Competition between the U.S. and West Africa in International Cotton Trade: A Focus on Import Demand in China[1]

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Competition between the U.S. and West Africa in International Cotton Trade: A Focus on Import Demand in China

We estimate the demand for imported cotton in China and assess the competitiveness of cotton-exporting countries. Given the assertion that African cotton producers are ill affected by U.S. cotton subsidies, our focus is the price competition between the C4 countries (Benin, Burkina Faso, Chad and Mali) and United States in China. Demand estimates are used to project how U.S. prices affect China's imports by country. In comparing demand projections, results show that the relationship between the United States and the C4 has more to do with how U.S. prices can affect global prices rather than any substitute or competitive relationship in the Chinese market.

Key Words: Africa, China, cotton, demand, imports, United States

JEL Classification: F17, Q11, Q17

It has been argued that cotton subsidies in industrialized countries negatively affect farmers in West Africa (Alston and Brunke, 2006). Quirke (2002), and Alston, Sumner and Brunke (2007) assert that subsidies in the United States and EU depress world cotton prices resulting in welfare loss for producers in developing countries. This issue is particularly important to the West African countries that comprise the Cotton-4 or C4 (Benin, Burkina Faso, Chad and Mali) because the cotton sector accounts for a significant source of farm income, employment, and foreign exchange earnings, and contributes to overall economic development in the region. Furthermore, cotton represents the largest share of non-oil export receipts in the region, with export earnings accounting for more than 3% of GDP (Hanson, 2007). From 2004 to 2007, the share of cotton exports in total agricultural export earnings ranged from 51% in Chad to as high as 80% in Burkina Faso (Jales, 2010).

China is the most important destination market for C4 cotton. Since China's accession to the World Trade Organization in December 2001, its cotton imports grew by more than 6,700% by 2006. This growth was further supported by the expiration of the Multi-Fiber Arrangement in January 2005. China is now the leading cotton importer in the world accounting for 28% of world trade in 2009 (UN Comtrade, 2011).[1] Of total cotton production in the C4, over 90% is exported to international markets with China being the primary destination (Perret, 2006). According to the United Nations, the total value of cotton exported by the C4 in 2005 was $842.6 million. China accounted for about half of this total.

In this study, we examine the factors that determine the demand for imported cotton and assess the competitiveness of exporting countries in China. Of particular interest is the

[1] Cotton imports are defined according to the HS classification 5201: cotton, not carded or combed.

competition between the C4 and United States and the impact of U.S. price shocks on C4 export earnings. The major exporters of cotton to China are the United States, India, and Uzbekistan. While individual C4 countries are smaller by comparison, their combined share of China's market has been comparable to India and Uzbekistan. In 2010, total cotton imports in China were valued at $5.7 billion where the United States, India, and Uzbekistan respectively accounted for 35%, 31%, and 12%. India's share of China's market increased from as low as 4.7% in 2005, while the U.S.'s share decreased from as high as 47.6% in 2008. During the period 2005-2010, the C4 accounted for as much as 12.2%; however, this decreased to 3.8% in 2010 (Table 1).

[Table 1 here]

The primary objective of this study is to estimate the demand for imported cotton in China where imports are assumed differentiated by country of origin (Armington, 1969). Past import demand studies have typically used consumer demand models such as the almost ideal demand system (AIDS) model (Deaton and Muellbauer, 1980) and Rotterdam model (Theil, 1980). However, given the intermediate nature of cotton imports, import demand is modeled as input demand and the differential approach to the theory of the firm is used for the analysis (Theil, 1977; Laitinen 1980). The empirical model is derived from a two-step profit maximization procedure, resulting in a structural system of import demand equations. The system of equations allows for the determination of total import expenditures and source-specific imports. The import demand estimates are used to derive conditional and unconditional demand elasticities which are used to project how U.S. price shocks affect cotton demand in China. Given the size of the U.S. cotton sector, a U.S. price shock could ultimately affect global prices. A vector autoregression procedure is used to assess the price relationship among the United States, India, Uzbekistan and the C4. Import demand simulations are conducted assuming global prices are independent, as well as the price relationships derived from the vector autoregression procedure.

The literature on the cotton sector and China is quite extensive. Studies have examined the impact of Bt cotton adoption in China on global cotton trade (Anderson, Valenzuela, and Jackson, 2008; Fang and Babcock, 2003; Frisvold, Reeves, and Tronstad, 2006; Huang and et al., 2004). Others have examined the effects of China's currency policy on global cotton markets (Ge, Wang, and Ahn 2010; Pan et al., 2007). Several studies have investigated how the elimination of the Multi-Fiber Agreement affected China's role in global cotton markets (Audet, 2007; Li, Mohanty, and Pan, 2005; MacDonald et al., 2010); while others examined how China's WTO accession affected global cotton trade (Fang and Babcock, 2003; Fuller et al., 2003). A more recent study has considered the global recession and China's cotton supply chain (Xiao, 2010).

While global cotton markets have been extensively studied, missing from the literature are studies that focus on the competition among exporting sources. Noted exceptions are Alston et al. (1990), Arnade, Pick, and Vasavada (1994), and Chang and Nguyen (2002), where they examined cotton demand differentiated by source in such countries as France, Italy, Japan, Taiwan, and Hong Kong. Although China is the largest cotton importer and an important destination market for a number of exporting countries, no study has examined China's cotton demand in this context. The primary reason is that the growth in China's imports is fairly recent and source-specific competition was limited in years prior. In 1995 for instance, the United States was the primary supplier of cotton to China accounting for 68% of its total imports, while India accounted for less than 1%.

Import Demand Model

Since cotton is used as an input in fabric production, cotton demand is modeled as firm demand and a production version of the Rotterdam model is used for the analysis. For the underlying theory and model derivation, see Theil (1977), Laitinen (1980), and Theil (1980), and for empirical applications, see Clements and Theil (1978), Davis (1997), Washington and Kilmer (2002), and Muhammad (2007, 2009).

Assume a firm that imports cotton from *n* countries which is then used to produce cotton fabric. Further assume that cotton imports and the domestic resources used in production are separable which implies that the demand for cotton from the *i*th country can be expressed as a function of the total expenditures on imported cotton and import prices by country (Clements and Theil, 1978). Let *q* and *p* denote the import quantity and price, respectively, and *i* and *j* the exporting country. Theil (1980, p. 35) shows that for a cost minimizing firm, the demand for cotton from the *i*th country can be specified as follows:

$$f_{it} d(\log q_{it}) = \theta_i d(\log Q_t) + \sum_{j=1}^{n} \omega_{ij} d(\log p_{jt}) + \alpha_{1i} \sin\left[\frac{2\vartheta}{z}\pi t\right] + \alpha_{2i} \cos\left[\frac{2\vartheta}{z}\pi t\right] + \varepsilon_{it} . \quad (1)$$

$f_i = \frac{p_i q_i}{\sum_i p_i q_i}$ is the share of total cotton imports from country *i*. $d(\log Q_t) = \sum_{i=1}^{n} f_{it} d(\log q_{it})$ is the Divisia volume index which is a measure of the change in real aggregate expenditures on cotton imports. $\theta_i = \frac{\partial p_i q_i}{\partial \sum_i p_i q_i}$ is the marginal share of the *i*th import (expenditure effect), and ω_{ij} is the conditional price effect which measures the impact of the price in country *j* on the quantity imported from country *i*. Following Arnade, Pick, and Gehlhar (2005), the sine and cosine terms are added to account for the seasonality in cotton imports where ϑ is the frequency of the seasonality cycle, equal to one in this instance, and *z* is the frequency of the data which is 12 because the data are monthly. θ, ω, and α are parameters to be estimated and ε is a random disturbance term.

Given the theoretical demand properties, adding up, homogeneity and symmetry, the following parameter restrictions should hold true:

$\sum_{i=1}^{n}\theta_i = 1$ and $\sum_{i=1}^{n}\omega_{ij} = \sum_{i=1}^{n}\alpha_{1i} = \sum_{i=1}^{n}\alpha_{2i} = 0$ (adding-up);

$\sum_{j=1}^{n}\omega_{ij} = 0$ (homogeneity); and

$\omega_{ij} = \omega_{ji}$ (symmetry).

Additionally, the matrix of conditional price effects **Ω** = [ω_{ij}] should be negative semidefinite (Laitinen, 1980).

Following Theil (1977), the determination of real aggregate expenditures can be expressed by the following Divisia index equation:

$$(2) \qquad d(\log Q_t) = \frac{\gamma\psi}{\gamma-\psi}\left[d(\log p_t^*) - d(\log P_t')\right] + \mu_t .$$

The variable p^* denotes the output price and $d(\log P')$ is the Frisch import price index where

$$(3) \qquad d(\log P_t') = \sum_{i=1}^{n}\theta_i d(\log p_{it}) .$$

ψ can be interpreted as a measure of cost-function curvature and is derived as

$$\frac{1}{\psi} = 1 + \frac{1}{\gamma^2}\frac{\partial^2 \log C}{\partial(\log Y)^2} .$$

Y is firm output, $C = \sum_{i=1}^{n} p_i q_i$ is total import cost, and γ is the elasticity of cost with respect to output. The term $\gamma\psi/(\gamma-\psi)$ is the Frisch deflated output price effect and is assumed constant for estimation. μ is a random disturbance term. All other terms and variables are as previously defined.

Equation (1) and (2) form a system where equation (1) is the import allocation decision which describes the change in demand for cotton from country *i* as function of real aggregate expenditures and import prices by country, and (2) is the determination of real aggregate expenditures where expenditures are a function of the domestic output price deflated by the Frisch import price index.

From equation (1), the conditional demand elasticities are derived. The expenditure elasticity is θ_i / f_i, and the conditional own- ($i = j$) and cross- ($i \neq j$) price elasticity is ω_{ij} / f_i. Additionally, the parameters from equation (1) and (2) can be used to derive unconditional demand elasticities. If we substitute equation (3) for the Frisch import price index in equation (2), and then substitute this into equation (1), we get the demand for an individual import with respect to the output price p^* and import prices p_j:

$$f_i d(\log q_i) = \theta_i \Theta d(\log p^*) - \theta_i \Theta \sum_{i=1}^{n} \theta_i d(\log p_i) + \sum_{j=1}^{n} \omega_{ij} d(\log p_j) . \tag{4}$$

Note that the seasonality terms, errors and *t* subscripts are ignored for convenience. Also note that $\Theta = \gamma\psi / (\gamma - \psi)$. Using equation (4), we can derive the unconditional import demand elasticities. Solving equation (4) for $d(\log q_i) / d(\log p^*)$ we get the output-price elasticity which is the percentage change in imports from the *i*th country with respect to a percentage change in the output price:

$$\eta_{p^*} = \frac{d(\log q_i)}{d(\log p^*)} = \frac{\theta_i \Theta}{f_i} . \tag{5}$$

Similarly, we can derive the unconditional own- and cross-price elasticity which is the percentage change in imports from the *i*th country with respect to a percentage change in price in country *j*:

(6) $$\eta_{ij} = \frac{d(\log q_i)}{d(\log p_j)} = \frac{-\Theta\theta_i\theta_j}{f_i} + \frac{\omega_{ij}}{f_i}.$$

The first term in equation (6) ($-\Theta\theta_i\theta_j / f_i$) is the indirect effect of a price change and accounts for the effect of import prices on total expenditures. Note that the second term (ω_{ij} / f_i) is the conditional price elasticity due changes in relative import prices. These two effects are analogous to the income and substitution effects in consumer theory.

Data and Estimation

Monthly import data are used for estimation and span the period January 2005−December 2010. The data are obtained from the World Trade Atlas ® database, Global Trade Information Services, Inc. Cotton imports are disaggregated by country of origin (India, United States, Uzbekistan, C4, and ROW) and defined according to HS classification 5201: cotton, not carded or combed. ROW is *the rest of the world*, an aggregation of all countries not specified. Import quantities are measured in kilograms and prices in U.S. dollars per kilogram. A representative output price is needed to estimate equation (2). We use China's export price of cotton fabrics as a proxy which is the HS classification 5208: woven fabrics of cotton, containing 85% or more cotton by weight, weighing not more than 200 G/M2. Export prices are measured in U.S. dollars per meter. Descriptive statistics for model variables are reported in table 2.

[Table 2 here]

In estimating the model, continuous log differences are replaced with finite one-period log differences (Theil, 1980). Thus, the quantity and price terms are approximated as $d(\log q_t) \approx \log q_t - \log q_{t-1}$ and $d(\log p_t) \approx \log p_t - \log p_{t-1}$. f_{it} is replaced with $\overline{f}_{it} = 0.5(f_{it} + f_{it-1})$, which is the conditional import share averaged over the periods *t* and *t*-1.

The Divisia volume index $d(\log Q_t)$ is replaced with a discrete measure DQ_t where $d(\log Q_t) \approx DQ_t = \sum_{i=1}^{n} \bar{f}_{it}(\log q_{it} - \log q_{it-1})$, and the Frisch import price index is also replaced with a discrete measure DP_t' where $d(\log P_t') \approx DP_t' = \sum_{i=1}^{n} \theta_i(\log p_{it} - \log p_{it-1})$.

The demand system represented by equations (1) and (2) is estimated using the LSQ procedures in TSP (version 5.0) which uses the generalized Gauss-Newton method to estimate the parameters in the system. Theil (1980) shows that if the parameters in equations (1) and (2) are assumed constant and the errors normally distributed, then $\mathrm{cov}(\varepsilon_{it}, \mu_t) = 0$. This indicates that the total expenditure equation and import allocation system do not have to be estimated jointly. Due to the adding-up property, the allocation system is singular and requires that an equation be deleted for estimation. The ROW equation was deleted for this purpose; however, as noted by Barten (1969), estimates are invariant to the chosen deleted equation.

Preliminary diagnostic tests indicate that the errors in equation (1) and (2) are well behaved, i.e. serially uncorrelated, homoskedastic, and normally distributed. Likelihood ratio tests are used to test the homogeneity and symmetry constraints. Both properties failed to be rejected at the 0.01 significance level. All reported estimates in the following section are homogeneity and symmetry constrained.

Empirical Results

The demand estimates for imported cotton in China are reported in Table 3. The marginal share estimates are all positive and significant at the 0.01 significance level. These estimates measure how a unit increase in total import expenditures is allocated across the exporting sources. Cotton imports from the United States and India are the most responsive to a unit increase in expenditures (0.338 and 0.394, respectively). They are followed by Uzbekistan (0.113) and

ROW (0.108). The C4 are the least responsive where an increase in total expenditures results in exports to China increasing by 0.047, less than five cents for every dollar.

The conditional own-price estimates are presented along the diagonal in Table 3. With the exception of the C4, the estimates are negative which is consistent with theory. However, of the countries considered, three of five own-price estimates are significant (United States, Uzbekistan, and ROW). Since the own-price effects are either negative or insignificant, the matrix of prices effects (**Ω**) is negative semidefinite. The own-price estimate for the United States, Uzbekistan, and ROW are -0.601, -0.041, and -0.436, respectively.

The cross-price estimates indicate that cotton imports by country are for the most part substitutes in the Chinese market. The complementary relationship between the C4 and India is the only exception (-0.174). However, this estimate is only significant at the 0.10 level. The most significant competition is between the United States and ROW (0.398). Note that ROW is mostly comprised of imports from Australia and to a lesser degree Brazil, Mexico, Egypt, and African countries other than the C4. What is particularly interesting is that cotton from Uzbekistan is price competitive (conditionally) with all exporting countries. Furthermore, the cross-price effect for Uzbekistan and all countries is around 0.011. The C4 is the only exception (0.007).

[Table 3 here]

The conditional and unconditional demand elasticities are reported in Table 4. The conditional expenditure elasticity, which measures the percentage responsiveness of an import to a percentage change in total import expenditures, is significant for all imported products. The expenditure elasticity is largest for cotton from India (2.165) and close to unity for Uzbekistan (1.088). The estimates for the U.S. (0.757), C4 (0.579), and ROW (0.580) are significantly smaller. The conditional own-price elasticities show that cotton demand in China is highly elastic when importing from the United States (-1.344) and the ROW (-2.344), but inelastic when importing from Uzbekistan (-0.395).

[Table 4 here]

An estimate of the deflated output-price effect $\Theta = \gamma\psi / (\gamma - \psi)$ is needed to derive the unconditional elasticities. First, the marginal share estimates reported in Table 3 were used to derive the Frisch import price index. Second, the fabric export price (in log differences) and the Frisch import price index where then used in estimating equation (2). The results indicate that the output price effect (Θ) is 0.568 (0.208) which is significant at the 0.01 level.[2] An interpretation of this estimate is that a percentage increase in the deflated output price results in total import expenditures increasing by 0.568%.

The output price elasticity, equation (5), measures how a percentage increase in the output price (fabric export price) affects cotton imports from each country. The results indicate that imports from India are the most responsive to an output price increase at 1.23%. The responsiveness of the remaining countries is significantly smaller: Uzbekistan (0.618), United States (0.430), C4 (0.329), and ROW (0.329).

The unconditional own- and cross-price elasticities are also reported in Table 4. As expected, import demand becomes more elastic when the expenditure effect of a price change is accounted for. However, the unconditional own-price elasticities for the United States, Uzbekistan, and ROW are not that different from the corresponding conditional own-price elasticities. This indicates that the expenditure effect is relatively small. The unconditional cross-price elasticities show that there is a particularly strong substitute relationship between the U.S. and ROW cotton which is not symmetric. Note that given a percentage increase in U.S. prices,

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[2] The standard error is in the parenthesis.

imports from the ROW will increase by 2.28%, but given a percent increase in ROW prices, imports from the U.S. increases by 0.843%. The unconditional cross-price elasticity between the United States and the C4 is insignificant suggesting that the C4 countries do not benefit from an increase in U.S. prices. This is discussed further in the following section.

Forecasting Procedure and Import Demand Simulation

An objective of this study is to simulate the impact of a U.S. price shock on China's demand for imported cotton. Assuming that U.S. cotton subsidies depress prices, a positive price shock could be viewed as a consequence of U.S. subsidy reductions. Following Kastens and Brester (1996), import demand projections are derived using an elasticity-based forecasting equation. The unconditional elasticities are used in the forecasting equation because they encompass the complete effect of a price change making them more suitable for projections. Based on equation (4), the elasticity forecasting equation is as follows:

$$(7) \qquad q_{i1} = \left(\eta_{p*} \left[\frac{p_1^* - p_0^*}{p_0^*} \right] + \sum_{j=1}^{n} \eta_{ij} \left[\frac{p_{j1} - p_{j0}}{p_{j0}} \right] \right) q_{i0} + q_{i0} .$$

Note that η_{p*} and η_{ij} are the unconditional import demand elasticities derived using equations (5) and (6).

Equation (7) states that the quantity imported from country *i* in the projection period (1) is a function of the quantity imported during the base period (0), and the percentage changes in the export price and source-specific import prices from the base period to the projection period. A number of studies have compared model and elasticity-based forecasts using demand systems. These include Kastens and Brester (1996), Gustavsen and Rickertsen (2003) and Muhammad

(2007). These studies concluded that demand forecasts derived from elasticities are superior to model-based forecasts.

The impact of a \$0.20/kg U.S. price shock on China's import demand is considered for the import demand simulation. Impulse response functions are used to assess the impact of U.S. cotton prices on prices in India, Uzbekistan, C4, and ROW, and derived via a vector autoregression (VAR) procedure.

The VAR representation is as follows:

$$\mathbf{p}_t = \boldsymbol{\alpha} + \mathbf{A}_1\mathbf{p}_{t-1} + \mathbf{A}_2\mathbf{p}_{t-2} + \cdots + \mathbf{A}_k\mathbf{p}_{t-k} + \boldsymbol{\varepsilon}_t \,.$$

$\mathbf{p}$ is the vector of import prices in levels for the United States, India, Uzbekistan, C4, and ROW. k is the lag order, $\boldsymbol{\alpha}$ is a vector of constants, $\mathbf{A}_i$ are $(n \times n)$ coefficient matrices, and $\boldsymbol{\varepsilon}$ is a vector of random disturbances. The advantage of using levels is that the estimates remain consistent regardless of prices being integrated or not. Furthermore, standard inference on impulse responses in levels will remain asymptotically valid, and the inference is asymptotically the same even in the presence of cointegrated prices (Sims, Stock, and Watson 1990; Lütkepohl and Reimers 1992).

We use the Schwartz Bayesian Criterion (SBC) to choose the lag order (k). A one-month lag specification was found to be optimal. We also perform Granger causality test to determine the relations among import prices. Our results (reported in Table 5) indicate that India, Uzbekistan, C4, and ROW cotton prices do not Granger cause U.S. cotton prices, Indian cotton prices Granger cause Uzbekistan cotton prices, Uzbekistan and ROW cotton prices Granger cause India cotton prices, U.S. and ROW cotton prices Granger cause C4 cotton prices, and C4 cotton prices Granger cause ROW cotton prices.

[Table 5 here]

The impulse response results are shown in figure 1. The solid line shows the mean price response and the dotted lines are the responses two standard deviations from the mean. Immediately after the $0.20 price shock, U.S. prices decline and the effect on Uzbekistan, India, C4, and ROW is fully realized within a year, exactly at 10 months. After the 10^{th} month, the confidence bands for each time path includes the zero axis which is indication that U.S. price shocks may not be long lasting.

[Figure 1 here]

Using equation (7), we make import demand projections for China given a $0.20 increase in U.S. cotton prices. The average price, total quantity and value, and market share in 2010 is used as the baseline or reference values. Two assumptions are considered. First, we assume that import prices are independent. In other words, a U.S. price shock has no affect on cotton prices in India, Uzbekistan, C4, or the ROW. Second, a U.S. price shock affects global cotton prices according to the estimated impulse response relationships. In this instance, peak import prices (10 months after the initial shock) are used in making the projections. The latter is referred to as the long-run and the former as the short-run.

The short-run results show that a $0.20 U.S. price shock will have little effect on the quantity and value of cotton imported by China from the C4. In fact, the results show that the quantity and value of C4 cotton will fall by 1%, as well as the C4's share of the Chinese market by 0.47%. These small values imply that there would be insignificant change in cotton exports from the C4 to China given a U.S. price increase. While the quantity and value of imports from India are projected to increase by about 6%, the results show that ROW stands to benefit most given a positive U.S. price shock. ROW imports are projected to increase by about 20% and the market share by 3%. Assuming that U.S. cotton subsidies depress U.S. prices, holding other prices constant, these results suggest that the countries that make up the ROW could be worse off as a consequence, but the African countries that make up the C4 are neither better nor worse off.

[Table 6 here]

The import demand projections are adjusted to account for the relationship in global prices (long-run projections). The impulse response results show that 10 months after the U.S. price shock U.S. cotton prices are higher by $0.12 and not $0.20. Cotton prices in the competing countries are higher by $0.10 to $0.11. Given these price increases, the long-run results are different from the short-run. First, no longer do cotton imports from India and the ROW increase, but imports from all countries decrease, with India experiencing the largest decrease (6.68%). Overall, total imports fall by 2.99%.

Although quantities are projected to fall, results show an increase in export earnings for all countries except India. The C4 and ROW experience the largest increase in export earnings at 4.05% and 4.7%, respectively. However, there is little to no change in market share. In comparing the short- and long-run projections, it is clear that the relationship between the United States and the C4 in the Chinese market has more to do with how U.S. prices impact global prices rather than any substitute relationship. Results suggest that U.S. subsidies affect C4 countries only to the degree that these subsidies depress global prices.

Summary and Conclusion

In this study, we examined the factors that determine the demand for imported cotton in China. Given the claim that African cotton producers are ill affected by U.S. cotton subsidies, our focus was the price competition between the C4 countries (Benin, Burkina Faso, Chad and Mali) and United States in China, and the impact of U.S. price shocks on C4 export earnings. Since cotton is an intermediate good, import demand was modeled as input demand and the differential approach to the theory of the firm was used for the analysis. The import demand estimates were used to derive unconditional demand elasticities that were used in simulating the effects of U.S. price shocks on China's import demand by exporting country. Projections were based on two assumptions: (1) U.S. price shocks have no effect on cotton prices in competing countries, and (2) given a U.S. price shock, cotton prices in competing countries respond accordingly. A vector autoregression procedure was used to assess the impact of U.S. cotton prices on global cotton prices.

Overall, results show a particularly strong competitive relationship between U.S. and ROW cotton in the Chinese market. Given a percentage increase in U.S. prices, China's imports from the ROW will increase by 2.28%. However, the relationship between the United States and the C4 was insignificant. In comparing the import demand projections, results showed that the relationship between the United States and the C4 in the Chinese market has more to do with how U.S. prices impact global prices rather than any substitute or competitive relationship. This suggests that U.S. subsidies affect C4 countries if subsidies depress global prices. However, in the case of the ROW which includes countries like Australia and Brazil, there is both a competitive relationship as well as a global price effect. However, it appears that the global price effect works against the substitute relationship. Thus, if U.S. subsidies are making ROW countries worse off, this negative effect is lessened when global prices respond accordingly. It must be noted that these results are specific to the Chinese import market. Although China is the largest cotton importer and accounts for over half of all exports from the C4, our results may not reflect the overall wellbeing of C4 countries in world cotton trade.

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Table 1. Cotton Imports in China and Exporter Market Shares: 2005-2010

Year	Total imports ($US bill.)	Market shares (%)							
		India	United States	Uzbek.	Benin	Burkina Faso	Chad	Mali	Africa (C4)
2005	3.193	4.7	45.9	11.9	4.0	5.1	0.6	2.5	12.2
2006	4.868	15.7	47.0	10.1	1.7	4.0	0.6	2.2	8.4
2007	3.479	25.0	46.1	8.6	2.3	4.5	0.2	0.9	7.9
2008	3.494	27.5	47.6	7.9	2.4	1.8	0.2	1.6	6.0
2009	2.114	21.2	41.3	8.3	3.3	5.4	0.2	1.1	10.0
2010	5.658	30.7	35.3	12.2	1.0	2.1	0.0	0.8	3.8

Source: World Trade Atlas® database, Global Trade Information Services, Inc.
Note: Market shares do not add to 100% due to imports from the rest of the world.

Table 2. Summary Statistic for Model Variables

Country	Price($/kg)		Quantity (million kg)		Value ($ millions)		Market share (%)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
United States	1.51	0.29	92.56	57.73	137.37	81.96	44.61	16.58
India	1.47	0.32	43.63	50.11	68.52	97.59	18.34	17.51
Uzbekistan	1.48	0.32	21.34	14.77	32.15	25.71	10.47	7.47
Africa (C4)	1.44	0.23	17.06	12.66	23.80	16.40	7.99	5.19
ROW	1.55	0.27	35.82	23.55	54.90	35.96	18.59	9.73
Export price ($/meter)	1.04	0.12						

Source: Authors' calculations using data from the World Trade Atlas® database.

Table 3. Conditional Demand Estimates for China's Cotton Imports by Source

Country	Marginal Share (θ)	Conditional price effects (ω)					Seasonality	
		United States	India	Uzbekistan	Africa (C4)	ROW	α_1(sin)	α_2(cos)
United States	0.338[a]	-0.601[a]	0.190	0.011[c]	0.003	0.398[a]	0.062[a]	-0.067[a]
	(0.032)	(0.220)	(0.177)	(0.006)	(0.112)	(0.132)	(0.019)	(0.019)
India	0.394[a]		-0.041	0.011[c]	-0.174[c]	0.014	-0.053[a]	0.083[a]
	(0.032)		(0.213)	(0.006)	(0.095)	(0.103)	(0.019)	(0.019)
Uzbekistan	0.113[a]			-0.041[a]	0.007[a]	0.011[a]	0.006	0.036[b]
	(0.030)			(0.006)	(0.003)	(0.003)	(0.018)	(0.018)
Africa (C4)	0.047[a]				0.152	0.013	0.007	-0.020[b]
	(0.014)				(0.115)	(0.094)	(0.008)	(0.008)
ROW	0.108[a]					-0.436[a]	-0.022[b]	-0.033[a]
	(0.015)					(0.146)	(0.009)	(0.009)

[a] Significance level = 0.01; [b] significance level = 0.05; [c] significance level = 0.10.
Homogeneity and symmetry are imposed. Asymptotic standard errors are in parentheses. ROW is rest of the world. The R^2 for each equation in order listed in the table is 0.709, 0.745, 0.601, 0.262, and 0.502.

Table 4. Conditional and Unconditional Import Demand Elasticities for China's Cotton Imports

	Conditional elasticities		Unconditional price elasticities						
					Cross-price				
Country	Expend.	Own-price	Output price	Own-price	United States	India	Uzbek.	Africa (C4)	ROW
United States	0.757[a]	-1.344[a]	0.430[a]	-1.490[a]		0.254	-0.023	-0.014	0.843[b]
	(0.071)	(0.491)	(0.162)	(0.498)		(0.402)	(0.026)	(0.251)	(0.296)
India	2.165[a]	-0.224	1.230[a]	-0.709	0.625		-0.075	-1.015[c]	-0.056
	(0.175)	(1.171)	(0.461)	(1.182)	(0.987)		(0.071)	(0.520)	(0.569)
Uzbekistan	1.088[a]	-0.395[a]	0.618[b]	-0.464[a]	-0.100	-0.133		0.038	0.042
	(0.290)	(0.056)	(0.280)	(0.063)	(0.110)	(0.124)		(0.028)	(0.041)
Africa (C4)	0.579[a]	1.876	0.329[b]	1.861	-0.079	-2.282[c]	0.048		0.123
	(0.169)	(1.417)	(0.154)	(1.415)	(1.385)	(1.169)	(0.036)		(1.156)
ROW	0.580[a]	-2.344[a]	0.329[b]	-2.380[a]	2.028[a]	-0.055	0.023	0.054	
	(0.082)	(0.787)	(0.129)	(0.788)	(0.711)	(0.557)	(0.023)	(0.504)	

[a] Significance level = 0.01; [b] significance level = 0.05; [c] significance level = 0.10.
Asymptotic standard errors are in parentheses. ROW is rest of the world.

Table 5. Chi-square Test Statistics for Granger Causality Test

Price of cotton from:	Dependent variable U.S.	Uzbekistan	India	Africa (C4)	ROW
U.S.		0.002 [0.968]	0.250 [0.617]	3.465 [0.063]	2.586 [0.108]
Uzbekistan	0.027 [0.869]		8.002 [0.005]	0.693 [0.405]	2.262 [0.133]
India	1.485 [0.223]	3.606 [0.058]		0.001 [0.982]	1.828 [0.176]
Africa (C-4)	1.125 [0.289]	0.032 [0.858]	0.027 [0.869]		2.872 [0.090]
ROW	1.175 [0.278]	0.086 [0.770]	2.970 [0.085]	5.938 [0.015]	

Probability values are in brackets.

Table 6. Import Projections Given a $0.20/kg U.S. Price Shock

	Short-run											
	Baseline				Projections				Difference			
Exporting Country	Price ($/kg)	Quantity (mill. kg)	Value ($ mill.)	Market Share (%)	Price ($/kg)	Quantity (mill. kg)	Value ($ mill.)	Market Share (%)	Price ($/kg)	Quantity (%)	Value (%)	Market Share (%)
United States	1.98	1,008.61	1,998.13	35.31	2.18	855.60	1,868.69	32.07	0.20	-15.17	-6.48	-3.25
India	2.00	868.02	1,737.12	30.70	2.00	921.60	1,841.90	31.61	0.00	6.17	6.03	0.91
Uzbekistan	2.01	344.83	692.56	12.24	2.01	341.31	685.64	11.77	0.00	-1.02	-1.00	-0.47
Africa (C4)	1.78	122.02	217.47	3.84	1.78	121.00	215.67	3.70	0.00	-0.83	-0.83	-0.14
ROW	2.05	495.14	1,012.89	17.90	2.05	595.00	1,215.69	20.86	0.00	20.17	20.02	2.96
Total		2,838.61	5,658.16	100.00		2,834.52	5,827.59	100.00		-0.14	2.99	0.00
	Long-run											
	Baseline				Projections				Difference			
Exporting Country	Price ($/kg)	Quantity (mill. kg)	Value ($ mill.)	Market Share (%)	Price ($/kg)	Quantity (mill. kg)	Value ($ mill.)	Market Share (%)	Price ($/kg)	Quantity (%)	Value (%)	Market Share (%)
United States	1.98	1,008.61	1,998.13	35.31	2.10	975.36	2,049.69	35.67	0.12	-3.30	2.58	0.35
India	2.00	868.02	1,737.12	30.70	2.11	810.02	1,706.32	29.69	0.11	-6.68	-1.77	-1.01
Uzbekistan	2.01	344.83	692.56	12.24	2.11	333.48	704.18	12.25	0.10	-3.29	1.68	0.01
Africa (C4)	1.78	122.02	217.47	3.84	1.88	120.19	226.27	3.94	0.10	-1.49	4.05	0.09
ROW	2.05	495.14	1,012.89	17.90	2.16	491.58	1,060.46	18.45	0.11	-0.72	4.70	0.55
Total		2,838.61	5,658.16	100.00		2,730.63	5,746.93	100.00		-3.80	1.57	0.00

Figure 1. Impulse Response Results Given a $0.20 U.S. Price Shock (the price change is on the vertical axis and time in months is on the horizontal axis)