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TITLE

THE EFFECT OF EXCHANGE RATE VOLATILITY ON THE VOLUME OF SOUTH AFRICAN EXPORTS

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ABSTRACT

The purpose of this paper is to investigate whether a relationship between export volumes and exchange rate volatility exists as suggested in the ASGISA document. It goes about this by first investigating the theoretical channels that predict the relationship between export volumes and exchange rate volatility. The theoretical prediction though is ambiguous depending on the justification used to get to the result. Furthermore, the paper provides evidence that the empirical results are ambiguous as well as some countries tend to exhibit a negative relationship and others a positive relationship. Thus the paper goes on to estimate two measures of exchange rate volatility using the real effective exchange rate. These measures are found to be integrated of order zero. A cointegrated model for export volume using the Johansen estimation technique is then estimated with the volatility variables included in the short run relationship only. The results suggest that exchange rate volatility has a significant negative effect on the growth of export volumes. The results are robust to the time period over which the models are run, but there is a difference in the coefficients on the exchange rate volatility measure in the short run models.

Section 1: Introduction

Since the inception of world trade, exports have comprised a significant portion of many countries' gross domestic product (GDP). They are also significant growth areas for developing countries through access to bigger and richer markets. During the period of fixed or managed exchange rates, there was a degree of certainty for suppliers as to their expected revenue from exporting their goods, but since the end of the Bretton Woods era and the adoption of market determined exchange rates, the level of exchange rate uncertainty for exporters and importers has increased (De Grauwe, 1988) and more so in developing countries (Grier & Smallwood, 2007). There is concern in the market that the level of exchange rate volatility has a negative effect on the level of exports (ASGISA summary document), although theoretically there is a school of thought that suggests the higher the level of exchange rate volatility, the more beneficial it is for exporters (De Grauwe, 1988).

This paper will consider the effect of exchange rate volatility on aggregate South African exports. The ASGISA document suggests that one of the major roadblocks to economic growth in South Africa is the level of exchange rate volatility and its effect on exports. There have not been many studies done on this to support this sentiment, and those that have been done have not been comprehensive in looking at alternative measures of exchange rate volatility. Thus the purpose of this paper is to comprehensively consider the theoretical reasoning behind the link between export volume and exchange rate volatility and to develop a structural model of export volume determination to test the theory.

The rest of this paper is structured as follows, section 2 will consider the theoretical background supporting the inclusion of exchange rate volatility in the export function, section 3 will look at the empirical issues encountered thus far, section 4 will look at the data and the model used, section 5 will report the results and section 6 will conclude.

Section 2: Why consider volatility at all?

When considering the effect of exchange rate volatility on exports, one has to consider why it would affect exports at all. The part of the export relationship that comprises the exchange rate volatility term would be the supply side, as it is the producers in this model that are affected in terms of the payment received for exported goods assuming that the country that the producers come from has no effect on the price of the good in the international market (i.e. the country is considered a 'small country'). Volatility becomes a consideration when looking at a producer's decision whether to enter a particular market, traditionally the decision is made by considering the opportunity cost of investing one's assets in any other available investments. This is often evaluated considering the expected return from an investment relative to the amount invested. The expected return can take on many measures, but it is generally expected that a firm's objective is to maximise profit. It is thus reasonable to expect that anything that affects profit is likely to affect the supply of a good by a firm. Profit most simply defined is the difference between total revenue from sales to the total cost of production of goods sold. In the case where the producers have strong global market power, it is likely that the effects of exchange rate volatility would be passed onto the consumer and in this case it would be expected that exchange rate volatility would affect the export demand equation. The purpose of this paper is to consider the effects of exchange rate volatility on South African export volumes (excluding gold), and as such the export supply equation is considered as evidence exists that South Africa is a 'small country' in terms of global supply of goods (Edwards & Alves, 2006).

The price of the good, as well as anything that will affect the cost of production is likely to affect the supply of the good. Further determinants of supply identified by theory include: changes in technology (generally affecting the cost per unit of production) and the expectations of future price changes and transport costs. Recently though, there has been the suggestion that the volatility of the exchange rate also affects a producer's profit maximisation decision (De Grauwe, 1988).

One of the major differences between supplying to a local market and supplying to foreign markets is the uncertainty of price received in local currency[1]. A contract to supply a local market will be made at a certain price, and that price will be paid. On the other hand, a contract to sell to a foreign market will include an agreement to a price, but in the foreign currency, and payment will only be made at the time of delivery which could be later than the date that the contract is signed which means that the value in local currency of the deal could change between the time that the contract is agreed and the time that payment is received. Thus there exists the possibility that a firm will receive less (or more) from exporting their goods than expected at the time of delivery. This is due to the fact that exchange rates are volatile, particularly so in the case of developing countries. This risk could be viewed to be higher at times of higher exchange rate volatility and lower at times of lower exchange rate volatility[2], as a result it may in fact be prudent to include a measure of this risk in the form of a measure of exchange rate volatility in the export function for a country, industry or firm.

To analyse the theoretical effect of exchange rate volatility on the volume of exports, we start by considering a typical profit function given by equation (1):

$$\Pi = PQ(x) - W(x) \tag{1}$$

where PQ(x) would have to be split up such that $PQ(x) = t(e,v)ep^{*}Q(x) + (1-t(e,v))pQ(x)$, with e the presiding exchange rate, p^{*} the foreign price of goods, p the local price of goods and $t(e,v)$ the proportion of produced goods, $Q(x)$, sent for export, this is allowed to be variable in the level of the exchange rate (e), and is expected to be positively related to e, and variable in the variability or spread of the exchange rate (v), ASGISA suggests that this relationship is negative, but theoretically, a number of models discussed below provide evidence for a positive relationship as well. The cost of production is invariant in the price received for the goods sold as well as in the split between goods sent for export

[1] Wilcox (2007) analyses two possible effects of exchange rate volatility, one being where the exporters are paid in foreign currency and the other where the exporters are paid in local currency. In the case of South Africa, it is more likely that contracts are made in the currency of the country where the goods are being supplied to or in US dollars, and less likely in Rands as South Africa is considered a 'small country' in the global market.

[2] This fits well into traditional financial investment theory where the higher the risk taken by an investor, the higher the possible loss and the higher the possible reward- the concept of a risk premium.

and those sold in the local market, thus it falls away for the purpose of this analysis[3]. Thus the focus of this paper is on what affects income maximisation by modifying the traditional export function by incorporating the effect of exchange rate volatility into the model. An advantage of this model is that it allows for theoretical ambiguity of the effect of exchange rate volatility on export volume as the reaction of producers is purely dependent on the relationship of the proportion of production exported and exchange rate volatility. There is no single existing theory that predicts the expected sign of this relationship. This is because the available literature suggests that either higher volatility indicates higher risk to producers and hence results in a lower proportion of production exported[4] , or that the higher volatility causes both the substitution effect, but a more dominant income effect for more risk averse producers (De Grauwe, 1988) or that the higher volatility could lead to an increase in the number of firms exporting (due to lower sunk costs when the currency appreciates strongly) with fewer firms exiting the market when the currency depreciates (De Grauwe, 1988).

Traditionally it can be assumed that most investors have a certain level of risk aversion (especially when it means that the firm is at risk of going bankrupt) and this can then be seen to mean that the higher the level of risk involved in an activity, the lower the number of risk averse investors willing to partake in that activity. To understand how the spread of the exchange rate affects the volume of exports, consider a situation when there is an increase the price of an exporter's goods in local currency terms (usually due to a currency depreciation), producers may increase the proportion of the goods that they export so as to ensure they maintain profit maximising behaviour. This reaction may be limited or even nullified by the volatility experienced in the currency at the time that such a decision is made, as the higher the volatility, the higher the probability that the price of exports will fall below the price of goods sold locally and the higher the probability that there is a loss to the company as a result of such a decision. This is especially the case for developing countries as there is speculation that they experience more volatility in their exchange rates than their developed counterparts. Furthermore in the absence of forward

[3] This is also done in the model presented by De Grauwe (1988)
[4] See Arize, Osang & Slottje (2000), Wilcox (2007), Bigman & Leite (2001) and Hooper & Kohlhagen (1978) for some examples.

markets in the country to hedge against sudden losses[5] there is full exposure to the volatility of the currency. Succinctly, basic risk-reward theory (Bode, Kane & Marcus, 2002) tells us it is not rational to increase the volume of exports (at the expense of the volume of goods sold on the local market), but rather it is rational to decrease the volume of exports if the risk involved increases but there is no increase in the expected return (this holds for risk neutral and risk averse investors). This also supports the switching from selling on foreign markets to selling on local markets which are relatively risk-free (in comparison) when such a situation occurs. Thus even when the probability of higher prices received by exporting more overseas increases, it is coupled with the probability of a much lower price from exported goods and risk averse investors like to ensure a certain sure level of return[6]. As a result they most likely decrease the amount they export as they place a much greater emphasis on the potential loss due to the increased volatility than the gain.

De Grauwe (1988) predicts a positive effect of volatility on exchange rate volume. He derives the coefficient of relative risk aversion for producers who income maximise with the result that a producer with a coefficient of relative risk aversion greater than one (more risk averse than one with a coefficient lower than one) is more likely to increase exports in periods of higher exchange rate volatility. The justification provided for this, is that the traditional model only takes into account the substitution effect and completely ignores the income effect which in fact works opposite to the substitution effect and is dominant. This is because whilst people are likely to substitute away from supplying to foreign markets in favour of local (or price certain) markets, marginal utility from exporting will increase for more risk averse producers as volatility increases induce an increase in export volumes rather than a decrease. This behaviour, he suggests, is because more risk averse individuals would be more concerned with the possibility of high losses and so try to prevent drastic declines in their revenue by increasing the volume sold overseas.

[5] Even in the presence of forward markets, for volatility to have little to no effect, it would have to be assumed that a majority of exporters make use of them for a majority of transactions. This is not necessarily the case as hedging contracts such as these can be costly.
[6] Bigman and Leite (1978) call this the subsistence profit

Whilst this is an interesting hypothesis, two problems exist, firstly why would a producer increase exports when there is a higher probability of getting a lower price for their goods on the export market than on the local market in the presence of higher exchange rate volatility? Maintaining revenue would be far simpler by substituting back to the local market[7]. Secondly, he mentions how more risk averse producers are more concerned with the worst possible outcome, so could this not just be getting less than in the local market, but rather as volatility increases, by maintaining or even increasing the level of export volume there is an increased risk of going bankrupt (especially in the absence of perfect capital markets that fully cover periods of loss in the expectation that there will be a recovery) which could cause these very risk averse producers to behave differently to his predictions. Rather his findings suggest that there exists a negative effect of exchange rate volatility on international trade, and his response to this is that risk aversion behaviour predicted by his model holds, but that results reflect the effect political economy weighing in on world trade through increased protectionist policies. This would be due to an effective labour force representation within the economy.

Another argument that could support the positive relationship is partly proposed by Melitz (2003) whereby there is likely to be an increase in the number of firms entering a foreign market when the currency is particularly weak, to do so though, involves sunk costs. As a result it is likely that during times of higher volatility, firms may enter the export market during currency weakness (minimising sunk costs), but if the decrease in the currency is partly as a result of increased volatility of the exchange rate then there is a strong probability that the currency could appreciate to levels higher than previously experienced. This may not cause firms to exit the market as quickly as they entered due to the sunk costs already incurred. As a result it could be that the increased volatility has led to an increase in the volume of exports from a country. This requires that the periods of weakness and strength are protracted enough for producers to react.

[7] The assumption behind this statement is that the local market is not saturated and that the producer is able to be an effective competitor in the market.

The theoretical exercises on this topic have been inconclusive as to the expected effects of exchange rate volatility on trade as shown above. The consensus as a result of this is that the actual effect of exchange rate volatility needs to be empirically tested (Arize et al 2000, Caballero & Corbo 1989).

Section 3: Evidence from the rest of the world and South Africa

Export functions have been empirically estimated for most economically active countries. The refining of techniques to provide the best possible export function has been the main focus of this field of study. With the adoption of floating exchange rates in the world market though, there has been a fundamental change in the structure of world trade. This section focuses on the choice of method to derive the exchange rate volatility variable, the different models and modelling considerations and the results obtained by different authors.

Which methodology should be used to derive the unobserved volatility variable?

Thus far there has been no consensus as to the best measure of exchange rate volatility in the literature. The moving average standard deviation of the exchange rate is a popular but controversial measure. This is because the choice of the number of moving average terms seems to be an arbitrary decision (Arize 1997). Furthermore it does imply that the assumed distribution of exchange rate volatility is normal which it does not seem to be. Finally, there is also the concern that this measure underestimates the actual level of volatility in the exchange rate. The advantage of this measure though is that it is easy to understand see equation 1 given below:

$$VOL = \left[\frac{1}{m} \sum_{i=1}^{m} \left(\left(R_{t+i-1} - R_{t+i-2} \right) / \left(R_{t+i-2} \right) \right)^2 \right]^{1/2} \qquad (2)$$

where m is the order of the moving average and R is the real effective exchange rate.

Another new technique in time series modelling has thus been adopted as a potentially more accurate measure. This is the use of Bollerslev's (1986) generalised autoregressive conditional heteroskedasticity (GARCH) models given in equations 3-6 below.

$$r_t = \alpha + \beta r_{t-1} + \mu_t \tag{3}$$

$$\mu_t \sim N(0, \sigma_t^2) \tag{4}$$

$$\sigma_t^2 = \theta_0 + \theta_1 \mu_{t-1}^2 + \theta_2 \sigma_{t-1}^2 \tag{5}$$

$$VOL_t = \sqrt{\sigma_t^2} \tag{6}$$

In the above system, equation 3 is the mean equation for the difference of the real effective exchange rate (logged), described for the sake of simplicity as a first order autoregressive process. In this case the error term, μ_t, is dependent on time rather than being a white noise process, i.e. it is expected that this process will suffer from heteroskedasticity, such that the error term is distributed as described in equation 4. Equation 5 then shows that the conditional variance of the mean equation is given by an ARMA process. Finally, to obtain the volatility measure used in the estimation, the conditional variance is square rooted. Bascially, this class of models hypothesise that whilst variables have a long term constant variance, in the short run they may experience periods of higher or lower variance. Thus the variance of the variable in the short run is conditioned on the previous levels of the variance (the autoregressive terms) and the previous errors in the expected variance (the moving average terms). This has been identified as a potentially better measure of exchange rate volatility in many models (Arize 1997) although it has also been suggested that this variable may also suffer from some level of measurement error. Another suggested measure of the volatility variable involves the use of instrumental variables following the linear moment methodology of Antle (1983, cited in Arize 1997).

Modelling considerations

Many papers follow some kind of derivative of Goldstein and Kahn's (1978) imperfect substitute model when constructing the export functions they estimate. In terms of estimation procedure though, there have been some differences. Earlier papers make use of maximum likelihood or ordinary least squares (Hooper & Kohlhagen, 1978; Caballero

& Corbo, 1989). They are limited to considering only short run models given that most of the data used in these models is integrated of order one and thus have to be differenced before being used in estimation. More recent papers though mostly make use of some kind of cointegration model allowing for the estimation of the long run model as well as the short run adjustment model. There are a number of different methods to estimate such models, and all are used, they include the Engle-Granger error correction model, the Pesaran, Shin and Smith (1996) Autoregressive Distributed Lag model (PSS ARDL) and the Johansen estimation technique (this allows for the estimation of a system of cointegrated vectors).

Fitted models tend to produce mixed results. This is most likely to be due to the different structure of economies (including different dominant behavioural effects of economic agents to economic volatility) across the world, but different modelling techniques and definitions of the variability variable could also contribute to this result.

Hooper and Kohlhagen (1978) construct a volatility measure that is the difference between the average spot rate for one period and the average forward rate from the previous period (all data in the models is quarterly, but the average spot and forward rates are calculated using weekly data within each quarter) for the USA and Germany over the period 1965 to 1975. They run a linear model for export prices and export volume and find that the volatility measure has a significant negative effect on the volume of exports for both countries, but that the effect on export prices is ambiguous. They do suggest though that the effect should be negative on the export price if the exporter received payment for their goods in foreign currency and suggest that this is the case for most countries exporting to the USA.

Kenen and Rodrik (1986) then add value to this literature by estimating 3 different measures of volatility (the standard deviation of the monthly change in the real exchange rate, the standard deviation of the real exchange rate from a log-linear trend equation and finally the standard deviation of the real exchange rate from a first order autoregressive equation) and estimating their effect on export volume for 11 developed countries. These measures are estimated over a 12 month period and a 24 month period. They find that the 24 month indices produced better results than the 12 month indicies, but that both measures showed a significant negative effect of exchange rate volatility on export volume for all countries considered.

Caballero and Carbo (1989) make use of the standard deviation of the exchange rate to estimate the effects of volatility on export volumes and by running an OLS model, find statistically significant negative results for six developing countries in the short run.

Chowdhury (1993) finds statistically significant negative results over the long run for G-7 countries by using a volatility measure constructed using the moving sample standard deviation of the exchange rate over the period 1973 to 1990 (quarterly data). This study uses cointegration techniques.

Kroner and Lastrapes (1993) construct their volatility measure using a GARCH in mean model (GARCH-M) for five industrialised countries and find that this measure has a stronger effect on export prices than on real exports in the short run, but that the effect are mixed across countries. One problem with this model is the use of real exports as opposed to export volumes and so the price of exports is effectively included on both the right and left hand side of that equation.

Finally in terms of international papers, Arize et al (2000) find that their exchange rate volatility variable (the moving sample standard deviation of the real exchange rate) has a significant and negative effect in the long and short run models for thirteen less developed countries (referred to as LDC's in their paper).

In terms of work done on South Africa, there have been a couple of papers recently written that focus on the effect of rand volatility on exports or the balance of trade. Todani and Munyama (2005) make use of two volatility measures to estimate the effect of exchange rate volatility on exports being the moving average standard deviation of the exchange rate and the conditional variance obtained from a GARCH(1,1) model. Their models are not successful in terms of results as not only are the volatility measures mostly insignificant, the traditional variables included are either insignificant or incorrectly signed. Wilcox (2007) suggests that this could be due to their use of real exports as the dependent variable rather than export volumes.

The most successful paper to date in terms of results has been a paper by Owen Wilcox (2007). He makes use of cointegration to see the effects of exchange rate volatility (a moving average standard deviation of the real exchange rate) on export volumes for the period 1972, quarter one to 2006, quarter one. His testing for cointegration suggests that there are two cointegrating vectors in his data. He theorises that this is due to simultaneity as the volume of exports are dependent on the level of the local GDP and the level of local GDP is dependent on the volume of exports. The paper finds a negative, statistically significant effect of exchange rate volatility on export volumes.

Schaling (2007) considers the contribution of exchange rate volatility to output volatility for South Africa and concludes that it contributes a smaller amount than the international business cycle. In doing so his analysis tries to establish whether producers price according to currency or price to market. He concludes that producer currency pricing is highly unlikely due to the fact that there is no solid evidence linking the real effective exchange rate and net exports. He also criticises pricing to market, suggesting that it imposes an inflation tax on local consumers whilst benefiting exporters. His focus on the effect of exchange rate volatility comes from volatility in the dollar causing the dollar price of goods exported to vary for consumers compared to this paper which considers the volatility of the Rand causing volatility in the price received for goods exported and hence the effect on suppliers.

Section 4: Data and Model

The data is mostly drawn from the South African Reserve Bank. The foreign GDP variable was constructed using SARB weights, as was the real effective exchange rate. The exchange rate volatility variables were derived from the real effective exchange rate and this shall be discussed further shortly. All of these variables are quarterly and span the time from the first quarter of 1961 to the fourth quarter of 2005 giving at most 180 observations to use in modelling. More importantly, since the use of time series techniques will be used, the period spans 45 years giving enough time over which to construct credible long run models. All variables are indexed on 2000 and logged the full data set was obtained from Lawrence Edwards.

Construction of the exchange rate volatility variable

The exchange rate volatility variable was constructed using two techniques. The first of these is the standard moving average of the standard deviation of the real effective exchange rate as used in Arize 1997, given in figure 1. The problem as so frequently pointed out with this measure is that the choice of the order of the moving average is arbitrary. For the purpose of this model a moving average of order 2 was chosen as this is the order chosen by Wilcox (2007). Many papers run the model using more than one order of the moving average, but the results are generally robust to this and as a result this is not deemed necessary for the purposes of this paper. This variable is called GEVMASD2, or LGEVMASD2 in the results.

The second technique used was to calculate the conditional variance of the exchange rate using the GARCH model. This model hypothesises that some data that may have a stationary mean, but that the volatility in the short run may vary from periods of high volatility to periods of lower volatility (whilst the long run volatility may in fact be constant). Standard models ignore this characteristic of the data when in fact it could add useful information in modelling. A look as the error term from running a standard OLS first order autoregressive model of the exchange rate suggests that this may be the case in South Africa as shown in figure 1.

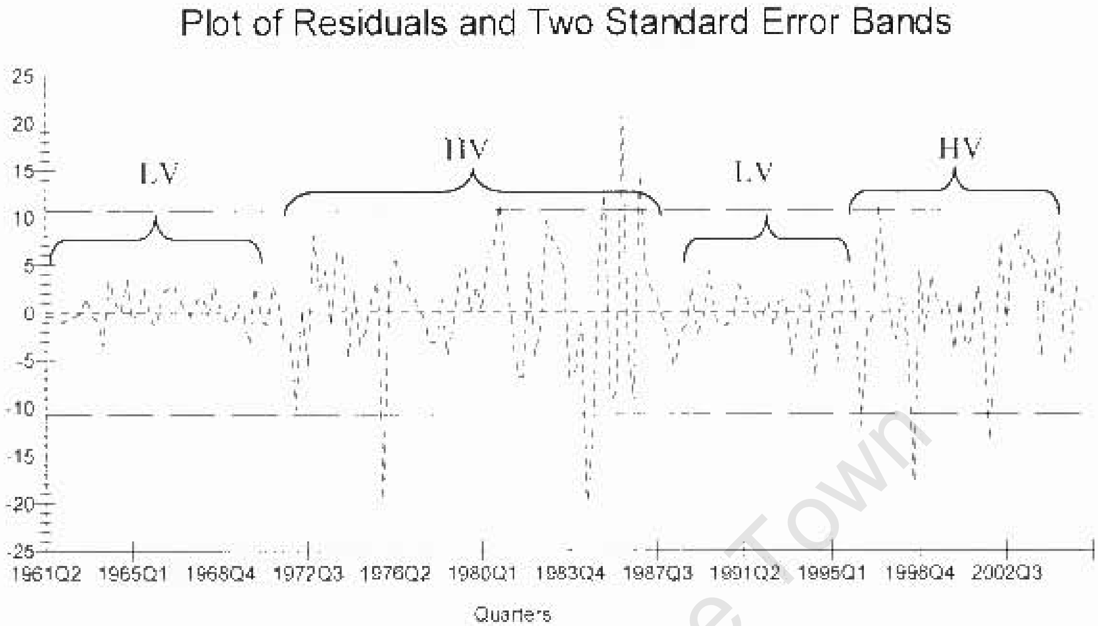

Figure 1. Volatility of the REER from OLS estimation of an autoregressive function. LV indicates low volatility periods and HV indicates high volatility periods.

As a result the use of the GARCH model to obtain the conditional volatility of the exchange rate is appropriate. The best specification seemed to be using an GARCH(3:0) model for both time periods considered (results can be found in Appendix 1). The volatility measure from this form of estimation is called HEV03 or LHEV03 in the results. Once the conditional variance was obtained from the modelling process, the volatility variable was obtained by square rooting the series and logging it. Another model that was considered was the GARCH-M model (or the GARCH in mean model) which suggests that the level of the variable considered is dependent on it's own conditional volatility such that the conditional volatility term is included in the mean equation for the model. The results were worse than the GARCH model and generally insignificant, suggesting that exchange rate volatility is not dependent on the level of the exchange rate.

A visual inspection of the two volatility variables in figure 2 establishes that the moving average standard deviation measure, HEV03 is of a much smaller scale (axis on the right) than the GARCH estimated measure, GEVMASD2, which could support the criticism that the first measure underestimates the actual level of volatility. What is interesting is that there does seem to be some correlation in terms of the large movements in volatility between the two measures.

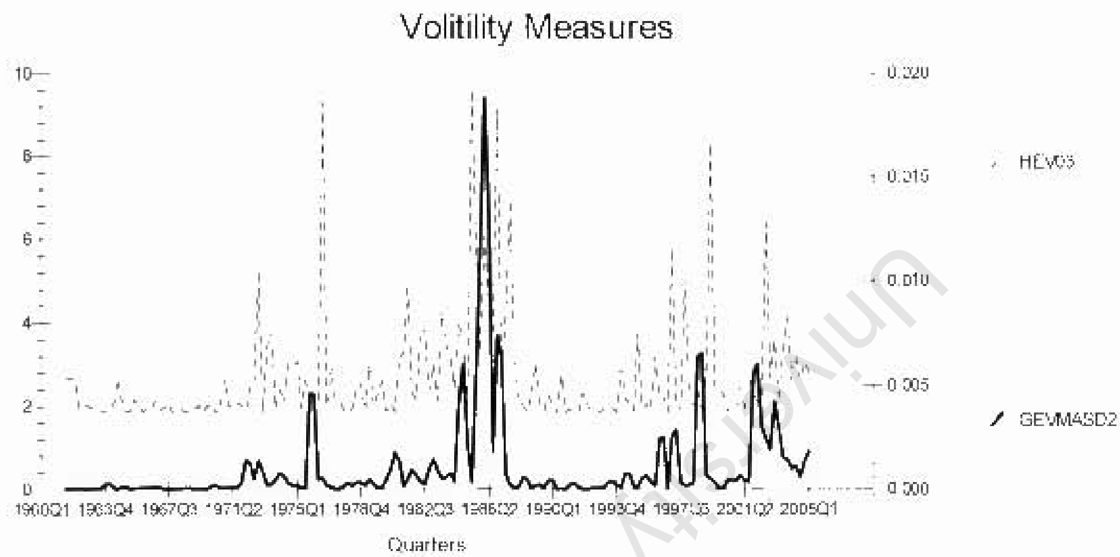

Figure 2.

Stationarity

Using the standard augmented Dickey Fuller test, it was found that all variables except the volatility and foreign GDP variables seem not to be stationary, whilst the volatility and foreign GDP variables are I(0). Whilst the foreign GDP variable seems to not be stationary, the results below show that it was successfully included in the long run relationship[8]. It is interesting to note here that all papers on South Africa thus far have found the volatility variable to be integrated of order one. Considering figure 2, it can be seen that a stationary mean is expected from these volatility variables, whilst there does not seem to be evidence supporting a constant variance. The spectral density and autocorrelation function for these variables did not return results strongly supporting stationarity, but also not strongly rejecting it. The results are reported in Appendix 2.

[8] It was also included in the model as weakly exogenous, but this did not affect the results in any significant way.

Exchange rate volatility and export volumes

The focus of this paper is to discover if there is a relationship for South Africa between exchange rate volatility and export volumes and to find out if it is in fact a negative relationship as suggested by the ASGISA document. Figure 3 and figure 4 show the export volume data series and the exchange rate volatility series plotted on the same graph. It is quite apparent that there is no immediate evidence of co-movement between the two variables regardless of the method used to produce the volatility variable. Thus there is no outright evidence that the level of exchange rate volatility should have any significant effect on the level of export volumes. Furthermore, graphical analysis is done to compare the change in export volumes with the volatility variables and there is more evidence that such a relationship exists with both volatility measures.

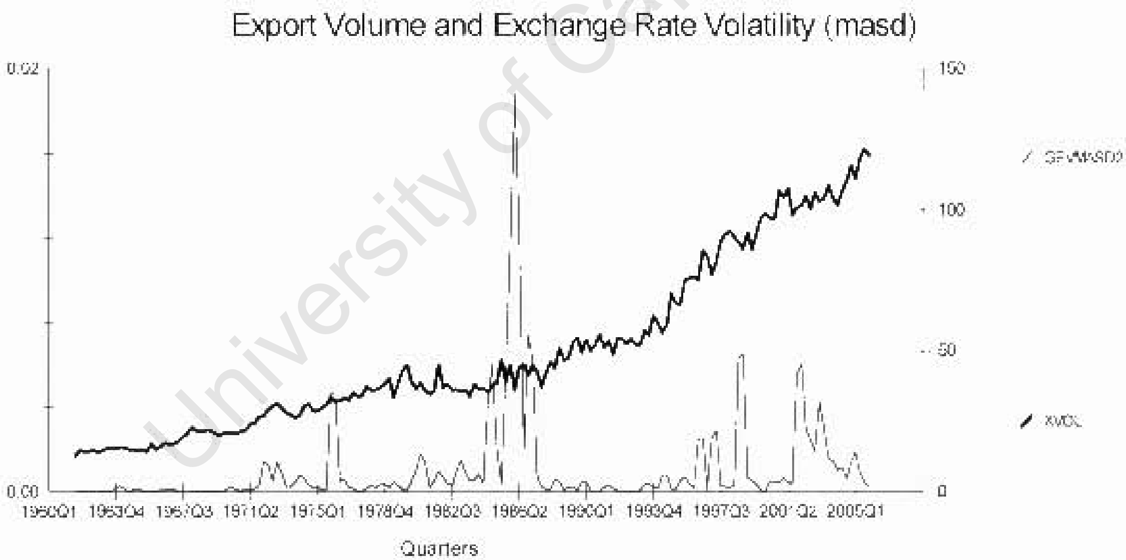

Figure 3

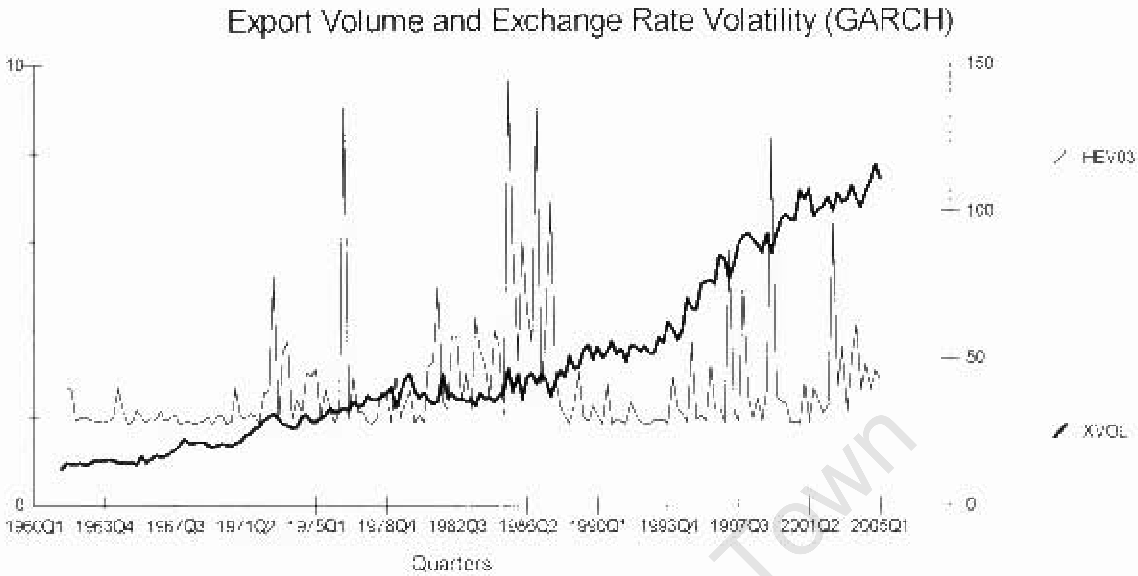

Figure 4

The Model

The purpose of this study is to investigate whether including exchange rate variability in the export function for South Africa would result in a better export function (effectively suggesting that without exchange rate variability the traditional export function suffers from omitted variable bias). Thus the model used will be

$$XVOL_t = \alpha_0 + \alpha_1 REER_t + \alpha_2 GDP_t + \alpha_3 GDPF_t + \alpha_4 VOL_t + \varepsilon \qquad (7)$$

where all variables are logged, XVOL is the volume of exports, REER is the relative price variable, GDP is the South African GDP, GDPF is the foreign GDP variable which is weighted according to SARB weights and VOL is the exchange rate volatility variable. This is inline with Goldstein and Khan's (1985) imperfect substitutes model whereby it is expected that α_1 is expected to be negative (such that an increase in local prices leads to a decrease in exports as producers sell more of their goods locally and an increase in foreign prices would lead to an increase in the volume of exports by producers). α_2 should be positive as it is used as a proxy for capacity to export and α_3 is expected to be positive as it is expected that should exporters see an increase in the GDP of the countries they export to, they will export more as they expect prices to go up due to an increase in demand. Finally the sign of α_4 is indeterminate and will be observed once the empirical results are obtained.

This model is estimated using aggregate measures due to data availability constraints at any level of disaggregation, but if it is assumed that all firms in the economy are price takers, the calculation of the aggregate supply curve is a simple addition of all individual supply curves[9]. As a result it can be expected that the determinants of the aggregate supply curve for an economy will be the average price of all goods sold in the economy as well as the average costs of production of all goods in the economy. This is a reasonable assumption in the case of South Africa[10], as the supply of any good from South Africa is too small to affect the price of that good in the global market (should it be withdrawn from the supply). One implication of this is that South African suppliers face a perfectly elastic demand curve. This is specifically when exports of gold are excluded from the South African export volume.

Estimation Approach

The estimation of the model was done using the Johansen cointegration technique. This technique allows for more than one cointegrating vector to be estimated and whilst the model aims to estimate one cointegrating vector, it seems prudent to see what results the tests return. Once the presence of cointegrating vectors is established through testing, estimation produces both the long run results (obtained by just-identifying restrictions imposed from economic theory) and the short run results (the error correction model) for the cointegrating vectors. Theory guides us as to the expected long run relationship and thus to establish the validity of the results. Importantly, the error correction term in the short run models must fall between 0 and -2 for there to be evidence that shocks to the system are temporary. If this is not the case, any shock to the system causes the variable to move farther away from the established long run relationship over time as opposed to returning to the expected long run relationship.

[9] Mas-Colell et al. Chapter 5, p. 147
[10] See Edwards and Alves (2006)

$$\begin{pmatrix} \Delta XVOL_t \\ \Delta REER_t \\ \Delta GDP_t \\ \Delta GDPF_t \\ \Delta VOL_t \end{pmatrix} = \Gamma \begin{pmatrix} \Delta XVOL_{t-1} \\ \Delta REER_{t-1} \\ \Delta GDP_{t-1} \\ \Delta GDPF_{t-1} \\ \Delta VOL_{t-1} \end{pmatrix} + \Pi \begin{pmatrix} XVOL_t \\ REER_t \\ GDP_t \\ GDPF_t \\ VOL_t \end{pmatrix} + \begin{pmatrix} \varepsilon_t^{XVOL} \\ \varepsilon_t^{REER} \\ \varepsilon_t^{GDP} \\ \varepsilon_t^{GDPF} \\ \varepsilon_t^{VOL} \end{pmatrix} \quad (8)$$

More technically, the Johansen technique allows for the modeling of endogenous variables and can help establish feedback effects between different relationships. The test for the level of cointegration involves testing the rank of the matrix Π in equation 8. Johansen and Julius (1990) suggest two methods to obtain the test statistic, the first is to consider the maximum eigenvalue and the second is to calculate a trace statistic of the Π matrix. The null hypothesis is that the rank is equal to r with the alternative hypothesis that the rank is equal to $r+1$. Once the number of cointegrating vectors is established, then the long run relationship is obtained from the second term on the right hand side of equation 8 (which is the short run relationship of the cointegration procedure). The Π matrix can be separated such that $\Pi=\alpha\beta'$. Thus β' multiplied by the matrix of the long run variables returns the long run relationship. This relationship is established once rxr just-identifying restrictions are imposed on the β matrix using maximum likelihood estimation. It is also possible to further use theory to impose over-identifying restrictions on the β matrix, with a log-likelihood ratio test used to establish the validity of the extra restrictions. If they are not rejected then the over-identifying restrictions are generally accepted for modeling.

The first attempt at the empirical estimation was done using the PSS ARDL given the expectation that there would be cointegration between the variables chosen for this model. This is because this model allows for the inclusion of I(1) and I(0) variables in the model and the data was expected to produce only one cointegrating vector. The bounds test was used to confirm this. Unfortunately, whilst bounds testing did accept one cointegrating vector, it was for a model with the foreign GDP variable as the dependent variable. This was obviously nonsensical from a theoretical point of view and the data used. Given that bounds testing is an arduous procedure, it was decided to rather use the Johansen procedure.

The testing for cointegration for this model is preferable for two reasons, firstly it tests for more than one cointegrating vector and secondly it is done so with fewer manual calculations. Fortunately the period over which the model is run is long enough to justify the use of cointegration techniques. Secondly, inspite of the I(0) result for the volatility measure obtained from ADF tests, cointegration tests were run with the volatility variable as part of the long run inline with recent papers on this topic (Arize, 1997; Wilcox,2007). Whilst the presence of cointegrating vectors in the data was accepted, the results were found to be variable depending on the order of VAR chosen, the inclusion of intercepts and/or trends and more so they tended to produce the wrong sign for the real effective exchange rate and other variables. To obtain a significant result (positive or negative) for the volatility variable, results for all other variables became variable and generally nonsensical. Finally, due to the fact that the volatility variables were I(0), they were included only in the short run models.

This then raises the question as to how it is that other South African papers that have used an exchange rate volatility measure have managed to include it in the long run model successfully when there is evidence against this, using the same or similar techniques for estimation. The inclusion of the volatility term in the short run does seem to make sense as it derived from the changes in the levels of an I(1) variable (and this is effectively the what makes the real effective exchange rate I(1) and not integrated of a higher order). The model was run using an order of VAR 2, this was particularly difficult to establish using the test provided by Microfit due to results being conflicting (as with Wilcox (2007)) as to the correct order. Thus the order of 2 was chosen partially because models run with a lower order of VAR caused diagnostic problems with the short run model, but at for longer orders of VAR the presence of cointegration became problematic.

Testing for the presence of cointegration yielded positive results for a model without intercepts or trends for the period 1963 to 2005. Both models produced results suggesting the presence of two cointegrating vectors in the data (results in appendix 3). This could be due to simultaneity in the determination of export volumes and GDP or even in the determination of export volumes and the price of exports. Neither of these models have been considered as the data included does not allow for exhaustive models of GDP or the price of exports to be estimated. Thus theoretical considerations were used to set the number of cointegrating vectors equal to one. The just-identifying restriction was to set the coefficient on export volumes equal to one, and an over-identifying restriction setting the coefficient on GDP equal to zero was not rejected. The results are reported in the following section.

Section 5: Results

Table 1 reports the long run results for the period and table 2 the short run results. Model 1 refers to the model where the moving average standard deviation is the volatility measure used, and model 2 refers to the model where the GARCH estimation of the conditional volatility measure is used. Looking at Table 1 it can be seen that the relationship between export volumes and the real effective exchange rate is negative as expected. This tells us that an increase in prices in South Africa causes a decrease in export volume and an increase in prices in the foreign countries causes an increase in export volume. The expectation at a higher level of foreign GDP causes an increase in export volume is confirmed by the results for both models. It is worth noting that the coefficients on the real effective exchange rate are consistently much lower than found in Golub and Ceglowski (2002), but on the foreign GDP variable, more similar (although in their models this variable jumps around a lot) although this could be attributed to the fact that they use OLS to estimate their model given that they do not find cointegration present.

The short run results for both models are again quite similar. Most importantly the error correction term is negative and statistically significant. Impulse response functions (graphs in appendix 3), show that it takes between 5 and 15 quarters for the models to return to a long run value, this translates into adjustment to equilibrium taking from just over a year to just under 4 years. In terms of the effect of exchange rate volatility, it is found that exchange rate volatility has a statistically significant negative effect on the growth of export volumes. In terms of the different measures used, the GARCH volatility measure gives a stronger response than the moving average standard deviation measure, which is to be expected since the GARCH measure is consistently higher than its counterpart (see figure 2.). The biggest problem encountered with the error correction models was that serial correlation was often found and difficult to correct for, the models in table 2 were the best diagnostically, normality of the residuals for these models remains a problem a though.

Table 1.

Long Run Results		
Variable	**Model 1**	**Model 2**
LXVOL	1.0000 (NONE)	1.0000 (NONE)
LREER	0.52490 (0.044624)	0.50812 (0.036594)
LGDP	0.0000 (NONE)	0.0000 (NONE)
LGDPF	-1.5025 (0.036633)	-1.5128 (0.039585)
Pr from LR test of Restrictions	0.778	0.904
Time Period	1963Q2 to 2005Q1	1963Q3 to 2005Q1
F-test of restriction		

Figures in brackets are standard errors. Results are reported as vectors, thus the sign in front of each variable except the export volume variable needs to be changed to establish the empirical relationship.

One final concern about this model is that it is run from 1963 to 2005, but floating nominal exchange rates were only adopted during the 1970's for most countries. This could possibly have caused some kind of behavioural change in exporting behaviour, in spite of the fact that the real exchange rate had experience a level of volatility prior to this period. Thus the models above were run from 1971 to 2005 to see if this was the case. The results are reported in appendix 4. Model 3 refers to the model using the moving average standard deviation measure and Model 4 the GARCH measure. The coefficients in the long run models do seem to be smaller than for Models 1 and 2, but the signs of the relationships do not change. In the short run relationships there is a significant increase in the error correction coefficients, but the coefficients on the volatility measures do not change significantly. Thus, at least in terms of the effect of exchange rate volatility on the growth of export volumes, there is no significant difference. Thus the inclusion of the pre-Bretton Woods period is valuable in the sense that it allows for a longer period of time to establish the nature of the long run relationship and it adds an extra period of low exchange rate volatility to the estimation.

Table 2.

Short Run Results		
dLXVOL	**Model 1**	**Model 2**
dLXVOL1	-0.28392*	-0.27723*
dLREER1	0.10380	0.16336
dLGDP1	-0.19577	-0.020926
dLGDPF1	-0.098956	0.18779
ecm(-1)	-0.24812*	-0.23516*
LGEVMASD2	-0.011397*	
LGEVMASD2(-1)	0.0096272**	
LGEVMASD2(-2)	-0.0099001**	
LGEVMASD2(-3)	0.0028958	
LGEVMASD2(-4)	0.0027240	
LHEV03		-0.037686**
LHEV03(-1)		-0.010357
LHEV03(-2)		0.015306
LHEV03(-3)		-0.0084497
LHEV03(-4)		0.0011597
LHEV03(-5)		0.012407
LHEV03(-6)		-0.0023652
LHEV03(-7)		0.044446*
LHEV03(-8)		-5.13E-03
RUBICON	0.012683	0.016036
SANCT	-0.061337*	-0.060335*
Obs	*168*	*167*
R-Bar-Squared	*0.22853*	*0.21096*

*, ** indicates level of significance of 1% and 5% respectively

Section 6: Conclusion

This paper set out to establish whether there was a link between exchange rate volatility and export volumes and the nature of that link in the case of South Africa. Whilst the model was somewhat different in estimation to previous versions due to the order of integration of the volatility measures, the evidence suggests that there is a significant negative impact of exchange rate volatility on the growth of exports. The implication of this for South Africa is that exchange rate volatility probably does affect national income and hence should be of concern to policy makers. Policy reactions to this are limited though as often volatility has been due to political instability and speculative attacks on developing countries. Other policy measures such as stable and predictable monetary and fiscal policy have been in effect in South Africa over the past couple of years and thus changes to these would at best have a small effect on this. The findings in terms of this relationship are robust to the different measures used as well as the varying time period. In terms of further work that could be done, it would probably be prudent to estimate the model with two cointegrating vectors, ensuring that the specification of the second vector is thorough and to see the effect of this on the established relationship. In terms of robustness, there is the instrumental variables measure suggested by Antle (1983, cited in Arize 1997) that could be estimated and used in estimation for further evidence.

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Appendices

Appendix 1: GARCH estimation

```
                 GARCH(0,3) assuming a normal distribution
                       converged after 65 iterations
*******************************************************************************
 Dependent variable is REER
 179 observations used for estimation from 1961Q2 to 2005Q4
*******************************************************************************
 Regressor              Coefficient        Standard Error         T-Ratio[Prob]
 REER(-1)                   1.0025            .0027975           358.3746[.000]
 RUBICON                  -10.3994              2.0238            -5.1386[.000]
 SANCT                    -.043556              .77277           -.056363[.955]
*******************************************************************************
 R-Squared                      .93994   R-Bar-Squared                   .93891
 S.E. of Regression             5.4062   F-stat.    F(  3, 175)  912.8519[.000]
 Mean of Dependent Variable   133.1562   S.D. of Dependent Variable     21.8721
 Residual Sum of Squares        5114.7   Equation Log-likelihood      -530.6475
 Akaike Info. Criterion      -534.6475   Schwarz Bayesian Criterion   -541.0222
 DW-statistic                   1.8023
*******************************************************************************

            Parameters of the Conditional Heteroscedastic Model
        Explaining H-SQ, the Conditional Variance of the Error Term
*******************************************************************************
                         Coefficient       Asymptotic Standard Error
        Constant           14.3268                 3.1455
        E-SQ(- 3)           .68537                 .29159
*******************************************************************************
 H-SQ stands for the conditional variance of the error term.
 E-SQ stands for the square of the error term.
```

```
                 GARCH(0,6) assuming a normal distribution
                       converged after 64 iterations
*******************************************************************************
 Dependent variable is REER
 144 observations used for estimation from 1970Q1 to 2005Q4
*******************************************************************************
 Regressor              Coefficient        Standard Error         T-Ratio[Prob]
 REER(-1)                   .99896            .0030440           328.1791[.000]
 SANCT                      .53859              .91458             .58889[.557]
 RUBICON                  -12.3910              2.5577            -4.8446[.000]
*******************************************************************************
 R-Squared                      .92440   R-Bar-Squared                   .92278
 S.E. of Regression             5.9817   F-stat.    F(  3, 140)  570.6455[.000]
 Mean of Dependent Variable   128.1560   S.D. of Dependent Variable     21.5265
 Residual Sum of Squares        5009.4   Equation Log-likelihood      -431.4747
 Akaike Info. Criterion      -435.4747   Schwarz Bayesian Criterion   -441.4143
 DW-statistic                   1.7981
*******************************************************************************

            Parameters of the Conditional Heteroscedastic Model
        Explaining H-SQ, the Conditional Variance of the Error Term
*******************************************************************************
                         Coefficient       Asymptotic Standard Error
        Constant           16.0013                 3.6946
        E-SQ(- 6)           .79200                 .28181
*******************************************************************************
 H-SQ stands for the conditional variance of the error term.
 E-SQ stands for the square of the error term.
```

Appendix 2: Stationarity Tests

Export Volume:

Unit root tests for variable LXVOL

The Dickey-Fuller regressions include an intercept but not a trend

171 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-.88460	203.5024	201.5024	198.3608	200.2277
ADF(1)	-.64118	217.8572	214.8572	210.1447	212.9451
ADF(2)	-.56150	220.2479	216.2479	209.9645	213.6984
ADF(3)	-.51994	221.7138	216.7138	208.8596	213.5269
ADF(4)	-.51398	221.7254	215.7254	206.3004	211.9011
ADF(5)	-.49408	221.9312	214.9312	203.9354	210.4696
ADF(6)	-.49720	222.1829	214.1829	201.6162	209.0839
ADF(7)	-.50719	222.6375	213.6375	199.5000	207.9011
ADF(8)	-.50192	222.8511	212.8511	197.1427	206.4773
ADF(9)	-.50003	222.8520	211.8520	194.5728	204.8408
ADF(10)	-.48746	225.6643	213.6643	194.8143	206.0158
ADF(11)	-.47449	226.0894	213.0894	192.6686	204.8035
ADF(12)	-.44740	226.6538	212.6538	190.6622	203.7306

95% critical value for the augmented Dickey-Fuller statistic = -2.8784
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LXVOL

The Dickey-Fuller regressions include an intercept and a linear trend

171 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-4.5951	213.2325	210.2325	205.5200	208.3204
ADF(1)	-3.1177	222.4910	218.4910	212.2077	215.9415
ADF(2)	-2.6850	223.7276	218.7276	210.8735	215.5408
ADF(3)	-2.3907	224.4941	218.4941	209.0691	214.6698
ADF(4)	-2.3931	224.5312	217.5312	206.5354	213.0696
ADF(5)	-2.3061	224.5571	216.5571	203.9904	211.4581
ADF(6)	-2.4615	225.1990	216.1990	202.0615	210.4626
ADF(7)	-2.3263	225.3396	215.3396	199.6313	208.9658
ADF(8)	-2.4709	225.9273	214.9273	197.6481	207.9162
ADF(9)	-2.4976	226.0170	214.0170	195.1671	206.3685
ADF(10)	-2.1203	227.9517	214.9517	194.5308	206.6658
ADF(11)	-1.9965	228.1293	214.1293	192.1376	205.2060
ADF(12)	-1.8551	228.4280	213.4280	189.8655	203.8674

95% critical value for the augmented Dickey-Fuller statistic = -3.4368
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLXVOL

The Dickey-Fuller regressions include an intercept but not a trend

170 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-19.7459	216.2344	214.2344	211.0986	212.9619
ADF(1)	-12.7816	218.5779	215.5779	210.8742	213.6692
ADF(2)	-10.3314	220.0437	216.0437	209.7721	213.4987
ADF(3)	-8.1305	220.0553	215.0553	207.2158	211.8741
ADF(4)	-7.1847	220.2506	214.2506	204.8432	210.4332
ADF(5)	-5.9520	220.4457	213.4457	202.4704	208.9920
ADF(6)	-5.8017	220.9426	212.9426	200.3994	207.8528

ADF(7)	-5.0017	221.1741	212.1741	198.0631	206.4480
ADF(8)	-4.6534	221.1746	211.1746	195.4956	204.8122
ADF(9)	-5.2195	223.9603	212.9603	195.7134	205.9617
ADF(10)	-5.1428	224.3440	212.3440	193.5292	204.7091
ADF(11)	-5.1356	224.8763	211.8763	191.4936	203.6052
ADF(12)	-4.8548	224.9267	210.9267	188.9761	202.0194

95% critical value for the augmented Dickey-Fuller statistic = -2.8785
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable DLXVOL
The Dickey-Fuller regressions include an intercept and a linear trend

170 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-19.6870	216.2344	213.2344	208.5307	211.3257
ADF(1)	-12.7430	218.5780	214.5780	208.3064	212.0330
ADF(2)	-10.2998	220.0441	215.0441	207.2046	211.8630
ADF(3)	-8.1056	220.0557	214.0557	204.6483	210.2383
ADF(4)	-7.1626	220.2512	213.2512	202.2759	208.7975
ADF(5)	-5.9335	220.4461	212.4461	199.9030	207.3563
ADF(6)	-5.7834	220.9445	211.9445	197.8334	206.2184
ADF(7)	-4.9835	221.1748	211.1748	195.4958	204.8124
ADF(8)	-4.6354	221.1752	210.1752	192.9283	203.1766
ADF(9)	-5.2008	223.9643	211.9643	193.1495	204.3295
ADF(10)	-5.1246	224.3497	211.3497	190.9671	203.0787
ADF(11)	-5.1180	224.8827	210.8827	188.9322	201.9754
ADF(12)	-4.8388	224.9333	209.9333	186.4148	200.3897

95% critical value for the augmented Dickey-Fuller statistic = -3.4370
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Real Effective Exchange Rate:

Unit root tests for variable LREER
The Dickey-Fuller regressions include an intercept but not a trend

167 observations used in the estimation of all ADF regressions.
Sample period from 1964Q2 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-1.7914	271.7345	269.7345	266.6165	268.4690
ADF(1)	-1.9241	272.3183	269.3183	264.6413	267.4200
ADF(2)	-1.6982	273.3310	269.3310	263.0950	266.8000
ADF(3)	-2.1086	277.8023	272.8023	265.0073	269.6385
ADF(4)	-2.1217	277.8451	271.8451	262.4911	268.0485
ADF(5)	-1.8802	278.7461	271.7461	260.8331	267.3168
ADF(6)	-1.5806	280.8175	272.8175	260.3455	267.7554
ADF(7)	-1.4931	280.9561	271.9561	257.9252	266.2613
ADF(8)	-1.4422	281.0038	271.0038	255.4138	264.6761
ADF(9)	-1.5418	281.4528	270.4528	253.3039	263.4924
ADF(10)	-1.4602	281.5760	269.5760	250.8680	261.9828
ADF(11)	-1.3502	281.8070	268.8070	248.5401	260.5811
ADF(12)	-1.1808	282.3029	268.3029	246.4770	259.4443

95% critical value for the augmented Dickey-Fuller statistic = -2.8788
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable LREER
The Dickey-Fuller regressions include an intercept and a linear trend

167 observations used in the estimation of all ADF regressions.
Sample period from 1964Q2 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-3.0120	274.6233	271.6233	266.9463	269.7250
ADF(1)	-3.2992	275.8534	271.8534	265.6174	269.3223
ADF(2)	-2.9654	276.2813	271.2813	263.4864	268.1175
ADF(3)	-3.8301	282.8236	276.8236	267.4696	273.0270
ADF(4)	-4.0089	283.5356	276.5356	265.6226	272.1063
ADF(5)	-3.6588	283.6717	275.6717	263.1997	270.6096
ADF(6)	-3.1537	284.6133	275.6133	261.5823	269.9184
ADF(7)	-3.0567	284.6133	274.6133	259.0233	268.2857
ADF(8)	-3.0181	284.6433	273.6433	256.4944	266.6829
ADF(9)	-3.2864	285.8148	273.8148	255.1068	266.2216
ADF(10)	-3.2032	285.8210	272.8210	252.5541	264.5951
ADF(11)	-3.0748	285.8316	271.8316	250.0056	262.9729
ADF(12)	-2.8784	285.9838	270.9838	247.5989	261.4924

95% critical value for the augmented Dickey-Fuller statistic = -3.4374
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLREER
The Dickey-Fuller regressions include an intercept but not a trend

166 observations used in the estimation of all ADF regressions.
Sample period from 1964Q3 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-12.0199	268.3391	266.3391	263.2271	265.0759
ADF(1)	-9.9452	269.7402	266.7402	262.0722	264.8454
ADF(2)	-6.3365	273.3932	269.3932	263.1692	266.8668
ADF(3)	-5.6716	273.3941	268.3941	260.6142	265.2362
ADF(4)	-5.8708	274.7662	268.7662	259.4303	264.9767
ADF(5)	-6.3345	277.3453	270.3453	259.4533	265.9242
ADF(6)	-5.9598	277.6143	269.6143	257.1663	264.5615
ADF(7)	-5.5728	277.7316	268.7316	254.7276	263.0473
ADF(8)	-4.7788	278.0158	268.0158	252.4558	261.6999
ADF(9)	-4.6893	278.2589	267.2589	250.1430	260.3115
ADF(10)	-4.6683	278.6461	266.6461	247.9742	259.0670
ADF(11)	-4.7530	279.3628	266.3628	246.1349	258.1522
ADF(12)	-3.6765	280.7497	266.7497	244.9658	257.9075

95% critical value for the augmented Dickey-Fuller statistic = -2.8789
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLREER
The Dickey-Fuller regressions include an intercept and a linear trend

166 observations used in the estimation of all ADF regressions.
Sample period from 1964Q3 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-11.9832	268.3412	265.3412	260.6733	263.4465
ADF(1)	-9.9139	269.7413	265.7413	259.5173	263.2149
ADF(2)	-6.3167	273.3940	268.3940	260.6140	265.2360
ADF(3)	-5.6541	273.3950	267.3950	258.0590	263.6054
ADF(4)	-5.8526	274.7671	267.7671	256.8751	263.3460
ADF(5)	-6.3145	277.3458	269.3458	256.8978	264.2931
ADF(6)	-5.9404	277.6144	268.6144	254.6104	262.9301
ADF(7)	-5.5544	277.7317	267.7317	252.1717	261.4158
ADF(8)	-4.7624	278.0160	267.0160	249.9001	260.0686
ADF(9)	-4.6727	278.2590	266.2590	247.5870	258.6799
ADF(10)	-4.6510	278.6464	265.6464	245.4185	257.4358
ADF(11)	-4.7353	279.3686	265.3686	243.5847	256.5263
ADF(12)	-3.6440	280.7509	265.7509	242.4110	256.2771

****

95% critical value for the augmented Dickey-Fuller statistic = -3.4376
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

South African Gross Domestic Product:

Unit root tests for variable LGDP
The Dickey-Fuller regressions include an intercept but not a trend

****

171 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q4

****

	Test Statistic	LL	AIC	SBC	HQC
DF	-3.2715	531.5637	529.5637	526.4220	528.2889
ADF(1)	-3.1288	531.5998	528.5998	523.8873	526.6877
ADF(2)	-2.4723	536.5369	532.5369	526.2535	529.9873
ADF(3)	-2.1221	538.3767	533.3767	525.5226	530.1898
ADF(4)	-2.3741	540.0364	534.0364	524.6114	530.2122
ADF(5)	-2.3619	540.0553	533.0553	522.0595	528.5936
ADF(6)	-1.9992	541.6405	533.6405	521.0738	528.5415
ADF(7)	-2.3133	543.3257	534.3257	520.1882	528.5893
ADF(8)	-2.3169	543.3659	533.3659	517.6576	526.9921
ADF(9)	-2.1698	543.5484	532.5484	515.2692	525.5372
ADF(10)	-2.0096	543.8318	531.8318	512.9818	524.1833
ADF(11)	-1.9132	543.9010	530.9010	510.4802	522.6151
ADF(12)	-2.1077	544.7981	530.7981	508.8064	521.8748

****

95% critical value for the augmented Dickey-Fuller statistic = -2.8784
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LGDP
The Dickey-Fuller regressions include an intercept and a linear trend

****

171 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q4

****

	Test Statistic	LL	AIC	SBC	HQC
DF	-3.6806	535.9587	532.9587	528.2462	531.0466
ADF(1)	-3.6350	535.9598	531.9598	525.6765	529.4103
ADF(2)	-3.3345	540.4991	535.4991	527.6449	532.3122
ADF(3)	-3.2216	542.2753	536.2753	526.8503	532.4510
ADF(4)	-3.2822	543.9382	536.9382	525.9424	532.4766
ADF(5)	-3.2847	543.9790	535.9790	523.4123	530.8800
ADF(6)	-3.1654	545.4990	536.4990	522.3615	530.7626
ADF(7)	-3.2900	547.3095	537.3095	521.6011	530.9357
ADF(8)	-3.2924	547.3573	536.3573	519.0782	529.3462
ADF(9)	-3.2544	547.5521	535.5521	516.7021	527.9036
ADF(10)	-3.2197	547.8728	534.8728	514.4520	526.5869
ADF(11)	-3.1952	547.9603	533.9603	511.9686	525.0370
ADF(12)	-3.2407	548.8389	533.8389	510.2764	524.2783

****

95% critical value for the augmented Dickey-Fuller statistic = -3.4368
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLGDP
The Dickey-Fuller regressions include an intercept but not a trend

****

170 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q4

****

	Test Statistic	LL	AIC	SBC	HQC
DF	-12.2200	524.5292	522.5292	519.3934	521.2568
ADF(1)	-6.7780	531.1045	528.1045	523.4008	526.1958
ADF(2)	-5.1017	533.5063	529.5063	523.2347	526.9614
ADF(3)	-5.2872	534.5347	529.5347	521.6952	526.3535
ADF(4)	-4.8578	534.5400	528.5400	519.1327	524.7226
ADF(5)	-3.8975	536.9317	529.9317	518.9564	525.4781

ADF(6)	-4.1677	538.0711	530.0711	517.5279	524.9812
ADF(7)	-3.8798	538.1345	529.1345	515.0234	523.4083
ADF(8)	-3.4368	538.6920	528.6920	513.0130	522.3296
ADF(9)	-3.0689	539.2500	528.2500	511.0032	521.2515
ADF(10)	-2.8567	539.4306	527.4306	508.6158	519.7958
ADF(11)	-2.9993	539.9711	526.9711	506.5884	518.7001
ADF(12)	-2.8155	540.1269	526.1269	504.1763	517.2196

95% critical value for the augmented Dickey-Fuller statistic = -2.8785
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable DLGDP
The Dickey-Fuller regressions include an intercept and a linear trend

170 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-12.5284	526.8092	523.8092	519.1055	521.9005
ADF(1)	-6.9700	532.3039	528.3039	522.0323	525.7589
ADF(2)	-5.2406	534.2753	529.2753	521.4358	526.0942
ADF(3)	-5.4877	535.6273	529.6273	520.2200	525.8099
ADF(4)	-5.0691	535.6364	528.6364	517.6611	524.1828
ADF(5)	-4.0137	537.5619	529.5619	517.0187	524.4720
ADF(6)	-4.3682	539.0721	530.0721	515.9611	524.3460
ADF(7)	-4.0662	539.0755	529.0755	513.3965	522.7132
ADF(8)	-3.5740	539.4193	528.4193	511.1724	521.4207
ADF(9)	-3.1581	539.8002	527.8002	508.9855	520.1654
ADF(10)	-2.9171	539.8968	526.8968	506.5142	518.6258
ADF(11)	-3.1222	540.6391	526.6391	504.6885	517.7318
ADF(12)	-2.9058	540.7041	525.7041	502.1856	516.1605

95% critical value for the augmented Dickey-Fuller statistic = -3.4370
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LGDPF
The Dickey-Fuller regressions include an intercept but not a trend

168 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-2.4184	434.1141	432.1141	428.9901	430.8462
ADF(1)	-3.1815	451.7655	448.7655	444.0795	446.8637
ADF(2)	-3.3419	452.4197	448.4197	442.1718	445.8840
ADF(3)	-5.9638	486.2451	481.2451	473.4352	478.0755
ADF(4)	-2.4626	567.1112	561.1112	551.7393	557.3076
ADF(5)	-3.2881	583.0678	576.0678	565.1339	571.6303
ADF(6)	-3.9621	588.0385	580.0385	567.5426	574.9670
ADF(7)	-4.2094	589.1037	580.1037	566.0458	574.3983
ADF(8)	-3.2439	594.5800	584.5800	568.9602	578.2408
ADF(9)	-3.2746	594.7237	583.7237	566.5419	576.7505
ADF(10)	-3.4746	595.6745	583.6745	564.9307	576.0674
ADF(11)	-3.3654	595.6756	582.6756	562.3699	574.4346
ADF(12)	-2.8066	598.6825	584.6825	562.8148	575.8075

95% critical value for the augmented Dickey-Fuller statistic = -2.8787
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Foreign Gross Domestic Product:

Unit root tests for variable LGDPF

The Dickey-Fuller regressions include an intercept and a linear trend

168 observations used in the estimation of all ADF regressions.
Sample period from 1963Q2 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-3.6232	439.4770	436.4770	431.7910	434.5752
ADF(1)	-3.0475	455.1854	451.1854	444.9375	448.6497
ADF(2)	-3.0248	455.7213	450.7213	442.9114	447.5516
ADF(3)	-3.8773	490.7776	484.7776	475.4057	480.9740
ADF(4)	-3.7759	572.9727	565.9727	555.0388	561.5352
ADF(5)	-3.4465	587.4981	579.4981	567.0022	574.4267
ADF(6)	-3.5687	592.4896	583.4896	569.4318	577.7843
ADF(7)	-3.6426	593.6118	583.6118	567.9920	577.2725
ADF(8)	-3.4745	599.0616	588.0616	570.8798	581.0884
ADF(9)	-3.4756	599.1890	587.1890	568.4452	579.5818
ADF(10)	-3.5054	600.1166	587.1166	566.8108	578.8755
ADF(11)	-3.4881	600.1167	586.1167	564.2489	577.2417
ADF(12)	-3.4350	603.2858	588.2858	564.8560	578.7768

95% critical value for the augmented Dickey-Fuller statistic = -3.4373
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable DLGDPF

The Dickey-Fuller regressions include an intercept but not a trend

167 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-19.6597	443.6123	441.6123	438.4943	440.3468
ADF(1)	-11.2409	443.7391	440.7391	436.0621	438.8408
ADF(2)	-14.4334	466.8737	462.8737	456.6377	460.3426
ADF(3)	-2.9808	563.4890	558.4890	550.6940	555.3252
ADF(4)	-4.4961	579.0771	573.0771	563.7231	569.2805
ADF(5)	-5.1640	582.4823	575.4823	564.5693	571.0530
ADF(6)	-4.8806	582.5049	574.5049	562.0329	569.4428
ADF(7)	-3.3574	591.1799	582.1799	568.1489	576.4850
ADF(8)	-3.2554	591.1810	581.1810	565.5910	574.8534
ADF(9)	-3.2886	591.3505	580.3505	563.2015	573.3901
ADF(10)	-3.0642	591.4688	579.4688	560.7608	571.8756
ADF(11)	-2.4084	596.4307	583.4307	563.1637	575.2048
ADF(12)	-2.6788	598.0373	584.0373	562.2114	575.1787

95% critical value for the augmented Dickey-Fuller statistic = -2.8788
LL = Maximized log-likelihood   AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion   HQC = Hannan-Quinn Criterion

Unit root tests for variable DLGDPF

The Dickey-Fuller regressions include an intercept and a linear trend

167 observations used in the estimation of all ADF regressions.
Sample period from 1963Q3 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-20.2450	447.4427	444.4427	439.7657	442.5444
ADF(1)	-11.8592	447.9931	443.9931	437.7571	441.4621
ADF(2)	-16.4293	480.0190	475.0190	467.2240	471.8551
ADF(3)	-3.3546	564.6768	558.6768	549.3228	554.8802
ADF(4)	-5.1243	581.9050	574.9050	563.9920	570.4756
ADF(5)	-6.0920	587.1411	579.1411	566.6691	574.0790
ADF(6)	-5.9456	587.7290	578.7290	564.6981	573.0342
ADF(7)	-4.0754	593.8588	583.8588	568.2688	577.5311
ADF(8)	-4.0189	593.9899	582.9899	565.8409	576.0295
ADF(9)	-4.1464	594.5732	582.5732	563.8653	574.9801
ADF(10)	-3.9302	594.5737	581.5737	561.3067	573.3478

ADF(11)	-3.0228	598.2411	584.2411	562.4152	575.3825
ADF(12)	-3.4730	600.6362	585.6362	562.2512	576.1447

95% critical value for the augmented Dickey-Fuller statistic = -3.4374
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LGEVMASD2
The Dickey-Fuller regressions include an intercept but not a trend

165 observations used in the estimation of all ADF regressions.
Sample period from 1964Q4 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-5.8441	-283.4750	-285.4750	-288.5810	-286.7358
ADF(1)	-5.2814	-283.4671	-286.4671	-291.1260	-288.3583
ADF(2)	-3.8003	-277.9648	-281.9648	-288.1767	-284.4864
ADF(3)	-3.4877	-277.8088	-282.8088	-290.5736	-285.9608
ADF(4)	-3.0259	-276.7186	-282.7186	-292.0364	-286.5010
ADF(5)	-2.8342	-276.5664	-283.5664	-294.4373	-287.9793
ADF(6)	-2.5860	-276.0527	-284.0527	-296.4765	-289.0960
ADF(7)	-2.5950	-276.0002	-285.0002	-298.9769	-290.6738
ADF(8)	-2.5443	-275.9995	-285.9995	-301.5292	-292.3036
ADF(9)	-2.5884	-275.8575	-286.8575	-303.9402	-293.7919
ADF(10)	-2.4575	-275.7250	-287.7250	-306.3607	-295.2899
ADF(11)	-2.3844	-275.7041	-288.7041	-308.8927	-296.8994
ADF(12)	-2.5932	-274.5220	-288.5220	-310.2636	-297.3477

95% critical value for the augmented Dickey-Fuller statistic = -2.8790
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Volatility Variable 1, Moving averages standard deviation of the REER:

Unit root tests for variable LGEVMASD2
The Dickey-Fuller regressions include an intercept and a linear trend

165 observations used in the estimation of all ADF regressions.
Sample period from 1964Q4 to 2005Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-6.1920	-281.5734	-284.5734	-289.2323	-286.4646
ADF(1)	-5.6559	-281.5459	-285.5459	-291.7578	-288.0676
ADF(2)	-4.0562	-276.9049	-281.9049	-289.6698	-285.0569
ADF(3)	-3.7392	-276.8341	-282.8341	-292.1520	-286.6166
ADF(4)	-3.2346	-275.9785	-282.9785	-293.8493	-287.3913
ADF(5)	-3.0296	-275.8968	-283.8968	-296.3206	-288.9400
ADF(6)	-2.7499	-275.5080	-284.5080	-298.4847	-290.1816
ADF(7)	-2.7753	-275.4039	-285.4039	-300.9336	-291.7079
ADF(8)	-2.7269	-275.3990	-286.3990	-303.4817	-293.3335
ADF(9)	-2.7968	-275.1720	-287.1720	-305.8077	-294.7369
ADF(10)	-2.6512	-275.1003	-288.1003	-308.2889	-296.2956
ADF(11)	-2.5751	-275.0971	-289.0971	-310.8387	-297.9228
ADF(12)	-2.8482	-273.6843	-288.6843	-311.9789	-298.1404

95% critical value for the augmented Dickey-Fuller statistic = -3.4377
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Volatility variable 2, GARCH estimation:

Unit root tests for variable LHEV03

The Dickey-Fuller regressions include an intercept but not a trend

162 observations used in the estimation of all ADF regressions.
Sample period from 1964Q4 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-9.7884	-59.3052	-61.3052	-64.3928	-62.5588
ADF(1)	-6.2015	-55.5077	-58.5077	-63.1391	-60.3881
ADF(2)	-4.0522	-47.6136	-51.6136	-57.7888	-54.1208
ADF(3)	-3.4611	-46.7046	-51.7046	-59.4236	-54.8387
ADF(4)	-3.1315	-46.3907	-52.3907	-61.6535	-56.1515
ADF(5)	-2.5569	-44.0873	-51.0873	-61.8939	-55.4749
ADF(6)	-2.6624	-43.7538	-51.7538	-64.1042	-56.7683
ADF(7)	-2.3971	-43.2124	-52.2124	-66.1066	-57.8536
ADF(8)	-2.1650	-42.6775	-52.6775	-68.1155	-58.9455
ADF(9)	-2.4868	-40.6051	-51.6051	-68.5868	-58.4999
ADF(10)	-2.6473	-40.0563	-52.0563	-70.5819	-59.5780
ADF(11)	-2.5674	-40.0561	-53.0561	-73.1255	-61.2046
ADF(12)	-2.3292	-39.6791	-53.6791	-75.2923	-62.4544

95% critical value for the augmented Dickey-Fuller statistic = -2.8793
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Unit root tests for variable LHEV03

The Dickey-Fuller regressions include an intercept and a linear trend

162 observations used in the estimation of all ADF regressions.
Sample period from 1964Q4 to 2005Q1

	Test Statistic	LL	AIC	SBC	HQC
DF	-10.0130	-57.7114	-60.7114	-65.3428	-62.5918
ADF(1)	-6.3886	-54.4410	-58.4410	-64.6162	-60.9482
ADF(2)	-4.1875	-47.0456	-52.0456	-59.7646	-55.1797
ADF(3)	-3.5855	-46.2463	-52.2463	-61.5091	-56.0072
ADF(4)	-3.2496	-45.9902	-52.9902	-63.7967	-57.3778
ADF(5)	-2.6580	-43.8004	-51.8004	-64.1508	-56.8149
ADF(6)	-2.7726	-43.4280	-52.4280	-66.3222	-58.0693
ADF(7)	-2.4977	-42.9405	-52.9405	-68.3785	-59.2086
ADF(8)	-2.2579	-42.4478	-53.4478	-70.4296	-60.3427
ADF(9)	-2.6051	-40.2720	-52.2720	-70.7976	-59.7936
ADF(10)	-2.7693	-39.6894	-52.6894	-72.7588	-60.8379
ADF(11)	-2.6924	-39.6893	-53.6893	-75.3024	-62.4645
ADF(12)	-2.4531	-39.3452	-54.3452	-77.5021	-63.7473

95% critical value for the augmented Dickey-Fuller statistic = -3.4382
LL = Maximized log-likelihood AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

Appendix 3

Model 1

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

168 observations from 1963Q2 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) LGEVMASD2(-4)
RUBICON SANCT
List of eigenvalues in descending order:
.15146 .12378 .014583 .0032937

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r = 1	27.5913	23.9200	21.5800
r<= 1	r = 2	22.1988	17.6800	15.5700
r<= 2	r = 3	2.4679	11.0300	9.2800
r<= 3	r = 4	.55425	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

168 observations from 1963Q2 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) LGEVMASD2(-4)
RUBICON SANCT
List of eigenvalues in descending order:
.15146 .12378 .014583 .0032937

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	52.8122	39.8100	36.6900
r<= 1	r>= 2	25.2210	24.0500	21.4600
r<= 2	r>= 3	3.0222	12.3600	10.2500
r<= 3	r = 4	.55425	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

Cointegration with no intercepts or trends in the VAR
Choice of the Number of Cointegrating Relations Using Model Selection Criteria

168 observations from 1963Q2 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) LGEVMASD2(-4)
RUBICON SANCT
List of eigenvalues in descending order:
.15146 .12378 .014583 .0032937

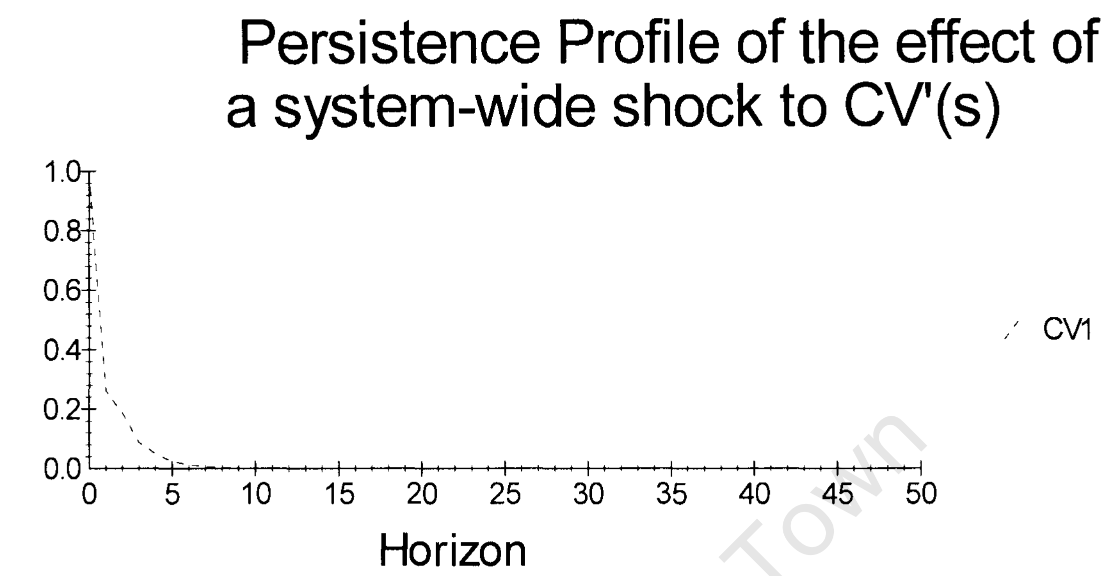
Rank	Maximized LL	AIC	SBC	HQC
r = 0	1489.7	1445.7	1376.9	1417.8
r = 1	1503.5	1452.5	1372.8	1420.1
r = 2	1514.6	1458.6	1371.1	1423.1
r = 3	1515.8	1456.8	1364.6	1419.4
r = 4	1516.1	1456.1	1362.4	1418.0

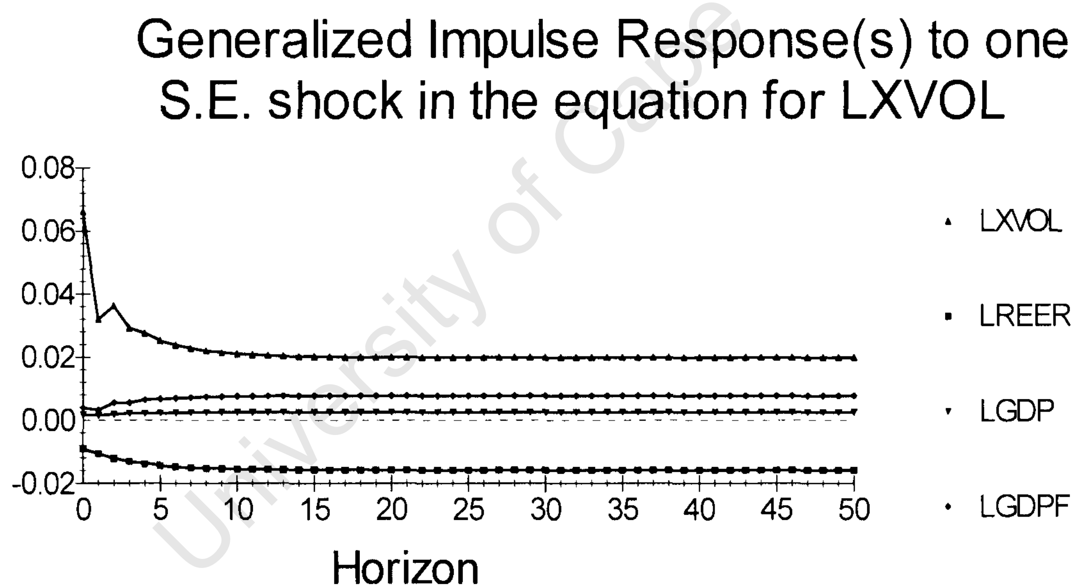
AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

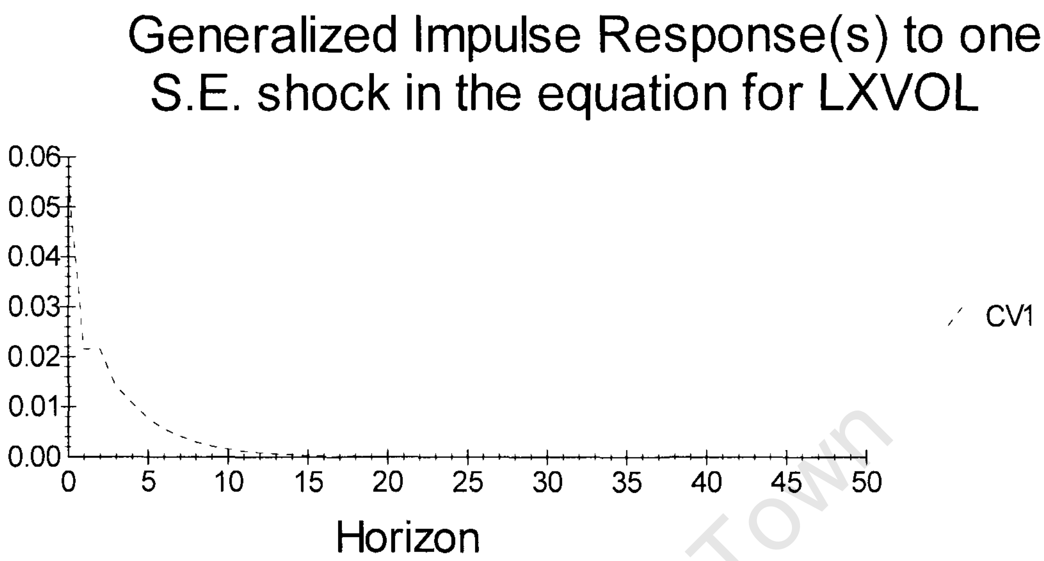
```
         ML estimates subject to exactly identifying restriction(s)
     Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                     Converged after 2 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 168 observations from 1963Q2 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL          LREER           LGDP            LGDPF
 List of I(0) variables included in the VAR:
 LGEVMASD2      LGEVMASD2(-1)   LGEVMASD2(-2)   LGEVMASD2(-3)   LGEVMASD2(-4)
 RUBICON        SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
    a1=1
*******************************************************************************
                 Vector  1
 LXVOL              1.0000
                 (   *NONE*)

 LREER              .60311
                 (   .27690)

 LGDP             -.055675
                 (   .19462)

 LGDPF             -1.4171
                 (   .30065)

*******************************************************************************
 LL subject to exactly identifying restrictions=    1503.5
*******************************************************************************


           ML estimates subject to over identifying restriction(s)
     Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                     Converged after 2 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 168 observations from 1963Q2 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL          LREER           LGDP            LGDPF
 List of I(0) variables included in the VAR:
 LGEVMASD2      LGEVMASD2(-1)   LGEVMASD2(-2)   LGEVMASD2(-3)   LGEVMASD2(-4)
 RUBICON        SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
    a1=1  ; a3=0
*******************************************************************************
                 Vector  1
 LXVOL              1.0000
                 (   *NONE*)

 LREER              .52490
                 (  .044624)

 LGDP                 0.00
                 (   *NONE*)

 LGDPF             -1.5025
                 (  .036633)

*******************************************************************************
 LR Test of Restrictions          CHSQ( 1)=  .079546[.778]
 DF=Total no of restrictions(2) - no of just-identifying restrictions(1)
 LL subject to exactly identifying restrictions=    1503.5
 LL subject to over-identifying restrictions=   1503.4
*******************************************************************************
```

ECM for variable LXVOL estimated by OLS based on cointegrating VAR(2)

```
*******************************************************************************
 Dependent variable is dLXVOL
 168 observations used for estimation from 1963Q2 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 dLXVOL1                  -.28392            .080212             -3.5396[.001]
 dLREER1                   .10380            .11902               .87212[.384]
 dLGDP1                   -.19577            .48203              -.40614[.685]
 dLGDPF1                 -.098956            .27156              -.36440[.716]
 ecm1(-1)                 -.24812            .068414             -3.6267[.000]
 LGEVMASD2               -.011397            .0038695            -2.9453[.004]
 LGEVMASD2(-1)           .0096272            .0046205             2.0836[.039]
 LGEVMASD2(-2)          -.0099001            .0046043            -2.1502[.033]
 LGEVMASD2(-3)           .0028958            .0047303             .61218[.541]
 LGEVMASD2(-4)           .0027240            .0038451             .70845[.480]
 RUBICON                  .012683            .034863              .36381[.716]
 SANCT                   -.061337            .020971             -2.9249[.004]
*******************************************************************************
 List of additional temporary variables created:
 dLXVOL = LXVOL-LXVOL(-1)
 dLXVOL1 = LXVOL(-1)-LXVOL(-2)
 dLREER1 = LREER(-1)-LREER(-2)
 dLGDP1 = LGDP(-1)-LGDP(-2)
 dLGDPF1 = LGDPF(-1)-LGDPF(-2)
 ecm1 =    1.0000*LXVOL +   .52490*LREER     0.00*LGDP   -1.5025*LGDPF
*******************************************************************************
 R-Squared                      .27934   R-Bar-Squared                 .22853
 S.E. of Regression             .065457  F-stat.    F( 11, 156)   5.4972[.000]
 Mean of Dependent Variable     .012173  S.D. of Dependent Variable    .074524
 Residual Sum of Squares        .66841   Equation Log-likelihood      225.8716
 Akaike Info. Criterion       213.8716   Schwarz Bayesian Criterion   195.1278
 DW-statistic                   2.0376   System Log-likelihood          1503.4
*******************************************************************************


                          Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   4)=   5.2745[.260]*F(   4, 152)=   1.2317[.300]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   .19440[.659]*F(   1, 155)=   .17957[.672]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   2.7217[.256]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=  .026832[.870]*F(   1, 166)=  .026517[.871]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```


Persistence Profile of the effect of a system-wide shock to CV'(s)
CV1
Horizon


Generalized Impulse Response(s) to one S.E. shock in the equation for LXVOL
LXVOL
LREER
LGDP
LGDPF
Horizon


Generalized Impulse Response(s) to one S.E. shock in the equation for LXVOL
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
5
10
15
20
25
30
35
40
45
50
Horizon
CV1

Model 2

```
            Cointegration with no intercepts or trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 167 observations from 1963Q3 to 2005Q1. Order of VAR = 2.
 List of variables included in the cointegrating vector:
 LXVOL          LREER          LGDP           LGDPF
 List of I(0) variables included in the VAR:
 LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     LHEV03(-4)
 LHEV03(-5)     LHEV03(-6)     LHEV03(-7)     LHEV03(-8)     RUBICON
 SANCT
 List of eigenvalues in descending order:
.16380     .11867     .065322    .1848E-4
*******************************************************************************
```

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r = 1	29.8752	23.9200	21.5800
r<= 1	r = 2	21.0953	17.6800	15.5700
r<= 2	r = 3	11.2813	11.0300	9.2800
r<= 3	r = 4	.0030859	4.1600	3.0400

```
*******************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).
```

```
            Cointegration with no intercepts or trends in the VAR
         Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 167 observations from 1963Q3 to 2005Q1. Order of VAR = 2.
 List of variables included in the cointegrating vector:
 LXVOL          LREER          LGDP           LGDPF
 List of I(0) variables included in the VAR:
 LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     LHEV03(-4)
 LHEV03(-5)     LHEV03(-6)     LHEV03(-7)     LHEV03(-8)     RUBICON
 SANCT
 List of eigenvalues in descending order:
.16380     .11867     .065322    .1848E-4
*******************************************************************************
```

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	62.2549	39.8100	36.6900
r<= 1	r>= 2	32.3797	24.0500	21.4600
r<= 2	r>= 3	11.2844	12.3600	10.2500
r<= 3	r = 4	.0030859	4.1600	3.0400

```
*******************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).
```

```
ML estimates subject to exactly identifying restriction(s)
     Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                      Converged after 2 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
167 observations from 1963Q3 to 2005Q1. Order of VAR = 2, chosen r =1.
List of variables included in the cointegrating vector:
LXVOL          LREER          LGDP           LGDPF
List of I(0) variables included in the VAR:
LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     LHEV03(-4)
LHEV03(-5)     LHEV03(-6)     LHEV03(-7)     LHEV03(-8)     RUBICON
SANCT
*******************************************************************************
List of imposed restriction(s) on cointegrating vectors:
   a1=1
*******************************************************************************
                  Vector  1
LXVOL                 1.0000
                  (   *NONE*)

LREER                 .48253
                  (   .21749)

LGDP                 .018561
                  (   .15548)

LGDPF                -1.5416
                  (   .24519)

*******************************************************************************
LL subject to exactly identifying restrictions=    1498.4
*******************************************************************************


          ML estimates subject to over identifying restriction(s)
     Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                      Converged after 2 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
167 observations from 1963Q3 to 2005Q1. Order of VAR = 2, chosen r =1.
List of variables included in the cointegrating vector:
LXVOL          LREER          LGDP           LGDPF
List of I(0) variables included in the VAR:
LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     LHEV03(-4)
LHEV03(-5)     LHEV03(-6)     LHEV03(-7)     LHEV03(-8)     RUBICON
SANCT
*******************************************************************************
List of imposed restriction(s) on cointegrating vectors:
   a1=1   ; a3=0
*******************************************************************************
                  Vector  1
LXVOL                 1.0000
                  (   *NONE*)

LREER                 .50812
                  (  .036594)

LGDP                    0.00
                  (   *NONE*)

LGDPF                -1.5128
                  (  .039585)

*******************************************************************************
LR Test of Restrictions          CHSQ( 1)=  .014517[.904]
DF=Total no of restrictions(2) - no of just-identifying restrictions(1)
LL subject to exactly identifying restrictions=    1498.4
LL subject to over-identifying restrictions=   1498.3
*******************************************************************************
```

ECM for variable LXVOL estimated by OLS based on cointegrating VAR(2)

Dependent variable is dLXVOL
167 observations used for estimation from 1963Q3 to 2005Q1

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLXVOL1	-.27723	.080256	-3.4543[.001]
dLREER1	.16336	.11887	1.3743[.171]
dLGDP1	-.020926	.48871	-.042819[.966]
dLGDPF1	.18779	.28364	.66208[.509]
ecm1(-1)	-.23516	.067374	-3.4903[.001]
LHEV03	-.037686	.016719	-2.2541[.026]
LHEV03(-1)	-.010357	.017091	-.60598[.545]
LHEV03(-2)	.015306	.016765	.91295[.363]
LHEV03(-3)	-.0084497	.016992	-.49726[.620]
LHEV03(-4)	.0011597	.016817	.068959[.945]
LHEV03(-5)	.012407	.016754	.74056[.460]
LHEV03(-6)	-.0023652	.016813	-.14068[.888]
LHEV03(-7)	.044446	.016614	2.6752[.008]
LHEV03(-8)	-.5130E-3	.017012	-.030154[.976]
RUBICON	.016036	.037407	.42868[.669]
SANCT	-.060335	.021620	-2.7907[.006]

List of additional temporary variables created:
dLXVOL = LXVOL-LXVOL(-1)
dLXVOL1 = LXVOL(-1)-LXVOL(-2)
dLREER1 = LREER(-1)-LREER(-2)
dLGDP1 = LGDP(-1)-LGDP(-2)
dLGDPF1 = LGDPF(-1)-LGDPF(-2)
ecm1 = 1.0000*LXVOL + .50812*LREER 0.00*LGDP -1.5128*LGDPF

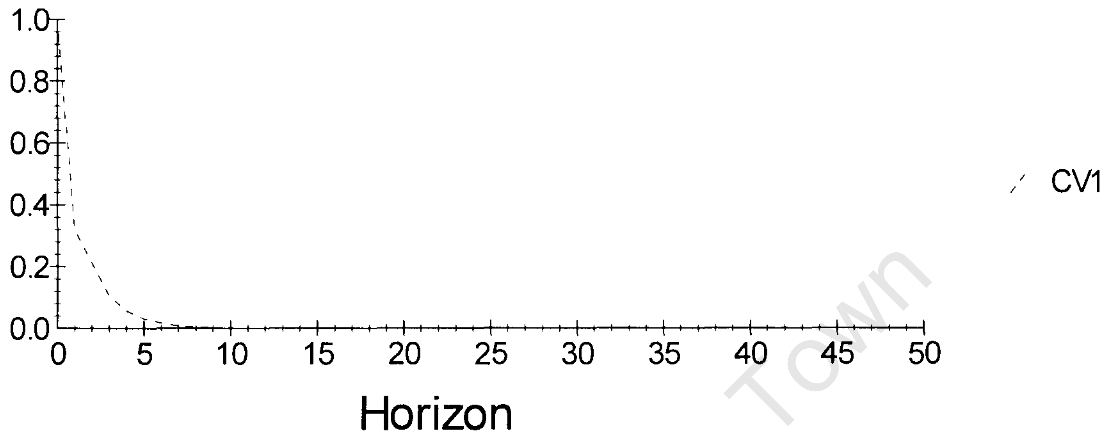
R-Squared	.28226	R-Bar-Squared	.21096
S.E. of Regression	.066313	F-stat. F(15, 151)	3.9588[.000]
Mean of Dependent Variable	.011882	S.D. of Dependent Variable	.074653
Residual Sum of Squares	.66400	Equation Log-likelihood	224.5803
Akaike Info. Criterion	208.5803	Schwarz Bayesian Criterion	183.6363
DW-statistic	2.0741	System Log-likelihood	1498.3

Diagnostic Tests

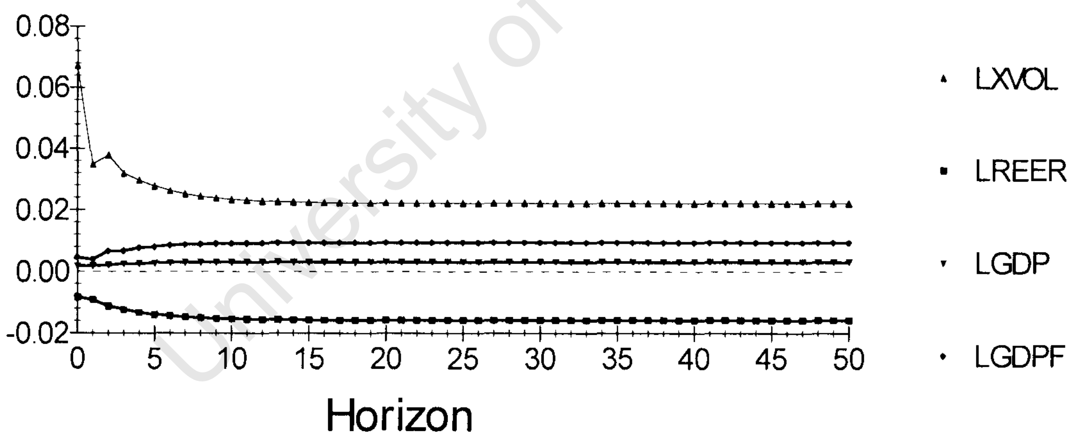
Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 8.5077[.075]	F(4, 147)= 1.9727[.102]
B:Functional Form	CHSQ(1)= .027986[.867]	F(1, 150)= .025141[.874]
C:Normality	CHSQ(2)= 6.4055[.041]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .21648[.642]	F(1, 165)= .21416[.644]

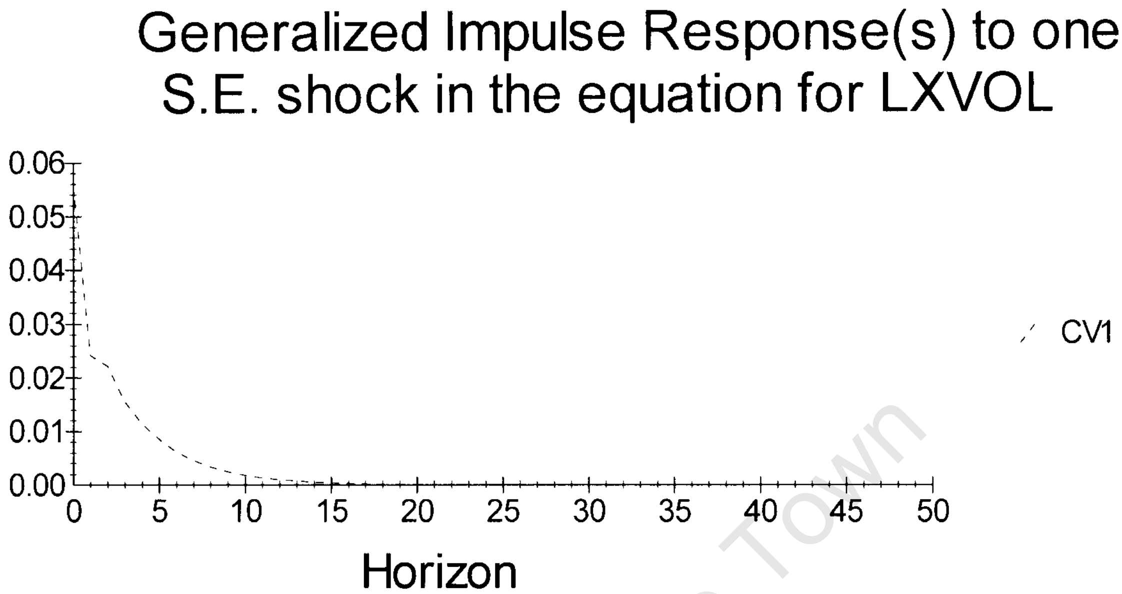
A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Persistence Profile of the effect of a system-wide shock to CV'(s)



Generalized Impulse Response(s) to one S.E. shock in the equation for LXVOL




Generalized Impulse Response(s) to one
S.E. shock in the equation for LXVOL
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
5
10
15
20
25
30
35
40
45
50
Horizon
CV1

Appendix 4

Model 3

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) RUBICON
SANCT
List of eigenvalues in descending order:
.16213 .11560 .029063 .0077977

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r = 1	24.2342	23.9200	21.5800
r<= 1	r = 2	16.8294	17.6800	15.5700
r<= 2	r = 3	4.0407	11.0300	9.2800
r<= 3	r = 4	1.0725	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) RUBICON
SANCT
List of eigenvalues in descending order:
.16213 .11560 .029063 .0077977

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	46.1768	39.8100	36.6900
r<= 1	r>= 2	21.9425	24.0500	21.4600
r<= 2	r>= 3	5.1131	12.3600	10.2500
r<= 3	r = 4	1.0725	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

Cointegration with no intercepts or trends in the VAR
Choice of the Number of Cointegrating Relations Using Model Selection Criteria

137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LGEVMASD2 LGEVMASD2(-1) LGEVMASD2(-2) LGEVMASD2(-3) RUBICON
SANCT
List of eigenvalues in descending order:
.16213 .11560 .029063 .0077977

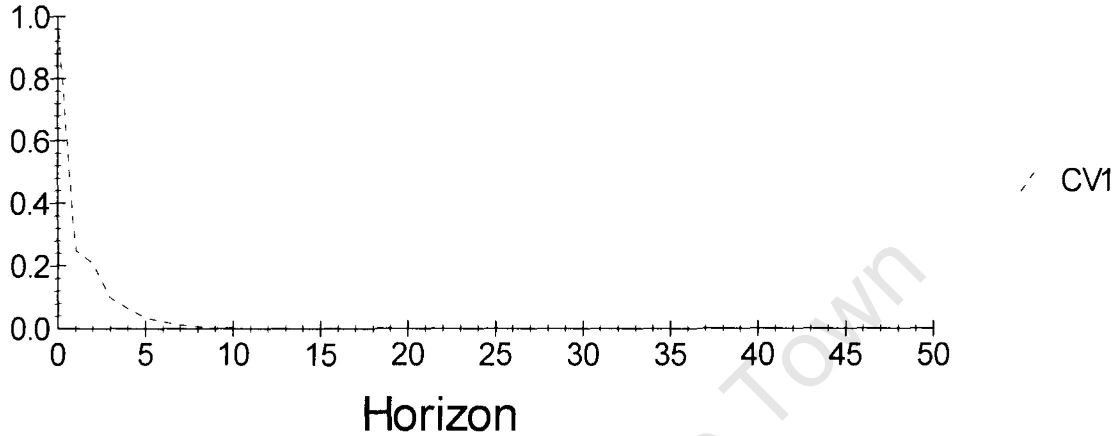
Rank	Maximized LL	AIC	SBC	HQC
r = 0	1268.0	1228.0	1169.6	1204.3
r = 1	1280.1	1233.1	1164.5	1205.2
r = 2	1288.5	1236.5	1160.6	1205.7
r = 3	1290.6	1235.6	1155.3	1202.9
r = 4	1291.1	1235.1	1153.3	1201.9

AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion
HQC = Hannan-Quinn Criterion

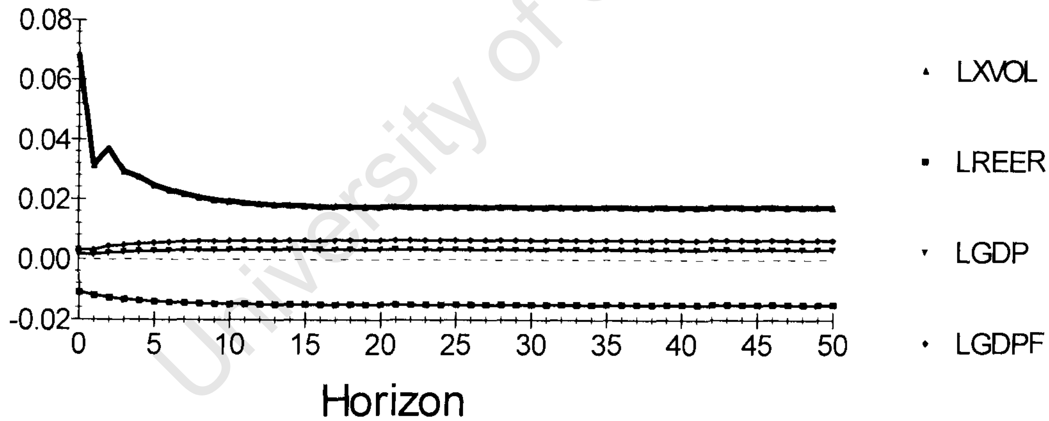
```
        ML estimates subject to exactly identifying restriction(s)
    Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                     Converged after 2 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 137 observations from 1971Q1 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL          LREER           LGDP            LGDPF
 List of I(0) variables included in the VAR:
 LGEVMASD2      LGEVMASD2(-1)   LGEVMASD2(-2)   LGEVMASD2(-3)   RUBICON
 SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
      a1=1
*******************************************************************************
                 Vector  1
 LXVOL               1.0000
                 (    *NONE*)

 LREER                .66882
                 (    .23795)

 LGDP               -.098351
                 (    .16367)

 LGDPF               -1.3186
                 (    .25522)

*******************************************************************************
 LL subject to exactly identifying restrictions=    1280.1
*******************************************************************************


          ML estimates subject to over identifying restriction(s)
    Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                     Converged after 14 iterations
           Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 137 observations from 1971Q1 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL          LREER           LGDP            LGDPF
 List of I(0) variables included in the VAR:
 LGEVMASD2      LGEVMASD2(-1)   LGEVMASD2(-2)   LGEVMASD2(-3)   RUBICON
 SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
      a1=1          ; a3=0
*******************************************************************************
                 Vector  1
 LXVOL               1.0000
                 (    *NONE*)

 LREER                .53015
                 (   .047027)

 LGDP                   0.00
                 (    *NONE*)

 LGDPF               -1.4703
                 (   .040017)

*******************************************************************************
 LR Test of Restrictions          CHSQ( 1)=    .34411[.557]
 DF=Total no of restrictions(2) - no of just-identifying restrictions(1)
 LL subject to exactly identifying restrictions=    1280.1
 LL subject to over-identifying restrictions=   1280.0
*******************************************************************************
```

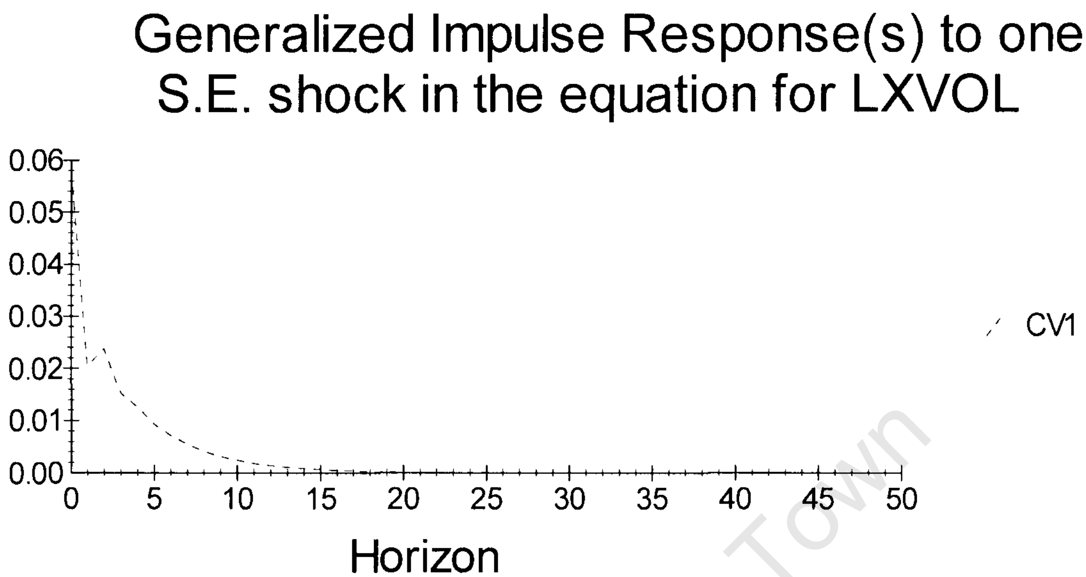
```
ECM for variable LXVOL estimated by OLS based on cointegrating VAR(2)
*******************************************************************************
 Dependent variable is dLXVOL
 137 observations used for estimation from 1971Q1 to 2005Q1
*******************************************************************************
 Regressor              Coefficient        Standard Error         T-Ratio[Prob]
 dLXVOL1                   -.30836             .087058            -3.5420[.001]
 dLREER1                    .12051              .12544             .96073[.339]
 dLGDP1                     .23248              .62450             .37227[.710]
 dLGDPF1                    .27305              .46129             .59192[.555]
 ecm1(-1)                  -.27313             .075073            -3.6382[.000]
 LGEVMASD2                -.013897            .0042082            -3.3024[.001]
 LGEVMASD2(-1)             .011118            .0050234             2.2132[.029]
 LGEVMASD2(-2)            -.010028            .0050912            -1.9697[.051]
 LGEVMASD2(-3)            .0017269            .0041526             .41587[.678]
 RUBICON                   .024653             .035582             .69287[.490]
 SANCT                    -.063583             .022442            -2.8332[.005]
*******************************************************************************
 List of additional temporary variables created:
 dLXVOL = LXVOL-LXVOL(-1)
 dLXVOL1 = LXVOL(-1)-LXVOL(-2)
 dLREER1 = LREER(-1)-LREER(-2)
 dLGDP1 = LGDP(-1)-LGDP(-2)
 dLGDPF1 = LGDPF(-1)-LGDPF(-2)
 ecm1 =    1.0000*LXVOL +   .53015*LREER      0.00*LGDP    -1.4703*LGDPF
*******************************************************************************
 R-Squared                       .30942   R-Bar-Squared                    .25462
 S.E. of Regression             .067256   F-stat.    F( 10, 126)    5.6456[.000]
 Mean of Dependent Variable     .012104   S.D. of Dependent Variable      .077901
 Residual Sum of Squares         .56995   Equation Log-likelihood        181.1352
 Akaike Info. Criterion        170.1352   Schwarz Bayesian Criterion     154.0753
 DW-statistic                    2.0955   System Log-likelihood            1280.0
*******************************************************************************


                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *         LM Version        *          F Version         *
*******************************************************************************
*                     *                           *                            *
* A:Serial Correlation*CHSQ(   4)=   8.2207[.084]*F(    4, 122)=    1.9470[.107]*
*                     *                           *                            *
* B:Functional Form   *CHSQ(   1)=   .87219[.350]*F(    1, 125)=    .80089[.373]*
*                     *                           *                            *
* C:Normality         *CHSQ(   2)=   3.1052[.212]*       Not applicable        *
*                     *                           *                            *
* D:Heteroscedasticity*CHSQ(   1)= .0017164[.967]*F(    1, 135)= .0016913[.967]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Persistence Profile of the effect of a system-wide shock to CV'(s)



Generalized Impulse Response(s) to one S.E. shock in the equation for LXVOL





Model 4

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LHEV03 LHEV03(-1) LHEV03(-2) LHEV03(-3) RUBICON
SANCT
List of eigenvalues in descending order:
.16767 .095638 .020462 .0042535

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r = 1	25.1431	23.9200	21.5800
r<= 1	r = 2	13.7719	17.6800	15.5700
r<= 2	r = 3	2.8324	11.0300	9.2800
r<= 3	r = 4	.58397	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
List of variables included in the cointegrating vector:
LXVOL LREER LGDP LGDPF
List of I(0) variables included in the VAR:
LHEV03 LHEV03(-1) LHEV03(-2) LHEV03(-3) RUBICON
SANCT
List of eigenvalues in descending order:
.16767 .095638 .020462 .0042535

Null	Alternative	Statistic	95% Critical Value	90%Critical Value
r = 0	r>= 1	42.3315	39.8100	36.6900
r<= 1	r>= 2	17.1883	24.0500	21.4600
r<= 2	r>= 3	3.4164	12.3600	10.2500
r<= 3	r = 4	.58397	4.1600	3.0400

Use the above table to determine r (the number of cointegratingvectors).

```
             Cointegration with no intercepts or trends in the VAR
Choice of the Number of Cointegrating Relations Using Model Selection Criteria
*******************************************************************************
 137 observations from 1971Q1 to 2005Q1. Order of VAR = 2.
 List of variables included in the cointegrating vector:
 LXVOL          LREER          LGDP           LGDPF
 List of I(0) variables included in the VAR:
 LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     RUBICON
 SANCT
 List of eigenvalues in descending order:
.16767    .095638    .020462   .0042535
*******************************************************************************
 Rank     Maximized LL        AIC             SBC             HQC
 r = 0        1270.8         1230.8          1172.4          1207.1
 r = 1        1283.4         1236.4          1167.7          1208.5
 r = 2        1290.2         1238.2          1162.3          1207.4
 r = 3        1291.7         1236.7          1156.4          1204.0
 r = 4        1292.0         1236.0          1154.2          1202.7
*******************************************************************************
 AIC = Akaike Information Criterion    SBC = Schwarz Bayesian Criterion
 HQC = Hannan-Quinn Criterion

          ML estimates subject to exactly identifying restriction(s)
      Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                       Converged after 2 iterations
             Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 137 observations from 1971Q1 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL          LREER          LGDP           LGDPF
 List of I(0) variables included in the VAR:
 LHEV03         LHEV03(-1)     LHEV03(-2)     LHEV03(-3)     RUBICON
 SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
 a1=1
*******************************************************************************
                 Vector  1
 LXVOL               1.0000
                 (   *NONE*)

 LREER               .66845
                 (   .19141)

 LGDP               -.14516
                 (   .13324)

 LGDPF              -1.2535
                 (   .20928)

*******************************************************************************
 LL subject to exactly identifying restrictions=    1283.4
*******************************************************************************
```

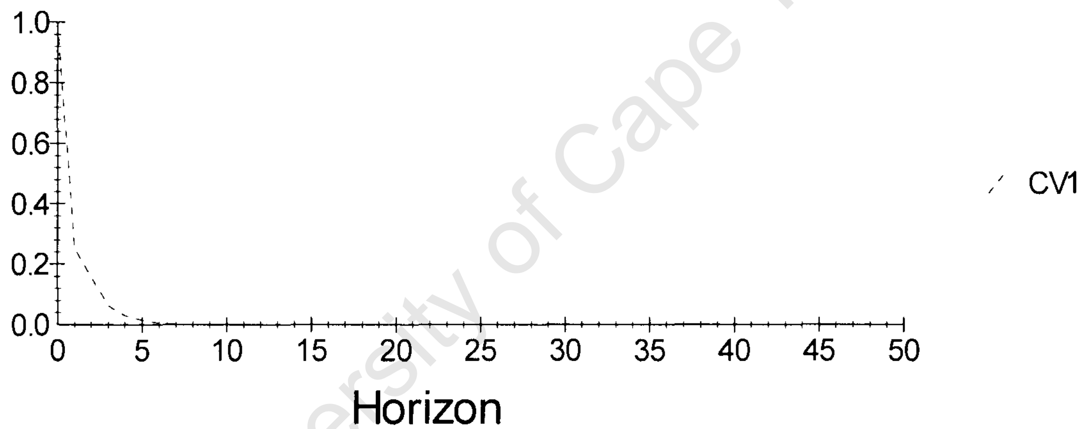
```
            ML estimates subject to over identifying restriction(s)
     Estimates of Restricted Cointegrating Relations (SE's in Brackets)
                      Converged after 14 iterations
            Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 137 observations from 1971Q1 to 2005Q1. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LXVOL           LREER           LGDP            LGDPF
 List of I(0) variables included in the VAR:
 LHEV03          LHEV03(-1)      LHEV03(-2)      LHEV03(-3)      RUBICON
 SANCT
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
 a3=0; a1=1
*******************************************************************************
                  Vector  1
 LXVOL               1.0000
                  (    *NONE*)

 LREER               .46298
                  (  .033609)

 LGDP               -.0000
                  (    *NONE*)

 LGDPF             -1.4792
                  (  .036083)

*******************************************************************************
 LR Test of Restrictions          CHSQ( 1)=    1.2415[.265]
 DF=Total no of restrictions(2) - no of just-identifying restrictions(1)
 LL subject to exactly identifying restrictions=    1283.4
 LL subject to over-identifying restrictions=    1282.7
*******************************************************************************

    ECM for variable LXVOL estimated by OLS based on cointegrating VAR(2)
*******************************************************************************
 Dependent variable is dLXVOL
 137 observations used for estimation from 1971Q1 to 2005Q1
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 dLXVOL1                   -.23670            .090750            -2.6083[.010]
 dLREER1                    .17272             .12297             1.4046[.163]
 dLGDP1                    -.13201             .64783            -.20378[.839]
 dLGDPF1                    .19243             .47879             .40192[.688]
 ecm1(-1)                  -.35255            .084108            -4.1917[.000]
 LHEV03                   -.038490            .016114            -2.3887[.018]
 LHEV03(-1)              -.5948E-3            .015942           -.037311[.970]
 LHEV03(-2)                .020970            .015658             1.3392[.183]
 LHEV03(-3)              -.0039098            .016447            -.23772[.812]
 RUBICON                  .0061776            .038736             .15948[.874]
 SANCT                    -.067533            .022443            -3.0091[.003]
*******************************************************************************
 List of additional temporary variables created:
 dLXVOL = LXVOL-LXVOL(-1)
 dLXVOL1 = LXVOL(-1)-LXVOL(-2)
 dLREER1 = LREER(-1)-LREER(-2)
 dLGDP1 = LGDP(-1)-LGDP(-2)
 dLGDPF1 = LGDPF(-1)-LGDPF(-2)
 ecm1 =    1.0000*LXVOL +   .46298*LREER     -.0000*LGDP    -1.4792*LGDPF
*******************************************************************************
 R-Squared                      .30034   R-Bar-Squared                   .24482
 S.E. of Regression            .067697   F-stat.    F( 10, 126)    5.4089[.000]
 Mean of Dependent Variable    .012104   S.D. of Dependent Variable     .077901
 Residual Sum of Squares        .57744   Equation Log-likelihood       180.2406
 Akaike Info. Criterion       169.2406   Schwarz Bayesian Criterion    153.1807
 DW-statistic                   2.0662   System Log-likelihood           1282.7
*******************************************************************************
```

Diagnostic Tests

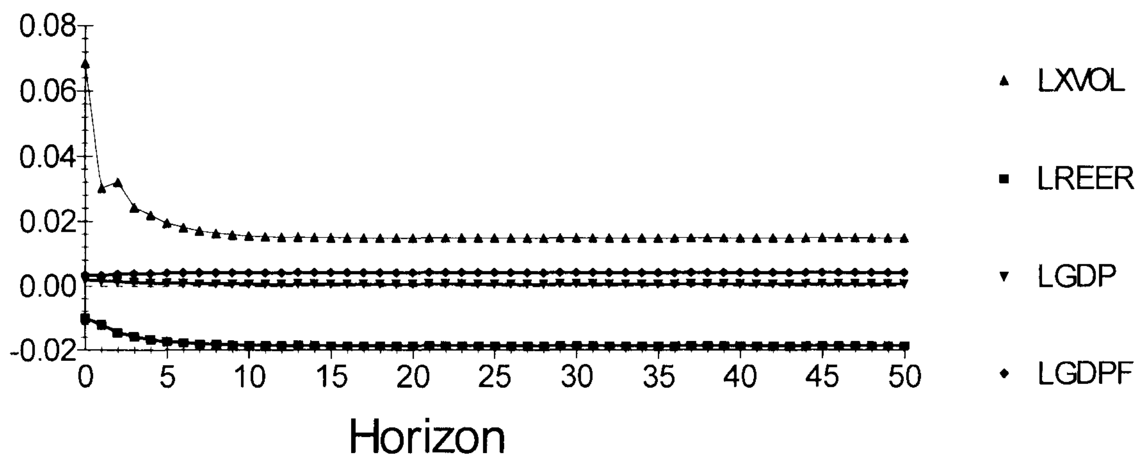
Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 5.9824[.200]	F(4, 122)= 1.3927[.240]
B:Functional Form	CHSQ(1)= .031499[.859]	F(1, 125)= .028747[.866]
C:Normality	CHSQ(2)= 5.3305[.070]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .064469[.800]	F(1, 135)= .063558[.801]

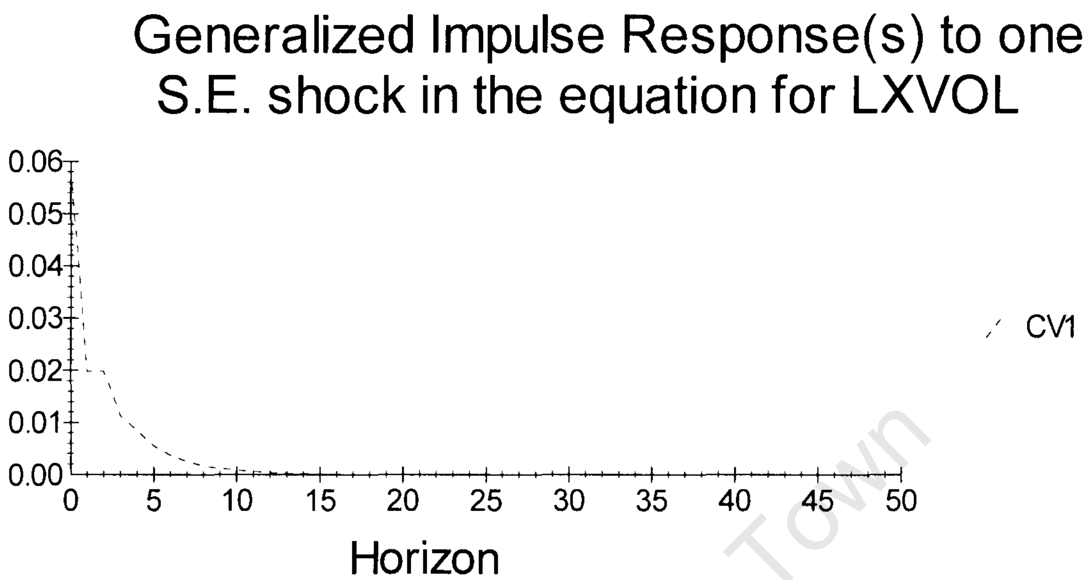
A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Persistence Profile of the effect of a system-wide shock to CV'(s)



Generalized Impulse Response(s) to one S.E. shock in the equation for LXVOL




Generalized Impulse Response(s) to one
S.E. shock in the equation for LXVOL
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
5
10
15
20
25
30
35
40
45
50
Horizon
CV1