The Effect of China’s Exchange Rate Policy on U.S. Textile Imports

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Abstract

This paper seeks to evaluate the effect of China’s exchange rate policy on the United States’ textile imports between May, 2001 and December 2010. The effect of the yuan/dollar exchange rate on textile imports is tested using a multiple regression model that incorporates both macroeconomic and microeconomic regressors. The analysis reveals that changes in China’s exchange rate have not had a statistically significant effect on the percentage change in the United States’ textile imports from China. Most of the changes in textile imports have arisen from changes in production costs for Chinese firms.

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I. Introduction

Since 1995, the Chinese government has pegged the value of its currency, the Chinese yuan, to the United States dollar. Specifically, when global demand causes an appreciation of the yuan, the Chinese central bank intervenes in the foreign exchange market by buying U.S. dollar-denominated assets in the form of Treasury Bills with Chinese yuan. This increase in the demand for dollars and increase in the supply of yuan causes a shift in the yuan/dollar exchange rate in the foreign exchange market. Specifically the yuan depreciates relative to the dollar. Until 2005, this policy kept the exchange rate relatively static. In June, 2005, in order to deal with an increasing risk of over-investment and high inflation, China changed its currency stance and allowed the yuan to float within a narrow band around a rate determined by a basket of currencies.

During the period in which China controlled the relative value of its currency, its annual trade surplus with the United States has been substantial. Indeed, in 2010, China’s annual trade surplus vis-à-vis the the United States was over USD $273 billion, an increase of 20%, or USD 46 billion, from 2009.

Many domestic producers are claiming that China has been using the artificially low exchange rate to gain an advantage over U.S. producers and make its exports more competitive in U.S. markets. When two countries trade, they need to change money from their domestic currency to the foreign currency in order to pay for the goods or services produced abroad. The rate at which one currency exchanges for another is the exchange rate.

Like goods and services, currencies are affected by the principles of supply and demand. When a country imports more, local firms will demand more of a foreign currency to purchase goods and services produced abroad. As demand for the foreign currency increases, the "price" of that currency increases, or it appreciates relative to the domestic currency. This means that it takes more domestic currency, to purchase the same amount of the exporter’s currency. Holding other factors, such as inflation, constant, an appreciation of an exporter’s currency means that the price of its exports will rise. Consequently, 

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6 op. cit. Krugman pp 427-431
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following an increase in price, the demand for the exporter’s products should fall. Pursuant to this logic, many in the United States feel that, if the yuan is given the freedom to appreciate, then the global demand for Chinese products will increase the value of the yuan, leading to higher prices of Chinese exports and a decrease in the United States’ trade deficit. Thus, many U.S. firms, pundits, and political figures have tried to portray China’s exchange rate policy as an unfair subsidy, and have been promoting retaliatory action, such as tariffs and non-tariff barriers against China to compensate for its artificially low exchange rate.7 Such policies would increase the price of Chinese goods in the United States. Faced with higher prices, Americans would be more likely to demand fewer goods produced in China and, instead, buy more domestically produced goods.

According to economic theory, when a country opens its borders to trade, it and its trading partners benefit since they export goods that they produce efficiently and import goods that they do not. According to the Ricardian Theory of Comparative Advantage, nations will specialize in and export the goods that they produce relatively more efficiently than another country.8 This relative efficiency, according to the Heckscher-Ohlin Theorem, is determined by a nation’s endowments of labor and capital. If a nation has an abundant supply of one factor, the price of utilizing that factor is relatively low. Conversely, if a nation has a scarce supply of a factor, then the price of using that factor will be higher. Hence, the nation will specialize in production and export the goods that most intensely use its abundant factor.9

Applied to the trade debate between the United States and China, one can classify textiles as a relatively labor intensive good. Textiles do not require a high level of technology to produce and, hence, do not require a high level of capital investment. Rather, textile goods depend on a high quantity of unskilled labor to run basic machinery. China has the world’s largest population, and as a result, is endowed with a relative abundance of labor compared to the United States. Consequently, it is possible that they have a comparative advantage in the production of textiles vis-à-vis the United States.

Based on these theories, this paper will attempt to examine the causes of the trade imbalance between the United States and China by focusing on the textile industry. By examining the effects of national price levels, production costs, industrial efficiency, and tariffs, I hope to determine whether the effect of China maintaining a "managed-float" exchange rate policy is statistically

8 op. cit. Krugman pp. 28-29
9 ibid. pp. 64-68
significant, or if other factors play a more significant role.

This paper is organized into four sections. The first is a review of the current literature addressing the relationships between exchange rates and trade patterns. The next section addresses the data used in this study, both in terms of descriptive statistics and potential problems that may arise due to exogenous data collection. In the third section, I describe the econometric model used. Lastly, I discuss the conclusions I drew from my model and some of the economic implications that arise.

II. Literature Review

The majority of the research on the relationship between exchange rates and trade focuses on macroeconomic determinants. Thus, many empirical studies aggregate trade across the entire economy, rather than breaking it down by industry. However, many of the theories derived from a macroeconomic level have implications at the microeconomic level as well.

One popular theory regarding the effect of exchange rates on imports is the J-Curve Theory. According to Pavle Petrović and Mirjana Gligorić in *Exchange Rate and Trade Balance: J-curve Effect* (2010), a deteriorating exchange rate has a substantial impact on a nation’s trade balance over time. In the short-run, while consumers are still trying to find cheaper substitute goods as the price of imports rises, the trade-balance actually worsens. However, in the long run, as consumers begin to find substitutes, the nation’s trade balance will begin to improve. These flows, plotted over time, create a distinct J-shaped curve. They illustrated that the length of time for a nation to adjust to the new exchange rate is based on a nation’s impulse response function to an exchange rate shock. For example, in Japan, Petrović and Gligorić found that in the first five quarters after the exchange rate changed, the trade deficit worsened. However, the trade deficit gradually improved and reached a new equilibrium 13 quarters later. This implies that, with regard to the United States’ trade deficit with China, there may be a lag between when the level of imports actually adjusts to a new exchange rate with the Chinese yuan.

One major theory that deals with shifts in exchange rates and the effects on prices is the theory of Purchasing Power Parity (PPP). The Purchasing Power Parity theory states that, in equilibrium, the exchange rate between two currencies is equal to the ratio of the two countries’ price levels. When the

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11 ibid. pp. 34-36
12 ibid. pp. 25
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goods sold in different countries have different prices, calculated using the same currency, people will attempt to buy the goods at a discount from the country where the price is cheaper, and sell them at a profit where the price is higher. This process is known as arbitrage.\textsuperscript{14} However, prices are inflexible in the short-run. The wages paid to the people producing a good and the cost of the property and equipment used to produce a good are not easily arbitraged in the short-run, and hence, PPP does not necessarily hold in the short-run.\textsuperscript{15}

According to Antweiler, exchange rates, in the short-run, are driven by the news and people’s expectations.\textsuperscript{16} Therefore, there may be a significant lag between adjustments in the yuan-dollar exchange rate and shifts in either nation’s price level. This means that there may be a delay between shifts in the exchange rate and shifts in the price of textile imports, implying that exchange rate shifts may not immediately affect import levels.

A paper written by Mohsen Bahmani-Oskooee and Yongqing Wang, \textit{United States-China Trade at the Commodity Level and the Yuan-Dollar Exchange Rate} (2007), broke down trade into individual industries to study the impact of the exchange rate on trade flows. In their study, they examined 88 different industries and examined the effect of the exchange rate on import and export values. However, while Bahmani-Oskooee and Wang disaggregated trade to the industry level, their model focused on more macroeconomic variables, such as the aggregate level of price and quantity for each industry and the national price levels of both China and the United States, rather than effects of microeconomic variables, such as wages and costs within the industries.\textsuperscript{17} The results of their export-value model showed that, while many products had negative price elasticities of demand, indicating that the quantity of these goods imported by the United States rose as the yuan appreciated, several others had positive coefficients. The majority of textile sub-industries had a negative elasticity coefficient, implying that a depreciation of the dollar would cause the exports of these goods to rise. In the cases where the estimated coefficient was positive, it was also not statistically significant.\textsuperscript{18} Their results showed that a depreciation of the dollar would significantly increase the export of textile goods from the United States.


\textsuperscript{14} op. cit. Krugman pp. 324
\textsuperscript{16} op. cit. Antweiler
\textsuperscript{17} Bahmani-Oskooee, Mohsen, and Yongqing Wang. "United States-China Trade at the Commodity Level and the Yuan-Dollar Exchange Rate". \textit{Contemporary Economic Policy} 25.3 (2007). pp. 342
\textsuperscript{18} ibid. 352
about the effect of the exchange rate on different types of industries. In this paper, as well as in *United States-China Trade at the Commodity Level and the Yuan-Dollar Exchange Rate* (2007), the authors focused on the effects of the exchange rate on different industries, rather than on trade as a whole. The main difference between the conclusions in these papers, however, was that Bahmani-Oskooee and Arladani compared different characteristics of industries rather than industries themselves. Their study found that smaller industries with lower fixed costs tended to be affected by movements in the exchange rate more than larger industries, and hence, would have a much greater effect on reducing the U.S. trade deficit.\(^{19}\) As a primarily labor intensive industry, the textile industry, according to their model, was significantly affected by the exchange rate. Therefore, shifts in the quantity of textile imports from China, due to the exchange rate, may have a significant impact on the U.S. trade deficit.\(^{20}\)

Even though most of the papers supporting the idea that appreciation of the yuan might directly serve to decrease the quantity of U.S. imports, none of them examine the issue from a microeconomic level. All of the papers test how a combined regression of GDP and the exchange rate affect the trade balance, level of imports, or level of exports. There do not seem to be many studies that really examine microeconomic effects of wages or industry productivity.

### III. Data and Descriptive Statistics

The data for this paper was gathered from several sources. The data on textile imports from May, 2001 through December, 2010 was obtained from the United States International Trade Commission. The data on the exchange rate was obtained from the Federal Reserve Bank of St. Louis. Lastly, the majority of the data on China was obtained from the National Bureau of Statistics of China via chinadataonline.com.

Due to limitations in data collection by various organizations, the scope of the model had to be limited to the aforementioned period. In addition, cost data for the Chinese textile industries was provided as monthly accumulated costs, with January being the base period of each year. This means that January of every year was given as a missing value while each monthly value was given as the total costs accrued from January until that month. Moreover, beginning in 2007, the cost data was recorded in quarterly increments rather than monthly. These missing values may have had an impact on the results of


\(^{20}\) ibid. 557
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my regression.

There were several issues with the data that needed to be addressed before any conclusions made by an Ordinary Least Squares (OLS) model would be statistically valid. The data that I used for the level of United States textile imports had a mean of roughly USD 2.180 billion, and a standard deviation of 985.678 x 10^6. However, as seen in Figure 1 in Appendix C the data had a very distinct, nearly linear, upward trend over time. OLS relies on the stochastic process of interest to be stationary, or to have no prevailing trend. Otherwise, the OLS regression may generate invalid estimates of the slope coefficients of the variables. In order to deal with the trending, I took the log difference of the level of imports. After this transformation, the series became stationary.

The exchange rate data that I used had a mean of $7.67 yuan per dollar and a standard deviation of 0.9485. However, there was a similar problem in the exchange rate data as in the import data. Initially, due to a rigid fixed exchange rate policy, the level of the exchange rate is nearly flat. However, in roughly June, 2005, China adopted a less rigid exchange rate policy and used a banded exchange rate rather than a completely fixed exchange rate. When this policy was implemented, the exchange rate developed a downward trend, creating a problem of non-stationarity. By taking the log difference of the exchange rate data, I was able to make the series stationary, and hence, usable in a valid OLS regression. More details on the statistical tests used to determine the adherence of my model to the necessary conditions of OLS can be found in Appendix D, Validity of Ordinary Least Squares Model and plots of the data can be found in Appendix C, Data Plots.

IV. Ordinary Least Squares Model

The regression used in this paper controls for variables that may have had an effect on the percentage change in imports from China. One of the main determinants of the demand for a good is the price of that good. As a result, the majority of the variables in my model are variables that might affect price.

The consumer price index (CPI) is a measure of the prevailing price level in an economy. When the CPI rises, it indicates that the price of goods in that country has risen. Hence, I would expect U.S. consumers to import more if the United States CPI rises. On the other hand, if the Chinese CPI rises, goods from China are more expensive to U.S. consumers, which implies that the United States will import less from China. Yet another measure of prevailing prices incorporated into the model is a relative exchange rate between the United States and China. When the overall price level in both economies rises

by the same percentage, this relative price level should stay constant because consumers gain no additional benefit by substituting one nation’s goods for the other. However, if the U.S. CPI rises relatively more than the Chinese CPI or the Chinese CPI falls relative to the U.S. CPI, then the percentage change in imports should rise. The model also controls for the firm level costs in China.

From a microeconomic standpoint, the price of a good may also be affected by shifts in the cost of inputs. When Chinese costs increase, the price of their exports should increase similarly, and hence, decrease the quantity of textile goods imported by the United States. Next, I controlled for the wages paid to United States workers in each textile sub-industry, identified by that sub-industry’s NAICS code. When wages increase, the cost of production increases, leading to an increase in the price of that good. Therefore, I expect that an increase in U.S. wages will lead to an increase in imports.

Using each sub-industry’s industrial production index, I also tried to control for the production efficiency for each United States textile sub-industry. A decrease in efficiency should lead to increases in price, which should increase the quantity of imports purchased by consumers. The last determinant of price that I thought was necessary was the percentage of imports paid in duties. As the percentage of imports paid in duties rises, it is reasonable that the price of those imports will rise, causing United States consumers to demand less imports.

Lastly, I examined the effect of personal income in the United States. As personal income rises, people tend to buy more goods overall. Therefore, imports, which represent a portion of consumption, should rise.

My final model specification is defined as follows:

\[ \ln \text{infadj.imp.diff} = \beta_0 + \beta_1 \ln \text{inf.diff} + \beta_2 \text{cpi.us} + \beta_3 \text{cpi.prc} + \beta_4 \text{cpi.rel} + \ldots \]
\[ + \beta_5 \ln \text{infadj.prc.text} + \beta_6 \ln \text{infadj.prc.app} + \beta_7 \ln \text{infadj.wage.313} + \beta_8 \ln \text{infadj.wage.314} + \ldots \]
\[ + \beta_9 \ln \text{infadj.wage.315} + \beta_{10} \text{ipi.313} + \beta_{11} \text{ipi.314} + \beta_{12} \text{ipi.315} + \beta_{13} \text{ln.pi.us} + \beta_{14} \text{tar.per.313} + \ldots \]
\[ + \beta_{15} \text{tar.per.314} + \beta_{16} \text{tar.per.315} + \epsilon \]

*note1: a glossary of the acronyms used in the model can be found in Appendix A

*note2: a table containing the estimated slope coefficients and standard errors can be found in Appendix B

After running the standard OLS regression, it is clear that the variance of the residuals is not constant over time, which indicates that the estimates of the slope coefficients may be inefficient and inconsistent. To account for these discrepancies, the model utilizes White heteroskedasticity-consistent standard errors.

To determine if any direct relationship exits between the percentage change in the level of imports over time and the percentage change in the exchange rate over time, I created the following base model:
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\[ \ln \text{ln.inftadj.imp.diff} = \beta_0 + \beta_1 \ln \text{er.diff} \]

As expected, the slope coefficient on the percentage change in the exchange rate, \( \hat{\beta}_1 \), was positive, which implies that as the percentage change in the exchange rate increases, or as the yuan appreciates more quickly, so does the percentage change in imports. However, this simple model was a very poor fit for the data. This base specification showed that there was essentially no statistical relationship between the percentage change in imports and the percentage change in the exchange rate. The coefficient of determination, or \( R^2 \), was 0.000252, indicating that essentially no variability in the percentage change in imports could be explained by variability in the percentage change in the exchange rate. In addition, a t-test of the \( \hat{\beta}_1 \) slope coefficient had a test statistic of 0.151, which has a probability of arising by chance, or a p-value, of 0.880. Because this is greater than any reasonable significance level, the test shows that this slope coefficient is likely equal to zero. Lastly, I used an overall F-test to test whether all the coefficients were jointly equal to zero, or whether the model was statistically significant, as a whole. The test statistic was only 0.028702, which had a p-value of 0.866. This indicates that all of the predicted estimators of the model are likely jointly equal to zero. Further explanation of the significance tests used can be found in Appendix E, Significance Tests.

Unfortunately, this base specification gives no insight into any potential causes of the changes in the level of United States textile imports. Most of the literature on trade and exchange rates uses the respective price levels of both countries in their models. Therefore, I created a secondary specification that controlled for the price levels in both the United States and China, as well as a relative price level, constructed by dividing the United States price level by the Chinese price level. The resulting equation was as follows:

\[ \ln \text{ln.inftadj.imp.diff} = \beta_0 + \beta_1 \ln \text{er.diff} + \beta_2 \text{cpi_us} + \beta_3 \text{cpi.prc} + \beta_4 \text{cpi.rel} \]

As can be seen in Appendix B, the coefficient on the percentage change in the exchange rate was still positive, which made little sense. However, the new slope coefficients of the model were fairly well explained by economic theory. By taking the partial derivative of the above equation with respect to \( \text{cpi_us} \), one can examine the effect of changes in the U.S. CPI. This partial derivative is defined as follows:

\[ \frac{\partial \ln \text{ln.inftadj.imp.diff}}{\partial \text{cpi_us}} = \hat{\beta}_2 + \frac{\hat{\beta}_4}{\text{cpi.prc}} \]

Based on the above equation, one can see that as the price level in the United States rises, the percentage change in imports will also rise because
\( \hat{\beta}_2 > \hat{\beta}_4 \) and \( \hat{\beta}_2 > 0 \). In addition, the effect of the coefficient on the relative price level is deflated by the Chinese CPI. This implies that, with a reasonably large Chinese CPI (\( cpi_{prc} \geq 0.763 \)), given an increase in the U.S. price level, the percentage change in textile imports should rise.

Next by taking the partial derivative of the above equation with respect to \( cpi_{prc} \), one can examine the effect of changes in the Chinese CPI. This partial derivative is defined as follows:

\[
\frac{\partial \ln{\text{infadjimpdiff}}}{\partial cpi_{prc}} = \hat{\beta}_3 - \left( \frac{\hat{\beta}_4 \times cpi_{us}}{cpi_{prc}^2} \right)
\]

We can assume that for a reasonably high Chinese CPI, \( \hat{\beta}_3 \gg \hat{\beta}_4 \times \frac{cpi_{us}}{cpi_{prc}^2} \). Therefore, based on this equation, we can conclude that an increase in the Chinese CPI will lead to a decline in the percentage change in textile imports from China.

This model is very useful for studying the effects of changes in national price levels on the percentage change in imports. In examining the effects of both nations’ price levels, one can observe a very distinct price effect. As prices in the U.S. rise, U.S. consumers will substitute away from U.S.-produced goods. In addition, if the Chinese price level increases, U.S. consumers will import less Chinese-produced goods. In addition, the slope coefficient on the relative price level plays an interesting role in identifying how consumers will find substitute products. As shown by taking the partial derivative of this model with respect to the U.S. CPI, consumers do not necessarily shift from U.S.-produced textiles to Chinese-produced textiles. Because the coefficient on the relative price level is negative, it implies that as the U.S. price level rises, U.S. consumers do not just import from China. Instead, based on this model, it seems that they import from other countries in addition to importing from China.

With regard to the changes in the price levels, \( \Delta \ln{\text{infadjimpdiff}} = \beta_2 \Delta cpi_{us} \) and \( \Delta \ln{\text{infadjimpdiff}} < \beta_3 \Delta cpi_{prc} \). Chinese price level to have a direct relationship with the relative price level, which would imply that, as the Chinese price level rises, the effect of \( \hat{\beta}_4 \) becomes larger as U.S. consumers substitute away from higher priced U.S. and Chinese goods to goods produced by other countries.

Overall, this model was only slightly better than the base specification. A t-test of each coefficient indicated that every term had a statistically insignificant effect. In addition, the terms of this model were jointly statistically insignificant. An overall F-test of the model had an F-statistic of only 0.619, and a p-value of 0.650, which indicates that the model, as a whole, has no statistical significance. The \( R^2 \) value did rise slightly to \( R^2 = 0.021822 \), indicating that
including the price level helped somewhat. However, this $R^2$ value means that roughly only two percent of the variability in the percentage change in imports is captured by variability in the model.

With the addition of extra regressors, the $R^2$ value becomes less reliable. Simply including more terms, whether they are actually relevant or not, can still explain some variability in the dependent variable, and therefore, will raise the $R^2$ value. At worst, with additional regressors, the $R^2$ value will remain unchanged. Therefore, I used the adjusted R-squared value, or $\hat{R}^2$, which adjusts for additional regressors, to measure the explanatory power of the model. The $\hat{R}^2$ value was -0.0134, indicating that the additional terms did very little to increase the explanatory power of the model. This, to me, indicates that macroeconomic variables do not necessarily have significant explanatory power, and that firm level data should be analyzed.

In the third model constructed, I accounted for several additional microeconomic variables. This model was specified as follows:

$$\ln(\text{infadj\_imp\_diff}) = \beta_0 + \beta_1 \ln(\text{er\_diff}) + \beta_2 \text{cpi\_us} + \beta_3 \text{cpi\_rel} + \ldots$$

$$+ \beta_4 \text{infadj\_proc\_text} + \beta_5 \text{infadj\_proc\_app} + \beta_6 \text{infadj\_wage\_313} + \beta_7 \text{infadj\_wage\_314} + \ldots$$

$$+ \beta_8 \text{infadj\_wage\_315} + \beta_9 \text{wpi\_313} + \beta_{10} \text{wpi\_314} + \beta_{11} \text{wpi\_315} + \beta_{12} \ln(\text{us\_w}) + \beta_{13} \text{tar\_per\_313} + \ldots$$

$$+ \beta_{14} \text{tar\_per\_314} + \beta_{15} \text{tar\_per\_315}$$

The main additions to the model were the monthly wages paid to American employees in each different textile sub-industry textile mills, textile products, and apparel, each identified by their respective NAICS code, and the costs of production in Chinese textile plants and apparel factories. In this specification, the $R^2$ value jumped to 0.364. The $\hat{R}^2$ increased significantly as well to 0.195. Most importantly, the F-statistic climbed to 2.149, which has a p-value of 0.0172. This means that, at the $\alpha = 0.05$ significance level, the coefficients are jointly not equal to zero, and that the model is statistically significant. However, even in this new model, a t-test of the percentage change of the exchange rate had a test statistic of 1.265, which has a p-value of 0.211. This indicates that, despite controlling for both macro- and microeconomic variables, the effect of the percentage change in the exchange rate on the percentage change in imports is still statistically insignificant, even at a relatively high level of significance.

Unfortunately, the added terms in this new model had some unexpected effects on the coefficients on the other variables. With regard to coefficients on the U.S. CPI, the Chinese CPI, and the relative CPI, while they became statistically significant in this model, they also changed sign. The U.S. CPI became negative, indicating that as U.S. prices rise, the percentage change in imports actually declines. In addition, the Chinese CPI became positive,
indicating that, as Chinese prices rise, the percentage change in imports rises. Hence, the convenient interpretation of these coefficients in the second model no longer applies. On the other hand, the coefficient on the relative CPI became positive, which makes more economic sense than in the second model. As the gap between U.S. prices and Chinese prices widens, people will tend to import more, thus increasing the percentage change in imports.

Of the additional terms in this model, only the Chinese costs in apparel and textiles were statistically significant. However, the coefficient on the Chinese textile costs was positive, which was the opposite of what I expected. A positive coefficient on the Chinese textile costs indicates that, as costs rise, the percentage change in imports rises. An increase in costs, according to economic theory, leads to an increase in price, which should cause demand for that product to decline. This term, however, has a miniscule impact on the percentage change in imports. As costs rise by one million yuan, imports only change by 0.08%.

In the final model that I generated, I tested a secondary hypothesis, that differences in the size of the labor force were a cause of the trade imbalance. To test this, I introduced the employment levels for textile mills, textile products, and apparel in the United States, denoted by the variables \( us_{\text{emp}}_{313} \), \( us_{\text{emp}}_{314} \), and \( us_{\text{emp}}_{315} \). The additional terms in this model really had no unexpected effects on other coefficients in the model. However, the terms decreased the validity of the model. The F-statistic dropped to only 1.791 and the adjusted R-squared dropped to \( R^2 = 0.165 \), indicating that adding these terms to the model made no difference in its explanatory power. This conclusion is verified in Appendix E.

V. Results and Conclusions

The purpose of this study was to determine the effects of changes in the exchange rate on changes in textile imports for the United States. In every model that was tested, the slope coefficient, \( \beta_i \), for the change in the exchange rate, was statistically insignificant. In conclusion, it appears that when firm level data is controlled for, the effect of the exchange rate becomes insignificant. However, the scope of this study was somewhat limited: only data between May 2001 and December 2010 was used. As was stated by Antweiler on Purchasing Power Parity, the effect of Purchasing Power Parity is a long-run condition, implying that it takes a significant amount of time before the exchange rate adjusts to equalize prices.\(^{22}\)

Caution should be used when analyzing the results of this paper. The data collected accounts for the effect of changes in the exchange rate on textile

\(^{22}\) op. cit. Antweiler
imports, but does not account for other products. It may be the case that the exchange rate has a different effect on other products. In *United States-China Trade at the Commodity Level and the Yuan-Dollar Exchange Rate*, for example, the authors found that changes in the exchange rate had different effects on different types of goods. Nevertheless, the conclusions of this paper are clear in the case of the United States textile industry. When accounting for firm level costs, the effect of changes in the exchange rate on changes in the level of imports is statistically insignificant over the sampled period.

Overall, it appears that the firm level costs of production have the largest effect on changes in the level of textile imports by the United States. In the last two models discussed, the effect of the percentage change in the exchange rate on the percentage change in textile imports from China was statistically insignificant. In the final model, all of the macroeconomic price measures were significant at the 10% level, while the Chinese costs for both textile mills and products and apparel were statistically significant at the 1% level. This result seems to indicate that imports of textiles from China seem to be dependent on other factors, with no significant effect coming from the exchange rate.

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References


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### Appendix A

#### Variables

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
<th>Units and Base Period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln_adj_mills_diff</td>
<td>Percentage change in the real value of textile imports from China from one year to the next</td>
<td>USD 1,000 (base year: 2000)</td>
<td>International Trade Commission</td>
</tr>
<tr>
<td>ln_nr_diff</td>
<td>Percent change in the nominal exchange rate from one year to the next</td>
<td></td>
<td>St. Louis Federal Reserve</td>
</tr>
<tr>
<td>cpi_us</td>
<td>United States headline Consumer Price Index</td>
<td>Level (base year: 2000=100)</td>
<td>St. Louis Federal Reserve</td>
</tr>
<tr>
<td>cpi_pre</td>
<td>Chinese Consumer Price Index</td>
<td>Level (base year: 2000=100)</td>
<td>OECD Statistics</td>
</tr>
<tr>
<td>cpi_rel</td>
<td>Relative Consumer Price index between the United States and China</td>
<td>China CPI / US CPI * 100 (%)</td>
<td>(Calculated Statistic)</td>
</tr>
<tr>
<td>infladj_textile</td>
<td>The cost of production of textile mill goods and textile products</td>
<td>CNY 100 million (base year: 2000)</td>
<td>China Data Online: Industry: Economic Benefit Indicators</td>
</tr>
<tr>
<td>infladj_apparel</td>
<td>The cost of production of apparel</td>
<td>CNY 100 million (base year: 2000)</td>
<td>China Data Online: Industry: Economic Benefit Indicators</td>
</tr>
<tr>
<td>infladj_wages_413</td>
<td>The wages paid per worker per month in the textile mills industry</td>
<td>USD (base year: 2000)</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
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<td>The wages paid per worker per month in the textile products industry</td>
<td>USD (base year: 2000)</td>
<td>Bureau of Labor Statistics</td>
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<td>infladj_wages_415</td>
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<td>USD (base year: 2000)</td>
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<tr>
<td>tpi_413</td>
<td>Industrial Production Index for Textile Mills</td>
<td>% Real Output (base year: 2000)</td>
<td>Econmagic</td>
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<tr>
<td>tpi_314</td>
<td>Industrial Production Index for Textile Products</td>
<td>% Real Output (base year: 2000)</td>
<td>Econmagic</td>
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<tr>
<td>tpi_215</td>
<td>Industrial Production Index for Apparel</td>
<td>% Real Output (base year: 2000)</td>
<td>Econmagic</td>
</tr>
<tr>
<td>ln_pl_us</td>
<td>Percentage change in United States personal income</td>
<td>USD 1,000 (base year: 2000)</td>
<td>St. Louis Federal Reserve</td>
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<tr>
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<td>The percentage of the value of imports of textile mill products collected in duties</td>
<td>%</td>
<td>International Trade Commission</td>
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<tr>
<td>tar_per_414</td>
<td>The percentage of the value of imports of textile products collected in duties</td>
<td>%</td>
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<tr>
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<td>The percentage of the value of imports of apparel products collected in duties</td>
<td>%</td>
<td>International Trade Commission</td>
</tr>
<tr>
<td>us_emp_413</td>
<td>The number of workers in the textile mill industry</td>
<td>1,000 people</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
<td>us_emp_314</td>
<td>The number of workers in the textile product industry</td>
<td>1,000 people</td>
<td>Bureau of Labor Statistics</td>
</tr>
<tr>
<td>us_emp_315</td>
<td>The number of workers in the apparel industry</td>
<td>1,000 people</td>
<td>Bureau of Labor Statistics</td>
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## The Effect of China's Exchange Rate Policy on U.S. Textile Imports

### Appendix B

#### Model Specifications

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Model 1 (Standard Error)</th>
<th>Model 2 (Standard Error)</th>
<th>Model 3 (Standard Error)</th>
<th>Final Mode (Standard Error)</th>
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<tbody>
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<td>C</td>
<td>0.0116 (0.0133)</td>
<td>3.064 (13.268)</td>
<td>-54.886** (25.218)</td>
<td>-58.060** (24.622)</td>
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<td>LN_EQDIFF</td>
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<td>CPLUS</td>
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<td>-0.482** (0.249)</td>
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<td>CPLPRC</td>
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<td>0.513** (0.229)</td>
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<tr>
<td>CPLREL</td>
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<td>0.175* (0.475)</td>
<td>0.524** (0.242)</td>
<td>0.524** (0.242)</td>
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<tr>
<td>INFADJPRC_TEXT</td>
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<td>-0.00213*** (0.00070)</td>
<td>-0.00213*** (0.00070)</td>
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<td>-0.000512 (0.000820)</td>
<td>-0.000512 (0.000820)</td>
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<td>-0.00069 (0.00956)</td>
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<td>IPL315</td>
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<td>0.00049 (0.00241)</td>
<td>0.00049 (0.00241)</td>
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<td>LN_PlUS</td>
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<tr>
<td>TAR_PER3H3</td>
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<td>0.433 (4.463)</td>
<td>0.433 (4.463)</td>
<td>0.433 (4.463)</td>
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<td>TAR_PER3H4</td>
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<td>11.794 (18.582)</td>
<td>11.794 (18.582)</td>
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<td>TAR_PER3H5</td>
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<td>1.647 (3.042)</td>
<td>1.647 (3.042)</td>
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<td>US_EMP313</td>
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<td>0.00412 (0.0107)</td>
<td>0.00412 (0.0107)</td>
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<td>0.000693 (0.0015)</td>
<td>0.000693 (0.0015)</td>
<td>0.000693 (0.0015)</td>
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<tr>
<td>S.E. of Regression</td>
<td>0.177</td>
<td>0.178</td>
<td>0.172</td>
<td>0.159</td>
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<td>Adj R²</td>
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<td>-0.0134</td>
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<td>0.186</td>
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<tr>
<td>F-Statistic</td>
<td>0.0287</td>
<td>0.019</td>
<td>1.591**</td>
<td>2.149**</td>
</tr>
</tbody>
</table>

*significant at 10%, ** significant at 5%, *** significant at 1%
Appendix C
Data Plots

Figure 1: The level of textile imports over time and the level of the yuan/dollar exchange rate over time.

As one can see in the above plots, there is a significant trend in both the level of imports and the level of the exchange rate over time. This strong of a trend will render the estimates of the slope coefficients by OLS to be biased and inefficient. Therefore, it will be necessary to transform the data in some way so as to remove the trend in the data.

Figure 2: The percentage change in textile imports over time and the percentage change in level of the yuan/dollar exchange rate over time.

After taking the first difference of the data, there seems to be much less of a trend in the data. This result will be verified in Appendix D, with an Augmented Dickey Fuller Test.
Appendix D

Validity of Ordinary Least Squares Model

Before actually using OLS to estimate the regression equation, it is necessary to first determine if the data has a trend or if it is stationary. It is clear from looking at the plots of the data over time in Figure 1 in Appendix C, that the level of imports and the level of the exchange rate are both non-stationary in that there is a distinct, deterministic trend in the data. By taking the log difference of the data, it is sometimes possible to remove a trend in the data. Plots of the log difference of the level of imports and of the exchange rate are shown in Figure 2 in Appendix C and seem to show that the trend has been removed from the data. An Augmented Dickey-Fuller (ADF) test was used to verify this result.

The ADF test tests the hypothesis that the data set has a unit root, or that it has a trend, against the null hypothesis that it does not. The log difference in the imports had a calculated test statistic of -9.70. The critical value for the test at the $\alpha = 0.05$ level of significance is -2.887 and the rejection region is given by $t < t_{crit}$. Because the calculated test statistic falls in the rejection region, I rejected the null hypothesis at the 0.05 level of significance. It is likely that the series has no unit root and there is an essentially zero probability of getting this test statistic randomly.

Next, I tested the log difference of the exchange rate for a unit root. The calculated test statistic for the difference in the exchange rate was -5.561. The critical value for the test is -2.887. Because the calculated test statistic falls in the rejection region, I rejected the null hypothesis at the 0.05 level of significance. It is likely that the series has no unit root and there is an essentially zero probability of getting this test statistic by chance.

Since running a regression is statistically valid, OLS can be used to estimate the parameters of the model. However, one should also test whether the estimates generated by OLS are valid. Many of the necessary conditions are determined by the residuals of the model. The first condition is that the residuals must be approximately normally distributed over time.
As one can see from the above plot of the distribution of the residuals, the mean of the distribution of residuals over time is essentially equal to zero. In checking for normality, I ran a Jarque-Bera test on the null hypothesis that the residuals are approximately normally distributed. My test statistic was 0.601, which has a p-value of 0.740. This means that I fail to reject the null hypothesis at the 0.05 level of significance because $p > \alpha$. It is likely that the residuals are approximately normally distributed.

Last, I attempted to determine if there was any correlation over time, in the residuals of my model, called serial correlation. As seen by Figure 4, below, there does not appear to be any trend in the residuals that would indicate correlation with time. However, this conclusion must be verified statistically.
To test for autocorrelation, I used the Durbin-Watson test to test the null hypothesis that the residuals are autocorrelated against the alternative that they are not autocorrelated. The Durbin-Watson statistic is compared to a range of values rather than a single value. If the test statistic falls below the range of values, then the residuals are correlated over time, whereas if the test statistic falls above the range, then the residuals display no autocorrelation. However, if the test statistic falls within the range, then the test is inconclusive. An ideal test statistic is close to 2. My regression had a Durbin-Watson statistic of 2.420. The Durbin-Watson critical values for (n=79, k=16) are $d_L=1.195$ $d_U=2.129$. Because the Durbin-Watson statistic for my model is outside of the upper range of the test, I reject the null hypothesis at the 0.05 level of significance. It is likely that the residuals of my model are not positively autocorrelated.
Appendix E

Significance Tests

In order to test the significance of my models as a whole, I used an analysis of variance test (ANOVA) to determine if the terms of each model are statistically significant as a whole. The ANOVA tests the following hypotheses: $H_0: \beta_1 = 0, \ldots, \beta_k = 0 \text{ vs. } H_A: \text{At least one of } \{\beta_1, \ldots, \beta_k\} \neq 0$.

First, I tested my base specification, Model 1, which had a calculated F-statistic of 0.028702. The F-critical value at (1,115) degrees of freedom and the $\alpha = 0.05$ level of significance is 3.924. Because $F_{\text{calc}} < F_{\text{crit}}$, I failed to reject the null hypothesis at the $\alpha = 0.05$ level of significance. It is likely that the estimate of the slope coefficient in the base model is equal to zero. The results of this test indicate that simply using the percentage change in the exchange rate and a constant term offer an insignificant amount of explanatory power.

Next, I tested Model 2, which was estimated by estimating the coefficients of the consumer price indices from both the United States and China and the relative consumer price index with the variables in Model 1. This model had a calculated F-statistic of 0.619059. The F-critical value at (4,112) degrees of freedom and the $\alpha = 0.05$ level of significance is 2.453. Because $F_{\text{calc}} < F_{\text{crit}}$, I still failed to reject the null hypothesis at the $\alpha = 0.05$ level of significance. It is likely that the estimates of the coefficients in the base model with the included price levels are jointly equal to zero. This low F-statistic implies that, even controlling for the absolute price level in both countries and the relative price level between them, the model still has an insignificant amount of explanatory power.

Third, I tested the model that I would eventually use as my final model. In this model, in addition to the exchange rate and the price levels, I controlled for the inflation adjusted Chinese costs in both textiles and apparel, the inflation adjusted wages in each United States textile sub-industry, the industrial production index of each United States textile sub-industry, the percentage change in personal income in the United States, and the percentage of imports collected in duties for each textile sub-industry. The calculated F-statistic for this model jumped to 2.149. The F-critical value at the $\alpha = 0.05$ level of significance and (16,61) degrees of freedom is 1.8211. Because $F_{\text{calc}} < F_{\text{crit}}$, I rejected the null hypothesis at the $\alpha = 0.05$ level of significance. It is very likely that the coefficients of the model were not jointly equal to zero. The probability of this statistic arising by chance, or the p-value of the test, is 0.0177, indicating a fairly low likelihood of this test being inaccurate.

Lastly, I tested a secondary theory that was mentioned in the introduction:
The Effect of China's Exchange Rate Policy on U.S. Textile Imports

that the United States' relative scarcity of labor, compared to China, was a significant factor in determining the percentage change in imports. To test this theory, I introduced the United States' employment in each textile sub-industry to estimate Model 3. This model had a calculated F-statistic of 1.791. The F-critical value at (19,58) degrees of freedom and $\alpha = 0.05$ level of significance is 1.775. Because $F_{calc} < F_{crit}$, I rejected the null hypothesis at the $\alpha = 0.05$ level of significance. It is likely that at least one of the slope coefficients of the model was not equal to zero, and therefore, the model had a statistically significant amount of explanatory value. However, the calculated test statistic has a p-value of 0.0475. While this is less than the significance level, indicating that model is statistically significant, the power of the model definitely declined from the previous model, indicating that the additional employment terms did not add any additional explanatory power to the model. To verify this statistically, I used a Wald Test to test whether those three estimates of the coefficients were statistically significant. The Wald Test tests the null hypothesis that a group of coefficients is equal to zero, against the alternative that at least one of them is not, much like an ANOVA test. The test yielded an F-statistic of 0.360, which has a p-value of 0.782. Because this p-value is greater than any reasonable level of significance, I failed to reject the null hypothesis, indicating that those three coefficients are likely jointly equal to zero, and verifying that they added little to the model.

By using an ANOVA test on the last two models, I was able to reject the null hypothesis that all of the coefficients in the model were jointly equal to zero, indicating that at least one was not equal to zero. Because the ANOVA test does not specify which coefficient does not equal zero, it is appropriate to use a t-test to examine each estimated coefficient individually. A t-test tests the following hypotheses:

$$H_0 : \beta_i = 0 \quad vs. \quad H_A : \beta_i \neq 0$$

I used a t-test to examine whether the percentage change in the exchange rate has a significant effect on the percentage change in imports. The calculated t-statistic for the slope coefficient of the exchange rate term in the third model was equal to 1.27, which has a p-value of 0.211. At the $\alpha = 0.05$ level of significance, and 60 degrees of freedom, the t-critical value is 2.000. Because $t_{calc} < t_{crit}$, I failed to reject the null hypothesis at the 0.05 level of significance. It is likely that the slope coefficient on the percentage change in the exchange rate is equal to zero, which indicates that the percentage change in the exchange rate has no explanatory power.

For the final model, I ran the same test on the slope coefficient on the exchange rate term. The test had a t-statistic of only 1.24, which had a p-value of 0.219. Because the p-value is greater than the level of significance...
and because $t_{calc} < t_{crit} = 2.002$, I failed to reject the null hypothesis at the 0.05 level of significance. This indicates that the estimated slope coefficient on the exchange rate term is still likely equal to zero and that the percentage change in the exchange rate has no explanatory power.