INDEXES OF AVERAGE APPAREL PRODUCT WEIGHT & MODELS OF U.S. END-USE CONSUMPTION

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Abstract

Global mill-use of cotton remains about 10% below its peak in the mid-2000s. Mill demand is ultimately a reflection of what order placement from retailer and brands and therefore is reflected in end-use consumption. Even though the U.S. represents only about 4% of the world's population, the U.S. accounts for 25% of the world end-use for cotton. Since the U.S. is such an important consumer market, an understanding of the dynamics affecting U.S. end-use should provide relevant insight regarding global cotton demand. There are several factors that can potentially explain the decline in U.S. end-use consumption in recent years. One of them is the decline in average product weight that has occurred since 2006-07. To better understand the effect of the change in average product weight relative to other explanatory variables, an objective of this research is to explore the significance of newly developed indexes of average garment weight to statistical models of U.S. end-use consumption.

Introduction

The world cotton market experienced a series of demand-side shocks in recent years. The first of these resulted from the global recession of 2008/09, which caused consumers to restrain spending and become increasingly value-focused. In turn, the reduction in consumer spending led retailers to pull back on order volume and to look into possibilities for reducing sourcing costs. The second shock was specific to the cotton supply chain and originated from the spike in fiber prices that occurred in 2010/11. This shock caused a loss in market share relative to competing fibers like polyester and viscose, but also could be seen as amplifying the retailers' drive to reduce sourcing costs that originated with the recession a few years earlier.

In combination, these two shocks can be seen as principal drivers that have pulled world mill-use lower (Figure 1). The 2015/16 crop year is seven years after the global recession and five years after the spike in cotton prices. Despite the growth in the global economy since the recession, and despite the declines in cotton prices that have occurred since these demand shocks, world mill-use of cotton is forecast (110.9 million bales according to the USDA's January forecast) to hold to levels about 10% below the peak enjoyed in 2006/07 and 2007/08 (average mill-use of 124.0 million bales).

The decline in global mill-use has been mirrored in the few available sources for tracking bale equivalence of end-use consumption (i.e., final consumption of apparel by consumers). One such source is the monthly Cotton & Wool Outlook produced by USDA's Economic Research Service (ERS). Since the U.S. apparel market is supplied almost entirely by imports (Cotton Incorporated's Retail Monitor™ indicates that about 2% of products offered for sale in the U.S. are labeled as made in the U.S.), the bale equivalence data published in Cotton & Wool Outlook can be considered an effective proxy for U.S end-use.

Over the past several years, these figures indicate that there has been an important reduction in the amount of cotton fiber represented by U.S. apparel imports in recent years. For the latest crop year with a complete set of data (2014/15), the estimated bale equivalence of the cotton contained in U.S. apparel imports (13.7 million bales) was 21% below the peak set between 2006 and 2007 (17.4 million bales).

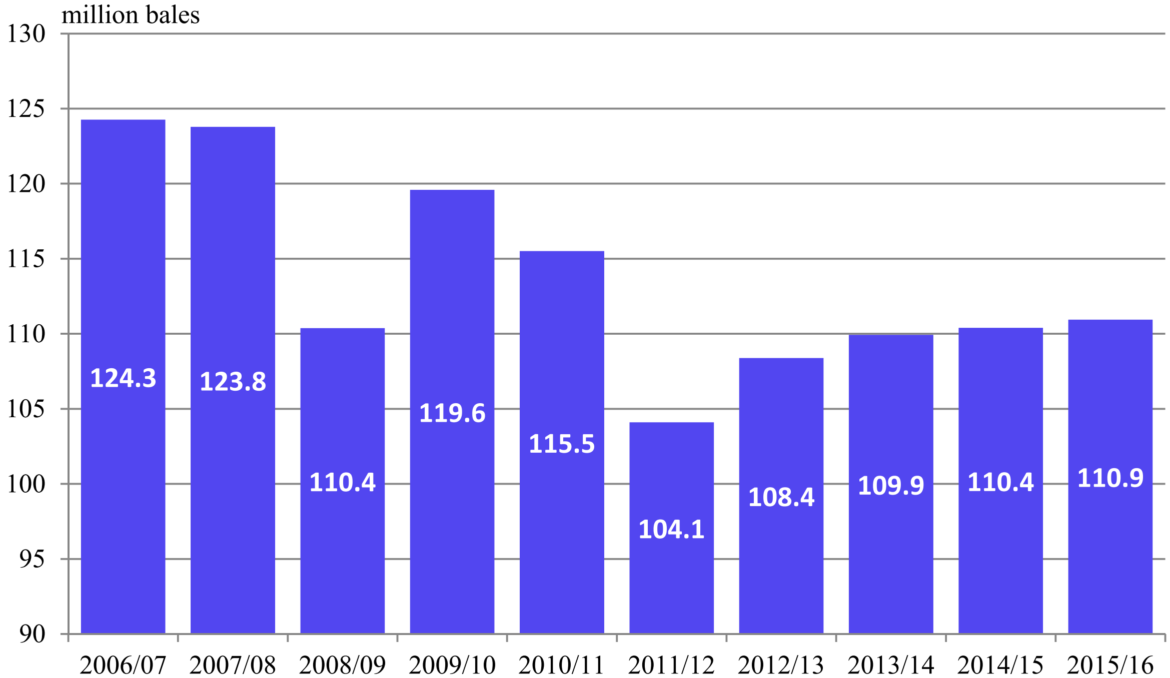

Figure 1. World Cotton Mill-Use (Foreign Agricultural Service)

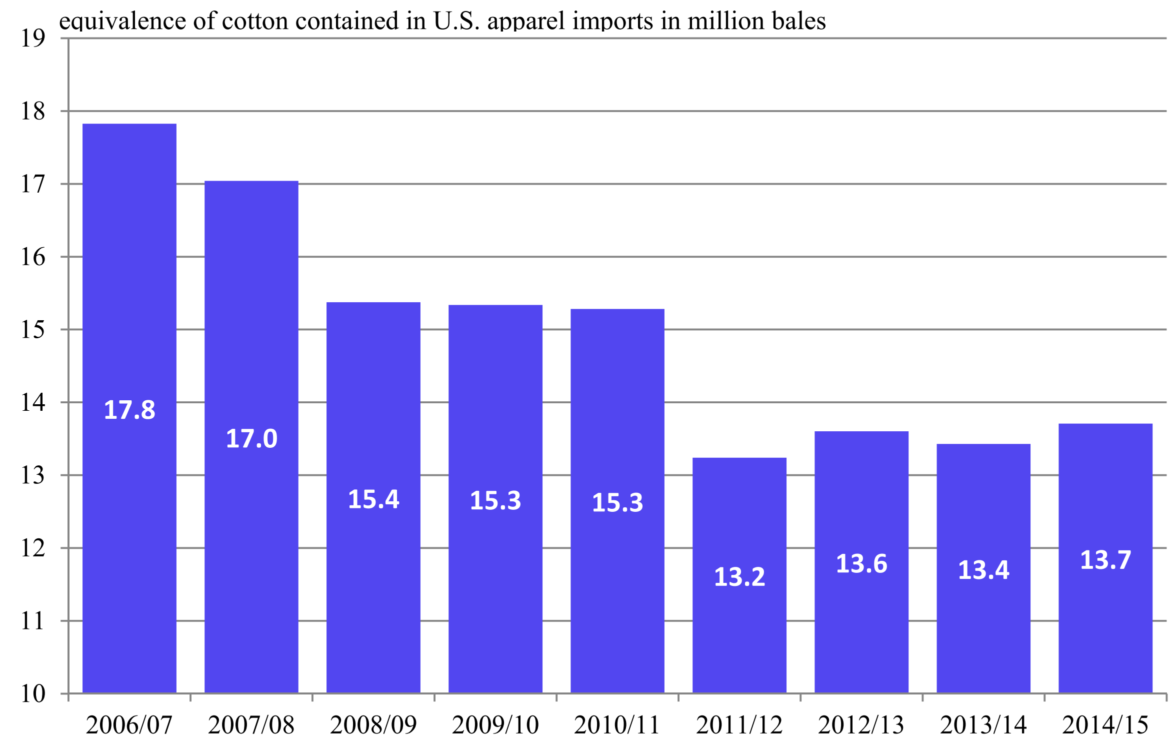

Figure 2. Cotton Bale Equivalence of U.S. Apparel Imports (Economic Research Service)

A possible explanation for the decline in the bale equivalence of cotton imports is the decline in cotton's share that has occurred in the wake of the 2010/11 price spike. While this certainly is one cause of the decline, it is appropriate to examine changes in the bale equivalence of the fiber contained in apparel imports of all fibers over the same time period (Figure 3). In those data, it is possible to see that there has not only been a decline in volume of cotton fiber contained in apparel imports, but that there has also been a decline in the volume of all fibers contained in apparel imports.

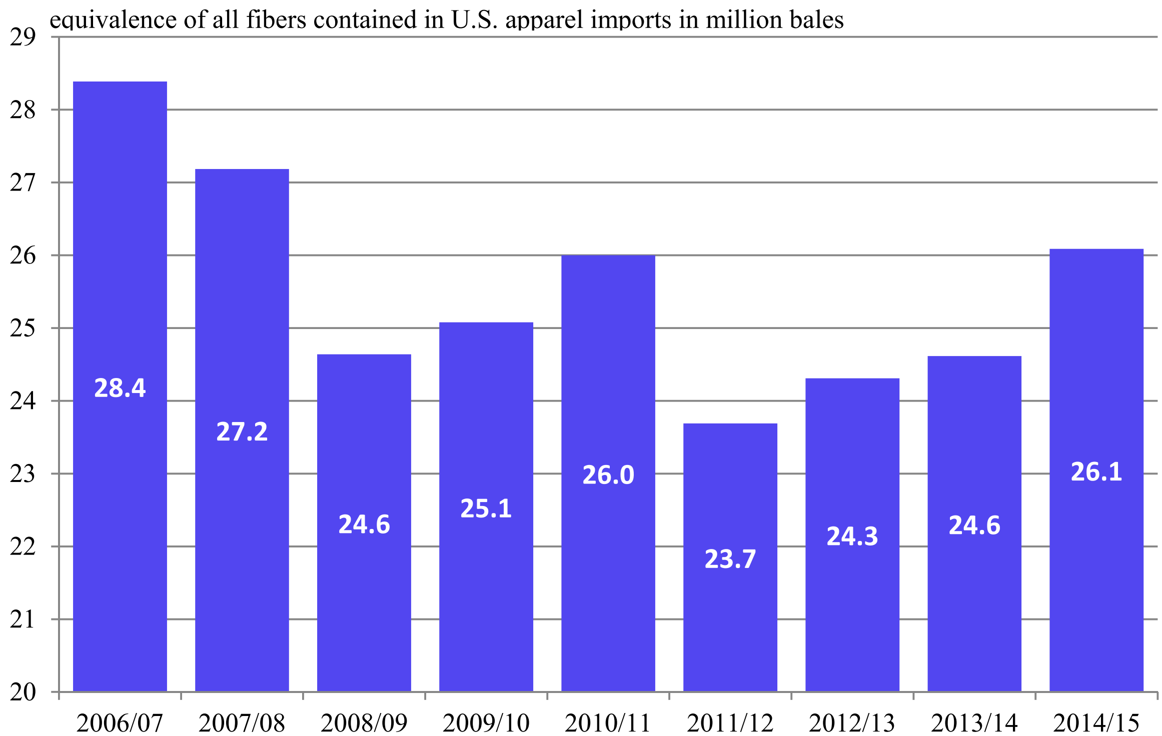

Figure 3. Bale Equivalence of All Fibers in U.S. Apparel Imports (Economic Research Service)

A factor that could be cited to explain the reduction in the bale equivalence of all fibers contained in U.S. apparel imports could be the depressed state of the U.S. consumer since the recession, which could translate into reluctant consumer spending on apparel and therefore lower order volumes from apparel retailers. To get a better understanding of any possible weakness in consumer spending on apparel, it is appropriate to look at consumer spending data over the past several years (Figure 4).

In terms of personal expenditures on garments, there has been strong growth over the past couple years. In monthly data since late 2014, the average year-over-year growth in consumer spending on apparel has consistently been between 4-5%. Despite strong increases in total spending (consistently near 3%), this has outpaced overall rate of expenditure growth and average annual rate of spending in recent months has been more than 10% above the levels from 2006/07 and 2007/08 (when the bale equivalence of all fibers contained by U.S. apparel imports peaked). Correspondingly, a weak consumer environment cannot explain the decline in the total bale equivalence of the fiber imported as apparel.

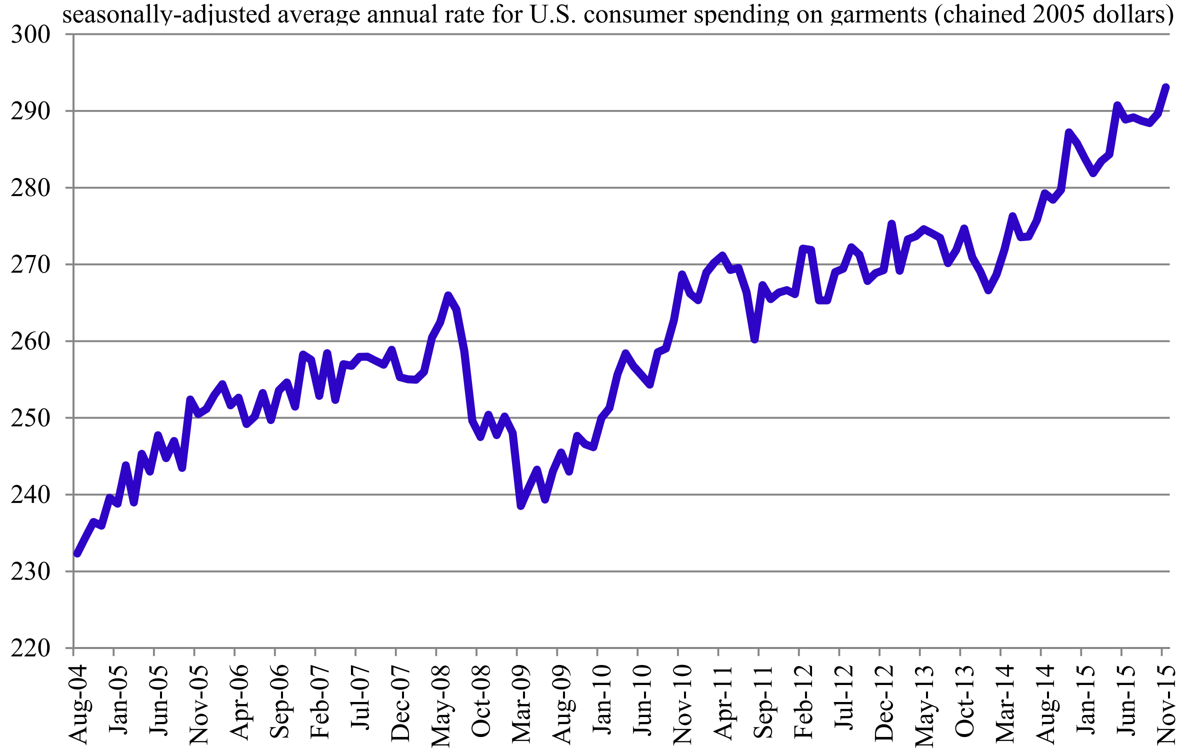

Figure 4. U.S. Consumer Spending on Garments (Bureau of Economic Analysis)

That leaves an explanatory gap and the question of how apparel spending can be higher while the bale equivalence of apparel imports can be lower. To help discover why end-use consumption has been declining despite growth in apparel spending, Cotton Incorporated created an import database. This database is essentially duplicates the one developed by the USDA that generates the figures published in *Cotton and Wool Outlook*. It is built from the complete set of the most precise apparel import categories available (HS 10-digit). Since it is built at this precise level, analysis of what is occurring at the individual product category level (e.g., men's cotton-dominant t-shirts) is enabled (figures in *Cotton and Wool Outlook* are published in terms of aggregates, such as apparel and home furnishings) and this was the motivation for its creation.

Attributes included in the database include the customs value, unit count, as well as the weight volume. The weight figures reported by U.S. Customs are transformed into their raw fiber equivalence using conversion factors provided by USDA ERS. The data are monthly, with coverage extending back to 1996.

With attributes for unit count and raw fiber equivalence, it has been possible to examine changes in average product weights over time. This analysis has revealed that there have been widespread reduction in the average weight of garments since the 2006-07 time period (Devine 2014; Devine 2015). This has proven true not only for cotton-dominant garments, but for man-made-fiber-dominant garments, so this phenomenon is not unique to garment of any particular fiber.

Reductions in fiber content represent reductions in raw material costs for retailers and brands, and it can be assumed that a cause of the decline in average product weight has been a result of a concerted effort by retailers and brands to lower costs in the wake of the demand-side shocks resulting from the recession and the fiber price spike. Changes in fashion, including a shift to tighter silhouettes and toward lighter athletic apparel, can be seen as other contributing factors.

While the implications in terms of loss in end-use consumption resulting from declines in average product weight have already been discussed (Devine 2015), aggregate representations of the decreases in unit weight had previously been unavailable. The purpose of this paper is to introduce several indexes that describe aggregate changes in average apparel product weight. Multiple specifications are examined and tested in the context of their ability to explain changes in the bale equivalence of total fiber and cotton imports.

Index Specifications

A challenge in developing indexes aggregated from a diverse set of subcategories is determining the appropriate method for aggregation. Due to questions of what the most appropriate method might be in the context of apparel import volumes, this research explores two alternatives for aggregation. The first is termed "naïve". The naïve indexes are derived simply as the ratio of total fiber weight by the total count of products. More formally, it can be written

$$Naive\ Index_m = \sum_{i=1}^{n} w_{im} \,/\, \sum_{i=1}^{n} c_{im}$$

where

m denotes a given month

i denotes a 10-digit HS import category

w_{im} *denotes the all-fiber or cotton weight for category i in month m*

c_{im} *denotes the all-fiber or cotton unit count for category i in month m*

This approach was implemented for both all-fiber and cotton aggregations.

A potential shortfall of the naïve approach is that it does not take into account the possibility of switching from one category to another over time. For example, consumers may have come to prefer lightweight t-shirts over heavier polo shirts. The switch to t-shirts would have a negative affect the naïve index. Such an impact could be considered "impure" since it does not describe the effect of declines in average weight for specific products over time. For example, t-shirts and jeans have gotten about 10% lighter over time. To capture those product specific changes over time, an alternate approach may be more appropriate.

The alternate approach that was taken is resulted in what is referred to as "weighted indexes" of product weight. These indexes were derived as

$$Weighted\ Index_m = \sum_{i=1}^{n} v_{im} * \mathrm{f}_i$$

where

m denotes a given month

i denotes a 10-digit HS import category

v_{im} *denotes a value an indexed of category-specific product weight so that*

$$v_{im} = (w_{im}/c_{im}) \,/\, (w_{ib}/c_{ib}) * 100$$

with w_{im} *the all-fiber or cotton weight for category i in month m*

c_{im} *denotes the all-fiber or cotton unit count for category i in month m*

w_{ib} *the all-fiber or cotton weight for category i in the base period 2006-07*

c_{ib} *the all-fiber or cotton unit count for category i in the base period 2006-07*

f_i *denotes category i's share of the total weight of all-fiber or cotton imports in the latest calendar year*

The base period was chosen so that changes over time would reflect the difference since the period of peak imports in 2006-07. The proportion of the category share was derived from the latest calendar year in order to best reflect the most current distribution of apparel products.

In addition to the indexes of product weight, parallel methods were used to derive aggregate prices in terms of USD/lb. The naïve indexes of price are simply the ratio of customs value to unit count, while the weighted indexes of price are sums of customs value weighted by the category share of total import weight. To explore how these variables may benefit efforts to explain variation in import volumes a two-step system for statistical analysis was conducted.

Modeling Process

To determine which index specification is most appropriate, they were applied in regression models designed to explain changes in the bale equivalence of imports. Two separate sets of analysis were performed. The first concerned bale equivalence of all fibers as the dependent variable. The second addressed the bale equivalence of cotton fiber.

In addition to the indexes of product weight, a series of other explanatory variables were considered. These explanatory variables covered import prices and fiber prices as well as a range of macroeconomic variables. The collection of macroeconomic variables were gathered from previous research concerning end-use demand (Capps & Williams, 2006; Capps & Williams, 2011). This included CPIs for energy and garments, disposable personal income, and real consumer spending on garments. In addition, data regarding clothing inventories, clothing store inventory/sales ratios, and the consumer savings rate were tested. A list of these variables, along with their sources and expected signs, appear in Table 1 (import and fiber variables) and Table 2 (macroeconomic variables.

In order to investigate the significance of the indexes of average garment weight, as well as the other explanatory variables and exploratory framework was implemented. The first step of this process was the identification of the lagged correlation between each of the dependent and independent variables. Since the orders by retailers tend to placed far in advance of the month that they are delivered in U.S. ports, a wide timeframe including lags from 0 to 24 months was examined. Results from this analysis are presented in Tables 3 and 4.

For the explanatory variables with correlations to dependent variables that matched the expected sign, the lag with the greatest absolute correlation values were considered for inclusion in the second, regression-based, step of the modeling process. For general categories with more than one variable (e.g., weight indexes or fiber prices), the variable with the greatest absolute lagged correlation value were included in the first iteration of the regression process. To illustrate, the China-adjusted cotton price (with 13-month lag) had the greatest absolute correlation with the bale equivalence of apparel imports of all fibers. As a result, this was the variable selected from the fiber price group of variables in the regression-based analysis of all-fiber apparel imports.

The two exceptions to this general approach for selecting the lag with the maximum correlation was for the weight indexes and for cotton's share. Relative to import volumes expressed in weight terms, average product weights are definitional (i.e., if products weigh more, there will be greater import volumes on a weight basis). As a result, the weight indexes were all entered into the regression phase of analysis without any lags. Similarly, for cotton, if cotton's share of total apparel is higher, there will be higher levels of cotton imports. For this reason, no lags are considered for cotton's share either.

In addition to the examination of the role of product weight in determining another goal of this analysis is to establish a parsimonious set of predictive variables for the forecasting of imports. To achieve this goal, an iterative process adopted from time series analysis was adopted (Enders, 2010). In the first iteration, the starting set of lagged explanatory variables identified from the correlation analysis used to describe import volumes. After this initial regression has been conducted, the statistical significance for each of the coefficients are collected and compared.

The variable with the least significance (highest p-value) is then dropped from the set of explanatory variables for the second iteration. In the second iteration, the least significant variable is again dropped. This process is repeated until only significant variables are left in our set of explanatory variables. The cutoff for significance that was selected for the purposes of this paper was a p-value 0.20. The final results from the regression analysis are presented in Tables 5 and 6.

Table 1. Import and Fiber Explanatory Variables Considered in the Modeling Process

Explanatory Variables	Source	Expected Sign and Rationale
Indexes of Product Weight		
Naïve Index	Cotton Incorporated Import Database, time series for all-fibers and cotton	Positive, higher product weights should imply greater import volumes
Weighted Index	Cotton Incorporated Import Database, time series for all-fibers and cotton	Positive, higher product weights should imply greater import volumes
Apparel Import Prices		
Naïve Index in USD/lb	Cotton Incorporated Import Database time series for all-fibers and cotton	Negative, higher sourcing costs should imply lower import volumes
Weighted Index in USD/lb	Cotton Incorporated Import Database time series for all-fibers and cotton	Negative, higher sourcing costs should imply lower import volumes
OTEXA USD/SME	OTEXA time series for all-fibers and cotton	Negative, higher sourcing costs should imply lower import volumes
Apparel Import Price Ratios		
Ratio of Naïve Index of Cotton Import Prices to Naïve Index of Man-Made Import Prices (USD/lb)	Cotton Incorporated Import Database time series for all-fibers and cotton	Negative (cotton model only), higher cotton sourcing costs should imply lower cotton import volumes
Ratio of Weighted Index of Cotton Import Prices to Weighted Index of Man-Made Import Prices (USD/lb)	Cotton Incorporated Import Database time series for all-fibers and cotton	Negative (cotton model only), higher cotton sourcing costs should imply lower cotton import volumes
Ratio of Cotton-dominant Import Prices to Man-Made-dominant Import Prices (USD/SME)	OTEXA time series for all-fibers and cotton	Negative (cotton model only), higher cotton sourcing costs should imply lower cotton import volumes
Fiber Prices		
A Index	Cotlook	Negative, higher fiber prices should imply lower import volumes
China-Adjusted Cotton	Cotlook and USDA, average of CC Index and A Index prices weighted by the share of Chinese mill-use not imported	Negative, higher fiber prices should imply lower import volumes
Chinese Polyester	Cotlook	Negative, higher fiber prices should imply lower import volumes
Asian Polyester	Cotlook, average of the two lowest Asian polyester values quoted	Negative, higher fiber prices should imply lower import volumes
Ratio of China-Adjusted Cotton and Asian Polyester	Cotlook, USDA	Negative (cotton model only), higher fiber prices should imply lower import volumes
Cotton's Share		
Cotton's Share	Cotton Incorporated Import Database	Negative (cotton model only), lower share for cotton should imply lower cotton import volumes

Note: As in Capps & Williams (2006, 2011), all variables expressed in dollar terms were converted to real values. All data except fiber prices are seasonally-adjusted.

Table 2. Macroeconomic Variables Explanatory Variables Considered in the Modeling Process

Macroeconomic Variables		
Consumer Spending on Garments	U.S. BEA	Positive, more apparel spending should imply larger import orders
CPI Energy	U.S. BLS	Positive, lower energy prices should allow for more to be spend on apparel and therefore allow for larger import orders
CPI Apparel	U.S. BLS	Negative, higher retail prices for apparel should lead to lower apparel spending and lower import orders
Disposable Personal Income	U.S. BEA	Positive, higher incomes should lead to more spending and more import orders
Consumer Confidence	Conference Board	Positive, greater confidence should lead to more spending and more import orders
Savings Rate	U.S. BEA	Negative, more saving suggests less spending and lower import orders
Clothing Store Inventories	U.S. Census	
Clothing Store Inventory/Sales Ratio	U.S. Census	

Note: As in Capps & Williams (2006, 2011), all variables expressed in dollar terms were converted to real values. All data except fiber prices are seasonally-adjusted.

Table 3. Maximum Absolute Lagged Correlations between Import Volumes & Explanatory Variables

Explanatory Variables	All Fiber Imports	Cotton Imports
Indexes of Product Weight		
Naïve Index	+74% Definitional, no lag	+41% Definitional, no lag
Weighted Index	+73% Definitional, no lag	+38% Definitional, no lag
Apparel Import Prices		
Naïve Index in USD/lb	Incorrect sign	Incorrect sign
Weighted Index in USD/lb	-29% No Lag	-36% 1-month lag
OTEXA USD/SME	Incorrect sign	-48% 3-month lag
Apparel Import Price Ratios		
Ratio of Naïve Index of Cotton Import Prices to Naïve Index of Man-Made Import Prices (USD/lb)	n/a	-20% 5-month lag
Ratio of Weighted Index of Cotton Import Prices to Weighted Index of Man-Made Import Prices (USD/lb)	n/a	-46% 3-month lag
Ratio of Cotton-dominant Import Prices to Man-Made-dominant Import Prices (USD/SME)	n/a	-48% 3-month lag
Fiber Prices		
A Index	-61% 14-month lag	-48% 12-month lag
China-Adjusted Cotton	-67% 13-month lag	-45% 12-month lag
Chinese Polyester	-46% 16-month lag	-48% 13-month lag
Asian Polyester	-58% 16-month lag	-57% 15-month lag
Ratio of China-Adjusted Cotton and Asian Polyester	n/a	-27% 9-month lag
Cotton's Share		
Cotton's Share	n/a	+18% Definitional, no lag
Macroeconomic Variables		
Consumer Spending on Garments	Incorrect sign	Incorrect sign
CPI Energy	-72% 15-month lag	-46% 7-month lag
CPI Apparel	-72% No lag	-37% 6-month lag
Disposable Personal Income	-78% 15-month lag	Incorrect sign
Consumer Confidence	+49% 12-month lag	+63% 5-month lag
Savings Rate	-58% No lag	-56% No lag
Clothing Store Inventories	-36% 5-month lag	-4% 9-month lag
Clothing Store Inventory/Sales Ratio	Incorrect sign	Incorrect sign

Table 4. Coefficients and p-values from Successive Regressions on All-Fiber Imports

	Iter. 1	Iter. 2	Iter. 3	Iter. 4	Iter. 5 Final Model
Intercept	2,009,286 0.0000	1,997,742 0.0000	2,124,765 0.0000	2,307,720 0.0000	2,427,341 0.0000
Naïve Wt Index (no lag)	4,184 0.3190	4,289 0.0228	4,458 0.0123	3,746 0.0214	3,267 0.0246
Weighted Index in USD/lb (no lag)	-147,706 0.0000	-145,984 0.0000	-145,455 0.0000	-152,512 0.0000	-144,965 0.0000
China-Adjusted Cotton (13-month lag)	-270 0.3986	-270 0.3971	-256 0.4140	-432 0.09840	-402 0.1170
Asian Polyester (16-month lag)	-785 0.4920	-927 0.3250	-944 0.3132	omitted	omitted
CPI Apparel (no lag)	2,720 0.3922	2,763 0.3815	2,504 0.4051	1,978 0.5039	omitted
CPI Energy (15-month lag)	-90 0.8253	omitted	omitted	omitted	omitted
Savings Rate (no lag)	-1,252 0.7934	-1,338 0.7780	omitted	omitted	omitted
Consumer Confidence (12-month lag)	2,488 0.0000	2,524 0.0000	2,540 0.0000	2,720 0.0000	2,692 0.0000
Clothing Store Inv. (5-month lag)	-16 0.0001	-16 0.0000	-16 0.0000	-16 0.0000	-15 0.0000
Adjusted R-Square	0.7836	0.7854	0.787	0.7872	0.7881
Durbin-Watson	1.7162	1.7251	1.7223	1.7182	1.6800

Table 5. Coefficients and p-values from Successive Regressions on Cotton Imports

	Iter. 1	Iter. 2	Iter. 3	Iter. 4 Final Model
Intercept	6,583,366 0.0000	6,1881,651 0.0000	6,173,748 0.0000	6,327,712 0.0000
Naïve Wt Index (no lag)	-24,710 0.0004	-21,743 0.0007	-21,656 0.0007	-19,943 0.0001
OTEXA USD/SME (3-month lag)	-720,151 0.1129	-666,529 0.1018	-707,434 0.0722	-739,40 0.0557
Ratio of China-Adjusted Cotton & Asian Poly (3-month lag)	-3,846 0.1129	omitted	omitted	omitted
Cotton's Share (no lag)	420,875 0.5682	302,060 0.6480	305,006 0.6437	omitted
CPI Apparel (6-month lag)	-18,912 0.0005	-17,390 0.0000	-17,283 0.0006	-18,159 0.0001
CPI Energy (7-month lag)	-784 0.0624	-859 0.0373	-878 0.0316	-855 0.0343
Savings Rate (no lag)	-3,227 0.0000	-3,480 0.0000	omitted	omitted
Consumer Confidence (5-month lag)	4,442 0.0000	4,214 0.0000	4,342 0.0000	4,150 0.000
Adjusted R-Square	0.5115	0.5122	0.5155	0.5187
Durbin-Watson	1.4900	1.4604	1.4648	1.4490

Discussion of Results

There are several interesting findings from the correlation stage of the analysis. As expected, the indexes of product weight are significant predictors of import volumes. For both all-fiber and cotton imports, the choice of specification (i.e., naïve or weighted) does not appear to have an important impact on significance, with correlations nearly virtually identical for both the all-fiber and cotton dependent variables. Although the significance of the weight indexes for cotton imports is much lower than for all-fiber imports, it is notable that the correlation values for weight indexes relative to cotton imports are also more than twice as large as the size of the correlation coefficient for share.

Another interesting relationship identified by the correlation analysis concerns the relationship between price variables and import volumes. In both the cases of all-fiber imports and cotton imports, the strongest correlations between import volumes and import prices were lagged less than the correlations between import volumes and fiber prices. A reason for this is likely that fiber prices are considered when orders are being placed. With order placement generally about a year ahead of delivery, it makes sense that the strongest correlations between import volumes and fiber prices are about a year apart. The comparatively short lags for the strongest correlations between import prices and import volumes is likely a result of the same temporal process. The curtailment of orders due to elevated fiber prices takes several months to manifest itself in deliveries, and that is why there is less of lag in terms of any response of import volumes to import prices.

In terms of the macroeconomic variables, an important finding from the correlation analysis is that neither consumer spending, clothing store inventories, nor the ratio of clothing store inventories/sales had the expected relationship with cotton imports and only the inventory/sales ratio had an explanatory power for all-fiber imports. The CPIs had a more pronounced effect on all-fiber import volumes than they did for cotton import volumes. Disposable personal income, was significant for all fiber imports, but not for cotton imports. Consumer confidence was the only variable in the analysis that offered greater predictive ability for cotton imports than for all-fiber imports.

With the regression portion of the analysis, which controls for interaction among variables, it was possible to narrow our focus to only the most significant variables. The statistical power of the all-fiber models was much greater than it was for the cotton models. This should not have been surprising considering that nearly of the explanatory variables had stronger correlations with all-fiber volumes than with cotton volumes.

In both models, the indexes of product weight and measures of import prices were highly significant. Fiber prices offered only limited significance, and that is likely due to (lagged) collinearity with import prices. Among the macroeconomic variables, only consumer confidence was consistently significant. Clothing store inventories were significant in the all-fiber model and the CPI for energy was significant in the cotton model.

Despite the identification of several significant variables in each model, the global fit statistics indicate that there is plenty of room for improvement in predictive ability and overall fit. The adjusted r-square figures suggest that only a little more than half of the variability in cotton imports can be explained by the model. In addition, the Durbin-Watson statistics indicate that model residuals are not normally distributed. As a result, neither of these models can be considered as strong forecasting tools. However, they were sufficient to meet the goals set forth in this paper, which was to introduce indexes of average product weight and to determine their significance to import volumes.

Conclusions

In this exploratory analysis of the role of product weight relative to import volumes, it was discovered that indexes or product weight do have explanatory ability. A secondary objective of this analysis was to identify parsimonious sets of explanatory variables to explain fluctuations in monthly import volumes. In this regard, it was found that indexes of average product weight, measures of import prices, and consumer confidence held the strongest predictive ability. That being said, in both the models of all-fiber and cotton import volumes, considerable room for improvement exists, with only 80% of the variation in all-fiber imports explained and only 50% of the variation in cotton import explained.

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