

Impacts of Exchange Rate Volatility on the U.S. Cotton Exports

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Background and Objective

Exchange rate—the price of a currency in terms of another currency— is arguably the single most important variable in determining the economic environment for trade sectors. Exchange rate affects trade by determining the relationship between international and domestic prices. Changes in the real (inflation-adjusted) exchange rate result in the rising or lowering of the prices of U.S. goods in local currency terms around the world. An appreciating dollar raises the price of U.S. goods on the international market, while a depreciating dollar lowers these prices. The movement of exchange rates not only makes the exports/imports costlier or cheaper, the unpredictable movement of exchange rate attaches a level of uncertainty or risk to trade. The volatility of exchange rate is a measure of the day- to-day movement of the exchange rate with respect to the importing and exporting country and the high volatility in exchange rates makes the financial environment for international transactions riskier. A representative exporter / importer generally makes the contract to sell / buy in one period and the money is received / paid in the other period which is dependent on the realization of the exchange rate in the second period. This exposes the traders to exchange rate risk.

The past three decades have seen a high volatility in the exchange rates. In the early 1970s it was argued that moving from a fixed to flexible exchange rates would make exchange rates more stable in the long run, but after more than thirty years it is evident that the volatility of exchange rates has increased rather than decreasing. Exchange rate risk gains additional importance in the present world since with the opening up of the

world market and reduction in trade barriers, international trade is expected to increase further, and along with it will increase the exposure to exchange rate risk.

Exchange rate movements are particularly important for the agriculture sector in the U.S., where exports account for a major portion of agricultural production. Historically, movements in exchange rates have accounted for approximately 25 percent of the change in U.S. agricultural export value (USDA, 2001). Among the U.S. import/export sector cotton and textiles play a significant role. While cotton has been one of the highest foreign exchange earners in the U.S. agriculture sector since decades, textiles have played an important role in the recently burgeoning trade deficit in the U.S economy. Cotton and textile have been an integral part of human life since centuries. Textile and apparel are basic items of consumption in all countries and cotton is an important ingredient for textile and apparel production. The strong demand for cotton products also explains textile manufacturing's extensive employment and economic benefits. Cotton and textile thus have been important elements of economic activity and growth since the Industrial Revolution.

The high volatility in international trade has led researchers to focus on the determinants of the trade volume. Since exchange rate volatility is one of the most important factors determining trade patterns, many researchers have focused on the impacts of exchange rate volatility on international trade. Exchange rate volatility not only imposes additional trading costs but also increases the operating costs to the firms. Firms deal with this risk either by hedging or by other risk management tools. Broll (1994) pointed out that the

availability of forward markets allows for a substantial reduction in the complexity of the decision making process of a multinational firm. Intuition says that with an increase in the volatility of exchange rate the amount of international trade should decrease, because a risk averse trader responds to exchange rate risk by reducing the volume of international trade

Results of previous research on the impacts of exchange rate volatility on trade mainly concluded that exchange rate volatility does play an important role, however, different markets respond differently to the volatility of exchange rate. Some respond positively, some negatively and some do not have a significant effect. There are many reasons that have been cited for the ambiguous result of the impacts of exchange rate volatility on trade. Some recent studies and literature surveys have found aggregation as one of the major reasons for the ambiguous results and suggest that impact of exchange rate volatility on trade can be better understood by looking at sectoral and bilateral trade rather than aggregate trade.

Perrie and Steinherr (1988) explained that aggregate trade equations neglect industrial and market structure and thus aggregate estimation is therefore likely to suffer from a variable underlying structure. McKinsey (1999) concluded that the use of disaggregated sectoral trade data in estimating the impact of exchange rate volatility on trade flows is potentially beneficial and the impact does differ both in magnitude and distinction between sectors. IMF (2004) pointed out aggregation as one of the causes of the theoretical and empirical ambiguity. Higher level of aggregation requires more

assumptions which also increase the variability of the results and thus the ambiguity. One of the possible reasons stated in this study for ambiguity is that when a firm trades with a large number of countries, the tendency of some exchange rates to move in offsetting directions provides a degree of protection to its overall exposure to currency risk. Goodwin (2001) adds that future research should give direct attention on discerning how and why different markets are affected in different ways by exchange rate risk. That is, what are the exact attributes of markets that explain why one market is significantly affected in a negative way, while another is affected in a positive fashion, and yet another show no statistically significant effect from exchange rate uncertainty. Are the differences spurious or do they reflect important differences in the markets for alternative goods?

Additionally, Cushman(1986), Bini-Smaghi (1991), Klaassen (1999) and Tenreyro (2004) pointed out that the main problems in analyzing the impacts of exchange rate volatility on trade include the third country effects, measurement of volatility, endogeneity of the exchange rate variable and methodological/specification issues.

With the increased dependence of trade on the international environment and the increased importance of cotton and textile trade to the U.S. agricultural sector, this study analyzes the impacts of exchange rate volatility on bilateral U.S. cotton exports to China, Mexico and Turkey . These countries are the top three exporting partners of the U.S. in the cotton sector. Previous research on U.S cotton trade has mainly emphasized on the domestic and international trade policies that have dominated the shifts in trade patters.

These policies have already resulted in major changes in the structure of the cotton and textile industry and necessitate an emphasis on the new business environment and the risks associated with it. Although a few studies have examined the impact of the movements in exchange rate, none of the studies have focused on the impact of exchange rate volatility on U.S. cotton trade.

This study focuses on the U.S. cotton market to determine the significance and direction of the impact of exchange rate volatility on the U.S. cotton and textile trade. The study estimates the impact of exchange rate volatility on bilateral cotton exports from different countries and tries to generalize the findings for cotton and textile trade as a whole. The study utilizes disaggregated bilateral U.S. cotton and textile trade data and thus avoids the aggregation problem generally prevalent in earlier studies. The study takes into consideration the problems in calculating volatility in previous research work by using the most efficient estimate for calculating volatility and giving due emphasis to the nature of financial variables and the time series properties of the data. The study utilizes a structural time series approach to improve upon the present specification in analyzing the impact of exchange rate volatility on trade by treating the trends, season and cyclical components as stochastic, filtering them out from exports and analyzing them separately.

Data and Methods

Classical time series econometrics has relied on the Box-Jenkins approach since decades. However recent researchers (Harvey 1989, Durbin and Koopman 2001) identify that the structural nature of the state space model makes it better than the traditional Box-Jenkins approach. The different components that make up a time-series such as trend, cycle and calendar variations, together with the effects of the explanatory variables and interventions, are modeled separately before being put together in the state space model. It is up to the investigator to identify and model any features in particular situations that require special treatment. In contrast the Box-Jenkins approach is a kind of 'Black Box', in which the model adopted depends purely on the data without prior analysis of the structure of the system that generated the data. Additionally the state space models are flexible because the recursive nature of the model and the computational techniques used to analyze them allow for known changes in the structure of the system over time. On the other hand the Box-Jenkins models are homogeneous through time since they are based on the assumptions that the differenced series is stationary. State space models are very general and cover a wide range including all ARIMA models. This study thus utilizes a state space model to estimate the impact of exchange rate volatility on the U.S. cotton exports.

The volatility of exchange rate is measured using an Exponential Generalized Autoregressive Conditional Heteroskedasticity model (EGARCH) with normal / non-normal conditional error distribution. GARCH models have been widely used in financial time series literature for the calculation of the conditional variance for stock return and

other financial variables and have been found to perform better than other methods for calculating volatility.

The Structural Time Series / Unobserved Components Model

Following Harvey (1989, 1990) and Koopman et al. (2000) the structural time series for U.S. cotton and textile trade was formulated as follows:

$$Exp_{i,t} = \mu_{i,t} + \psi_{i,t} + \gamma_{i,t} + X_{i,t}B + \varepsilon_{i,t} \quad (1.1)$$

$$\mu_{i,t} = \mu_{i,t-1} + \beta_{i,t-1} + \eta_{i,t} \quad (1.2)$$

$$\beta_{i,t} = \beta_{i,t-1} + \xi_{i,t} \quad (1.3)$$

$$\begin{bmatrix} \psi_{i,t} \\ \psi^*_{i,t} \end{bmatrix} = \rho \begin{bmatrix} \cos \lambda_1 & \sin \lambda_1 \\ -\sin \lambda_1 & \cos \lambda_1 \end{bmatrix} \begin{bmatrix} \psi_{i,t-1} \\ \psi^*_{i,t-1} \end{bmatrix} + \begin{bmatrix} v_{i,t} \\ v^*_{i,t} \end{bmatrix} \quad (1.4)$$

$$\begin{bmatrix} \hbar_{i,t} \\ \hbar^*_{i,t} \end{bmatrix} = \rho_2 \begin{bmatrix} \cos \lambda_2 & \sin \lambda_2 \\ -\sin \lambda_2 & \cos \lambda_2 \end{bmatrix} \begin{bmatrix} \hbar_{i,t-1} \\ \hbar^*_{i,t-1} \end{bmatrix} + \begin{bmatrix} \tau_{i,t} \\ \tau^*_{i,t} \end{bmatrix} \quad (1.5)$$

$$\gamma_{i,t} = -\sum_{j=1}^{s-1} \gamma_{i,t-j} + \kappa_{i,t} \quad (1.6)$$

Equation 1.1 represents the cotton export equation where Exp_{it} is the U.S. cotton exports to country i . Exports are decomposed in terms of the trend ($\mu_{i,t}$), cycle ($\psi_{i,t}$), seasonal ($\gamma_{i,t}$) and the stochastic component ($\varepsilon_{i,t}$). In equation 1.2 the trend component is further decomposed into its level ($\mu_{i,t-1}$), slope ($\beta_{i,t-1}$) and the stochastic component ($\eta_{i,t}$). The slope has a stochastic component represented by $\xi_{i,t}$ in equation 1.2. The specification used in the equations 1.2 and 1.3 provide a stochastic nature to the trend and enable the level and the slope to grow slowly over time (Harvey et al. 1986). At the steady state point, the level represents the actual value of the trend and the parameter of the slope is its growth rate. The cyclical component is represented in equation 1.4 and 1.5 and is specified as a succession of sine and cosine waves with the parameter ρ_1 and $\rho_2 \in [0,1]$ and λ_1 and λ_2 representing the damping factor and the frequency of the cycle respectively. A deterministic cycle is a sine-cosine wave with a given period. A stochastic cycle is constructed by shocking it with disturbances and introducing a damping factor. Such stochastic cycles have are capable of modeling the cyclical behavior in most time series. A deterministic cycle emerges s a limiting case. Equation 1.6 illustrates the seasonal components specified as a summation of the (12-1=11) dummy variables for different months. The stochastic nature of the cycle is measured by $[v_{i,t}, v_{i,t}^*]$ and $[\tau_{i,t}, \tau_{i,t}^*]$ while that for the seasonal component is due to $\kappa_{i,t}$.

The error component in the equations 1.1 to 1.6 are assumed to follow a normal distribution with mean zero and variances $\sigma_\varepsilon^2, \sigma_\eta^2, \sigma_\xi^2, \sigma_v^2, \sigma_\kappa^2, \sigma_\tau^2$ for the irregular exports, trend, slope, cyclical and seasonal components respectively. As one of

the variances converges to zero, the corresponding unobserved component becomes zero or deterministic. If all the variances governing the trend, cycles, and the season converge to zero the stochastic model collapses to a pure deterministic model that can be estimated by ordinary least squares.

State Space Specification

The structural time series model in equations 1.1 to 1.6 is then cast into the state space form to be estimated using the maximum likelihood procedure using the kalman filter (Harvey 1989, koopman et al, 2000). The state space form in general comprises of the measurement equation and the transition equation. The measurement and transition equations in the present context are specified as follows:

$$Y_{i,t} = Z_{i,t} \alpha_{i,t} + X_{i,t} B + G_{i,t} u_{i,t} \quad (1.7)$$

$$\alpha_{i,t} = T_{i,t} \alpha_{i,t-1} + H_{i,t} u_{i,t} \quad (1.8)$$

Where Y_{it} is the dependent variable, that is, the bilateral U.S. cotton exports or textile and apparel imports from country i .

$\alpha_{i,t} = (\mu_{i,t}, \beta_{i,t}, \psi_{i,t}, \psi_{i,t}^*, \bar{h}_{i,t}, \bar{h}_{i,t}^*, \gamma_{i,t}, \dots, \gamma_{i,t-10})'$ is the state vector and

$u_{i,t} = (\varepsilon_{i,t}, \eta_{i,t}, \xi_{i,t}, v_{i,t}, v_{i,t}^*, \tau_{i,t}, \tau_{i,t}^*, \kappa_{i,t})'$ is the vector for stochastic

components. Z_t and T_t are fixed matrices of known and unknown values, while G_t and H_t are sparse matrices for which non-zero values are the standard deviations of the errors

associated with the irregular, trend, cyclical and the seasonal components. The unknown values in the fixed matrices (which include the damping factor and the amplitude) and the sparse parameters (hyperparameters), along with the state vectors and the parameters of the explanatory variables, are jointly estimated using the maximum likelihood framework.

The specification of the state space system is completed by two further assumptions.

- a) the initial state vector, α_0 , has a mean of a_0 and a covariance matrix P_0 , that is
$$E(\alpha_0) = a_0 \text{ and } \text{Var}(\alpha_0) = P_0$$
- b) the disturbances ε_t and η_t are uncorrelated with each other in all time periods and uncorrelated with the initial state.

Once in the state space form, the Kalman Filter provides the means of updating the state as new information becomes available. Smoothing algorithms are used to obtain the best estimate of the state at any point within the sample. The Kalman filter is a recursive procedure for computing the optimal estimator of the state vector at time t , based on the information available at time t . The information consists of the information up to and including Y_t . The system matrices (Z, G, T, H) together with a_0 and P_0 are assumed to be known in all time periods and so do not need to be explicitly included in the information set. The starting values for the Kalman filter may be specified in terms of a_0 and P_0 . Given these initial conditions the Kalman filter delivers the optimal estimator of the state vector as each new observation becomes available. When all T observations have been processed, the filter yields the optimal estimator of the current state vector, and

/ or the state vector in the next time period, based on the full information set (Harvey 1989).

U.S. Cotton Export Demand

Let $X_{i,t}$ represent a vector of all the explanatory variables that determine the U.S. cotton exports to country i at month t . i is a major importer of U.S cotton in the international market and includes China, Mexico, Turkey, South Korea and India. $X_{i,t}$ can thus be represented by the following vector

$$X_{i,t} = (\text{Exp}_{i,t-1}, \text{Exp}_{i,t-2}, \text{Exp}_{i,t-3}, \text{INC}_{i,t}, P_{i,t}^{\text{US}}, R_{i,t}, (V)_{i,t}) \quad (1.9)$$

Where $\text{Exp}_{i,t-1}, \text{Exp}_{i,t-2}$, are the two period (month) lag of the U.S cotton exports to country i . $\text{INC}_{i,t}$ is a proxy for the GDP of country i which is the index of industrial production of country i , $P_{i,t}^{\text{US}}$ is the CIF price of US cotton at country i 's port, $R_{i,t}$ is the real exchange rate of country i 's currency with respect to the U.S. dollar, $(V)_{i,t}$ is the exchange rate volatility of country i 's currency.

Calculating Volatility

Addressing the issues raised by different researchers regarding the drawbacks of the GARCH model this study utilizes the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model with a Generalized Error distribution (GED). The EGARCH model was first proposed by Nelson (1991). To deal with the problem of non-normality of the conditional error distribution this study used a student distribution, a Generalized Error Distribution (GED) also known as the Power Exponential distribution (PE) and a skewed student distribution as an approximation for the error distribution. The student t distribution and the GED take care of the kurtosis problem, however they are still symmetric distributions. To take into account the kurtosis

as well as skewness, the skewed t distribution is used. The skewed $-t$ distribution has been used earlier by many researchers. The conditional distribution used finally depends on the convergence of the performance of the EGARCH model.

Data

This study utilized monthly data from January 1995 to December 2005. The monthly real exchange rate data was collected from the Economic research Service (ERS) of the U.S. Department of Agriculture (USDA). The monthly exports of US cotton to China, Mexico, and Turkey was collected from the USDA- FATUS export data. The monthly price data for US cotton and the cotton “A” index was collected from the national cotton council of America website (www.cotton.org). The Index of industrial production data that was used as a proxy for the monthly GDP is from the international financial statistics of the IMF as well as the OECD online data.

Results and Discussion

Conditional Variance Analysis

Before starting the final analysis of the impact of exchange rate volatility the coefficient for exchange rate volatility is calculated. Since the exchange rate of all countries is found to be non-stationary and mostly not normally distributed the first difference of the logs of the exchange rate is used in the conditional mean equation of the GARCH/ EGARCH model. Table 5.1 shows the different types of model, the type of distribution and the specification of the conditional mean and conditional variance equation for the GARCH/EGARCH models for different countries. The specification of the conditional

mean and conditional variance equations is selected based on autocorrelation plots of the exchange rates and the convergence and performance of different models and specifications.

Table 5.1. The specification for the conditional mean and conditional variance equation for the GARCH/EGARCH model for China, Turkey and Mexico

Country	Model	Order of GARCH	Order of ARCH	AR Order	Conditional distribution	Other variable
China	GARCH	0	1	0	Gaussian	Dummy
Turkey	EGARCH	1	0	0	Skewed student	-
Mexico	EGARCH	0	1	0	Skewed student	-

Note: The dummy for China is for the year 1995 and represents a structural change as evident from the distribution of the Chinese exchange rate.

Analysis of the State Vector and Structural Relationships

The results from the state space model show that, in the case of China, the variance associated with none of the components (the level, seasonal and cycle) converge to zero which indicates that none of the components is deterministic. For Turkey the variance associate with the level and slope converge to zero indicating the deterministic nature and for Mexico the variance associated with the slope converges to zero. The deterministic nature of these components is also evident in the component graphics for these countries* . The figure shows no variability in those components which are deterministic.

The stochastic characteristics of the U.S. cotton exports to China are mainly governed by the level and two stochastic cycles with standard deviations evaluated at 0.069, 0.054 and 0.20 and the q-ratios (signal to noise ratios) evaluated at 0.34, 0.26 and 1.00, respectively. Thus the variability in the U.S. cotton exports to China is primarily the result of a level

* The component graphics include the plots of the trend, slope, seasonal and the cyclical component for each country. The component graphics for each country are available from the author on request.

and transitory cyclical innovations. For Turkey the fluctuations in exports are governed by a seasonal and two stochastic cycles with standard deviations evaluated at $3.04E4$, 0.051 and 0.001 and q-ratios of 0.001 , 0.050 and 0.001 respectively. The U.S. cotton exports to Mexico are governed by a level, a seasonal and two cyclical components with standard deviations of 0.001 , $1.6E4$, 0.068 and 0.004 and q-ratios of 0.015 , 0.002 , 1.00 and 0.062 respectively. The above results are visible from the component graphics for each country where each stochastic component can be seen to have some variability over time while the deterministic components show no variability. The results indicate that most of the observed variability in the U.S cotton exports to China and Mexico emanates from the level and cyclical innovations and thus both permanent and transitory components contribute to the observed variability. However for the U.S. cotton exports to Turkey most of the observed variability arises from the seasonal and cyclical innovations. Thus permanent shocks do not contribute to the observed variability in the U.S. cotton exports to Turkey.

The cyclical component of the U.S. exports to different countries follows distinct paths indicated by the estimated parameters of their long cycles. The presence of the cyclical component is also evident from the spectral density plots of the exports series for different countries. For China, Turkey and Mexico both the cycles are stochastic in nature and somewhat irregular in period and amplitude.

The estimation of the final state vector indicates that for China the level is significant at the 10% level and for Turkey the slope is significant at the 5% level. The results for the

state vector show a trend level estimated at 20.30, 8.40, and 6.62 for China, Turkey and Mexico respectively. Similarly the slope for these countries is estimated at 0.028, 0.026, and 0.005 respectively. The estimated value of the slope parameter indicates that at the steady state level, the U.S. cotton exports increased by 33.6%, 31.2% and 6% for China, Turkey and Mexico respectively. The component graphics illustrate the path of the slopes (growth rates) for exports to different countries. The trend component has the same unit at the dependent variable while the slope is in percent. The season and cycle panels do not have unit, they are proportionality factors by which the trend needs to be multiplied to obtain the systematic part of the series. For Turkey the trend is deterministic and thus the parameter of the slope is more predictable. For Mexico too the trend is mostly deterministic with a very little variation and the slope is a straight line. However, in the case of China the trend is not deterministic. For China the parameter of the slope changes from one period to the next and the variability displayed in its path is the resulting effect of the stochastic nature of the slope despite the relatively small magnitude of its variance. The slope parameter exhibits a relatively stable path between -20% to -30% from 1994 to 1998 after which it moves upwards and becomes positive in 2000. Chinese accession to the WTO may also have played a role in the upward trend. The growth rate of exports at the steady state point also exhibits the nature of the short term future trend in exports.

The estimated parameters of the cycle along with the root mean square errors are provided, significance tests based on the t-statistics are not conducted as the expected value of the cycle is zero (Koopman, 2000). The amplitudes of the cycle are calculated from the estimated state parameters of the cycle. The amplitude of the large cycle

amounts to 2.9%, 52.8% and 8.5% of the trend of exports to China, Turkey and Mexico respectively. The estimated seasonal parameters for exports show no significant difference in exports flow between the months of February to November for exports to China. For Turkey this was for the months of March and May to November, and Mexico for the months of January, February, March, May, June, July and October. Further results show that for China, the U.S. cotton exports are on average above the trend line from November to April with exports in January and March almost 52% and 69% above the trend line, respectively. Exports are below the trend line from May to October with the lowest in August, almost 42% below the trend line. Exports to Turkey are above the trend line from December to July with exports in January and March almost 84% and 107% above the trend line. Exports are below the trend line from August to November with the lowest in September (66% below the trend line). In the case of Mexico the exports are above the trend line from January to July and below the trend line from August to December with exports in January and July about 17% and 114% above the trend line and exports in August 22% below the trend line.

The estimation of the explanatory variables in the state space model is presented in table A1 along with the standard errors of the variables. The Industrial Production Index which is a proxy for the monthly GDP of the cotton importing country is found to be positive for Turkey and Mexico although significant for Mexico only, while it is found to be negative and insignificant for China. The negative sign for IPI of China is unexpected. The parameter estimate of the ratio of domestic price of cotton to A-index is negative for all the five countries and significant at 5% level for Turkey. Thus, the U.S. cotton exports

decrease when the domestic price of U.S. cotton rises above the international price. The Exchange rate volatility variable is found to have a negative impact on exports to all countries, although the effect is only significant for China and at the 5% level.

The two monthly lag variables are mostly significant for all the countries. The second month lag is not used for Turkey since it causes a sharp increase in the AIC values and does not add to the explanatory power of the model. A dummy for Chinese WTO accession for October 2001 was used in the Chinese equation but was found to be insignificant. With the NAFTA (North American Free Trade Agreement) in 1992, the U.S. trade with Mexico increased and the U.S. textile production shifted its base to Mexico. By 2004 Mexico became the highest importer of U.S. cotton and the largest exporter of Textile and Apparel to the U.S. However with the removal of quotas the U.S. imports of textile and apparel from other low cost countries increased and resulting in a negative impact on the demand for U.S. cotton in Mexico. To take into account this effect a dummy for January 2005 was used in the Mexico equation and was found to be negative and significant as expected.

Overall the results indicate a weak impact of exchange rate volatility which could be attributed to the high exposure of the cotton and textile sector to the domestic and international policies since the formation of WTO in 1994. These policies might have undermined the impact of exchange rate volatility on exports. It also indicates that as the influence of domestic and international policies reduces and the countries move more towards free trade, the impact of exchange rate volatility could become more distinct and

clear and thus exchange rate volatility may be one of the important determinants of U.S. cotton exports in a free trade world.

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APPENDIX

Table A1: Estimated coefficients of explanatory variables: U.S. Cotton Exports

Variables	Definition	China		Mexico		Turkey	
		Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
INC_{it}	Industrial production	-0.128	0.178	2.904**	1.000	0.765	2.025
P_{it}	Price of the U.S. cotton at country i 's port	-2.495	1.850	-0.254	0.489	-5.268**	2.020
V_{it}	Exchange rate volatility of country i	-28.98**	6.980	-0.203	1.229	-0.382	0.384
Exp_{it-1}	One month lag of exports	0.223**	0.076	-0.296**	0.082	0.035	0.084
Exp_{it-2}	Second month lag of exports	-0.193**	0.072	-0.303**	0.084	--	--
R_{it}	Real exchange rate of country i with respect to the U.S. dollar	-5.199	4.983	-1.049	0.807	2.448**	1.165
Dummy	2001 WTO entry(China)	-		-0.444*	0.252	--	--
Q(n)	Autocorrelation	3.7(2)	--	3.15(4)		4.96(5)	--
H(h)	Heteroskedasticity	2.4(28)	--	0.37(44)		0.2(44)	--
R^2	Goodness of Fit	0.73	--	0.61		.60	--

Note: * indicates significance at the 10 percent level, ** indicates significance at the 5 percent level. The statistic Q(n) is Chi-square distributed with n degrees of freedom and is tested against a Chi-square distribution at the 1% level, which indicates a failure to reject the null of no autocorrelation for all the countries. The H (n) statistic has an F distribution with (h, h) degrees of freedom and is tested against a two-sided $F_{h,h}$ test at 1% level. It indicates a failure to reject the null of no heteroskedastic results.