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EVALUATION AND ADJUSTMENT OF USDA WASDE COTTON FORECASTS

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EVALUATION AND ADJUSTMENT OF USDA WASDE COTTON FORECASTS

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ABSTRACT

The dynamic and volatile nature of agricultural markets causes individuals to rely on forecasts in their decision-making. WASDE cotton forecasts are shown to be especially volatile as cotton is one of the most trade dependent commodities in the world. Therefore, its evaluation requires us to look beyond U.S. WASDE categories and evaluate forecasts for China and the World.

This study will use data from monthly WASDE balance sheets for upland cotton for the U.S, China and World over 1985/1986 through 2008/2009 including unpublished price forecasts. The results of this study will provide information that can be used to improve the accuracy of USDA cotton forecasts. The proposed study will fill the gap in knowledge of the level of supply and demand forecast uncertainty and its contribution to price forecast errors by 1) evaluating all weak-form forecast optimality conditions for the U.S., China and World balance sheet categories for cotton, including trends in forecast accuracy; 2) investigating whether errors in forecasts are correlated with the U.S., China and World balance sheet categories, and 3) identifying a statistical correction of systematic errors in independent variables of the U.S. cotton price model.

DEDICATION

This work is dedicated to all the friends and faculty at Clemson University who have not only challenged me to achieve great things but have also provided the inspiration. They all have made this one of my most enriching experiences. A big thanks goes to all.

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CHAPTER ONE

INTRODUCTION

The dynamic and volatile nature of agricultural markets causes individuals to rely on forecasts in their decision-making. Multiple efforts have been devoted in the recent literature to improve the models for price forecasting with a special focus on futures price forecasting (e.g. Lence, Hart, and Hayes, 2009; Ticlavilca, Feuz, and McKee, 2009). Other recent studies demonstrated a growing concern about changes in the relationship between futures prices and cash prices in the United States (e.g., Irwin, Garcia and Good, 2007; Timmer, 2009) which would limit the usefulness of futures price information for the purpose of cash price forecasting by USDA. Most cash price forecasting models rely on fundamental analysis of supply and demand factors (e.g., Meyer, 1998; Westcott and Hoffman, 1999; Dawe, 2002; Plato and Chambers, 2004; Schaffer, 2004; Goodwin, Schnepf, and Dohlman, 2005; Goreux, et al., 2007; Isengildina and MacDonald, 2009). These models are used for forecasting commodity prices throughout the forecasting cycle which spans several months before (with a typical start in May) and after (most crops are finalized by November) the U.S. marketing year. The challenge that many forecasters face early in the forecasting cycle is having to rely on highly uncertain supply and demand estimates as inputs in their price forecasting models.

Previous forecast evaluation literature has largely focused on forecast accuracy of two major components of WASDE balance sheets, production (e.g., Gunnelson, Dobson and Pamperin, 1972; Thomson, 1974; Isengildina, Irwin, and Good, 2006b) and price (e.g., Marquardt and McGann, 1977; Just and Rausser, 1981; Irwin, Gerlow and Liu, 1994; Sanders and Manfredo, 2002; Egelkraut et al., 2003; Isengildina, Irwin, and Good, 2004). The importance of price forecasts is obvious, given the role price expectations play in decisions on resource allocation. Production forecasts are important because they are a major determinant of future supply. Interestingly, the accuracy of most other categories describing supply and demand forces in WASDE forecasts have been overlooked in the previous literature. To the best of our knowledge, only one previous study (Botto et.al., 2006) investigated the accuracy of all U.S. WASDE categories.

Knowledge of supply and demand forecast accuracy is important because these categories serve as building blocks for price forecast accuracy. Furthermore, supply and demand estimates are published within a set of other forecasts in WASDE reports that have been shown to affect the markets (e.g, Colling and Irwin, 1990; Fortenbery and Sumner, 1993; Baur and Orazem, 1994; Isengildina, Irwin, and Good, 2006a). It is a commonly held belief of agricultural market participants and analysts that WASDE forecasts function as the "benchmark" to which other private and public forecasts are compared. The dominant role of WASDE forecasts is not surprising given the classic public goods problem of private underinvestment in information, and the critical role that public information plays in coordinating the beliefs of market participants. Therefore it is important to ensure that WASDE forecasts provide accurate and reliable information to the public.

The proposed study will fill the gap in knowledge of the level of supply and demand forecast uncertainty and its contribution to price forecast errors by 1) evaluating all weak-form forecast optimality conditions for the U.S., China and World balance sheet categories for cotton, including trends in forecast accuracy; 2) investigating whether errors in U.S. cotton price and ending stocks forecasts are correlated with the U.S., China and World balance sheet categories, and 3) identifying a statistical correction of systematic errors in independent variables of the U.S. cotton price model.

This study will concentrate on USDA cotton forecasts as little is known about their accuracy. Only a few studies have concentrated on a subset of WASDE categories for cotton (MacDonald, 2002) or included examination of cotton in studies of WASDE export forecasts for a number of commodities (MacDonald, 1999 and MacDonald 2005). In fact, the USDA was legally prohibited from forecasting cotton prices from 1929 to 2008. Although cotton price forecasts were not published, USDA's Interagency Commodity Estimates Committee for cotton calculated unpublished price forecasts each month. The accuracy of these unpublished forecasts should be evaluated as USDA moves forward with its cotton price forecasting mission. Cotton also presents a challenge of being one of the most trade dependent U.S. commodities. Therefore, its evaluation will require us to look beyond U.S. WASDE categories which has not been done before. This study will use data from monthly WASDE balance sheets for upland cotton for the U.S, China and the World over 1985/1986 through 2008/2009 including unpublished price forecasts. The results of this study will provide information that can be used to improve the accuracy of USDA cotton forecasts. The methodology used in this study can be directly applied to investigation of trends and potential improvements in forecast accuracy in other commodities.

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CHAPTER TWO

DATA

WASDE reports are released by the USDA usually between the 9th and the 12th of each month and contain forecasts of supply and demand for most major crops. Supply and demand estimates are forecasted on a marketing year basis. The first forecast for a marketing year is released in May preceding the U.S. marketing year. Estimates are typically finalized 18 months later, by November of the following marketing year for cotton (Figure 1). USDA WASDE forecasts are considered fixed-event forecasts because the series of forecasts is related to the same terminal event (y^i_T), where *T* is the release month of the final estimate for the category for the *i*th marketing year. The forecast of the terminal event for month *t* is denoted as: y^i_t , where *t*=1, ..., *T*, and *i*=1985/86, …, 2008/09. Thus, each subsequent forecast is essentially an update of the previous forecast as it describes the same terminal event. The WASDE forecasting cycle generates 18 updates (*T*=19) for each forecasted variable within each marketing year for cotton.

WASDE forecasts for the U.S. and the world follow a balance sheet approach to account for supply and utilization (see Vogel and Bange (1999) for a detailed description of the USDA crop forecast generation process). The major components of the supply and demand balance sheet are beginning stocks, imports and production on the supply side and domestic use, exports and ending stocks on the demand side. Domestic use is usually further subdivided based on commodity specific uses. The balance sheet approach means that individual estimates are cross checked against each other, across commodities and countries. For example, "total supply must equal domestic use plus exports and ending stocks. Prices tie both sides of the balance sheet together by rationing available supplies between competing uses." (Vogel and Bange, p. 10). WASDE price projections describe marketing year average prices received by farmers, which are based on commodity models reflecting the supply and demand conditions via stock-to-use ratios, lagged prices and other variables (Labys, 1973; Wescott and Hoffman, 1999, Isengildina and MacDonald, 2009). Price forecasts are different from all other WASDE categories as they are published in the form of an interval to reflect the uncertainty associated with the estimate. Because analysis of interval forecast accuracy is different from point estimate accuracy (e.g., Isengildina, Irwin, and Good, 2004), midpoints of price forecasts were used in this study to be consistent with the rest of the analysis.

The focus of this study is monthly WASDE Balance Sheets for the U.S., China, and World Upland Cotton for the marketing years of 1985/86 through 2008/09. The final estimates for cotton supply and demand (19^{th} forecast for each marketing year) were used to calculate the descriptive statistics found in Table 1. The descriptive statistics were calculated for each region for the following categories: beginning stocks, production, imports, domestic use, exports, ending stocks, and price. The statistics calculated for each of these categories were, mean, standard deviation, coefficient of variation, skewness, and kurtosis. According to Timmerman (2006), "Data availability and data quality may vary significantly across regions and there can be significant differences even within each region"; therefore, coefficients of variation were used to compare the variability associated with forecasting cotton across regions and across categories within a region. Coefficients of variation were chosen as the preferred measure of variability because the estimates are a unit-less value and represent the amount of variability as a percentage of the mean. Thus the estimated values are comparable across regions. For example, Table 1 shows that China has the largest values of coefficients of variation in all categories except ending stocks and price (price data for China was unavailable). In particular, coefficients of variation for imports and exports were 127.89 and 118.74, respectively. These large values imply that China's supply and demand categories are more volatile than any of the US and world forecast categories. This also indicates the added difficulty associated with forecasting China's cotton supply and demand estimates. As for the US, the coefficients of variation for exports and ending stocks were nearly twice as large as the coefficients of variation in other US categories (exports and ending stocks were approximately 43%, other US catergories were around 20%), indicating higher volatility and potential challenges in forecasting these categories. Similarly, the coefficient of variation for world ending stocks at 26.8% echoes the pattern observed in the US, revealing evidence that also suggests ending stocks are more difficult to predict than other supply and demand categories.

Skewness and kurtosis describe the shape of forecast distributions. Skewness is a comparative measure of the symmetry of sample observations, while kurtosis is a relative measure of the "peakedness" of the forecasts. The normal distribution provides the benchmark for comparison of skewness and kurtosis values. Therefore if the sample values are much higher or lower than the expected values for the normal distribution, this implies that the sample distribution may not be normal. Normal skewness values typically range between -.711 and .711 for a sample size of 25 while kurtosis values generally range between -1 and 1. For the World and China, several WASDE categories exhibit significant positive skewness and leptokurtic distributions. Specifically, production, imports, domestic use, and exports were all shown to have positive skewness and kurtosis values near or above 1. Kurtosis values above 1 implies the distribution tends to be leptokurtic, displaying a higher "peak" and longer "fatter tails" as compared to a normal distribution. Skewness values at or above 1 suggests positive skewness which implies there may be "upward spikes" and/or unpredictably large values within these categories (Ramirez and Fadiga, 2003). For the World and China, the departures from normality highlight the extreme difficulty in forecasting these series. In fact, the Chinese and World production estimates both observed a sizeable increase in 2004 as Chinese estimates went from 22 million bales to over 29 million bales and World production estimates went from 94 million bales to over 120 million bales, all within a single year. In addition to the "upward spikes" in production, Chinese imports realized the single largest jump in estimates from 2004 to 2005. Chinese imports tripled within a single year, where in 2004 imports were valued at 6 million bales and over 19 million bales in 2005. These examples illustrate that Chinese and World forecasts for production, imports, domestic use, and exports do not follow a normal distribution. Furthermore, the positive skewness and large kurtosis values tends to show how unpredictable these categories are and how much volatility within the WASDE Balance Sheets is the result of these characteristics.

Figures 2-5 display time series plots for the final estimates from WASDE Balance sheets over of 1985/86 to 2008/09 marketing years. In Figure 2, WASDE U.S. Cotton

Estimates over Time, there were two very obvious trends present in the data. In the years of 1999 to 2008, exports displayed an upward trend and domestic use displayed a downward trend. Because both domestic use and exports are demand categories within the WASDE balance sheet they are directly related to one another. Therefore, the increasing demand for cotton abroad signaled the US to increase the amount of cotton exported. As a result, ending stocks were found to be very volatile during this time period, as shown in Figure 2 and referenced in Table 1. Ending stocks saw a sharp rise in the year 2001 to a value of 7 million bales and then a sharp decline the next two years to a value of approximately 4 million bales. This volatility was mostly associated with ending stocks reflecting the difference between total supply and total consumption. Hence, the unexpected trends in the demand categories of domestic use and exports increased the overall variability associated with ending stocks.

The time series plot for US cotton price estimates is presented in Figure 3 which highlights the volatility that has been associated with the forecasts since the year 2000. Double digit gains and losses for price (measured in ¢/lb) was a frequent occurrence for the years of 2000-2008. Thus the volatility in price corresponds to trends associated with domestic use and exports. There also seems to be a corresponding relationship between ending stocks and price, as price estimates follow a completely reverse pattern of US ending stock estimates for the same time period. Both categories experienced large deviations that resulted in a very unstable and unpredictable cotton market.

In Figure 4, China estimates for production and domestic use showed explosive growth in the years following 2000. Both categories more than doubled in value the final eight years of the study as production increased from 18 million bales to approximately 38 million bales, and domestic use went from 20 million bales to over 50 million bales all within the 8 year time period of 2000 to 2008. This overwhelming increase in demand for cotton also caused China to rely more heavily on imports. During the same time, imports experienced significant growth (nearly doubling) as well. The volatility associated with import estimates during the years of 2004 to 2007 was also substantial. Large deviations in imports were the reason the coefficient of variation for imports in Table 1 was so high, at 127.89%. Exports, despite having a large coefficient of variation in Table 1, remained relatively stable for the observations described in Figure 4. The reason for the inconsistency is due to the relatively small mean as compared to the amount of deviation (coefficient of variation is the amount of variation as percentage of the mean). Because China tended to export very little unprocessed cotton, any deviations from that small value resulted in a very large coefficient of variation. The real story for WASDE cotton forecasts in the Chinese market is the incredible growth experienced since the year 2000. Of particular concern is how forecasting is affected by the increasing demand for cotton in China.

Figure 5 represents time series plots for WASDE World Cotton estimates. Corresponding to China's explosive growth, World cotton estimates also showed significant trends. In particular, domestic use and production showed considerable growth from 1998 to 2008. Interestingly, this parallels China's remarkable growth during the same time and for the same demand categories, thereby emphasizing China's impact on the World cotton market. According to MacDonald "China plays a dominant role in the world's cotton economy" as China is defined as the world's largest textile exporter, has the largest population, and is the world's second largest economy. There tends to be a direct relationship with China and World categories. As evidenced through the categories of domestic use and production, the forecasts follow very similar patterns. In particular, Chinese production estimates hit a peak in 2005 and declined in 2006 just as World production estimates hit a peak in 2005 and dropped in 2006. As another example, domestic use for China continued sharp growth until 2007, which was followed by a drop in 2008. Similarly, World domestic use exhibited steady growth until 2007 and fell in 2008. The emerging patterns highlight the effect that China's cotton economy has on the rest of the World, especially the volatility associated within China's balance sheet.

CHAPTER THREE

METHODS

Forecast Evaluation Framework:

To evaluate the quality of WASDE forecasts it is necessary to establish a set of testable properties that an optimal forecast should have. Following Timmerman (2006), this study assumes that the objective function is of the mean squared error (*MSE*) type so the forecasts minimize a symmetric, quadratic loss function. The properties of WASDE forecasts are investigated using error and revision analysis. For each category, monthly announcement and marketing year forecast errors and revisions were calculated as following:

1. $e^i_t = y^i_T - y^i_t$; $t=1,\ldots, T-1$; $i=1985/86,\ldots,2008/09$

   $r^i_t = y^i_t - y^i_{t-1}$; $t=2,\ldots, T$; $i=1985/86,\ldots,2008/09$

where e^i_t corresponds to the error, r^i_t is the revision for a given report month *t*, and marketing year *i*. As defined earlier, y^i_t is the forecast for marketing year *i* released in month *t* and y^i_T corresponds to the final estimate for marketing year *i*, *T*=19 for cotton.

The fundamental measures of optimal forecasts are bias and efficiency (Diebold and Lopez, 1998). The test of bias can be performed using a regression:

2. $e^i_t = \alpha_t + \varepsilon^i_t$ $i=1985/86,\ldots,2008/09$

The null hypothesis of an unbiased forecast is $\alpha = 0$. This hypothesis can be tested using a t-test. Following Bailey and Brorsen (1998), changes in forecast bias over time can be detected by including a trend variable:

3. $e^i_t = \alpha_t + \beta_t I + \varepsilon^i_t$ *i=1985/86,…,2008/09,* *I=1, …, 24.*

Where the marketing year, *i*, relates to the year variable, *I*, such that the year variable represents the study period year (*i – 1984*), therefore *i=1985/86* corresponds to *I*=1, and *i=1986/87* corresponds to *I*=2, and so on. The null hypothesis for an unbiased forecast over time is that both $\alpha = 0$ and $\beta = 0$.

Weak efficiency tests evaluate whether forecast errors are orthogonal to forecasts themselves as well as to prior forecast errors (Nordhaus). Thus, weak efficiency is tested using the following regressions (Pons, 2000):

4. $e^i_t = \alpha_t + \beta_t y^i_t + \varepsilon^i_t$ *i=1985/86,…,2008/09*,

and

5. $e^i_t = \alpha_t + \beta_t e_t^{i-1} + \varepsilon^i_t$ *i=1985/86,…,2008/09.*

The null hypotheses for efficient forecasts is for $\beta = 0$ in equations (4) and (5). These hypotheses can be tested using a t-test as well.

Furthermore, weak form efficiency of fixed-event forecasts implies independence of forecast revisions (Nordhaus). According to Nordhaus, if forecasts are weak form efficient, revisions should follow a random walk. This property can be tested using the following regressions for each time period *t* (Isengildina, Irwin, and Good, 2006):

6. $r^i_t = \gamma\, r^i_{t-1} + \varepsilon^i_t$ *i=1985/86,…,2008/09,*

The null hypothesis for efficiency in forecast revisions is $\gamma = 0$. For (t=3), γ represents the slope coefficient of all October revisions made from 1985/86 to 2008/09 regressed against previous September revisions (*t-1=2*) for the same respective years.

Forecast Evaluation Results:

The quality of WASDE cotton forecasts for the US, China, and the World was examined over 1985/86 through 2008/09 marketing years. Each month out of the 19 month forecasting cycle was evaluated based on the forecast evaluation framework described in the previous section. Tables 2-4 show the results of the dynamic test of bias displayed in equation 3. The results show that intercept terms were found to be significant throughout U.S. domestic use forecasts. The intercept coefficients represent the initial bias estimated for the first year of the study period (marketing year of 1984/85). U.S. domestic use forecasts were found to exhibit the initial bias in months 1-15 of the forecasting cycle. The values of the initial bias were positive which implied U.S. domestic use was underestimated. Specifically, during the first three months of the forecasting cycle, the initial bias in domestic use forecasts was estimated at approximately 1 million bales below the final estimate. Later in that marketing year the bias decreased to an underestimation of about 200 thousand bales for months 13-15 of the forecasting cycle. The dynamic component of bias was measured by a trend variable. The bias in months 1-14 of U.S. domestic use forecasts changed significantly over time ($p < 0.05$). The coefficients of trend in each month were negative. Since the coefficients of the intercept and the trend term were of opposing signs, this suggested that forecast accuracy improved for the marketing years following 1985/86. The magnitude of this improvement ranged from 70-80 thousand bales per year for the early months in the forecasts cycle to about 10-20 thousand bales per year towards the end of the forecasting cycle.

To further study the dynamic component of bias within WASDE forecasts, regression plots were analyzed on a month-to-month basis to determine how the bias changed across the forecasting cycle and over time. Regression Plots of the Test of Bias for US Domestic Use presented in Appendix B demonstrate that while the initial bias in the first month of the forecasting cycle was 1 million bales, according to Table 2, the actual amount underestimated in 1985/86 was 1.5 million bales as shown in Appendix B. Another interesting finding observed in these plots is the fact that toward the end of the study period the trend dominates the initial bias. Thus, in the five most recent marketing years, U.S. domestic use was overestimated as demonstrated by the errors months 1-6. The findings suggest that the biases in these forecasts were changing over time and any adjustments must take into account the dynamic component.

Table 3, compiled from China forecast errors, shows that beginning stocks, production, exports, and ending stocks all exhibit significant initial bias ($p < 0.05$). In particular, forecasts for beginning stocks, production, and ending stocks display a negative initial bias (overestimation) whereas forecasts for exports display a positive initial bias (underestimation). The bias found in the forecasts for ending stocks is the strongest and most prevalent of all the categories, as 9 out of the 18 months forecasted show a significant negative initial bias ($p < 0.05$). In terms of magnitude, months 3-6 of the forecasting cycle show that ending stocks were overestimated by more than 3 million bales. Ending stock forecasts for months 14-16, the initial bias had reduced to an overestimation of approximately 1 million bales. Table 3 also provides evidence that trend terms in each of the categories were significant. Trends in forecasts for imports and domestic use were found at a significance level of 0.1. Beginning stocks, production, exports, and ending stocks displayed trends at a significance level of less than 0.01. Ending stock forecasts were found to exhibit the strongest and most prevalent trends as 15 of the 16 months forecasted were significant with p-values less than 0.05. In Table 3, ending stock's coefficients for trend ranged from 350 thousand bales per year for the 3rd month of the forecasting cycle down to 80 thousand bales per year for the 17th month. The values represent the rate at which bias decreased each year, as an increasing trend in the forecasting cycle implies improvements in the forecasts when the signs of the intercept coefficients are negative.

To further explore the biases associated with Chinese cotton forecasts, Regression Plots of the Test of Bias for China Ending Stocks (Appendix C) were analyzed. The plots illustrate graphically the trends associated with ending stock errors and how these trends change from month-to-month and over time. For instance, in the early months of the forecasting cycle ending stock errors display a large positive trend. For every additional month in the forecasting cycle, the magnitude of the trend diminished, until in the 18th month of the forecasting cycle when the trend was no longer present. This pattern is also evident in Table 2, which shows changes in magnitude of the bias during the forecasting cycle and the fact that the bias is not significantly different from zero in month 18. Regression plots are also useful in determining whether the bias changes signs throughout the course of the forecasting cycle or throughout the years of the study. As each coefficient of the intercept was shown to be negative, the initial forecasts tend to overestimate the true value of ending stock. An increasing trend for every month in the forecasting cycle implies that throughout the years since the 1984/85 marketing year there have been improvements in the forecasts, as the signs of the intercept and trend are opposite. However, the values also indicate that over time bias decreases and can quite possibly change signs. For instance, ending stock's 3rd forecast has an initial bias of -3.42. The negative bias means that in the early years 1985/86 through 1993/94, the USDA forecasts overestimated ending stocks. The coefficient of trend for ending stocks is 0.35 and positive, thus later forecasts 1994/95 through 2008/09 the trend overcomes the initial bias and therefore changes the sign from negative to positive in these years. Therefore the latest forecasts for ending stocks the USDA underestimated, which provides further evidence that bias is dynamic and changes over time. As a result, any adjustments must consider both components, coefficients of bias and coefficients of trend.

WASDE World Cotton bias and trends for forecast errors are displayed in Table 4. The World cotton market contains three categories that exhibit a significant initial bias. Domestic use and ending stocks show an initial bias at a significance level of 0.1, while imports were found to have an initial bias at a significance level of 0.05. The table clearly shows that the initial biases found in the imports category are the most prevalent of all the categories in WASDE World cotton forecasts. For the first 12 months of the forecasting cycle for World cotton imports, the forecasts were found to be significantly underestimating cotton imports ($p < 0.05$). In fact, the initial bias for the first two months of the forecasting cycle was an underestimation of more than 2.5 million bales, though by the 12th month the initial bias had reduced to an underestimation of around 720 thousand bales. The errors in World cotton forecasts also showed significant trends in bias. Beginning stocks, production, imports, and ending stocks all proved to have observable trends, as a trend variable explained a significant amount of variation within these categories. Predominantly, beginning stocks, imports, and ending stocks displayed the most significant trends, as each category exhibited 12 or more months where the errors were significantly correlated with the trend ($p < 0.05$). Trends for errors in production only occurred sporadically (5 months out of the 18 forecasted). Import trends were of particular concern to the study due to the extensive bias found. Months 1-7 of the forecasting cycle for imports showed that the trends ranged from -210 thousand bales per year to -150 thousand bales per year. For the months 11 and 12 of the forecasting cycle the trend had been reduced to around -60 thousand bales per year.

In order to review specific months of World import forecasts, Regression Plots of the Test of Bias for World Imports are shown in Appendix D. From these plots, it is evident that the significant trend may be influenced considerably by the last three years of data. The final three forecasts fall outside of the expected 95% confidence limits and are located in what is considered influential locations. Therefore, what seemed to be a trend in World import errors may actually be a group of extreme observations that give the impression of a trend. For example, if the last three extreme observations were removed, the plots would look much different and the errors would indicate a positive rather than a negative trend. A Chow Test shows a significant break in the forecasts starting with the 2006/07 marketing year as seen in Appendix E. The Chow Test verifies that for months 1-10 in the forecasting cycle there exists a significant difference in intercept and trend when the year is 2006 or later. This implies that the last three observations are not consistent in trend with the prior observations. This difference in relationship should be taken into account in any possible adjustments for bias in these forecasts.

Table 5 shows the results of the test of orthogonality (equation 4) for US cotton forecasts. This test evaluates whether forecast errors are correlated with forecast levels, as explained in the Methods section. The null hypothesis of an efficient forecast is Ho:$\beta=0$, which indicates no correlation between forecast errors and forecast levels. When $\beta > 0$, large forecast values are associated with large positive errors (underestimation). However, when $\beta < 0$, large forecast values are associated with large negative errors (overestimation). Results shown in Table 5 indicate that orthogonality in US cotton forecasts was violated in only a few cases: significant positive correlation between forecast values and forecast errors was found in months 10-11 for production forecasts and in months 14-17 for export forecasts; significant negative correlation between forecast values and forecast errors was found in months 13 through 15 for ending stock forecasts. For production forecasts, the value of the β coefficient was 0.02, thus for each additional 1 million bales forecasted there was, on average, an increase of 20 thousand bales in error. On the other hand, ending stock's β coefficient value of -0.10, indicates that for each additional 1 million bales forecasted there was, on average, a decrease in the value of error by 100 thousand bales. It is important to keep in mind that when error is already less than zero ($y^i_T - y^i_t < 0$), the decrease in error represents an increase in the overestimation of ending stocks. In all three categories, the inefficiencies were found late in the forecasting cycle, generally when forecast errors were fairly small.

Table 6 displays the results of the test of orthogonality for WASDE forecasts for China. Forecast errors for production, imports, domestic use, exports, and ending stocks were all found to exhibit significant correlation with forecast levels ($p < 0.05$). The categories of production and exports had β coefficients greater than zero whereas imports, domestic use, and ending stocks had β coefficients less than zero. Specifically, production forecast values exhibited significant positive correlation with forecast errors for months 12-17, while export forecast values exhibited significant positive correlation with forecast errors during months 9-16. Significant negative correlation with forecast errors was found during months 2-9 for forecasted values of imports and domestic use, while ending stock forecast values exhibited significant negative correlation in months 3-8. Import forecasts were of upmost concern in Chinese cotton forecasts, as Table 6 showed that β coefficients for the imports category had the largest values and the most months significant of all the Chinese forecast categories. For instance, imports during months 3-10 had β coefficient values that range from -0.32 to -0.10, the values represent that for an additional 1 million bales forecasted in the imports category, the average decrease in error was approximately 320 thousand bales to 100 thousand bales. β coefficients for production were relatively smaller than imports and ranged from 0.10 to 0.06 indicating an increase in production forecast errors of 100 to 60 thousand bales in months 12-17, when an additional 1 million bales were forecasted. The values for the β coefficients in exports ranged from 0.28 to 0.10 while domestic use β coefficients ranged from -0.10 to -0.05. Ending stocks displayed β coefficients with larger values (-0.36 to -0.22), however, the level of significance was less than the other categories ($p < 0.1$). As a result, WASDE Chinese cotton forecasts are not efficient when the tests of orthogonality yield significant β coefficients that display correlation with forecast levels.

The test of orthogonality in Table 7 displays several significant β coefficients with respect to WASDE World cotton forecast categories ($p < 0.05$). Imports, domestic use, and exports exhibited negative β coefficients, whereas beginning stock, production, and ending stocks exhibited positive β coefficients. Most notably, β coefficients for World imports were the strongest in magnitude and the most prevalent. As Table 7 shows β coefficients for imports in months 1-4 indicate there was a 310-270 thousand bale decrease in errors when an additional 1 million bales were forecasted. For month 14 of imports the β coefficient had been reduced to 60 thousand bales per 1 million forecasted. In domestic use forecasts, β coefficients ranged from -0.15 to -0.07 in months 1-9 and exports showed β coefficients in months 1-4 ranged from -0.24 to -0.19. For the production category the β coefficient values ranged from 0.18 to 0.02, for months 4-17 throughout the forecasting cycle, whereas beginning stock showed significant β coefficients only for months 4 and 5 at values of 0.10 and 0.11, respectively. Thus β coefficients change throughout the forecasting cycle and imply that the forecasts for World imports are not optimal. Therefore the objective of our learning framework will be to make adjustments such that import forecasts will be improved.

Another condition for forecast efficiency is that forecast errors must be independent of prior errors as specified in equation (5). US, China, and World forecast errors were evaluated in Tables 8-10. Table 8 shows the results from the test of independence of lagged errors for US cotton forecasts. Domestic use forecast errors exhibited significant positive correlation with lagged errors for months 1-6 of the forecasting cycle ($p < 0.05$) whereas, exports displayed significant positive correlation in months 16-17 of the forecasting cycle ($p < 0.1$). Domestic use represented the primary concern for US cotton forecast categories as the first six months in the forecasting cycle were found to have the largest values of β coefficients that were significantly different than zero at $p < 0.05$. In particular, the 4th month of the forecasting cycle for US domestic use was shown to have the largest β coefficient at 0.55. As positive correlation describes the consistency in errors, the value for the β coefficient implies that if this year's forecast error is increased 1 million bales, then the value for next year's error is expected to increase 550 thousand bales. Consequently, the error terms for domestic use forecasts are not independent of one another, as the first six months show that the current year's error is correlated with the previous year's error. Hence specific adjustments were investigated to improve the forecasting performance of domestic use based upon these criteria.

WASDE cotton forecasts for China were explored in Table 9 to examine whether the categories within the Chinese forecasts exhibited any significant correlation with lagged errors. The four categories of production, domestic use, exports, and ending stocks had significant correlation with lagged errors at $p < 0.05$. Therefore for these categories, the forecasted errors are not independent from year to year. Particularly, the domestic use category in 10 of the 18 forecasted months exhibit significant correlation with lagged error. The largest coefficient in magnitude is the 3rd forecasting month of July with a value 0.86. This value indicates that if the current year forecast error is increased 1 million bales the expected value for next year's forecast error will increase 860 thousand bales. Results in later months (12-16) show that the coefficient changes from positive to negative. This means in months 12-16, an increase in forecast error results in a decrease in error for the subsequent year. Specifically, for a 1 million bale increase in error, the next year's forecast error is expected to decrease 520 thousand to 570 thousand bales. Conversely, if error decreases then the following year's error is expected to increase. Considering these coefficients, the early months of the forecasting cycle show there was a positive correlation between lagged errors and current errors, however for later months of the forecasting cycle, the correlation was negative. Thus the trends are dynamic throughout the forecasting cycle. Therefore, in order for the USDA to improve forecasting efficiency, adjustments for equation (5) must describe the relationship between previous year's errors and the current year's errors.

Results from Table 10 show that lagged errors in domestic use forecasts are the primary concern in the evaluation of World cotton forecasts. Domestic use forecasts exhibited similar patterns as what was found in the evaluation of U.S. and Chinese markets. Domestic use errors were shown to be higher correlated with lagged errors than other forecast categories. Specifically, domestic use errors showed significant negative correlation with lagged errors in months 12 through 15 ($p < 0.05$). In particular, month 15 displayed the largest β coefficient which showed that errors were expected to decrease 560 thousand bales in the next year when the current year error increased an additional 1 million bales, while month 12 displayed the smallest β coefficient which described that domestic use error was expected to decrease 470 thousand bales for the next year when the error increased an additional 1 million bales this year. Beginning stock and export forecast errors were also found to exhibit significant correlation with lagged errors ($p < 0.1$) as evidenced in Table 10, although, only two months were significant for each category. Beginning stocks displayed significant β coefficients for months 2 and 5 with values of 0.36 to 0.38, respectively, whereas exports exhibited significant correlation with lagged error in months 15 and 18 with β coefficients of 0.36 and -0.45. Thus lagged errors were shown to contribute to variation in forecasts and forecast errors. Thus, in order to improve forecasts, adjustments are needed to correct for the correlated errors within the forecasting cycle.

Equation (6) in the forecast evaluation framework evaluates whether forecast revisions are independent within a forecasting cycle. According to the results of the tests of independence for US revisions shown in Table 11, production, domestic use, exports, ending stocks, and price all exhibited significant correlation in forecast revisions ($p < 0.1$). Thus revisions are not independent of one another. In particular, domestic use forecast revisions displayed the most prevalent and largest β coefficients of all the categories in the evaluation. Specifically, β coefficients for revisions showed significant positive correlation in 8 months out of the 17 months recorded which designated that there was a positive relationship between the revisions in the forecasting cycle. For instance, domestic use revisions for the 10^{th} month of the forecasting cycle exhibited the largest β coefficient value at 1.51, which indicated that the revisions from month 9 to month 10 were 1.51 times larger than the revisions from month 8 to month 9, on average. In other months that were found to be significant for domestic use revisions the β coefficient values were considerably less than in month 10, such that the coefficient values ranged from 0.26 in month 9 to 0.85 in month 3. In other categories from US cotton forecasts the correlations were not as prevalent or as strong as with domestic use, though the β coefficients were significant. For production, the β coefficients ranged from 0.57 in month 6 reducing down to less than 0.01 in month 14. The β coefficients in US exports ranged from 0.99 in month 6 down to 0.23 in month 17, while ending stocks displayed β coefficients that ranged from 0.68 in month 10 down to 0.33 in month 4. Price, on the other hand, displayed the smallest amount of correlation with forecast revisions as only month 8 and month 16 were significant with β coefficient values of 0.34 and -0.14, respectively. Therefore, as found within Table 11, relationships between revisions may have significant effects on forecast errors and the forecasts themselves, hence, the relevance of the proposed learning framework.

Table 12 displays the results for the test of independence of revisions in WASDE Chinese forecasts. The categories of production, imports, domestic use, exports and ending stocks were all shown to exhibit significant correlation with forecast revisions. Imports exhibited not only the strongest relationships between revisions but also displayed the most months out of the forecasting cycle that were significant. Specifically, 8 months were shown to exhibit p-values of less than 0.05, with month 5 displaying the largest β coefficient value at 1.61. Therefore, the revisions from month 4 to month 5 are expected to be 1.61 times larger than the revisions from month 3 to month 4. As for the production category, four months were found to have significant β coefficients that ranged in value from 0.76 in month 5 to less than 0.01 in month 16. In domestic use and exports, each category displayed 6 months in which β coefficients were significant, where the coefficients ranged in values from 0.95 in month 10 to -1.34 in month 17 for domestic use, and exports displayed values that ranged from 1.16 in month 16 to 0.43 in month 11. Ending stocks displayed the smallest number of significant β coefficients as only month 9 and month 14 were significant with values of 0.62 and -0.41, respectively. Thus, months in which significant β coefficients were displayed indicates that the forecasts are not independent of one another. Therefore, proposed corrections based upon the β coefficient values are identified and evaluated for China imports within the learning framework.

Table 13, the test of independence of forecast revisions for World forecasts, showed that every category displayed significant correlation with revisions throughout the forecasting series. However, the domestic use category, yet again, exhibited the highest number of months with significant correlation in forecast revisions and the strongest β coefficients. Thus, the results from Table 13 provide even more evidence to investigate the adjustment of domestic use forecasts. For the World cotton market, domestic use forecasts displayed 8 months in which significant correlation was present in forecast revisions ($p < 0.05$). In particular, domestic use's largest β coefficient was found in month 10 at a value of 1.34, which indicated that the revisions between month 9 and month 10 were 1.34 times larger than the revisions between month 8 and month 9. Furthermore, for the other 7 months in which revisions were found to be significantly correlated the β coefficients ranged from 1.17 in month 6 reducing down to 0.31 in month 11. Thus, forecasts and forecast revisions are not independent of one another throughout the domestic use forecasting cycle. As for the other World forecasting categories, the β coefficient**s** were less significant and had much smaller values than the values displayed for domestic use. For instance, beginning stocks exhibited only one month in which revisions were significant (month 17), and the β coefficient's value was -0.27. Production and imports, on the other hand, displayed 5 months and 6 months that were respectively significant. Production had β coefficients that ranged from 0.48 in month 9 down to -0.07 in month 19, whereas β coefficients for imports ranged from 0.92 in month 6 down to 0.22 in month 12. Export and ending stock forecasts also displayed significant correlation between revisions, as export forecasts showed 7 months that were significant and ending stock forecasts showed 4 months that were significant. Export β coefficients ranged from 0.76 in month 10 down to -0.18 in month 14, while ending stock β coefficients ranged from 0.53 in month 9 and reducing down to -0.81 in month 18. Thus, in order improve forecasts evaluated in Table 13, the study proposed a correction/adjustment procedure based on the results of evaluation.

CHAPTER FOUR

LEARNING FRAMEWORK

Adjustment Procedure:

The purpose of adjusting forecasts is to reduce bias and systematic error within USDA WASDE cotton forecasts. The end goal being a forecast that is optimal based upon the properties/criteria defined in the evaluation framework. Adjustments were made based on the results of the forecast evaluation only in months where significant deviations from efficiency were found. The adjustments were performed in the following manner: the study period (1985-2008) was split into two subsets, an evaluation subset (starting with 1985-1998) and validation subset (1999-2008). The evaluation subset was then used to estimate parameters for the test of bias, test of orthogonality, test of weak form efficiency, and the test of revisions. The validation subset was used to adjust published forecasts and evaluate whether these adjustments improved the forecasts. Thus, for the first observation in the validation subset, the marketing year of 1999/00, the estimation subset consisted of 1985-1998 marketing years. The second observation in the validation subset was adjusted based on parameters calculated with 15 observations (1985/86-2000/01) in the evaluation subset. The process was repeated until the evaluation subset consisted of 24 observations to generate parameters used to evaluate the last year of the validation subset (2008/09) forecasts. Thus the validation subset consisted of 10 observations (1999/00-2008/09). The adjusted forecasts ($_{\text{adj}}\, y_t^{i+1}$) were calculated as follows:

For forecasts that demonstrated significant bias using the test described in equation 3 (results shown in Tables 2-4), adjustments were developed using α and β coefficients estimated by applying equation 3 in the evaluation subset.

7. Adjustment of Bias: $_{adj}\, y_t^{i+1} = y_t^{i+1} + \alpha_t + \beta_t\, I$ *i=1985/86,…,2008/09*

I=1, …, 24

Note: $\alpha \neq 0$ and $\beta \neq 0$

Thus, bias and systematic error is removed from the forecasts, while taking into account the changes in bias and trends throughout the study period.

For forecasts that demonstrated significant correlation with forecast levels using the test described in equation 4 (results shown in Tables 5-7), adjustments were decided by evaluating the β coefficients from equation 4 estimated in the evaluation subset.

8. Adjustment of Forecast levels: $_{adj}\, y_t^{i+1} = y_t^{i+1} + \alpha_t + \beta_t\, y_t^{i+1}$ *i=1985/86,…,2008/09*

Note: $\beta \neq 0$

For forecasts that demonstrated significant correlation with lagged errors using the test described in equation 5 (results shown in Tables 8-10), adjustments were decided by evaluating the β coefficients from equation 5 estimated in the evaluation subset.

9. Adjustment of Lagged Errors*:* $_{adj}\, y_t^{i+1} = y_t^{i+1} + \alpha_t + \beta_t\, e_t^{i}$ *i=1985/86,…,2008/09*

Note: $\beta \neq 0$

The adjustment procedures for the weak efficiency tests were modeled using the regression coefficients from the evaluation and integrating the intercept terms and β coefficients into the original forecasts.

For forecasts that demonstrated significant correlation between revisions using the test described in equation 6 (results shown in Tables 11-13), adjustments were calculated by evaluating the β coefficients from equation 6 estimated in the evaluation subset.

10. Adjustment of Revisions: $_{adj}\, y_{t+1}^{i+1} = y_{t+1}^{i+1} + \gamma_{t+1}\, r_i^t$ *i=1985/86,…,2008/09*

t=2,…,19

Note: $\gamma \neq 0$

Validation Measures:

Two measures that were used to compare and evaluate forecast improvements were mean absolute error (*MAE*) and root mean squared error (*RMSE*), as defined below:

11. $MAE_t = \frac{1}{n}\sum_{i=15}^{24} \left|e_t^i\right|$

and

12. $RMSE_t = \sqrt{\frac{1}{n}\sum_{i=15}^{24} \left(e_t^i\right)^2}$

MAE estimates the average of the absolute errors between the final forecast and the observed monthly forecasts, whereas *RMSE* estimates the square root of the average squared difference between the final forecast and the observed monthly forecasts. Hence, when both statistics are zero the monthly forecasts are perfect and estimate the final forecast values exactly. However, when error is found in the forecasting series, *MSE* and *RMSE* increase the larger the magnitude of the error. Both measures were calculated because both are effective at comparing models. Specifically, *MAE* describes the average magnitude of the forecast errors, whereas *RMSE* measures how far, on average, the monthly forecasts were from the final value and is more sensitive to forecasts that have large errors than *MAE*.

Validation of Adjustments:

Tables 15-26 show results from the comparison of original forecast errors and adjusted forecast errors for the most significant categories from the forecast evaluations. Each table shows the original errors, errors associated with adjusted forecasts, and the difference between the two as an indication of the improvement due to the adjustments. Table 15 shows that US domestic use forecasts adjusted for bias improve forecast efficiency overall using *MAE* as a measure of error. However, using *RMSE* as a measure of error determined that adjusted domestic use forecasts were less accurate than the original. Thus adjusted forecasts for domestic use displayed forecast errors that were on average closer to zero than the original forecasts yet exhibited forecast errors that were also more extreme than the original forecast errors. Therefore, the averages of the squared errors were larger, which indicates that adjustments at times over-corrected for bias causing more extreme errors. This suggests that adjustments to US domestic use forecasts may not be appropriate given there is no agreement between the two measures of error. For instance, the only two months out of the forecasting cycle that were shown to have improved *MAE* and *RMSE* values were the 5th and 6th months of the forecasting cycle, September and October. Though, the improvements were relatively small at 40 thousand bales for both months using *MAE* as a measure of error and 20 to 30 thousand bales using *RMSE* as a measure of error. Consequently, it is questionable whether forecast adjustments would improve US domestic use forecast efficiency.

Evaluation for the adjustment of bias in Chinese ending stocks is displayed in Table 16. The improvement in forecast errors is obvious as adjusted forecasts were shown to improve both *MAE* and *RMSE* overall. Evidence shows that in 12 months out of the 15 months adjusted, improvements were made in *MAE* and *RMSE*. For *MAE* the largest improvements were early in the forecasting cycle at 750 thousand bales and 980 thousand bales, on average, for months 3 and 4 of the forecasting cycle. Improvements were also evident in month 5 and months 8-16 ranging from 710 thousand bales to 160 thousand bales, on average. The *RMSE* column displays similar positive results from the evaluation of the adjustment of bias suggesting that not only the mean, but also variability of forecasts were improved due to adjustment. The largest improvements in *RMSE* occurred in months 4 and 5 of the forecasting cycle at 1.18 and 1.03 million bales, while the improvements in months 3 and months 8-17 ranged from 170 to 840 thousand bales. This leads us to believe that China ending stocks could benefit substantially from adjustments based upon the Dynamic Test of Bias.

For the world, the Dynamic Test of Bias evaluation model was ineffective at producing adjustments that actually benefit import forecasts. Table 17 shows that *MAE* and *RMSE* were smaller, overall, before the adjustments were made. In particular, there was only two months in which both *MAE* and *RMSE* actually improved from the forecast adjustments (month 7 & 16). The improvement, measured as *MAE*, was 200 thousand bales in month 7 and 10 thousand bales in month 16. Likewise, the improvement, measured as *RMSE*, was 30 thousand bales in month 7 and 10 thousand bales in month 16. Additional improvements were realized in in terms of *MAE* during months 6, 8, 9 which ranged from 230 thousands bales in month 8 to 80 thousand bales in month 9. However, the overall difference in original forecast error and adjusted forecast error was negative for both measures of error, *MAE* and *RMSE,* which indicated that the adjusted forecasts were not improvements to the original forecasts but actually a loss in quality.

The evaluation for the adjustment of forecast levels, Tables 18-20, proved that forecast adjustments based on the test of orthogonality were ineffective in producing more efficient forecasts for the regions of US, China, and the World. Specifically, Table 18 does not display any improvements at all in US production forecasts. Neither measure of error, *MAE* or *RMSE,* was improved by allowing adjustments to the original production forecasts, as there was not a single month in which adjusted forecasts provided any benefits to the US production forecasting cycle. Interestingly, there was not a single month that displayed a significant decrease or increase in forecast error for production, as every month in which forecasts were adjusted displayed zero as the difference between the original and adjusted forecast errors, for both *MAE* and *RMSE*. This implies that the relationship detected between forecast levels and forecast errors in US production was not strong enough in magnitude to yield significantly different forecast errors/forecasts when the forecast adjustments were applied.

Table 19 displays the results from the evaluation for the adjustment of forecast levels in Chinese import forecasts. As mentioned previously, the test of orthogonality was ineffective at producing adjusted forecasts that were more efficient than the original forecasts. Thus, there was no overall improvement in *MAE* or *RMSE* in Chinese import forecasts. In fact, the import forecast errors were greater, on average, for every month in which adjustments were included. The difference in errors for *MAE* seemed to be the largest around month 5 at 340 thousand bales and was the smallest during month 3 at 80 thousand bales. The increased errors in *RMSE* were the largest in magnitude for the early months of the forecasting cycle (months 3-5) where values reached 1.25 million bales, and reduced down to 240 thousand bales for month 13. Therefore, the adjustments for forecast levels did not provide any value to Chinese import forecasting.

In Table 20, adjustments of forecast levels for World import forecasts were found to increase forecast errors in terms of *MAE* and *RMSE*. In fact, only 4 months out of the 14 months adjusted were errors smaller as measured by *MAE*, such that month 1 saw a decrease in error of 10 thousand bales and months 6-9 saw a decrease in errors of 30 to 60 thousand bales. Particularly, there were no months found in which both measures, *MAE* and *RMSE* improved due to the adjustments of forecast levels. For *RMSE*, every month that was adjusted, the forecast errors increased, on average, ranging from 20 thousand bales in month 1 up to 440 thousand bales in month 12. Thus, overall, the forecast errors were not any smaller than what was found for the original forecasts.

Tables 21-23 represent the evaluation of the adjustments for the weak efficiency criteria described in equation (5). For US domestic use forecasts, the evaluation for the adjustments of lagged errors are shown in Table 21. The results describe that when domestic use forecasts were adjusted for lagged errors, overall improvement was found in terms of *MAE*, but not *RMSE*. This implies that absolute error for the US domestic use forecasts decreased on average when the forecasts were adjusted but squared forecast error, on average, was found to remain about the same or larger than the original forecasts. Thus, there is indication that there may be additional error associated with extreme values when evaluating error using *RMSE*. In particular, improvement in terms of *MAE* was shown in months 2-6, ranging from 10 thousand bales in month 2 up to 70 thousand bales in month 3. As for improvement in *RMSE*, only months 4 and 5 showed positive values for the difference in error of original forecasts and adjusted forecasts, the values for the improvement in terms of *RMSE* were 30 thousand bales and 20 thousand bales, respectively. Therefore, the errors in US domestic use forecasts were improved in some cases by using adjustments for lagged errors, although the improvement overall was small relative to the error from the original forecasts. Specifically, *MAE* saw the most improvement overall (150 thousand bales) while *RMSE* displayed no difference in original forecast errors and adjusted forecast errors.

Adjustments made to Chinese domestic use forecasts were evaluated in Table 22. The forecasts showed overall improvement in both *MAE* and *RMSE*. Specifically, 6 months out of the 11 months adjusted showed improvement in terms of both *MAE* and *RMSE* (months 3-7, 15). The most improvement for *MAE* was found early in the forecasting cycle during months 3-6 and ranged in values from 510 to 560 thousand bales, while later in the forecasting cycle (month 15) improvement was reduced down to 40 thousand bales. Similarly for *RMSE*, the greatest improvement was found in months 3-6, ranging in values from 510 thousand bales in month 3 down to 260 thousand bales in month 6. Adjustments for months 7, 15, 16 also showed improvements in *RMSE*, although the improvements were all less than 160 thousand bales. Thereby, including adjustments for lagged errors increased the overall forecasting performance for WASDE Chinese domestic use forecasts in terms of *MAE* and *RMSE*.

Table 23 displays the results from the evaluation for the adjustment of lagged errors in World domestic use forecasts. By using *MAE* as a measure of error, overall improvement in forecast errors was shown, which implies that forecast errors were on average closer to zero. However, *RMSE* showed that there tended to be increased variation with extreme values as indicated by the negative difference from original forecast error and adjusted forecast error in *RMSE*. Specifically, improvements in forecast errors were noted in both *MAE* and *RMSE* for months 11, 12, 15. *MAE* returned the greatest improvement at 330 thousand bales in month 12, while *RMSE* displayed an improvement of 100 thousand bales in month 15. Improvements in *MAE* were also noted in months 10 and 13 which displayed values of 60 thousand bales and 90 thousand bales, respectively. In terms of *RMSE*, no other improvements were evident outside the months of 11, 12, 15. Consequently, there was an overall increase in error. Thus, the evaluation of adjustments for lagged errors in World domestic use forecasts is determined by which measure of error that USDA decides most indicative of a efficient forecast, *MAE* or *RMSE*.

Revision adjustments were evaluated in Tables 24-26. Overall improvement was shown for each region. In Table 24, the adjustments of revisions for US domestic use forecasts were evaluated. The results show that *MAE* and *RMSE* both improved overall when the adjustments were integrated into the forecasts. Particularly, *MAE* and *RMSE* both showed decreases in forecast error for 7 months out of the 11 adjusted. Improvements in *MAE* ranged from 40 thousand bales in month 3 down to less than 10 thousand bales for month 13. Improvements in *RMSE* ranged from 30 thousand bales in month 3 down to less than 10 thousand bales in month 10. Interestingly, both *MAE* and *RMSE* saw the most improvement early on, as adjustments for revisions in the 3rd month of the forecasting cycle returned the greatest decrease in forecast error. Thus, there is reason to believe that revision adjustments might be beneficial for future forecasts as well. Although, most revision adjustments were found to be relatively small in comparison to the forecasted values, the adjustments did provide overall improvement, in terms of *MAE* and *RMSE*. As a result, US domestic use forecasts could benefit if the adjustment procedure were adopted.

Adjustments of revisions for Chinese import forecasts were evaluated in Table 25. The results show that overall improvement was found in terms of *MAE* and *RMSE*. *MAE* improved for 7 months out of the 8 months adjusted, while *RMSE* improved in every month adjusted. The improvement in *MAE* ranged from 10 thousand bales in month 9 up to 380 in month 7, whereas improvement in *RMSE* ranged from 10 thousand bales in month 10 up to 490 thousand bales in month 7. Thus, substantial improvements in forecast errors were evidenced when Chinese import forecasts were adjusted for revisions. Particularly, in terms of *RMSE*, which tends to amplify errors associated with extreme observations, the improvements were the greatest. Therefore, revision adjustments may significantly reduce forecast errors and improve the forecasting performance for Chinese imports.

Table 26 displays the results from the evaluation for the adjustment of revisions in World domestic use forecasts. In terms of both *MAE* and *RMSE*, overall improvement in forecast errors was shown, which implies that forecast errors were, on average, not only closer to zero, but squared errors were improved as well. Specifically, the results showed that of the 8 months adjusted, 6 months displayed considerable improvement in terms of *MAE* and *RMSE*. For *MAE*, months 4-6 and months 8-10 showed that forecast errors decreased on average from 30 thousand bales in month 4 up to 160 thousand bales in month 10. In terms of *RMSE*, the same six months were found to exhibit improvements, where month 8 displayed the largest improvement at 310 thousand bales and month 4 displayed the smallest improvement at 70 thousand bales. Thus forecast errors in terms of *MAE* and *RMSE* decreased during the same months and exhibited similar improvements. Therefore, the adjustments of revisions for World domestic use forecasts provided valuable improvements to the original forecasts.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

This study applied an evaluation framework to test the efficiency of USDA WASDE cotton forecasts. The framework provided useful insight into the errors associated with forecasting WASDE cotton categories. Adjustment procedures were designed to correct for the inefficiencies found within the WASDE forecasts. The corrections or "adjustments" were validated, by comparing the errors from adjusted forecasts to the errors from the original forecasts, thus providing evidence to confirm the benefits of adjustment.

The findings from the study show that some forecasts from the US, China, and the World, suffer from inefficiencies defined in the forecast evaluation framework. In particular, domestic use forecasts displayed the most problems among the US cotton forecast categories. Table 14 illustrates that domestic use displayed significant β coefficients for the test of bias, the test of weak efficiency, and the test of revisions. Thus, indicating that domestic use forecasts may benefit from forecast adjustments. US domestic use forecast adjustments were evaluated in Tables 15, 21, 24. The results describe that the adjustments of bias and the adjustments of lagged errors provided improvement to forecasts with a 2% reduction in *MAE* and a 4% reduction in *RMSE*. Though, *RMSE* was found to remain the same for the test of bias and the test of weak efficiency. The test of revisions showed the most positive results from the adjustment procedure as both *MAE* and *RMSE* improved. *MAE* displayed a 2% reduction as a result of the adjustment of revisions, while *RMSE* displayed a 1% reduction as a result of the adjustment of revisions.

Chinese ending stock forecasts displayed the most substantial improvement of all the adjusted forecasts. Particularly, in terms of the adjustment for bias, there was approximately a 20% reduction in *MAE* and a 20% reduction in *RMSE* due to the forecast adjustments. The adjustments made based upon the test of orthogonality showed the least improvement to cotton forecasts for China as neither *MAE* nor *RMSE* improved. However, for domestic use forecasts the adjustments for lagged errors showed considerable improvement in *MAE* and *RMSE* at 9% and 7%, respectively. Adjustment of revisions for Chinese import forecasts also indicated a substantial improvement in *MAE* and *RMSE*, as *MAE* was shown to be reduced by 6% due to the adjustments made in forecasts, while *RMSE* was reduced by 7% due to the adjustments made in forecasts. Thus, forecast adjustments were found to be very beneficial for WASDE Chinese cotton forecast categories.

World forecast evaluations followed similar patterns as found in US forecast adjustments. This implies that for the World forecasts, imports and domestic use were the primary categories that displayed deviations from efficiency. As for the evaluation of forecast adjustments, the World forecasts were extremely different than Chinese forecasts. In particular, the adjustment for bias and the adjustment for forecast levels provided no benefit to World import forecasts. However, for domestic use forecasts, the adjustment for lagged errors provided a considerable benefit to *MAE* with approximately a 3% reduction, although, *RMSE* was shown to increase as a result of additional error.

The adjustment of revisions provided the most consistent improvement in World forecast errors as domestic use forecasts were adjusted such that both *MAE* and *RMSE* were improved. *MAE* was reduced by 2% due to forecast adjustments in domestic use, while *RMSE* was reduced by 3% due to the forecast adjustments. Therefore, World forecast categories were shown to benefit from the adjustments of lagged errors and the adjustments of revisions.

Overall, the evaluation and the adjustment of forecasts provided a framework to study and improve forecasting techniques. The results from the study suggest that every region would benefit from an adjustment procedure. In particular, Chinese cotton forecasts would benefit most of all, as Chinese forecasts tended to express significant bias and trends that increased forecast errors. The framework developed in the study will provide the USDA a valuable opportunity to reduce and improve forecast accuracy and efficiency.

In conclusion, there are plenty more opportunities for future researchers in the evaluation of USDA WASDE cotton forecasts, such as: 1) Investigation of correlation of errors between forecast categories. 2) Research different functional forms of the equations in the evaluation framework. 3) Develop a new test statistic or formal hypothesis test, in order to test whether forecast errors are significantly less than original forecast errors. 4) Develop an adaptive adjustment procedure that adjusts forecasts dynamically according to evaluation subset.

Table 1. USDA WASDE Forecast Evaluation Summary for 1985-2008 Marketing Years:
Most Significant Categories found within the Forecasting Evaluation Framework (By Region)

	Category	Beginning Stocks (M.Bal)	Production (M.Bal)	Imports (M.Bal)	Domestic Use (M.Bal)	Exports (M.Bal)	Ending Stocks (M.Bal)	Price (¢/lb)
World	Mean	40.90	92.42	28.80	93.23	28.46	40.58	N/A
	Std Deviation	10.61	14.50	5.35	13.22	5.82	10.87	N/A
	Coeff Variation (percent)	25.95	15.69	18.58	14.18	20.45	26.80	N/A
	Skewness	0.77	0.92	1.31	1.20	1.39	0.70	N/A
	Kurtosis	0.02	0.03	1.81	0.53	1.97	-0.29	N/A
China	Mean	13.14	22.94	3.72	26.79	0.76	12.56	N/A
	Std Deviation	5.15	6.01	4.76	10.63	0.90	4.85	N/A
	Coeff Variation (percent)	39.20	26.22	127.89	39.69	118.74	38.65	N/A
	Skewness	-0.10	1.43	1.92	1.42	1.50	-0.11	N/A
	Kurtosis	-0.93	1.19	3.94	0.63	1.53	-0.92	N/A
US	Mean	N/A	17.12	N/A	8.22	8.92	5.22	55.82
	Std Deviation	N/A	3.41	N/A	2.27	3.84	2.20	10.71
	Coeff Variation (percent)	N/A	19.89	N/A	27.61	43.04	42.21	19.19
	Skewness	N/A	-0.01	N/A	-0.35	0.63	0.84	-0.29
	Kurtosis	N/A	0.07	N/A	-0.87	-0.09	-0.03	0.12

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 2. Dynamic Test of Bias for WASDE U.S. Cotton Forecasts, 1985-2008 Marketing Years

	Production		Exports		Domestic Use		Ending Stocks		Average Farm Price	
	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (¢/lb)
1 May$_{(i)}$	-0.14	0.03	-0.06	0.01	1.00***	-0.08***	-0.98	0.09	1.86	-0.33
2 June$_{(i)}$	-0.15	0.04	0.01	0.00	0.99***	-0.07***	-0.96	0.09	2.87	-0.42*
3 July$_{(i)}$	0.05	0.04	0.08	0.01	1.02***	-0.07***	-0.84	0.08	0.96	-0.30
4 August$_{(i)}$	-0.55	0.05	0.20	-0.01	0.88***	-0.07***	-1.46*	0.11*	1.20	-0.25
5 September$_{(i)}$	-0.18	0.03	0.15	0.00	0.80***	-0.06***	-0.99	0.09	2.30	-0.32
6 October$_{(i)}$	0.14	0.01	0.20	0.01	0.65***	-0.05***	-0.63	0.05	3.10	-0.28*
7 November$_{(i)}$	0.06	0.00	0.25	0.00	0.57***	-0.04***	-0.69	0.04	2.72	-0.20
8 December$_{(i)}$	0.01	0.00	0.14	0.00	0.53***	-0.04***	-0.61	0.03	1.65	-0.14
9 January$_{(i+1)}$	-0.06	0.01	0.02	0.01	0.52***	-0.04***	-0.55	0.03	0.37	-0.08
10 February$_{(i+1)}$	-0.06	0.01	-0.22	0.03	0.48***	-0.03***	-0.26	0.00	0.02	-0.07
11 March$_{(i+1)}$	-0.07	0.01	-0.25	0.03	0.39***	-0.02**	-0.16	0.00	0.07	-0.05
12 April$_{(i+1)}$	0.00	0.00	-0.14	0.02	0.35***	-0.02***	-0.17	0.00	-0.06	-0.04
13 May$_{(i+1)}$	0.00	0.00	-0.24	0.03*	0.24**	-0.01*	0.04	-0.01	-0.11	-0.02
14 June$_{(i+1)}$	0.00	0.00	-0.26	0.03**	0.21**	-0.01*	0.10	-0.02	-0.03	-0.02
15 July$_{(i+1)}$	0.00	0.00	-0.18	0.02*	0.20**	-0.01	0.06	-0.01	0.11	-0.02
16 August$_{(i+1)}$	0.00	0.00	-0.10	0.01	0.10	0.00	0.05	-0.01	0.08	-0.02
17 September$_{(i+1)}$	0.00	0.00	-0.10**	0.01**	0.07	-0.01	0.04	0.00	0.08	-0.02
18 October$_{(i+1)}$	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.02	0.00

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 3. Dynamic Test of Bias for WASDE China Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock		Production		Imports		Domestic Use		Exports		Ending Stocks	
	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)
1 May$_{(i)}$												
2 June$_{(i)}$												
3 July$_{(i)}$	-1.81*	0.22***	-2.34*	0.21**	1.64	-0.14	1.04	-0.06	0.13	-0.02	-3.42**	0.35***
4 August$_{(i)}$	-2.01**	0.23***	-2.12*	0.20**	1.63	-0.13	1.09	-0.07	0.16	-0.02	-3.47**	0.35***
5 September$_{(i)}$	-1.68*	0.21***	-1.84	0.20**	1.46	-0.12	0.96	-0.05	0.15	-0.01	-2.96**	0.33***
6 October$_{(i)}$	-1.46*	0.16**	-1.80	0.17**	1.39	-0.11	1.02	-0.05	0.15	-0.01	-3.10**	0.30***
7 November$_{(i)}$	-1.24	0.15**	-1.10	0.14**	1.35	-0.11*	0.89	-0.05	0.19	-0.02	-2.11	0.24**
8 December$_{(i)}$	-1.16	0.14**	-0.83	0.12**	1.18	-0.10*	0.85	-0.04	0.21	-0.02	-1.89	0.22**
9 January$_{(i+1)}$	-1.12	0.14**	-0.77	0.11**	0.91	-0.07	0.85	-0.04	0.25	-0.02	-2.10*	0.24***
10 February$_{(i+1)}$	-0.98	0.12**	-0.42	0.08	0.68	-0.05	0.83	-0.03	0.24	-0.02	-1.82*	0.20***
11 March$_{(i+1)}$	-0.98	0.13**	-1.13*	0.12***	0.54	-0.05	0.66	-0.02	0.21	-0.01	-2.47**	0.24***
12 April$_{(i+1)}$	-1.05	0.12**	-0.40	0.07**	0.48	-0.04	0.12	0.01	0.22	-0.01	-1.36**	0.15***
13 May$_{(i+1)}$	-0.65	0.08**	-0.34	0.06**	0.33	-0.03	0.04	0.01	0.24	-0.01	-1.05*	0.12***
14 June$_{(i+1)}$	-0.60	0.08**	-0.47	0.06**	0.12	-0.01	0.00	0.01	0.27**	-0.02**	-1.33***	0.15***
15 July$_{(i+1)}$	-0.15	0.02	-0.36	0.05**	0.10	-0.01	0.18	-0.01	0.25***	-0.01**	-0.91**	0.10***
16 August$_{(i+1)}$	-0.21	0.03*	-0.36	0.05**	0.03	0.00	0.24	-0.01	0.14***	-0.01**	-0.99**	0.10***
17 September$_{(i+1)}$	-0.21	0.03*	-0.26	0.03*	0.04	0.00	0.33	-0.03*	-0.02	0.00	-0.64	0.08**
18 October$_{(i+1)}$	-0.04	0.01	0.00	0.00	0.01	0.00	0.20	-0.01	0.00	0.00	-0.23	0.02

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 4. Dynamic Test of Bias for WASDE World Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock		Production		Imports		Domestic Use		Exports		Ending Stocks	
	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)	Constant	Trend (M.Bal)
1 May$_{(i)}$	-0.92	0.24***	-2.34	0.23	2.70*	-0.21**	2.55	-0.20	1.76	-0.15	-4.57*	0.58***
2 June$_{(i)}$	-0.85	0.23***	-2.48	0.25	2.66*	-0.21**	2.55	-0.21	1.70	-0.15	-4.53*	0.59***
3 July$_{(i)}$	-0.44	0.18**	-2.34	0.24	2.47*	-0.18*	2.40	-0.19	1.45	-0.12	-3.87	0.52***
4 August$_{(i)}$	-0.63	0.19**	-2.93	0.26*	2.47*	-0.18*	2.10	-0.17	1.36	-0.11	-4.19*	0.52***
5 September$_{(i)}$	-0.57	0.19**	-2.38	0.24*	2.27*	-0.16*	1.81	-0.15	1.25	-0.09	-3.47	0.49***
6 October$_{(i)}$	-0.79	0.16**	-1.81	0.17	2.33**	-0.15**	1.90	-0.14	1.24	-0.08	-3.43*	0.41***
7 November$_{(i)}$	-0.77	0.15**	-1.25	0.15	2.27**	-0.15**	1.77	-0.12	1.18	-0.08	-2.70	0.36***
8 December$_{(i)}$	-0.89	0.15**	-0.56	0.12	2.11**	-0.13**	1.80	-0.10	1.11	-0.07	-2.25	0.30**
9 January$_{(i+1)}$	-0.79	0.14**	-0.32	0.10	1.71**	-0.10**	1.86	-0.10	0.85	-0.04	-2.12	0.29***
10 February$_{(i+1)}$	-0.84	0.14**	0.18	0.06	1.41**	-0.08*	1.77*	-0.08	0.68	-0.02	-1.68	0.22**
11 March$_{(i+1)}$	-0.97	0.14**	-0.70	0.11**	1.28**	-0.07*	1.41	-0.05	0.45	-0.01	-2.24*	0.24***
12 April$_{(i+1)}$	-0.98	0.13**	0.32	0.04	1.26**	-0.06*	1.00	-0.03	0.49	0.00	-0.90	0.15**
13 May$_{(i+1)}$	-0.72	0.10**	0.53	0.03	0.72*	-0.04	0.89	-0.03	0.10	0.01	-0.54	0.11*
14 June$_{(i+1)}$	-0.56	0.08**	0.35	0.03	0.59	-0.02	0.70	-0.02	0.07	0.03	-0.47	0.10**
15 July$_{(i+1)}$	0.08	0.01	0.29	0.03	0.35	-0.01	0.61	-0.02	0.20	0.01	-0.07	0.05
16 August$_{(i+1)}$	0.10	0.01	0.09	0.03*	0.17	0.00	4.10	-0.56	0.13	0.00	-0.09	0.05*
17 September$_{(i+1)}$	0.10	0.01	-0.11	0.03*	0.08	0.00	0.32	-0.03	-0.11	0.01	-0.03	0.05*
18 October$_{(i+1)}$	0.00	0.00	-0.02	0.00	0.09	0.00	0.15	0.00	0.01	0.00	-0.07	0.01

Note: N=24 years   * Denotes significance level of 0.1   ** Denotes significance level of 0.05   *** Denotes significance level of 0.01

Table 5. Test of Orthogonality for WASDE U.S. Cotton Forecasts, 1985-2008 Marketing Years

	Production		Domestic Use		Exports		Ending Stocks		Price	
	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (¢/lb)
1 May$_{(i)}$	0.74	-0.03	0.70	-0.08	0.78	-0.08	1.35	-0.24	1.24	-0.06
2 June$_{(i)}$	0.46	-0.01	0.65	-0.07	0.92	-0.10	1.30	-0.22	10.83	-0.23
3 July$_{(i)}$	1.38	-0.05	0.63	-0.06	0.83	-0.08	1.12	-0.19	6.90	-0.17
4 August$_{(i)}$	0.23	-0.01	0.45	-0.05	0.77	-0.07	1.60	-0.32	11.70	-0.24
5 September$_{(i)}$	-0.68	0.05	0.36	-0.04	0.70	-0.06	1.39	-0.25	9.07	-0.19
6 October$_{(i)}$	-0.61	0.05	0.05	0.00	0.80	-0.06	0.87	-0.16	8.59	-0.16
7 November$_{(i)}$	-0.28	0.02	0.05	0.00	0.78	-0.06	0.51	-0.12	4.16	-0.07
8 December$_{(i)}$	-0.39	0.02	-0.03	0.01	0.54	-0.04	0.35	-0.10	2.01	-0.04
9 January$_{(i+1)}$	-0.27**	0.02**	-0.01	0.01	0.31	-0.02	0.13	-0.06	-1.58	0.02
10 February$_{(i+1)}$	-0.27**	0.02**	0.06	0.01	-0.08	0.03	0.18	-0.08	-1.57	0.01
11 March$_{(i+1)}$	-0.27**	0.02**	0.05	0.00	-0.26	0.04	0.25	-0.08	-1.60	0.02
12 April$_{(i+1)}$	-0.04	0.00	-0.01	0.01	-0.22	0.04	0.26	-0.08	-2.05	0.03
13 May$_{(i+1)}$	0.00	0.00	0.03	0.00	-0.27	0.04	0.28	-0.08*	-0.89	0.01
14 June$_{(i+1)}$	0.00	0.00	0.01	0.01	-0.38	0.05**	0.38	-0.10**	-0.77	0.01
15 July$_{(i+1)}$	0.00	0.00	-0.01	0.01	-0.31*	0.04**	0.29	-0.07**	-0.57	0.01
16 August$_{(i+1)}$	0.00	0.00	-0.08	0.01	-0.15*	0.02*	0.17	-0.04	-0.89	0.01
17 September$_{(i+1)}$	0.00	0.00	-0.05	0.01	-0.15**	0.02***	0.06	-0.01	-0.80	0.01
18 October$_{(i+1)}$	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.00	-0.69	0.01

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 6. Test of Orthogonality for WASDE China Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock		Production		Imports		Domestic Use		Exports		Ending Stocks	
	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)
1 May$_{(i)}$												
2 June$_{(i)}$												
3 July$_{(i)}$	1.20	-0.02	-0.93	0.06	1.12	-0.32***	2.96**	-0.10**	-0.05	-0.03	5.12**	-0.36*
4 August$_{(i)}$	0.95	-0.01	-0.66	0.05	1.10	-0.31***	2.84**	-0.10**	-0.07	0.02	4.88**	-0.34*
5 September$_{(i)}$	1.10	-0.01	-0.84	0.07	0.98	-0.26**	2.44*	-0.08*	-0.04	0.00	4.41*	-0.28
6 October$_{(i)}$	0.99	-0.03	0.83	-0.02	0.83	-0.23**	2.54**	-0.08*	-0.06	0.04	4.45**	-0.32**
7 November$_{(i)}$	0.81	-0.02	-0.27	0.04	0.62	-0.19**	2.12**	-0.07*	-0.09	0.10	3.79**	-0.25*
8 December$_{(i)}$	0.95	-0.02	-0.21	0.04	0.59	-0.17**	1.94**	-0.06*	-0.13	0.17	3.53**	-0.22*
9 January$_{(i+1)}$	0.99	-0.03	-0.98	0.07	0.49	-0.13*	1.74**	-0.05*	-0.16	0.24**	3.24**	-0.20
10 February$_{(i+1)}$	0.84	-0.02	-0.35	0.04	0.39	-0.10*	1.47*	-0.04	-0.18*	0.28***	2.75*	-0.17
11 March$_{(i+1)}$	0.90	-0.02	-1.43	0.08	0.20	-0.07	1.03	-0.03	-0.14	0.23**	2.26	-0.15
12 April$_{(i+1)}$	0.41	0.00	-1.91**	0.10***	0.18	-0.05	0.43	-0.01	-0.11	0.22**	0.16	0.03
13 May$_{(i+1)}$	0.47	-0.01	-1.57*	0.09**	0.15	-0.05*	0.36	-0.01	-0.10	0.21**	-0.15	0.05
14 June$_{(i+1)}$	0.44	-0.01	-1.93**	0.10***	0.09	-0.02	0.16	0.00	-0.09	0.25***	0.10	0.03
15 July$_{(i+1)}$	0.17	0.00	-1.63***	0.08***	0.09	-0.01	0.34	-0.01	-0.07	0.20***	-0.18	0.04
16 August$_{(i+1)}$	0.05	0.01	-1.63***	0.08***	0.02	0.00	0.31	-0.01	-0.04	0.10***	-0.54	0.06
17 September$_{(i+1)}$	0.05	0.01	-1.09**	0.06**	0.03	0.00	0.54*	-0.02*	-0.01	0.00	-0.26	0.05
18 October$_{(i+1)}$	0.17	-0.01	0.00***	0.00***	0.01	0.00	0.17	0.00	0.00	0.00	-0.02	0.00

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 7. Test of Orthogonality for WASDE World Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock		Production		Imports		Domestic Use		Exports		Ending Stocks	
	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)	Constant	Forecast (M.Bal)
1 May$_{(i)}$	-1.58	0.10	-8.00	0.09	8.98***	-0.31***	14.30**	-0.15**	6.85**	-0.24**	1.04	0.04
2 June$_{(i)}$	-1.50	0.09	-10.60	0.12	8.79***	-0.30***	14.54**	-0.16**	6.55**	-0.23**	0.54	0.06
3 July$_{(i)}$	-1.34	0.08	-13.50	0.15	8.22***	-0.28***	13.16**	-0.14**	5.81*	-0.21*	0.26	0.06
4 August$_{(i)}$	-2.15	0.10*	-16.0*	0.18**	7.82***	-0.27***	11.93**	-0.13**	5.24	-0.19*	-0.97	0.09
5 September$_{(i)}$	-2.34	0.11*	-13.5*	0.15**	6.97**	-0.24**	10.56*	-0.11**	4.40	-0.15	-1.29	0.11
6 October$_{(i)}$	-0.58	0.04	-8.32	0.09	6.33**	-0.21**	10.60**	-0.11**	3.34	-0.11	0.88	0.02
7 November$_{(i)}$	-0.83	0.05	-8.63*	0.10*	5.81***	-0.19***	8.87*	-0.09*	2.81	-0.09	-0.09	0.05
8 December$_{(i)}$	-0.82	0.05	-6.81	0.08*	5.23***	-0.17***	7.36*	-0.07*	2.36	-0.07	-0.46	0.05
9 January$_{(i+1)}$	-0.50	0.04	-5.96*	0.08**	4.20**	-0.13**	7.03*	-0.07*	1.30	-0.03	-0.92	0.06
10 February$_{(i+1)}$	-0.23	0.03	-3.71	0.05*	3.80**	-0.12**	5.55*	-0.05	0.92	-0.02	0.38	0.02
11 March$_{(i+1)}$	-0.26	0.03	-5.00**	0.06**	3.14**	-0.09**	3.12	-0.03	0.19	0.01	0.08	0.02
12 April$_{(i+1)}$	-1.19	0.05	-1.84	0.03	3.16**	-0.09**	2.22	-0.02	0.20	0.01	-0.95	0.05
13 May$_{(i+1)}$	-0.68	0.03	-0.89	0.02	2.05**	-0.06*	1.67	-0.01	-0.49	0.03	-0.09	0.02
14 June$_{(i+1)}$	-0.13	0.01	-1.42	0.02	1.66*	-0.05	1.33	-0.01	-1.03	0.05	-0.55	0.03
15 July$_{(i+1)}$	0.11	0.00	-1.05	0.02*	0.89	-0.02	1.36	-0.01	-0.68	0.03	-0.29	0.02
16 August$_{(i+1)}$	0.00	0.01	-1.41*	0.02**	0.43	-0.01	0.23	0.00	-0.28	0.02	-0.91	0.04*
17 September$_{(i+1)}$	0.01	0.01	-1.41*	0.02**	0.42	-0.01	1.74	-0.02*	-0.69**	0.03**	-1.11	0.04**
18 October$_{(i+1)}$	0.34	-0.01	0.05	0.00	0.41	-0.01	0.25	0.00	-0.33*	0.01**	0.37	-0.01

Note: N=24 years   * Denotes significance level of 0.1   ** Denotes significance level of 0.05   *** Denotes significance level of 0.01

Table 8. Test of Weak Efficiency for WASDE U.S. Cotton Forecasts, 1985-2008 Marketing Years

	Production		Domestic Use		Exports		Ending Stock		Price	
	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (¢/lb)
1 May$_{(i)}$	0.16	0.20	-0.06	0.41**	0.15	0.20	0.00	0.07	-2.40	-0.08
2 June$_{(i)}$	0.20	0.20	-0.04	0.43**	0.10	0.25	0.03	0.07	-2.49	-0.11
3 July$_{(i)}$	0.34	0.26	-0.02	0.51***	0.23	0.23	0.05	0.11	-2.96*	-0.03
4 August$_{(i)}$	0.06	0.21	-0.05	0.55***	0.17	0.21	-0.09	0.28	-1.97	0.02
5 September$_{(i)}$	0.23	0.03	-0.05	0.52***	0.18	0.22	0.05	0.17	-1.70	0.08
6 October$_{(i)}$	0.32	0.03	-0.04	0.43**	0.30	0.21	-0.01	0.22	-0.42	0.33
7 November$_{(i)}$	0.11	-0.02	-0.02	0.30	0.26	0.20	-0.16	0.17	0.13	0.32
8 December$_{(i)}$	0.05	-0.08	0.01	0.27	0.21	0.19	-0.21	0.10	-0.04	0.35
9 January$_{(i+1)}$	0.01	-0.14	0.04	0.21	0.17	0.14	-0.23	0.09	-0.54	0.28
10 February$_{(i+1)}$	0.01	-0.14	0.10	0.05	0.19	0.04	-0.31	-0.11	-0.76	0.14
11 March$_{(i+1)}$	0.01	-0.13	0.09	-0.05	0.13	-0.03	-0.25	-0.26	-0.58*	0.05
12 April$_{(i+1)}$	0.00	0.02	0.07	0.00	0.11	0.09	-0.21	-0.16	-0.53*	0.02
13 May$_{(i+1)}$	0.00	-0.05	0.06	-0.01	0.08	0.15	-0.15	-0.01	-0.37	-0.16
14 June$_{(i+1)}$	0.00	-0.05	0.07	-0.07	0.08	0.32	-0.15	0.10	-0.35	-0.18
15 July$_{(i+1)}$	0.00	-0.05	0.09*	-0.11	0.03	0.42**	-0.10	0.11	-0.17	-0.26
16 August$_{(i+1)}$	0.00	-0.05	0.04	-0.16	0.00	0.37*	-0.05	-0.27	-0.25	-0.26
17 September$_{(i+1)}$	0.00	-0.05	0.00	-0.31	0.00	0.27	0.01	-0.24	-0.18	-0.36
18 October$_{(i+1)}$	0.00	-0.05	0.00	0.02	0.00	-0.05	0.00	0.00	-0.06	-0.06

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 9. Test of Weak Efficiency for WASDE China Cotton Forecasts, 1985-2008 Marketing Years

	Beginning stock		Production		Import		Domestic Use		Export		Ending Stock	
	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)
1 May$_{(i)}$												
2 June$_{(i)}$												
3 July$_{(i)}$	0.64	0.30	0.41	0.24	-0.14	0.23	-0.32	0.86***	-0.12	0.12	0.85	0.29
4 August$_{(i)}$	0.62	0.31	0.49	0.18	-0.08	0.17	-0.28	0.84***	-0.10	0.15	0.91	0.29
5 September$_{(i)}$	0.70	0.25	0.70	0.17	-0.01	0.07	-0.20	0.78**	-0.09	-0.08	1.08	0.30
6 October$_{(i)}$	0.54	0.14	0.56	0.11	-0.03	0.12	-0.17	0.74**	-0.09	-0.02	0.86	0.24
7 November$_{(i)}$	0.54	0.19	0.74*	0.22	-0.10	0.09	-0.05	0.60**	-0.07	0.02	0.99	0.29
8 December$_{(i)}$	0.58	0.16	0.80**	0.17	-0.05	0.09	0.14	0.40	-0.06	0.09	1.02*	0.28
9 January$_{(i+1)}$	0.58	0.18	0.74**	0.21	0.03	-0.09	0.20	0.29	-0.04	0.23	0.99*	0.35*
10 February$_{(i+1)}$	0.63	-0.05	0.72**	0.11	0.01	-0.21	0.47	-0.12	-0.03	0.34**	0.84*	0.28
11 March$_{(i+1)}$	0.64	-0.03	0.48**	0.23	-0.06	-0.22	0.46	-0.23	-0.02	0.39**	0.65	0.33*
12 April$_{(i+1)}$	0.37	0.15	0.34	0.29	-0.01	-0.15	0.39	-0.52**	-0.01	0.33*	0.48	0.32
13 May$_{(i+1)}$	0.29	0.03	0.37	0.16	-0.04	0.00	0.30	-0.54***	-0.01	0.34**	0.45	0.21
14 June$_{(i+1)}$	0.37	-0.01	0.23	0.23	0.03	0.08	0.21	-0.55***	0.02	0.40**	0.33	0.52***
15 July$_{(i+1)}$	0.18	-0.07	0.15	0.39*	0.04	0.22	0.13	-0.57***	0.02	0.38**	0.21	0.51**
16 August$_{(i+1)}$	0.15	-0.04	0.15	0.39*	0.01	0.10	0.18	-0.57***	0.01	0.37**	0.18	0.49**
17 September$_{(i+1)}$	0.15	-0.04	0.18	-0.06	0.03	-0.14	-0.05	-0.20	-0.01	0.04	0.24	0.29
18 October$_{(i+1)}$	0.03	-0.20	0.00***	0.00***	0.01	-0.07	0.07	-0.14	0.00	-0.08	-0.05	-0.27

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 10. Test of Weak Efficiency for WASDE World Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock		Production		Import		Domestic Use		Export		Ending Stock	
	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)	Constant	LagErrors (M.Bal)
1 May$_{(i)}$	1.43*	0.29	0.30	0.15	-0.19	0.40	-0.45	0.47	-0.23	0.34	2.10	0.20
2 June$_{(i)}$	1.18	0.38*	0.34	0.20	-0.16	0.31	-0.55	0.52*	-0.21	0.25	2.16	0.23
3 July$_{(i)}$	1.32*	0.21	0.46	0.17	0.00	0.20	-0.43	0.47	-0.13	0.20	2.23	0.14
4 August$_{(i)}$	1.21*	0.29	0.29	0.20	0.08	0.11	-0.45	0.46	-0.10	0.12	2.08	0.17
5 September$_{(i)}$	1.10	0.36*	0.56	0.19	0.19	0.01	-0.43	0.45	0.05	0.02	2.40*	0.17
6 October$_{(i)}$	0.87	0.27	0.32	0.15	0.31	0.14	-0.23	0.34	0.12	0.17	1.67	0.12
7 November$_{(i)}$	0.85	0.28	0.52	0.28	0.11	0.31	-0.02	0.23	0.05	0.20	1.69	0.19
8 December$_{(i)}$	0.84	0.16	0.88	0.16	0.20	0.32	0.40	0.08	0.13	0.24	1.58	0.13
9 January$_{(i+1)}$	0.83	0.15	0.91	0.16	0.29	0.21	0.44	0.06	0.23	0.18	1.39	0.20
10 February$_{(i+1)}$	0.87	-0.02	1.05**	0.04	0.37	0.09	0.92*	-0.24	0.38	0.05	1.18	0.09
11 March$_{(i+1)}$	0.82	0.00	0.62*	0.27	0.35	0.06	0.93*	-0.21	0.33	0.01	0.87	0.11
12 April$_{(i+1)}$	0.57	0.12	0.77**	0.05	0.38	0.07	0.83**	-0.47**	0.40	0.05	0.89	0.04
13 May$_{(i+1)}$	0.48	-0.02	0.86**	0.05	0.14	0.10	0.76**	-0.47**	0.19	0.18	0.80	0.05
14 June$_{(i+1)}$	0.46	-0.01	0.89***	-0.14	0.23	0.09	0.57*	-0.52**	0.28	0.26	0.72*	0.11
15 July$_{(i+1)}$	0.26	-0.21	0.68***	-0.12	0.27**	-0.09	0.52**	-0.56***	0.16	0.36*	0.54*	-0.03
16 August$_{(i+1)}$	0.27	-0.18	0.43**	0.08	0.18**	-0.23	0.36	-0.54***	0.10	0.24	0.52**	-0.01
17 September$_{(i+1)}$	0.30*	-0.17	0.36**	-0.15	0.06	-0.30	-0.09	-0.14	0.05	0.05	0.53**	0.07
18 October$_{(i+1)}$	0.07	-0.10	0.01	0.02	0.11*	-0.09	0.12	-0.23	0.09**	-0.45**	0.02	-0.29

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 11. Test of Independence of Forecast Revisions for WASDE U.S. Cotton Forecasts, 1985-2008 Marketing Years

	Production Revision (M.Bal)	Domestic Use Revision (M.Bal)	Exports Revision (M.Bal)	Ending Stock Revision (M.Bal)	Price Revision (¢/lb)
1 May$_{(i)}$					
2 June$_{(i)}$					
3 July$_{(i)}$	0.77	0.85***	-0.05	1.18	0.06
4 August$_{(i)}$	0.28	0.21	-0.02	0.33*	0.19
5 September$_{(i)}$	0.11	0.28	0.01	-0.14	-0.10
6 October$_{(i)}$	0.57***	0.27	0.99***	0.19	0.41
7 November$_{(i)}$	0.47***	0.37***	0.07	0.19	0.20
8 December$_{(i)}$	0.28**	0.54***	0.21	0.11	0.34*
9 January$_{(i+1)}$	0.53***	0.26**	0.61***	0.45***	0.04
10 February$_{(i+1)}$	0.00***	1.51***	0.68***	0.68***	0.09
11 March$_{(i+1)}$	0.00***	0.26	0.45*	0.35	-0.10
12 April$_{(i+1)}$	0.00	0.47***	0.31***	0.39***	0.12
13 May$_{(i+1)}$	-0.16	0.37*	0.36*	0.43*	0.07
14 June$_{(i+1)}$	0.00***	0.24	0.20	0.24	0.02
15 July$_{(i+1)}$	0.00***	0.44**	0.10	0.04	-0.33
16 August$_{(i+1)}$	0.00***	0.32	0.59**	0.47**	-0.14*
17 September$_{(i+1)}$	0.00***	0.24	0.23***	0.54**	-0.09
18 October$_{(i+1)}$	0.00***	0.03	0.26	0.06	0.15
19 November$_{(i+1)}$	0.00***	0.02	0.00	0.07	0.00

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 12. Test of Independence of Forecast Revisions for WASDE China Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock Revision (M.Bal)	Production Revision (M.Bal)	Imports Revision (M.Bal)	Domestic Use Revision (M.Bal)	Exports Revision (M.Bal)	Ending Stocks Revision (M.Bal)
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$						
4 August$_{(i)}$						
5 September$_{(i)}$	-0.09	0.76**	1.61***	0.27	0.39	0.16
6 October$_{(i)}$	-0.12	0.18	0.73***	0.51**	0.00	-0.26
7 November$_{(i)}$	0.00	-0.10	0.93***	0.23	0.00	-0.19
8 December$_{(i)}$	0.03	0.03	0.13	0.53***	0.13	0.02
9 January$_{(i+1)}$	0.00	0.77	0.98***	0.48***	0.54***	0.62*
10 February$_{(i+1)}$	0.00	-0.06	0.55***	0.95**	0.70**	-0.30
11 March$_{(i+1)}$	0.00	0.03	0.44	0.22*	0.43***	0.05
12 April$_{(i+1)}$	0.00	0.00	0.20**	0.28	0.19	0.12
13 May$_{(i+1)}$	0.06	0.00	0.44**	0.09	0.11	-0.03
14 June$_{(i+1)}$	0.00	0.00	0.46	0.01	0.87	-0.41**
15 July$_{(i+1)}$	0.01	0.00	0.33***	0.04	0.16*	-0.30
16 August$_{(i+1)}$	0.00	0.00***	-0.18	-0.08	1.16***	0.02
17 September$_{(i+1)}$	0.00	0.00***	0.02	-1.34*	0.75***	-0.12
18 October$_{(i+1)}$	-230.00	0.00	0.02	0.18	0.02	-0.12
19 November$_{(i+1)}$	0.00	0.00***	0.00	0.01	0.00	0.00

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 13. Test of Independence of Forecast Revisions for WASDE World Cotton Forecasts, 1985-2008 Marketing Years

	Beginning Stock Revision (M.Bal)	Production Revision (M.Bal)	Imports Revision (M.Bal)	Domestic Use Revision (M.Bal)	Exports Revision (M.Bal)	Ending Stocks Revision (M.Bal)
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$	0.36	0.44	0.07	0.07	0.14	0.43
4 August$_{(i)}$	0.16	0.34**	-0.05	0.36**	-0.01	0.25*
5 September$_{(i)}$	-0.01	0.23	0.45**	0.53***	0.48**	0.08
6 October$_{(i)}$	-0.72	0.23	0.92**	1.17***	0.79**	-0.26
7 November$_{(i)}$	0.00	-0.16	0.35**	0.49**	0.39**	-0.11
8 December$_{(i)}$	-0.13	0.28**	0.29	0.71***	0.32	0.05
9 January$_{(i+1)}$	0.02	0.48**	0.61***	0.44***	0.56***	0.53**
10 February$_{(i+1)}$	0.05	0.15	0.79***	1.34***	0.76***	-0.04
11 March$_{(i+1)}$	0.07	0.31	0.34	0.31**	0.36*	0.49**
12 April$_{(i+1)}$	0.27	0.04	0.22**	0.26	0.16	0.12
13 May$_{(i+1)}$	0.17	0.02	-0.26	0.12	0.31	0.07
14 June$_{(i+1)}$	0.17	-0.44	-0.09	-0.12	-0.18***	0.00
15 July$_{(i+1)}$	0.08	0.20	0.47	0.18	-0.01	0.27
16 August$_{(i+1)}$	0.01	0.38***	0.10	0.17	0.30	0.16
17 September$_{(i+1)}$	-0.27**	-0.12	0.14	0.22	0.23	-0.02
18 October$_{(i+1)}$	0.04	0.01	0.03	0.10	0.01	-0.81*
19 November$_{(i+1)}$	0.15	-0.07*	-0.30	-0.04	0.19	-0.05

Note: N=24 years * Denotes significance level of 0.1 ** Denotes significance level of 0.05 *** Denotes significance level of 0.01

Table 14. USDA WASDE Forecast Evaluation Summary for 1985-2008 Marketing Years
Most Significant Categories found within the Forecasting Evaluation Framework (By Region)

Region	Test	Beginning Stocks (M.Bal)	Production (M.Bal)	Imports (M.Bal)	Domestic Use (M.Bal)	Exports (M.Bal)	Ending Stocks (M.Bal)	Price (¢/lb)
U.S.	Test of Bias				X			
	Test of Orthogonality		X					
	Test of Weak Efficiency				X			
	Test of Revisions				X			
China	Test of Bias						X	
	Test of Orthogonality			X				
	Test of Weak Efficiency				X			
	Test of Revisions			X				
World	Test of Bias			X				
	Test of Orthogonality			X				
	Test of Weak Efficiency				X			
	Test of Revisions				X			

Table 15. Evaluation for the Adjustment of Bias in USDA WASDE U.S. Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$	0.73	0.60	0.12	0.80	0.81	-0.01
2 June$_{(i)}$	0.68	0.56	0.12	0.74	0.76	-0.02
3 July$_{(i)}$	0.61	0.52	0.09	0.68	0.72	-0.04
4 August$_{(i)}$	0.56	0.48	0.08	0.66	0.66	0.00
5 September$_{(i)}$	0.51	0.46	0.04	0.62	0.61	0.02
6 October$_{(i)}$	0.49	0.44	0.04	0.61	0.57	0.03
7 November$_{(i)}$	0.44	0.44	0.00	0.55	0.54	0.00
8 December$_{(i)}$	0.36	0.41	-0.05	0.48	0.48	-0.01
9 January$_{(i+1)}$	0.32	0.39	-0.07	0.44	0.46	-0.02
10 February$_{(i+1)}$	0.31	0.35	-0.05	0.39	0.43	-0.04
11 March$_{(i+1)}$	0.27	0.32	-0.05	0.34	0.37	-0.04
12 April$_{(i+1)}$	0.24	0.29	-0.05	0.30	0.32	-0.02
13 May$_{(i+1)}$	0.20	0.26	-0.06	0.27	0.30	-0.03
14 June$_{(i+1)}$	0.17	0.21	-0.04	0.25	0.27	-0.02
15 July$_{(i+1)}$						
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.12	*RMSE* Overall Improvement		-0.19

Table 16. Evaluation for the Adjustment of Bias in USDA WASDE China Ending Stock Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$	3.27	2.51	0.75	3.98	3.14	0.84
4 August$_{(i)}$	3.19	2.22	0.98	3.92	2.74	1.18
5 September$_{(i)}$	3.11	2.52	0.59	3.93	2.90	1.03
6 October$_{(i)}$	2.29	2.31	-0.01	2.84	2.85	-0.02
7 November$_{(i)}$	2.16	2.20	-0.04	2.63	2.66	-0.04
8 December$_{(i)}$	2.12	1.95	0.17	2.58	2.40	0.19
9 January$_{(i+1)}$	2.38	1.70	0.68	2.90	2.08	0.83
10 February$_{(i+1)}$	2.00	1.33	0.66	2.22	1.73	0.49
11 March$_{(i+1)}$	2.11	1.39	0.71	2.44	1.87	0.57
12 April$_{(i+1)}$	2.07	1.69	0.38	2.49	1.93	0.56
13 May$_{(i+1)}$	1.56	1.07	0.50	1.75	1.32	0.43
14 June$_{(i+1)}$	1.76	1.32	0.43	2.12	1.47	0.65
15 July$_{(i+1)}$	1.14	0.98	0.16	1.57	1.28	0.30
16 August$_{(i+1)}$	1.12	0.90	0.22	1.61	1.32	0.29
17 September$_{(i+1)}$	0.99	1.00	-0.01	1.58	1.41	0.17
18 October$_{(i+1)}$						
	MAE Overall Improvement		6.18	*RMSE* Overall Improvement		7.47

Table 17. Evaluation for the Adjustment of Bias in USDA WASDE World Import Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$	3.72	3.76	-0.04	4.82	4.85	-0.02
2 June$_{(i)}$	3.60	3.63	-0.03	4.75	4.75	-0.01
3 July$_{(i)}$	3.57	3.75	-0.18	4.60	4.73	-0.14
4 August$_{(i)}$	3.35	3.42	-0.07	4.35	4.46	-0.11
5 September$_{(i)}$	3.02	3.07	-0.05	3.99	4.11	-0.12
6 October$_{(i)}$	2.62	2.45	0.17	3.25	3.32	-0.07
7 November$_{(i)}$	2.20	2.00	0.20	2.75	2.72	0.03
8 December$_{(i)}$	1.88	1.66	0.23	2.30	2.30	0.00
9 January$_{(i+1)}$	1.44	1.36	0.08	1.84	1.88	-0.04
10 February$_{(i+1)}$	1.26	1.33	-0.07	1.57	1.66	-0.09
11 March$_{(i+1)}$	0.82	0.90	-0.08	1.00	1.09	-0.09
12 April$_{(i+1)}$	0.76	0.83	-0.07	0.84	0.96	-0.12
13 May$_{(i+1)}$	0.57	0.73	-0.17	0.72	0.91	-0.18
14 June$_{(i+1)}$	0.54	0.65	-0.11	0.70	0.81	-0.11
15 July$_{(i+1)}$						
16 August$_{(i+1)}$	0.21	0.20	0.01	0.31	0.30	0.01
17 September$_{(i+1)}$	0.25	0.26	-0.01	0.32	0.35	-0.03
18 October$_{(i+1)}$						
	MAE Overall Improvement		-0.19	*RMSE* Overall Improvement		-1.07

Table 18. Evaluation for the Adjustment of Forecast Levels in USDA WASDE U.S. Production Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$						
4 August$_{(i)}$						
5 September$_{(i)}$						
6 October$_{(i)}$						
7 November$_{(i)}$						
8 December$_{(i)}$						
9 January$_{(i+1)}$	0.13	0.13	0.00	0.02	0.02	0.00
10 February$_{(i+1)}$	0.13	0.13	0.00	0.02	0.02	0.00
11 March$_{(i+1)}$	0.13	0.13	0.00	0.02	0.02	0.00
12 April$_{(i+1)}$						
13 May$_{(i+1)}$						
14 June$_{(i+1)}$						
15 July$_{(i+1)}$						
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.00	*RMSE* Overall Improvement		0.00

Table 19. Evaluation for the Adjustment of Forecast Levels in USDA WASDE China Import Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 $\text{May}_{(i)}$						
2 $\text{June}_{(i)}$						
3 $\text{July}_{(i)}$	3.56	3.64	-0.08	4.74	5.85	-1.11
4 $\text{August}_{(i)}$	3.37	3.60	-0.22	4.57	5.81	-1.24
5 $\text{September}_{(i)}$	2.95	3.26	-0.32	4.10	5.35	-1.25
6 $\text{October}_{(i)}$	2.61	2.84	-0.23	3.57	4.45	-0.89
7 $\text{November}_{(i)}$	2.18	2.32	-0.14	2.94	3.52	-0.58
8 $\text{December}_{(i)}$	1.95	2.05	-0.11	2.68	3.22	-0.55
9 $\text{January}_{(i+1)}$	1.66	1.89	-0.24	2.31	3.03	-0.72
10 $\text{February}_{(i+1)}$	1.53	1.73	-0.20	2.11	2.75	-0.64
11 $\text{March}_{(i+1)}$						
12 $\text{April}_{(i+1)}$						
13 $\text{May}_{(i+1)}$	0.62	0.84	-0.22	0.96	1.20	-0.24
14 $\text{June}_{(i+1)}$						
15 $\text{July}_{(i+1)}$						
16 $\text{August}_{(i+1)}$						
17 $\text{September}_{(i+1)}$						
18 $\text{October}_{(i+1)}$						
	MAE Overall Improvement		-1.74	*RMSE* Overall Improvement		-7.22

Table 20. Evaluation for the Adjustment of Forecast Levels in USDA WASDE World Import Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$	3.72	3.71	0.01	4.82	4.85	-0.02
2 June$_{(i)}$	3.60	3.61	-0.01	4.75	4.80	-0.05
3 July$_{(i)}$	3.57	3.76	-0.20	4.60	4.89	-0.30
4 August$_{(i)}$	3.35	3.47	-0.12	4.35	4.66	-0.30
5 September$_{(i)}$	3.02	3.16	-0.13	3.99	4.36	-0.37
6 October$_{(i)}$	2.62	2.57	0.05	3.25	3.49	-0.24
7 November$_{(i)}$	2.20	2.14	0.06	2.75	2.86	-0.11
8 December$_{(i)}$	1.88	1.85	0.03	2.30	2.46	-0.17
9 January$_{(i+1)}$	1.44	1.57	-0.13	1.84	2.04	-0.20
10 February$_{(i+1)}$	1.26	1.42	-0.16	1.57	1.81	-0.25
11 March$_{(i+1)}$	0.82	1.09	-0.27	1.00	1.42	-0.41
12 April$_{(i+1)}$	0.76	1.03	-0.27	0.84	1.28	-0.44
13 May$_{(i+1)}$	0.57	0.78	-0.21	0.72	0.95	-0.22
14 June$_{(i+1)}$	0.54	0.71	-0.17	0.70	0.85	-0.14
15 July$_{(i+1)}$						
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		-1.49	*RMSE* Overall Improvement		-3.22

Table 21. Evaluation for the Adjustment of Lagged Errors in USDA WASDE U.S. Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$	0.73	0.73	-0.01	0.80	0.81	-0.01
2 June$_{(i)}$	0.68	0.66	0.01	0.74	0.76	-0.02
3 July$_{(i)}$	0.61	0.54	0.07	0.68	0.69	-0.01
4 August$_{(i)}$	0.56	0.51	0.05	0.66	0.63	0.03
5 September$_{(i)}$	0.51	0.50	0.01	0.62	0.61	0.02
6 October$_{(i)}$	0.49	0.46	0.02	0.61	0.62	-0.02
7 November$_{(i)}$						
8 December$_{(i)}$						
9 January$_{(i+1)}$						
10 February$_{(i+1)}$						
11 March$_{(i+1)}$						
12 April$_{(i+1)}$						
13 May$_{(i+1)}$						
14 June$_{(i+1)}$						
15 July$_{(i+1)}$						
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.15	*RMSE* Overall Improvement		0.00

Table 22. Evaluation for the Adjustment of Lagged Errors in USDA WASDE China Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$	2.99	2.43	0.56	3.72	3.21	0.51
4 August$_{(i)}$	2.79	2.26	0.53	3.48	3.05	0.43
5 September$_{(i)}$	2.65	2.13	0.52	3.32	2.94	0.38
6 October$_{(i)}$	2.80	2.29	0.51	3.35	3.09	0.26
7 November$_{(i)}$	2.31	2.06	0.25	2.72	2.61	0.11
8 December$_{(i)}$						
9 January$_{(i+1)}$						
10 February$_{(i+1)}$						
11 March$_{(i+1)}$						
12 April$_{(i+1)}$	1.31	1.33	-0.02	1.62	1.53	0.09
13 May$_{(i+1)}$	1.42	1.66	-0.25	2.09	2.16	-0.08
14 June$_{(i+1)}$	1.26	1.54	-0.29	2.03	2.23	-0.20
15 July$_{(i+1)}$	1.00	0.96	0.04	1.63	1.47	0.16
16 August$_{(i+1)}$	0.95	1.01	-0.06	1.69	1.62	0.08
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		1.79	*RMSE* Overall Improvement		1.75

Table 23. Evaluation for the Adjustment of Lagged Errors in USDA WASDE World Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$						
4 August$_{(i)}$						
5 September$_{(i)}$						
6 October$_{(i)}$						
7 November$_{(i)}$						
8 December$_{(i)}$						
9 January$_{(i+1)}$						
10 February$_{(i+1)}$	2.39	2.33	0.06	2.69	2.71	-0.02
11 March$_{(i+1)}$	1.73	1.72	0.01	2.18	2.12	0.06
12 April$_{(i+1)}$	1.66	1.33	0.33	2.16	2.09	0.07
13 May$_{(i+1)}$	1.53	1.44	0.09	2.36	2.49	-0.13
14 June$_{(i+1)}$	1.34	1.49	-0.15	2.22	2.37	-0.16
15 July$_{(i+1)}$	1.14	0.99	0.14	1.80	1.71	0.10
16 August$_{(i+1)}$	1.02	1.19	-0.17	1.79	1.85	-0.06
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.32	*RMSE* Overall Improvement		-0.14

Table 24. Evaluation for the Adjustment of Revisions in USDA WASDE U.S. Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$	0.61	0.57	0.04	0.68	0.65	0.03
4 August$_{(i)}$						
5 September$_{(i)}$						
6 October$_{(i)}$	0.49	0.48	0.01	0.61	0.60	0.01
7 November$_{(i)}$	0.44	0.45	-0.01	0.55	0.55	-0.01
8 December$_{(i)}$	0.36	0.34	0.02	0.48	0.47	0.01
9 January$_{(i+1)}$	0.32	0.31	0.01	0.44	0.43	0.01
10 February$_{(i+1)}$	0.31	0.30	0.00	0.39	0.39	0.00
11 March$_{(i+1)}$	0.27	0.28	-0.01	0.34	0.36	-0.02
12 April$_{(i+1)}$	0.24	0.22	0.01	0.30	0.29	0.01
13 May$_{(i+1)}$	0.20	0.20	0.00	0.27	0.27	0.00
14 June$_{(i+1)}$						
15 July$_{(i+1)}$	0.15	0.16	0.00	0.23	0.23	0.00
16 August$_{(i+1)}$	0.13	0.13	0.00	0.22	0.22	0.00
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.07	*RMSE* Overall Improvement		0.03

Table 25. Evaluation for the Adjustment of Revisions in USDA WASDE China Import Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$						
4 August$_{(i)}$						
5 September$_{(i)}$	2.95	2.82	0.13	4.10	3.95	0.15
6 October$_{(i)}$	2.61	2.40	0.21	3.57	3.29	0.27
7 November$_{(i)}$	2.18	1.80	0.38	2.94	2.45	0.49
8 December$_{(i)}$						
9 January$_{(i+1)}$	1.66	1.65	0.01	2.31	2.26	0.05
10 February$_{(i+1)}$	1.53	1.59	-0.06	2.11	2.10	0.01
11 March$_{(i+1)}$						
12 April$_{(i+1)}$	0.75	0.71	0.04	1.15	1.09	0.06
13 May$_{(i+1)}$	0.62	0.52	0.11	0.96	0.84	0.13
14 June$_{(i+1)}$						
15 July$_{(i+1)}$	0.29	0.28	0.02	0.39	0.38	0.01
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.83	*RMSE* Overall Improvement		1.17

Table 26. Evaluation for the Adjustment of Revisions in USDA WASDE World Domestic Use Forecasts, 1999-2008 Marketing Years

Month	Mean Absolute Error			Root Mean Square Error		
	Original M.Bal	Adjusted M.Bal	Improvement M.Bal	Original M.Bal	Adjusted M.Bal	Improvement M.Bal
1 May$_{(i)}$						
2 June$_{(i)}$						
3 July$_{(i)}$						
4 August$_{(i)}$	3.73	3.70	0.03	5.41	5.33	0.07
5 September$_{(i)}$	3.66	3.57	0.09	5.18	5.01	0.17
6 October$_{(i)}$	3.81	3.77	0.04	5.09	4.93	0.16
7 November$_{(i)}$	3.48	3.63	-0.15	4.22	4.34	-0.12
8 December$_{(i)}$	3.11	2.95	0.16	3.55	3.24	0.31
9 January$_{(i+1)}$	2.81	2.67	0.14	3.12	2.93	0.19
10 February$_{(i+1)}$	2.39	2.24	0.16	2.69	2.61	0.08
11 March$_{(i+1)}$	1.73	1.81	-0.08	2.18	2.21	-0.03
12 April$_{(i+1)}$						
13 May$_{(i+1)}$						
14 June$_{(i+1)}$						
15 July$_{(i+1)}$						
16 August$_{(i+1)}$						
17 September$_{(i+1)}$						
18 October$_{(i+1)}$						
	MAE Overall Improvement		0.38	*RMSE* Overall Improvement		0.84

Figure 1. WASDE Forecasting Cycle for Cotton 2006/07 Marketing Year

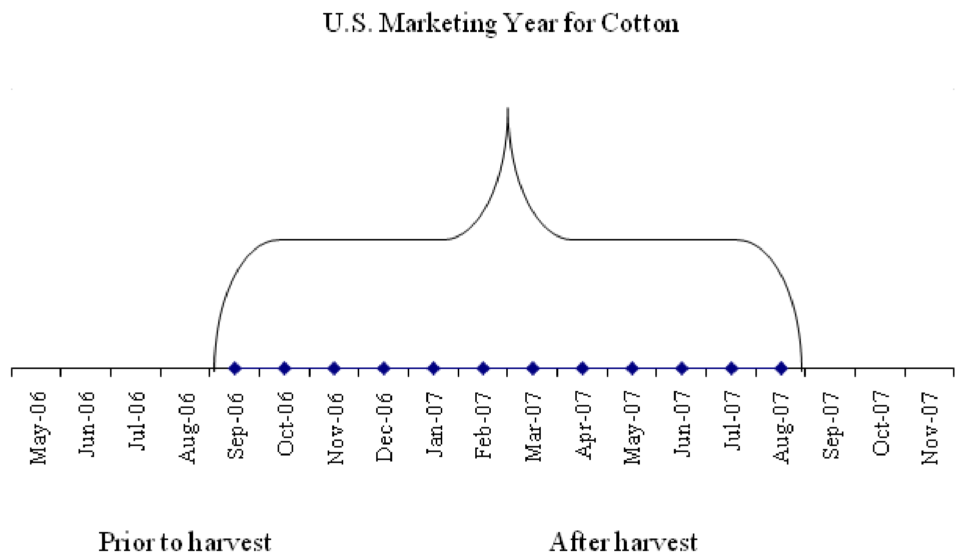


Figure 2. WASDE U.S. Cotton Forecast Estimates over Time, 1985-2008 Marketing Years

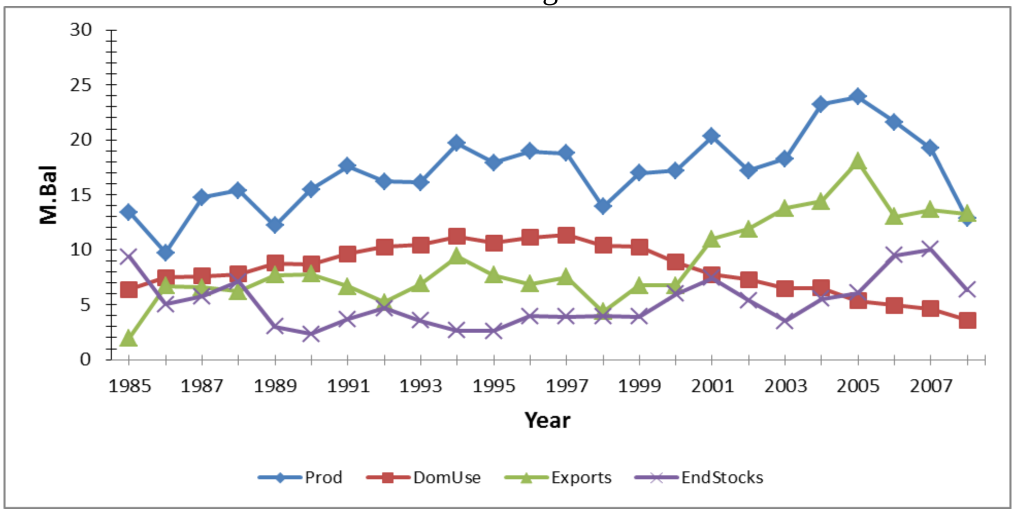


Figure 3. WASDE U.S. Cotton Price Estimates over Time, 1985-2008 Marketing Years

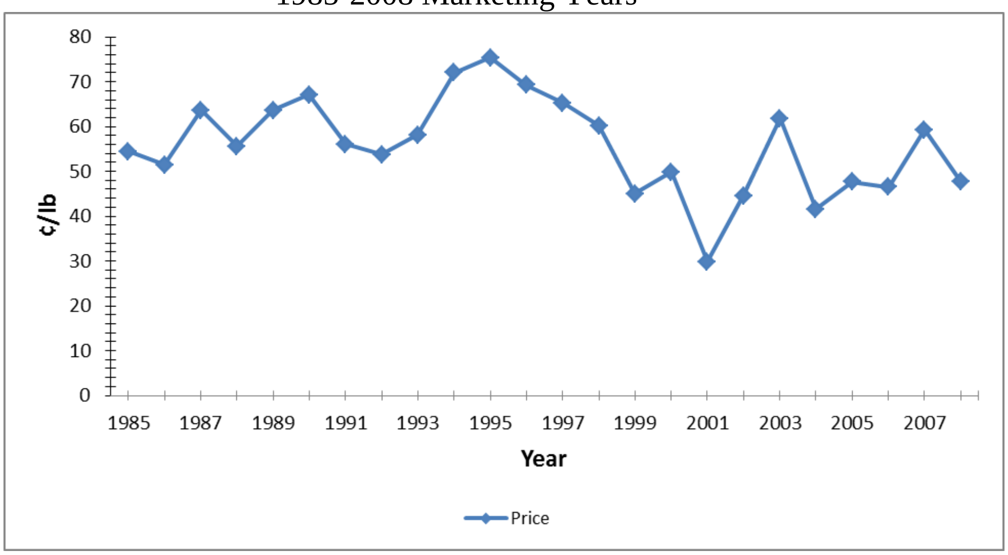


Figure 4. WASDE China Cotton Forecast Estimates over Time, 1985-2008 Marketing Years

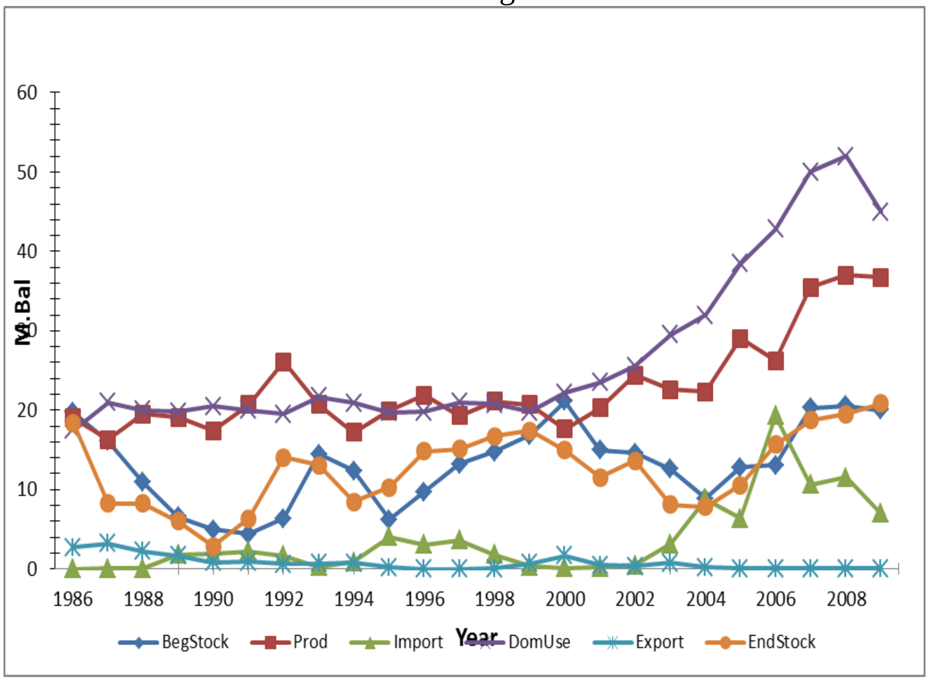
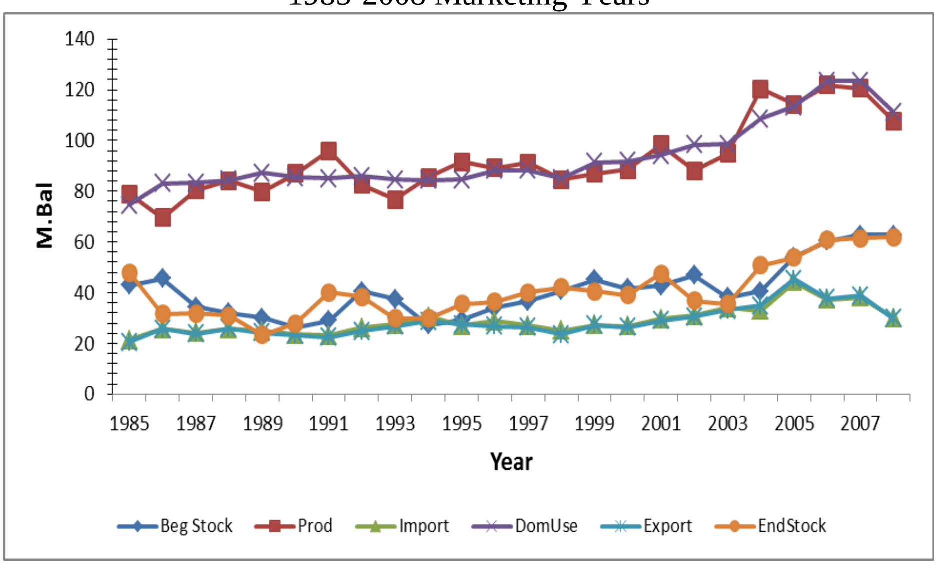


Figure 5. WASDE World Cotton Forecast Estimates over Time, 1985-2008 Marketing Years



APPENDICES

Appendix A

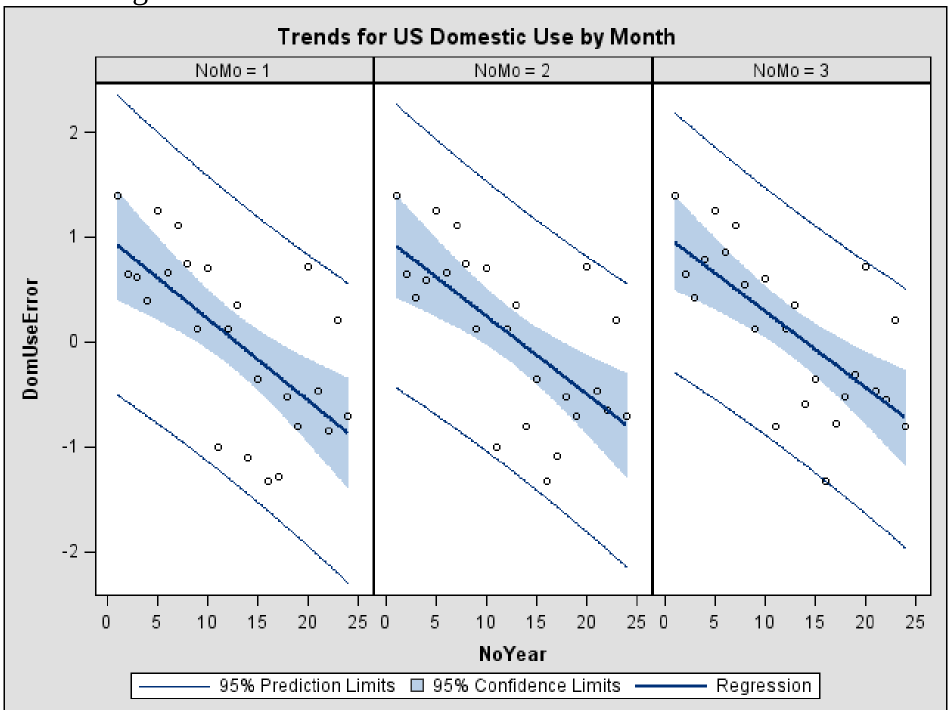
SAS Code

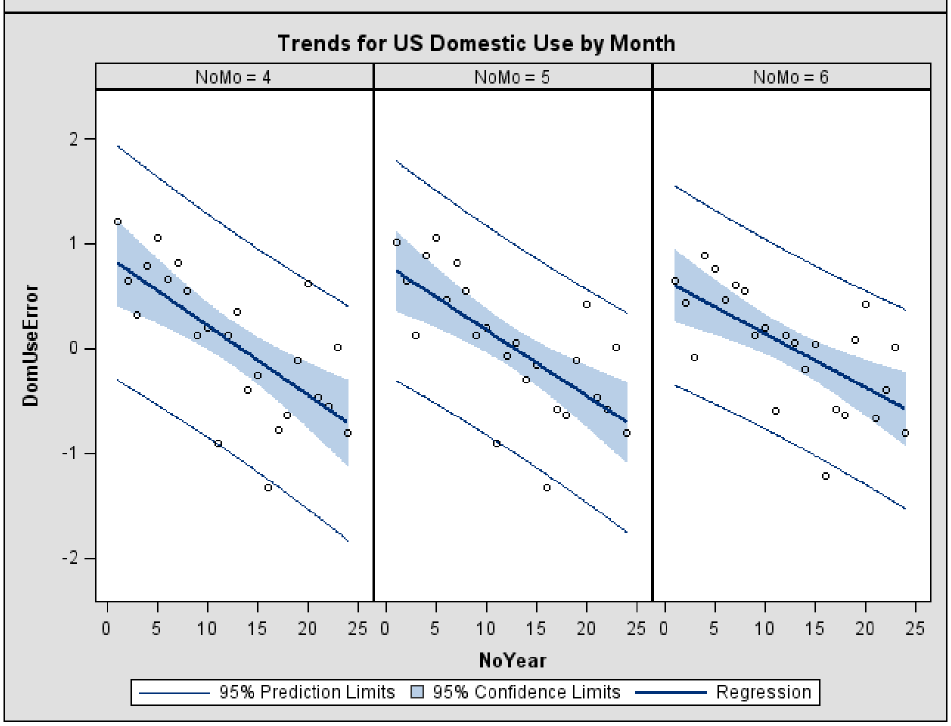
```
Data OriginalData;
input Year YearNo Month Prod DomUse Exports EndStocks Price ;

Data nineteen (keep = Year FProd FDomUse FExports FEndStocks FPrice);
set OriginalData;
if Month = 19;
FProd=Prod;
FDomUse=DomUse;
FExports=Exports;
FEndStocks=EndStocks;
FPrice=Price;

Proc Sort data=nineteen;
by Year;
run;

Proc Sort data=OriginalData;
by Year;
run;

Data Combine;
Merge OriginalData nineteen;
by Year;
run;

Data Errors;
set Combine;
ProdError=FProd-Prod;
DomUseError=FDomUse-DomUse;
ExportsError=FExports-Exports;
EndStocksError=FEndStocks-EndStocks;
PriceError=FPrice-Price;
PerProdError=(FProd-Prod)/FProd;
PerDomUseError=(FDomUse-DomUse)/FDomUse;
PerExportsError=(FExports-Exports)/FExports;
PerEndStocksError=(FEndStocks-EndStocks)/FEndStocks;
PerPriceError=(FPrice-Price)/FPrice;

Proc Sort Data=Errors;
by Month;
run;

Data TestGroups;
set Errors;
 do group= 1 to 11;
 if yearno le 13
 then output;
 else if yearno - group le 13
  then output; end; run;
  proc sort;
```

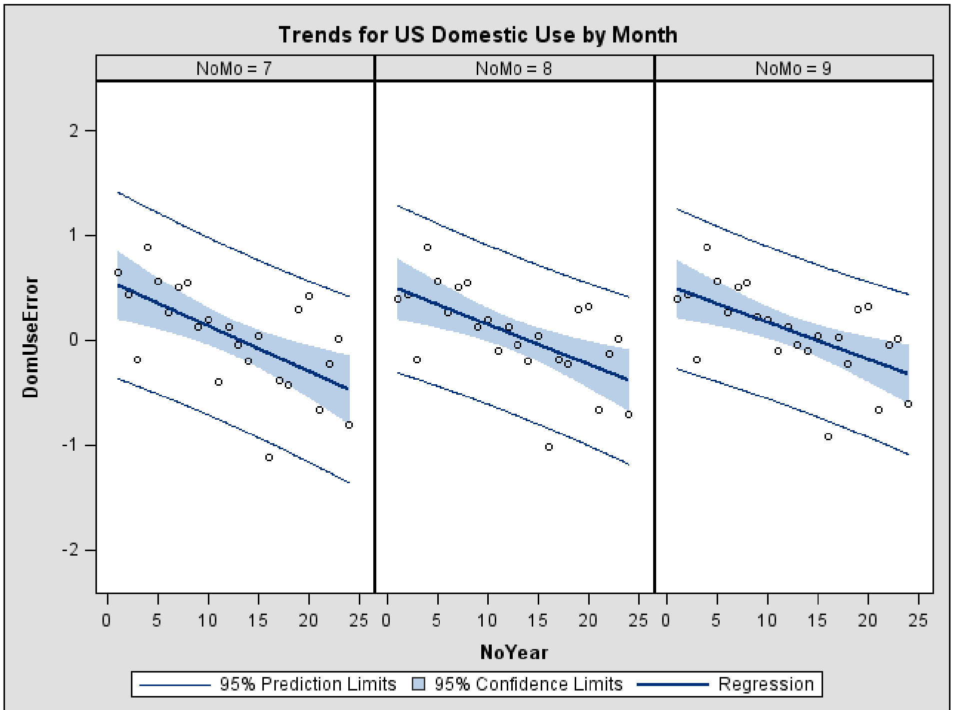
```
  by group month;

  Proc Reg data=TestGroups;
  ods output parameterestimates=DomUseErrorbygroup;
  model DomUseError=yearno;
  by group month;
  run;
            proc transpose data=DomUseErrorbygroup
out=DomUseErrorbygroupColumn;
            by group month;
            id variable ;
            var estimate ;
            run;
data DomUseErrorbygroupColumn ;
set DomUseErrorbygroupColumn;
trendcoef=yearno*1;
drop _Label_ _name_ yearno;
  run;

Data TestMerge;
set errors;
if yearno > 14;
group=yearno - 14 ;
run;

Proc Sort Data=   TestMerge;
by Group month;
Proc Sort Data=   DomUseErrorbygroupColumn;
by Group month;

Data FinalMerge;
Merge TestMerge DomUseErrorbygroupColumn;
by Group Month;

run;

libname mine 'F:\TestOfBias-Validation\' ;
Data mine.MergeUSData;
set FinalMerge;

run;
quit;
```

Appendix B

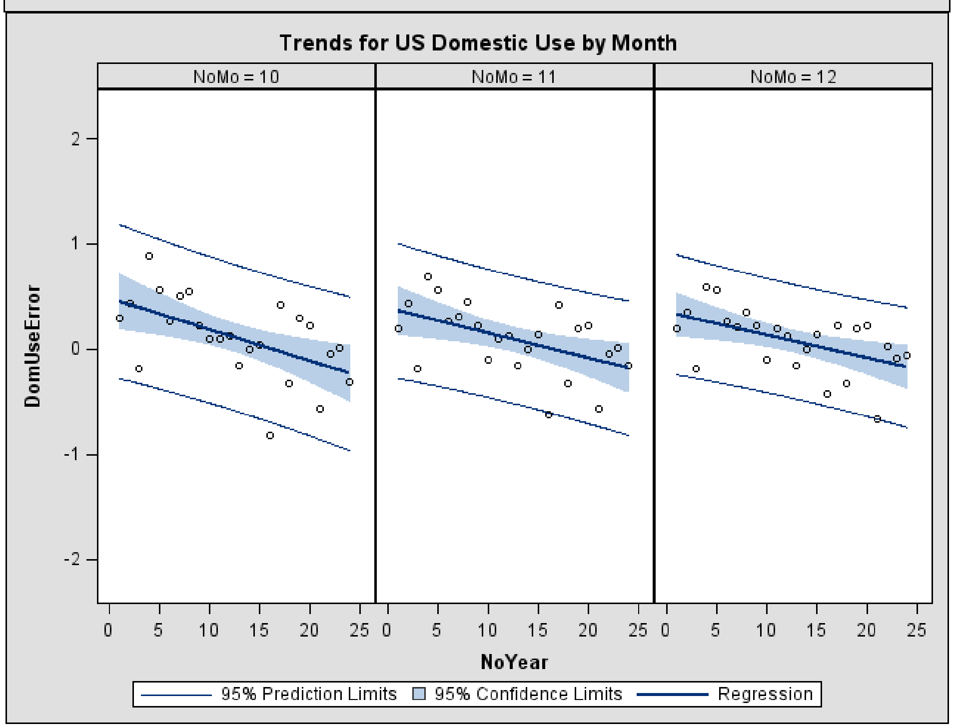
Regression Plots of the Test of Bias for U.S. Domestic Use



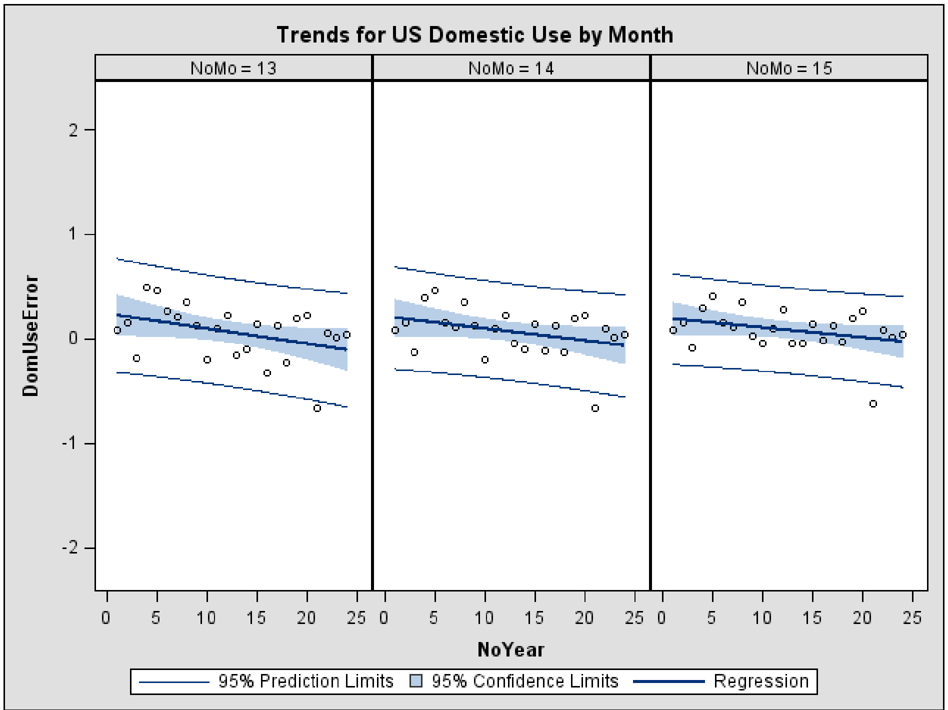


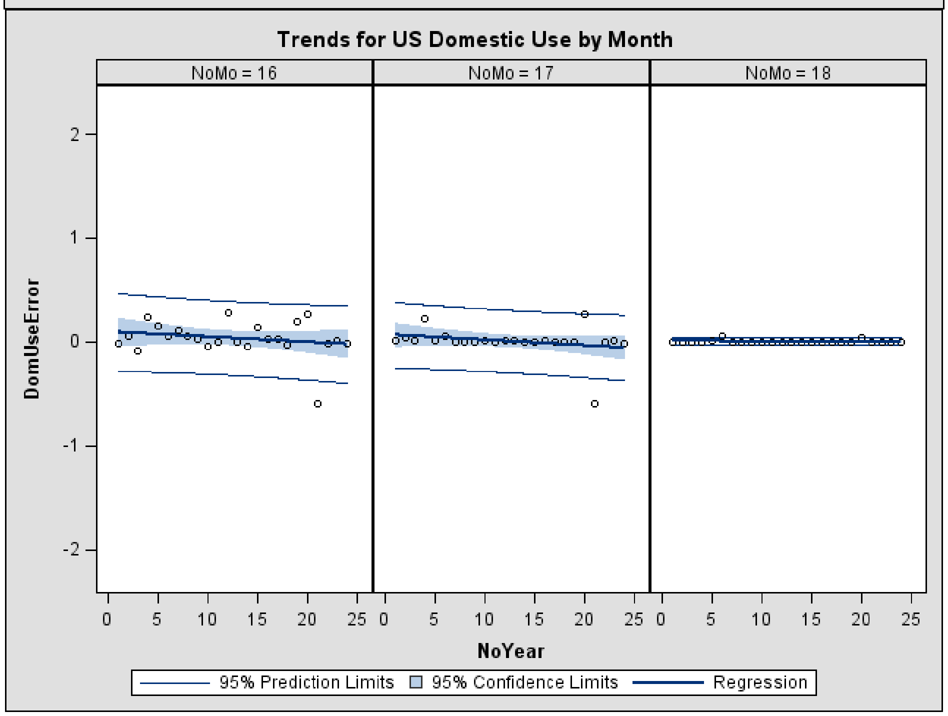


Trends for US Domestic Use by Month
NoMo = 7
NoMo = 8
NoMo = 9
DomUseError
NoYear
95% Prediction Limits
95% Confidence Limits
Regression



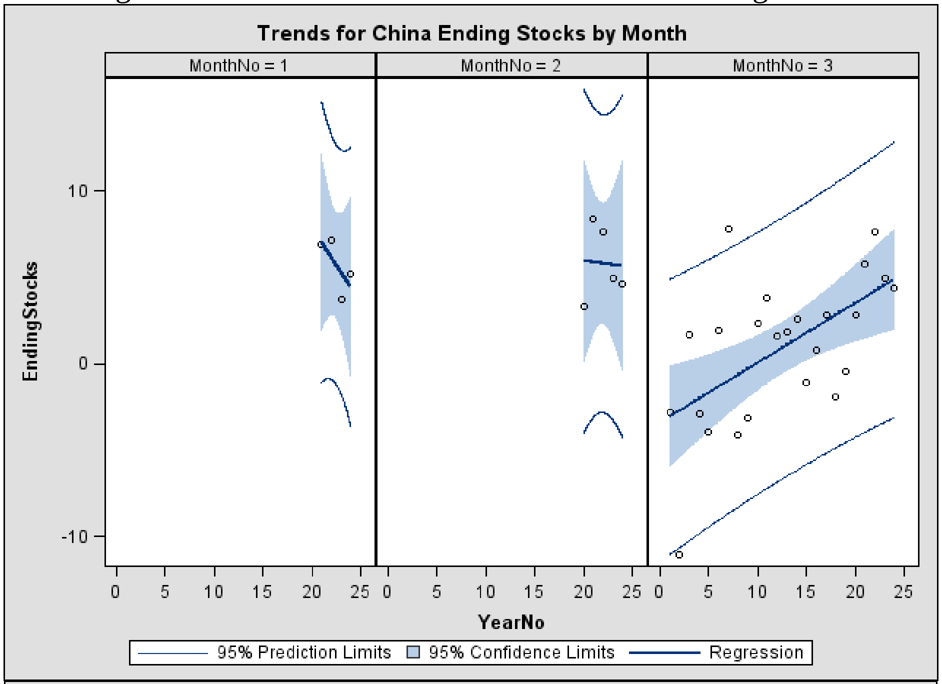
Trends for US Domestic Use by Month
NoMo = 10
NoMo = 11
NoMo = 12
DomUseError
NoYear
95% Prediction Limits
95% Confidence Limits
Regression

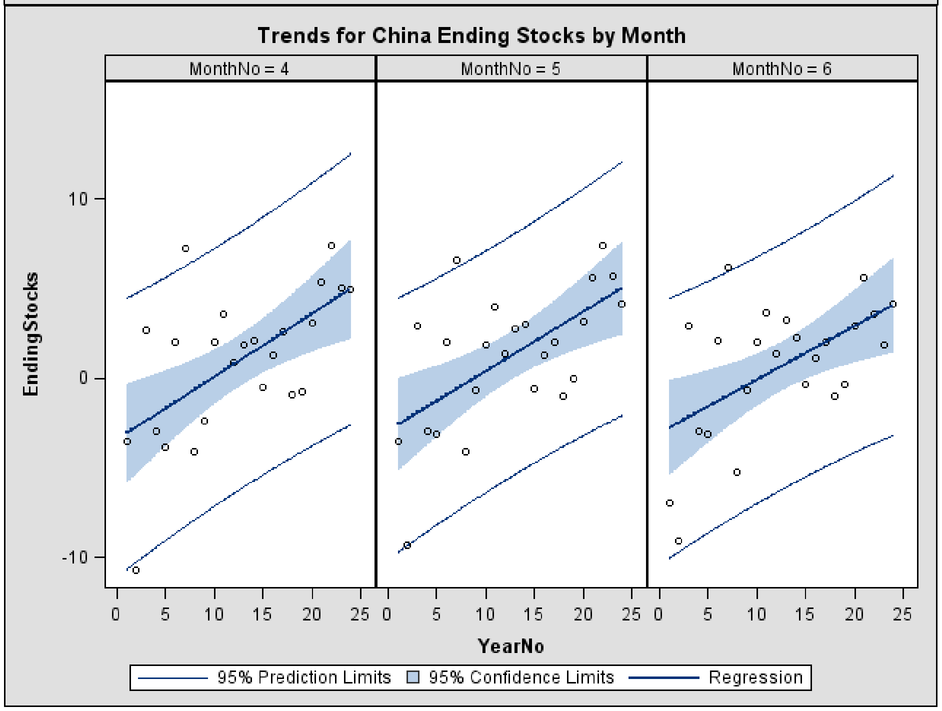

Trends for US Domestic Use by Month
NoMo = 13
NoMo = 14
NoMo = 15
DomUseError
NoYear
95% Prediction Limits
95% Confidence Limits
Regression

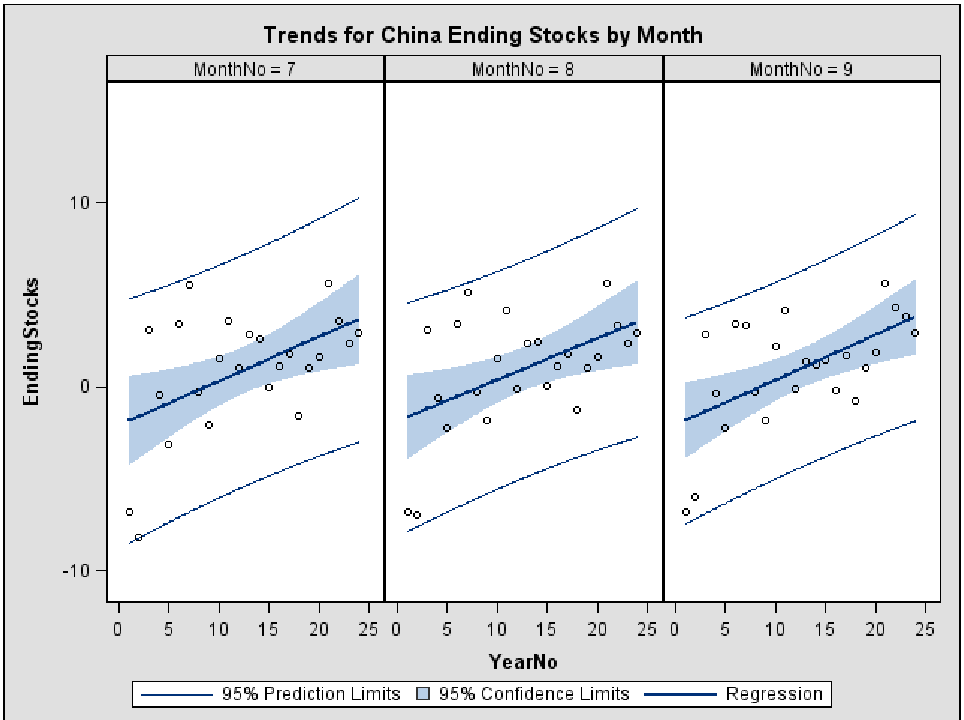

Trends for US Domestic Use by Month
NoMo = 16
NoMo = 17
NoMo = 18
DomUseError
NoYear
95% Prediction Limits
95% Confidence Limits
Regression

Appendix C

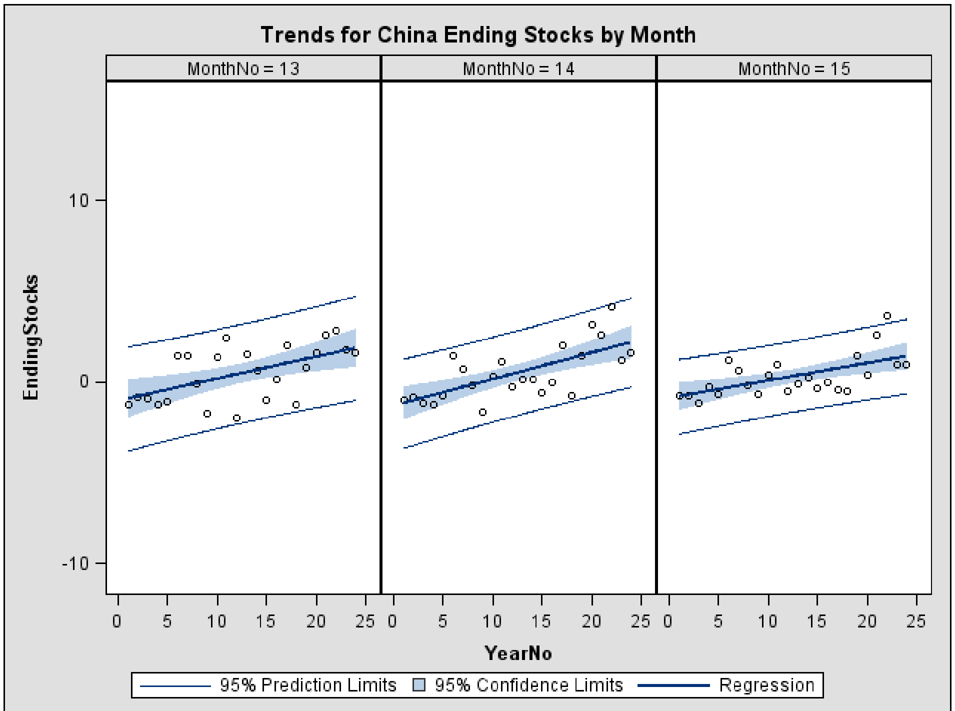
Regression Plots of the Test of Bias for China Ending Stocks



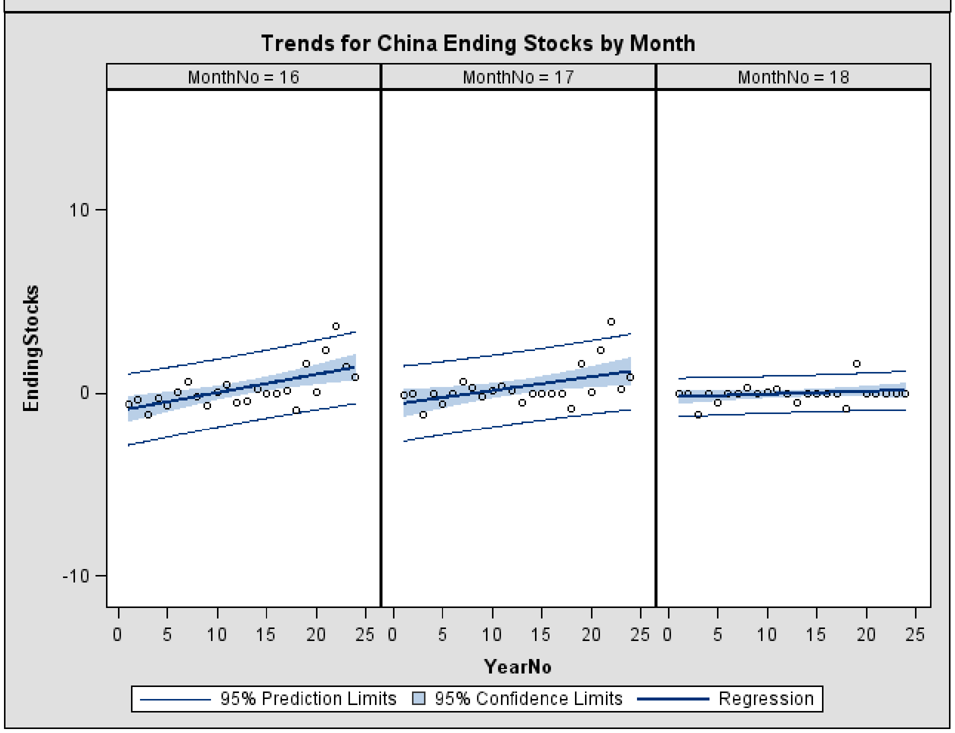



Trends for China Ending Stocks by Month
MonthNo = 7
MonthNo = 8
MonthNo = 9
EndingStocks
10
0
-10
0 5 10 15 20 25
YearNo
95% Prediction Limits
95% Confidence Limits
Regression


Trends for China Ending Stocks by Month
MonthNo = 10
MonthNo = 11
MonthNo = 12
EndingStocks
10
0
-10
0 5 10 15 20 25
YearNo
95% Prediction Limits
95% Confidence Limits
Regression



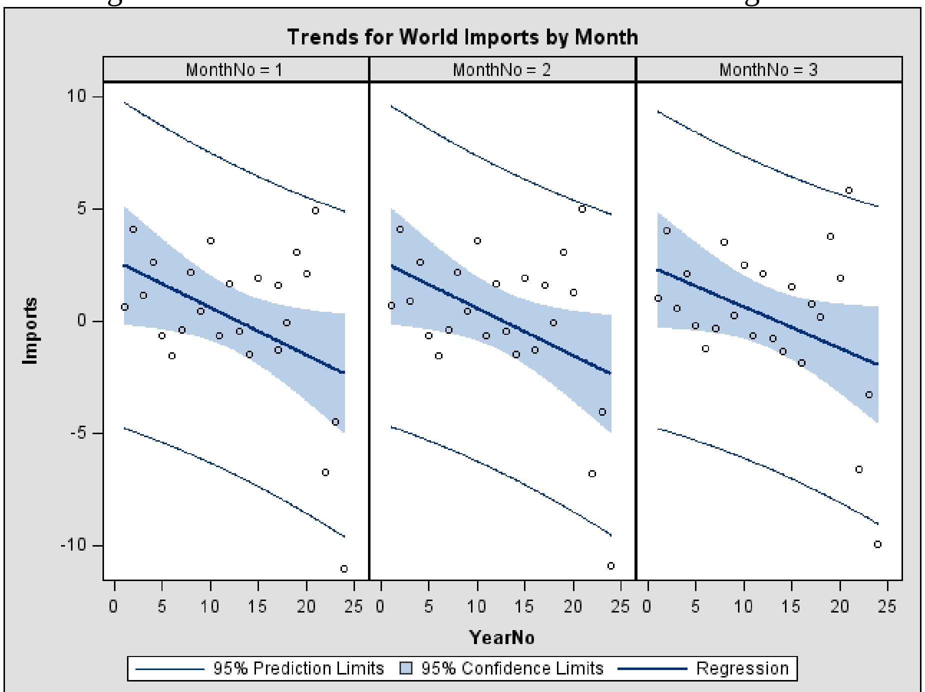
Trends for China Ending Stocks by Month
MonthNo = 13
MonthNo = 14
MonthNo = 15
EndingStocks
10
0
-10
0 5 10 15 20 25
YearNo
95% Prediction Limits
95% Confidence Limits
Regression

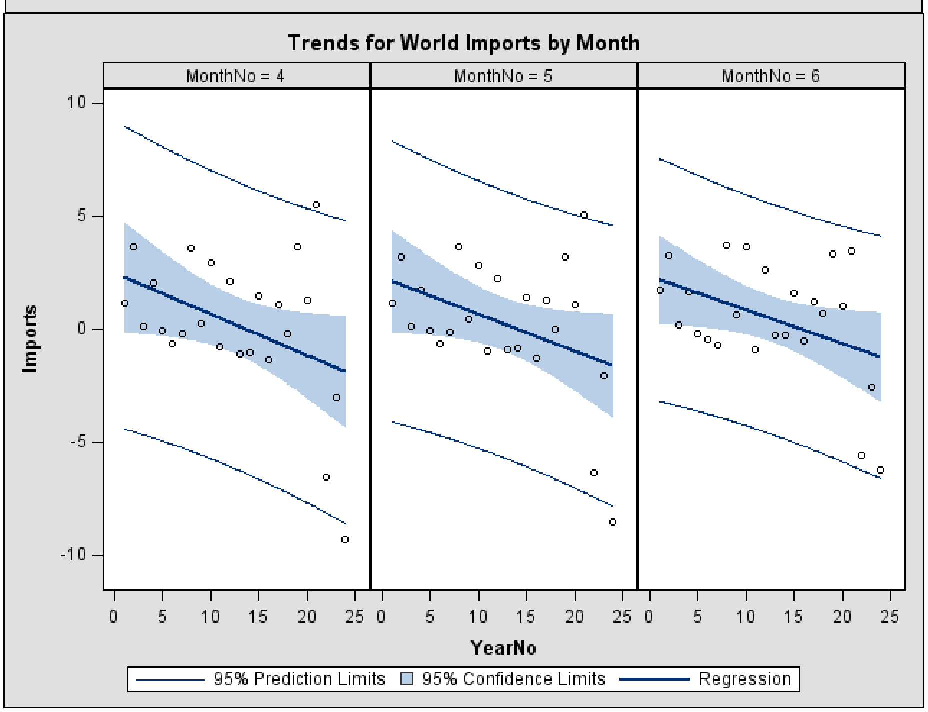


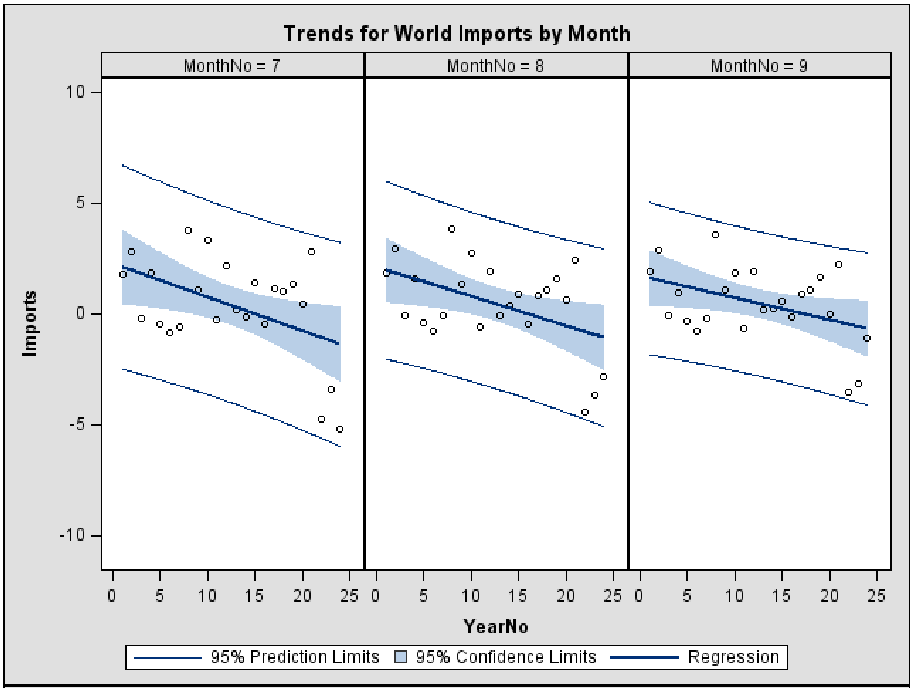
Trends for China Ending Stocks by Month
MonthNo = 16
MonthNo = 17
MonthNo = 18
EndingStocks
10
0
-10
0 5 10 15 20 25
YearNo
95% Prediction Limits
95% Confidence Limits
Regression

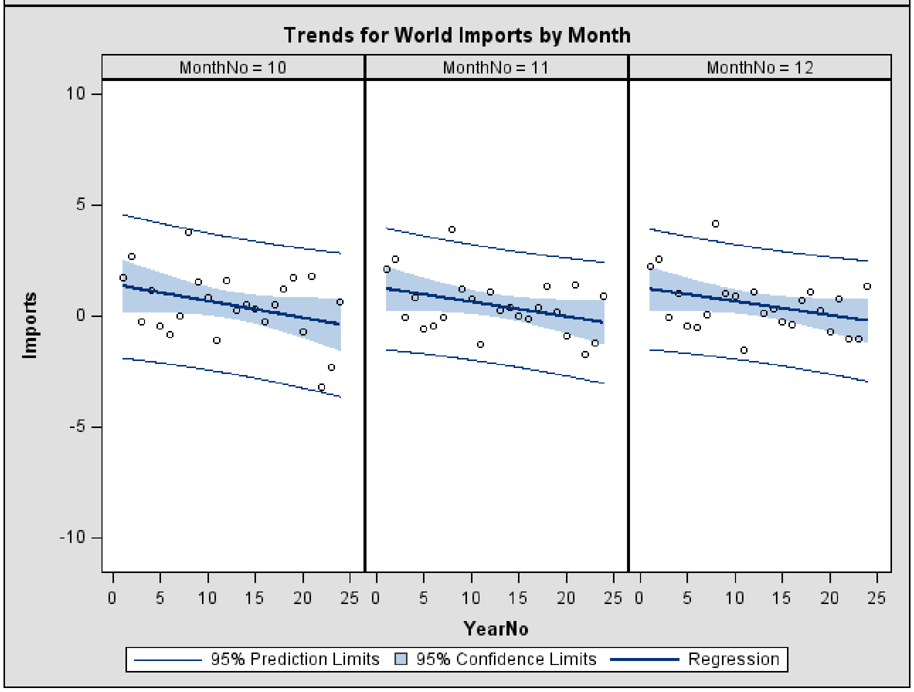
<u>Appendix D</u>

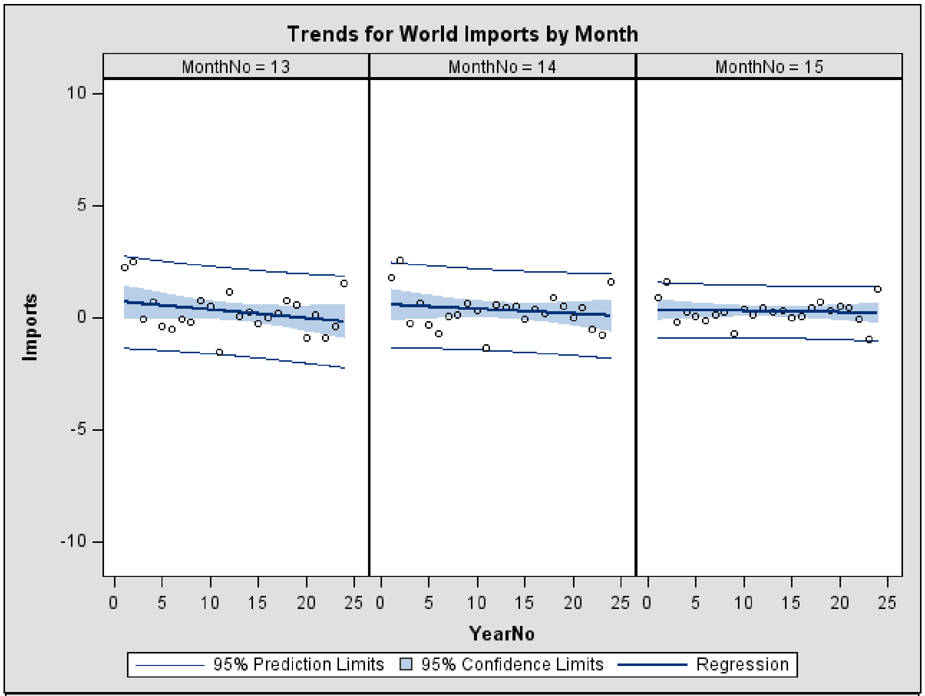
Regression Plots of the Test of Bias for China Ending Stocks

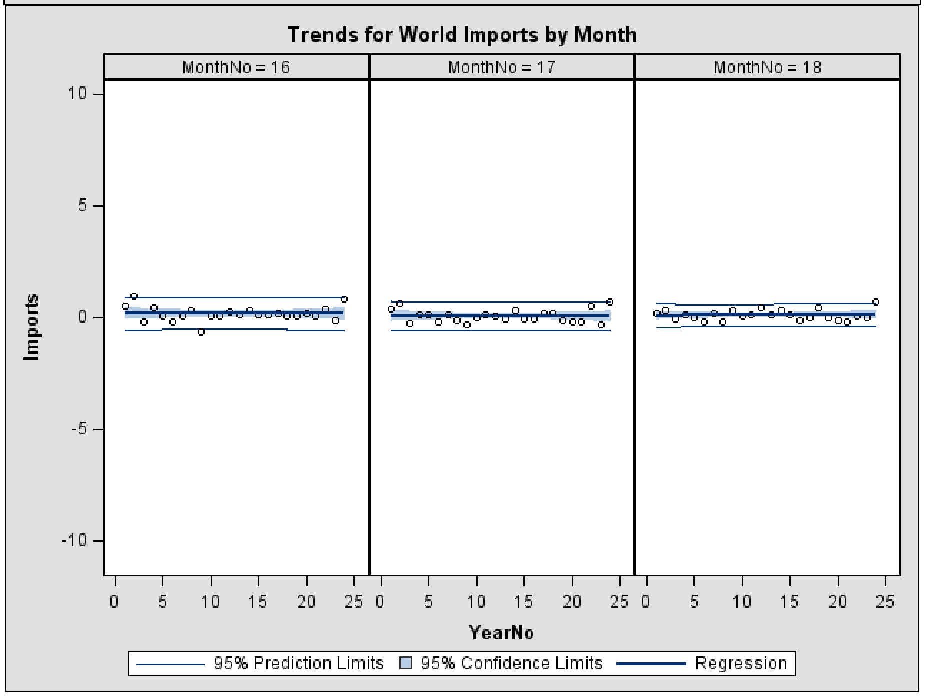





Trends for World Imports by Month
MonthNo = 7
MonthNo = 8
MonthNo = 9
Imports
YearNo
95% Prediction Limits
95% Confidence Limits
Regression


Trends for World Imports by Month
MonthNo = 10
MonthNo = 11
MonthNo = 12
Imports
YearNo
95% Prediction Limits
95% Confidence Limits
Regression


Trends for World Imports by Month
MonthNo = 13
MonthNo = 14
MonthNo = 15
Imports
YearNo
95% Prediction Limits
95% Confidence Limits
Regression


Trends for World Imports by Month
MonthNo = 16
MonthNo = 17
MonthNo = 18
Imports
YearNo
95% Prediction Limits
95% Confidence Limits
Regression

Appendix E

Chow Test

-- MonthNo=1 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	18.05	<.0001

-- MonthNo=2 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	16.51	<.0001

-- MonthNo=3 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	12.86	0.0003

-- MonthNo=4 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	12.67	0.0003

-- MonthNo=5 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	11.42	0.0005

-- MonthNo=6 ----------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	12.19	0.0003

--- MonthNo=7 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	13.29	0.0002

--- MonthNo=8 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	11.76	0.0004

--- MonthNo=9 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	8.41	0.0022

--- MonthNo=10 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	5.36	0.0136

--- MonthNo=11 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	1.66	0.2151

--- MonthNo=12 ---

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	1.06	0.3656

-- MonthNo=13 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	2.35	0.1208

-- MonthNo=14 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	1.76	0.1973

-- MonthNo=15 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	1.63	0.2213

-- MonthNo=16 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	1.43	0.2634

-- MonthNo=17 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	2.16	0.1414

-- MonthNo=18 ---------------------------------

Structural Change Test

Test	Break Point	Num DF	Den DF	F Value	Pr > F
Chow	22	2	20	3.27	0.0591

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