CARIBBEAN CENTRE FOR MONETARY STUDIES

PRESENTATIONS

XXXV ANNUAL CONFERENCE OF MONETARY STUDIES

DOES EXCHANGE RATE VARIABILITY AFFECT BILATERAL EXPORT VOLUME IN CARICOM

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24-28 November 2003

Sir Cecil Jacobs Auditorium
Eastern Caribbean Central Bank
Basseterre
St Kitts

THEME:
Economic Reform:
Towards A Programme For The Resuscitation of Economic Growth And Development In The Caribbean

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By utilising techniques of multivariate cointegration and error correction models, I have investigated the impact of exchange rate variability on the bilateral exports between selected Caribbean countries. The aim will be to determine whether exchange rate variability is conducive to trade flows. The evidence suggests that exchange rate variability has a substantial short and long run effect on export demand.

1 INTRODUCTION

Conventional economic theory or wisdom identifies exchange rate risk as an obstacle to international trade flows. The argument views hedging as impossible or expensive and traders are assumed to be utility maximising individuals and therefore bear undiversified exchange risk; and increased variability means a decrease in the risk-adjusted profitability of foreign trade. One lemma would then be an expected decrease in trade.

Although numerous studies have focused on the effect of exchange rate volatility on international trade, neither theoretical nor empirical analyses have been successful in producing a consensus on the direction and magnitude of that effect. The empirical uncertainty may be the result of three common problems associated with econometric modeling, namely: (1) the true functional form of economic relationships are unknown; (2) at least one unidentified explanatory variable is typically excluded from econometric models; and (3) these unidentified excluded variables are most often incorrectly assumed to be uncorrelated with the included explanatory variables. This empirical study uses a stochastic coefficient model to address these issues in an examination of the effect of real exchange rate variability on bilateral exports between Barbados, Jamaica and Trinidad and Tobago using annual data for varying periods between 1954 and 2001.

The paper is organized as follows. Section 2 discusses the theoretical background and literature. Section 3 outlines the econometric methodology employed; Section 4

analytically discusses the data and results and finally, Section 5 provides a brief summary and conclusion.

2 *THEORETICAL BACKGROUND AND LITERATURE*

The empirical literature on the determinants of bilateral trade flows has largely focused on (i) the gravity model, (ii) the Linder hypothesis and (iii) the effect of exchange rate variability between two countries as a positive function of the incomes of the countries and a negative function of the distance between. The latter in this case is insignificant due to the geographical location of the countries being investigated. Studies by Leamer and Stern (1970), Anderson (1979) and Bergstrand (1985) form part of the empirical successes by various authors to theoretically justify the gravity model. The bilateral version of Linder's hypotheses is that trade of manufactured goods between two countries will be inversely related to the difference in their per capita incomes. This hypothesis has tended to be rejected empirically, as a high proportion of bilateral trade takes place between countries with similar levels of per capita income. Lastly, studies by Abrams (1980), Cushman (1983) and Thursby and Thursby (1985) have found support for the hypothesis that exchange rate variability affects the patterns of bilateral trade.

The choice of the export function follows the modern empirical literature (Chowdhury 1993, Arize 1995 and Arize et al, 2000) on the estimation of long-run export functions. As suggested by the gravity model, real domestic income is added so that we get the following:

$$X_t = \beta_0 + \beta_1 Y_t + \beta_2 Y_t^* + \beta_3 P_t + \beta_4 P_t^* + \beta_5 V_t + u_t \qquad (1)$$

X_t stands for real exports, Y_t for real domestic income; Y_t^* for real foreign income, P_t for the domestic price level, P_t^* for the foreign price level, V_t for exchange rate variability, which is a measure of exchange uncertainty and u_t is the error term. The model is also adapted to reflect the ratio of the two price levels.

$$X_t = \psi_0 + \psi_1 Y_t + \psi_2 Y_t^* + \psi_3 RP_t + \psi_4 V_t + v_t \qquad (2)$$

where RP_t is the relative price level and v_t is the error term.

Economic theory suggests that the impact of real foreign income and foreign price level on real exports should be positive and that of the domestic price level negative. Since

real domestic income can be viewed as a supply proxy, its impact on real exports is also expected to be positive. The impact of exchange rate variability is less simple to quantify, as there are diverging views in this issue. Traditionalists argue that increased exchange rate variability would increase the uncertainty of profits on contracts denominated in foreign currency. This perceived increase in risk would in turn reduce international trade flows to levels lower than otherwise exists if uncertainty were removed. This uncertainty of profits, or risk, would lead risk-averse and risk-neutral agents to redirect their activity from higher-risk foreign markets to the lower-risk home market. On the other hand, the risk-portfolio school maintains that the higher exchange rate risk presents greater opportunities for profit and should increase trade. De Grauwe (1988) convincingly argues that due to the convexity of the profit function, exporters' return from favourable movements in the exchange rate and the accompanying increased output outstrip the decreased profits associated with adverse exchange rates and decreased output; and therefore "As a result, risk-neutral individuals will be attracted by these higher profit opportunities."

Though the convexity of the profit function may imply a positive correlation between trade and exchange rate risk, the more prominent tenet of the risk portfolio school examines exchange rate risk in light if modern portfolio diversification theory. As summarised by Farrell, et al, economic agents maximise profitability by diversifying the risk levels in their investment portfolio by simultaneously engaging in low-, medium- and high-risk activity with corresponding *potential* rates of return. Greater exchange rate volatility resulting in higher risk would then not discourage risk-neutral agents from engaging in trade, but would present an opportunity to diversify their risk portfolios and increase the likelihood of profitability.

3 ECONOMETRIC METHODOLOGY

According to the Granger representation theorem (Engle and Granger 1987), it can be shown that the following error correction model (ECM) exists for a cointegrating vector (X, Y, Y*, P, P*, V):

$$\Delta X_t = \alpha_0 + \alpha_1 R_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta X_{t-i} + \sum_{i=1}^{n} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \omega_i \Delta Y^*_{t-i}$$
$$+ \sum_{i=1}^{n} \eta_i \Delta P_{t-i} + \sum_{i=1}^{n} \theta_i \Delta P^*_{t-i} + \sum_{i=1}^{n} \phi_i \Delta V_{t-i} + e_t$$

where Δ is the first-differenced operator, R_{t-1} is the lagged ECM term and is the residual from the cointegrating regression equation. It should be noted that if the variables have a cointegrating vector, then $R_t \sim I(0)$ represents the deviation from equilibrium in period t. The ECM shows how the system converges to the long-run equilibrium implied by the cointegration regression. It also allows for estimation of the short-run relationship between exports and their determinants. The parameter α_1 measures the response of real exports in each period to the departures from equilibrium. With the cointegration vector normalised on exports, this parameter is expected to be negative in sign and should be statistically significant.

The Johansen multivariate cointegration framework is utilised here in order to estimate a long run relationship between exports and their determinants, as is consistent with developments in the econometrics on non-stationary time series.

4 *DATA AND RESULTS*

4.1 DATA

The data analysed in this paper are annual series for varying periods depending on the country being investigated. The largest time period is from 1954 until 2001, whilst the smallest is from 1966 until 2001. The countries primarily included in the sample are Barbados, Jamaica and Trinidad and Tobago. These are the countries for which sufficiently large data sets were readily available. The export variable measures each country's bilateral exports. The explanatory variables included in the export function are domestic and foreign income, which are proxied by real GDP for the respective countries. The domestic price level is proxied by the consumer price index and the foreign price level by the export price index. For Barbados, the export price index for the Western Hemisphere was used as a proxy for the export price index series. The sources of the trade data were various editions of the IMF *Direction of Trade Statistics* (DOTS) yearbooks and the Central Bank of Barbados Annual Statistical Digest. The incomes, prices and exchange rate data were sourced from the IMF *International Financial Statistics* (IFS) CD-Rom June 2003. The Central Statistical Office of Trinidad and Tobago provided some of the trade data not found in the DOTS for that country. Natural logarithms have been taken of all the variables mentioned above.

The moving standard deviation of the growth rate of the real exchange rate is used as a measure of time-varying exchange rate variability:

$$V_t = \left[\frac{1}{m} \sum_{i=1}^{m} \left(\ln Z_{t+i-1} - \ln Z_{t+i-2} \right)^2 \right]^{1/2}$$

where Z is the monthly real exchange rate and m, the order of the moving average, is set equal to 12. The use of monthly exchange rates allows for the measurement of exchange rate volatility (variability) during the year and hence to calculate one figure of volatility (variability) for each year in our sample. The literature seems to conclude that the impact of variability on trade is similar independently of the choice of the nominal or real exchange in measuring exchange rate variability; see Thursby and Thursby (1987), Lastrapes and Koray (1990) and Chowdhury (1993). Fountas and Aristotelous (2003) also conclude that the impact of the exchange rate regime on trade also robust to the choice of the nominal exchange rate in measuring variability.

4.2 RESULTS

Firstly, augmented Dickey-Fuller unit root tests were applied to all the time series in the dataset in order to determine the integration properties. The results of these tests (which can be found in the appendix of this paper) indicate that all of the time series are I(1) except for the domestic price level for Trinidad and Tobago and the exchange rate variability series for Barbados. One should note there that though the series appears to be variable before 1975, the fixed exchange rate employed in Barbados since 1975 ensures that the series over the entire period is sufficiently stationary. The domestic price level for Trinidad and Tobago is integrated of order 2, so we opt for the use of the relative prices series in the model for that country. Of note also, is that generally, models that include the relative prices series have tended to perform better than those with explicit domestic and foreign price level series.

Table 1

Error Correction Regression Results: Barbados Exports to Jamaica (1956-2001)

Lag	*C*	R	ΔX	ΔY	ΔY^*	ΔRP_{BAR}	*V*	*Summary Statistics*
0	-0.284385						0.023748	Adjusted R^2 = 0.12
	(1.28086)						(0.00386)	F Statistic = 1.45
1		-0.061537		2.201195	0.9426	-3.337049		
		(2.20962)		(1.85443)	(1.77243)	(1.83183)		
2			-0.13753			-4.399681		
			(0.82334)			**(2.33932)**		
3				3.403244				
				(2.66201)				

Notes: The figure in parentheses are the absolute *t* statistics. Figures in **bold** are significant at the 5% level.

Table 2

Error Correction Regression Results: Barbados Exports to Trinidad (1954-2001)

Lag	*C*	R	ΔX	ΔY	ΔY^*	ΔP	ΔP^*	*V*	*Summary Statistics*
0	0.041973							-1.841043	Adjusted R^2 = 0.34
	(0.83872)							(0.86443)	F Statistic = 4.52
1		-0.479566	0.372646	-1.195622	0.093946	1.874492	-0.119408		
		(4.00150)	**(2.72540)**	**(2.37289)**	(0.30938)	**(2.42161)**	(0.35103)		
2									
3									

Notes: The figure in parentheses are the absolute t statistics. Figures in bold are significant at the 5% level.

Table 3

Error Correction Regression Results: Jamaica Exports to Barbados (1957-2001)

Lag	*C*	R	ΔX	ΔY	ΔY^*	ΔRP_{JAM}	*V*	*Summary Statistics*
0	0.159029							Adjusted R^2 = 0.47
	(2.44220)							F Statistic = 3.42
1		-0.264475		-0.687543		-1.559921	-0.71958	
		(3.04334)		**(2.94384)**		**(2.83012)**	**(3.72814)**	
2			0.532751			-1.67407		
			(3.47050)			**(2.84784)**		
3				-0.390408	0.920229		-0.167907	
				(1.91939)	**(2.69948)**		(1.52971)	

Notes: The figure in parentheses are the absolute *t* statistics. Figures in **bold** are significant at the 5% level.

Tables 1-6 report the short-run dynamics reflected in the estimated ECMs. Using the cointegrating vectors normalised on exports, we estimate the ECMs for exports. Tables 1 and 2 report the ECM for Barbados exports to Jamaica and Trinidad and Tobago; Tables 3 and 4 report the ECM for Jamaica exports to Barbados and Trinidad and Tobago and Tables 5-6 report the ECM Trinidad and Tobago exports to Barbados and Jamaica respectively. To decide on the final forms of the ECMs, we start with the maximum lag suggested by the likelihood ratio test for each variable included in the VAR and eliminate insignificant lags unless this introduces serial correlation in the error term. This allows for the derivation of a parsimonious model.

The ECM results indicate that generally, changes in domestic income, foreign income and relative prices have statistically significant short-run effects (in some cases at the 10 percent level of significance) on the bilateral exports. The results also indicate that for Trinidad and Tobago, the real exchange rate variability has positive and significant short-run impact on bilateral exports to both Barbados and Jamaica, whilst the relationship is also positive and significant for Jamaica exports to Trinidad and Tobago but negative for Jamaica exports to Barbados.

Table 4

Error Correction Regression Results: Jamaica Exports to Trinidad (1964-2001)

Lag	*C*	R	ΔX	ΔY	ΔY^*	ΔRP_{JAM}	*V*	*Summary Statistics*
0	-0.351425							Adjusted R^2 = 0.42
	(1.83363)							F Statistic = 3.46
1		-0.430732	-0.40825	-0.785094	1.176167	4.18375	1.809602	
		(3.19389)	**(2.17309)**	(1.02179)	(1.61695)	**(2.28909)**	**(2.66313)**	
2								
3								

Notes: The figure in parentheses are the absolute *t* statistics. Figures in **bold** are significant at the 5% level.

Table 5

Error Correction Regression Results: Trinidad Exports to Barbados (1956-2001)

Lag	*C*	R	ΔX	ΔY	ΔY^*	ΔRP_{INT}	*V*	*Summary Statistics*
0	0.01012							Adjusted R^2 = 0.02
	(0.14593)							F Statistic = 1.07
1		-0.106853						
		(2.00435)						
2			-0.326195	0.870396			0.744784	
			(1.27538)	(1.69049)			(1.71771)	
3					0.659443	0.757154		
					(1.43748)	(1.58173)		

Notes: The figure in parentheses are the absolute *t* statistics. Figures in **bold** are significant at the 5% level.

Table 6

Error Correction Regression Results: Trinidad Exports to Jamaica (1964-2001)

Lag	*C*	*R*	ΔX	ΔY	ΔY^*	ΔRP_{INT}	*V*	*Summary Statistics*
0	0.04907							Adjusted R^2 = 0.50
	(0.53047)							F Statistic = 4.42
1		-0.394116	0.377922	1.037443			1.657106	
		(2.75087)	**(2.66712)**	(1.85744)			**(2.69628)**	
2			0.294419		-0.67515	0.617558	0.839746	
			(1.92197)		**(2.38101)**	(0.84068)	(1.84461)	
3								

Notes: The figure in parentheses are the absolute *t* statistics. Figures in **bold** are significant at the 5% level.

Table 7 Estimates of the Cointegrating Relationships

BARBADOS

Exports	C	Y	Y^*	RP_{BAR}	V	
Jamaica	62.87897	2.085684	-12.35206	31.50665	---	
		(1.76606)	(1.45318)	(1.44724)	---	
	C	Y	Y^*	P	P^*	V
Trinidad & Tobago	-12.71093	2.589827	0.432135	-3.389373	1.732199	---
		(4.60484)	**(3.12526)**	**(4.41064)**	**(9.38711)**	---

JAMAICA

Exports	C	Trend	Y	Y^*	RP_{JAM}	V
Barbados	6.799125	0.206971	0.980463	-0.917178	-1.381056	1.859232
		(5.52366)	**(4.90555)**	**(2.96343)**	**(4.45279)**	**(4.59843)**
Trinidad & Tobago	21.4206	---	3.288058	0.022118	-3.100596	-3.802671
		---	**(5.67913)**	(0.07990)	**(6.72466)**	**(4.26367)**

TRINIDAD AND TOBAGO

Exports	C	Trend	Y	Y^*	RP_{TNT}	V
Barbados	-2.792572	-0.02992	-0.516697	1.695708	1.160076	-7.372178
		(0.61950)	(1.02189)	**(3.21723)**	(1.60694)	**(2.89962)**
Jamaica	-13.32877	---	0.370771	1.712305	0.436593	0.587833
		---	**(2.19397)**	**(5.11504)**	(1.22281)	(0.37740)

Notes: The figures in parentheses are absoulte t statistics. Figures in **bold** are significant at the 5% level.

Table 7 provides parameter estimates that represent long run elasticities together with their respective asymptotic t-ratios. These elasticities are obtained by normalising the estimates of the unconstrained cointegrating vectors on real exports. As can be seen from Table 7, the estimated foreign economic activity carried the expected positive sign and is significantly different (at the 5 percent level) from zero for Trinidad and Tobago exports to Barbados and Jamaica, and Barbados exports to Trinidad and Tobago. Of note is that for the latter, the long run elasticity is less than unity.

The estimated price elasticity has that expected negative sign and is statistically different from zero for Jamaica exports to Barbados and Trinidad and Tobago. With respect to panel 1 in Table 7 and Barbados exports to Trinidad and Tobago, both domestic and foreign price elasticities have the correct signs and are statistically significant. Note also that both of these parameter estimated are greater than unity in absolute value. Insignificant price effects, which are also observed in Table 7, are generally attributed to at least one of the following reasons. Firstly, the use of unit-value indices that are only accurate if the

composition of the unit remains the same or if the net effect of such changes is insignificant; and secondly, price elasticities that positive and/or insignificant can certainly be the result of poor data quality.

The exchange rate variability elasticities have positive signs and are statistically significant for bilateral exports Jamaica and Trinidad and Tobago and between Trinidad and Tobago and Barbados. The long run elasticities are –3.80 and –7.37 respectively, implying that the exchange rate variability exerts a significant adverse effect on bilateral export volume. For bilateral exports from Jamaica to Barbados, it appears that exchange rate variability is particular conducive to export flows.

Based on the evidence, the dynamics of both the short and long run equations show that changes in foreign income activity, relative prices and exchange rate variability have significant short and long run effects on exports. For Jamaica, it is clear that both in the short and long run, export volumes respond faster to changes in relative prices, whilst for Trinidad and Tobago, export volumes respond faster to changes in foreign income activity both in the short and long run. More importantly, the results indicate that exchange rate variability has a substantial short run as well as long run effect on export demand.

5 SUMMARY AND CONCLUSION

In this paper, I have examined the impact of exchange rate variability on bilateral exports between Barbados, Jamaica and Trinidad and Tobago using annual data for varying time periods between 1954 and 2001. Our results concerning the effect of exchange rate variability on export flows are mixed at best, in that the evidence suggests that exchange rate variability is both conducive and prohibitive to trade flows between the three Caribbean countries. Though the study has primarily focused on exchange rate variability, from the evidence foreign incomes seems to exert the most influence on bilateral exports.

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APPENDIX

Results from the ADF Unit Root test.

	BARBADOS		JAMAICA		TRINIDAD AND TOBAGO	
Exports	Levels	First Difference	Levels	First Difference	Levels	First Difference
Barbados	---	---	-0.49685	-6.662932	-2.233015	-5.085156
Jamaica	-2.434357	-3.872445	---	---	-2.462444	-3.788381
Trinidad & Tobago	-1.376135	-4.217918	-1.562941	-4.200396	---	---
GDP	-0.924772	-4.299546	-2.453846	-4.683007	-1.865028	-4.925252
CPI	-1.161217	-3.604063	-2.083428	-3.066011	-2.0304	-1.720198
EPI	-2.199154	-4.458865	-1.931382	-6.156048	-1.948739	-4.418003
Relative Prices	-1.525813	-5.071033	0.041622	-6.317431	-1.024109	-4.374303
Variability	-3.180481		-2.688729	-6.431497	-2.334425	-5.040357

Notes: The asymptotic critical values are -3.5066 and -2.9256 for the levels and first difference respectively. Note though that the crictical value for the exchange rate variability series for Barbados is in fact -2.9202 which makes this series stationary in levels.