World Cotton Consumption: Transition and Competition

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Abstract

Following a global economic recession and nearly unprecedented price volatility, world cotton consumption in 2014/15 is forecast virtually unchanged from its level of 10 years earlier. A USDA model of world cotton consumption indicates that recent price changes and expectations for global income growth mean world cotton consumption could grow at a well-above-average rate in 2015/16, between 4.3 and 6.1 percent. A model of cotton's share of fiber consumption indicates a small rise in cotton's share can be expected, given recent trends in cotton and polyester prices, consistent with the expectation of higher world consumption. Uncertainties in the forecast are large since cotton's share of world fiber consumption fell so sharply after 2007/08 and China initiated a price support system in 2010/11 that shifted cotton consumption between countries and drove ending stocks to unsustainable levels. China's 2014/15 cotton policy reforms mean its textile industry could claim an above-average share of an increase in world cotton consumption.

The views expressed here are those of the authors and should not be attributed to the Economic Research Service or USDA.

Introduction

World cotton consumption showed strong gains in the mid-2000s, reaching a peak of 124 million bales in 2006/07 and again in 2007/08. Robust world economic growth, relatively weak cotton prices, and efficiencies achieved through the liberalization of world textile trade were the main factors supporting global cotton spinning. Cotton consumption then declined sharply with the 2008 global recession, and again with subsequent cotton price volatility through 2010/11—it has yet to recover to the 2007/08 level. In the aftermath of the recession, declining world production resulted in supply shortages, which in turn caused the A Index to reach $2.30 per pound at its peak in March 2011. Unsettled by the extreme volatility of cotton prices and resulting effects on domestic spinners, China's government set a price support policy for the 2011 through 2013 crops which kept both China and world prices at artificially high levels. World cotton production has exceeded consumption for five consecutive marketing years, from 2010/11 to 2014/15, generating an ever-increasing global cotton surplus, which is held mainly in China.

China's decision to withdraw price supports for this season's crop is the major factor causing world prices to fall 20 percent during the early 2014/15 marketing year. The world cotton industry anticipates below-average cotton prices for the next several years, as China disposes of its massive stocks. The rate at which the surplus can be liquidated will depend in large measure on how world consumption of cotton responds to lower prices. USDA is currently projecting above-average consumption growth of 3.3 percent for 2014/15, and expected prices and income suggest an even larger gain for 2015/16. However, the recent 10-year history of market shocks and extremes makes it very difficult to assess the underlying trends and responsiveness of cotton consumption to price changes. This paper attempts to summarize the information and analysis relevant to projecting world cotton consumption as prices fall.

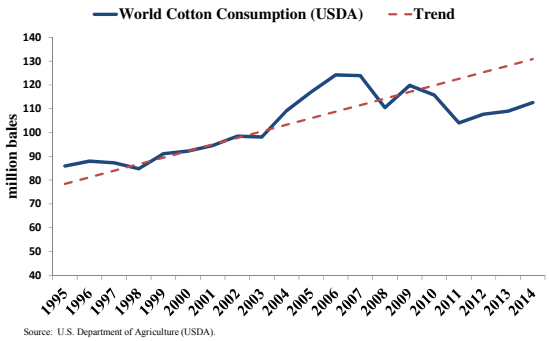

Figure 1. World Cotton Consumption Has Not Recovered from 2011 Shock.

Materials and Methods

Different approaches are needed for long-run and short-run cotton consumption forecasting, so USDA's Economic Research Service has developed a short-run model to assist with USDA's monthly global supply and demand forecast updates (see Appendix). This model supplements USDA's long-run projections analysis, which projects world cotton consumption to grow 2.3 percent annually over 2014-2023 (USDA/ERS, 2014a). In this short-run model, annual change in world cotton consumption is estimated as a function of inflation-adjusted changes in world income, cotton price, and polyester price.

Manmade fibers have replaced cotton in most industrial applications, so consumption of cotton is largely driven ultimately by households' clothing purchases. Households purchase clothing to update or expand their inventories of clothing, in contrast with food which is purchased to meet immediate consumption needs (Taylor and Houthakker, 2010). Clothing purchases and cotton consumption are particularly responsive to short-run income changes because of this household inventory effect.

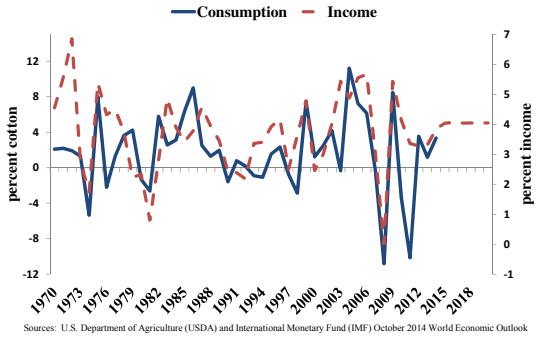

Figure 2. Annual Growth in World Cotton Consumption and Income Are Highly Correlated

Price also affects cotton consumption, particularly through competition between cotton and other fibers. Further upstream in the clothing supply chain, fiber costs account for a larger share of total costs, and relative fiber prices have a significant impact on consumption decisions such as fiber choices or blend levels. Raw fiber costs represent a small portion of the final consumer's clothing price, but consumers always face limits and alternatives in their consumption choices, so any changes in cost can have an effect on consumption at the end-use or household level.

In the long run, per capita cotton consumption changes are also a function of demographic shifts (such as changing population age profiles), consumers' tastes, and rising incomes. Also, innovations in engineering and manufacturing processes can alter the relative profitability of different fibers for textile manufacturers and fiber use can shift even with constant prices and end-user preferences. Finally, government policy can alter consumption, through taxation of imports or consumption for example, including taxation biased for or against specific fibers.

Short-run consumption can be affected when such shifts occur, and the ERS consumption model incorporates breaks to account for the immediate effects of several events that have had long-run impacts (Table 1). These include: the transition from rigid U.S. price supports under the 1981 farm legislation to the marketing loan program in 1986, China's state-owned enterprise reforms in 1998, and the completion of the Multifibre Arrangement's phase-out in 2004. Finally, a dummy is included to capture the large downward shift in consumption that occurred in 2011 in the aftermath of the largest annual cotton price increase in nearly 150 years. This nearly unprecedented price shock altered expectations regarding cotton's future price volatility, resulted in a wave of violations of contract sanctity between cotton buyers and sellers (*Wall Street Journal*, June 5, 2014), and helped set the stage for China's costly price support program.

Table 1. World cotton consumption growth model, parameter coefficients.

Variable	Estimated Coefficient	Standard Error	t-statistic	Prob. value
				Percent
GDP	2.032	0.342	5.94	0
Cotton price:				
Lag = 0	-0.058	0.021	2.76	1
Lag = 1	-0.099	0.021	4.77	0
Polyester price:				
Lag = 0	0.058	0.040	1.45	16
Lag = 1	-0.024	0.038	0.62	54
Exchange Rate	0.001	0.040	0.03	97
Dummies:				
1986	0.041	0.011	3.74	0
1998	-0.061	0.007	9.35	0
2004	0.074	0.013	5.51	0
2011	-0.054	0.022	2.44	2
Trend	-0.001	0.000	1.01	32
Constant	-0.046	0.018	2.51	2

Source: ERS calculations based on data from USDA/FAS (2014), IMF (2014), Cotlook Ltd, CNCotton, BEA (2014), and IHS Global Insight. Model's dependent variable is world cotton consumption annual change.

Time-series analysis is useful in estimating a lagged response of cotton's share of fiber consumption—as represented by the ERS raw-fiber-equivalent data for the United States—to the ratio of world cotton to polyester prices (see Appendix). The analysis shows a 12-month lag in the share response of the U.S. import data to changes in the China cotton/polyester price ratio (Table 2).

With the cotton/polyester price ratio as its sole independent variable, the model uses intercept shifts to capture a significant portion of the variation in cotton's share, with the largest shift occurring after July 2012.

Results and Discussion

Short-run Consumption Model

Annual cotton consumption changes were affected by changes in world income and cotton prices by relatively similar amounts during 1977-2011. Consumption's income elasticity is substantially larger than its price elasticity (Table 1), but prices are subject to much larger annual variation than is world income (Table 3). Cotton prices have significant impacts on cotton consumption with both no lag and a one-year lag, with the larger impact occurring with a lag. Polyester prices are estimated to have an impact on consumption similar to cotton prices (with the opposite sign) in the first year, and little impact after a lag.

Table 2. U.S. textile imports' cotton fiber share model, parameter coefficients.

Variable	Estimated Coefficient	Standard Error	t-statistic	Prob. value
				Percent
Constant:				
Jun 07–Jul 12	65.2	0.961	67.90	0
Aug 12-Jul 13	61.7	1.056	58.40	0
Aug 13-Jun 14	59.0	1.026	57.48	0
Price ratio (t-12)	-10.9	0.815	13.43	0
Dummies:				
Spring Festival	1.729	0.768	2.25	3
Jun 07-Oct 07	-2.233	0.653	3.42	0
Dec 09-Jan 10	2.646	0.931	2.84	1

Source: ERS calculations based on data from USDA/ERS (2014), Cotlook Ltd, and, CNCotton. Model's dependent variable is the cotton share of U.S. textile imports in mill-use, fiber-equivalents.

Table 3. Summary statistics for consumption model variables, 1977-2014.

			Price:		Exchange
	Consumption	Income	Cotton	Polyester	Rate
Skewness	-0.202	-0.542	0.365	0.591	-0.583
Kurtosis	4.197	3.682	2.750	1.026	3.352
			Percent		
Average	1.8	3.5	-3.5	-2.8	-1.1
Median	1.8	3.5	-1.9	-5.6	-0.5
Standard deviation	4.5	1.2	21.7	12.7	6.7

Source: ERS calculations based on data from USDA/FAS (2014), IMF (2014),Cotlook Ltd, CNCotton, BEA (2014), and IHS Global Insight.

The 2014/15 A Index is estimated to average 67 cents, down 32 percent in real terms from 2013/14, a relatively large decline. Polyester is estimated at 61 cents, or 18 percent below a year earlier. The IMF's October 2014 World Economic Outlook (IMF, 2014) projected calendar 2015 income growth at 3.8 percent, an improvement from 3.3 percent in 2014, but slightly below the 2010-2014 average (see Appendix for discussion on linking calendar and marketing years).

World cotton consumption growth in 2014/15 is projected at 2.0 percent by the short-run projection model. A range of estimates based on alternative forecasts of the 2014 A Index extends from 1.7 percent with a 71-cent price to 2.6 percent at a 60-cent price (Table 4). Polyester price is held constant for 2014/15 across this range of alternative cotton prices, and to the extent that polyester prices moved from baseline expectations in tandem with cotton prices during the latter months of 2014/15, the range of these estimates around the 2.0-percent estimate would narrow. The model's 2014/15 forecast is above the 1.3-percent growth realized in 2013, but below USDA's December 2014 forecast of 3.3 percent. USDA is forecasting a greater response than indicated by the model mainly because, unlike weather or other intra-seasonal developments affecting prices, China's reduction in price support was announced well in advance of the marketing year; since lower prices were widely expected, the time lag for consumption

response is expected to have been reduced accordingly.

Table 4. Model forecasts of world cotton consumption in 2014 vary with assumed price.

2014 A Index assumption	Consumption growth
Cents/lb	Percent
60	2.6
61	2.6
62	2.5
63	2.4
64	2.3
65	2.2
66	2.1
67	2.0
68	1.9
69	1.8
70	1.8
71	1.7

Source: Simulations by authors.

Extending the forecast horizon to 2015/16 requires estimates of cotton and polyester prices in that year. The IMF provides forecasts of income growth for 2015 and several years beyond, but until February 2015 there will be no published USDA estimates of world cotton prices. Polyester prices are not forecast by USDA, but the past relationship between cotton and polyester prices can be used to make polyester price forecasts conditional on cotton price forecasts. Cotton prices are more volatile than polyester prices, and annual changes in the cotton/polyester price ratio are driven more strongly by changes in cotton prices than polyester prices. The past relationship between changes in the cotton price and changes in the ratio can be used to construct a set of 2015 polyester prices consistent with various cotton prices in 2014 and 2015, shown in Table 5.

Table 5. Polyester prices in 2015 as a function of alternative 2014 and 2015 cotton price assumptions.

2014/15	2015/16 A Index						
A Index	55	60	65	70	75	80	85
	Cents/lb						
60	54	55	57	59	62	65	68
61	55	56	58	60	62	65	68
62	55	57	58	60	63	65	69
63	56	57	59	61	63	66	69
64	57	58	59	61	63	66	69
65	58	59	60	62	64	66	69
66	59	59	60	62	64	67	70
67	59	60	61	63	65	67	70
68	60	61	62	63	65	68	70
69	61	61	62	64	66	68	71
70	62	62	63	64	66	68	71
71	63	63	64	65	67	69	71

Source: Calculations by authors. First difference of logged cotton/polyester price ratio during 1995-2014 found by ordinary least squares to equal 0.0053392 + 0.628733 * first difference of logged real cotton price – 0.754552 * squared first difference of logged real cotton price.

The model results forecast 2015/16 world cotton consumption to grow between 4.3 percent and 6.1 percent. World GDP growth is forecast slightly higher than the year before, at 4.0 percent, but the main factor driving cotton

consumption sharply higher in 2015/16 is the larger lagged cotton price decline. In 2014/15, the lagged cotton price change was a positive 1.4 percent, but in 2015/16 its negative 32-percent change from the year before supports higher consumption. The range of 2015 cotton prices used to generate the range of consumption forecasts is 55-85 cents/lb., and polyester prices range from 54 to 71 cents. For example, if the A Index in 2015/16 is 65 cents—about unchanged from the year before—the polyester price in 2015/16 is also projected about unchanged, and consumption is projected to rise 5.2 percent.

Actual consumption growth will be determined by actual price and income changes—which are forecast with uncertainty here. The uncertainty of the GDP forecasts was highlighted by a December 2014 statement co-authored by the IMF's chief economist that oil price changes since the publication of the IMF's October 2014 forecasts could raise world GDP growth in 2016 by 0.4 to 0.8 percentage points (Arezki and Blanchard, 2014). Similarly, during the 4 years that the IMF has published 2-year-out world GDP forecasts that can be compared with actual realizations (2007-2011 publications of 2009-2013 forecasts), the root-mean squared error of the October forecasts has been 1.025 percentage points. If one assumes a symmetric GDP forecast range around the 4.0 percent forecast, and again assumes a 70 cent 2015 A Index, world cotton consumption in 2015/16 could range between 2.4 and 6.6 percent. The errors were not symmetric—with the forecast too high in 3 out of 4 years—but the trend of recent events seems in favor of avoiding such an error in this forecast.

Other uncertainties are inherent in the construction of the model. The model was constructed to extract the impact of exogenous factors from its analysis of the relationship between consumption and prices and income, but its simple, parsimonious construction puts the accuracy of its forecasts at risk due to a range of unforeseen shocks. The model was estimated with a historical sample covering 1977-2011, and its 2012/13 and 2013/14 estimates using current price and income data were 3.9 and 1.0 percent growth, respectively, compared with USDA's estimates of 3.4 and 1.3 percent. Whether the model's current 2015/16 forecast will be as accurate will depend on the world cotton market's continually evolving response to the profound shock experienced in 2010 and 2011.

Because of these inherent uncertainties, the 95 percent prediction interval for the model's 2015/16 forecast is relatively wide. Even if the IMF's 2016 GDP forecast was exactly correct, interaction of random shocks to historical cotton consumption, income, and prices means the model's 5.2 percent consumption growth forecast is the mid-point of a 0.1 – 9.8 percent range within which the model predicts consumption growth has a 95 percent chance of falling.

Cotton's Share of Total Fiber Use

Cotton's share of total textile fiber use has declined gradually since 1960—the International Cotton Advisory Committee (ICAC) estimates that cotton's share fell by half between 1970 and 2013, from 56 percent to 28 percent. At the same time, however, increases in textile consumption due to rising world population and incomes have supported cotton consumption, which nearly doubled in absolute terms during the same period. Of greater concern to the global cotton industry is the very sharp drop in cotton's share which began in 2009, apparently in response to economic recession and rising cotton prices. The A Index for January 2010 was 77 cents per pound, 34 percent above January 2009. Cotton prices rose from that point, reaching record levels by mid-2011.

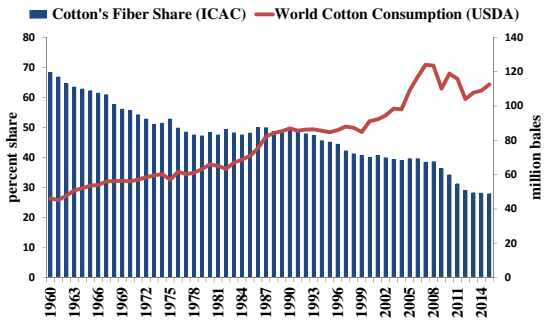

Figure 3. Cotton's Fiber Share and World Cotton Consumption

USDA monitors changes in cotton's share by tracking cotton textile imports into the United States. Textile imports account for most consumer use by the world's largest consumer of both textiles and cotton. The estimates are made by ERS, based on customs data converted to raw fiber weight equivalents (USDA/ERS, 2014). ERS estimates that cotton's share of total U.S. textile imports averaged 54.4 percent in calendar year 2009, falling to 48.2 percent in 2013. The decline in share between 2009 and 2013 equates to a loss of 2.3 million bale-equivalents that would have been used by U.S. consumers in calendar 2013 if share had remained steady.

Cotton's average share of the fibers in U.S. textile imports fell to 47 percent in the last of the 3 time segments in the share model, compared with 52.8 percent in the earliest (Table 6) The average cotton/polyester price ratio peaked during the middle time segment at 1.197, compared with 1.075 in the final segment.

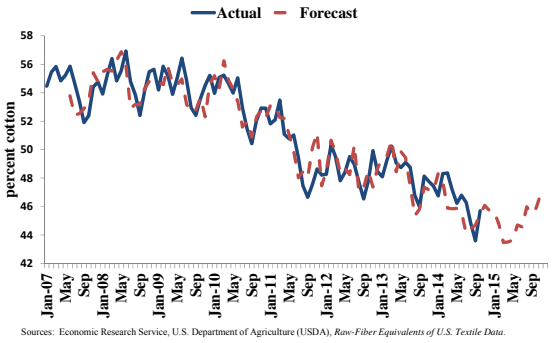

Figure 4. Cotton's Fiber Share of U.S. Textile Imports Has Not Recovered from 2011 Shock

Table 6. Summary statistics for share model variables, 2007-2014.

	Price ratio (lagged):				Share:			
	Full sample	Jun 07-Jul 12	Aug 12-Jul 13	Aug 13-Jun 14	Full sample	Jun 07-Jul 12	Aug 12-Jul 13	Aug 13-Jun 14
Skewness	0.678	0.712	0.682	0.405	-0.173	-0.649	-0.379	-0.189
Kurtosis	2.978	2.549	3.067	2.474	1.640	2.323	2.798	1.861
Average	1.140	1.134	1.205	1.079	51.735	52.778	48.638	47.142
Median	1.133	1.064	1.197	1.075	52.239	53.533	48.751	47.107
Standard deviation	0.196	0.219	0.046	0.039	3.101	2.673	1.020	0.786

Source: ERS calculations based on data from USDA/ERS (2014), Cotlook Ltd, and CNCotton.

Analysis developing the model shows a 12-month lag in the share response of the U.S. import data to changes in the world cotton/polyester price ratio; since the cotton is spun in advance of shipment and delivery, a lag of about 6 months in the spinning impact is assumed to translate the expected changes in U.S. imports to the preceding changes in fiber consumption in the exporting countries. Based on prices during the summer and fall of 2014, the model indicates that cotton's fiber share of spinning should recover by as much a 1 percentage point in the final months of the 2014/15 marketing year. If China's cotton prices stabilize at the depressed levels currently indicated by the Zhengzhou futures market, it is reasonable to expect another 1-percentage point increase in share in 2015/16. Similar share data are not available for non-U.S. textile consumption; however, while base share levels and elasticities may vary by country, a positive world response to a diminishing cotton/polyester price relationship is likely. A simple extrapolation from the U.S. to the global level shows that each percentage point increase in fiber share would add 2-3 million bales to world consumption.

Experts on world textile markets highlight other variables which may have contributed to cotton's loss of fiber share in recent years (Driscoll, 2014) The effects of these variables are very difficult to quantify, but could have a significant impact on the potential recovery of world cotton consumption as prices fall. Anecdotal information suggests that consumers have adjusted to the substitution of manmade fibers for cotton in fabric blends. Since manmade fibers are generally both cheaper and easier to use, minimal consumer reaction may indicate a permanent downward shift in the elasticity of demand response to price. Another residual shock effect is a preference on the part of manufacturers for manmade fibers due to their relative price stability compared with recent extreme fluctuations in cotton prices. It is unclear how long cotton prices would need to stabilize in order to neutralize this effect. Finally, technological advances in manmade fibers, such as polyester filament and viscose, have improved their competitive position relative to cotton and may have contributed to the recent losses in fiber share, which the quantitative models are capturing as an exogenous shift.

Effects of China's Policies

China continues to be the world's largest importer and spinner of cotton. Between 2010/11 and 2013/14, cotton consumption in China fell by 25 percent while consumption outside of China grew by 8 percent. This poor performance stands in stark contrast to the period from 1999, when China began reform of its cotton sector in anticipation of WTO membership, until 2007, just before the 2008 global recession. In these years, China captured 80 percent of the total growth in world spinning and nearly doubled its share of world consumption.

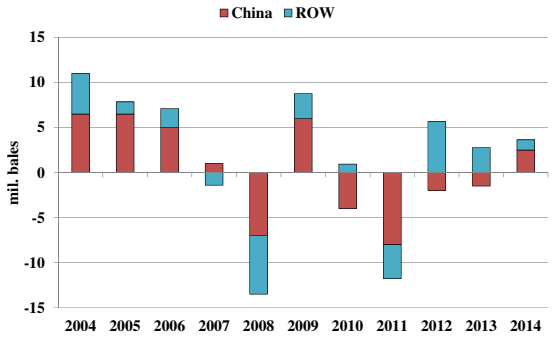

Figure 5. Changes in China and Rest-of-World Cotton Consumption, 2004/05 to 2014/15

The recent sharp losses in China's cotton spinning sector were due in large part to the shift in 2010/11 to a price support program which significantly increased the differential between internal and external cotton prices. Previously, the price premium in China was largely the result of border protection (the use of sliding scaled import duties and other such measures) and so as world prices moved, prices in China also adjusted, constraining the price differential. Then in 2010/11, the government established a fixed internal price which was not dependent on world prices. As world prices declined, the gap between internal Chinese and world prices widened and yarn produced within China became less competitive, causing China's imports of both raw cotton and cotton yarn to rise. China's textile operations relied increasingly on imports of spun yarn, which are not constrained by import restrictions, as an alternative to using raw cotton from the domestic market. USDA estimates that the raw-fiber equivalent of China's yarn imports nearly tripled between 2010/11 and 2013/14, rising from 3.2 to 8.6 million bale-equivalents, an increase which accounted for roughly half of the decline in China's spinning consumption. Mills in India, Vietnam, and Pakistan were the major yarn suppliers to China, contributing nearly 80 percent of China's cotton yarn imports during the most recent three seasons. As a result, cotton mill use in India, Vietnam, and Pakistan expanded, accounting for a combined 34 percent of global mill use in 2013/14 compared with 28 percent in 2010/11.

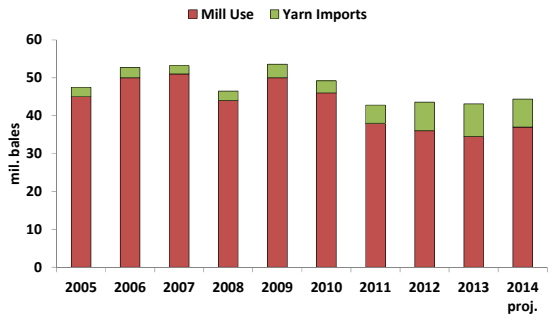

Figure 6. China's Cotton Mill Use and Yarn Import Equivalents, 2005/06 to 2014/15

New policies effective in the 2014/15 marketing year shift from income payments to price support, returning internal prices to a much more market-driven position and allowing the differential with world prices to return to historical levels. As a result, consumption in China should recover some of the spinning lost due to the very high prices during the previous three seasons. Spinning is likely to rise as yarn spun in China replaces a portion of the burgeoning yarn imports of the past three years. In addition, China should capture some of the growth in world spinning that is likely to occur in response to lower cotton prices, both in China and around the world. As of December 2014, USDA forecasts that China's consumption will rise about 7 percent in 2014/15.

Conclusions

World cotton consumption is highly correlated with incomes and the relative prices of cotton and polyester. Consumption has fallen sharply since its peak of 124 million bales in 2007/08 due to severe income and price shocks; for 2014/15, consumption is forecast at just under 113 million bales, a 9-percent decline from the record of the mid-2000s. However, world cotton prices have fallen by 25 percent in the past 6 months and are likely to remain low as China implements policy changes intended to reduce its large reserve stocks.

USDA's basic model for projecting world cotton consumption indicates a growth of 2 percent in 2014/15 and between 4 and 6 percent for 2015/16, due mainly to the lagged response of spinning mills to changes in raw material prices. Stronger growth in 2015/16 is supported by time series analysis of cotton's fiber share, which has lost ground over the past five years and is now poised to partly recover. In addition, the substitution in China of yarn produced domestically for the rising yarn imports of the past few years may increase efficiencies and boost consumption in the aggregate.

At the same time, however, the analysis has identified a number of uncertainties which could materially affect the outlook for recovery in world consumption. The statistical representations are hampered by the severe shocks of the past few years, including the market instability introduced by the run-up in prices that occurred in 2010 and 2011, followed by China's price intervention program and its recent reversal. In addition, USDA's simple forecasting models have difficulty predicting structural changes. The models indicate the presence of shocks that can be interpreted as structural change, but cannot distinguish between shocks that are permanent (e.g. rapid adoption of technical change) and those that will diminish with time (e.g. perceptions of cotton price volatility). The prospect of significant future policy changes in China—the world's largest cotton consumer and importer—further cloud the outlook.

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Appendix: Model Specification and Estimation

Annual world cotton consumption is modeled as a function of global income, cotton prices, polyester prices, and exogenous shocks:

$$\%\Delta C = f\left(\%\Delta GDP, \%\Delta P_{\text{cotton}}, \%\Delta P_{\text{polyester}}, Z_f\right)$$

The consumption model's dependent variable is the annual percent change in world marketing year (August-July) cotton consumption from USDA's PS&D database (USDA/FAS, 2014), The variable for global income is the International Monetary Fund's annual percent change in world gross domestic product (GDP) measured in purchasing power parity terms (IMF/WEO, 2014). GDP is measured on a calendar year by the IMF, and a given marketing year's cotton consumption is associated with GDP in the second calendar year spanned by the marketing year. The variables are deflated by a marketing year equivalent of the Bureau of Economic Analysis's (BEA) U.S. GDP deflator, and converted to first differences of logged values. The cotton price is the marketing year average of Cotlook's A Index and the current polyester price is the marketing year average of the China polyester price published by CNCotton. Before 2005, the polyester price was a production-weighted average of polyester prices in a selection of countries published in Cotton Outlook. The exchange rate variable is the first difference of the logged values of the IMF's broad, effective U.S. dollar exchange rate.

The consumption model's residuals appear to be normally distributed and free from heteroskedasticity and first-order autocorrelation (Table 7). The maximum variance inflation factor for any variable (cotton price at zero lags) of 2.67 is well below even the lower bound of 5 as an indicator of significant multicollinearity, and statistic for the Ramsey Regression Equation Specification Error Test (RESET) indicates we cannot reject the null hypothesis that non-linear combinations of the explanatory variables have no power in explaining the dependent variable, suggesting we have avoided omitting important variables. The potential endogeneity of cotton price was tested by including the consumption equation in a system that included a first-differenced version of a forecasting model for the A-Index (MacDonald, 1997). The low value of the Hausman test statistic indicated that ordinary-least-squares

and 3-stage-least-squares estimates do not produce coefficient estimates that are systematically different, indicating an absence of endogeneity bias.

Table 7. Model evaluation statistics for consumption and share models.

	Statistic value:		Prob. value	
Statistic	Consumption	Share	Consumption	Share
Adjusted R-squared	0.372	0.999	--	--
Standard error of regression	0.037	1.292	--	--
Durbin-Watson	2.281	1.460	--	--
Jarque-Bera (normality), $\chi 2$	5.210	0.220	0.074	0.894
White's (heteroskedasticity), $\chi 2$	35.00	17.43	0.435	0.180
Variance inflation factor (max.)	2.67	2.64	--	--
Ramsey RESET test (F-test)	1.01	2.68	0.407	0.053
Hausman test, $\chi 2$	3.09	--	0.961	--
Number of observations	35	80	--	--

Source: ERS calculations based on data from USDA/FAS (2014), USDA/ERS (2014), IMF (2014), Cotlook Ltd, CNCotton, BEA (2014), and IHS Global Insight.

The monthly cotton share of U.S. textile imports in mill-use fiber-equivalents is models as a function of a time varying constant, the cotton/polyester price ratio, and exogenous shocks:

$$\frac{\text{cotton in U.S. texitle imports}}{\text{all fiber in U.S. textile imports}} = g\left(C_1, C_2, C_3, \left[\frac{P_{\text{cotton}}}{P_{\text{polyester}}}\right]_{t-12}, Z_g\right)$$

The share model's dependent variable is the share (percent) of cotton in the total, monthly fiber- equivalence at the mill-use level of U.S. textile imports (USDA/ERS, 2014). The independent variable is the monthly ratio between Cotlook's A Index for cotton delivered to Far East ports to CNCotton's price for polyester staple in China. China's polyester prices are used because China is the world's largest supplier of polyester, and also because of the difficulty of estimating a meaningful world polyester price.

The series for cotton share and price ratio are highly autocorrelated and non-stationary. There is a strong contemporaneous, spurious correlation, but there is also a strong correlation at a twelve-month lag. This is consistent with the findings of the world consumption model and the lagged correlation at annual frequency between the relative growth rates of U.S. end-use of textiles made of cotton versus other fibers and the cotton/polyester price ratio. An additional variable was added to capture the years when China's Spring Festival occurred unusually late, driving the impact of the holiday from February into March, and altering the typical seasonality.

The model is estimated linearly, in levels, with the independent variables segmented into three time periods as indicated in the text. Two sets of outliers were identified, and with the outliers accounted for with dummy variables the model residuals were normally distributed, in addition to being homoscedastic and not serially correlated according to the Durbin-Watson test.

Restrictions on the price parameter forcing equality between any pair of time periods and all three time periods could not be rejected, but all analogous restrictions on the intercept terms could be. When estimated with a single price variable for all three time periods the model again passed tests for homoscedasticity, freedom from serial correlation, and normally distributed errors (Table 7).