Cotton Price Risk Management across Different Countries

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Abstract

Cotton price relationships between major cotton producers and New York cotton December future price are investigated by the regression model, the VAR model and the error-correction model, the error-correction model generates the hedge ratios that display the largest value in size in most of the cases except Australia. The results indicate that the price relationships between US, China and Australia and New York Future market prices are much higher than the relationships between other cotton producers and New York Future market prices.

Key words: cotton price, New York future market prices, the regression model, the VAR model, the error-correction model

INTRODUCTION

Cotton is one of the major nature fibers which accounted for around 40 percent of the world's annual textile fiber production and served as an engine of economic growth. It provides income to millions of farmers in both industrial and developing countries worldwide. Between 1-2 million households produce cotton in West Africa, up to 16 million people are involved in cotton production in some way. The contribution of cotton to national GDP varies according to country. It provides 3-5% of GDP in Benin, Burkina Faso, Mali, and Chad. Cotton exports generate significant resources for national economies: for example, cotton export share in total exports of the country is 51.4%, 37.6%, 36.2%, 25% and 11.2% for Burkina Faso, Benin, Chad, Mali, and Togo, respectively (Hussein, Perret, and Hitimana 2005). Cotton also does play an important part in US, the United States has produced about 20 percent of the world's cotton supply and consumed 10 percent of world cotton. It provides about 0.1 percent of U.S. Gross domestic Product (Irwin 2001). Importance of cotton trade is verified by the facts that much of the world's cotton crosses international borders at least more than once before reaching its final consumers (MacDonald 2000).

In recent years, several policies and technologies changed in the textile as well as the cotton market around the world affect world cotton trade. First, beginning with 2005, world textile trade is ruled by the Agreement on Textiles and Clothing (ATC) instead of the Multi Fiber agreement (MFA). Based on the new rule, all the quotas in the cotton textile industry are eliminated. Second, China was admitted into the World Trade Organization (WTO) and became a major player in the textile industry. China continues to increase its share of mill consumption, which increased from 27% in 2001 to 42% in 2008 (FAS 2008). Third, India cotton production increases dramatically due to the adoption of Bt cotton. India's cotton production has been dramatically changed in the last couple years and the pace of Bt adoption by producers has accelerated. Average yields have increased from 676 lb/ha in 2001/02 to 1309 lb/ha in 2008/09, a 94 percent increase (FAS, 2008). As the result, India becomes second largest cotton exporter in the world which accounts for 24 percent of world trade (FAS 2008). Forth, dramatic grain prices increase due to the expansion of biofuel production expansion in the United States, Europe, and South America. The credibility of this association is heighted by the facts that practically all biofuels in the world are produced from feedstocks that could be used to produce food or that are produced on land that could produce food (Babcock 2008). Because of land competition between cotton and corn, soybean, and other crops, it is reasonable to think that planting area in some major cotton producers such as the United States will decrease. It is indeed the case in US: the harvested area decreased 7.8 percent in 2006/07 compared with 2005/06; 17.6 percent decreased in 2007/08 compared with 2006/07; 22.8 percent decreased in 2008/09 compared with 2007/08. The total harvested area decreased around 2.3 million hectares, which is more than total cotton harvesting area in the four major cotton producing countries in Africa franc zone countries (Benin, Burkina Faso, Chad, and Mali). Fifth, cotton is a substitute of manmade fibers which are produced from crude oil. The production of manmade fibers decreases as crude oil price increases. As the results, cotton demand increases. Sixth, exchange rate volatility and inflation for many countries are driven by factors other than the fundamental forces behind trade and price levels. Devaluation of the CFA franc in January 1994, by 100% against the nch franc, boosted cotton production. The U.S. dollar climbed to a peak against the euro in February 2002. The trend reversed since, affecting the profitability of cotton production in the African franc zone (Estur, 2004). Based on an orderly correction in the US current account deficit in 2006, the

World Bank said that it expects an annual, 5% effective decline in US currency through 2008 (Business News 2006).The long term depreciation of the US dollar reflects the long term decline in commodity prices and also world's historically higher rates of inflation. Appreciation of Chinese currency would increase the cost of textile exports and as a results decrease Chinese cotton imports. Cotton producers face higher US dollar costs with this inflation and the depreciation of the USD serves only to offset these costs. Cotton producers can be caught in a vicious cycle as depreciation drives up the cost of imported inputs.

Those new trends in the world cotton indicate that the cotton price is volatility. Some of them may cause world cotton price increases while others have negative effects. However, the net effects are unclear.

The cotton price volatility and the effect of the above-mentioned factors as well as the importance of the cotton in the economy of developing countries such as the African franc zone countries increase their exposure to the risk involved in producing cotton. Presently, cotton producers in developing countries such as African franc zone countries make very limited use of risk management instruments to hedge this exposure. Commodity cash prices are more variable than futures prices. Futures and options provide the most efficient way for dealing with short-term price uncertainty, In addition, futures and options contracts can add to the flexibility of selling decisions. Therefore, hedging is useful for cotton market. However, there are several main obstacles for using hedging in those countries: first, agricultural products in both developed and developing countries are not a totally free market and markets are not fully developed especially in developing countries; second, there is the lack of technical in using risk management instruments in developing countries. Although some governments could make good use of hedging instruments in reducing cotton price volatility, there is only to provide limited coverage; third, another reason could be the cost of hedging.

Therefore, the purpose of the study is to examine the relationship between New York cotton future price and domestic farm prices in major cotton players such as US, China, India, Brazil, Pakistan, and the Africa Franc Zone. The results will provide reliable analytical tools that would contribute to a comprehensive understanding of the cotton price transmission and present an economic analysis of the price relationship between domestic cotton farm prices and A-index as well as NYCE near December contract prices.

Conceptual Framework

Farmers of cotton producers face substantial income risk due to price fluctuations. Apart from price support schemes from the government such as counter cycle payments, loan rate, and other programs as used in the US, a number of alternative market-based techniques are practiced to deal with these income risks as we discussed earlier. For example, farmers can spread their sources of income by the cultivation of various crops; harvested output stored in order to sell commodities during a high-price period instead of a low-price period. It is shown that stockholding is an important device for small holders to reduce price risks (Zant 1998). A relatively new technique is to hedge price risks on futures exchanges, or more in general to use so-called financial risk management instruments. These types of instruments have received increased attention in the recent policy discussion (ITF 1999). With respect to the use of these instruments, questions such as the size of costs of hedging price risks and the size of the welfare gains to be obtained of using such a facility are often raised. Consider a farmer who will harvest cotton at a known date in the future. The price at which cotton will be sold at that date is uncertain; hence, the profit from cotton production is stochastic. We assume the farmer only consider the present and some future "terminal" date. That is, the cotton producer is myopic agent (Johnson 1960, Stein 1961, Holthausen 1979) such that his decision horizon equals his planning horizon. The famer cannot revise his cash or his hedging position between the time of placing the hedge and the time when it is liquidated. Based on these assumptions, farmers' production decisions are executed at two distinct dates. At time 1, the output price is not known with certainty. It is assumed that farmers can hedge the risk associated with the output price uncertainty by taking positions in the futures market. At time 2, the uncertainty about the output price is resolved, and the farmers choose the level of hedging conditional on the open futures and options position determined at time 1. To compare the efficiency of different risk management methods, especially whether farmers adopt December New York future contract price to hedge, we consider risk-minimizing strategies. We assume farmers choose a best risk management strategy based on a risk comparison among different choices. That is, farmers will look at the additional risk of a given strategy relative to the optimal one. Following Lence, Kimle, and Hayenga (1993), a benchmark in the hedging literature is the static minimum variance hedge ratio (SMV). The SMV is the proportion of the cash position to be hedged in order to minimize the variance of terminal wealth, for a given cash position. The SMV is important because it represents the optimal hedge ratio for myopic agents who are extremely risk averse (Ederington 1979 ; Kahl 1983). Other reasons include SMV is the optimum hedge ratio when futures prices are unbiased (Benninga, Eldor, Zilcha 1984); as well SMV is easy to estimate empirically and provide a handy operational tool (Lence, Kimle, and Hayenga 1993). Under this framework, if the difference between the cash price and the futures price, referred to as basis, remains constant the hedger is easily able to offset all his risk by taking an equally large position is the futures market as his planned transaction, a hedge ratio of 1. His losses or gains in the cash market will be perfectly offset by his losses or gains in the future market. In reality basis is not stable and the hedger has to weigh together the price risk and the basis risk. In mathematics term, a risk averse farmer's objective is to choose the hedge ratio H_0^* that minimizes the variance of terminal wealth, given the information current available:

(1) $$\min_{H_0} \text{var}_0(\pi)$$

Expected profits at time *t* for cotton producer are

(2) $$\pi = (F_2 - F_1)z + (P_1 - P_2)x - C(x)$$

Where F_j is the futures price quoted at date *j (j=1,2)* for delivery at date 2; *z* is the future position take at date 1, *x* is the known cash position, P_j is the cash price for cotton at data j(j=1,2), and *C(x)* is the cost function for production of *x* units of cotton.

The farmer's objective is to minimize risk as measured by the variance of profit in (2). Based on Mathews and Holthausen (1991), the reasons for this assumption includes: a mean-variance framework is more understandable and requires less information than a full expected-utility-maximizing model and mean-variance models are equivalent to expected utility maximization. The farmer minimizes the variance of profit, σ_π^2, holding output, *X*, fixed by choosing the hedge, *z*, that solves

(3) $$\min \sigma_\pi^2 = \min[z^2\sigma_2^2 + x^2\sigma_P^2 - 2zX\sigma_{2P}]$$

Where σ_j^2 is the variance of future price F_j , σ_P^2 is the variance of *P*, σ_{2P} is the covariance between F_j and *P*. The first order condition for (3) is

(4) $$z\sigma_2^2 - x\sigma_{2P} = 0$$

Therefore, the minimum risk hedge ratio is

$$(5)\quad H_0^* = \frac{z}{x} = \frac{\sigma_{2p}}{\sigma_2^2}$$

The formula is well known in the literature (Kahl 1983) and is called standard hedge ratio (Mathews and Holthausen 1991). *H* is a hedge ratio because it is the proportion of the physical position being hedged. The amount hedged in the market by the farmer is *Hx.*

If basis is constant the two variances and the covariance will be the same and a minimum of zero can be reached at h=1. If the two prices are uncorrelated, indicating a covariance is zero, the optimal value must be reached at h=0. The covariance between the changes in the cash and futures market is therefore the key.

Method and Procedures

Instruments, such as forward and futures contracts, options or derivatives exist which can be used for hedging purposes. However, a major problem faced by commodity traders is to select the proportion of spot positions that should be covered by opposite positions on futures markets. It is crucial that the optimal quantity of hedging instrument(s) to be used is determined. The calculation of the optimal hedge ratio plays a critical role in the hedging process. A crucial input in the hedging of risk is the optimal hedge ratio – defined by the relationship between the price of the spot instrument and that of the hedging instrument. A frequently recommended solution is to set the hedge ratio equal to the ratio of the covariance between spot and futures prices to the variance of the futures price. But in order to implement this seemingly simple rule, the relevant covariance and variance must be estimated from available date. There is a significant amount of empirical research on the calculation of the optimal hedge ratio (see, for example, Cechetti et. al.,1988; Myers and Thompson, 1989; Baillie and Myers, 1991; Kroner and Sultan, 1991; Lien and Luo, 1993; and Park and Switzer, 1995). Methods for empirically estimating the optimal hedge ratio have been proposed and developed which generally fall into the use of following: (a) Ordinary Least Squares (OLS) Models. (b) The Bivariate VAR Model. (c) Error Correction (ECM) Models. OLS is suitable if the spot and futures prices are not cointegrated and the conditional variance-covariance matrix is time invariant. Ederington (1979), Malliaris and Urrutia (1991) and Benet (1992) used this method. However, The OLS has been criticized for not taking into account time varying distributions, serial correlation, heteroskedasticity and cointegration. It has been pointed out in the literature that by not considering cointegration, it results in model misspecification and downward bias in hedge ratios and consequently underhedging. As noted in Herbst, Kare and Marshall (1989), one aspect of the above regression model's invalidity has been the fact that the residuals are autocorrelated. They suggested that the spot and futures prices be modeled under a bivariate VAR framework. It is obvious to know that this model ignored the effect that the two series are cointegrated, which is further addressed in Ghosh (1993). Hedge ratios based on ECM models have therefore been found to yield better performance over those derived from OLS and VAR methods (see Ghosh, 1995; Lien, 1996; Ghosh and Clayton, 1996; Chou, et. al, 1996 and Sim and Zurbruegg, 2001 among others). This method is largely based on the theory of cointegration between futures and spot market in determining the optimal hedge ratio.

For our purpose, we first use Augmented Dickey-Fuller (ADF) test to check whether a price series is consistent with an I(0) process, that is whether it is stationary. Then we use Johnson Cointegration Test to check whether tow or more price series are themselves non-stationary, but a linear combination of them is stationary. The Johansen (1991) methodology provides two statistics to determine the number of cointegrating vectors: Trace and Maximum Eigenvalue statistics. After we check the stationary and cointegration, we estimate the minimum variance of hedge ratios for the major cotton players and choose the optimal hedging ratios, we assumed that hedging was performed using the December New York December cotton contract. Following the literatures, the following different models are described and estimated to calculate optimal hedge ratios and minimum variance.

First, the traditional model. Based on literatures (Leuthold, Junkus, and Cordier, 1989,. 92), ex post minimum variance hedge ratios are typically estimated with the following ordinary least squares regression:

(6) $$\Delta CP_t = \alpha + \beta \Delta FP_t + \varepsilon_t$$

where ΔCP, and ΔFP, are the change in the spot price (CP) and futures price (FP), respectively, over interval ***t.*** The parameter β is the ex post minimum variance hedge ratio, α is the systematic trend in cash prices, and ε is the residual basis risk.

Second, the bivariate VAR model. As we discussed in the literature review, based on Herbst, Kare and Marshall (1989), one aspect of the above regression model's invalidity has been the fact that the residuals are autocorrelated. In order to eliminate the serial correlation, the spot and futures prices are modelled under a bivariate-VAR framework:

(7) $$\begin{aligned} \Delta CP_t &= \alpha_c + \sum_{i=1}^{k} \beta_{si} \Delta CP_{t-i} + \sum_{i=1}^{k} \gamma_{si} \Delta FP_{t-i} + \varepsilon_{ct} \\ \Delta FP_t &= \alpha_f + \sum_{i=1}^{k} \beta_{fi} \Delta CP_{t-i} + \sum_{i=1}^{k} \gamma_{fi} \Delta FP_{t-i} + \varepsilon_{ft} \end{aligned}$$

Where α is the intercept, and β_{si} , β_{fi} and γ_{si} , γ_{fi} are positive parameters. ε_{ct} , ε_{ft} are independently identically distributed (i.i.d) random vectors. The model has to decide its optimal lag length, *k*, which starts from one and is added up by one in each of the iteration until the autocorrelation in residuals is eliminated from the system equations.

If we let var (ε_{ct}) = σ_{ss}, var (ε_{ft}) = σ_{ff} , and cov ($\varepsilon_{ct}, \varepsilon_{ft}$) = σ_{sf}, many previous studies have shown that the minimum variance hedge ratio is

(8) $h^* = \sigma_{sf} / \sigma_{ff}$.

Third, the error-correction model. Based on Ghosh (1993), Lien and Luo (1994) and Lien (1996), the second model ignores cointegration between two price series. Based on their suggestion, if two series are cointegrated, a VAR model should be estimated along with the error-correction term which accounts for the long-run equilibrium between spot and futures price movements. Therefore the second model should be changed as follows:

(9)
$$\Delta CP_t = \alpha_c + \sum_{i=1}^{k} \beta_{si} \Delta CP_{t-i} + \sum_{i=1}^{k} \gamma_{si} \Delta FP_{t-i} + \pi_s Z_{t-1} + \varepsilon_{ct}$$
$$\Delta FP_t = \alpha_f + \sum_{i=1}^{k} \beta_{fi} \Delta CP_{t-i} + \sum_{i=1}^{k} \gamma_{fi} \Delta FP_{t-i} + \pi_f Z_{t-1} + \varepsilon_{ft}$$

Zt-1 is the error-correct term, which measures how the dependent variable adjusts to the previous period's deviation from long-run equilibrium.

(10) $Z_{t-1} = CP_{t-1} + \delta FP_{t-1}$

Where δ is the cointegrating vector. This two-variable error-correction model expressed in equation (9) is a bivariate VAR (*k*) model in first differences augmented by the error-correction term π_s *Zt-1* and π_f *Zt-1*. The coefficients π_s and π_f have the interpretation of speed of adjustment parameters. The larger π_s is, the greater the response of CP_t to the previous period's deviation from long-run equilibrium.

Data

The data sets used in the studies came from different places. The major data source is "the cost of production of raw cotton", published by International Cotton Advisory Committee. Other sources include attached report in USDA foreign Agricultural Service, Food and Agriculture Organization of the United States, the World Bank, and personal contacts in different countries.

Table 1 presents the basic statistics for the twelve major cotton producing countries' domestic farm prices collected in the past thirty years, as well as New York Future market price. It shows that price distributions are quite different among countries. The average cotton price of US, Australia and China is more close to New York Market price. Africa Franc Zone countries and Pakistan have lower average price than the rest of those countries. Since data source limited, there are only 28 years price record to collect for Africa Franc zone countries.

Table 2 shows that US, Australia, China and Turkey cotton prices have strong correlation with New York Future Cotton price. On the contrary, Africa Franc Zone countries cotton price have weak correlation with New York Future Cotton price, like Benin, Chad, Mali. Egypt cotton price also shows that the correlation with New York Future price is weak, which may be related with the government intervention as discussed by Levy (1983). Based on Levy, export taxes, production taxes, and acreage restrictions and heavily subsidized domestic textile industry was contributed to the low relationship between Egypt and world cotton market.

Results and Discussion

<u>Tests of Unit Roots and Cointegration</u>

The results of unit root test for NYDC and farm prices in different major cotton players are reported in Table 3. The Dickey-Fuller or augmented Dicky-Fuller (ADF) tests is used to account for temporally dependent and heterogeneously distributed errors by including lagged sequences of first differences of the variable in its set of regressors (Dickey and Fuller 1981).

The null hypothesis for ADF test is that the variables contain a unit root or they are non-stationary at a certain significant level. In the table, it shows that most of time series are evidenced of non-stationary as the ADF t-statistic is insignificant. After being differentiated once, they all become stationary, that is, the ADF t-statistic become significant. Therefore, it can be concluded that the NYCE and domestic farm prices are process, which is an important precondition for the test of a cointegrating relationship: each of the variables of concerned should be integrated to the same order great than zero (Enders 1995).

Table 4 presents the results of Johnson and Juselius (1990) cointegration test. The results of Johansen's cointegration test are presented in the Table, where two tests, one designed to test for the presence of *r* cointegrating vectors (the 'trace' test), and the other designed to test the hypothesis of *r* cointegrating vectors in *r+1* cointegrating vectors (the maximum eigenvalue test), are undertaken on NYCE and domestic farm prices. When the null hypothesis is that there is no cointegrating vector existing, both eigenvalue and trace statistics strongly reject the null. When the null is that there exists a single cointegrating vector, both statistics tend not to reject it. Therefore, there is an indication of a cointegrating relationship between the variables with rank of one. After testing, it shows that there are no cointegration in US, China, Australia, Turkey and Benin.

<u>The Results from the Three Model</u>

The estimated parameters based on model 1 are presented in Table 5. According to Schwarz Bayesian Criterion (SBC) and log-likelihood ratio statistics (LL), the appropriate lag length of the VAR model is one for most of the series. After checking for empirical regularities that may exist in the data, the estimates from the bivariate VAR (1) model is presented in Table 6. Similarly, the error correction model can be estimated by incorporating the error correction term into the VAR(1) model. The results are presented in Table 7, which shows that for both equations of changes in domestic farm prices and changes in futures prices, the coefficients of the error-correction term (as shown in bold characters) are significant, as indicated by the large values of the *t*-ratios.

Estimated hedging ratio

Using the variance and covariance of the residuals, the hedge ratios of the three models are calculated in Table 8. As expected and in line with most of the previous studies by Ghosh (1993) and others, the hedge ratio estimated by the error-correction model is greater than that obtained from other models in most of the cases except Australia. The hedger ignorant of the cointegrating relationship between futures and spot prices is likely to take a smaller than optimal futures position. The results indicate that countries with higher market powers such as China and US and countries without many market distortions such as Australia will have higher hedging ratio than other countries such as India, Turkey, Brazil and Egypt. For countries without market power as well as suffering significant domestic policy distortions, New York future market price is not a good target for hedging.

Conclusion

The futures hedge ratios have been calculated in this study using various econometric time series models. Of the three constant hedge ratios derived from the regression model, the VAR model and the error-correction model, the error-correction model generates the hedge ratios that display the largest value in size in most of the cases except Australia. This finding agrees with Ghosh (1993) and Lien's (1996) demonstration that non-inclusion of a cointegration relationship leads to a hedge ratio that is biased downwards in size.

The results indicate that the price relationships between US, China and Australia and New York Future market prices are much higher than the relationships between other cotton producers and New York Future market prices. The results may be related with the domestic policies as well as the importance of the country in the cotton market. Based on the results, New York cotton future prices can be used to hedge in US, China and Australia. However, it is not a good hedging tool for African countries. Brazil and India may use the tool since they are becoming an important player in the cotton market.

Future research in the area of hedge ratios can use dynamic methods such as the multivariate GARCH model. As pointed out by Park and Bera (1987) and Pagan (1996), most economic and financial time series encounter the characteristic of heteroskedasticity (or ARCH effects) in the second movements, which partly invalidate hedge ratio estimates.

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Table 1. Statistic Description of Domestic and New York Future Price

	Variable	N	Mean	Std Dev	Minimum	Maximum	Data Source
US Producer Price	USPP	39	54.2915	12.5706	22.82	75.57	National cotton council
Brazil Producer Price	BRPP	19	21.0311	5.9679	11.6951	32.9033	ICAC (International Cotton Advisory Committee)
China Producer Price	CNPP	29	72.0075	13.218	50.5794	92.5625	Chinese National Council
Egypt Producer Price	EGPP	42	29.11	14.0403	10.2904	67.8517	ICAC (International Cotton Advisory Committee)
India Producer Price	INPP	38	28.3977	17.7036	6.5612	60.58	ICAC (International Cotton Advisory Committee)
Benin Producer Price	BNPP	28	14.2085	1.9602	10.379	17.7309	World Bank
Buknin Farso Producer price	BKPP	38	11.6537	3.5924	4.9223	18.4184	World Bank
Chad Producer price	CDPP	28	12.8498	2.1438	9.521	16.2052	World Bank
Mali Producer price	MAPP	38	11.1806	3.6113	3.6917	17.911	World Bank
Australia Producer price	AUPP	48	62.0774	22.4158	27.7526	99.6018	Australia Cotton
Turkey Producer price	TKPP	41	27.3561	7.7567	10.47	42.3647	ICAC (International Cotton Advisory Committee)
Pakistan Producer price	PKPP	39	9.4309	3.4996	3.5136	16.3769	PCGA(Pakistan Cotton Ginners' Association)
New York December Future Price	NYP	33	64.2103	11.2519	42.34	88.29	National cotton council

Table 2. Correlation Matrix between Domestic Cotton Price and New York Future Price

Major Country domestic cotton price	New York Future Price Correlation coefficient	P Value
U.S	0.89079	< 0.0001
Brazil	0.39135	0.0975
China	0.5129	0.0044
India	-0.04762	0.7924
Pakistan	0.26346	0.1051
Australia	0.89472	<0.0001
Turkey	0.51299	0.0008
Egypt	0.12353	0.4934
Burkina Faso	0.34147	0.0359
Benin	-0.00168	0.9932
Chad	0.07093	0.7199
Mali	0.40307	0.0121

Table 3. DF/ADF Unit root Tests

		LAG		DIFFERENCE	
Country		level (0)	first difference(1)	level (0)	first difference(1)
US	Zero mean	-0.06	0.07	-7.44	-4.88
	single mean	-3.26	-3	-7.4	-4.88
	trend	-3.08	-2.81	-7.49	-5.11
Australia	Zero mean	-0.33	-0.14	-8.26	-7.2
	single mean	-2.3	-2.03	-8.21	-7.19
	trend	-2.37	-1.95	-8.19	-7.28
China	Zero mean	-0.56	-0.58	-6.13	-5.44
	single mean	-2.98	-3	-6.01	-5.34
	trend	-2.85	-2.83	-6.08	-5.61
India	zero mean	0.15	0.49	-7.49	-7.69
	single mean	-1.26	-0.99	-7.63	-8.32
	trend	-3.31	-2.74	-7.51	-8.2
pakistan	zero mean	-0.85	-0.98	-6.51	-3.55
	single mean	-0.91	-0.8	-6.51	-3.58
	trend	-2.34	-2.07	-6.46	-3.52
Brazil	zero mean	0.26	0.1	-3.52	-3.92
	single mean	-1.23	-1.87	-3.46	-3.78
	trend	-0.91	-1.53	-3.58	-4.37
Egypt	zero mean	-0.8	-0.61	-7.69	-3.72
	single mean	-2.36	-2.06	-7.6	-3.66
	trend	-2.3	-1.79	-7.67	-3.76
Turkey	zero mean	-0.35	-0.06	-8.43	-5.97
	single mean	-3.26	-3	-8.38	-5.97
	trend	-3.24	-3.09	-8.44	-6.18
Benin	zero mean	-0.1	-0.01	-6.32	-4.59
	single mean	-2.97	-2.54	-6.2	-4.52
	trend	-3.18	-2.8	-6.07	-4.43
Burkina F	zero mean	-0.17	0.3	-9	-5.65
	single mean	-2.6	-2.18	-9.03	-5.76
	trend	-3.51	-2.44	-9.05	-5.87
Chad	zero mean	-0.21	0.1	-5.49	-4.1
	single mean	-2.51	-2.76	-5.41	-4.06
	trend	-2.78	-2.85	-5.29	-3.98
Mali	zero mean	0.27	0.47	-6.97	-4.79
	single mean	-2.22	-2.23	-7.09	-4.98
	trend	-2.99	-2.79	-7.1	-5.06

Table 4. Johansen's Cointegration Test

country	H0 (rank=r)	H1(rank>r)	Eigenvalue Test	Trace Test	Critical Value(5%)
US	r=0	r>0	0.447	19.238*	12.21
	r=1	r>1	0.009	0.292	4.14
China	r=0	r>0	0.371	13.222*	12.21
	r=1	r>1	0.009	0.255	4.14
Egypt	r=0	r>0	0.166	5.978	12.21
	r=1	r>1	0.006	0.187	4.14
India	r=0	r>0	0.115	3.897	12.21
	r=1	r>1	0.000	0.004	4.14
Australia	r=0	r>0	0.450	19.524*	12.21
	r=1	r>1	0.012	0.370	4.14
Turkey	r=0	r>0	0.387	15.916*	12.21
	r=1	r>1	0.009	0.279	4.14
Pakistan	r=0	r>0	0.080	3.516	12.21
	r=1	r>1	0.027	0.860	4.14
Brazil	r=0	r>0	0.241	5.029	12.21
	r=1	r>1	0.004	0.067	4.14
Benin	r=0	r>0	0.424	14.955*	12.21
	r=1	r>1	0.002	0.057	4.14
Burkina Faso	r=0	r>0	0.327	12.694*	12.21
	r=1	r>1	0.000	0.003	4.14
Chad	r=0	r>0	0.351	11.789	12.21
	r=1	r>1	0.004	0.099	4.14
Mali	r=0	r>0	0.250	9.224	12.21
	r=1	r>1	0.001	0.032	4.14

Notes: Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix and Trace of the Stochastic Matrix. *r* represents the number of linearly independent cointegrating vectors.

Table 5. Parameter estimates based on traditional model

country	parameter estimate	standard error	t- value
US	0.58	0.05	11.99
Australia	0.73	0.10	7.24
China	0.42	0.16	2.60
India	0.10	0.10	1.05
Pakistan	0.04	0.01	2.85
Brazil	0.10	0.08	1.15
Benin	-0.01	0.03	-0.34
Burkina Faso	-0.04	0.03	-1.38
Chad	-0.02	0.03	-0.56
Mali	0.00	0.02	0.17
Egypt	0.20	0.12	1.65
Turkey	0.07	0.07	0.92

Table 6. Estimates of a Bivariate VAR (1) Model

Country		D-Domestic		D-NYEC	
		Coefficient	Standard error	Coefficient	Standard error
US	constant	0.036	0.000	0.339	0.000
	DUSPP (-1)	0.762	0.354	1.609	0.518
	DNYP(-1)	-0.705	0.221	-1.383	0.323
China	constant	-0.441	0.000	-0.586	0.000
	DCNPP(-1)	-0.111	0.203	0.336	0.202
	DNYP(-1)	-0.136	0.190	-0.530	0.190
Egypt	constant	-0.053	0.000	-0.109	0.000
	DEGPP(-1)	-0.165	0.175	0.030	0.241
	DNYP(-1)	-0.109	0.123	-0.477	0.169
India	constant	1.533	0.000	0.342	0.000
	DINPP(-1)	-0.303	0.163	-0.397	0.290
	DNYP(-1)	0.199	0.090	-0.422	0.157
Australia	constant	-0.470	0.000	0.106	0.000
	DAUPP(-1)	0.419	0.253	0.939	0.227
	DNYP(-1)	-0.686	0.231	-1.157	0.208
Brazil	constant	0.582	0.000	-0.213	0.000
	DBRPP(-1)	0.147	0.235	-0.161	0.647
	DNYP(-1)	-0.041	0.085	-0.305	0.233
Benin	constant	0.152	0.000	0.311	0.000
	DBNPP(-1)	-0.204	0.179	-2.486	1.158
	DNYP(-1)	0.044	0.027	-0.347	0.177
Burkina Faso	constant	0.271	0.000	0.094	0.000
	DBKPP(-1)	-0.334	0.156	-0.974	0.928
	DNYP(-1)	0.049	0.027	-0.507	0.161
Chad	constant	0.248	0.000	0.188	0.000
	DCDPP(-1)	-0.026	0.185	-1.263	1.330
	DNYP(-1)	0.060	0.028	-0.292	0.196
Mali	constant	0.240	0.000	0.280	0.000
	DMAPP(-1)	-0.220	0.163	-1.915	1.141
	DNYP(-1)	0.042	0.022	-0.454	0.153
Pakistan	constant	-0.138	0.000	0.040	0.000
	DPKPP(-1)	0.254	0.181	1.011	1.977
	DNYP(-1)	-0.041	0.016	-0.516	0.178
Turkey	constant	-0.346	0.000	0.006	0.000
	DTKPP(-1)	-0.290	0.165	0.398	0.390
	DNYP(-1)	-0.058	0.068	-0.495	0.160

D-difference

Table 7. Estimate of Error Correction model

country		D-country		D-NYCPC	
		Coefficient	Standard error	Coefficient	Standard error
US	Constant	0.28334	1.5269	0.705	1.9023
	DUSPP(-1)	-0.37206	0.30706	0.41149	0.38255
	DNYP(-1)	0.3214	0.24933	-0.03313	0.31062
	LUSPP(-1)	0.66777	0.14922	1.07875	0.18591
	LNYP(-1)	-1.39714	0.3122	-2.257	0.38896
	Long-run Parameter beta				
	USPP	1			
	NYP	-2.09223			
Australia	Constant	-0.06471	2.07566	0.65721	1.86329
	DAUPP(-1)	-0.21408	0.16652	0.60669	0.14948
	DNYP(-1)	0.49019	0.21877	-0.33745	0.19639
	LAUPP(-1)	-0.12369	0.02228	-0.10245	0.02
	LNYP(-1)	-1.53059	0.27567	-1.26779	0.24746
	Long-run Parameter beta				
	AUPP	1			
	NYP	12.3741			
China	Constant	0.30814	3.47032	0.51389	2.60312
	DCNPP(-1)	-0.20562	0.28477	-0.38166	0.21361
	DNYP(-1)	-0.34426	0.30547	0.14088	0.22913
	LCNPP(-1)	-0.32044	0.37562	1.08667	0.28176
	LNYP(-1)	0.46445	0.54444	-1.57505	0.40839
	Long-run Parameter beta				
	CNPP	1			
	NYP	-1.44942			
India	Constant	2.36143	1.26976	0.61202	3.102
	DINPP(-1)	0.33861	0.15535	-0.66761	0.37952
	DNYP(-1)	-0.20558	0.07703	-0.49847	0.18818
	LINPP(-1)	-1.83119	0.27623	0.32994	0.67481
	LNYP(-1)	0.58991	0.08898	-0.10629	0.21739
	Long-run Parameter beta				
	INPP	1			
	NYP	-0.32215			

Table 7. (continued)

country		D-country		D-NYCPC	
		Coefficient	Standard error	Coefficient	Standard error
Pakistan	Constant	-0.01914	0.23666	1.07624	2.01106
	DPKPP(-1)	-0.62618	0.16863	-3.96308	1.43296
	DNYP(-1)	0.01406	0.02069	0.42894	0.17578
	LPKPP(-1)	0.11923	0.0677	3.99976	0.57531
	LNYP(-1)	-0.05868	0.03332	-1.96844	0.28313
	Long-run Parameter beta				
	PKPP	1			
	NYP	-0.49214			
Turkey	Constant	-0.06072	1.23322	1.50069	2.71848
	DTKPP(-1)	0.05074	0.19744	-0.89035	0.43524
	DNYP(-1)	-0.26961	0.07339	-0.2055	0.16178
	LTKPP(-1)	-1.06292	0.2828	2.15489	0.62341
	LNYP(-1)	0.4515	0.12013	-0.91533	0.2648
	Long-run Parameter beta				
	TKPP	1			
	NYP	-0.42477			
Brazil	Constant	0.07616	1.08882	2.18134	4.48694
	DBRPP(-1)	0.61507	0.29644	-0.66616	1.22159
	DNYP(-1)	-0.11948	0.05691	-0.47449	0.23453
	LBRPP(-1)	-1.38233	0.33458	0.22181	1.37879
	LNYP(-1)	0.10034	0.02429	-0.0161	0.10008
	Long-run Parameter beta				
	BRPP	1			
	NYP	-0.07259			
Egypt	Constant	-0.68957	2.0971	0.30001	2.15074
	DEGPP(-1)	-0.73854	0.14283	-0.21287	0.14649
	DNYP(-1)	0.17332	0.16765	0.31193	0.17194
	LEGPP(-1)	0.04856	0.0318	0.20309	0.03262
	LNYP(-1)	-0.43928	0.2877	-1.83728	0.29506
	Long-run Parameter beta				
	EGPP	1			
	NYP	-9.04647			

Table 7. Continued

country		D-country Coefficient	Standard error	D-NYCPC Coefficient	Standard error
Benin	Constant	0.10087	0.4844	0.02923	2.21558
	DBNPP(-1)	-0.54282	0.14978	-2.31273	0.68506
	DNYP(-1)	-0.0039	0.03965	0.19333	0.18134
	LBNPP(-1)	-0.12719	0.08361	1.8509	0.38243
	LNYP(-1)	0.0986	0.06482	-1.43485	0.29647
	Long-run Parameter beta				
	BNPP	1			
	NYP	-0.77522			
Burkina F	Constant	0.04881	0.52893		
	DBKPP(-1)	-0.48006	0.12993		
	DNYP-1)	-0.04609	0.0409		
	LBKPP(-1)	-0.35815	0.14115		
	LNYP(-1)	0.16425	0.06473		
	Long-run Parameter beta				
	BKPP	1			
	NYP	-0.45861			
Chad	Constant	0.01865	0.43862	0.23026	2.25462
	DCDPP(-1)	-0.35171	0.1695	0.5543	0.87127
	DNYP(-1)	0.04751	0.03556	0.28328	0.18276
	LCDPP(-1)	0.02994	0.0518	-1.53821	0.26628
	LNYP(-1)	0.03431	0.05937	-1.76274	0.30515
	Long-run Parameter beta				
	CDPP	1			
	NYP	1.14597			
Mali	Constant	0.04317	0.40692	1.05163	2.17453
	DMAPP(-1)	-0.4137	0.1623	0.38457	0.86732
	DNYP(-1)	0.08363	0.02983	0.08691	0.15941
	LMAPP(-1)	-0.13702	0.09854	-2.70429	0.52657
	LNYP(-1)	-0.07565	0.05441	-1.49319	0.29075
	Long-run Parameter beta				
	MAPP	1			
	NYP	0.55216			

Table 8. Estimated Hedging ratio based on three models

Hedge Ratio of country	Number of Observation	Traditional Model	Bivariate VAR Model	Error Correction Model
US	32	0.58	0.60	0.67
Australia	32	0.73	0.83	0.52
China	28	0.42	0.48	0.97
India	32	0.10	0.20	0.23
Pakistan	32	0.04	0.03	0.03
Brazil	18	0.10	0.10	0.15
Turkey	32	0.07	0.06	0.23
Egypt	32	0.20	0.17	0.17
Benin	27	-0.01	0.01	0.03
Burkina F	32	-0.04	-0.03	0.03
Chad	27	-0.02	0.00	-0.03
Mali	32	0.00	0.02	-0.01