THE EFFECTS OF EXCHANGE RATE VARIABILITY ON EXPORTS: EVIDENCE FROM UGANDA (1988 – 2001)

By

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Abstract

Using monthly data, this study investigates the effects of exchange rate variability on Uganda's aggregate export growth under the floating exchange rate policy regime (1994-2001), benchmarked on the fixed exchange rate regime (1988-1993). The main research question it posits is: "What is the effect of exchange rate variability on Uganda's exports?" Premised on risk-aversion, the study tests the main hypothesis that 'Uganda's exports are negatively and significantly correlated with exchange rate variability.' Due to lack of pure I(0) or I(1) for all the series, and absence of endogeneity and simultaneous bias problems between export supply and export demand, the ARDL approach to cointegration and OLS are applied in the study. The results suggest support for the research hypothesis. The policy implication is that intervention targeting the minimisation of excessive volatility in the real effective exchange rate under the floating regime may contribute to supporting export sector growth, economic growth, and overall external macroeconomic stability in Uganda.

1 Introduction[1]

There is a close, but opposite, link between developments in the current account vis-à-vis those in the capital account of the balance of payments. On account of this link, a stable and competitive exchange rate, which leads to an increase in exports, may also have direct and indirect effects on foreign direct investment (FDI) and other capital flows in less developing countries (LDCs). The present study empirically investigates the effect of exchange rate variability on Uganda's aggregate export growth under the floating exchange rate policy regime.

Early supporters of the floating exchange rate regime system (Friedman, 1953; Johnson, 1969) argued, among other things, that a flexible exchange rate regime would reduce protectionist tendencies and promote trade. Secondly, flexible exchange rates would provide macroeconomic independence, by bearing the burden of adjustment vis-à-vis imbalances in the 'current' and 'capital' accounts of the balance of payments. Following Friedman (1953), exchange rate volatility associated with the

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floating exchange rate regime did not pose any potential threat to the growth of international trade and macroeconomic stability partly because hedging facilities would protect one against risk.

Theoretically, the effect of exchange rate variability on exports is still a debatable issue. In spite of the importance of exports for specialisation and economic growth in line with comparative advantage theory, the Prebisch Singer thesis as well as elasticity pessimism argue primary-commodity dependent economies may not benefit from exports trade on account of adverse terms of trade (Sapsford and Chen, 1999; Singer 1999). There is however, a strong view that exports remain an important factor for economic growth (Balassa, 1989) and hence a competitive exchange rate may be a useful possible anchor for export growth (Dornbusch and Kuenzler, 1993: 92; and Ghei and Prilchett, 1999: 467). With respect to exchange rate variability, consistent with Friedman (1953) and Johnson (1969), some economists believe that it is not an important factor for trade in line with the *risk-neutrality* hypothesis (Abbott, Darnell and Evans, 2001; Aristotelous, 2001; McKenzie and Brooks, 1997; Pozo, 1992; Bailey, Tavlas, and Ulan, 1986).

In contrast to the above, some literature suggests that exchange rate variability under the floating exchange rate regime may be detrimental to exports on account of *risk-averseness* hypothesis (De Grauwe, 1988; Hooper and Kohlhagen, 1978). This is partly because markets may be imperfect particularly in less developed countries (Doroodian, 1999; Krugman, 1989). In addition, hedging may be both imperfect and very costly as a basis for avoiding exchange risk (Doroodian, 1999: 467), as evidenced in some of the available literature (Sukar and Hassan, 2001; Sekkat and Varoudakis, 2000, 2002; Saurer and Bohara, 2001; Hassan and Tufte, 1998; Doroodian, 1999; Arize, 1995, 1996; Ghura and Grennes, 1993; Grobar, 1993; Savvides, 1992; Bahmani-Oskooee, and Ltaifa, 1992; Bini-Smaghi, 1991; De Grauwe, 1988).

In Uganda, government adopted a floating exchange rate regime in November 1993, partly to improve the incentives to the exporters by removing the implicit taxation to exporters and related rent-seeking activities (Reinikka, and Collier, 2001). Since then, the exchange rate for the shilling to the United States Dollar (*Shs/US$*) has been flexible and at times very volatile. However, there are mixed (largely speculative) views about the effects of exchange rate variability on the export sector. For example, in Henstridge and Kasekende (2001) it is argued that "…although subsequent periods of [*exchange rate*] turbulence have taken place, the overall performance of the foreign exchange market as a way to determine the exchange rate and allocate foreign exchange has been good enough for it not to have been called into question" (p. 56). However, there is no sufficient evidence to suggest that an empirical study investigating the effect of exchange rate variability on Uganda's exports exists.

The main research question the present study posits is: "What is the effect of exchange rate variability on Uganda's exports?" The investigations aim at contributing to the literature by addressing the issue of what biases against exports does ignoring exchange rate variability bring into the magnitude of Uganda's export- and related macroeconomic policy relevant parameters? The main hypothesis tested is that, 'Uganda's exports are negatively and significantly correlated with exchange rate variability.'

However, given that Uganda is largely an agricultural primary commodity dependent economy, the supply response of her exports to price incentives, terms of trade, exchange rate movements, and exchange rate variability remains an important macroeconomic aspect. The following section examines the recent trends in these respects.

2 Exports and Recent Trends in Uganda

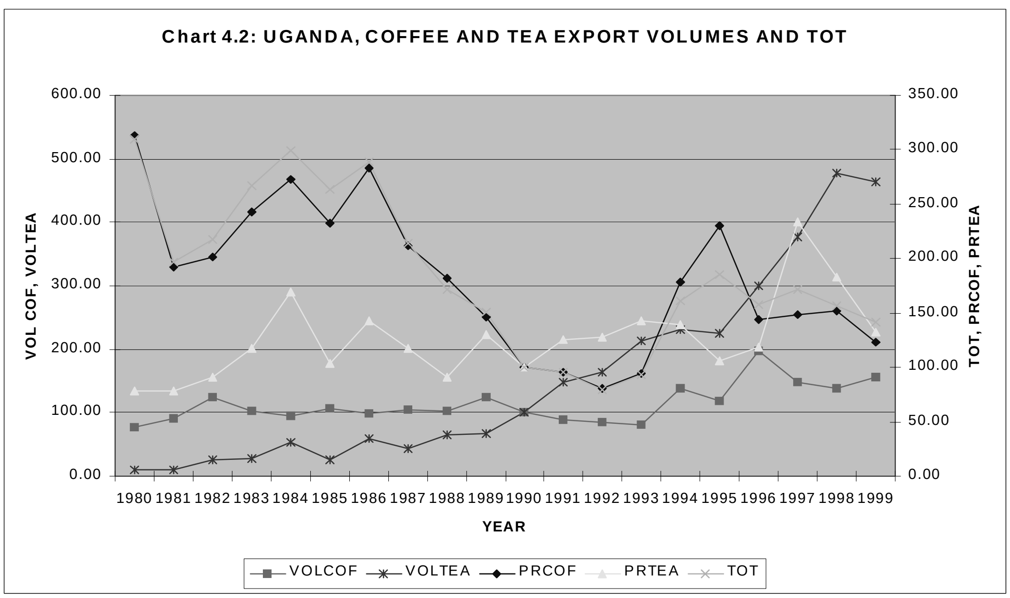
The export sector is considered an important factor in Uganda (Reinikka, and Collier, 2001). Based on the World Bank (2000) data, the decline in exports/GDP ratio since independence partly explains Uganda's subsequent economic decline. However, the recovery since mid-1990s closely matched by improvements in the trade balance, domestic savings/GDP ratio, national savings/GDP ratio, capital formation/GDP ratios as well as Debt service/Exports ratios. Recent trends recognise exports as an important factor for the Ugandan economy.

TABLE 2.1: UGANDA, EXPORTS AND KEY MACROECONOMIC INDICATORS

YEAR	EXPORTS/GDP	IMPORTS/GDP	TRADE BALANCE/GDP	DOMESTIC SAVINGS/GDP	NATIONAL SAVINGS/GDP	CAPITAL FORMATION/GDP	DEBT SERVICE RATIO OF EXPORTS
1961-1965	26.46	22.89	3.57	15.06	...	7.35	...
1966-1970	23.94	22.56	1.38	14.59	3.12	12.80	...
1971-1975	15.83	15.97	-0.14	11.08	10.12	10.73	5.24
1976-1980	14.61	15.97	-1.36	5.31	4.99	0.99	7.90
1981-1985	11.91	16.51	-4.60	3.19	-11.96	6.91	26.79
1986-1990	8.77	17.70	-8.94	1.62	3.52	10.56	53.29
1991-1995	8.76	21.47	-12.70	2.79	6.00	15.32	51.75
1996-2000	11.37	22.63	-11.26	5.09	12.03	16.54	21.65

Source: Compiled with data from World Bank (2000): World Development Indicators, CD-Rom 2000.

Reinikka and Collier (2001) form one of the early studies examining exports response to extensive macroeconomic and marketing reforms in Uganda. Based on firm-data, results from their study suggest that the stated reforms have significantly improved Uganda's climate for doing business and the incentives to export. This view corroborates with another study of Uganda's trade reform and performance on the private sector, (Gauthier, 2001). Using survey data of 250 firms in Uganda's five industrial sectors conducted by the World Bank over the period 1995-97, Gauthier's study reveals that export-orientation was a significant determinant of firms' performance (i.e. output growth, productivity levels and growth).



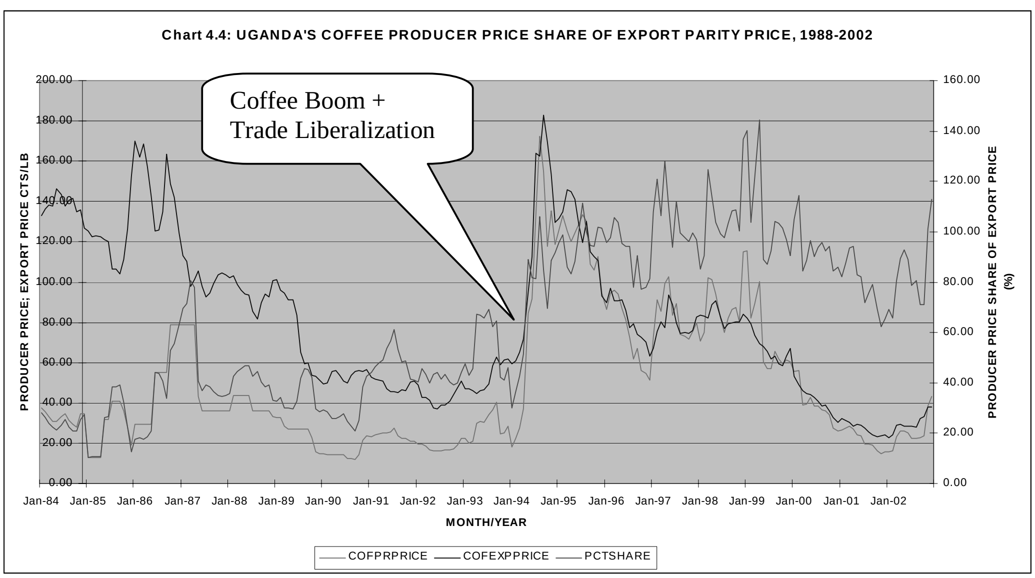
Source: Based on data from IMF's IFS; ICO (2000); UCDA; and Bank of Uganda.

2.1 Uganda's Exports and Changes in Terms of Trade

Chart 4.2 above shows the trends in export volumes of coffee and tea and the corresponding likely response to *TOT*, export prices of coffee and tea. The trends suggest that the terms of trade for Uganda's coffee exports showed a persistent declining trend from over 300% in 1980 (1990=100) to just 100% in 2000. It is likely that part of the sluggish increase in coffee export earnings may be attributable to adverse *TOT*. On the other hand, the *TOT* for Uganda’s tea exports remained relatively stable at around 100% between 1980 and 2000, although there was some marked volatility in between. This implies that changes in *TOT* may not have affected Uganda’s exports of tea.

2.2 Trends in Producer Prices/Export Parity Price, and Exports Volumes

As shown in Chart 4.4 below, the trends in world coffee export price (*COFEXPRICE*) have been erratic and on a downward trend since 1984 (save for the coffee boom in 1994/95). In addition, trends in the share of producer price for *robusta* coffee (*COFPRPRICE*) as a percentage of world export price (*COFEXPRICE*) suggest that coffee producers suffered an implicit tax before the liberalisation of the coffee trade in November 1993, since they received less than 50% of world export prices. Following liberalisation, this share has since increased to above 80%, suggesting that higher world prices were transferred to the coffee producers following the liberalisation. However, the declining world coffee export prices in the post-liberalisation period suggests that this may have exerted a negative effect on Uganda’s exports.



Source: Based on data from Uganda Coffee Development Authority and International Coffee Organisation (ICO)

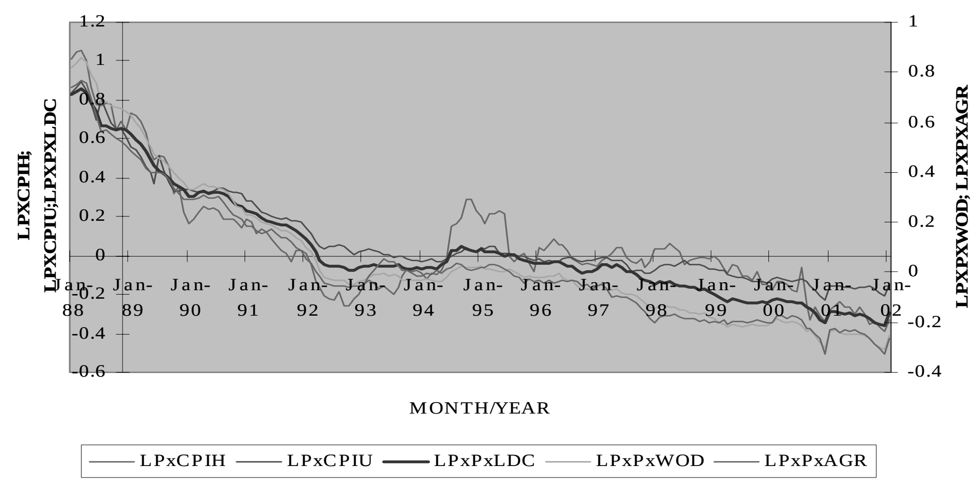


Chart 4.5: UGANDA, LOG-RATIOS OF INDICES(1995=100) OF DOMESTIC EXPORT PRICES TO WORLD EXPORT PRICES AND DOMESTIC PRICE LEVELS, 1988M1-2002M1

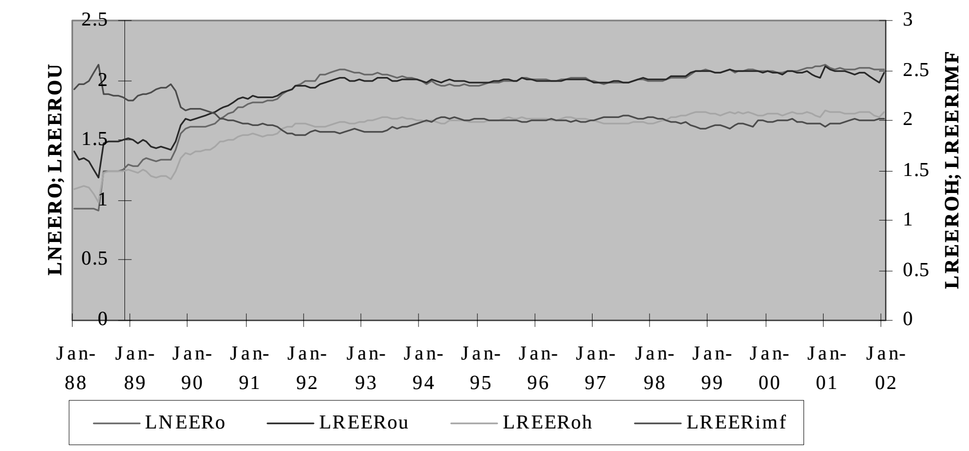
Source: Based on data compiled from IMF's IFS, various issues; UBOS, and from Bank of Uganda.

Chart 4.5 indicates trends in various series of Uganda's relative export prices. In line with the theory of comparative advantage, the trends suggest that prices of non-traded goods tended to rise faster than Uganda's export prices, both domestically and internationally. This pattern suggests that exports may have been adversely affected, as it may have been more profitable to produce non-traded goods than exportables particularly in the early period to early 1994. After 1994, the patterns still indicate a declining but smaller trend, suggesting that on the basis of comparative advantage, non-traded goods may on the whole be more profitable to produce compared to exports. These trends suggest that relative export prices may have acted to the detriment of export growth.

2.3 Exports and Real Effective Exchange Rate (REER)

Chart 4.6 below shows the trends in nominal and real exchange rates. Following devaluation theory, the exchange rate may be used to correct imbalances in export competitiveness. Meanwhile, the view that overvaluation of the real exchange rate may have slowed down the growth of exports before the liberalisation period (Belshaw, Lawrence and Hubbard, 1999) is not very apparent as there was a tendency for the real effective exchange rate indices to reach 100, and has since 1994 been stable at close this level. This may partly explain the rapid increase in non-traditional exports after 1994-95 and the increase in private transfers. This suggests that the effect of the level of the ‘nominal’ and ‘real’ effective exchange rates may not have had significant negative effects on exports growth.

Chart 4.6: UGANDA, TRENDS IN EFFECTIVE EXCHANGE RATE INDEXES (1994-95=100) :(Interbank Market) 1988M1-2002M1

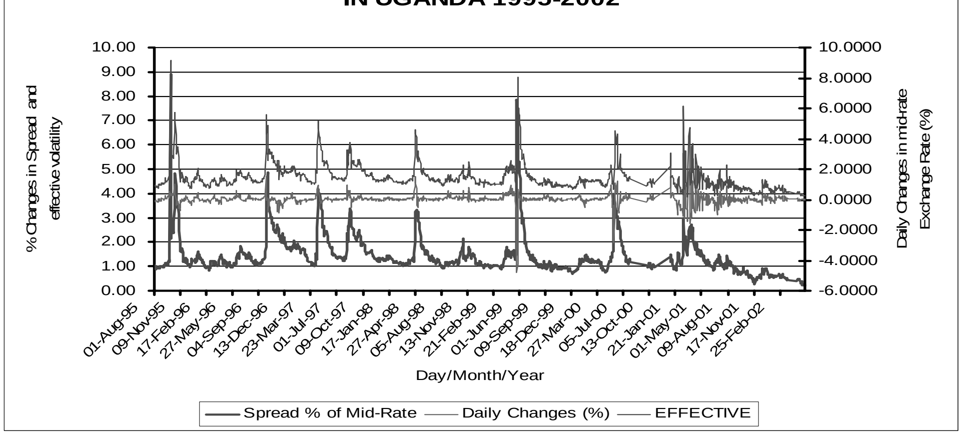


Source: Based on data compiled from IMF’s IFS, various issues; UBOS, and from Bank of Uganda.

2.4 Exports and Real Effective Exchange Rate Variability

In a most recent study on Uganda, it has been observed that while real exchange rate appreciation may be costly to some sections of the private sector in the long-run, it is likely that greater costs attach to short-term exchange rate overshooting and that there may be a stronger case for policy interventions to assist sectors exposed to damaging short-run movements in the real exchange rate (Adam 2001: 13). The possibility that exchange rate variability might affect Uganda’s exports performance is highlighted in Graph 4.5 below. Premised on risk-averseness, it is likely that there exists an inverse relationship between export earnings and nominal exchange rate variability.

GRAPH 4.5: FLOATING EXCHANGE RATE VOLATILITY (%) IN UGANDA 1995-2002



Source: Based on daily exchange rate data collected from BOU (May-July 2002).

There is, however, insufficient evidence to suggest that this is true. On the other hand, no study in the literature has been identified in relation to examining the effects of exchange rate variability on Uganda's exports under the floating exchange rate regime. Following the above discussions, the following section formulates a conceptual model of exports to investigate the main research question, hypothesis and objectives as stated in section above.

3 Theoretical Framework and Hypotheses

Based on the discussions in sections 1 and 2, the study adapts an analytical framework encompassing two concepts: the mean-variance-analysis (Tobin, 1959; De Grauwe, 1988) and the imperfect substitution model proposed by Goldstein and Khan, (1978, 1985).

3.1 Mean Variance Analysis and Risk Aversion

Following De Grauwe (1988), Mean-variance-analysis suggests that utility increases positively with increase in level of profits, and negatively with the variance of profits. It draws on the early work of Tobin (1959). The core idea is that a hypothetical investor faces risk, which involves uncertainty about the future rate of interest: any investment involves a risk of capital gain or capital loss. However, the proportion of investments increases simultaneously with the increase in the expected returns, R; and negatively with the variance of returns, R. Based on this notion, a utility-of-return function in the form $U(R) = (1 + b)R + bR^2$ obtains; where R is the rate of return, and b is a parameter. Based on this function, the expected utility function is derived in the form:

$$E(\mu_R, \sigma_R) = \left(\frac{\mu_R + \mu_R^{'}}{2}, \frac{\sigma_R + \sigma_R^{'}}{2} \right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where μ_R is the expected mean of return; $\mu_R^{'}$ is the first moment of return; σ_R is the standard deviation of the return; and $\sigma_R^{'}$ is the corresponding first moment of the standard deviation of return. Following Tobin (1959: 76), since utility cannot be negative, the feasible solutions for R are such that $b > 0$ for a *risk-lover* and $b < 0$ for a *risk-averse* person. Premised on risk-aversion, there are several possible theoretical reasons explaining why exchange rate variability might affect exports (Ethier, 1973; Hooper and Kohlhagen, 1978; Akhtar and Hilton, 1984; De Grauwe, 1988; Abbott, 2001), including the fact that:

- Since most export contracts are priced and paid for in foreign currency, exchange rate variability affects export earnings valued in domestic currency.

- Export contracts may involve long time lags due to production delays, delivery lags and the actual settlement date, all of which may increase the extent of uncertainty.

- Imperfections regarding hedging facilities may make it difficult to fully anticipate and contain uncertainty caused by exchange rate variability.

- The extent of export product diversification, and market power determines a firm's ability to suffer or export the risk.

It can be inferred from the above that exchange rate variability is a major source of uncertainty regarding prices exporters receive measured in domestic currency terms. If agents are sufficiently *risk-averse*, such variability could be detrimental to the exports growth as agents reduce their export volumes (Baum, Barkoulus and Caglayan, 2002; De Grauwe, 1988; Hooper and Kohlhagen, 1978; Ethier, 1973).

3.2 Imperfect Substitution Export Model

The present study adapts an imperfect substitution model (Goldstein and Khan, 1978; 1985) to examine 'export' supply and demand for Uganda, consistent with a dependent-economy- theoretical framework. The structural model adapted incorporates exchange rate variability; and other controllable determinants (real income, domestic capacity, relative prices, terms of trade and real effective exchange rate) of exports. The choice of the Goldstein and Khan (1978) model is informed by the fact that it conforms with various theoretical approaches to the balance of payments (Machlup 1955), and is consistent with the dependent economy framework, which characterises most economic structures of LDCs, (Dornbusch 1976, 1980). The key assumption of the *imperfect substitution model* is that neither imports nor exports are perfect substitutes for domestic goods as the subsequent discussions indicate (Goldstein and Khan, 1978, 1985).

3.2.1 The Structural Export Supply Function

The exports supply function is derived from the assumption of profit maximization on the part of the producer. In the Goldstein and Khan (1978) two-country model of international trade, the main determinants of structural export supplies are domestic relative prices of exports, and domestic capacity utilisation, which is consistent with other studies (Belshaw and Lawrence, 2002; Balassa, 1989; Gotur, 1985; IMF, 1984; Hooper and Kohlhagen, 1978). Consistent with the literature (see Section 3.4 below), the present study extends this theoretical framework to include terms of trade, (*TOT*); real effective exchange rate, (*REER*); and exchange rate variability, (*V*). Consolidating the main determinants of exports supplies by including domestic relative price, *REER*, *TOT*, and exchange rate variability and capacity utilisation yields the extended structural export supply function as:

$$X_t^s = f(P_x / P, CU, REER, TOT, V) \qquad \textbf{(2)}$$

$f_1,\ f_2,\ f_3 > 0;\ f_4 \pm 0;\ f_5 < 0$

Where

X_t^s Refers to the country's supply of exports,

P_x / P Refers to the relative price of exportables in the domestic market:

P_x Is the price of exportable commodity in terms of domestic currency,

P Is the non-traded domestic price levels,

CU Represents domestic capacity utilisation relative to its trend potential,

TOT Is the terms of trade,

$REER$ Is the real effective exchange rate, representing the general domestic competitiveness, and

V Is a measure of exchange rate variability as explained above, premised on risk on averseness.

3.2.2 The Structural Export Demand Function

The study has observed that Ugandan exporters sell to very many importing companies abroad, although the European Union countries dominates. This suggests that the world demand curve for Uganda's exports exists. Following Goldstein and Khan (1978), the main determinants of the demand for a country's exports are external relative prices of exports; and foreign income levels. Consistent with the literature, the present study extends this to include:-

- The Terms of Trade, *TOT*, (Saurer and Bohara, 2001; Bahman-Oskooee, 1993; Savvides, 1992);
- Effective exchange rate $REER_x\,(orNEER)$ (Abbott, et.al. 2001; Doyle, 2001; Arize, 1995, 1996, 1997; Savvides, 1992; De Grauwe, 1988; and Goldstein and Khan 1978);
- And exchange rate variability, (Abbott, et.al. 2001; Doyle, 2001; Arize, 1995, 1996, 1997; Savvides, 1992; De Grauwe, 1988).

The extended model then assumes that relative export prices, income of major trading partners, terms of trade, levels of real exchange rate, and exchange rate variability determine the world demand for a country's level of exports. The specific extended world export demand function for Uganda is then defined as:-

$$X_t^d = g(P_x / P_x^*, Y_t^*, REER, TOT, V) \quad \textbf{(3)}$$

$g_1,\ g_3,\ g_5 < 0;\quad g_2,\ g_4 > 0$

Where

X_t^d	Is the demand for a country's exports
P_x / P_x^*	Refers to the relative price of exportables abroad:
P_x	Is the price of exportable commodity in terms of domestic currency,
P_x^*	Is the foreign world price of close substitutes
Y_t^*	Represents the level of real foreign income of major trading partners.
REER	Is the real effective exchange rate,
TOT	Is the terms of trade, and
V	Is a measure of exchange rate variability.

3.2.3 The Reduced-form Equilibrium Export Supply Model for Uganda

Following Hooper and Kohlhagen, (1978: 493), although the export functions (2) and (3) above may be non-linear, the corresponding linear approximations are possible. Expressing functions (2) and (3) above into log-linear econometric model approximations yields the corresponding export growth econometric model equations (4), (5) and (6) as follows:

$$\log X_t^s = \beta_0 + \beta_1 \log(P_x / P)_t + \beta_2 \log CU_t + \beta_3 \log REER_t + \beta_4 \log TOT + \beta_5 V_t + \mu' \quad \textbf{..........(4)}$$

$$\beta_0, \quad \beta_1, \quad \beta_2, \quad \beta_3 > 0; \qquad \beta_4 \gtrless 0; \qquad \beta_5 < 0$$

$$\log X_t^d = \alpha_0 + \alpha_1 \log(P_x / P_x^*)_t + \alpha_2 \log Y_t^* + \alpha_3 \log REER_t + \alpha_4 \log TOT + \alpha_5 V + \varepsilon' \quad \textbf{.......(5)}$$

$$\alpha_0, \quad \alpha_2, \quad \alpha_4 > 0; \qquad \alpha_1, \quad \alpha_3, \quad \alpha_5 < 0;$$

$$\log X_t^s = \log X_t^d = \log X \quad \text{(Equilibrium)} \textbf{.. (6)}$$

An examination of the above model suggests that the structural equations are exactly identified, implying that ordinary least squares estimation methods may apply, subject to there being no endogeneity or simultaneous bias problems. It can be shown that the reduced-form equilibrium export quantity function based on (4), (5), and (6) takes the form of econometric model (7) below:-

$$\log X = \lambda_0 + \lambda_1 \log P_t + \lambda_2 \log P_{x\,t}^* + \lambda_3 \log CU_t + \lambda_4 \log Y_t^* + \lambda_5 \log REER + \lambda_6 \log TOT + \lambda_7 V_t + \upsilon \quad \textbf{..........(7)}$$

$$\lambda_0, \quad \lambda_2, \quad \lambda_3, \quad \lambda_4 > 0; \quad \lambda_1, \quad < 0; \quad \lambda_5, \quad \lambda_6, \quad \lambda_7 \gtrless 0$$

Where,

$$\lambda_0 = \frac{(\alpha_0\beta_1 + \beta_0\alpha_1)}{(\alpha_1 + \beta_1)}; \quad \lambda_1 = \frac{\alpha_1\beta_1}{(\alpha_1 + \beta_1)}; \quad \lambda_2 = \frac{\alpha_1\beta_1}{\alpha_1 + \beta_1}; \quad \lambda_3 = \frac{\alpha_1\beta_2}{\alpha_1 + \beta_1}; \quad \lambda_4 = \frac{\alpha_1\beta_2}{\alpha_1 + \beta_1}.;$$

$$\lambda_5 = \frac{(\alpha_1\beta_3 - \alpha_3\beta_1)}{(\alpha_1 + \beta_1)}; \quad \lambda_6 = \frac{(\beta_1\alpha_4 - \alpha_1\beta_4)}{(\alpha_1 + \beta_1)}; \quad \lambda_7 = \frac{(\beta_1\beta_5 - \alpha_1\alpha_5)}{(\alpha_1 + \beta_1)}; \quad \upsilon_t = \frac{(\beta_1\varepsilon + \alpha_1\mu)}{(\alpha_1 + \beta_1)}.$$

However, the view that export markets are always in equilibrium (e.g. Abbott, et.al. 2001; Savvides, 1992; Hooper and Kohlhagen, 1978) is widely contested particularly in developing countries, as markets may usually be in disequilibrium due to time lags and market imperfections (Doroodian, 1999: 467; Krugman, 1989). This contra-view suggests that an empirical investigation of the impact of exchange rate variability on Uganda's exports may best be pursued in a *disequilibrium* export supply model in line with the option suggested in Goldstein and Khan, (1978: 277-278).

3.2.4 The Reduced-form Disequilibrium Export Supply Model for Uganda

Following Goldstein and Khan (1978, 1985) and Doroodian (1999), conditions in the export market may obtain in a disequilibrium mode framework due to time lags associated with market imperfections. In line with Goldstein and Khan (1985: 1049; 1978: 277-278), export quantities may adjust to the difference between export supply and the actual flows in the previous period (equation (8) below); while the corresponding export price adjusts to conditions of excess world demand (equation (9) below)[2].

$$\Delta \log X \quad = \quad \psi(\log X_t^s - \log X_{t-1}) \text{ .... } \mathbf{(8)}$$

$$\Delta \log P_X \quad = \quad \vartheta f(\log X_t^d - \log X_t) \text{ .... } \mathbf{(9)}$$

Following from (4) (5) (8) and (9), it can be shown that the reduced-form disequilibrium export supply model for Uganda is as summarised in (10) below, i.e.

$$\log X_t = \pi_0 + \pi_1 \log P_t + \pi_2 \log P_{xt}^* + \pi_3 \log Y_t^* + \pi_4 \log CU_t + \pi_5 \log REER_t + \pi_6 \log TOT_t + ...$$
$$+ \pi_7 V_t + \pi_8 \log X_{t-1} + \pi_9 \log P_{xt-1} + \xi_t \text{ .... } \mathbf{(10)}$$

$$\pi_0,\ \pi_2,\ \pi_3,\ \pi_4,\ \pi_8,\ \pi_9 > 0; \qquad \pi_1,\ \pi_7 < 0; \qquad \pi_5,\ \pi_6 \ \substack{\geq \\ \leq}\ 0$$

Where

$$\pi_0 = \frac{\psi\beta_0(1+\vartheta\alpha_1)+\vartheta\alpha_0\psi\beta_1}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_1 = -\frac{\psi\beta_1}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_2 = \frac{\psi\beta_1\vartheta\alpha_1)}{(1+\vartheta\alpha_1+\vartheta)};$$

$$\pi_3 = \frac{\psi\beta_1\vartheta\alpha_2}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_4 = \frac{\psi\beta_2}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_5 = \frac{\psi\beta_3+\vartheta\psi(\alpha_1\beta_3-\beta_1\alpha_3)}{(1+\vartheta\alpha_1+\vartheta)};$$

$$\pi_6 = \frac{\vartheta\psi(\alpha_4\beta_1-\beta_4\alpha_1)-\psi\beta_4}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_7 = \frac{\psi\vartheta(\alpha_5\beta_1+\beta_5\alpha_1)+\psi\beta_5}{(1+\vartheta\alpha_1+\vartheta)};$$

$$\pi_8 = \frac{(1-\psi)}{(1+\vartheta\alpha_1+\vartheta)}; \quad \pi_9 = \frac{1}{(1+\vartheta\alpha_1+\vartheta)}; \text{ and } \xi_t = \frac{\psi\mu'(1+\vartheta\alpha_1)+\vartheta\varepsilon_t^{'}}{(1+\vartheta\alpha_1+\vartheta)}$$

The above suggests that it is possible to empirically investigate the impact of exchange rate variability on Uganda's exports under three possible frameworks (see Table 2.1 below):

(a) Single equation structural export supply, model (4);
(b) Reduced-form equilibrium export supply econometric model (7); or
(c) Reduced-form disequilibrium export supply econometric model (10) above.

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[2] The approach used here focuses on the supply side, consistent with a supply-constrained economy. In spite of this, this approach is consistent with that adopted in Goldstein and Khan's (1978), although theirs focuses on the demand side.

Table 2.1: Hypothetical Effect of Exchange Rate Variability on Uganda's Exports, Expected Signs in a Developing Country Contex

EXPORT MODEL	**INDEPENDENT VARIABLES**									
	$log\ P_{xt}$	$og\ P^*_{xt}$	$log\ P_t$	$og\ Y^*_t$	$log\ CU_t$	$log\ REER_t$	$log\ TOT_t$	$log\ P_{xt-1}$	$log\ X_{xt-1}$	V_t
Structural Export Supply, Log X_t^s	+	n.a.	-	n.a.	+	+	+-	n.a.	n.a.	-
Equilibrium Export Supply, Log X^s	n.a.	+	-	+	+	+-	+-	n.a	n.a.	-
Dis-equilibrium Export Supply, Log X^D	n.a.	+	-	+	+	+-	+-	+	+	-

Source: Adapted from Goldstein and Khan, (1978, 1985): see model equations explained above

Given possible differential interpretations of the concepts for the various variables, the next section explains how the above conceptual framework is empirically operationalised in Uganda to investigate the impact of exchange rate variability on exports.

3.3 Operationalising the Structural Export Demand Function in Uganda

In operationalising the structural demand function for Uganda's exports on the world market, one of the arguments sometimes made is that Uganda's low export growth is due to lack of global market opportunities. However, a review of the globalisation trends vis-à-vis Uganda suggests that opportunities for Uganda's exports in international trade have widened considerably since the adoption of structural adjustment programs in 1987. This is because Uganda enjoys preferential trade treatments from its expanded signatory to many trade agreements.

The above global market environment developments suggest that the world demand for Uganda's total exports may be taken as 'infinitely elastic' and 'exogenously given'. A review of the data from the IMF's IFS (2000) yearbook indicates that Uganda's exports constitute a very small proportion of the world total exports. The annual average of Uganda's exports is less than 0.02 percent of total world exports since 1970. The corresponding shares for Africa suggests a decline from over 4% in 1970-75 to 1.85% in 1996-2000. The share for LDCs as a group, remained between 30%-35%, while industrial countries account for over 66% of total world exports. These developments suggest that Uganda may be appropriately categorised as a 'small open exporting country' facing an infinitely elastic world export demand function (See also Goldstein and Khan, 1978: 275; 1985: 1048).

3.4 Operationalising the Structural Export Supply Function in Uganda

Considering that Uganda is largely a supply-constrained economy, we adopt all the theoretical aspects of export supply function as discussed above. An explanation of the operationalisation of the various concepts of the export growth model is as summarised in Table 3.2 below. The main concepts include exports, export prices, producer export prices, exchange rate, exchange rate variability, terms of trade, external relative export prices, domestic relative export prices, and domestic income capacity.

Table 3.2: Exports and Exchange Rate Variability - Conversion of Concepts into Operational Variables in Uganda

	CONCEPT	INDICATORS	VARIABLES	OPERATIONAL VARIABLE(S)	EVIDENCE
1	EXPORTS	-Physical goods shipped from one country to another -Value of earnings from goods and services sold from one country to another -Real Index of gross earnings from abroad	-Volume of goods -Annual value of export earnings (US$mn) -Nominal export earnings (US$m) deflated by trading partners price index	log-Export Real Value Index (1995=100)	Goldstein and Khan, (1978, 1985); Sukar and Hassan, (2001), Savvides (1992); Hassan and Tufte, (1998)
2	EXPORTS PRICES	Unit value of goods actually exported	Price index of exports of major trading partners	log-External Relative price index (Export price index relative to World export price index)	Goldstein and Khan, (1978, 1985);Hassan and Tufte, (1998) Arize (1997, 1996, 1995); Bini-Smaghi (1991); Hooper and Kohlhagen (1978);
3	PRODUCER EXPORT PRICES	Unit value of exportable goods paid to producers	Index of Prices of exports accruing to exporters	log-Domestic Relative price index (Export price index relative to Price Index of other domestic price levels)	Goldstein and Khan, (1978, 1985)
4	DOMESTIC PRICES	Unit value of goods sold for domestic consumption	Domestic consumer price index		
5	EXCHANGE RATE	Bilateral Value of domestic currency per unit value of a trading partner country's foreign currency for each of the countries involved in trade	- NEER index (interbank) - REER index (interbank) - NEER index (bureau) - REER index (bureau)	log-NEERO log-REEROH (log-REEROU) log-NEERP log-REEROH (log-REEROU)	Goldstein and Khan, (1978, 1985); Savvides A., (1992); Gotur (1985); Bleaney and Greenaway (2001); Doyle, (2001); Gotur, (1985); Sauer and Bohara (2001);
6	EXCHANGE RATE VARIABILITY	Movements in the observed exchange rates	Standard deviation of three-month-moving average of:- - NEER index (interbank) - REER index (interbank) - NEER index (bureau) - REER index (bureau)	log Standard deviation of NEERO log of Standard deviation of REEROH log Standard deviation of NEERP log Standard deviation REEROH	Savvides (1992); Abbott, Darnell and Evans (2001); Sekkat and Varoudakis (2002); Arize (1997, 1996, 1995); Bini-Smaghi (1991); Chowdhury (1993); De Grauwe P (1988);Hooper and Kohlhagen (1978)
7	TERMS OF TRADE	Unit price of a country's exports per unit price of a country's imports	Export price index as ratio of import price index	log-Terms of Trade (log-TOT)	Savvides, (1992); Sauer and Bohara (2001); Bleaney and Greenaway (2001);Thursby and Thursby (1987)
8	EXTERNAL EXPORT RELATIVE PRICES	Unit price of a country's exports as a ratio of unit price of export prices of rival suppliers prevailing in the rest of the world	Export price index as ratio of world export price index	log-External Relative price index (Export price index relative World export price index)	Goldstein and Khan, (1978, 1985); Hassan and Tufte, (1998) Arize (1997, 1996, 1995); Bini-Smaghi (1991)
9	DOMESTIC EXPORT RELATIVE PRICES	Unit price of a country's exports per unit price of other non-export domestic prices in the economy	Export price index as a ratio of domestic price index	log-Domestic Relative price index (Export price index relative Price index of other domestic price levels)	Goldstein and Khan, (1978, 1985); Balassa, 1989; Lawrence and Belshaw, 2002); Arize, 1995, 1996, 1997.
10	WORLD INCOME	Income value of a country's major trading partner countries	Weighted index of industrial prodn of trade partners	log-index of industrial production of industrial countries	Goldstein and Khan, (1978, 1985); Du and Zhu, (2001); Arize (1997, 1996, 1995); Doyle, (2001); Sukar and Hassan (2000); Doroodian (1999)
11	DOMESTIC INCOME CAPACITY	Actual production as a ratio of trended production in the domestic economy	Actual level of index of industrial production as a ratio of trend average of index of industrial production	log-Actual level of index of industrial production as ratio of trend average of index of industrial production	Goldstein and Khan, (1978, 1985); IMF, (1984); Gotur, (1985); Sekkat and Varoudakis (2000); Balassa, (1989); Hooper and Kohlhagen, (1978).

Source: Developed from various studies as shown in the table

4 The Data and Empirical Procedure

4.1 The Data

The study compiled data on the basis of the theoretical model and various concepts as explained above during a visit to Uganda during May-July 2002. Most of the data was solicited from various organisations in Uganda (including Bank of Uganda, BOU; the IMF, Uganda Bureau of Statistics (UBOS); Ministry of Finance and Economic Planning, Uganda; Uganda Revenue Authority; and Uganda Exporters Association as shown in Appendix (1) below. The study constructed various series of multilateral ‘nominal’ and ‘real’ effective exchange rates (and their corresponding variabilities) in ‘the interbank’ and ‘the bureau’ foreign exchange markets in Uganda over the period 1988M1-2001M12, as well as the real export index, relative export prices and capacity utilisation. An explanation of the constructed series is as discussed in Appendix 1 below.

4.2 Empirical Procedures

Being an export supply constrained economy, the study on Uganda focuses on the export supply side. The empirical procedure adopted aims at addressing the main research proposition as stated above. To arrive at a meaningful conclusion, it was necessary to establish an appropriate estimation technique. As will be demonstrated below, the preliminary analysis of the data suggests no evidence of multicollinearity between variables. Furthermore, on account of lack of *I(0)* or *I(1)* in all series, and the absence of endogeneity and any simultaneous bias problems between export supply and export demand, the study adopted an *ARDL* approach to cointegration related estimation techniques.

The empirical procedure adopted in the analysis involved two main phases. The first phase involved three main sub-phases: (i) Establishing the integration properties of all the series under the study in order to decide on an appropriate error correction estimation technique to adopt. (ii) Testing for endogeneity of the determinants of the structural export supply function based on Hausman-tests for exogeneity. (iii) Testing for simultaneous bias between the structural export supply function and the structural export demand function using Hausman tests for simultaneous bias technique with a view to establishing an appropriate estimation technique. The following sub-sections 4.2.1, 4.2.2, and 4.2.3 discuss the results of the main findings in these respects. The second phase was application of the preferred estimation technique, which is discussed in section 5.

4.2.0. Correlations

The results of correlation analysis suggest no evidence of multiple correlations. They suggest that only capacity utilisation variable is weakly correlated with most of the variables.

Table 4.2(b): Correlations Analysis Between Export Supply and its Determinants in Uganda (1988-2001)

		LEXPTDX	LTOTU	LCUIID	LNEERO	LVNEERO	LPXCPIU
LEXPTDX	Pearson Correlation	1	.703(**)	.089	-.485(**)	-.493(**)	.381(**)
	Sig. (2-tailed)	.	.000	.250	.000	.000	.000
	N	168	168	168	168	167	168
LTOTU	Pearson Correlation	.703(**)	1	.050	-.335(**)	-.409(**)	.201(**)
	Sig. (2-tailed)	.000	.	.522	.000	.000	.009
	N	168	168	168	168	167	168
LCUIID	Pearson Correlation	.089	.050	1	-.050	-.007	.027
	Sig. (2-tailed)	.250	.522	.	.524	.932	.730
	N	168	168	168	168	167	168
LNEERO	Pearson Correlation	-.485(**)	-.335(**)	-.050	1	.472(**)	-.958(**)
	Sig. (2-tailed)	.000	.000	.524	.	.000	.000
	N	168	168	168	168	167	168
LVNEERO	Pearson Correlation	-.493(**)	-.409(**)	-.007	.472(**)	1	-.409(**)
	Sig. (2-tailed)	.000	.000	.932	.000	.	.000
	N	167	167	167	167	167	167
LPXCPIU	Pearson Correlation	.381(**)	.201(**)	.027	-.958(**)	-.409(**)	1
	Sig. (2-tailed)	.000	.009	.730	.000	.000	.
	N	168	168	168	168	167	168

** Correlation is significant at the 0.01 level (2-tailed).
Source: Results of Spearman's Correlation analysis (1988-2001) based on Uganda data collected in May-July. 2002.

4.2.1 Unit Root Tests

Since the study is based on monthly time-series data, we first investigated the stationarity properties of the data. Following Engle and Granger (1991: 102), the Augmented Dickey-Fuller *(ADF)* test provides a sufficient method for testing unit roots on account of three main reasons. First, it yields the same critical values in finite sample experiments. Secondly, it exhibits very good power properties in relation to other methods. Thirdly, it has the same theoretical large sample properties as in the finite sample case. However, the *ADF* test suffers from small sample biases. Following Charemza and Deadman, (1997), this can be addressed by ensuring that the sample size is large enough, (at least over 50 observations). Mindful of the above, we *ADF-tested* each of the series for unit roots in the database based on a standard *ADF* regression equation of the form as in equation (13) below:

$$\Delta y_t = \mu + \beta t + \rho y_{t-1} + \sum \gamma_j \Delta y_{t-j} + v_t \quad \textbf{(13)}$$

Where $\boldsymbol{\rho}$ is the parameter of interest, and Δy_{t-j} corresponds to the lagged dependent variables required to correct for possible autocorrelation and ensure that the error term, v_t, is *white noise* and is not serially autocorrelated (Charemza and Deadman, 1997: 104; Gujarati, 1995: 720). Premised on satisfactory diagnostic tests, we then *ADF-tested* the null hypothesis $\boldsymbol{H_0}$ of a unit root i.e. $\boldsymbol{\rho = 0}$, (i.e. the coefficient of y_{t-1} is zero) as a basis for concluding that y_t is not stationary against the alternative hypothesis $\boldsymbol{H_a}$ that $\boldsymbol{\rho} < 0$ i.e. mean reverting (and therefore stationary).

Table 4.3: Summary of results of unit root tests based on ADF- and Phillips and Perron tests

	1988M1-2001M12				1988M1-1993M06				1994M1-2001M12			
	I(0)		I(1)		I(0)		I(1)		I(0)		I(1)	
	SERIES	Lag	SERIES	Lag	SERIES	Lag	SERIES	Lag	SERIES	Lag	SERIES	Lag
	B0		*B1*		*C0*		*C1*		*D0*		*D1*	
EXPORTS			LXVOLNDX	11			LXVOLNDX	16			LXVOLNDX	8
			LGRXPTS	11			LGRXPTS	16			LGRXPTS	11
EXCH. VAR.	LVNEERo	2	LVREERoh	7	LVNEERo	3	LVNEERp	5	LVNEERo	1	LVREERoh	7
	LVNEERp	2	LVREERph	10	LVREERou	1	LVREERpu	0	LVNEERp	2		
	LVREERou	1			LVREERmf	3	LVREERoh	7	LVREERou	1		
	LVREERpu	2					LVREERph	10	LVREERph	1		
	LVREERmf	1							LVREERpu	1		
									LVREERmf	1		
ACTIVITY			LIIPWOD	12	LIIPWOLD	0					LIIPWOD	18
			LIID	12	LIID	2					LIID	12
	LCUIID	18			LCUIID	3			LCUIID	17		
	LCUGDP	22					LCUGDP	13	LCUGDP	10		
REL. PRICE	LCPHPXAG	2	LPxCPIH	0			LPxPxLDC	0			LPxPxLDC	1
			LPxCPIU	0			LPxPxWOD	0			LPxPxWOD	1
			LPxPxLD	2			LPxPxAGR	0			LPxPxAGR	1
			LPxPxWD	2			LPxCPIH	0			LPxCPIH	1
			LPxPxAG	5			LPxCPIU	0			LPxCPIU	1
			CPHPXLD	1			LCPHPXLD	24			LCPHPXLD	0
			CPHPXWD	1			LCPHPXWD	23			LCPHPXWD	0
			CPUPXLD	6			LCPHPXAG	1			LCPHPXAG	0
			CPUPXWD	6			LCPUPXLD	24			LCPUPXLD	0
			CPUPXAG	2			LCPUPXWD	24			LCPUPXWD	0
							LCPUPXAG	1			LCPUPXAG	0
TOT			LTOTu	1			LTOTu	0			LTOTu	1
REER, NEER	LNEERo	1	LREERoh	0			LNEERo	0			LNEERo	0
	LNEERp	1	LREERou	1			LNEERp	0			LNEERp	0
			LREERph	1			LREERoh	0			LREERoh	1
			LREERpu	5			LREERph	12			LREERph	1
			LREERimf	0			LREERou	0			LREERou	1
							LREERpu	9			LREERpu	1
							LREERimf	22			LREERimf	0

Source: Based on the ADF tests for unit-roots (Appendix 1 and 2 below) and the data on Uganda collected during May- July 2002.

Table 4.3 above provides a summary of the key findings from unit root test analysis (See Appendix (2) for details). The following conclusions can be drawn:

- First, at the 10% level of confidence and for the sample period as a whole, unit root tests suggest that there is no a joint pure *I(0)* or pure *I(1)* for all the series. This suggests that ARDL approach to cointegration is an appropriate method for the present study on Uganda (Pesaran, Shin and Smith, 2001; Pesaran and Pesaran, 1997).

- Secondly, different series have different convergent lag structures. This implies that a method involving ARDL techniques or general-to-specific methods of analysis may be more relevant in examining the effect of exchange rate variability on exports in Uganda taking into account appropriate short-term dynamics.

- Thirdly, the results of unit root tests suggest that the stationarity properties of some series vary across the period under study. For example, the series relating to the ratio of the underlying domestic consumer price index as a ratio of world prices of exports from other developing countries, (*CPUPXLD*) suggests that it is *I(1)* over the period 1988M01-2001M12; and over the period 1988M01-1993M06 respectively; and I(0) in the period 1994M01-2001M12. This pattern suggests that some of the series may be fractionally integrated.

Given that there is no pure *I(0)* or pure *I(1)* in all the series, we concluded that *ARDL-ECM* methods (i.e. *ARDL* approach to cointegration) are more appropriate (Pesaran, Shin, and Smith, 2001) (see sub-section 4.2.3 below for more details).

4.2.2 Exogeneity Tests for Exports and its Determinants in Uganda

From the discussions in section (3) above, it has been revealed that some of the important determinants of exports include relative export prices, the terms of trade, levels of exchange rate and its misalignment and capacity utilisation. So far, the classification of these variables as exogenous *a priori* has been adopted by assumption, in line with most of the empirical literature without any solid explanation. In line with Gujarati (1995: 672) and Pyndick and Rubinfeld (1991:303-304), Hausman tests for exogeneity were carried out to determine the endogeneity/exogeneity status of the various determinants of exports (exchange rate variability, real levels of exchange rate, export prices, terms of trade and capacity utilisation). This was aimed at establishing an appropriate estimation technique (*OLS* or instrumental variables estimation technique) depending on whether or not these *explanatory factors* prevail in an otherwise deterministic environment.

Table 4.4 below provides the summary of the results of the analysis (highlighted in grey. Since each of the coefficients of the '*residual variable'* is invariantly zero, we concluded that the various determinants of the structural export supply equation are *truly* exogenous. On this basis, the *OLS* may be rendered as an appropriate estimation technique for the structural export supply function. This is because in the absence of endogeneity problems, *OLS* estimations yield results that are consistent and efficient (Gujarati, 1995). Correspondingly, instrumental variable technique is not appropriate:

although it would lead to results that are consistent, they would not be efficient (Gujarati, 1995: 672).

Table 4.4: Results of Hausman-test for exogeneity of: exchange rate variability, capacity utilisation, terms of trade, relative export prices, and real exchange rate as determinants of exports supply in Uganda, 1988-2001*.

HAUSMAN TESTS (ACTUAL OBSERVATION OF VARIABLE, AND ITS RESIDUALS) FOR EXOGENEITY OF….(t-values in italics)													
		EX. RATE VAR.		***LCUIID***		***LTOTU***		***LPXCPIH***		***LPXCPIU***		***LREEROH***	
		ACTUAL	*RESIDUAL*	*ACTUAL*	*RESIDUAL*	*ACTUAL*	*RESIDUAL*	*ACTUAL*	*RESIDUAL*	*ACTUAL*	*RESIDUAL*	*ACTUAL*	*RESIDUAL*
1	LVNEERO	-0.0013	-0.0804	-2.9988	3.8616	0.6147	-0.1345	0.6887	-0.1140	0.3023	0.6313	0.6296	-0.43668
		-0.0122	*-0.7232*	*-1.3966*	*1.6092*	*1.6399*	*-0.2941*	*1.8060*	*-0.2506*	*0.3517*	*0.6058*	*1.1804*	*-0.60524*
2	LVNEERP	-0.1424	0.0647	-1.3348	3.1340	0.6345	-0.1256	0.9716	-0.3838	1.3797	-0.6438	0.1820	-0.10499
		-1.1674	*0.4897*	*-0.7456*	*1.4336*	*1.4548*	*-0.2489*	*2.1237*	*-0.7353*	*1.3583*	*-0.5542*	*0.6710*	*-0.24256*
3	LVREEROH	0.0248	-0.0956	-0.8370	2.5967	0.7214	-0.2426	0.8192	-0.2348	0.7819	0.2657	-1.4104	0.21742
		0.2153	*-0.7861*	*-0.6148*	*1.4221*	*1.7659*	*-0.4993*	*2.0994*	*-0.5089*	*0.8754*	*0.2444*	*-2.1977*	*0.54377*
4	LVREERPH	0.0192	-0.1037	-0.1761	1.9544	0.4820	0.0423	0.6545	0.0056	0.9671	0.2432	-0.1038	-0.1752
		0.1959	*-0.9817*	*-0.1338*	*1.0644*	*1.1546*	*0.0871*	*1.5687*	*0.0117*	*0.9808*	*0.2136*	*-0.3303*	*-0.37908*
5	LVREERMF	-0.0197	0.0614	-0.1080	1.2685	0.8006	-0.4021	1.0540	-0.5666	1.3568	-0.5322	0.3428	-0.11159
		-0.1811	*0.5127*	*-0.0806*	*0.6854*	*2.0800*	*-0.8528*	*2.7274*	*-1.2282*	*1.4258*	*-0.4820*	*0.7625*	*-0.16033*
	UNDERLYING CPI												
6	LVNEERO	-0.0040	-0.0770	0.1910	0.4791	0.6097	-0.1271	0.6926	-0.1182	0.3446	0.5806	0.6214	-0.42238
		-0.0385	*-0.6965*	*0.1369*	*0.2611*	*1.6268*	*-0.2780*	*1.8167*	*-0.2599*	*0.4022*	*0.5577*	*1.1662*	*-0.58542*
7	LVNEERP	*0.0325*	-0.1318	-0.7128	-0.5142	0.6226	-0.1106	0.9619	-0.3720	0.3549	0.8148		
		0.2199	*-0.8417*	*2.5290*	*1.3397*	*1.4280*	*-0.2192*	*2.1078*	*-0.7139*	*0.3984*	*0.7591*		
8	LVREEROU	0.1196	-0.1723	-1.0397	2.4971	0.6715	-0.1792	0.7968	-0.2284	0.7586	0.1211		
		1.1711	*-1.5963*	*-0.7555*	*1.3624*	*1.6772*	*-0.3762*	*2.0180*	*-0.4927*	*0.8248*	*0.1107*		
9	LVREERPU	0.0279	-0.1058	-0.1016	1.6202	0.4203	0.1094	0.5485	0.1235	0.9397	0.2287		
		0.2819	*-0.9837*	*-0.0697*	*0.8515*	*1.0062*	*0.2250*	*1.3488*	*0.2599*	*0.9695*	*0.2016*		
10	CONCLUSION	EXOGENOUS		EXOGENOUS		EXOGENOUS		EXOGENOUS		EXOGENOUS		EXOGENOUS	

(*t-statistics in italics*).

* For convenience purposes, only partial results focusing on the coefficient of the residual equation as well as the corresponding contemporaneous variable are reported. In all cases, estimated equations passed all the underlying diagnostic tests.

Source: Summary of results of Hausman tests for exogeneity, based on data on Uganda (1988-2001). Estimations were made using Microfit IV software (Pesaran and Pesaran, 1997) and summarised in excel worksheet.

Although the above findings suggest that the determinants of exports are truly exogenous, they do not necessarily render *OLS* an appropriate estimation method. This is because as discussed in section (3) above, Uganda's exports take place in a conceptual framework involving both exports supply and the world's demand for Uganda's exports conditions. So far, the world demand conditions for Uganda's exports have only been assumed to be exogenous in line with the 'small country' assumption. Yet, following Goldstein and Khan's (1985), "…simultaneity is not a problem that can be dealt with by assumption, particularly in relation to exports" (p.1072). Accordingly, the next sub-section empirically investigates simultaneity bias to establish further an appropriate estimation technique (either *OLS* or *2SLS*).

4.2.3 Simultaneous Bias and the Exports Supply Function

It is sometimes argued that in the context of international trade, the export price may not be a truly exogenous variable in the system as a whole (Goldstein and Khan, 1985: 1071-1072; and Mukherjee, White and Wuyts, 1998: 417-424). In case simultaneous bias exists, then the relative export price in the export supply function will be related to the error term, thereby biasing the results of the estimated coefficients. As an alternative, a simultaneous estimation technique must be applied. Following Pyndick and Rubinfeld (1991: 303-304); Gujarati, (1995: 670-671); and Mukherjee, White and Wuyts (1998: 417-424), simultaneity bias of the export price variable can be tested using Hausman-test simultaneous bias to decide whether the relative export price variable in the export supply function can be treated as truly exogenous in the system as a whole.

The study undertook an empirical investigation for simultaneous bias tests for the relative export price variable based on all alternative series for the export supply function. The summary of the key results is shown in Table 4.5 below[3]. Since for each case, the calculated *F-value* for Hausman specification test for simultaneous bias was lower than the tabulated *F(1, 69) statistic* of 4.000 at the 5% level of confidence, it can be concluded there is no sufficient evidence to reject the null hypothesis of a "no simultaneous bias between the 'structural export' supply and demand functions".

Table 4.5: Hausman-tests for simultaneous bias of the relative export price in Uganda's export supply

	HAUSMAN TEST FOR SIMULTANEOUS BIAS				DIAGNOSTIC TESTS*			
		LEADING EXCHANGE RATE	Coefficient	*Hausman-test statistic (Calculated F(1, 69) Value**)*	Serial Correlation	Func. Form	Normality	Heteroske-dasticity
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	***LPXCPIH***	***LNEERO***	0.290	0.016	15.761	1.350	0.011	4.657
			0.732	*0.900*	*0.202*	*0.245*	*0.900*	*0.031*
	R1		0.047					
			0.127					
2	***LPXCPIH***	***LNEERP***	0.477	0.015	18.637	1.303	1.443	1.697
			0.933	*0.904*	*0.098*	*0.254*	*0.486*	*0.193*
	R2		-0.058					
			-0.121					
3	***LPXCPIH***	***LREEROH***	0.171	0.139	35.409	0.434	0.603	7.279
			0.405	*0.710*	*0.000*	*0.510*	*0.740*	*0.007*
	R3		0.160					
			0.399					
4	***LPXCPIH***	***LREERPH***	0.861	0.418	20.165	4.668	0.080	1.556
			1.806	*0.520*	*0.064*	*0.031*	*0.961*	*0.212*
	R4		-0.297					
			-0.646					
5	***LPXCPIH***	***LREERIMF***	-0.165	1.102	12.015	0.002	0.497	3.043
			-0.356	*0.297*	*0.444*	*0.960*	*0.780*	*0.081*
	R5		0.444					
			1.050					
6	***LPXCPIU***	***LNEERO***	-0.048	0.096	14.890	0.244	0.435	1.696
			-0.060	*0.757*	*0.247*	*0.621*	*0.805*	*0.193*
	R6		0.198					
			0.310					
7	***LPXCPIU***	***LNEERP***	0.564	0.130	21.842	1.442	1.775	0.607
			0.697	*0.720*	*0.039*	*0.230*	*0.412*	*0.436*
	R7		-0.202					
			-0.361					
8	***LPXCPIU***	***LREEROU***	-0.144	0.813	17.035	0.002	0.122	4.084
			-0.215	*0.370*	*0.148*	*0.968*	*0.941*	*0.043*
	R8		0.436					
			0.902					
9	***LPXCPIU***	***LREERPU***	0.993	0.465	18.136	7.031	0.586	1.275
			1.218	*0.498*	*0.112*	*0.008*	*0.748*	*0.259*
	R9		-0.326					
			-0.682					

* Reported figures in italics below the estimated coefficients refer to t-values. For convenience, the corresponding estimated coefficients of other variables are not reported. Under the column 'Diagnostic Tests' the figures in italics refer to probability values for accepting the null hypothesis of the estimated equation.
Source: Results of Hausman-tests for simultaneous bias using aggregate data on Uganda (1988M1-2001M12) compiled from various sources in Uganda during May-July 2002.

On the basis of the results in Table 4.5, it can be concluded that:

- There is no sufficient evidence to reject the null hypothesis that 'there is no simultaneous bias between 'structural export' supply and demand functions via the external relative export price variable.
- As a result of the above, the assumption that the world demand for Uganda's exports is exogenous is adopted.
- Given the above, Instrumental Variable (*IV*) estimation technique (or 2-stage least squares (*2SLS*) estimation technique may be rendered inappropriate for the purposes of the present study. This is because applying these methods when there is no simultaneous bias problem yields parameter estimates that may be consistent, but not efficient (Gujarati 1995: 670).

- Since there is neither endogeneity, nor simultaneous bias problem, estimation of the 'structural export supply function' based on *OLS* related methods is considered appropriate for the present study. This is because when no simultaneous bias prevails, *OLS* estimation methods yield estimates that are both consistent and efficient (Gujarati 1995: 669)[4].

Based on the results from sub-sections 4.2.1, 4.2.2 and 4.2.3 above, an *ARDL* approach to cointegration is adopted to investigate the effects of exchange rate variability on Uganda's export supply growth based on *OLS* related estimation techniques. Section 5 below provides the results of the analysis based on the structural export supply function, focusing on the general-to-specific *ARDL-ECM* estimations; and the long-run relationships based on *ARDL* approach to cointegration.

5 Results / Findings

[4] If there is a simultaneous bias problem, using OLS method yield estimates that are not consistent (Gujarati, 1995: 669).

The results are based on ARDL-ECM general-to-specific estimations of the structural export supply model in Uganda, and the corresponding results of the long-run estimations based on *ARDL* approach to cointegration estimations. Since it has been decided that the analysis of the structural export function suffices to make inferences about the 'research' question and objectives, the ARDL approach to cointegration focused on an *ARDL-ECM* econometric of model (4) above i.e.

$$\log \Delta X_t^S = \beta_0 + \sum_{i=1}^{l-1} \beta_{1i} \Delta \log(P_X/P)_{ti} + \sum_{i=1}^{m-1} \beta_{2i} \Delta \log CU_{ti} + \sum_{i=1}^{n-1} \beta_{3i} \Delta \log REER_{ti} + \sum_{i=1}^{p-1} \beta_{4i} \Delta \log TOT_{ti} + \sum_{i=1}^{q-1} \beta_{5i} \Delta V_{ti} + ..$$
$$+ \gamma \log X_{t-1}^S + \gamma_1 \log(P_X/P)_{t-1} + \gamma_2 \log CU_{t-1} + \gamma_3 \log REER_{t-1} + \gamma_4 \log TOT_{t-1} + \gamma_5 V_{t-1} + \upsilon_t \quad \textbf{............(14)}$$

Based on (14) above, the null hypothesis tested is, 'H_0 of no long-run relationship' against the alternative hypothesis 'H_A that there is a long-run relationship' i.e..

$$H_0 \; : \; \gamma = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0 \quad \textbf{........................(14.a)}$$

$$H_A \; : \; \gamma \neq \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0 \quad \textbf{........................(14.b)}$$

If H_0 is rejected, then support for existence of a long-run relationship is established. Accordingly, the corresponding *ARDL-ECM* long-run parameter estimates are derived from (14) above in an equation of the form:-

$$\log X_t^S = \varphi_1 \log(P_X/P)_t + \varphi_2 \log CU_t + \varphi_3 \log REER_t + \varphi_4 \log TOT_t + \varphi_5 V_t \quad \textbf{................(15)}$$

Where, $\varphi_1 = \dfrac{\gamma_1}{\gamma}; \quad \varphi_2 = \dfrac{\gamma_2}{\lambda}; \quad \varphi_3 = \dfrac{\gamma_3}{\gamma}; \quad \varphi_4 = \dfrac{\gamma_4}{\gamma}; \quad \varphi_5 = \dfrac{\gamma_5}{\gamma}$ **........................(16)**

The results of the parsimonious model based on general-to-specific *ARDL-ECM (12,12,12,12,12,12)* estimations are as summarised in Table 5.1(b) below. The results suggest that the final model passes all the diagnostic tests relating to serial correlation, functional specification, normality, as well as heteroskedasticity. The study *F-tested* the null hypothesis that 'variable deletion is data-permissible' against the alternative hypothesis that 'variable deletion is not data permissible.' The calculated *F-statistic* of 0.88769 was much lower than the tabulated $F_{(63, 74)}$ statistic of 1.53 at the 5% level of confidence. We therefore concluded that there is no sufficient evidence to reject the null hypothesis that 'variable deletion is data permissible'.

Table 5.1(b): Results of General to Specific Estimations, 1989M3-2001M12 (159 Observations)

	MONTHLY LAGS												
	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
C	0.1928 *(0.5950)*												
T													
DLEXPTDX										-0.2261 *(-4.0830)*			
DLCUIID		1.1313 *(1.8217)*								-1.9915 *(-5.1812)*	-1.7397 *(-4.4999)*		
DLTOTU		-0.2830 *(-1.6896)*								-1.6195 *(-4.7798)*			
DLPXCPIU									-0.3304 *(-2.1124)*	1.4315 *(4.2595)*			
DLNEERO											-0.6820 *(-2.6891)*		
DLVNEERO					-0.0122 *(-0.4783)*								
LEXPTDX(-1)		-0.3543 *(-5.8547)*											
LTOTU(-1)		-3.2117 *(-2.7495)*											
LCUIID(-1)		0.3158 *(3.3232)*											
LPXCPIU(-1)		-0.0439 *(-0.3572)*											
LNEERO(-1)		-0.0792 *(-0.7006)*											
LVNEERO(-1)		-0.0122 *(-0.4783)*											
R2-Bar					0.4606								
DW Statistic					1.9938								
RSSR					1.1252								
Serial Correlation		χ^2 (12) (LM version)			7.7026 *(0..808)*								
Functional Form		χ^2 (1) (LM version)			0.0006 *(0.980)*								
Normality		χ^2 (2) (LM version)			0.9682 *(0.616)*								
Heteroskedasticity		χ^2 (1) (LM version)			0.0370 *(0.847)*								

Key coefficient of interest as highlighted

Source: Results from Microfit 4.0 estimations based on data (1988M1-2001M12) collected from Uganda (May-July, 2002)

Based on the results of the *ARDL-ECM* general-to-specific parsimonious model above, we observed that the optimum lag-lengths for the short-term dynamics differ for different variables in the model. In the subsequent estimations, it is found that applying a uniform lag-length did not always result in the initial *general* model with well-behaved diagnostic tests. As an alternative, we used varying lag-lengths in the initial model in order to obtain a general model, which passes the diagnostic tests. Consequently, this allowed us to formally proceed with hypothesis tests associated with variable deletions/addition based on an initially ‘well-behaved’ general model. Thirdly, carrying out the *bounds-test* procedures, prior to obtaining the parsimonious model resulted in a downward bias in the calculated *F-statistics.* Since the initial general model is over-parametised with ‘redundant’ variables, this risked one to committing ‘Type II’ error of accepting the null-hypothesis of ‘no long-run relationships between exports and its determinants’, whereas one may actually prevail (Burns, 2000: 116-117). Accordingly, we carried out *bounds-tests* on the basis of the parsimonious model.

The results of *bounds test* are based on Tables 5.1(b) above and the 'null' and 'alternative' hypothesis as in equations 14(a) and 14(b) above reveal that the calculated *F-statistic* of 8.4408 is much higher than the tabulated bounds-test critical values of I(0)=2.649; I(1)=3.805 (intercept, with no trend) at the 5% level of confidence (See Pesaran and Pesaran 1997: 478). On this account, we concluded that there is no sufficient evidence to accept the null hypothesis of 'no long-run relationships between export supply and its major determinants'.

Given that a long-run relationship between export supply growth and its determinants has been established, we then adopted an *ARDL-ECM* model as a basis for obtaining the corresponding estimates of the long-run elasticities from equation. A similar analysis was done for the fixed exchange rate regime sub-sample period 1988M1-1993M6 and the Floating Exchange rate regime period 1994M1-2001M12. Table 5.1(d) below provides a summary of the results with a focus on the coefficient of the exchange rate variability variable as highlighted in the table.

Table 5.1(d): Results of ARDL long-run Estimations: Bounds Test for Cointegration
(BASED ON ARDL-AKAIKE INFORMATION CRITERIA, ARDL-AIC))

	ARDL(1,0,0,1,0,0) ***1988M1-2001M12***	***ARDL(1,0,0,1,0,0)*** ***1988M1-1993M6***	***ARDL(1,0,0,0,1,0)*** ***1994M1-2001M12***
C	0.65371	-0.9511	0.0039
	(0.8765)	*(-1.0363)*	*(0.0026)*
LTOTU	0.80131	1.1170	-0.259
	(4.4234)	*(3.8008)*	*(-1.0217)*
LCUIID	1.4067	0.7984	1.3173
	(1.2926)	*(0.9499)*	*(1.2815)*
LPXCPIU	-0.0317	0.7123	2.1282
	(-0.1116)	*(2.7481)*	*(3.7193)*
LNEERO	-0.1753	0.2487	1.2792
	(-0.6677)	*(1.0930)*	*(1.8439)*
LVNEERO	-0.2067	-0.0534	-0.204
	(-3.2073)	*(-1.2772)*	*(-3.2356)*

Measure of interest in this row

Source: Summary of long-run estimations from *ARDL-ECM* model above, based on the data compiled from Uganda (1988M1-2001M12) during May-July 2002.

Based on the results from the above analysis, it can be concluded that:

- For the sample as whole, Uganda's exports supply was significantly and negatively correlated with variability in the nominal exchange rate *(LVNEERO)*. The results from the long-run *ARDL-ECM* estimations suggest that for every

100% increase in exchange rate variability, real export supply index decreases by approximately 20%.

- Under the fixed exchange rate regime (1988M1-1993M6), Uganda's exports supply was *invariantly* correlated with variability in the nominal exchange rate.
- Under the floating exchange rate regime (1994M1-2001M12), Uganda's exports supply was significantly and negatively correlated with exchange rate variability. The results from the long-run ARDL-ECM estimations suggest that for every one percent increase in exchange rate variability, export supply would decrease by approximately twenty percentage points.
- Based on the above information alone, one may conclude that by adopting a floating exchange rate regime in November 1993, nominal exchange rate variability has been a significant negative factor for Ugandan exporters.

However, the above results alone are inadequate to make generalised macroeconomic inferences for exports and exchange rate variability in Uganda. It is intuitive for one to ask, 'doesn't the evidence based on alternative series lead to alternative conclusions?' Following the same procedures as above, further empirical investigation is carried out in this regard. The results as summarised in Table 5.1(e) below suggest that:-

- For the sample as a whole, the effect of exchange rate variability on Uganda's exports supply is ambiguous: negative or invariantly zero. In four out of the nine cases considered, the results were positive although insignificant. In the remaining five cases, the results were only significantly negative in two estimations.
- Under the fixed exchange rate regime (1988M1-1993M6), Uganda's exports supply was invariantly correlated with exchange rate variability
- Under the floating exchange rate regime (1994M1-2001M12), Uganda's exports supplies are significantly negatively correlated with exchange rate variability.
- However, based on the underlying inflation rate, exports are negatively correlated to the nominal effective exchange rate variability under the floating regime, and invariant to real effective exchange rate variability under both regimes.
- Based on the above information alone, one may conclude that since the adoption of a floating exchange rate regime in November 1993, exchange rate variability is an important negative factor for Ugandan exporters.

Table 5.1(f): Effects of Exchange Rate Variability on Uganda's Aggregate Exports: Results of long-run estimations based on ARDL approach to Cointegration

	TOTAL EXPORT SUPPLY					CAP.	TOT	EL.TO DOM. PRIC		LOG-EXCHANGE RATE									EXCHANGE RATE VARIABILITY (STDD DEVIATION OF 3-MONTHS LOG-EXCHANGE RATE)									
	ARDL (REAL EXPORT EARNINGS INDEX)				CONST	LCUIID	LTOTU	LPXCPIH	LPXCPIU	LNEERo	LNEERp	LREERoh	LREERph	LREERimf	LNEERo	LNEERp	LREERou	LREERpu	LVNEERo	LVNEERp	LVREERoh	LVREERph	LVREERmf	LVNEERo	LVNEERp	LVREERou	LVREERpu	*AKAIKE INF. CRITERIA*
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	AS111	1988M1-2001M12	HEADLINE	LNEERo	0.4769	1.1919	0.8621	-0.0059		-0.1469									-0.2038									ARDL(1,0,2,1,0,0)
	AS111				*1.1715*	*1.1033*	*3.2529*	*-0.0207*		*-0.5509*									*-3.1979*									
2	AS122			LNEERp	0.5951	1.6441	0.8793	0.1423			-0.2360									-0.0405								ARDL(1,0,1,1,3,1)
	AS122				*0.5975*	*1.4415*	*3.3607*	*0.4460*			*-0.3875*									*-0.4739*								
3	AS133			LREERoh	0.3231	1.0853	0.7506	0.3007				0.0398									-0.0931							ARDL(1,0,2,1,1,0)
	AS133				*0.7568*	*1.0127*	*2.7905*	*1.1766*				*0.1352*									*-1.5346*							
4	AS144			LREERph	-1.1266	1.2294	0.8076	0.3222					0.6896									0.0157						ARDL(1,0,2,1,2,1)
	AS144				*-1.4761*	*1.2560*	*3.8671*	*2.6025*					*1.6208*									*0.2316*						
5	AS155			LREERimf	-0.4279	0.9685	0.8345	0.1499						0.3140									0.0164					ARDL(1,0,2,1,1,2)
	AS155				*-0.6995*	*0.9463*	*4.5339*	*1.1987*						*1.0840*									*0.2106*					
6	AS166		UNDERLYING	LNEERO	0.6537	1.4067	0.8013		-0.0317						-0.1753									-0.2067				ARDL(1,0,0,1,0,0)
	AS166				*0.8765*	*1.2926*	*4.4234*		*-0.1116*						*-0.6677*									*-3.2073*				
7	AS177			LNEERP	0.3282	1.6604	1.0182		0.1402							-0.2413									-0.0411			ARDL(1,0,0,1,3,1)
	AS177				*0.2158*	*1.4559*	*4.6069*		*0.4437*							*-0.4017*									*-0.4854*			
8	AS188			LREEROU	-0.1615	0.9075	1.1229		0.2077								-0.1097									0.0466		ARDL(1,0,2,1,1,2)
	AS188				*-0.1924*	*0.8174*	*6.0284*		*0.7563*								*-0.3435*									*0.5505*		
9	AS199			LREERPU	-0.8910	1.1019	1.0984		0.2396									0.2829									0.0005	ARDL(1,0,2,1,2,1)
	AS199				*-0.8623*	*1.0377*	*6.8140*		*1.7584*									*0.5771*									*0.0073*	
10	BS111	1988M1-1993M6	HEADLINE	LNEERo	0.4751	0.7947	0.4038	0.7127		0.2488									-0.0536									ARDL(0,0,0,0,0,0)
	BS111				*0.6825*	*0.9462*	*1.2605*	*2.7555*		*1.0956*									*-1.2815*									
11	BS122			LNEERp	-1.4239	10.2221	0.7798	0.7662			0.8417									0.0681								ARDL(0,1,2,0,2,1)
	BS122				*-1.4488*	*2.7592*	*2.4927*	*3.6712*			*2.1301*									*0.9804*								
12	BS133			LREERoh	0.2696	0.8971	0.6768	0.4948				0.0665									0.0948							ARDL(0,0,0,0,0,3)
	BS133				*0.3627*	*1.1177*	*2.0667*	*2.8846*				*0.3188*									*1.0411*							
13	BS144			LREERph	-0.5953	7.2810	0.8779	0.3960					0.3679									-0.0537						ARDL(0,3,2,3,2,2)
	BS144				*-0.4916*	*1.9952*	*2.1017*	*2.8378*					*1.0831*									*-0.6860*						
14	BS155			LREERimf	1.6420	0.5247	0.4259	0.5957						-0.3977									0.1031					ARDL(2,0,0,0,3,2)
	BS155				*2.1645*	*0.6812*	*1.3775*	*3.6483*						*-1.5382*									*1.5302*					
15	BS166		UNDERLYING	LNEERO	-0.9511	0.7984	1.1170		0.7123						0.2487									-0.0534				ARDL(0,0,0,0,0,0)
	BS166				*-1.0363*	*0.9499*	*3.8008*		*2.7481*						*1.0930*									*-1.2772*				
16	BS177			LNEERP	-3.4540	13.3796	1.7383		0.7770							0.9223									0.0742			ARDL(0,1,2,3,2,1)
	BS177				*-2.7921*	*3.4583*	*5.7613*		*3.8243*							*2.3441*									*1.1056*			
17	BS188			LREEROU	-0.9877	0.7669	1.2295		0.5269								0.1535									0.0769		ARDL(0,0,0,0,0,3)
	BS188				*-1.0534*	*0.9214*	*3.9013*		*2.8025*								*0.6559*									*0.8631*		
18	BS199			LREERPU	-1.1320	9.9741	1.3035		0.3184									0.1954									0.0004	ARDL(0,1,2,3,2,1)
	BS199				*-0.9846*	*2.5705*	*4.2867*		*2.2317*									*0.5096*									*0.0066*	
19	CS111	1994M1-2001M12	HEADLINE	LNEERo	4.2532	1.3119	-2.3746	2.1183		1.2703									-0.2043									ARDL(1,0,0,0,1,0)
	CS111				*3.4765*	*1.2756*	*-3.2946*	*3.7011*		*1.8298*									*-3.2396*									
20	CS122			LNEERp	4.0426	0.9040	-2.6000	2.2633			1.6031									-0.2172								ARDL(1,0,0,1,1,0)
	CS122				*3.2052*	*0.8957*	*-3.5769*	*4.0016*			*2.1689*									*-3.4923*								
21	CS133			LREERoh	4.2911	-13.1248	-1.5118	1.3150				0.3736									-0.1122							ARDL(1,3,1,1,1,0)
	CS133				*2.9470*	*-1.7326*	*-2.3049*	*2.9142*				*0.6046*									*-1.9230*							
22	CS144			LREERph	4.2543	1.1752	-1.4533	1.2743					0.3269									-0.0841						ARDL(1,0,1,1,1,0)
	CS144				*2.8157*	*1.0748*	*-2.2935*	*2.9603*					*0.5082*									*-1.4954*						
23	CS155			LREERimf	6.9880	0.8979	-1.5178	1.3735						-0.9643									-0.1686					ARDL(1,0,1,1,1,0)
	CS155				*3.6565*	*0.8840*	*-2.6435*	*3.7687*						*-1.5796*									*-3.0535*					
24	CS166		UNDERLYING	LNEERO	0.0039	1.3173	-0.2587		2.1282						1.2792									-0.2039				ARDL(1,0,0,0,1,0)
	CS166				*0.0026*	*1.2815*	*-1.0217*		*3.7193*						*1.8439*									*-3.2356*				
25	CS177			LNEERP	-0.5889	1.1198	-0.2262		2.1569							1.5401									-0.2073			ARDL(1,0,0,0,1,0)
	CS177				*-0.3756*	*1.0969*	*-0.9083*		*3.8192*							*2.0576*									*-3.3258*			
26	CS188			LREEROU	2.6058	1.3471	-0.2653		1.2783								-0.0381									-0.0370		ARDL(1,0,0,1,1,2)
	CS188				*1.7923*	*1.1346*	*-0.9330*		*2.4481*								*-0.0528*									*-0.4728*		
27	CS199			LREERPU	2.7308	1.1422	-0.2252		1.2103									-0.1447									-0.0204	ARDL(1,0,0,1,1,2)
	CS199				*1.7895*	*0.9517*	*-0.7920*		*2.3524*									*-0.1906*									*-0.2352*	

Source: Results from long-run estimations from ARDL approach to cointegration based on data compiled from Uganda (May-July2002)

6 Conclusions

This study aimed at addressing the debatable issue in Uganda's foreign exchange market: i.e. "What is the effect of exchange rate variability on Uganda's exports?" and secondly, 'what biases against exports, does ignoring exchange rate variability bring into the magnitude of Uganda's export- and related macroeconomic policy relevant parameters?'

To address the above, the study tested the main research hypothesis that: 'Uganda's exports are negatively and significantly correlated with exchange rate variability' under the floating exchange rate regime. The results from the study suggest that there is no sufficient evidence to reject the research hypothesis. Over the long-run, Uganda's aggregate real export value index is negatively and significantly correlated with exchange rate variability in both the bureau- and inter-bank foreign exchange markets. The results contrast with those corresponding to the fixed exchange rate regime, where the correlation is invariantly zero. One may therefore conclude that since the adoption of a floating exchange rate regime in November 1993, exchange rate variability is an important negative factor for Ugandan exports.

The above results support the *risk-aversion* hypothesis. Consistent with Doroodian (1999), this may partly be attributable to lack of well-developed hedging facilities and institutions in Uganda to protect exporters against exchange risk. Secondly, it may reflect the view that exporters in Uganda are *risk-averse* rather than risk-neutral or risk-taking.

On the basis of the results above, exchange rate variability may be a significant negative factor for Ugandan exporters in general. Hence, while a competitive exchange rate is important for exports, exchange rate variability cannot be ignored in relation to policies aimed at export growth and overall macroeconomic stability. Hence intervention policy targeting at minimising excessive volatility in the nominal and real exchange rate under the floating regime may contribute to supporting 'export sector' and 'economic' growth, and overall external macroeconomic stability in Uganda. However, future research may be needed to underpin the effects of exchange rate variability on exporters at 'sector' and 'individual' specific levels in Uganda.

Appendix 1: Sources and nature of data, Uganda (1988-2001)

1.1 Constructed Series

Some of the series of the theoretical model are constructed from the original data compiled from the survey. The constructed series include: Real export value index; Relative Export prices; Nominal- (*NEER*) and Real Effective Exchange Rates (*REER*); Exchange Rate Variability (*V*)[5]; and Capacity Utilisation. The sub-sections below explain the methods followed in constructing these series.

1.1.1 Real Export Value Index

Consistent with Gotur, (1985), this series was constructed as a weighted index of real exports values (1995=100). Since the monthly series of exports for Uganda's balance of payments are compiled in US$ equivalent values, the study deflated the corresponding data with a weighted price index of Uganda's major thirteen trade partners.

1.1.2 Nominal- (NEER) and Real Effective Exchange Rates (REER)

Following the methodology suggested in Hinkel and Nsengiyumva (1999), the study constructed several series of effective exchange rates (nominal effective exchange rate in the *IFEM, NEERO*; real effective exchange rate in the *IFEM* deflated by headline *CPI, REEROH*; and real effective exchange rate in the *IFEM* deflated by underlying *CPI, REEROU*). In addition, the study constructed the corresponding (nominal effective exchange rate in the Bureau market, *NEERP*; real effective exchange rate in the Bureau market deflated by headline *CPI, REERPH;* real effective exchange rate in the Bureau market deflated by underlying *CPI, REERPU*).

To construct the various effective exchange rate series, the study took into account the main series of consumer price indices and the corresponding series of exchange rates per US$ for Uganda's thirteen main trading partners. The IMF Office in Kampala advised the study of Uganda's largest thirteen trading partner countries, (Kenya, (0.168); U.K., (0.158); Germany, (0.139); U.S.A., (0.097); Italy, (0.087); Japan, (0.079); France, (0.055); Netherlands, (0.049); Brazil, (0.040); Pakistan, (0.036); Belgium, (0.035); India, (0.032); and Spain, (0.026)), which together account for over

[5] *V* is used here for convenience. Elsewhere in this study, the various measures of exchange rate variability are the shown with a *V* in front of the respective NEER or REER.

80 percent of Uganda's trade. The study then constructed a multilateral geometric mean series for each of the nominal and real effective exchange rate variable as mentioned above, taking into account appropriate price deflators where applicable. Accordingly, the *NEER* is based on the geometric mean (equation (7) below):

$$NEER = \prod_{i=1}^{i=13} E_{dci}^{w_{id}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Where $\Sigma\omega_{id} = 1$ and ω_{id} is the appropriate weight of the trading partner country, *i*, chosen in the calculation of the *NEER*. E_{dci} is the exchange rate of local currency per unit of foreign country *i*'s currency. The geometric mean is used in deriving additional REER series for Uganda on account of its consistency and symmetrical attributes, which the arithmetic averaging doesn't contain (Hinkle and Nsengiyumva, 1999: 41-112). The choice of the weighted multilateral 'nominal' and 'real' effective exchange rate as opposed to bilateral exchange rate follows from the IMF Study, (1984: 10) that such a choice depends on whether one wishes to measure uncertainties affecting the economy as a whole (therefore *REER* more preferred), or that facing individual traders (in which bilateral *RER* is more appropriate). The present study focuses on Uganda's economy-wide export concerns. The corresponding external Real Effective Exchange Rate (*REER*) concept is also estimated on the basis of a geometric mean (equation (8) below) i.e.

$$REER = \prod_{i=1}^{i=13} [E_{dc} * P_{fi}]^{w_{id}} / P_d \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

Where $\Sigma\omega_{id}=1$, ω_{id} and E_{dc} are defined as above; P_{fi} and P_d are foreign and domestic price levels respectively. Consistent with Gotur (1985), the *REER* and *NEER* are rebased to 1994/5 = 100 to closely match the base period of the series of other indices used in the study.

1.1.3 Exchange Rate Variability in Uganda

Consistent with other studies (Abbott, et.al, 2001; Arize, 1995, 1997; Bini-Smaghi, 1991; De Grauwe, 1988; Kenen and Rodrick, 1986; IMF, 1984), the study adopted a measure of exchange rate variability based on a simple standard deviation of 3-month-moving of each of the effective exchange rate series mentioned above. This differs slightly from other studies that have focused their analyses based on different measures of exchange rate variability for a single exchange rate series. Our aim was to establish whether analysis based different exchange rate series lead to alternative conclusions.

1.1.4 Relative Export Prices in Uganda

In line with Lawrence and Belshaw, (2002: 357); Savvides, (1992: 448), and Goldstein and Khan, 1978: 276); the study constructed internal *relative commodity exports prices* for Uganda on the basis of Uganda's export price index as a ratio of domestic consumer price index. Following Goldstein and Khan, (1985: 1028), the consumer price index was used as a proxy for other non-traded goods prices[6]. The idea here is that this series measures the internal competitiveness of Uganda's exports and provides a reasonable indicator of export supplies stimuli. If prices of Uganda's export commodity prices increase faster than prices of non-traded goods, then agents may divert resources towards the production of traded goods. Likewise, the study constructed the relative price of domestic price levels to different possible categories of world export prices as a relevant series for the reduced-form equilibrium export supply model[7].

1.1.5 Capacity Utilisation in Uganda

Following Gotur (1985) and IMF (1984), the study constructed this series by dividing the actual index of industrial production in Uganda by the trended output. To conform to other series, the study first re-based the original index of industrial production series from 1990=100 to 1995=100 as the new base period.

[6] There are some limitations of using consumer price index as proxy for non-tradable goods because it includes prices of imported consumer goods. In Uganda, Food accounts for 50.06 per cent of total headline CPI (1989=100) and 33.6 percent in the underlying CPI.

[7] The study also constructed competitiveness series based on export prices as a ratio of world export prices of substitutes from rival suppliers in line with Doroodian, 1999; Arize, 1995, 1996, 1997; and Gotur 1985).

Appendix 2: Table 4.2: Summary Results of Unit Root Analysis and Augmented Dickey-Fuller (ADF) Tests

	VARIABLE	*1988M1-2001M12*						*1988M1-1993M06*						*1994M1-2001M12*					
	DEP. VAR.	*ADF $_T$ (C&T)*	*Integ.*		*Lag*	*P-P Sttc*	*Integ.*	*ADF $_T$ (C&T)*	*Integ.*		*Lag*	*P-P Sttc*	*Integ.*	*ADF $_T$ (C&T)*	*Integr.*		*Lag*	*P-P Sttc*	*Integ.*
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*	*P*	*Q*	*R*	*S*	*T*
1	dLNERo	-2.2934	*I(1)*		12	-3.495	I(0)*	1.5221	I(1)	W.D.	24	-2.577	I(1)	-4.3786	I(0)*		0	0.418	I(1)
1	ddLNERo	-3.2157	*I(0)***		7	-8.781		-2.0485	I(1)	W.D.	24	-10.318		-8.6888	I(0)*		0	-12.780	
2	dLNERp	-4.0379	*I(0)**	*W.D.*	9	-3.023	I(0)**	-1.0858	I(1)	W.D.	9	-2.090	I(1)	-4.4628	I(0)*		0	0.439	I(1)
2	ddLNERp	-8.4254	*I(0)**	*W.D.*	6	-8.696		-2.3932	I(1)	W.D.	22	-8.511		-8.0905	I(0)*		0	-10.025	
3	dLCPIH	-2.0554	*I(1)*	*W.D.*	13	-5.704	I(0)*	-0.4650	I(1)	W.D.	24	-2.982	I(0)***	-4.5849	I(0)*		1	-1.059	I(1)
3	ddLCPIH	-4.2246	*I(0)**	*W.D.*	12	-4.601		-3.1725	I(0)***	W.D.	23	-4.371		-3.7275	I(0)*	W.D.	12	-8.219	
4	dLCPIU	-2.2021	*I(1)*	*W.D.*	0	-5.891	I(0)*	-1.5811	I(1)	W.D.	23	-3.366	I(0)***	-2.4074	I(1)	W.D.	0	-0.096	I(1)
4	ddLCPIU	-10.9912	*I(0)**		0	-3.423		-4.3542	I(0)*	W.D.	22	-3.824		-10.0892	I(0)*		0	-11.527	
5	dLGRXPTS	-1.6614	*I(1)*		14	-3.094	I(0)**	-1.8998	I(1)		11	-5.500	I(0)*	-5.4969	I(0)*	W.D.& S	0	-6.668	I(0)*
5	ddLGRXPT	-4.3821	*I(0)**		11	-16.731		-2.2039	I(1)		16	-17.509		-3.5356	I(0)**		11	-10.907	
6	dLNEERo	-2.9875	*I(0)***		1	-3.855	I(0)*	2.1190	I(1)	W.D.	24	-2.643	I(1)	-3.3218	I(0)**		1	-1.196	I(1)
6	ddLNRo	-3.2157	*I(0)***		7	-6.679		-4.7210	I(0)*		0	-9.941		-8.8419	I(0)*		0	-10.016	
7	dLNEERp	-3.6934	*I(0)**		1	-3.565	I(0)*	-0.7583	I(1)	W.D.	1	-1.497	I(1)	-3.3419	I(0)**		1	-1.088	I(1)
7	ddLNRp	-8.4254	*I(0)**		0	-9.382		-3.9640	I(0)**		0	-8.565		-8.2348	I(0)*		0	-11.238	
8	dLREERoh	-3.6201	*I(0)**		0	-2.585	I(1)***	-3.1543	I(0)***		6	-1.646	I(1)	-2.5478	I(1)		0	-2.990	I(0)**
8	ddRRoh	-10.6933	*I(0)**		0	-7.148		-5.0151	I(0)*		0	-6.830		-7.7666	I(0)*		1	-9.521	
9	dLREERou	-3.0885	*I(0)***		0	-2.007	I(1)	-1.5321	I(1)		0	-1.686	I(1)	-2.1472	I(1)		0	-2.688	I(0)***
9	ddLRRou	-9.3149	*I(0)**	*W.D.*	1	-7.433		-5.2874	I(0)*	W.D.	0	-6.871		-8.4683	I(0)*		1	-8.036	
10	dLREERph	-5.0099	*I(0)**		1	-2.358	I(1)	-3.7532	I(0)**	W.D.	1	-2.213	I(1)	-2.4600	I(1)		0	-2.720	I(0)***
10	ddLRRph	-8.7521	*I(0)**	*W.D.*	1	-7.847		-2.9496	I(1)	W.D.	12	-4.426		-7.7994	I(0)*		1	-8.866	
11	dLREERpu	-4.0847	*I(0)**		0	-2.269	I(1)	-2.3410	I(1)	W.D.	7	-2.215	I(1)	-2.0344	I(1)	W.D.	0	-2.330	I(1)
11	ddLRRpu	-5.3906	*I(0)**		5	-8.518		-3.2036	I(0)***	W.D.	9	-4.823		-8.4329	I(0)*		1	-7.467	
12	dLREERimf	-2.8815	*I(0)***		0	-1.833	I(1)	-0.9537	I(1)	W.D.	24	-1.855	I(1)	-2.7324	I(0)***		0	-2.375	I(1)
12	ddLRRmf	-10.8111	*I(0)**		0	-7.142		-2.7184	I(1)	W.D.	22	-6.528		-9.6115	I(0)*		0	-10.728	
13	dLVNEERo	-5.7053	*I(0)**		2	-7.014	I(0)*	-3.7733	I(0)**		3	-5.396	I(0)*	-7.3646	I(0)*		1	-11.269	I(0)*
13	ddLVNRo	-9.1458	*I(0)**	*W.D.*	4	-16.570		-4.2971	I(0)*		9	-11.906		-8.4274	I(0)*	W.D.	3	-13.366	
14	dLVNEERp	-5.2523	*I(0)**		2	-9.523	I(0)*	-2.2711	I(1)		5	-6.071	I(0)*	-4.7778	I(0)*		2	-11.669	I(0)*
14	ddLVNRp	-6.9618	*I(0)**	*W.D.*	7	-14.532		-1.8709	I(1)	W.D.	23	-13.388		-7.8362	I(0)*	W.D.	3	-10.984	
15	dLVREERoh	-7.9389	*I(0)**	*W.D.*	1	-7.379	I(0)*	-5.9273	I(0)*		1	-5.194	I(0)*	-6.9519	I(0)*	W.D.	0	-5.790	I(0)*
15	ddLVRRoh	-8.1183	*I(0)**	*W.D.*	7	-12.464		-5.0200	I(0)*	W.D.	6	-7.292		-6.7885	I(0)*	W.D.	7	-15.142	
16	dLVREROu	-7.5967	*I(0)**		1	-8.907	I(0)*	-4.6382	I(0)*		0	-5.959	I(0)*	-6.8337	I(0)*		1	-5.937	I(0)*
16	ddLVRRou	-6.6161	*I(0)**		9	-13.172		-6.8279	I(0)*	W.D.	1	-6.779		-7.7159	I(0)*	W.D.	3	-11.280	
17	dLVRERph	-7.1027	*I(0)**	*W.D.*	0	-7.526	I(0)*	-3.1988	I(0)***	W.D.	24	-6.447	I(0)*	-6.2549	I(0)*		1	-6.841	I(0)*
17	ddLVRRph	-6.4858	*I(0)**	*W.D.*	10	-26.233		-2.7387	I(1)	W.D.	24	-17.012		-6.6417	I(0)*		7	-18.713	
18	dLVRERpu	-4.8432	*I(0)**		2	-6.881	I(0)*	-2.7479	I(1)		0	-3.954	I(0)**	-6.7272	I(0)*		1	-5.666	I(0)*
18	ddLVRRpu	-6.9736	*I(0)**	*W.D.*	9	-17.735		-5.6939	I(0)*	W.D.	1	-10.543		-6.2607	I(0)*		9	-14.233	
19	dLVRERmf	-8.2083	*I(0)**		1	-4.103	I(0)*	-6.1678	I(0)*		3	-4.212	I(0)*	-6.6272	I(0)*		1	-7.691	I(0)*
19	ddLVRRmf	-8.3509	*I(0)**		6	-16.452		-3.7949	I(0)**		10	-8.775		-7.6589	I(0)*		4	-22.518	
20	dLVVNERo	-6.5811	*I(0)**		2	-7.162	I(0)*	-5.0690	I(0)*	W.D.	22	-7.377	I(0)*	-5.4181	I(0)*		2	-7.103	I(0)*
20	ddLVVNRo	-7.1589	*I(0)**	*W.D.*	5	-13.934		-5.5086	I(0)*	W.D.	5	-12.434		-7.2190	I(0)*	W.D.	3	-19.412	

KEY: *, **, and *** refer to significant at 1%, 5% and 10% levels of confidence respectively. W.D.: observed weaknesses in diagnostic tests. The Critical values for the ADF tests (including drift and trend) are sourced from Charemza and Deadman (1997, pp281-283). For the sample period 1988M1-2001M12 the lower critical values for 1%, 5% and 10% are -3.45, -2.74, and -2.38 respectively. Corresponding values for 1988M1-1993M6 are -4.11, -3.34, and -2.97; while those for 1994M1-2001M12 are -3.62; -2.91; and -2.55 respectively.

Appendix 2: Table 4.2 (ctd.): Unit Root Analysis and Augmented Dickey-Fuller (ADF) Test Results.

	VARIABLE	1988M1-2001M12						1988M1-1993M06						1994M1-2001M12					
	DEP. VAR.	ADF $_{\tau}$ (C&T)	Integ.		Lag	P-P Sttc	Integ.	ADF $_{\tau}$ (C&T)	Integ.		Lag	P-P Sttc	Integ.	ADF $_{\tau}$ (C&T)	Integr.		Lag	P-P Sttc	Integ.
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
21	dLVVNERp	-7.4106	I(0)*	W.D.	1	-6.850	I(0)*	-4.7598	I(0)*		3	-7.812	I(0)*	-6.8954	I(0)*	W.D.	0	-8.866	I(0)*
21	ddLVVNRp	-8.6286	I(0)*	W.D.	5	-26.995		-5.8608	I(0)*	W.D.	5	-17.221		-6.4201	I(0)*	W.D.	5	-23.680	
22	dLVVERoh	-7.2080	I(0)*	W.D.	2	-4.049	I(0)*	-6.0206	I(0)*		0	-3.368	I(0)**	-5.8729	I(0)*	W.D.	3	-8.899	I(0)*
22	ddLVVRRoh	-7.8733	I(0)*	W.D.	7	-13.714		-5.9639	I(0)*	W.D.	4	-10.784		-4.9925	I(0)*	W.D.	15	-15.080	
23	dLVVERou	-7.8211	I(0)*	W.D.	0	-6.073	I(0)*	-5.5397	I(0)*		24	-4.674	I(0)*	-6.4024	I(0)*	W.D.	0	-9.046	I(0)*
23	ddLVVRRou	-8.1279	I(0)*	W.D.	5	-20.212		-5.8508	I(0)*	W.D.	4	-15.405		-6.3587	I(0)*	W.D.	5	-23.164	
24	dLVVERph	-6.9111	I(0)*	W.D.	3	-6.199	I(0)*	-4.5226	I(0)*		0	-5.637	I(0)*	-6.0049	I(0)*	W.D.	3	-6.094	I(0)*
24	ddLVVRRph	-6.4505	I(0)*	W.D.	15	-19.544		-6.1332	I(0)*	W.D.	1	-20.362		-4.5345	I(0)*	W.D.	15	-13.431	
25	dLVVERpu	-7.7450	I(0)*	W.D.	0	-8.484	I(0)*	-4.2864	I(0)*		0	-5.962	I(0)*	-6.7040	I(0)*	W.D.	0	-9.689	I(0)*
25	ddLVVRRpu	-8.9732	I(0)*	W.D.	5	-29.562		-1.2020	I(1)	W.D.	16	-20.069		-6.9160	I(0)*	W.D.	5	-22.415	
26	dLVVERmf	-3.7486	I(0)*	W.D.	7	-7.604	I(0)*	-3.2615	I(0)***	W.D.	24	-6.101	I(0)*	-3.6796	I(0)*		7	-6.240	I(0)*
26	ddLVVRRmf	-3.7508	I(0)*	W.D.	18	-22.847		-5.6703	I(0)*	W.D.	5	-19.001		-5.3431	I(0)*	W.D.	11	-13.727	
27	dLXVOLDX	-2.0890	I(1)		14	-5.732	I(0)*	-2.1317	I(1)		12	-7.160	I(0)*	-5.4992	I(0)*	W.D.& S	0	-6.337	I(0)*
27	ddLXVODX	-4.7072	I(0)*		11	-16.561		-2.3634	I(1)		16	-8.370		-2.9766	I(0)**		8	-12.843	
28	dLMVOLDX	-2.5872	I(0)***	W.D.	2	-3.596	I(0)*	-5.4271	I(0)*		0	-3.893	I(0)**	-3.0794	I(0)**		3	-3.333	I(0)**
28	ddLMVODX	-5.9489	I(0)*	W.D.	7	-25.169		-9.4747	I(0)*		1	-20.150		-12.3558	I(0)*		1	-30.169	
29	dLPxNDXu	-1.1472	I(1)		2	-2.624	I(0)***	-3.3000	I(0)***		0	-2.873	I(1)	-3.1081	I(0)**	W.D.	0	-1.855	I(1)
29	ddLPxNDX	-10.0108	I(0)*		1	-12.065		-6.6484	I(0)*		0	-28.234		-8.3251	I(0)*		1	-8.413	
30	dLPmNDXu	-1.9479	I(1)	W.D.	1	-5.732	I(0)*	-4.1803	I(0)*	W.D.	19	-4.559	I(0)*	-3.1129	I(0)**		0	-2.290	I(1)
30	ddLPmNDX	-10.1385	I(0)*	W.D.	0	-15.389		-4.3287	I(0)*		0	-17.709		-9.2776	I(0)*		0	-11.382	
31	dLTOTu	-1.4587	I(1)		2	-2.777	I(0)**	-2.5105	I(1)		0	-2.574	I(1)	-3.3329	I(0)**	W.D.	0	-1.963	I(1)
31	ddLTOTu	-10.2420	I(0)*		1	-13.365		-6.1411	I(0)*		0	-18.592		-8.6647	I(0)*		1	-8.710	
32	dLIIPWOD	-2.2753	I(1)	W.D.	12	-0.905	I(1)	-4.0843	I(0)**		0	-3.363	I(0)**	0.8966	I(1)		18	-2.125	I(1)
32	ddLIIPWD	-1.9729	I(1)		11	-14.626		-5.6549	I(0)*		2	-12.704		-4.3329	I(0)*		15	-9.149	
33	dLPxLDC	-1.1823	I(1)	W.D.	2	-0.183	I(1)	-4.0714	I(0)**		6	-1.185	I(1)	-3.4496	I(0)**	W.D.	2	0.473	I(1)
33	ddLPxLDC	-6.1023	I(0)*	W.D.	1	-12.132		-4.8469	I(0)*	W.D.	24	-6.624		-4.8291	I(0)*	W.D.	1	-10.267	
34	dLPxWOD	-1.8677	I(1)		12	-0.467	I(1)	-2.1905	I(1)	W.D.	1	-2.011	I(1)	-3.2008	I(0)**		0	0.324	I(1)
34	ddLPxWD	-7.0079	I(0)*		1	-12.163		-1.3414	I(1)	W.D.	24	-9.183		-2.2467	I(1)		14	-7.828	
35	dLPxAGR	-1.0841	I(1)		2	-1.578	I(1)	1.0070	I(1)	W.D.	10	0.091	I(1)	-2.8415	I(0)***	W.D.	2	-0.476	I(1)
35	ddLPxAG	-7.5276	I(0)*	W.D.	1	-9.144		-0.9560	I(1)	W.D.	16	-7.375		-12.5450	I(0)*	W.D.	0	-10.196	
36	dLIID	-0.7064	I(1)		12	-2.271	I(1)	-3.0410	I(0)***		2	-3.185	I(0)**	-1.1387	I(1)		12	-3.210	I(0)**
36	ddLIID	-4.2063	I(0)*		11	-26.091		-10.6042	I(0)*		0	-15.766		-3.9910	I(0)*		11	-22.607	
37	dLCUIID	-6.3491	I(0)*		18	-38.704	I(0)*	-6.6570	I(0)*		3	-23.496	I(0)*	-5.7289	I(0)*		17	-32.861	I(0)*
37	ddLCUIID	-4.8915	I(0)*		23	-45.076		-0.6555	I(1)	W.D.	23	-30.521		-5.8571	I(0)*	W.D.	21	-41.014	
38	dLREXPOT	-2.6113	I(0)***		24	-3.104	I(0)**	-0.7191	I(1)	W.D.	24	-8.200	I(0)*	-1.7551	I(1)	W.D.	12	-3.765	I(0)*
38	ddLREXPT	-1.5236	I(1)		23	-73.547		-1.5718	I(1)	W.D.	23	-32.362		-2.4278	I(1)	W.D.	11	-51.098	
39	dLREXPDX	-2.6086	I(0)***		24	-4.243	I(0)*	-0.7102	I(1)	W.D.	24	-8.199	I(0)*	-1.7556	I(1)	W.D.	12	-3.766	I(0)*
39	ddLREXDX	-1.5249	I(1)		23	-16.866		-1.5777	I(1)	W.D.	23	-32.344		-2.4276	I(1)	W.D.	11	-51.123	
40	dLRIMPOT	-2.9161	I(0)**	W.D.	12	-4.011	I(0)*	-2.3236	I(1)	W.D.	12	-7.005	I(0)*	-3.3832	I(0)**	W.D.	12	-3.139	I(0)**
40	ddLRIMPT	-2.2880	I(1)	W.D.	11	-52.898		-1.3524	I(1)	W.D.	11	-51.689		-2.1817	I(1)	W.D.	11	-46.837	

KEY: *, **, and *** refer to significant at 1%, 5% and 10% levels of confidence respectively. W.D.: observed weaknesses in diagnostic tests. The Critical values for the ADF tests (including drift and trend) are sourced from Charemza and Deadman (1997, pp281-283). For the sample period 1988M1-2001M12 the lower critical values for 1%, 5% and 10% are -3.45, -2.74, and -2.38 respectively. Corresponding values for 1988M1-1993M6 are -4.11; -3.34; and -2.97; while those for 1994M1-2001M12 are -3.62; -2.91; and -2.55 respectively. The ADF Critical values also apply to Phillips and Perron Tests for stationarity (Pesaran and Pesaran, 2000).
Decision on integration: Whichever is of higher integration order among the two tests.

Appendix 2: Table 4.2 (concluded): Unit Root Analysis and Augmented Dickey-Fuller (ADF) Test Results.

VARIABLE		1988M1-2001M12						1988M1-1993M06						1994M1-2001M12					
	DEP. VAR.	ADF $_T$ (C&T)	Integ.		Lag	P-P Sttc	Integ.	ADF $_T$ (C&T)	Integ.		Lag	P-P Sttc	Integ.	ADF $_T$ (C&T)	Integr.		Lag	P-P Sttc	Integ.
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
41	dLRGDP	-0.5854	I(1)	W.D.	24	-1.164	I(1)	-1.8972	I(1)		12	-1.470	I(1)	0.1039	I(1)	W.D.	24	-2.459	I(1)
41	ddLRGDP	-2.6399	I(0)***		11	-24.189		-2.2641	I(1)	W.D.	11	-11.675		-2.2315	I(1)	W.D.	23	-23.697	
42	dLRGDPDX	-0.5827	I(1)	W.D.	24	-1.164	I(1)	-1.8984	I(1)		12	-1.470	I(1)	0.1028	I(1)	W.D.	24	-2.458	I(1)
42	ddLGDPDX	-1.8857	I(1)		23	-24.414		-2.2630	I(1)	W.D.	11	-11.688		-2.2310	I(1)	W.D.	23	-23.721	
43	dLCUGDP	-4.6919	I(0)*		22	-41.065	I(0)*	-6.1016	I(0)*	W.D.	10	-19.029	I(0)*	-21.0043	I(0)*		10	-42.898	I(0)**
43	ddLCUGDP	-4.5613	I(0)*	W.D.	23	-46.375		-4.6116	I(0)*	W.D.	13	-21.614		-3.7888	I(0)*	W.D.	23	-48.382	
44	dLPxCPIH	-1.8557	I(1)		0	-4.572	I(0)*	-2.3260	I(1)		1	-3.221	I(0)**	-3.0515	I(0)**	W.D.	0	-0.950	I(1)
44	ddLPxCPH	-9.2204	I(0)*		1	-10.727		-5.2493	I(0)*		0	-10.882		-8.0556	I(0)*		1	-8.425	
45	dLPxCPIU	-1.8260	I(1)		0	-3.486	I(0)*	-2.3151	I(1)		0	-2.664	I(1)	-2.8867	I(0)***	W.D.	0	0.717	I(1)
45	ddLPxCPU	-9.3120	I(0)*		1	-11.026		-5.7608	I(0)*		0	-12.652		-7.9919	I(0)*		1	-8.585	
46	dLPxPxLD	-1.8588	I(1)		2	-1.318	I(1)	-3.2065	I(0)***		0	-1.426	I(1)	-2.4012	I(1)		2	1.031	I(1)
46	ddPxPxLD	-11.2007	I(0)*		1	-15.549		-6.7644	I(0)*		0	-20.550		-9.3516	I(0)*	W.D.	1	-10.794	
47	dLPxPxWD	-1.6394	I(1)		2	-1.328	I(1)	-3.2533	I(0)***		0	-1.376	I(1)	-2.9664	I(0)**		0	1.003	I(1)
47	ddPxPxWD	-10.7516	I(0)*		1	-14.608		-6.6679	I(0)*		0	-21.303		-8.9421	I(0)*		1	-10.294	
48	dLPxPxAG	-2.8667	I(0)**		0	-1.102	I(1)	-2.9253	I(1)		0	-0.580	I(1)	-3.0360	I(0)**		0	0.734	I(1)
48	ddPxPxAG	-6.8873	I(0)*		5	-15.004		-6.0635	I(0)*		0	-17.997		-8.7132	I(0)*		1	-10.180	
49	dCPHPXLD	-1.8903	I(1)	W.D.	1	-5.308	I(0)*	-2.3992	I(1)	W.D.	21	-3.362	I(0)**	-3.4332	I(0)**	W.D.	1	0.928	I(1)
49	ddCHPxLD	-8.2138	I(0)*	W.D.	0	-6.565		-2.8312	I(1)	W.D.	24	-4.886		-8.0445	I(0)*		0	-10.393	
50	dCPHPXWD	-2.0919	I(1)		1	-6.406	I(0)*	-1.7662	I(1)	W.D.	21	-3.493	I(0)**	-3.0205	I(0)**		0	0.588	I(1)
50	ddCHPxWD	-8.9811	I(0)*		0	-5.690		-2.6233	I(1)	W.D.	23	-3.704		-8.9186	I(0)*		0	-8.704	
51	dCPHPXAG	2.4826	I(0)***		2	-3.912	I(0)*	-2.6205	I(1)		3	-2.848	I(1)	-3.0651	I(0)**		0	0.111	I(1)
51	ddCHPxAG	-6.7671	I(0)*	W.D.	1	-4.667		-2.3595	I(1)		1	-3.979		-11.4301	I(0)*	W.D.	0	-11.921	
52	dCPUPXLD	-1.8245	I(1)		6	-4.408	I(0)*	-2.6060	I(1)		8	-4.179	I(0)*	-2.6735	I(0)***		0	1.280	I(1)
52	ddCUPxLD	-3.7832	I(0)*	W.D.	5	-5.348		-3.2413	I(0)***	W.D.	24	-6.450		-11.4301	I(0)*	W.D.	0	-8.942	
53	dCPUPXWD	-2.0110	I(1)		6	-5.239	I(0)*	0.1740	I(1)	W.D.	23	-4.566	I(0)*	-2.7750	I(0)***		0	0.931	I(1)
53	ddCUPxWD	-3.7474	I(0)*		5	-5.243		-2.5418	I(1)	W.D.	24	-5.471		-9.0632	I(0)*		0	-9.701	
54	dCPUPXAG	-2.3356	I(1)		2	-3.331	I(0)**	-1.3458	I(1)	W.D.	2	-3.327	I(0)*	-3.0372	I(0)**	W.D.	0	0.406	I(1)
54	ddCUPxAG	-7.3380	I(0)*	W.D.	1	-4.684		-2.8699	I(1)		1	-4.728		-10.1883	I(0)*		0	-11.584	
KEY: *, **, and *** refer to 1% , 5% and 10% levels of confidence respectively. W.D.: observed weaknesses in diagonistic tests.																			

Table 4.2: Augmented Dickey-Fuller (ADF) Test Results concluded.

Source: Results of the unit root analysis of the data series on Uganda based on regressions of ADF models and ADF tests; and Phillips and Perron Tests for stationarity.

KEY: *, **, and *** refer to significant at 1%, 5% and 10% levels of confidence respectively. W.D.: observed weaknesses in diagnostic tests. The Critical values for the ADF tests (including drift and trend) are sourced from Charemza and Deadman (1997, pp281-283). For the sample period 1988M1-2001M12 the lower critical values for 1%, 5% and 10% are -3.45, -2.74, and -2.38 respectively. Corresponding values for 1988M1-1993M6 are -4.11; -3.34; and -2.97; while those for 1994M1-2001M12 are -3.62; -2.91; and -2.55 respectively. The ADF Critical values also apply to Phillips and Perron Tests for stationarity (Pesaran and Pesaran, 2000).

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