Studies in Economics and International Finance
ISSN: 2583-1526
Vol. 2, No. 2, 2022, pp. 179-193

https://DOI:10.47509/SEIF.2022.v02i02.03

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

ANALYSIS OF THE J-CURVE HYPOTHESIS IN UGANDA

Mukisa Ibrahim[1] & Allan Kayongo[2]

[1]*Department of Economic Theory & Analysis, School of Economics, Makerere University Kampala, Uganda. Corresponding author E-mail: mukisaibrahim@yahoo.com; ibrahim.mukisa@mak.ac.ug*
[2]*Strategic Planning Department National Planning Authority Kampala, Uganda. E-mail: allankayongo1@gmail.com*

ARTICLE HISTORY

Received : 10 August 2022
Revised : 13 September 2022
Accepted : 21 September 2022
Published : 27 December 2022

TO CITE THIS ARTICLE

Mukisa Ibrahim & Allan Kayongo (2022). Analysis of the J-Curve Hypothesis in Uganda *Studies in Economics & International Finance*, Vol. 2, No. 2, pp. 179-193. *https:// DOI: 10.47509/ SEIF.2022.v02i02.01*

Abstract: This paper analyses Uganda's J-curve hypothesis with the foreign world, for a period of 40 years, between 1982 and 2021, while using the ARDL methodology. 48.5 percent of Uganda's long run instability in trade balance stabilizes in the next year. There doesn't exist a J-curve effect in Uganda. Nonetheless, the paper finds that increase in Uganda's real domestic (foreign) income worsens (improves) trade balance when import (export) demand increases. Going forward, Uganda should prioritise, finance and implement favourable exchange rate policies, Export Promotion strategies and Import Replacement Action Plan (IRAP) for the prioritized commodities. This is even more critical during this COVID-19 era as the country designs and implements strategies for economic recovery from the pandemic shocks.

Keywords: J-Curve, Trade balance, ARDL, Uganda, COVID-19.

JEL Classification: F13; F14; F30

1. INTRODUCTION

Exchange rate and balance of trade inter-relationships are fundamentally of importance among policy makers and academics (Bahmani-Oskooee & Arize, 2020). There is a consensus among economists and policy makers that variations in a country's currency significantly affect its trade balance. Marshall (1923) postulated that the balance of trade of a country improves when its domestic currency depreciates. It is often assumed by default that domestic currency depreciation increases export volumes. This is because the country's exports are seemingly cheaper on the world market and so are highly demanded. However, for many countries, the trade deficit has persisted even with a depreciation in their currencies.

During the past decade, the Uganda Shilling has greatly depreciated against the US Dollar (USD). For instance, the Ugandan Shilling, in regard to the USD depreciated from Ushs. 14 in June 1986, to Ushs. 1,577 in June 2000, and Ushs. 3,729 in June, 2020. These effects were even amplified during global shocks, like the coronavirus global pandemic, in which the Ugandan Shilling depreciated by 4 percent in a period of one month, between February, 2020 and March, 2020.

Government has undertaken a number of interventions to improve its trade balance. Such interventions include among others: development and implementation of the export promotion strategy; export promotion action plan and local content provisions like the Buy Uganda Build Uganda (BUBU) Policy and Initiatives. Relatedly, foreign exchange market interventions were undertaken so as to smoothen out excess volatility arising from global financial shocks. More recently, the country led by National Planning Authority, developed the Import Replacement Action Plan, so as to help mitigate the international trade vulnerability brought about by trade and supply-chain disruptions of the global coronavirus pandemic. Indeed, Uganda has made some achievements from these interventions. For example, Uganda had a trade surplus of USD 122.78 million with Kenya in FY 2017/18; and the highest trade balance with the East Africa Community (EAC) trade bloc at USD 413.86 million during the same period. This was driven by exports like gold and gold products, fish and maize among others.

Nonetheless, Uganda's imports highly exceeded exports by; USD -366.93 million in 1994, to USD -653.53 million in 2000, to USD -3,164.39 million in 2010, and USD -4,188.37 in 2019. This is on the account of high volume and value of high import bill products like, petroleum and the associated products, iron, steel and the associated products, wheat, vehicles and machinery among others.

Therefore, it is insightful to investigate and understand, whether the Ugandan economy follows the stipulated J-curve hypothesis or if there are some other unique trade occurrences. A number of previous research studies pertaining the J-curve have been carried out in developed countries. These include among others (Alsaleh & Abdul-rahim, 2019; Bahmani-Oskooee & Nasir, 2020; Wu, 2020). The J-curve hypothesis has also been analysed in developing countries by some studies like (Bahmani-Oskooee & Arize, 2020; Bahmani-Oskoee & Gelan, 2012). Seldomly, previous J-curve studies have focused on developing and African countries.

Specifically, Uganda's J-curve hypothesis has only been previously analysed by (Mahebe, Wasswa, & Kagarura, 2020). The major criticism of their study however is that they analysed only the J-curve trade effects between Uganda and Kenya, neglecting the effects with the rest of the world. This is in addition to the East Africa regional homogeneous factors that are expected to be captured than if Uganda's trade was estimated with say another country from a different region or continent. Therefore, this paper contributes to the debate by analyzing the J-curve effects between Uganda and the rest of the world, instead of just Uganda and Kenya.

The paper analyzes the effect of Uganda's exchange rate fluctuations on its balance of trade, between 1982 and 2021. More specifically, the paper analyses whether the continuous depreciation of Uganda's Shilling has led to improvements in its trade balances. This paper uses the most recent data and an Auto-regressive Distributed Lag (ARDL) methodology, to estimate symmetric J-curve effects in Uganda.

The other sections of the paper are organised in such a way that: Literature is surveyed in section 2 and in section 3 we display the estimation techniques to be used. Section 4 elucidates the findings; while in section 5 gives the conclusion and prescribes the required policy.

2. REVIEW OF LITERATURE

2.1. Theoretical Underpinning

The orientation of most theoretical models is towards analysing how real exchange rate dynamics affect the export competitiveness of a country. A high real exchange rate leads to high surplus in net exports that a country obtains (Zhang, 2008; Andersson, 2010). This is in line with the theory of standard trade. Lerner (1944) furthered this by anchoring it on the elasticities on whatever is brought in or sold out of the country. Focus is also laid more on the value than volume of traded commodities.

Other theorists argue that the level of price elasticity of imports and that of exports, determines a country's balance of trade (Bickerdike, 1920; Chee-Wooi & Tze-Haw, 2008). This is in line with the elasticity theory. Notwithstanding, Marshall (1997) avers that depreciation of a domestic currency increases the country's trade balance. However, this can only happen on a critical assumption that the absolute sum of the price elasticity of imports and that of exports is greater than one. The model makes a number of assumptions, including; partial equilibrium in the two countries; partial equilibrium of two goods, and a foreign market that operates based on perfect competition market structure.

The monetary approach elucidates that a nation's balance of trade is affected by excess demand of money as well as the supply of money. It further assumes the Central Bank on behalf of Government controls supply of money. Lower domestic supply of money compared to domestic demand of money necessitates the need for foreign countries to fill this gap, and therefore a favorable trade balance. On the other hand, a higher domestic money supply than the domestic money demand creates an excess in terms of money supply, this leads to money outflow from the economy and so creating a decline in trade balance.

Trade balance was defined as the gap between total domestic income and expenditure, under the absorption approach (Alexander, 1952; Johnson, 1972). This approach explains that during an economy's under-employment, depreciation improves a country's trade balance whereas during an economy's full employment, it decreases trade balance. The approach is also centered on several assumptions like: fixed Government spending; net exports are increased by devaluation; export volumes are independent of the national income while imports are positively affected by national income; and the economy is viewed from the aggregate expenditure side among others.

Rose and Yellen (1989) also proposed the two imperfect substitute model where they analysed exchange rate between two countries and the corresponding short and long run trade balances. The model also makes a number of assumptions like; a positive domestic income elasticity and a positive foreign income elasticity. Additionally, exports are influenced by income in the foreign markets. This is besides the domestic price of substitutes and imported commodities.

2.2. Etmpirical Literature

The evidence of balance of trade and exchange rate inter-relationships in a number of studies is inconclusive. The mixed results could be explained by the differences in the time periods, differences in methodologies and the use of aggregate trade balance data. Aggregate trade data conceals the actual variations in the trade between countries. For example, depreciation of a local currency may either increase or lower balance of trade balance of that nation in regard to its trading partner or partners.

Noting this bias in aggregation, Rose and Yellen (1989) were the first authors to analyse USA's J-curve effects, however much that they didn't find any of such effects. Bahmani-Oskooee, Economidou, and Goswami (2006) confirmed these effects in the United Kingdom. Additionally, Yazici and Islam (2012) analysed the effects of Turkey's agriculture with 15 of the other European Union countries. The study concluded that currency depreciation in the short-run increases balance of trade. However, most studies rely more on bilateral level analysis than multi-sectoral analysis.

Not so many studies have been done on Africa. For example, the J-curve was confirmed among a spectrum of different African countries (excluding Uganda), (Bahmani-Oskooee and Arize 2020). This is also corroborated by Bahmani-Oskooee and Arize (2019), in their J-curve effects study between selected African countries and United States of America.

An asymmetric assessment of South Africa and USA's J-curve effects, confirms the existence of short and long run asymmetries in 19 and 14 industries respectively (Bahmani-Oskooee and Gelan, 2019). This finding was corroborated by Amusa and Fadiran (2019). In contrast, the J-curve wasn't confirmed by Onakoya, Johnson and Ajibola (2019) in Nigeria.

Uganda's J-curve conclusions are largely still incomprehensible. Mahebe, Wasswa and Kagarura (2020) estimated inter-relationships between the volatility of Uganda's exchange rate and its balance of trade. Existence of a J-curve was confirmed between Kenya and Uganda. The current paper contribution to literature is the extension of Mahebe, Wasswa and Kagarura (2020)'s beyond the bilateral analysis between two EAC neighbours to include trade effects with the external world.

3. ESTIMATION METHODOLOGY

This paper follows earlier studies (Bahmani-Oskooee and Arize, 2019; Bahmani-Oskooee and Arize, 2020) and is theoretically aligned to Rose and Yellen (1989). Functionally trade estimation model used in this paper is as expressed below.

$$\ln TB_t = \alpha_0 + \alpha_1 \ln REXR_t + \alpha_2 \ln Y_t + \alpha_3 \ln W_t + \varepsilon_t \qquad (1)$$

Where *TB* represents Uganda's balance of trade between with the foreign world. This is captured by the ratio between Uganda's purchases from other countries and its sales to the other countries. *REXR* represents the country's effective exchange rate in real terms. Uganda's local production is represented by *Y* whereas *W* represents foreign production. The original variables are transformed into logarithms (ln) while ε is the error term.

The J-curve effect is explained by an increase in the balance of trade of a country arising from depreciation of the local currency. Also, a real domestic income increase worsens the balance of trade when import demand increases. The domestic income coefficient is anticipated to be negative.

Equation 1 estimates the long run coefficients of exogenous variables. The ARDL model (Pesaran *et al.*, 2001) is employed in estimating both short and long run coefficients. The choice of the ARDL methodology is because of a multiplicity of reasons like: simultaneously estimating short and long run effects; proficiency to estimate small samples; inclusion of variables with different order of integration and ability to estimate variables with differing lag length. The ARDL is based on the premise that the used variables in the estimation are endogenous.

The exchange rate effects are specified as in equation 2 below;

$$\Delta\ln(TB)_t = \alpha_0 = \Sigma_{j=1}^{p} \alpha_{1j} \Delta\ln(REXR)_{t-j} + \Sigma_{j=0}^{p} \alpha_{2j} \Delta\ln Y_{t-j} + \Sigma_{j=0}^{p} \alpha_{3j} \Delta\ln W_{t-j} + \Sigma_{j=0}^{p} \alpha_{4j}$$
$$\Delta\ln REXR_{t-j} + \beta_0\ln(TB)_{t-1} + \beta_1\ln REXR_{t-1} + \beta_2\ln Y_{t-1} + \beta_2\ln Y_{t-1} + \beta_3\ln W_{t-1} + \omega_t \qquad (2)$$

Long run effects are obtained from the original logarithmic variables while the terms that are differenced are used for estimation of short run effects. Use is made of the F-test to determine the overall significance of the model and the long run relationship among variables. The F-tests poses two critical asymptotic bounds, for which cointegration is denied if the bound is low and accepted if the bound is high. If at all a long run cointegrating relationship exists, then an error correction model has to be estimated. The *ARDL* error correction model is as illustrated in equation (3).

$$\Delta\ln(TB)_t = \alpha_0 = \Sigma_{j=1}^{p} \alpha_{1j} \Delta\ln(TB)_{t-j} + \Sigma_{j=0}^{p} \alpha_{2j} \Delta\ln REXR_{t-j} + \Sigma_{j=0}^{p} \alpha_{3j} \Delta\ln Y_{t-j} + \Sigma_{j=0}^{p} \alpha_{4j} \Delta\ln W_{t-j} + \tau_0 ECT_{t-1} + \omega_t \quad (3)$$

The residuals in equation 2 capture the error correction term represented as *ECT* in equation 3. The adjustment speed is represented by τ_j. For results validity, the post estimation diagnostics used include; The Serial correlation test; ARCH-heteroscedasticity test; and Jacque Bera normality test, while model stability was analysed using the *CUSUM* and *CUSUMQ* tests.

4. DISCUSSION OF EMPIRICAL FINDINGS

4.1. Data Sources

The paper makes use of annual time series data from 1982 to 2021, which is extracted from World Development Indicators (WDI) dataset. A total of forty data points are estimated. The variables estimated are: balance of trade; real exchange rate; local production; and foreign production. A simple formula is adopted to calculate trade balance; that is, the ratio between Uganda's imports and exports. The exposition of the descriptive statistics is in Table 1. All variables exhibit notable variability over time.

Table 1: Descriptive Statistics

Variables	*Observations*	*Mean*	*Standard Deviation*	*Median*	*Min.*	*Max*
TB	40	2.293	0.698	2.121	1.214	3.718
REXR	40	182.736	135.288	115.14	90.1	537.97
Y	40	1.28E + 10	8.29E + 9	9.91E + 9	4.04E + 9	3.03E + 10
W	40	5.18E + 13	1.62E + 13	4.99E + 13	2.85E + 13	8.27E + 13

Sources: Authors' computation based on the dataset

4.2. Correlational Analysis

The correlation coefficients are also as shown in table 2. The correlation between Uganda's GDP and that of the other countries (rest of the world) is high. Real exchange rate and foreign production are also highly related. Trade balance is lowly and negatively related with the other variables. There is a positive correlation between Uganda's production and foreign production.

A Variance Inflation Factor (VIF) test and coefficient variance decomposition was undertaken to check for multicollinearity. This is because real effective

Table 2: Correlation Matrix

	ln *TB*	ln *REXR*	ln *Y*	ln *W*
ln *TB*	1.00			
ln *REXR*	–0.032	1		
ln *Y*	–0.393	–0.613	1	
ln *W*	–0.187	–0.846	0.924	1

Sources: Authors' computation based on the dataset

exchange rate is highly related with both domestic and foreign production. The variance inflation factors and variance decompositions results point towards non-existence of multicollinearity. The cut-off threshold for multicollinearity in the decomposition proportions is 0.5. This is as shown in Appendix Table II.

4.3. Unit Root Tests

In testing for unit root, we estimated the ADF and Phillips tests. All variables have unit roots for the Phillips test; except for real exchange rate, in the ADF unit root test. The exposition of unit root findings is in table 3. The findings validate the usage of ARDL as the estimation strategy of choice.

Table 3: Unit root Results

Variable	*ADF*		*Phillips–Perroni*		*Order of Integration*
	Level	*First Difference*	*Level*	*First Difference*	
ln *TB*	–2.249	–5.882***	–2.372	–9.960***	I (1)
ln *REXR*	–3.465**		–2.139	–4.065***	
ln *Y*	–1.047	–4.227***	–0.851	–4.234***	I (1)
ln *W*	–1.619	–4.149***	–1.619	–4.149***	I (1)

Sources: Authors' computation based on the dataset

4.4. Lag Length Selection Criteria

The ARDL estimation technique enables us to use variables with unequal lag length. In selecting the optimal lag length, we employed the Akaike Information Criteria (AIC). (ln *TB,* ln *REXR,* ln *Y,* ln *W*) (1, 1, 4, 4) was selected as the best model specification.

4.5. F-Bounds Cointegration Test

The F-Bounds confirmed the presence of a long run relationship for trade balance and other estimation variables[2]. This is because the F-test was beyond the critical upper bounds. This is as exposed in table 4.

Table 4: F-Bounds Test

	ARDL Value *K = 3*
F-Statistic	7.807
95% Bound (Lower, Upper)	(3.164, 4.194)
99% Bound (Lower, Upper)	(4.428, 5.816)

Note: Confidence level figures for the respective lower and upper bounds are given in parentheses

4.6. Discussion of Results

The estimation results are suitable for interpretation, going by the outturn of the diagnostic tests. Specifically, the Arch-heteroscedasticity tests and Breusch Godfrey don't find heteroscedasticity and serial correlation for the models, respectively. This is illustrated in table 5. The estimation is also stable as illustrated in Appendix III.

The ARDL model results are as exposed in Table 5. The error correction term is negatively signed, significant and adjusting at a speed of 0.485. Real exchange rate and foreign production have positive coefficients. Conversely, local production has a negative coefficient. This result is contrary to (Mahebe, Wasswa and Kagarura, 2020).

The estimation results partly deny the J-curve notion. This is because they violate the primary condition that the depreciation of exchange rate deteriorates and spurs the balance of trade in the short and long run respectively. Not withstanding, other secondary J-curve effects that relate to domestic and foreign income are satisfied. This is evidenced by an increase in Uganda's real domestic (foreign) income worsening (improving) trade balance as import (export) demand increases. The study results are contrary to Wasswa (2020), who found out the presence of a J-curve effect in Uganda. This is probably because their study used Kenya's GDP as the proxy for foreign income instead of using the world's GDP as has been done in this study. Indeed, in the most recent years, Uganda's trade balance between with Kenya has improved. As already alluded to, regional East African homogeneous factors and trade size affected the estimation results. On the contrary, the trade size and trade direction between Uganda and the foreign world also influenced our finding, signifying that size of trade between two trading partners affects the J-curve existence dynamics.

5. CONCLUSION AND POLICY RECOMMENDATIONS

We used the ARDL approach to hypothesize Uganda's J-curve. The error correction term supports the presence of significant long run effects. 48.5 percent of Uganda's trade balance instabilities in the long run are rectified in the subsequent period.

Table 5: Estimation Results ARDL (1, 1, 4, 4)

Variable	*Coefficient (Standard error)*
C	–76.21 (48.96)
ln *REXR*	1.467 (1.054)
ln *Y*	–1.602 (0.197)
ln *W*	3.362 (–1.476)
D (ln *REXR)*	0.412** (0.184)
D (ln *Y)*	–0.437** (0.197)
D (ln *Y* (–1))	0.077 (0.318)
D (ln *Y* (–2))	0.528*** (0.312)
D (ln *Y* (–3))	–0.230* (0.119)
D (ln *W)*	1.530*** (0.358)
D (ln *W* (–1))	–1.22*** (0.405)
D (ln *W* (–2))	–0.256 (0.399)
D (ln *W* (–3))	–1.394*** (0.438)
ECT	–0.485*** (0.071)
R-Squared	0.785
Adjusted *R*-squared	0.700
F-Statistic	9.792***
S.E. of Regression	0.096
Residual Sum of Squares	0.215
DW	2.744
Breusch-Godfrey Test	7.195 (0.005)
Arch-Heteroscedasticity	0.647 (0.4111)
JB Normality Test	1.557 (0.459)

Notes: (1) 10%, 5% and 1% levels of significance are reflected by *, ** and *** represent respectively; (2) coefficients are shown in the tables whereas Number in parentheses against these coefficients reflect the corresponding standard errors. (3) Number in parentheses for diagnostic tests are probabilities

The J-curve effect doesn't exist in Uganda. This is especially because depreciation of the Uganda Shilling increases Uganda's balance of trade in the short run. Also, an increase in Uganda's real domestic (foreign) income worsens (improves) trade balance when import (export) demand increases.

Government of Uganda should therefore use a three-pronged policy lever for; beneficent favorable exchange rate policies; promotion of exports; and import replacement strategies. Government and the policy actors should rally the public and other economic agents to intensify domestic production and exports so as to benefit from the depreciation of the Uganda Shilling. Therefore, all activities in the Export Promotion Action Plan that was formulated in 2016 should be operationalized and financed, especially for the prioritized commodities. Additionally, the Import Replacement Action Plan should also be operationalized for the prioritized commodities. It should be noted that import replacement is a stepping stone for the advancement to Export Promotion in the medium to long term.

References

Alsaleh, M. ln *TB*& Abdul-Rahim, S. (2019). The J-Curve Effects and The EU28 Bioenergy Trade Balance: Co-Integration Approach. *Journal of Sustainability Science and Management,* Volume 14 Number 6, 73-87.

Alexander, S. S. (1952). Effects of a Devaluation on a Trade Balance. *IMF Staff Papers*.

Amusa, H., & Fadiran, D. (2019). The J-Curve Phenomenon: Evidence from. *Economic Research Southern Africa Working Paper 777*.

Andersson, A. (2010). *How Does a Depreciation in the Exchange Rate Affect Trade Over Time?* Jonkoping: Economics Thesis; Jonkoping International Business School.

Bahmani-Oskoee, M., & Gelan, A. (2012). Is there J-Curve effect in Africa? *International Review of Applied Economics*, 26(1), 73-81.

Bahmani-Oskooee, M., & Arize, A. (2020). On the Asymmetric Effects of Exchange Rate Volatility on Trade Flows: Evidence from Africa. *Emerging Markets Finance and Trade*, vol. 56, issue 4, 913-939.

Bahmani-Oskooee, M., Economidou, C., & Goswami, G. (2006). Non-linear ARDL Approach and the J-Curve Phenomenon. *Open Economies Review*, 27 (1): 51-70.

Bahmani-Oskooee, M., & Arize, A. (2019). U.S.-Africa trade balance and the J-curve: An. *The International Trade Journal*, 33:4, 322-343.

Bahmani-Oskooee, M., & Harvey, H. (2015). The J-Curve: Evidence from Industry-Level Data Between the U.S. and Indonesia. *The International Trade Journal*, 29(2): 103.

Bahmani-Oskooee, M., & Nasir, M. A. (2020). Asymmetric J-curve: evidence from industry trade between U.S. and U.K. *Applied Economics*, Vol. 52, issue 25, 2679-2693.

Bickerdike, C. F. (1920). The instability of foreign exchange. *The Economic Journal 30*, (30) 118-122.

Chee Wooi, H., & Tze-Haw, C. (2008). The Impact of Yuan/Ringgit on Bilateral Trade Balance of China and Malaysia. *MPRA Paper 11306*.

Johnson , H. G. (1972). The Monetary Approach to Balance-of-Payments Theory . *Journal of financial and quantitative analysis*, 7(02): 1555-1572.

Lerner, A. P. (1944). *The Economics of Control – Principles of Welfare Economics.* New York: The MacMillian Company.

Mahebe, D., Wasswa, F., & Kagarura, W. (2020). The Effect of Real Efffective Exchange Rate Volatility on Uganda's. *Journal of Modern Economy*.

Marshall , A. (1923). *Money Credit and Commerce.* London: MacMillian & Company Ltd.

Marshall, A. (1997). *Money Credit and Commerce.* Bristol: Overstone Press.

Onakoya, A. B., Johnson, S. B., & Ajibola, O. J. (2018). Exchange Rate and Trade Balance: The Case for J-curve Effect in Nigeria. *KIU Journal of Social Sciences*, Volume 4. Number 4.

Pesaran , M. H., Shin, Y., & Smith , R. (2001). Bounds testing approaches to the analysis of level. relationships. *Journal of Applied Econometrics*.

Rose, A. K., & Yellen, J. Y. (1989). Is there a J-Curve? *Journal of Monetary Economics*, 24 (1) 53-68.

Wu, M. L. (2020). An empirical timeseries econometric study and the J-curve effect of exchange rate in trade balance between China and the US. Journal of Economics, Management and Trade.

Yazici, M., & Islam , M. Q. (2012). Exchange rate and Turkish Agricultural Trade Balance with EU (15). *Agricultural Economic Review*, 13(2):35-47.

Zhang, W. B. (2008). *International trade theory- Capital, knowledge, economic, structure, money and prices over time.* New York: Springer.

2. We further estimated the non-linear ARDL specification but the results were less informative for presentation here.

Appendix I: Variance Inflation Factor

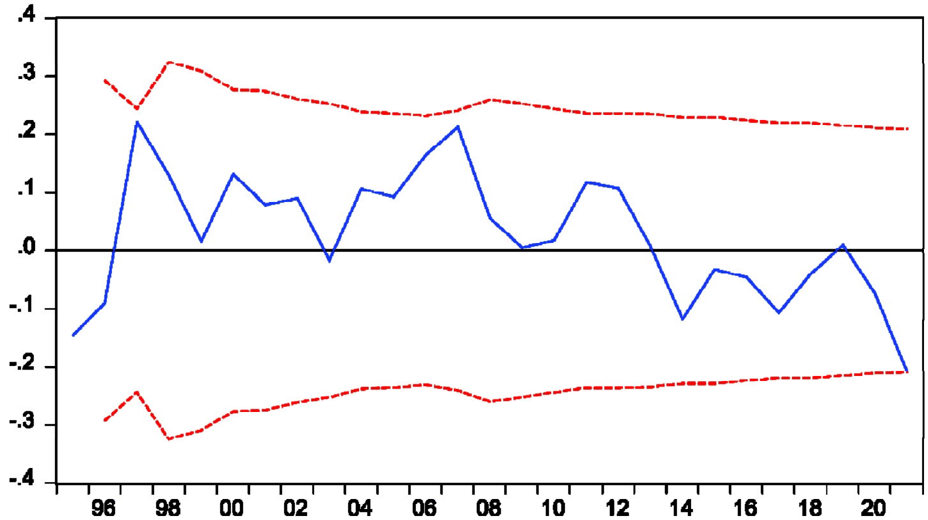
Variable	*Coefficient Variance*	*Uncentered VIF*	*Centered VIF*
ln *TB* (–1)	0.029392	38.52513	4.908321
ln *REXR*	0.070262	4969.451	46.93311
ln *REXR* (–1)	0.072304	5209.895	53.84879
ln *Y*	0.132636	203882.0	198.9846
ln *Y*(–1)	0.112498	171985.4	164.0776
ln *Y* (–2)	0.066725	101472.7	93.54789
ln *Y* (–3)	0.043986	66471.71	62.57190
ln *Y*(–4)	0.022067	33122.65	30.70869
ln *W*	0.286512	821892.4	217.8079
ln *W* (–1)	0.450385	1287248.	367.8934
ln *W* (–2)	0.569169	1620812.	496.3671
ln *W* (–3)	0.586519	1664193.	541.8455
ln *W* (–4)	0.291484	824058.2	280.5975
C	231.4556	676292.8	NA

Appendix II: Coefficient Variance Decomposition Table

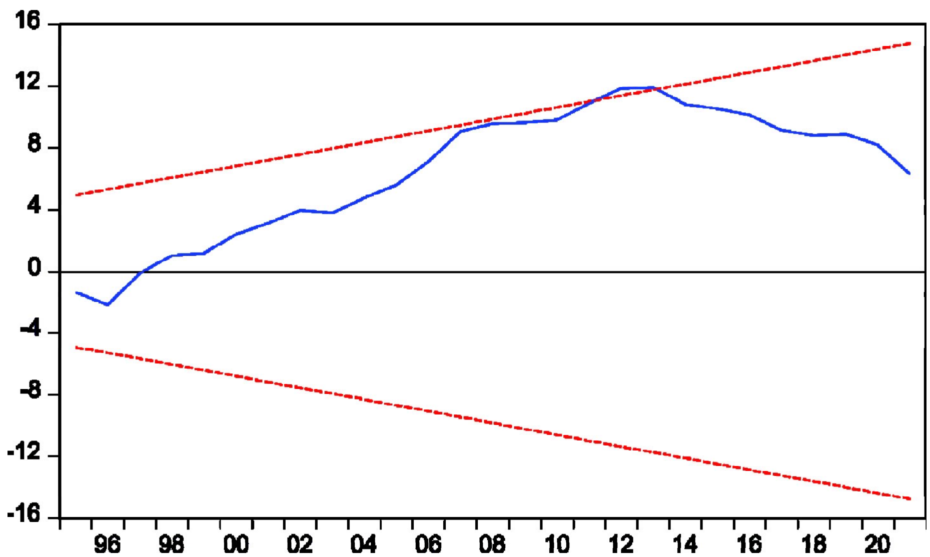
	Eigen Values													
Eigen values	231.794	1.3075	0.495	0.209	0.165	0.0778	0.059	0.046	0.017	0.015	0.003	0.001	0.0005	4.55E-08
Condition	1.96E-10	3.48E-08	9.19E-08	2.17E-07	2.75E-07	5.84E-07	7.77E-07	9.88E-07	2.75E-06	3.08E-06	1.63E-05	4.56E-05	9.56E-05	1.000000
	Variance Decomposition Proportions													
	Associated Eigenvalue													
Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
ln *TB*(–1)	0.166	0.001	0.044	0.005	0.17	0.093	0.192	0.002	0.05	0.259	0.015	0.002	8.44E–05	8.00E–11
ln *REXR*	0.427	0.122	0.057	0.029	0.061	0.018	0.223	0.0189	0.0278	0.0122	3.69E–05	0.001	0.003	2.06E–09
ln *REXR*(–1)	0.454	0.106	0.063	0.044	0.056	0.037	0.207	0.008	0.0139	0.004	0.002	0.0013	0.003	2.03E–09
ln *Y*	0.494	0.066	0.070	0.152	0.143	0.024	0.0001	0.0185	0.026	0.0008	0.005	0.001	7.18E–05	2.40E–08
ln *Y*(–1)	0.069	0.129	0.154	0.274	0.282	0.009	0.0171	0.039	0.0001	0.025	0.0009	0.001	9.19E–05	2.81E–08
ln *Y*(–2)	0.026	0.043	0.139	0.053	0.332	0.207	0.102	0.036	0.056	0.003	0.0006	0.002	0.0002	4.72E–08
ln *Y*(–3)	0.008	0.011	0.064	0.044	0.168	0.222	0.108	0.350	0.007	0.012	0.011	0.002	0.0005	7.11E–08
ln *Y*(–4)	0.007	1.69E–05	0.0001	0.049	0.002	0.182	0.339	0.158	0.178	0.045	0.038	0.0006	0.001	1.41E–07
ln *W*	0.359	0.077	0.316	0.131	0.046	0.045	0.003	0.023	0.0002	0.0003	7.96E–05	0.0002	3.19E–05	2.07E–08
ln *W*(–1)	0.023	0.483	0.441	0.0002	0.033	0.014	0.0004	0.005	8.86E–07	0.0002	3.80E–05	0.0001	1.33E–05	1.31E–08
ln *W*(–2)	0.013	0.834	0.016	0.082	0.053	0.0002	0.0003	0.0004	0.0002	5.99E–05	1.56E–05	9.62E–05	6.30E–06	1.04E–08
ln *W*(–3)	0.007	0.781	0.152	0.04	0.006	0.009	3.34E–06	0.003	0.0006	0.0002	9.93E–06	9.77E–05	3.21E–06	1.00E–08
ln *W*(–4)	0.245	0.315	0.200	0.134	0.033	0.051	0.0006	0.0169	0.0003	0.003	2.79E–05	0.0002	3.59E–06	2.01E–08
C	0.999	5.33E-07	6.77E-10	2.95E-07	8.17E-11	1.86E-08	2.53E-09	5.87E-10	2.51E-09	6.81E-09	4.88E-10	6.38E-10	1.05E-09	2.61E-14

							Eigen Values							
Eigen values	231.794	1.3075	0.495	0.209	0.165	0.0778	0.059	0.046	0.017	0.015	0.003	0.001	0.0005	4.55E-08
Condition	1.96E-10	3.48E-08	9.19E-08	2.17E-07	2.75E-07	5.84E-07	7.77E-07	9.88E-07	2.75E-06	3.08E-06	1.63E-05	4.56E-05	9.56E-05	1.000000
							Eigenvectors							
							Associated Eigenvalue							
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ln *TB*(–1)	0.005	0.006	–0.051	–0.025	0.174	–0.188	0.311	–0.039	0.298	–0.717	0.402	–0.252	0.072	0.007
ln *REXR*	–0.011	–0.081	0.090	0.098	–0.161	0.127	0.518	–0.17	0.344	0.241	–0.03	0.277	0.616	0.056
ln *REXR*(–1)	–0.012	0.077	–0.096	–0.124	0.157	–0.185	–0.505	0.111	–0.246	–0.138	0.241	0.309	0.638	0.057
ln *Y*	0.017	0.082	–0.137	–0.31	0.339	–0.201	–0.018	0.231	0.457	–0.084	–0.486	0.356	–0.141	0.264
ln *Y*(–1)	0.006	–0.105	0.187	0.383	–0.438	–0.113	–0.181	–0.308	–0.031	–0.437	–0.194	0.392	–0.147	0.264
ln *Y*(–2)	0.003	0.047	–0.136	–0.130	0.366	0.422	0.341	–0.23	–0.477	–0.120	0.117	0.362	–0.162	0.263
ln *Y*(–3)	0.0006	–0.019	0.075	0.096	–0.211	–0.354	0.285	0.578	–0.137	0.188	0.409	0.257	–0.208	0.262
ln *Y*(–4)	–0.0008	–0.0005	–0.003	–0.072	0.016	0.227	–0.357	–0.275	0.487	0.259	0.55	0.112	–0.228	0.261
ln *W*	–0.021	0.130	0.429	0.423	0.283	0.406	–0.116	0.379	0.064	–0.081	–0.091	–0.225	0.139	0.361
ln *W*(–1)	–0.007	–0.408	–0.634	–0.019	–0.301	0.280	–0.056	0.225	0.005	–0.087	–0.078	–0.228	0.112	0.361
ln *W*(–2)	–0.006	0.603	0.136	–0.472	–0.427	0.041	0.052	–0.068	–0.083	–0.048	–0.056	–0.234	0.087	0.36
ln *W*(–3)	0.004	–0.592	0.425	–0.335	0.148	–0.264	0.006	–0.2	–0.149	0.109	–0.046	–0.240	0.063	0.36
ln *W*(–4)	–0.018	0.265	–0.343	0.431	0.242	–0.438	0.057	–0.327	–0.076	0.258	–0.054	–0.242	0.047	0.359
C	0.992	0.01	–0.0006	0.018	0.0003	0.007	–0.003	0.002	–0.006	0.010	0.006	–0.012	0.023	0.012

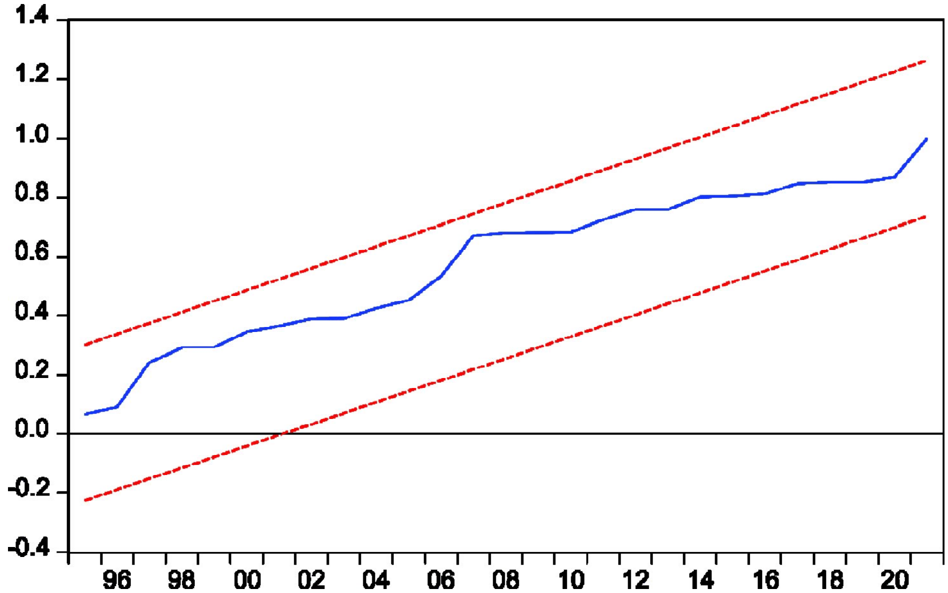
Appendix III: Stability Tests



Recursive Residual Graph



CUSUM Stability Test



CUSUMQ Stability Test