.68 million bales). The remaining 20 percent of Brazilian cotton production is mostly represented by the states of Goiás (8 percent) and Mato Grosso do Sul (5 percent), which are also part of the Cerrado area.

Mato Grosso is expected to continue as the number one producing state (4.56 million bales) followed by Bahia (2.73 million bales), Goiás (693,100 bales), and Mato Grosso do Sul (403,900 bales) for 2010/11. Overall, these four states will account for approximately 94 percent of the Brazilian cotton production, which is forecast to be 8.95 million bales in 2010/11, an all-time high.

According to the SECEX/MDIC (2012), South Asia and Southeast Asia are large importers of Brazilian cotton. Based on the average of the 2009-2011 calendar years of Brazilian cotton exports, China, Indonesia and South Korea imported 623.7, 527.4, and 460.1 thousand bales, respectively (Figure 2). This represents 59 percent of Brazil's average total cotton exports (2.72 million bales). The remaining cotton exports are evenly distributed with most of the exports having final destinations in the Southern and Southeastern parts of Asia. The only exception is the European Union, which accounted for 3 percent (nearly 65 thousand bales) of the export market.
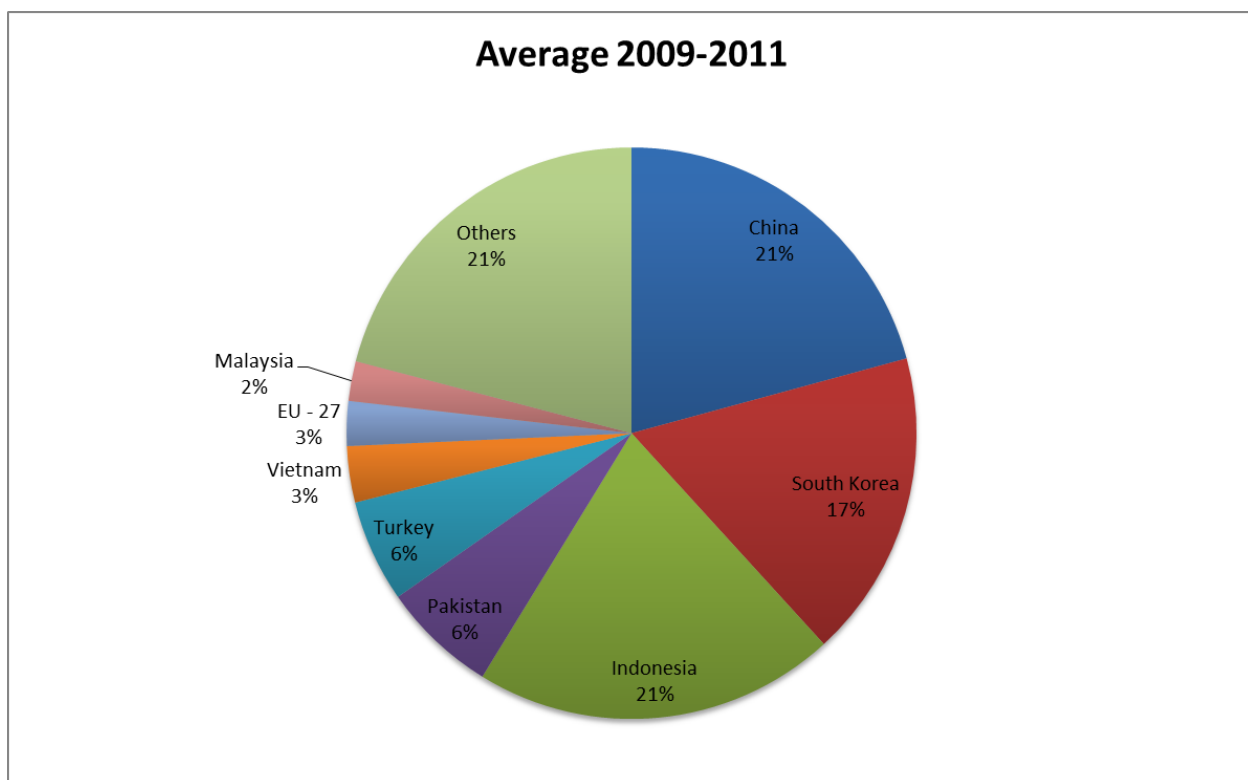
Figure 2. Share of final destination of Brazilian cotton exports, Average 2009-2011
Source: SECEX/MDIC (2012).

Based on the data from SECEX/MDIC (2011), Brazil's total cotton exports are disaggregated to state and region levels as shown in table 1. Brazil's total cotton exports rose from 1.40 million bales in 2006 to 3.48 million bales in 2011, a record amount. During the previous record high export year of 2008, the total quantity exported reached a record level, which, according to the FAS/USDA (2011), placed Brazil as the third largest cotton exporter in the world behind the U.S. (13.26 million bales) and Uzbekistan (3.0 million bales). Since that time, India has overtaken both Brazil and Uzbekistan for second place, and Brazil, Australia and Uzbekistan round out the top five. Furthermore, for the 2011/12 market year, preliminary estimates of Brazil's cotton exports are 3.8 million bales, which represent an increase of nearly 1.5 bales when compared to 2010.

In 2011, Brazilian cotton exports did indeed rise by more than a million bales to 3.48 million bales. Mato Grosso, Bahia, and Goiás account for, on average, more than 90 percent of Brazil's total quantity of cotton exported (table 1). During 2006-2011, cotton exports from the state of Mato Grosso averaged 1.24 million bales, a 53.4 percent share of average total exports (2.32 million bales). As for Bahia and Goiás, their participation with respect to the total exports was an average of 32.6 percent (756,980 bales) and 6.8 percent (157,950 bales), respectively.

Table 1. Cotton Exports by State/Region in Brazil (1,000 bales), 2006 - 2011

State	2006	2007	2008	2009	2010	2011
Mato Grosso	750.5	1,087.5	1,516.0	1,230.5	1,186.4	1,665.8
Bahia	445.0	586.6	584.8	708.9	819.9	1,396.7
Goiás	94.0	133.8	150.7	200.3	179.0	189.9
São Paulo	21.9	26.0	26.3	40.0	57.0	38.4
Mato Grosso do Sul	54.2	44.6	77.7	65.8	47.3	74.4
Maranhão	11.3	18.7	31.8	53.5	46.8	81.6
Minas Gerais	12.6	14.7	50.4	12.8	8.8	18.0
Subtotal	*1,389.7*	*1,912.2*	*2,438.0*	*2,312.0*	*2,345.5*	*3,464.8*
Rest of Brazil	8.7	9.5	9.7	7.0	8.3	18.0
Total	**1,398.5**	**1,921.7**	**2,447.7**	**2,319.0**	**2,353.9**	**3,482.8**

Source: SECEX/MDIC (2012).

Of total textile production, cotton represents approximately 80 percent of the input (ABIT 2011). In general for 2005 to 2009, cotton consumption was distributed among three regions: Northeast, Southeast, and South (table 2). The Northeast was the leading cotton yarn producer representing on average 38.1 percent (1.94 million bales) of Brazilian cotton consumption followed by the Southeast (33.2 percent) and the South (27.6 percent). The largest cotton producing region of Brazil, Central-West, only accounted for one percent (48,900 bales) of domestic consumption.

Table 2. Cotton yarn production by region in Brazil, 2005 – 2009 (1,000 bales)

Region	2005	2006	2007	2008	2009	Average
North	0.0	0.0	0.0	0.0	0.0	0.0
Northeast	1,762.9	1,870.5	1,940.8	2,030.8	2,101.9	1,941.4
Southeast	1,712.0	1,687.0	1,731.8	1,675.7	1,658.0	1,692.9
South	1,370.9	1,434.2	1,422.5	1,388.8	1,419.4	1,407.1
Central-West	16.8	43.2	51.4	59.1	74.1	48.9
Total	4,862.5	5,034.9	5,146.5	5,154.4	5,253.3	5,090.3

Source: ABIT (2012).

Cotton Transportation Network in Brazil

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, reliance on truck transportation increases 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 truck share increases to virtually 100 percent of the total cotton transported to ports (Caixeta Filho and Gameiro 2001).

Often, trucks prevail as the dominant mode of transportation due to efficient highways, but this is not the case in Brazil. In fact, the highway systems in developed areas of Brazil are very inefficient and are 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, having various deficiencies such as: 58.2 percent of the traffic road signs are inadequate and 39.8 percent of the roads do not have shoulders. In addition, more than 88 percent of Brazilian roads are one-way which causes very heavy congestion (CNT 2011). Furthermore, due to the poor conditions of the paved roads, estimates are that the Brazilian operational costs of cargo trucks are 28 percent 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 systems to link producing areas to exporting ports; (ii) railways have multiple gauges thereby requiring costly transshipment stops when transporting across different-gauged tracks; (iii) most of the Brazilian railroads lack sufficient locomotives and railcars to keep up with transportation demand[3]; and (iv) environmental constraints hinder the development of major waterways (Schnepf, Dohlman, and Bolling 2001; ANUT 2008).

Santos is the leading cotton exporting port with an average share of 67.7 percent of total cotton exports from 2006-2011 (table 3). Paranaguá is second and represents on average 23.0 percent of cotton exports. Historically, Santos and Paranaguá together accounted for on average 90.7 percent of Brazilian cotton exports. Foz do Iguaçu port is a border port with Argentina and Paraguay where these two countries are mainly the final destination for Brazilian cotton exported via that route. For the period 2006-2011, these three ports combined represented approximately 97 percent of Brazilian cotton shipments. The port of Salvador (Bahia) had an average of two percent of total Brazilian exports.

Table 3. Cotton Exports by Ports in Brazil (1,000 bales), 2006 - 2011

Port	2006	2007	2008	2009	2010	2011
Santos	821.1	1,283.3	1,522.9	1,644.8	1,615.3	2,541.1
Paranaguá	330.4	390.2	617.4	477.8	644.4	748.9
Foz do Iguaçu	149.9	130.8	138.3	96.1	74.2	29.8
Salvador	105.7	49.8	4.2	16.0	20.1	49.0
Subtotal	*1,398.5*	*1,854.1*	*2,282.7*	*2,234.7*	*2,353.9*	*3,368.8*
Others	0.0	67.6	165.0	84.3	0.0	114.0
Total	***1,398.5***	***1,921.7***	***2,447.7***	***2,319.0***	***2,353.9***	***3,482.8***

Source: SECEX/MDIC (2012).

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[3] The estimates are for a growth in demand and a shortage in supply for railroad transportation over the next five years

Table 4 presents the share of cotton exports by port and state. For Mato Grosso, from 2006 to 2011, cotton exports through the port of Santos were equivalent to, on average, 742,600 bales, which represents 59.9 percent of the total exports from Mato Grosso (1.24 million bales). As for the other two main exporting states, Bahia and Goiás, the share of exports via the port of Santos were equal to 78.0 and 65.0 percent, respectively. As table 4 shows, the port of Paranaguá is the second most important port for exports. Cotton exports from the state of Mato Grosso via the Paranaguá port were equal to 368,900 bales, which is 29.7 percent. On the other hand, cotton producers located in the state of Bahia only shipped seven percent of exports through the port of Paranaguá. The Foz do Iguaçu border crossing port had minor participation as an exporting option for the analyzed states (less than 6 percent for all states). It is important to note that the port of Salvador only accounted for 2.6 percent of the exports from the state of Bahia, and nearly nil from the other states.

Table 4. Average and Share of Cotton Exports for each Port by State, 2006-2011.

Port	Mato Grosso		Bahia		Goiás	
	6-year Average[a]	Share (%)	6-year Average	Share (%)	6-year Average	Share (%)
Santos	742.6	59.9	590.9	78.0	102.7	65.0
Paranaguá	368.9	29.7	68.8	9.0	37.2	23.6
Foz do Iguaçu	58.4	4.7	15.1	1.9	3.2	2.0
Salvador	0.0	0.0	17.1	2.6	0.1	0.1
Subtotal	*1,169.9*	*94.3*	*691.9*	*91.5*	*143.2*	*90.7*
Other	69.6	5.7	65.1	8.5	14.7	9.3
Total	*1,239.5*	*100.0*	*757.0*	*100.0*	*157.9*	*100.0*

[a] Average from 2006 to 2011, 1,000 bales and percent of total.
Source: Calculated based on the data from SECEX/MDIC (2012).

In summary, Brazilian cotton transportation network from supply region to exporting ports is heavily concentrated in three major producing states, Mato Grosso, Bahia, and Goiás. Figure 3 depicts the supply locations (municipality level) for the three states and the two main exporting ports. It is interesting to note the long distances between cotton supply and export locations. For example, the average distances from the farm location in Mato Grosso to the ports of Santos and Paranaguá are equal to 1,100 and 1,240 miles, respectively. As for the producing areas in the state of Goiás, the average truck haul distances to the ports of Santos and Paranaguá are 640 and 880 miles, respectively.
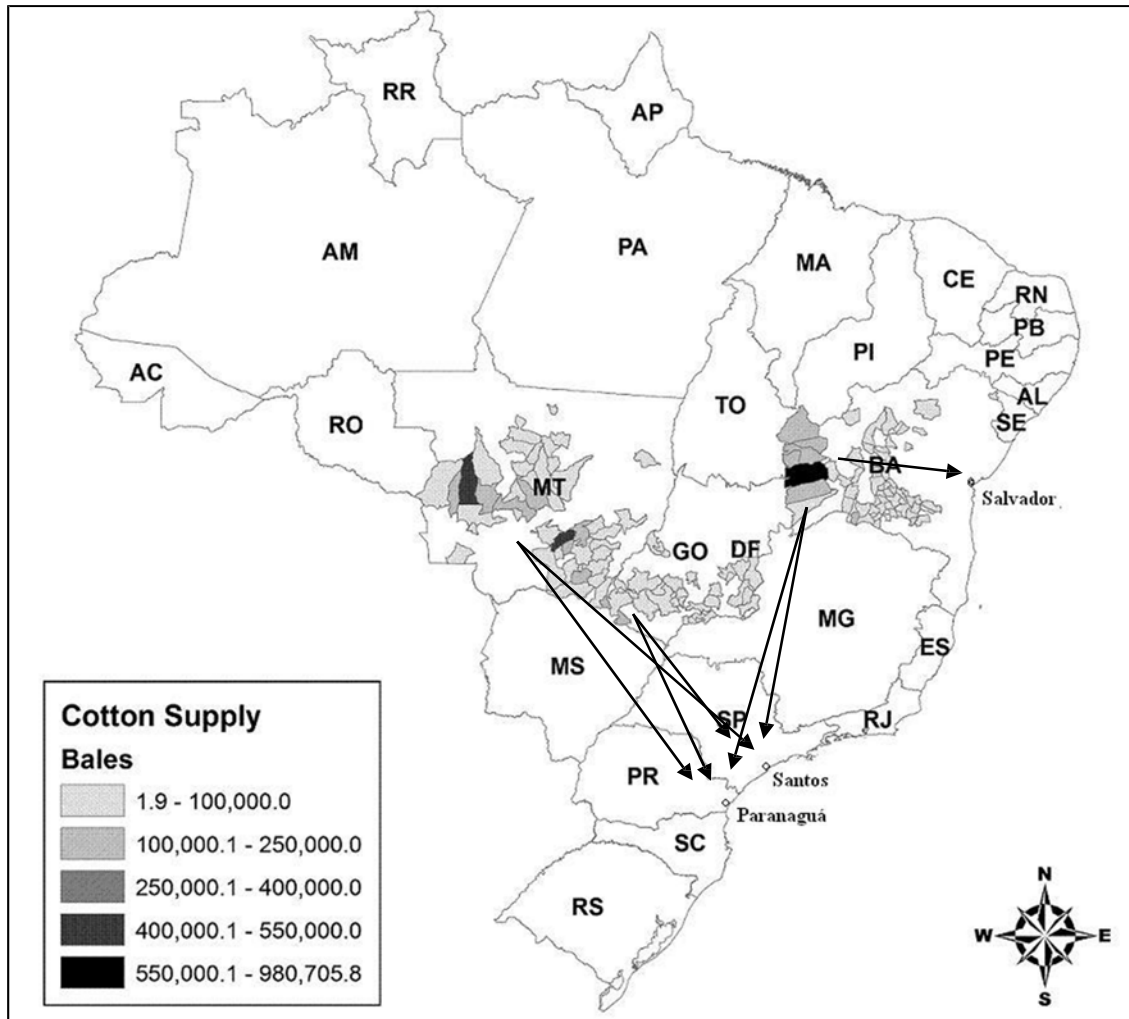
Figure 3. Main export routes for the cotton producing states of Mato Grosso (MT), Bahia (BA), and Goiás (GO). Source: constructed with data from IBGE/MPOG (2011).

Cotton producers in Bahia rely heavily on exports via the port of Santos where the average distance is 1,046 miles. The port of Salvador, which is on average 530 miles away, has a minor role in Western Bahia cotton exports.

With respect to inland transportation costs, Brazilian truck rates for cotton were based on an estimated truck rate equation using data from CEPEA (2011). Estimated charges for transporting cotton to port at average distances of 400, 600, 800, 1,000, and 1,200 miles for all Brazil regions were $13.35, $16.33, $19.31, $22.29, and $25.27/bale, respectively. During the peak shipping period (harvest quarter), trucking charges are approximately $1.09/bale higher than the off-peak.

Port of Salvador Improvements and Direct Ocean Shipping Lines to Asian Markets

In the previous section, table 4 indicated that the port of Salvador accounted for less than two percent of the cotton exports originating in Bahia. As figure 3 depicted, instead of shipping cotton to the closer port of Salvador, farmers located in Western Bahia deliver most of their

cotton to the port of Santos, which is on average 516 miles further than the port of Salvador. According to Lomanto (2011), the main factors which force exporters to haul cotton to the port of Santos are: (i) lack of direct shipments from the port of Salvador to the importing markets in Asia and (ii) costly ocean freight rates when compared to the port of Santos.

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. In other words, ocean vessels first arrive 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 transshipment 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 cotton from Barreiras in Western Bahia to the port of Santos ($22.98/bale) is nearly 50 percent greater than the truck cost to the port of Salvador ($15.26/bale).

Regarding port capacity, 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[4]. Therefore, based on inland cost advantages and current port capacity, one can argue that the most cost-efficient export route for producers in Western Bahia would be to ship to the port of Salvador.

However, as discussed previously, the port of Salvador is minimally utilized for exporting cotton. Wilson Sons maritime company, which operates the container terminal in the port of Salvador (Tecon Salvador), along with the Brazilian government both agreed on cooperating to improve the port infrastructure by trying to attract direct shipping lines from Salvador to Asian markets and competing against other major ports for both vessel calls and container availability. The private company will invest nearly $100 million and will be responsible for the improvements of the port facilities and purchase of new equipment. The government of Brazil (GOB) will spend approximately $250 million on building an expressway to link the Bay of All Saints to the federal highway (BR-324) and dredging of the port access channel from 40 feet to 50 feet (CODEBA 2011b).

According to Lomanto (2011), in order to draw interest from ocean shipping companies to consider direct shipments from Salvador to Asian markets, Tecon Salvador is making the following improvements: (i) structural reinforcement and expansion of the current terminal berth from 210 to 377 meters; (ii) dredging of the berth from the current 40 to a 50 foot draft; (iii)

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[4] 10 If total cotton exports from Bahia equaled 819,900 bales and one 1 TEU (20 foot container) holds 44 bales, then 18,634 TEUs (20 foot containers) would be needed to export all of the states's cotton.

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 74,000 to 118,000 square meters.

When the aforementioned improvements are completed, Tecon Salvador will be able to accommodate efficient access of Post-Panamax vessels that are in excess 300 meters in length and capable of transporting 10,000 TEU. According to CODEBA (2011b), several shipping lines have recently shown interest in the new port facility at Salvador. Three ocean shipping companies (CMA CGM, CSAV, and China Shipping) have already offered direct liner services between the port of Salvador and several locations in Asia. Additionally, 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 was analyzed. Table 5 shows that inland trucking costs for cotton originating in Barreiras to the port of Salvador is $7.72/bale cheaper than to the port of Santos. When the port charges are taken into consideration, the total logistics costs for the port of Salvador equal $24.23/bale, which is 28.9 percent lower than the costs for Santos. These lower costs at Salvador result in a cotton price at the port (FOB) of $300.38/bale, which is approximately 3.1 percent lower than the FOB cotton price at Santos.

Table 5. 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 MY, $/480 lbs. bale.

Cost Item	Santos	Salvador
Farm Price[a] (Barreiras, Bahia)	**276.15**	**276.15**
Distance to Port (kms)	**1,046**	**530**
Inland Truck Cost[b]	22.98	15.26
Port Charges[c]	11.11	8.97
Total Logistics Cost	**34.09**	**24.23**
Price at the Port (FOB)	**310.24**	**300.38**
Freight Costs to Asia[d]	7.80	11.32
Price at Asia (CIF)	**318.04**	**311.70**

[a]CEPEA (2011). [b]Based on author's calculation (see appendix A). [c]Mello (2010) and Lomanto (2011). [d]Lomanto (2011).

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 import markets are expected to be $11.32/bale, still higher than the rates from the port of Santos by $3.52/bale. However, in CIF price terms, estimates indicate that the cotton price in Asian countries for Santos and Salvador

are $318.04 and $311.70/bale, respectively, which a slight advantage to the port of Salvador. For the Asian importing countries, cotton produced in the state of Bahia from the port of Salvador will cost two percent less than the port of Santos.

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 competition[5]. As a result, producers located in the state of Bahia are expected to shift exports to the port of Salvador and eventually gain competitiveness. The port of Santos is expected to reduce its participation, not only in the state of Bahia's total cotton exports, but also in total Brazilian exports.

Purpose and Objectives

The purpose of this study is to assess the economic consequences of transportation infrastructure improvement in Brazil on the world cotton market. The primary objectives include examination of (1) the impacts of transportation infrastructure improvements in Brazil by port and final destination; (2) changes in exports and producer revenue; and (3) the effects of transportation infrastructure on global cotton distribution and competitiveness.

Procedures

To accomplish the main objectives, three scenarios are examined. The first scenario evaluates the effects of introducing the Port of Salvador as a viable option for Western Bahia cotton exporters by reducing the export cost by two percent. The second scenario examines the effects of assuming equal ocean freight costs for Santos and Salvador to Asian importing countries. The final scenario assumes a large reduction in export costs from the port of Salvador to Asian countries by introducing a 10 percent reduction, which seems plausible over time as volumes increase and costs are lowered. Other inland transportation improvements were considered as a potential gain for cotton exporter located in West Bahia. The West-East railroad is being considered by some agricultural experts in Brazil as a very important improvement for the producing areas of São Desidério and Barreiras. This railroad will connect the central-west state of Tocantins, cross the state of Bahia and reach the port of Ilhéus, coast of Bahia. It is estimated that the Brazilian government via the Growth Acceleration Program (Programa de Aceleração do Crescimento) will spend around R$6 billion (approximately $3.3 billion) on the construction (SEPLAN, 2012). However, the railroad is not expected to be fully operational until 2016 at the earliest and has been receiving severe criticism from the private sector because of the lack of initiative by the federal government in releasing funds (Valor Online, 2012).

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[5] For importing countries in Asia, the CIF prices for cotton exported via the ports of Santos and Salvador are $318.04 and $311.70/bale, respectively, which indicates that the port of Salvador is two percent less costly.

Methodology

Theses analyses are performed with a spatial, inter-temporal equilibrium model of the international cotton industry that includes substantial detail on domestic and international transportation. A base model representing international cotton trade is estimated for the 2008/09 marketing year and used for comparison for the three scenarios noted above.

The effects of the new direct ocean shipping lines were determined by adjusting the appropriate parameters (ocean freight rates) in the base model, obtaining the solution to the model, and then contrasting these results with the base model. The lower ocean freight rates were incorporated into the model by reducing ocean freight rates on routes that link the Port of Salvador with Asian importing demand regions. The model solution representing lower ocean freight rates was contrasted with the base model solution to estimate the impacts on Brazil cotton flows, export levels, and producer revenues for the domestic cotton sector and competing countries.

RESULTS

Scenario one assumes that the new direct shipping lines are in place and analyzes a two percent reduction in export cost for the Port of Salvador to Asian cotton importing countries. In the second scenario, freight rates from the port of Salvador are assumed to be equal to the port of Santos ($7.80/bale). This assumption generates export cost competitiveness for the port of Salvador that is 3.1 percent lower than the port of Santos. The third scenario analyzes a 10 percent reduction in export cost competitiveness from the port of Salvador to Asian importing markets.

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 Bahia, it is expected that a shift in exports from 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 6). The absolute change in exports was an additional 103,400 bales. Santos decreased shipments modestly by reducing total exports approximately 101,500 bales, which is 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). For the major exporting port of Paranaguá, there was no significant change in cotton exports.

Table 6. 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 (1,000 480 lbs. bales)

Port	Base Model	2% Reduction	Change (%)	3.1% Reduction	Change (%)	10% Reduction	Change (%)
Santos	1,738.9	1,637.3	-5.84	1,310.6	-24.63	567.9	-67.34
Paranaguá	583.4	583.4	0.00	583.4	0.00	583.0	-0.06
Salvador	6.4	109.8	1,616.40	438.1	6,745.61	1,242.6	19,316.11
Subtotal	*2,328.7*	*2,330.6*	*0.08*	*2,332.2*	*0.15*	*2,393.5*	*2.78*
Others	251.0	251.0	0.00	251.0	0.00	251.0	0.00
Total Brazil	***2,579.7***	***2,581.6***	***0.07***	***2,583.2***	***0.13***	***2,644.5***	***2.51***

Cotton flow patterns resulting from the analysis of scenario two (3.1 percent reduction) were similar to scenario one in direction, but larger in magnitude. The port of Salvador increased cotton exports to 438,100 bales, an increase of 431,700 bales (table 6). This increase generates a share of total Brazilian exports for Salvador of almost 17 percent, up 13 percentage points when compared to scenario one. The port of Santos underwent a decline in exports from 1.74 million bales to 1.31 million bales, which is a drop of nearly 25 percent. Another key observation is that Santos reduced its share of total Brazilian cotton exports. Half of the Brazilian cotton exports are shipped via Santos port, which is equal to a 16.7 percentage points decrease when compared to the base model (from 67.4 percent to 50.7 percent). Similar to scenario one, Paranaguá does not undergo any significant change as its exports continues to be equal to the base model values.

In scenario 3 the change in exports by ports is accentuated. The cotton exports from Salvador increased to 1.24 million bales (table 6). With 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 567,900 bales, which represents a decrease of 67.3 percent when compared to the base model. As a result, the port of Santos share of Brazilian cotton exports drops to 21.4 percent, 46 percent below the base model. Despite a very small reduction in exports (370 bales), the port of Paranaguá becomes the second most important cotton exporting port in Brazil, surpassing the port of Santos.

Similar to the analysis of the changes in exports by ports, changes in exports by state are presented in table 7. For scenario one (2 percent reduction), the changes in export levels by state were not significant. The state of Bahia, which was expected to benefit the most due to the location of the port of Salvador, only increased its exports by 900 bales (an increase of 0.14 percent). Similarly, Mato Grosso and Goiás were shown to have positive gains in exports, which were not expected. Due to less costly direct ocean shipping from Salvador, these states were supposed to lose exports to the state of Bahia. Nonetheless, their gains were modest with only slight increases in exports (less than 1,000 bales). As for the share of exports by state, since there

were no major changes in exports levels, the state of Mato Grosso continued to be the leading cotton exporting state followed by Bahia and Goiás.

Table 7. 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 (1,000 480 lbs. bales)

State	Base Model	2% Reduction	Change (%)	3.1% Reduction	Change (%)	10% Reduction	Change (%)
Mato Grosso	1,509.8	1,510.4	0.04	1,511.0	0.08	1,099.2	-27.19
Bahia	667.1	668.0	0.14	670.6	0.53	1,218.0	82.62
Goiás	187.9	188.3	0.15	186.7	-0.69	87.7	-53.32
Subtotal	*2,364.8*	*2,366.7*	*0.07*	*2,368.3*	*0.15*	*2,405.2*	*1.71*
Others	214.9	214.9	0.00	214.9	0.00	239.3	11.37
Total Brazil	*2,579.7*	*2,581.6*	*0.07*	*2,583.2*	*0.13*	*2,644.5*	*2.51*

In scenario two (3.1 percent reduction), the changes in export levels by state were insignificant (table 7). Cotton exports from Bahia increased by 3,500 bales. Mato Grosso was estimated to gain in exports by increasing its total amount by 1,240 bales (0.08 percent increase). Goiás is found to decrease its exports by 1,310 bales. As in the case for the other states, in relative terms, this change in export levels for the state of Goiás are small.

In contrast to scenarios one and two, the 10 percent reduction in export costs for the port of Salvador induced the largest increase in exports for the state of Bahia. Table 7 indicates that the state of Bahia increased its exports by 551,100 bales, which represents a gain of 82.6 percent. It is interesting to note that total cotton exports of 1.22 million bales would be the highest historical level for that state. Since its production was estimated to be 1.70 million bales by the IBGE/MPOG (2011) for the 2008/09 marketing year, model results suggest that the state would export almost 72 percent of its cotton production.

The state of Bahia is shown to become the leading cotton exporting state in Brazil. As for Mato Grosso, cotton exports are reduced to 1.10 million bales, down 27.2 percent from the base model. This amount places 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 187,900 bales to 87,700 bales). As for the share of exports, the state of Bahia would account for 46 percent of the nation's total (up 21 percent over to the base model).

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. For scenario one, the increase in total cotton exports from Brazil was equal to 1,900 bales which is equivalent to a 0.07 percent increase (table 6 or table 7). As for the second scenario, a greater reduction in export cost for the port of Salvador increased total Brazilian

cotton exports by 3,500 bales, a 0.13 percent increase. 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. Total cotton exports for this scenario were 2.64 million bales, which was an increase of 64,800 bales when compared to the base model.

Changes in Producer Prices and Revenues in Brazil

As the new direct shipping lines from the port of Salvador to Asia are put in place, there would be an anticipated reduction in transportation costs linking exporters in Brazil to importers in Asia. This would result in an increase in 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 $0.09/bale (table 8). The states of Mato Grosso and Goiás also have gains in prices with an increase of $0.04/bale for both states. It is interesting to note that all states were shown to benefit with respect to price gains. However, these values are presented at the state level which averages all the gains and losses of the municipalities.

Regarding the gains and losses in producer revenue, in scenario one, the state with the largest gain in revenue was Bahia (table 8). The increase in producer revenues for that state was equal to $298,660. Taking into account the relatively small change in price that occurs in Bahia ($0.09/bale), model estimates indicate that the main reason for such increase in producer revenue is the expansion of cotton production[6].

The gain for Bahia is relevant since the port of Salvador is located in that state and local cotton producers were the beneficiaries of the export cost reductions. Unexpectedly, the states of Mato Grosso and Goiás had significant gains in producer revenues as well, with $195,620 and $34,740, respectively. In this scenario, all states gain from the reduction in export cost for the port of Salvador.

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[6] According to IBGE/MPOG (2011), cotton production for the state of Bahia was approximately 1.7 million bales for the 2008/09 market year.

Table 8. Estimated Annual Increase in Brazilian Cotton Producer Revenues ($1,000) and Farm Price ($/bale) 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	$0.16	$12.89	$0.49	$206.16	$7.75
Bahia	$298.66	$0.09	$1,135.75	$0.37	$24,860.13	$7.51
Ceará	$1.68	$0.16	$5.24	$0.49	$83.91	$7.76
Goiás	$34.74	$0.04	$(7.17)	$(0.01)	$74.59	$0.15
Maranhão	$26.25	$0.16	$81.65	$0.49	$1,306.48	$7.75
Mato Grosso	$195.62	$0.04	$(13.89)	$(0.01)	$(1,237.95)	$(0.23)
MS[a]	$16.58	$0.04	$(3.42)	$(0.01)	$(98.69)	$(0.25)
Minas Gerais	$6.41	$0.04	$(1.32)	$(0.01)	$(38.12)	$(0.25)
Paraíba	$8.83	$0.16	$27.46	$0.49	$439.13	$7.75
Paraná	$2.17	$0.05	$(0.11)	$(0.01)	$(10.50)	$(0.23)
Pernambuco	$2.51	$0.16	$7.82	$0.49	$125.10	$7.75
Piauí	$25.02	$0.15	$81.01	$0.49	$1,296.19	$7.75
RN[b]	$10.08	$0.16	$31.34	$0.49	$501.26	$7.75
São Paulo	$7.38	$0.05	$(1.33)	$(0.01)	$(38.23)	$(0.25)
Tocantins	$5.85	$0.15	$18.93	$0.49	$302.91	$7.75
Total Brazil	*$645.92*	*$0.08*	*$1,374.85*	*$0.19*	*$27,772.38*	*$3.61*

[a] Mato Grosso do Sul. [b]Rio Grande do Norte.

Figure 4 shows the changes in producer revenue by municipality for the states of Mato Grosso, Bahia, and Goiás. Bahia receives the highest gains due to export cost reductions at Salvador Gains in producer revenue were concentrated in the west side of the state. The municipalities of São Desidério and Formosa do Rio Preto obtained gains of $112,200 and $57,600, respectively. For most of its municipalities, the state of Mato Grosso is shown to have had gains in producer revenue except for two: Sapezal (-$14,500) and Campos de Júlio (-5,200). The largest increase in producer revenue for the state of Mato Grosso occurred in the municipalities of Campo Verde and Pedra Preta with gains of $27,800 and $17,500, respectively. As for the state of Goiás, all municipalities were found to have a positive change in producer revenue, with the largest increase in producer revenue in the municipality of Chapadão do Céu ($9,900).

In scenario two, the 3.1 percent reduction in export cost for the port of Salvador to Asian markets, the estimated increase in annual producer revenue for the state of Bahia was $1.14 million (table 8). For the state of Bahia, the increase in cotton price of $0.37/bale was the
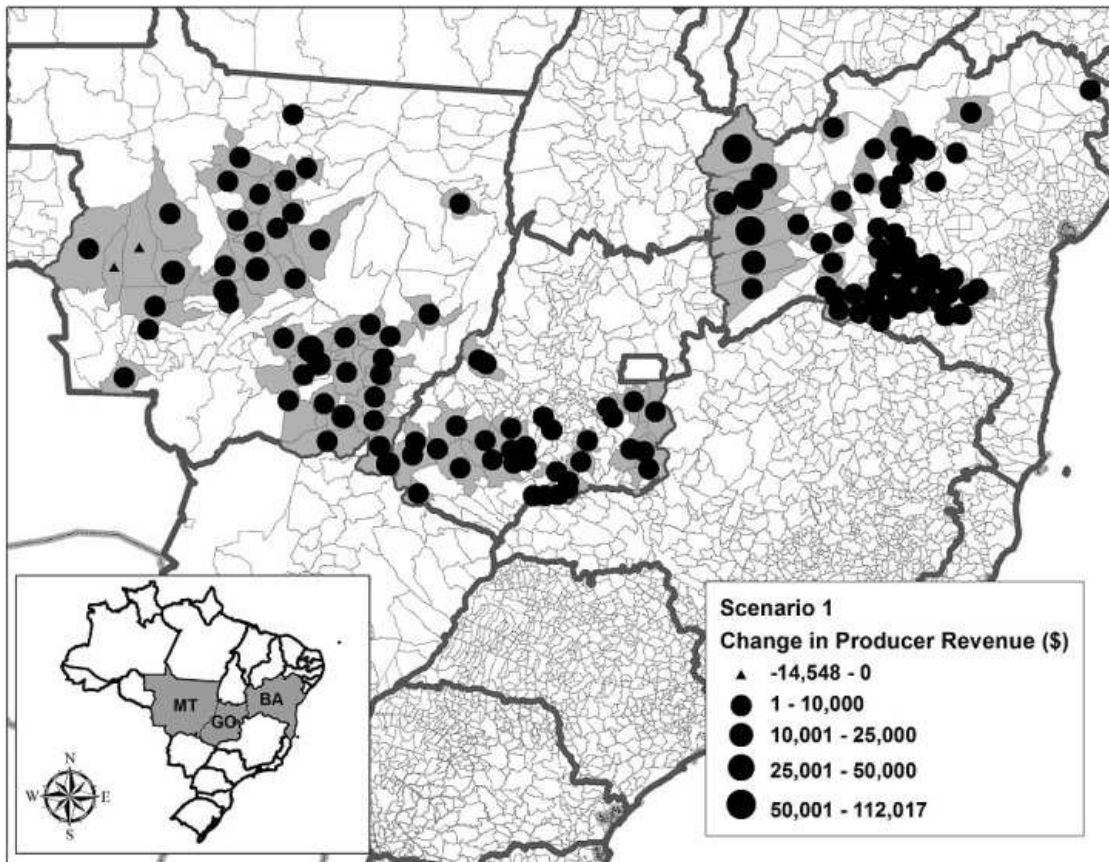
Figure 4. Model-estimated changes in cotton producer revenues by municipalities for the states of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for scenario 1
Note: Scenario 1 is 2 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

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. In contrast to scenario one, decreases in producer revenue are found in this scenario. By losing competitiveness relative to the producers in the state of Bahia, the states of Mato Grosso and Goiás experienced reductions in producer revenues of $13,890 and $7,170, respectively. Few other states were found to have negative change in producer revenue. However, all decreases in producer revenue were small (less than $15,000) when compared to the gains for Bahia ($1.14 million). In contrast to scenario one, as the export cost reduction gets larger, it leads to losses in producer revenue for some regions.

As figure 5 indicates, the municipalities located in western Bahia experienced the largest increases in revenues since cotton is mostly shipped through the port of Salvador. Similar to scenario one, the municipalities of São Desidério and Formosa do Rio Preto are shown to gain the most for that state as their revenues increase by $511,100 and $179,100, respectively. For the
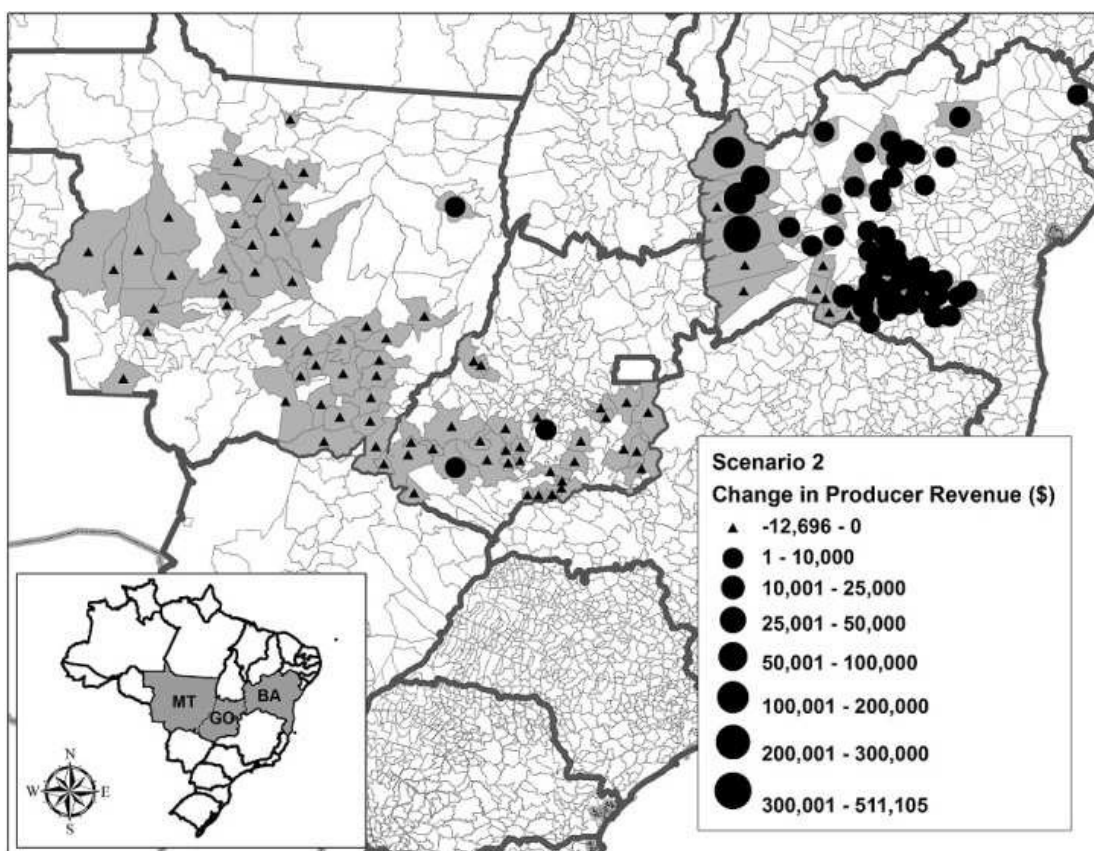
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Figure 5. Model-estimated changes in cotton producer revenues by municipalities for the states of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for scenario 2
Note: Scenario 2 is a 3.1 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

state of Mato Grosso, the municipality of Sapezal is the largest loser, with a producer revenue decrease of $12,700. Only one municipality in the state of Mato Grosso, Bom Jesus do Araguaia, was shown to gain in this scenario (up $5,700). As for the municipalities located in the state of Goiás, the decreases in producer revenue were projected to take place in the entire state except for two municipalities: Cezarina and Jataí. Still, the gains in producer revenue for these outliers in the state of Goiás were nil.

Scenario three estimated 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 $24.9 million. On the other hand, the state of Mato Grosso decreases its producer revenue by $1.2 million, which is the largest negative change of all states. In contrast, the state of Goiás gains from the export cost reduction by increasing its revenue (only up by $74,600). 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

Bahia exports more cotton, these states gained by offering their cotton to local mills at a higher price.

The municipalities located in Bahia experienced the largest increases in revenues (figure 6). São Desidério is shown to increase producer revenue by $11.2 million, which represents almost half of the gains for the state ($24.8 million). Furthermore, the Western Bahia region, which is composed of six municipalities[7] accounted for almost 90 percent ($22.3 million) of the gains. As in scenario two, in the state of Mato Grosso, only the municipality of Bom Jesus do Araguaia ($6,800) was shown to gain producer revenue. The largest decreases in producer revenue for that state occurred in the municipalities of Sapezal and Campo Verde with losses of $179,600 and $159,500, respectively. For Goiás, some municipalities had increases in producer revenue. The largest increases in producer revenue occurred in the municipality of Rio Verde ($33,500) followed by Montividiu ($18,900). On the other hand, the largest decrease in producer revenue took place in the municipality of Chapadão do Céu ($50,100).
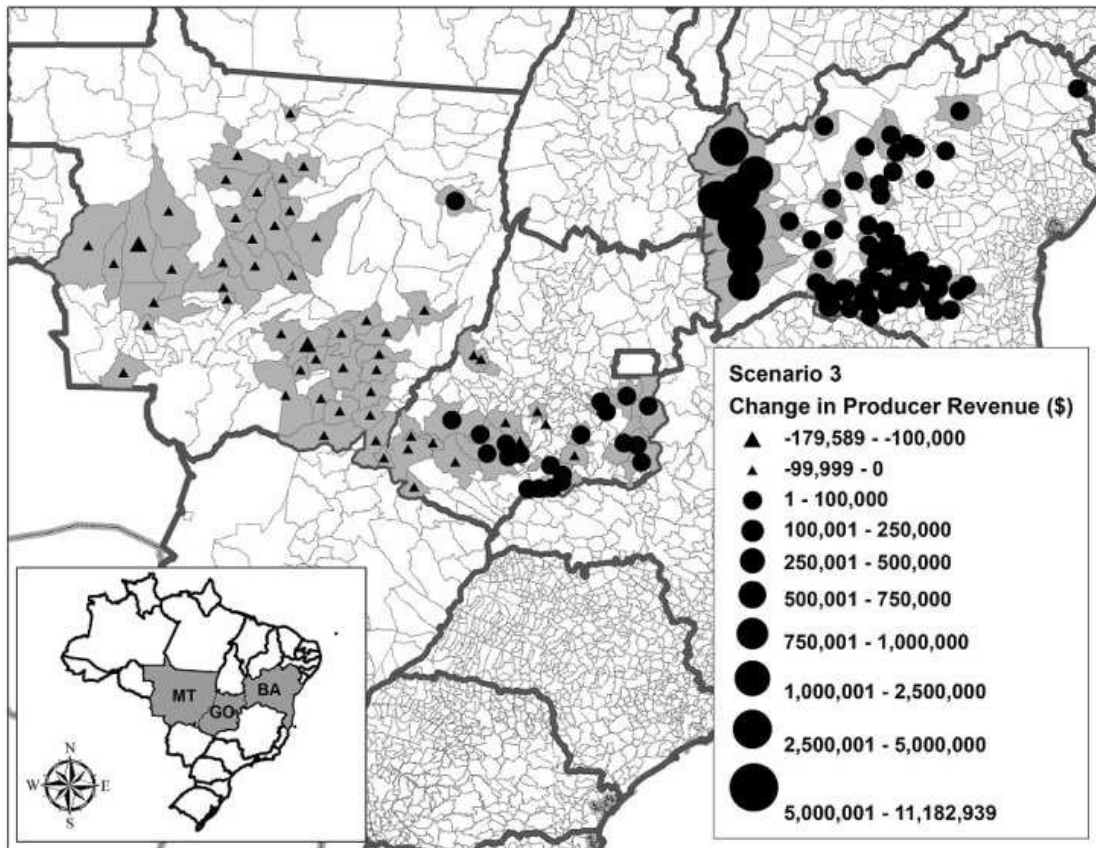

Figure 6. Model-estimated changes in cotton producer revenues by municipalities for the states of Mato Grosso (MT), Bahia (BA), and Goiás (GO) for scenario 3
Note: Scenario 3 is a 10 percent reduction in export cost for the Port of Salvador to Asian cotton importing countries.

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

In summary, producer revenue for cotton increased in all scenarios (table 8). A two percent reduction in export cost for the port of Salvador to Asian cotton importing countries is projected to increase annual cotton producer revenues by approximately $645,900. In relative terms, for this scenario, the total increase in producer revenue for Brazil is equal to 0.04 percent. For scenario two, the 3.1 percent export cost reduction causes a greater positive impact on the producer revenue for Brazil. The total increase in Brazilian cotton producer revenue is equal to $1.37 million, which, in relative terms, is equivalent to an increase of 0.09 percent. Overall, the largest gain in producer revenue for Brazil takes place in scenario three. As expected, the total increase in producer revenue is equal to $27.8 million, which is, in relative terms, an increase of 1.79 percent.

Brazilian Cotton Competitiveness in the World Market

The impact of the reduction in export cost for Salvador to Asian importing countries on the competitiveness of exporting countries is evaluated with the focus on exports, prices, and revenue. Table 9 presents the results of the scenarios that were analyzed previously. With the exception of scenario one, all scenarios indicated 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 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 experiences the largest 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.

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 9). There are increases in exports, price, and revenue for Brazil. The largest impacts occurred for 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 64,830 bales, $3.61/bale, and $27.8 million, respectively. However, in relative terms, the Brazilian cotton export 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.

Table 9. 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 (1,000 480 lbs. bales)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	1.90	3.50	64.83
United States	0.64	-0.13	-4.49
Australia	-0.04	-0.03	-0.52
India	-0.71	-0.51	-8.50
Sub-Sahara Africa	-0.17	-0.12	-2.10
Uzbekistan	-0.15	-0.11	-1.80
Rest of the World	-0.73	-0.50	-8.30
Prices ($/bale)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	$0.08	$0.19	$3.61
United States	$0.02	$(0.01)	$(0.28)
Australia	$(0.03)	$(0.02)	$(0.26)
India	$(0.03)	$(0.02)	$(0.27)
Sub-Sahara Africa	$(0.03)	$(0.02)	$(0.27)
Uzbekistan	$(0.03)	$(0.02)	$(0.27)
Rest of the World	$(0.03)	$(0.02)	$(0.26)
Revenues ($1,000)	2% Reduction	3.1% Reduction	10% Reduction
Brazil	$645.9	$1,374.9	$27,772.4
United States	$457.9	$(198.2)	$(5,720.9)
Australia	$(45.2)	$(35.2)	$(493.2)
India	$(714.2)	$(204.0)	$(3,240.5)
Sub-Sahara Africa	$(176.6)	$(103.0)	$(1,491.2)
Uzbekistan	$(151.5)	$(86.6)	$(1,250.9)
Rest of the World	$(727.9)	$(224.5)	$(3,416.5)

CONCLUSIONS

By the end of 2012, Salvador is expected to have undergone 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 able to export products directly to Asia. The Bahia cotton industry is expected to benefit from these direct shipping lines. To analyze the potential impacts of these new direct ocean shipping lines, a spatial price equilibrium model of the international cotton sector was used.

To accomplish the main objectives, 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 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). Scenario three analyzes a 10 percent decrease in export costs from Salvador to Asia.

For all scenarios, the port of Salvador was found to become a more cost-efficient option for cotton exported from Bahia. For the 10 percent reduction scenario, the cotton flows and exports had substantial changes. Cotton exports from Salvador increased substantially, with total exports reaching to 1.24 million bales. Salvador became the leading exporting port in Brazil. The port of Santos decreased participation in total cotton exports considerably, down almost 68 percent. 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 64,830 bales, which is a 2.51 percent rise.

With respect to the export share by state, in scenario three, the state of Mato Grosso is shown to lower 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 by increasing exports to an all-time high of 1.2 million bales. This increase in cotton exports places Bahia as the leading cotton exporting state in the country. As for the share of exports, the state of Bahia increases its participation in total Brazilian exports to 46.0 percent, up by 20.2 percentage points. As for the state of Goiás, the total exports declined by 53.3 percent.

A 10 percent reduction in export cost for the port of Salvador is projected to annually increase revenues of Brazilian cotton producers by $27.8 million, with the state of Bahia accruing the largest gains ($24.9 million). 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. All competing export countries had very modest reductions in exports, prices and revenues with individual countries such as the U.S. and India experiencing the largest declines.

In summary, the new direct ocean shipping lines from the port of Salvador provide a crucial improvement in transportation infrastructure to increase the export competitiveness for cotton. As port improvements are completed and the ocean carriers introduce new service to Asia, the analysis indicated 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 exporting region in Brazil. Modest declines in exports, prices, and revenues are expected to occur for export competing countries, including the United States.

REFERENCES

Associação Brasileira da Indústria Têxtil e de Confecção (ABIT), 2011. *Produção por Região.* São Paulo, Brazil. Available at http://www.abit.org.br/site/, accessed April, 2012.

Associação Nacional dos Usuarios de Transporte de Cargas (ANUT), 2008. *Transporte – Desafio ao Crescimento do Agronegocio Brasileiro.* Rio de Janeiro, Brazil. Available at http://www.anut.org.br/estudos_trabalhos.asp, accessed September, 2011.

Buainain, M.A. and M.O. Batalha, 2007. "Cadeia Produtiva do Algodão." Instituto Interamericano de Cooperação para a Agricultura (IICA), Série Agronegócios, Vol. 4, January.

Caixeta Filho, J.V.; Gameiro, A. H., 2001. Transporte e Logística em Sistemas Agroindustriais. São Paulo, Atlas, 218 p.

Centro de Estudos Avançados em Economia Aplicada (CEPEA), 2011.*Análise Mensal do Algodão.* São Paulo, Brazil. Available at http://www.cepea.esalq.usp.br/, accessed August, 2011.

Companhia das Docas do Estado da Bahia (CODEBA), 2011a. *Estatística Portuária,* Salvador, Brazil. Available at http://www.codeba.com.br/, last accessed October, 2011.

Companhia das Docas do Estado da Bahia (CODEBA), 2011b. "Algodão baiano começa a ser exportado pelo porto de Salvador." Salvador, Brazil. Available at http://www.codeba.com.br/, last accessed October, 2011.

Confederação Nacional do Transporte (CNT), 2011. *Pesquisa CNT de Rodovias 2010.* Brasília, Brazil. Available at http://www.sistemacnt.org.br/pesquisacntrodovias/2010/, accessed October, 2011.

Costa, Rafael de Farias, 2012. "Chapter III: The Potential Effects of Port Improvements in Brazil on the World Cotton Market." *Three Essays on International Trade.* PhD Dissertation, Department of Agricultural Economics, Texas A&M University, College Station, Texas.

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, March.

Ministério da Agricultura, Pecuária e Abastecimento, Companhia Nacional de Abastecimento (CONAB/MAPA), 2011a. *Safras Históricas – Algodão*. Brasília, Brazil. Available at http://www.conab.gov.br/conabweb/, accessed August, 2011.

Ministério da Agricultura, Pecuária e Abastecimento, Companhia Nacional de Abastecimento (CONAB/MAPA), 2011b. *Balança Comercial do Agronegócio*. Brasília, Brazil. Available at http://www.conab.gov.br/conabweb/, accessed September, 2011.

Ministério do Desenvolvimento, Indústria e Comércio Exterior, Secretaria de Comércio Exterior (SECEX/MDIC), 2011. *Aliceweb*. Brasília, Brazil. Available at http://aliceweb.desenvolvimento.gov.br/default.asp, accessed April, 2012.

Ministério do Planejamento, Orçamento e Gestão, Instituto Brasileiro de Geografia e Estástica (IBGE/MPOG), 2011. *Produção Agrícola Municipal – PAM*. Brasília, Brazil. Available at http://www.ibge.gov.br/home/estatistica/economia/pam/, accessed August, 2011.

Schnepf, R.D., E. Dohlman, and C. Bolling. 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.

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