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Inventories of Asian Textile Producers, US Cotton Exports, and the Exchange Rate

Summary: The present paper develops a model with US cotton exports depending on the stock-to-use ratio, trade weighted exchange rates, and the relative cotton prices. The role of inventories in cotton consumption is examined in five textile producing cotton importers, China, Indonesia, Thailand, South Korea, and Taiwan. Cotton inventory dynamics is diverse among Asian textile producers. Relative prices have negative effect in all markets as expected. Exchange rate elasticities show that effects should be examined for each separate market. Changes in rates of depreciation also have stronger effects than exchange rate. Results reveal that these countries are not all that homogenous.

Key words: Cotton imports, Exchange rates, Stock-to-use ratio, Asian textile producers.

JEL: F14, F31, Q17.

One of the principles of international economics is that currency appreciation should lower demand for exports. The present paper tests the evidence for US cotton exports to five major textile producing importers, China, Indonesia, South Korea, Taiwan, and Thailand during the floating exchange rate era. Other major importers Turkey and Pakistan are not included because the lira and the rupee have been fixed with little variation relative to the dollar. Sample begins with the earliest bilateral US cotton export data in 1978 and extends through 2011.

The market context is increasing demand for cotton in developing textile producers along with falling US production cost. Importers may, however, be able to avoid their depreciating currency or they may have stocks of cotton, cash, or credit that allow undisrupted imports. Therefore a novel model of the textile producing cotton warehouse stock is used as an exogenous demand variable. The effect of 1997 Asian financial crisis is also considered.

With average exchange rates, depreciation of one currency might lower exports while importers in another currency might be less sensitive and dominate the aggregate effect. Aggregated export data and average exchange rates may conceal differences in underlying bilateral relationships. There are differences in these five importer markets but the bilateral exchange rates have no impacts on US exports, consistent with the literature. An increase in the rate of depreciation, however, lowers imports due to diminished wealth of the textile producers.

1. The Literature on Exchange Rates, Exports, and Inventories

Cotton is a major agricultural commodity in the Southeastern and Southwestern region of the United States. According to a recent world cotton markets report world cotton trade was about 46 million bales in 2012 (United States Department of Agriculture - USDA 2013). In 2013 marketing year it is expected to decline about 3 million bales. The US is the largest cotton exporter followed by India, Australia, Brazil, and Uzbekistan. In 2012 US raw cotton exports were 11.7 million bales down 2.66 million from 2011 marketing year. According to USDA - Foreign Agriculture Service database, total US raw cotton exports correspond to roughly 29 percent of the world cotton exports in 2012. A report by James Kiawu, Constanza Valdes, and Stephen MacDonald (2011) states that with the additional agricultural land and favorable cotton prices could increase Brazil's cotton production which makes competition difficult for US cotton exporters in Asian and European markets. Since 2002, China has been the largest cotton importer. Due to rebuilding stock policy in China cotton imports had been more doubled last year to 24.5 million from 11.9 million bales. In the last couple of years Turkey and Bangladesh followed China as other major cotton importers.

Literature on the effects of exchange rates on agricultural product exports is quite broad. However the effects on cotton exports are narrow. In his report Mathew Shane (2001) describes trends in the exchange rate and the US share of the world cotton market but does not examine the econometrics. Similarly, another report by the Cotton Research and Development Corporation (2003) stresses the critical nature of the exchange rate for Australian cotton producers but does not include econometric analysis. In an extensive study on aggregate agricultural products, Shane, Terry L. Roe, and Agapi Somwaru (2008) find no effect of the exchange rate on aggregate US cotton exports although they do find effects for other commodities. Nazif Durmaz and Henry Thompson (2013) find that the changes in depreciation rate have stronger effects on cotton exports in the US than on the changes in the exchange rates on the levels.

An Asian crisis study prepared by Essahbi Essaadi, Jamel Jouini, and Wajih Khallouli (2009) point out some structural changes that followed the devaluation of the Thai baht in the links among the Asian countries. Yuanlong Ge, Holly H. Wang, and Sung K. Ahn (2010) find that the changes in China's exchange rate regimes and cotton trade liberalization made significant influences on the cotton future markets, especially in the US market. Xiaowen Jin (2012) suggests that Chinese government should consider a flexible exchange rate policy. Another study on China by MacDonald et al. (2010) argue that if equilibrium levels of income and exchange rates are assumed the adoption of Agreement on Textiles and Clothing (ATC) would increase China's cotton consumption, cotton production and cotton imports. Mohsen Bahmani-Oskooee and Jia Xu (2012) find that US dollar - Chinese yuan real exchange rate volatility affects most of the Chinese importing industries when a third-country effect is considered. Ho-don Yan and Cheng-lang Yang (2012) present a causal relationship between exchange rate misalignment and GDP from 1998 to 2008 when the Taiwan dollar is undervalued currency. However they conclude that undervaluation cannot be a fit strategy due to slowness of US exports to Taiwan in recent years.

Abdul Almarwani, Curtis M. Jolly, and Thompson (2007) find dollar appreciation lowers some agricultural exports but the impacts vary across countries and commodities. William M. Liefert and Suresh Persaud (2009) report that due to trade policies and market deficiencies in most developing countries the exchange rate transmission for agricultural products has been low. May Peters, Shane, and David Torgerson (2009) argue that a weaker dollar would be beneficial for US agricultural sector since it would bring higher export income, higher commodity prices, and increased production. A recent panel data study, by Ian Sheldon et al. (2013), reports that real exchange rate uncertainty negatively affects bilateral fresh fruit trade between US and 26 other countries.

Agricultural policy support is also critical for the cotton market. The effects of subsidies are examined by Suwen Pan et al. (2007), Frederick J. Rossi, Andrew Schmitz, and Troy G. Schmitz (2007) and John Baffes (2011). In another study by Andrew Muhammad, Lihong Lu McPhail, and Kiawu (2012) concludes that US cotton subsidies distortion would be lessened if the global prices move according to the market. Authors also add that elimination of subsides may not be helpful to the Chinese cotton imports due to temporary increase in global prices. The interplay of subsidies and exchange rates is an area for future research, both theoretical and empirical.

The present study utilizes bilateral real trade-weighted exchange rates rather than an average exchange rate, focuses on export levels rather than market shares, and analyzes the impact of the rate of appreciation as well as appreciation. Other important factor is the stock-to-use ratio that influences the trade between economies which changes constantly due to policies and price ratios. The present study also finds changes in the level of the exchange rate have similar effects as the changes in the rate of depreciation. Exchange rate sensitivity also varies considerably across the textile producing cotton importers.

2. A Model of the Imported Cotton Market

The present model assumes the market equilibrium for cotton is determined by cotton demand for textile production and by supply from US exports and from the rest of the world. The focus is on the effect of the exchange rate on market equilibrium US exports. Demand and supply functions are assumed linear. The demand for cotton in textile production is based on maintaining two stocks for mill operations, a stock of cotton W for input, and a stock of domestic currency B. Assuming all cotton input is imported, the stock of cotton changes according to:

$$\Delta W = M + S - U, \tag{1}$$

where M is imports from the US, S is imports from other sources, and U is mill use. Higher mill use U lowers the cotton stock of inventory as ΔW falls, and would increase import demand to maintain W. The timing of cotton purchases M and S do not necessarily match mill use U suggesting a nonzero varying stock of inventory W.

The two sources M and S are imperfect substitutes. The quantities of each purchase may be small relative to W with many purchases made during the year, the period of observation in the present data. Over the course of a year:

$$\Delta W \; = \; 0, \text{and } M \; + \; S \; = \; U. \tag{2}$$

Total potential imports from US, M^{US} are assumed to be less than M suggesting purchases from both sources. Depreciation relative to the dollar increases the relative price of US cotton, decreases US exports M^{US}, and decreases relative imports M / S. Regarding the other stock, cash B is maintained to pay local expenses L and for imported cotton, and changes according to:

$$\Delta B \; = \; R - L - (P^w /E)X \; + \; (P^w /E_S)S, \tag{3}$$

where R is revenue from selling textiles, L is local expenses, P is the international price of cotton in dollars, E is the \$/yuan exchange rate, and E_S is the yuan exchange rate with other sources assumed constant. The other source could also be domestic. Depreciation relative to the dollar lowers E and raises the local price P^* for a given US price P^{US} since $P^* = P^{US} / E$. Depreciation relative to the dollar induces substitution toward the other source S and M / S falls. Both M and S fall due to the higher costs of operation but M is expected to fall more. Depreciation also lowers the dollar value EB of the stock of cash reserves, a wealth diminishing effect, according to $B\Delta E < 0$. The hypothesis is that this lost wealth diminishes mill operations and further lowers cotton demand in the mills.

US cotton supply M^{US} is increasing function of the local price where $P^* = P^{US} / E$, P^{US} is the dollar price, E is the local \$/domestic currency exchange rate. Dollar appreciation, a decrease in E, lowers M^{US}. Alternative supply S is insensitive to the dollar exchange rate. Textile producer cotton demand D is a decreasing function of the local currency price based on textile demand. Higher textile prices or mill investment would increase mill use U. Demand is also sensitive to local currency depreciation that reduces the purchasing power of textile producer stock B of local currency.

The Asian cotton market, the identity between supply and demand, can be written as:

$$W_t + U_t + X_t = W_{t-1} + A_t + M_t, \tag{4}$$

where W_t is ending stock of inventory, W_{t-1} is beginning stock of inventory, U_t is domestic consumption, X_t is exports, A_t is domestic production, M_t is imports. The identity can be expressed by the demand for domestic consumption and the demand for exports to represent current demand D_t. In the same way, the total of beginning inventory, domestic production, and imports reveals current supply S_t. The identity then takes the following form:

$$S_t - D_t - \Delta W_t = 0. \tag{5}$$

Following Olga Isengildina-Massa and MacDonald (2009) each variable in the identity is a function of a set of explanatory variables:

$$S_t = b(E_{t-1}(p_t), z_t) \qquad \text{Supply}$$
$$D_t = g(p_t, y_t) \qquad \text{Demand}$$
$$W_t = h(p_t, v_t) \qquad \text{Inventory,}$$

where p_t is the inflation adjusted price, $E_{t-1}(p_t)$, is the period $t-1$ expectation of p_t, and z_t, y_t, and w_t are exogenous variables affecting supply, demand, and inventory. Paul C. Westcott and Linwood A. Hoffman (1999) specify price in forecasting models as a function of the stocks-to-use ratio. Stocks-to-use ratio can be introduced in (6) dividing through by $g(p_t, y_t)$:

$$S_t - g(p_t, y_t) - h(p_t, w_t) = 0, \tag{6}$$

$$\frac{S_t}{g(p_t, y_t)} - 1 = \frac{h(p_t, v_t)}{g(p_t, y_t)} = W(p_t, v_t, y_t) = W/U, \tag{7}$$

where W/U denotes the ratio of stock-to-use. Then the linear demand for cotton is:

$$D = a_0 - a_1 P^* + a_2 RP - a_3 E + a_4 W, \tag{8}$$

where D is the quantity of cotton bales demanded, P^* is local price of cotton, RP is relative prices of imported cotton from US and other alternative sources, E is exchange rate, and W is the stock-to-use ratio. Parameters are positive and signs of expected effects are indicated. Dollar appreciation (depreciation of the local currency relative to the dollar), a decrease in E, lowers quantity cotton demanded in the coefficient a_3 due to the higher local price of US cotton. This price effect of depreciation is examined in the literature. Higher mill use U increases demand D to maintain the warehouse W but a_4 might not equal one given spare warehouse capacity.

An increase in the dollar price of cotton P^* lowers quantity of US imports demanded in coefficient a_1. Mill operation could continue at the same level given a nonzero cotton inventory W. Similarly, a fall in P leads to an increase in the quantity of cotton demanded without necessarily increasing textile output but with temporary stockpiling of cotton in W. An exchange rate effect not examined in the literature is the effect of a change in the rate of appreciation $N = \Delta E/E$ on the purchasing power of cash balances B. Generally N is negative in the data indicating local currency depreciation. An increase in the rate of depreciation $-N$ diminishes the wealth of cash balances, lowering the purchasing power of producer cash reserves. Producers holding cash reserves B anticipate depreciation but an increase in the rate of depreciation unexpectedly lowers wealth. The coefficient a_4 on the rate of depreciation N is this wealth diminishing effect on cotton demand due to the change $B\Delta E$ in the dollar value of cash reserves.

The quantity of imports from US is a function of relative price RP, dollar defined ratio of US price P^{US} to the price of other imported price of alternative cotton sources P^{ALT}.

$$M = -b_o + b_1 RP. \tag{9}$$

To relate US supply to the local currency price P the effect of E is separated into:

$$M = -b_o + b_3 E + b_4 RP, \tag{10}$$

where M is bales of cotton imported and RP is the relative prices and E is exchange rate.

The supply of cotton from the rest of the world is a function of price only:

$$S = -c_o + c_1 P^{ALT}. \tag{11}$$

Equilibrium in the importing country market is pictured in Figure 1 where quantity demanded D equals total quantity supplied, the horizontal sum of quantities supplied from the two sources, $D = M + S$. Substitute (8), (10), and (11) equilibrium market P is function of three exogenous variables.

$$\begin{matrix} (+) & (?) & (-) & (+) \\ P^e = d_o + d_1 E & - d_2 RP & + d_3 W, \end{matrix} \tag{12}$$

where $d_0 = (a_0 + b_0 + c_0)/\gamma > 0$, $d_1 = (a_3 - b_1)/\gamma$, $d_2 = (a_2 - b_2)/\gamma > 0$, $d_3 = a_3/\gamma > 0$, and $\gamma = a_1 + c_1$. Dollar appreciation lowers supply from the US but also lowers - demand making the effect of E on P^e ambiguous. The effects of W and C on P^e are positive.

Substitute the equilibrium price P^e into the US import function (10) to find the reduced form equilibrium US imports M_e^{US} as a function of three exogenous variables:

$$\begin{matrix} (?) & (+) & (-) & (+) \\ M_e^{US} = \alpha_o + \alpha_1 E & - \alpha_2 RP & - \alpha_3 W. \end{matrix} \tag{13}$$

Estimated equation signs of coefficients follow from the underlying demand and supply relations. Dollar appreciation lowers US supply M^{US} and also lowers demand D due to the wealth reduction of cash balances leading to the lower M_e^{US}.

An exchange rate effect not considered in the literature is the effect of a change in the rate of local currency depreciation; $N = -\Delta E / E$. The present depreciation rates are stationary and highly variable while exchange rates have smooth trends. To test sensitivity of exports to depreciation rates, equilibrium exports X^e are also estimated as:

$$M_e^{US} = \beta_o + \beta_1 N - \beta_2 RP - \beta_3 W. \tag{14}$$

Depreciation or a fall in the exchange rate E raises the local price of cotton and lowers demand, and the equilibrium level of imports from US M_e^{US} falls. An increase in the depreciation rate N also lowers demand by reducing the purchasing power of cash reserves. An exogenous increase in warehouse W decreases cotton demand D lowering M_e^{US}. Increased mill use M increases demand for cotton and raises equilibrium level of imports from US M_e^{US}. Lower US production cost C increases US supply resulting in an increase in M_e^{US}.

3. Data Series in the Cotton Export Model

Although the timing and patterns differ, trade-weighted exchange rate trend appears can easily be predicted. As shown by the series in Figure 1, the dollar has appreciated relative to these currencies over the 33 years of the sample period, a total of 83% relative to the Chinese yuan, 85% to the Indonesian rupiah, 90% South Korean won, 64% Taiwanese dollar, and 67% to the Thai baht. For the Chinese yuan rate there was a fairly consistent depreciation over the three decades although the rate of depreciation slowed in 1986.
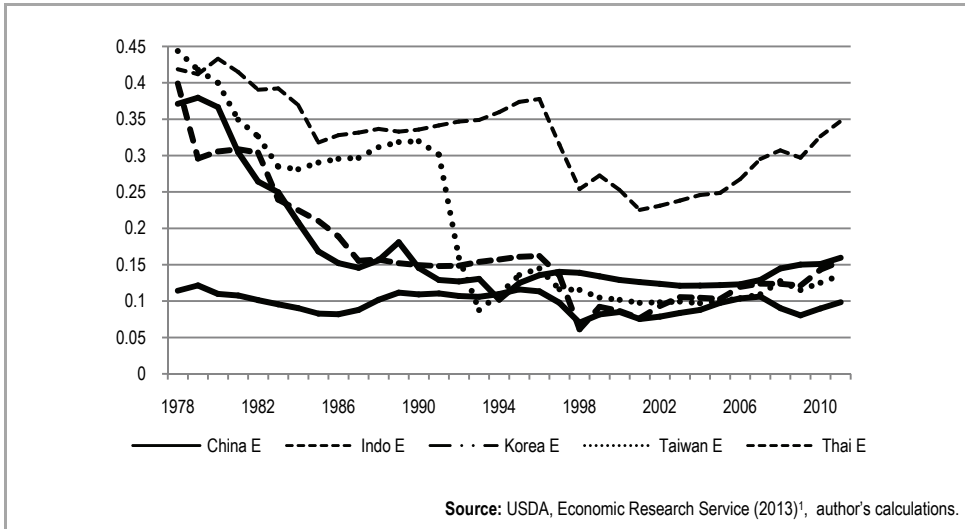
Source: USDA, Economic Research Service (2013)[1], author's calculations.

Figure 1 US Dollar Exchange Rates of the Chinese Yuan, Indonesian Rupiah, South Korean Won, Taiwanese Dollar and Thai Baht

Indonesian rupiah has depreciated more steadily 1996 during the Asian financial crisis. Since then the rupiah has been stable. Except a slight fall during the Asian financial crisis South Korean won has been steady over the sample period. The Taiwanese dollar has also followed same sharp depreciations as the Indonesian rupiah and the Thai baht. Since the financial crisis Taiwanese dollar has maintained its steadiness for the last decade. Other than sharp depreciations the Thai baht has been steady. Such sharp depreciations are hard on traders with contracts for delivery. Figure 2 shows the appreciation rates for the five currencies. These depreciation rates all prove stationary. The high depreciation rates in China, Indonesia, and Taiwan might be particularly disruptive.

Figure 3 displays cotton imports from US in thousands of bales. There has been growth in all five series except South Korea but the patterns are different. US exports account for stationary averages of 39% of total cotton imports into Indonesia, 54% into South Korea, 35% into Taiwan, and 29% into Thailand over the sample period. Although the yuan exchange rate is fixed, China is included in the sample since it has become the largest US cotton importer, averaging close to 17% of US exports over the sample period and reaching 54% in 2011. Chinese imports, China *M*, have fluctuated until the 1990s but since 2001 cotton imports have risen and China has become the largest cotton importer in the world. Taiwanese imports, Taiwan *M*, have been fairly steady with some growth during the 1990s.

Indonesian cotton imports from US, Indo *M*, have a much more dramatic pattern. Thai imports, Thai *M*, were fairly stable before increasing after 2000 and have had considerable ups and downs over the years. Finally South Korean imports have been constantly decreasing since 1978 when they have been the top cotton importer

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[1] **United States Department of Agriculture - USDA, Economic Research Service.** 2013. http://www.ers.usda.gov/data-products.aspx#.U6fmyLGLUpk (accessed March 1, 2013).

from US. Over the sample period they have also been affected by the market fluctuations but their steady downsizing textile sector is easy to observe in the data.
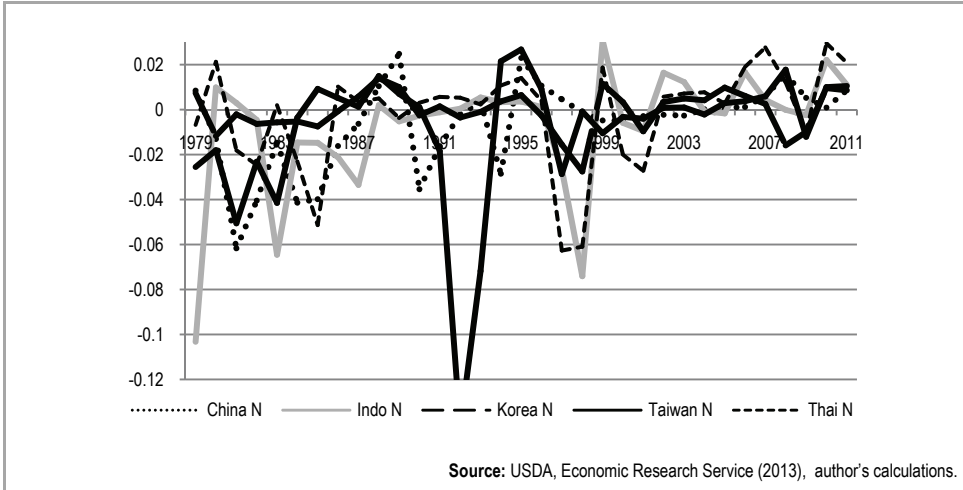

Source: USDA, Economic Research Service (2013), author's calculations.

Figure 2 Depreciation Rates of the Importing Currencies

Source: National Cotton Council of America (2013)[2], author's calculations.
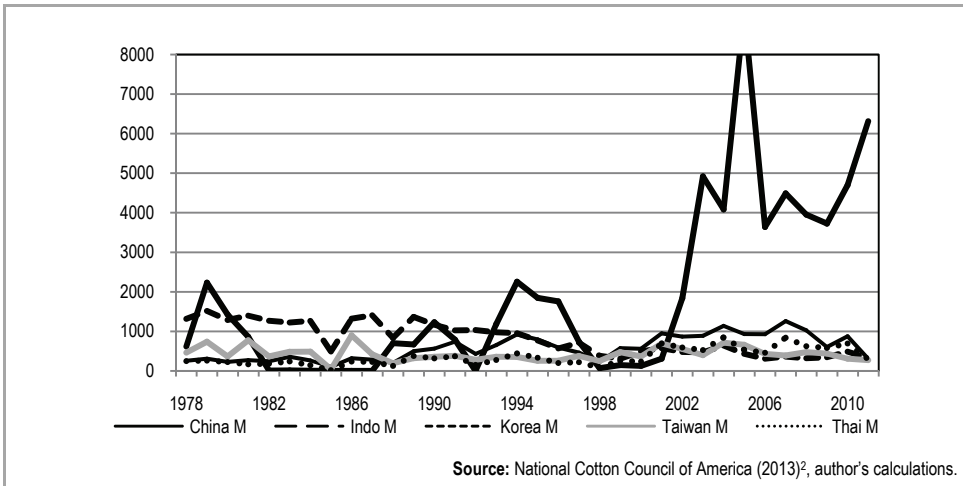
Figure 3 China, Indonesia, South Korea, Taiwan, and Thailand Imports from US

Figure 4 shows the stock-to-use ratios where increased mill use that would increase demand for US imports in the five importing countries. All countries have different warehouse patters and management. China stock-to-use ratio, China W, has two major increases in 1984 and 1998. Stock-to-use ratio in Indonesia, Indo W, has declined after its peak in 1986. South Korean stock-to-use ratio, South Korea W, has

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[2] **National Cotton Council of America.** 2013. http://www.cotton.org/econ/index.cfm (accessed March 1, 2013).

been on the decline among the five. Taiwanese stock-to-use ratio, Taiwan *W*, saw a decline after 1981 but up since 2000. After ups and downs from 1978 to 1989 Thailand stock-to-use ratio, Thai *W*, has increased and has been steady.

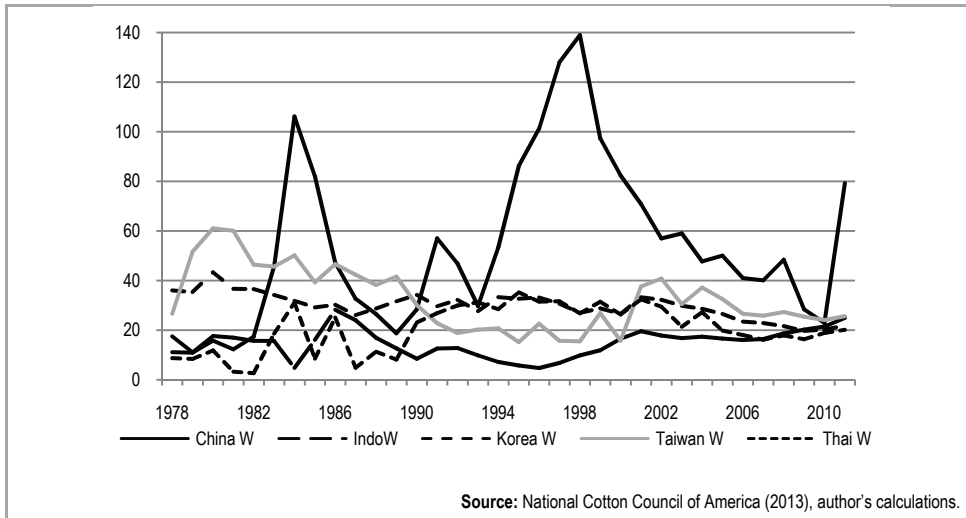**Source:** National Cotton Council of America (2013), author's calculations.

Figure 4 Stock-to-Use in 1000s of Bales

Finally, Figure 5 shows the relative prices of imported cotton prices defined as unit cost of production for US cotton over the average of the cheapest five quotations of internationally traded cotton. The data is the cents per pound. The assumption is that the farm price is competitive and examined countries have alternative close markets other than US such as India and Australia.
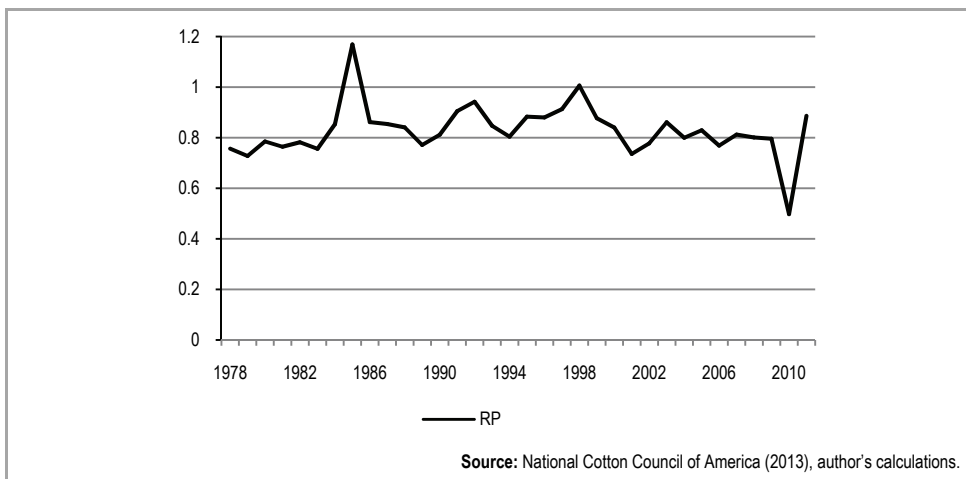

Source: National Cotton Council of America (2013), author's calculations.

Figure 5 Relative Prices of Imported Cotton P^{US} / P^{ALT}

4. Stationarity Analysis

A preliminary question is the order of integration of the variables in (13) that would suggest the form of variables for regression analysis. If the series are integrated of the same order they may be cointegrated indicating a long term dynamic equilibrium relationship. Ordinary least squares regression assumes variables have constant means while stationary variables at least have a tendency toward a long term dynamic equilibrium. Economic variables that are not stationary might be difference stationary, as is the case with the present data. An innovation in applied time series is the error correction model (ECM) that considers transitory partial adjustment relative to a long term dynamic equilibrium. Variables are transformed into natural logs to estimate elasticities directly. There is no evidence of residual autocorrelation in the correlation coefficient ρ.

Table 1 reports stationarity analysis for the natural logs transformed variables. The five exchange rates are difference stationary according to the augmented Dickey-Fuller (ADF) test $\Delta lnE_t = a_0 + a_1 lnE_{t-1} + a_2 t + a_3 \Delta lnE_{t-1} + e_t$ with the critical a_1 variable equal to zero according to the DF statistic and all coefficients equal to zero by φ tests. There is no evidence of residual autocorrelation or heteroskedasticity making the differences ΔlnE_t stochastic as suggested in Figure 2.

First column in Table 1 reports stationarity analysis for the natural logs of cotton imports from US to the five countries. US Imports to China are stationary as suggested by Figure 2 as are exports to Thailand. The next column in Table 1 reports the difference stationary tests on exchange rate. Exchange rate appreciation, a test of I(2) second order integration of the exchange rates. Variables in an ECM should be integrated of the same order and appreciation rates should not be included with levels of variables that are I(1) in a cointegration model. Summarizing, natural logs of variables are all difference stationary. The I(1) difference stationary random walk series can be expected to produce spurious regressions in levels but reliable statistics in difference regressions, and may be cointegrated. An ECM will be run in on the model (13) with the level of the exchange rate.

Table 1 Unit Root Test on First Differences (Δ) of Individual Variables

	ΔM	ΔE	ΔW
China	-4.334***	-3.341***	-4.643***
Indonesia	-5.106***	-4.487***	-4.722***
South Korea	-7.566***	-4.446***	-4.119***
Taiwan	-8.885***	-3.290***	-5.802***
Thailand	-6.333***	-3.740***	-5.336***
	ΔRP		
	-5.600***		

Notes: For critical values James G. MacKinnon (1996) is followed: 1% = -2.653; 5% = -1.964; 10% = -1.610. Lag lengths are in parentheses. Ex; null hypothesis: ΔE has a unit root.

Source: Author's estimation.

5. Regression Model Results

The estimated reduced form equation for US exports with the exchange rate lnE in (13) is:

$$lnM_e^{US} = \alpha_o - \alpha_1 lnE - \alpha_2 lnRP - \alpha_3 lnW + \varepsilon, \tag{15}$$

where ε is a white noise residual.

Table 2 Import-Exchange Rate Model

Country	Constant	lnE	lnRP	lnW	Trend		Cointegration Engel-Granger
China	2.61 (0.75)	-3.18* (-1.78)	-10.82* (-1.71)	-1.03 (-1.02)	--	R² 0.204 DW 2.53	EG -5.32
Indonesia	4.97*** (9.47)	-0.93*** (-5.39)	-4.03*** (-4.35)	-0.39*** (-2.25)	--	R² 0.582 DW 1.33	EG -2.78
South Korea	7.87*** (4.69)	0.49 (1.42)	-1.25** (2.41)	0.13 (0.35)	-0.04*** (-6.16)	R² 0.819 DW 1.45	EG -3.53
Taiwan	5.37*** (7.73)	0.10 (0.19)	-4.71*** (-5.57)	0.02 (0.13)	--	R² 0.546 DW 1.94	EG -3.79
Thailand	2.68*** (5.18)	-0.86* (1.88)	-6.79*** (-7.46)	0.40*** (3.07)	--	R² 0.698 DW 1.76	EG -3.12

Dependent variable: *lnM*

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively; *t*-statistics are reported in parenthesis.

Source: Author's estimation.

Table 2 reports estimates of (15), or import-exchange rate model. Relative price variable is statistically significant and has the correct negative sign in all countries, which suggests an elastic effect on cotton imports from US. For instance, a one per cent increase in relative prices induces a 10.8 per cent decrease in cotton imports from US to China. In other words if price of US cotton is higher than alternative cotton prices from other sources, Chinese textile producers decrease their cotton imports from US for other cotton input to find the least expensive production combinations. Indonesia and Thailand are the only countries the stock-to-use has significant effects but possible residual correlation discounts those effects in Indonesia. However while the effect is positive in Thailand, it is negative in Indonesia. This may be associated with the warehouse cost and the level of the textile industry in both countries. Weak results for Taiwan and South Korea could be associated with the downsizing textile sector, as the significant negative deterministic trend variable indicates in South Korea case. As expected, in China, Indonesia, and Thailand, an increase in the exchange rate decreases the import levels from US. While this is inelastic in Thailand and In-

donesia, it is elastic in China. The series are cointegrated by Engle-Granger tests in China and Taiwan, suggesting adjustment relative to the dynamic equilibrium in each market.

Table 3 reports the related ECM:

$$\Delta lnM_e^{US} = \alpha_o - \alpha_1\Delta lnE - \alpha_2\Delta lnRP - \alpha_3\Delta lnW + \alpha_4\varepsilon_{t-1} + e, \qquad (16)$$

where ε_{-1} refers to the lagged residual from (15).

Table 3 Error Correction Representations for Import-Exchange Rate Model

Dependent variable: *ΔlnM*							
Country	Constant	*ΔlnE*	*ΔlnRP*	*ΔlnW*	Trend	γ residual ECM_{t-1}	
China	0.18 (0.49)	5.64 (1.60)	-2.92 (-0.79)	-0.13 (-0.15)	--	-0.51*** (-3.55)	R² 0.356 DW 2.31
Indonesia	0.03 (0.56)	0.38 (1.29)	-3.52*** (-6.36)	-0.17 (-1.18)	--	-0.59*** (-4.17)	R² 0.662 DW 1.99
South Korea	0.01 (0.11)	0.46 (1.08)	-1.89*** (-4.31)	0.11 (0.28)	-0.00 (-0.57)	-0.67*** (-3.61)	R² 0.649 DW 2.06
Taiwan	0.01 (0.11)	-1.20 (-1.26)	-6.12*** (-9.35)	0.28 (1.26)	--	-0.88*** (-5.08)	R² 0.850 DW 2.04
Thailand	0.03 (0.44)	2.43** (2.55)	-5.85*** (-8.52)	0.22** (2.12)	--	-0.98*** (-5.95)	R² 0.821 DW 1.96

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively; *t*-statistics are reported in parenthesis.

Source: Author's estimation.

The ECM for Thailand has a strong 2.43 transitory exchange rate elasticitiy α_1, a strong -5.85 transitory relative price elasticity α_2, and 0.22 transitory stock-to-use elasticity α_3. Except China other three countries also have transitory relative price elasticities. Error correction adjustments are 1.62 = 0.51 x -3.18 for the exchange rate E for China and 0.55 = 0.59 x 0.93 for Indonesia. Transitory stock-to-use ratio elasticity is also significant for Indonesia with -0.35. Error correction adjustment for Indonesia is -0.26. There are no residual correlations in the models. Nevertheless, the strong transitory and elastic error correction effects indicate cotton imports from US to Indonesia, South Korea, Taiwan, and Thailand is sensitive to relative prices. Warehouse also has some part in import decision in Thailand.

For the depreciation rate, the estimated model in Table 4 is:

$$lnM_e^{US} = \beta_o + \beta_1 lnN - \beta_2 lnRP - \beta_3 lnW + \varepsilon, \qquad (17)$$

where N is in level from since it is a percentage change, $N = \Delta lnE$.

Table 4 Import-Depreciation Model

Dependent variable: *lnM*

Country	Constant	*lnN*	*lnRP*	*lnW*	Trend	
China	5.62 (1.65)	-9.97** (-2.16)	-7.99 (-1.24)	-0.13 (-0.17)	--	R² 0.239 DW 1.21
Indonesia	6.76*** (12.02)	-1.22** (-2.38)	-2.93** (-2.47)	-0.34 (-0.14)	--	R² 0.307 DW 0.68
South Korea	6.49*** (4.55)	-0.38 (-0.84)	-1.33** (2.52)	0.21 (0.54)	-0.05*** (-6.41)	R² 0.812 DW 1.38
Taiwan	5.22*** (8.85)	0.97 (0.93)	-4.74*** (-5.74)	0.04 (0.22)	--	R² 0.558 DW 2.00
Thailand	3.61*** (9.31)	-2.72** (-2.42)	-5.91*** (-6.01)	0.46*** (3.99)	--	R² 0.718 DW 1.91

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively; *t*-statistics are reported in parenthesis.

Source: Author's estimation.

Overall the import-depreciation model did not yield the expected results in the country-specific equations. The estimated coefficients for the depreciation rates in the model do not have the correct signs excluding Taiwan. The relative price variable is elastic and significant in all countries except in China. Stock-to-use ratio is significant only in Thailand and has an opposite sign than expected. Cointegration is not tested in this model since the depreciation rate is not difference stationary. In an unreported regression with the crisis dummy variable, the effect in Thailand is 9.22 per cent pre-crisis *versus* 1.73 per cent post-crisis.

Finally, the next three tables display the regression results for the pooled data of the different layouts. All countries are analyzed in pooled panel models to observe whether they contain similar characteristics in importing US cotton for their textile industry with a financial crisis dummy. The outputs for these models reveal effects that are similar to separate regressions but the countries are different as indicated by the country-named dummy variables.

Table 5 Pooled Sample with Depreciation and the Asian Financial Crisis

Dep. var.	Constant	*lnN*	*lnRP*	*lnW*	Indonesia	South Korea	Taiwan	Thailand	*D₉₇*	*D₉₇N*	
lnM	5.66*** (7.12)	-5.41*** (-3.51)	-4.03*** (-3.34)	-0.09 (-0.43)	0.20 (0.53)	0.48 (1.50)	-0.16 (-0.48)	-0.46 (-1.27)	0.45** (2.20)	4.42** (2.35)	R² 0.237 DW 0.93

Source: Author's estimation.

Table 5 shows the results for pooled regressions with depreciation rate in the model. The post-crisis depreciation rate is significant and has the correct positive

sign. This result implies that, holding other variables constant, for every unit decrease in N (or 1 per cent depreciation) lowers exports by 4.42 per cent. Here, some of the influence must go to the reforms that strengthened banking system in Asia after the 1997 financial crisis. The coefficient of relative price is significant with a correct sign. Financial crisis dummy is significant too. Next, Table 6 reports the same depreciation rate effect regression results. But this time only four countries pooled without China due to its outlier effect. Post-crisis depreciation rate effect is significant with the expected sign. However, 1997 dummy is not significant.

Table 6 Pooled Sample less China with Depreciation and the Asian Financial Crisis

Dep. var.	Constant	InN	InRP	InW	South Korea	Taiwan	Thailand	D_{97}	$D_{97}N$	
InM	5.25*** (18.49)	-2.37*** (-2.78)	-3.18*** (-5.78)	0.23** (2.27)	0.14 (0.91)	-0.50*** (-3.29)	-0.66*** (-5.03)	0.04 (0.44)	1.81* (1.89)	R² 0.479 DW 0.89

Finally, Table 7 displays again pooled data regression results less China with exchange rate variable. Results reveal significant exchange rate and post-crisis exchange rate effects. Although the exchange rate has an elasticity of 0.84 following the Asian crisis with an opposite sign, the gray area residual correlation discounts this effect. Financial crisis dummy is significant in this model as well.

Table 7 Pooled Sample less China with Exchange Rates and the Asian Financial Crisis

Dep. var.	Constant	InE	InRP	InW	South Korea	Taiwan	Thailand	D_{97}	$D_{97}E$	
InM	2.90*** (7.05)	-1.47*** (-6.96)	-4.04*** (-8.68)	0.14* (1.66)	-0.33** (-2.19)	0.47** (2.18)	0.18 (0.94)	1.08*** (4.49)	0.84*** (6.23)	R² 0.631 DW 1.19

Since the models in Table 6 and Table 7 yield opposite signs and different results, we can take this as a signal that these five textile producing countries are not all that homogenous. Instead a more advanced approach in Panel Regression family, for instance Random Effects model may be more appropriate to use in this case. However that approach would be a different topic for a future study.

6. Conclusion

There are no apparent effects of bilateral exchange rates on US cotton exports for China, Indonesia, South Korea, Taiwan, and Thailand in the present model. Depreciation or its threat must lead cotton importers to hedge or pursue other ways to avoid exposure with forward contracts, dollars as inventory currency, transactions in foreign currencies, and foreign bank accounts. An increase in the depreciation rate of Indonesia, China, and Thailand clearly lowers imports from US. An increase in the depreciation rate in South Korea and Taiwan, however, has no effect on imports from US.

A novel finding of the present paper is that rates of depreciation have stronger effects than exchange rates themselves. A change in the rate of depreciation diminishes the wealth of cash balances. This wealth effect is more robust before the Asian financial crisis. While textile producers may hedge or use foreign bank accounts to avoid currency risk, the rate of local currency depreciation has a negative impact. Stock-to-use ratio has negative effect in Indonesia but has positive effect in Thailand. It has the positive effect when pooled data is used. More smoothly adjusting exchange rates would diminish abrupt changes in critical rates of depreciation. The Asian financial crisis marked a move away from government owned banking systems leading to weaker impacts of depreciation rates.

The present model can be applied to other commodities. The wealth reducing effect of an increase in the depreciation rate can be examined for other commodities and countries. The present results suggest effects may vary across importers. The global cotton market consists of numerous exporters and importers. A complete model would include interrelated trade flows and bilateral exchange rates of each. The present paper focuses on US exports but may be a precursor to a more complete model. Ideally, data on bilateral cotton exports and imports would lead to a more complete model of the international market including the effects of bilateral exchange rates and, more critically perhaps, depreciation rates.

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