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EMPIRICAL ANALYSIS OF TRILEMMA IN EMERGING ECONOMIES

Mustapha A. Akinkunmi[1]

[1]*Brickfield Road Associates Limited, Akin Adesola Victoria Island Lagos, Nigeria*

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ABSTRACT

The increasing debate on empirical evidences in testing the Mundell-Fleming theory has been the focus of this study. The study examines the effect of central banks' interventions on trilemma constraint using a panel dataset of 30 emerging market economies for the sample period 1980-2014. With the aid of the portfolio balance framework, the findings indicate that the weighted sum of the three trilemma objectives falls in the presence of foreign exchange market intervention. The capacity to loosen the constraints has decreased over time and has been most substantial in African emerging economies.

Contribution/ Originality: This study contributes in the existing literature by testing the hypothesis of trilemma constraint in all emerging economies, using the most recent data. The paper contributes the first logical analysis of disaggregating the emerging markets. It documents that central banks do not have the capacity to loosen the trilemma trade-off.

1. INTRODUCTION

The inability to simultaneously achieve the goals of exchange rate stability, monetary independence and capital mobility, limits the room of macroeconomic policy in open economy countries. In addition, this poses a great challenge to the central banks in choosing only two of these three objectives. It implies that if they attach more weight to one trilemma variable, there will be a decline in weight placed on the other two variables.

The trilemma derives its source from the Mundell-Fleming framework that links the significance of exchange rate regime as well as the capital mobility to the monetary policy effectiveness. Of recent, numerous empirical studies have tested its validity. For instance, Aizenman *et al.* (2013) confirmed the existence of the trilemma by concluding that a step in attaining one objective of the impossible trinity causes a migration from at least one of the other two policy goals. Other studies such as Obstfeld *et al.* (2005) and Popper *et al.* (2013) supported the trilemma

theory. However, Steiner (2017) examines the strictness of the trilemma constraints. He found that economic policy is only constrained by the trilemma in the long –run but all three goals that can be achieved jointly if they are complemented by other policies such as changes in foreign reserves.

In the light of this, this study adds to the ongoing policy discussions by testing the hypothesis of trilemma constraint in all emerging economies. In addition, it explores the most recent and higher frequency data to these countries that are highly vulnerable to external influences. With upward trends of capital mobility in developing countries, many countries need to decide between a stable exchange rate and an independent monetary policy.

The rest of this study is divided into four sections. Section Two reviews relevant and recent works on the trilemma constraints while methodology is provided in Section Three. Empirical results and discussion are presented in Section Four, whereas Section Five is concluding remark.

2. LITERATURE REVIEW

Empirical studies on the impossible trinity mainly investigate whether there is an inverse connection between exchange rate stability and the degree of monetary independence. However, inconclusive results are presented. For example, Shambaugh (2004) and Obstfeld *et al.* (2004;2005) strongly supported the validity of the impossible trinity. To them, a country's interest rate moves almost similar to its base country rates under the pegged exchange rate regime, than in the flexible exchange rate regimes. This occurred in the gold period (1870-1914) characterized with open capital markets. However, the monetary policy was not regarded as a constraint during the Bretton Woods period, because of the presence of capital controls.

In addition, Klein and Shambaugh (2013) confirmed the existence of the trilemma constraint through focusing on intermediate policies (managed exchange rates and partial capital controls). They found that managed exchange rates with partial capital controls (round corners), provide more monetary independence than fixed exchange rate with closed capital account (hard corners). Aizenman *et al.* (2009) tested the hypothesis of the trilemma trade-off using an index for each objective of the trilemma (a monetary independence index; an exchange rate stability index; and an index of capital mobility). They run a regression with a constant as dependent variable on these indices. Their conclusion is that the trade-off between the trilemma objectives is subsistent.

However, other studies found a positive link between monetary independence and exchange rate volatility (Rose, 1996) long-run domestic interest rates depend on global one rather than exchange rate regime (Frankel *et al.*, 2004) exogenous interest rate shocks indicate a greater accordance with trilemma theory than anticipated changes (Bluedorn and Bowdler, 2010) short-term interest rates exhibit more independence than long-term rates and there is a rise in monetary independence under the pegged exchange rate regime, even with financial globalization (Obstfeld, 2014).

The recent global financial crisis renewed research interests in the need for adequate policy to response to capital flows (Korinek, 2010; Ostry *et al.*, 2011; Forbes and Warnock, 2012; Jinjarak *et al.*, 2013; Bordo *et al.*, 2015). Steiner (2017) argued that central banks are equipped with foreign exchange intervention as addition to the common monetary policy instrument "interest rate". The intervention provides a platform for a monetary authority to implement the same exchange rate and monetary targets including capital controls.

2.1. Causes and Implication of Trilemma Choices

The evolving nature of the indexes over time indicates the extent to which policy choices are varying over time. This is as a result of changes in the international monetary system and shifts in preferences. The dynamics of international monetary system poses an additional puzzle on selecting choices within the trilemma. This might trigger a central bank to adopt policies in favour of one objective at the expense of the other two objectives. Examples are monetary systems under the gold era and the Bretton Wood era.

In addition, changes in preferences might influence the trilemma policy choices. For instance, advanced economies give more preference for capital mobility over the monetary autonomy after the Bretton Woods period. Similarly, emerging economies witnessed a decline in exchange rate stability during the 1970s while their capital mobility has been rising since 1990. The same situation is experienced in developing countries in the same period but at a slower pace. Aizenman *et al.* (2010; 2011) analyzed the economic implications of policy choices in the context of the trilemma space. They indicate that monetary independence has a link with lower output volatility and higher inflation, relative to a trilemma space prioritizing a fixed exchange rate.

2.2. Trilemma and the Level of Reserves

Reserve accumulation is viewed by Obstfeld *et al.* (2010) as a by-product of a shift in the trilemma space towards capital mobility. In the same vein, Aizenman *et al.* (2013) concluded that reserves are regarded as a buffer that improves the stability of the trilemma variables especially in emerging and developing economies. Popper *et al.* (2013) postulated that the large reserve holdings support trilemma.

Aizenman *et al.* (2010) conducted a comparative analysis of low-reserve and high-reserve countries in the context of the trilemma. They concluded that high-reserve countries have a larger weighted average of the trilemma variables than the low-reserve countries. Therefore, higher reserves relax the trilemma. However, Steiner (2017) argued that the flow of reserves might relax the trilemma constraint rather than the stock of reserves. Similarly, Bussière *et al.* (2015) found that both pre-crisis level of reserves and the presence of capital controls have a positive link with economic growth. This implies that both are utilized to buffer external shocks.

2.3. Exchange Rate and Reserve Accumulation

Previous studies on the exchange market intervention, investigate how changes in reserves influence the exchange rate. However, inconclusive results are still established in the literature. Prior to the 1990s, many studies revealed that sterilized intervention is effective at most in the short run. The substantial influence of interventions was observed in advanced countries in the 1990s (Dominguez and Frankel, 1993). Of recent, the significant relevance of intervention was also found in emerging countries (Menkhoff, 2013; Daude *et al.*, 2014). Melvin *et al.* (2009) observed that interventions reduced exchange rate volatility in the long-run. Other previous works such as (Bacchetta and van Wincoop, 2000; Aghion *et al.*, 2009; Menkhoff, 2013) found that a stable exchange rate enhances trade and boosts growth and employment.

Literature also indicates that the purpose of central bank's accumulation of reserves is to stabilize or undervalue the exchange rate. For instance, Levy-Yeyati *et al.* (2013) postulated that the central banks' intervention in the foreign exchange market focuses on depreciating the exchange rate or postponing its appreciation. Similarly, Adler and Tovar (2011) revealed empirically that sterilized exchange market interventions played a significant role in reducing the pace of appreciation in the 2000s. However, Pontines and Rajan (2011) employed a sample of six Asian countries, and found that asymmetric effect of central bank intervention on the exchange rate. To them, interventions are stronger in the face of appreciations than depreciations.

Another stream of the literature on foreign reserves suggests that mercantilist's motives is a driving force of their accumulation (Dooley *et al.*, 2003; Aizenman and Lee, 2007). Korinek and Serven (2010) found that the motive could be welfare-improving if learning-by-investing externalities are established in the tradeable sector. On the other hand, Loffler *et al.* (2016) analyzed the impact of capital inflow and its increasing pressures on the exchange rate. They concluded that monetary policy is independently restricted by the chosen exchange rate regime. The problem of costly distortions in the domestic financial system is attached to fixed exchange rates, whereas flexible exchange rate entails significant revaluation losses and sterilization costs.

3. METHODOLOGY

3.1. Model Specification

The use of a simple portfolio balance model is applied to examine whether changes in international reserves could relax the trilemma constraint. The model assumes that capital controls and changes in reserves are substitutes. In addition, both encourage a central bank to manage net capital inflows and to balance changes in the relative demand for assets. Therefore, an independent monetary policy is in line with a stable exchange rate through exchange market interventions.

The model is a dynamic method of determining exchange rate, based on the assumption that the interaction of international asset markets and current account balances determines the equilibrium exchange rate. In addition, it reduces the interest rate parity by placing an assumption of imperfect substitutability between assets. The model adopts the work of Blanchard *et al.* (2005) that includes valuation effects. At equilibrium, the current account is balanced and the net foreign asset status is fixed. The debtor country finances interest payments on its net debt position through a trade surplus.

Steiner (2017) contributes to the model by explicitly including the central bank as an additional actor. He added an assumption that central banks are allowed to influence the exchange rate behaviour through foreign exchange market intervention. Thus, this study adopts the work of Steiner (2017) with the assumption that the intervention allows to attain all three policy goals of the trilemma jointly. However, it extends the scope in terms of time dimension as well as focusing on all emerging economies.

The model consists of two economies, the U.S and a foreign nation which captures the rest of the world, with two assets (US and foreign bonds).The wealth of US investors (W) in units of US goods is the difference between the stock of US assets(X) and the US net debt position with respect to the foreign country (F):

$$W = X - F \quad (1)$$

The similar connection is established for the foreign nation. Net debt position of the US (F) is the same as the net foreign asset position of the foreign country, with assumption that the US and the foreign country form a closed economy.

$$\frac{W*}{E} = \frac{E*}{E} + F \quad (2)$$

Where E refers to the real exchange rate which is the price of US goods in terms of foreign goods (a fall in E denotes a depreciation of the dollar) while * denotes foreign.

The gross real rate of return on assets relies on their interest rate and changes in exchange rates. The expected gross real rate of return of US relative to foreign assets are:

$$R^e = \frac{1+r}{1+r^*}\frac{E^e_{+1}}{E} \quad (3)$$

Where r and r* represent US and foreign real interest rates respectively. E^e_{+1} is the expected real exchange rate one period ahead.

As suggested in Blanchard *et al.* (2005) consider two private investors (US and Foreign) with an addition of the foreign central bank as a third investor. The foreign central bank in terms of foreign goods can be specified as:

$$M^* + R^* = X^{CB*} = B^* + IR.E \quad (4)$$

Where M^* is foreign currency in circulation; R^* is deposits of private banks held at the central bank. X^{CB*} is assets of the foreign central bank(the entire foreign government sector); B* is foreign assets; IR is international reserves held in form of US assets. The total amount of foreign assets is the sum of foreign private investors and the foreign central bank:

$$X^* = X^{PR*} + X^{CB*} \quad 5$$

Investors have a choice of buying assets between US and foreign country. US investors allocate α of their wealth to US assets and (1- α) to foreign assets. In the foreign nation, private investors and the central bank take independent decision on the composition of their portfolio of each other. Foreign private investors allocate $\propto^{PR*}$ of their wealth to foreign assets and invest a share (1- $\propto^{PR*}$) in US assets. The private investors' shares rise based on the expected relative gross return of the respective asset:

$$\propto = \propto (R^e), \propto^{PR*} = \propto^{PR*} (R^e) \; with \; \propto_{R^e} > 0, \propto^{PR*}_{R^e} < 0 \; and \; 0 \leq \propto, \propto^{PR*} \leq 1 \quad 6$$

Foreign central bank's asset composition does not depend on relative return. 1- $\propto^{CB*}$ represents the share of total foreign central bank wealth X^{CB*} put in international reserves, which is utilized as a policy instrument. Its choice intends to encourage an independent monetary policy under a fixed exchange rate and perfect capital mobility. The change in international reserve is written as:

$$dIR = -d \propto^{CB*} . \frac{X^{CB*}}{E} \quad 7$$

US asset market is equilibrium when the supply of US assets (X) is the same as the demand for US assets by US and foreign private investors, and by the foreign central bank:

$$X = \propto (R^e) W + (1 - \propto^*) \frac{W^*}{E} \quad 8$$

Where α* denotes a weighted mean of $\propto^{PR*}$and $\propto^{CB*}$. On the other hand, with the use of equation 2 and 5, this condition can be specified as follows:

$$X = \propto (R^e)(X - F) + (1 - \propto^{PR*}) \left(\frac{X^{PR*}}{E} + F \right) + (1 - \propto^{CB*}) \frac{X^{CB*}}{E} \quad 9$$

Growth of the net foreign asset position of the foreign economy, is expressed as

$$dF = rF + (1 + r)(1 - \propto) \left(1 - \frac{1 + r^*}{1 + r} \frac{E}{E_{+1}} \right) (X - F) + D(E) \quad 10$$

Where D (E) is the US trade deficit assumed to rise in E. This equation implies that the change in the net foreign asset position equals the current account balance.

This study is framed on investigating the following policy: Foreign central bank exercises its independence policy by selecting its preferred interest rate in the first place. The US interest rate is assumed to be exogenous and

constant. In addition, foreign central bank credibly fixes the real exchange rate to be $E = E^{e}_{+1}$. Thus, the relative return R^{e} is given, implying that asset shares $\propto$ and $\propto^{PR*}$ are predetermined. Equation 9 can be solved for the equilibrium real exchange rate:

$$E = \frac{(1-\propto^{PR*})X^{PR*}+(1-\propto^{CB*})X^{CB*}}{(1-\propto)X+(\propto+\propto^{PR*}-1)F} \qquad 11$$

The study considers the following scenarios:

Scenario 1: Perfect capital mobility

This is based on the following assumptions: - a) assets are imperfect substitutes b) capital is perfectly mobile, that is international capital flows are not affected by de jure restrictions c) the policy trilemma occurs when the exchange rate is endogenous, and d) the adjustment of exchange rate clears the asset markets and the long-term equilibrium exchange rate is achieved when F is constant implying that the sum of interest payments on F and excess returns, is equivalent to trade balance D

Scenario 2: Capital Controls

Under this scenario, the legal restriction of capital account openness can be in form of quantitative limits, prohibitions and taxes on inflows and outflows. This creates a deviation between optimal allocation of investors' wealth and actual allocation of assets to other country when quantitative restrictions take place. In a foreign country, controls on capital inflows influence the value of $\propto$ whereas controls on outflows determine $\propto^{PR*}$. The effective $\propto$ and $\propto^{PR*}$ are taken as policy instruments. Asset market are at equilibrium given the exchange rate. Thus, central bank can choose an independent monetary policy and peg the exchange rate. Similarly, tax on capital flows, creates a wedge between market rates and effective return. This influences the optimal shares $\propto$ and $\propto^{PR*}$ taken by the private investors. The central bank influences the choices of private investors in an indirect way. During the holding era (unremunerated reserve requirement portion of capital inflows ends up at the central bank), the effective share $\propto^{eff}$ can be expressed as $\propto^{eff}=\propto(1-\theta)$, where θ represents the fraction of the investment to be deposited at the central bank. Another policy instrument to impact private investors' agent shares is minimum reserve requirements imposed on private banks. For instance if foreign central bank increases the minimum reserve ratio, this may influence the share of domestic to foreign assets, thus reduce the need for central bank intervention. These controls allow a central bank to direct $\propto$ and /or $\propto^{PR*}$ in a way that exchange rate peg is sustainable.

Scenario 3: Perfect capital mobility with central bank intervention

Its assumptions are: (a) a pegged exchange rate (b) perfect capital mobility. In this scenario, the central bank sets its preferred interest rate in the first place, and then participates in a foreign exchange market intervention to hold E constant. As X^{CB*} is given, the central bank engages in accounting exchange on the asset side such as exchange

foreign assets β^* for international reserves vice versa (it sets $\propto^{CB*}$). Put differently, foreign exchange interventions are based on the assumption of a sterilized type. Differentiating Eq.11 is expressed as:

$$dE = \frac{(\propto+\propto^{PR*}-1)E.dF+X^{CB*}.d\propto^{CB*}}{(1-\propto^{PR*})\frac{X^{PR*}}{E}+(1-\propto^{CB*})\frac{X^{CB*}}{E}} \quad 12$$

in order to maintain E at the given level ($dE = 0$), the central bank purchases or sells dollar assets in exchange for foreign assets. The appropriate change in the share of foreign assets in its balance sheet is specified as

$$d\propto^{CB*} = -\frac{(\propto+\propto^{PR*}-1)dF}{\frac{X^{CB*}}{E}} \quad 13$$

This implies that the necessary change in international reserves to maintain a certain exchange rate is written as:

$$dIR = (\propto+\propto^{PR*}-1)\,[rF + (1-\propto)(r-r^*)(X-F) + D(E)] \quad 14$$

Where Eq. (13) is inserted in Eq. (7), the change in reserves is a positive function of the current account balance. Thus, the accumulation of foreign reserves depends positively on the income stream, emanating from the net foreign asset positon of the foreign country; excess returns on its US assets; and the surplus in its trade balance. The larger the necessary reserve change, the stronger the home bias in both countries is (large $\propto, \propto^{PR*}$). Reserve accumulation from stable exchange rate is a function of the net foreign asset position for given dF. $\propto+\propto^{PR*}=1$ the equilibrium exchange rate is independent of wealth transfers (dF) and constant over time.

In this version of the model with predetermined asset shares and constant global wealth, private capital flows are a driving factor of wealth transfer between both countries. Flows of capital occur when there are differences in economic growth between the two regions. An assumption is made that real output grows at a rate g in the US, but remains constant in the foreign country. Thus, US assets also grow at a rate g so that X in the subsequent is $X_{g,+1} = X(1+g)$. Considering US private investors allocate a share $(1-\propto)$ of their wealth to foreign assets, this encourages a net capital flow from the US to the foreign country as denoted by $(1-\propto)gX$. Assuming the supply of foreign assets is fixed or constant, the equilibrium in asset markets requires real exchange rate to appreciate (from the perspective of the foreign country). Then Eq. 13 is expressed as:

$$d\propto^{CB*} = -\frac{(\propto+\propto^{PR*}-1)dF+(1-\propto)XdG}{\frac{X^{CB*}}{E}} \quad 16$$

The study's analysis assumes that investors trust in the central bank's announcement of a fixed exchange rate i.e. $E^e_{+1} = E$. Given expectations of an exchange rate adjustment, this calls for the central bank to intervene more heavily on the foreign exchange market relative to the scenario of adaptive expectations. For instance, if agents expect a depreciation of foreign currency ($E^e_{+1} > E$), expected returns of US assets to foreign assets increase, and assets are reallocated towards US assets. This reallocation further depreciates the foreign currency, thus, the

central bank has to mitigate these changes by an appropriate shift in asset composition. If the announced domestic monetary policy triggers expectations of an adjustment in the exchange rate, central bank intervention must be stronger to address the trilemma objectives.

The investment risks also influence expected relative returns. Risks are associated with institutional quality, default probabilities, enforceability of creditor rights, and the likelihood of financial and economic crises. These variables are subjected to a change and shocks. Changes in US interest rates are exogenous from the view of the foreign economy, might induce capital flows.

Under a given monetary policy, a central bank can employ two policy instruments (capital controls and intervention) to maintain an exchange rate target. These two instruments are substitutes. Three trilemma objectives can be jointly attained if exchange rate is managed through intervention.

4. EMPIRICAL RESULT AND DISCUSSIONS

This segment utilizes data to examine the validity of the theoretical statement. The following hypothesis is tested using annual data for 30[1] selected emerging economies:

Do interventions relax trilemma? Is the relaxation of the trilemma a position function of the degree to which reserve changes offset changes in private external debts?

The study employs a pooled data set of cross country and time-series observations. Annual data from 1980 to 2014 for emerging countries are obtained. Its scope is constrained by the data availability.

4.1. Variables Description

- Monetary independence Index is calculated as the correlation the country's interest rate with the interest rate of a base country where the base is chosen in line with Shambaugh (2004). Higher correlation implies less monetary independence.
- Exchange rate stability index is calculated as the inverse of annual standard deviation of monthly exchange rates between home and base country. Small standard deviations indicate relatively stable exchange rate regimes.
- Capital mobility is captured by the Chinn-Ito index obtained from IMF data on de jure exchange restrictions (capital account openness).

All the three indices are obtained from Aizenman *et al.* (2013). These indexes are normalized between 0 and 1. Higher index values show that policy is closer to the respective objective.

This study utilizes the technique developed by (Aizenman *et al.*, 2009; Aizenman *et al.*, 2013) to examine the trilemma constraint. It carries out a regression of the constant on the three trilemma variables. In addition, it creates an augmented model by adding another variable to capture exchange market intervention, as suggested in Steiner (2017). This leads to an augmented trilemma equation, which is expressed as

$$1 = \rho EXS_{it} + \varphi MI_{it} + \tau KAOPEN_{it} + \sigma INT_{it} + \varepsilon_{it} \qquad 17$$

Where EXS represents exchange rate stability, MI captures monetary policy independence, $KAOPEN$ is the de jure openness of the capital account, and INT denotes the intensity of exchange market intervention. i and t refer to a specific country and time period respectively. The model is built on the assumption of a linear relationship.

Theoretical expectations are as follows:

[1] Countries and their ranks in terms of exchange rate stability, monetary independence and capital mobility are reported in Appendix Table A.1-A.3

- If the coefficients of the first three trilemma variables are positive, this supports the evidence of a trade-off among the three objectives, indicating that if a country approaches closer to one objective, thus it shifts away from at least one of the remaining two objectives.
- A negative coefficient is expected from intervention because intervention allow countries to raise the weighted sum of the three trilemma variables, through moving towards one objective without giving up the other two.

This study empirically captures exchange market intervention as the change in central bank's international reserves to the change in private external indebtedness, unlike Steiner (2017) that applied two measures. The reason is that the adopted measure is very straightforward in its computation and performs better. Intervention index is then specified as:

$$INT_{it} = {}^{\Delta IR_{it}}/_{\Delta NFA_{it}{}^{PR}}$$

Where IR and NFA denote reserve assets and private net foreign assets respectively, and Δ symbolizes a change.

4.2. Empirical Results

This sub-section entails the presentation and discussion of the regression findings. The results of the conventional trilemma specification that encapsulates exchange rate stability index, monetary independence index and capital mobility as independent variables are presented in Table 1. Then, the study compares these results with the augmented trilemma regression that adds exchange rate intervention among the explanatory variables.

Table-1. Pooled Regression of Trilemma of selected emerging markets

	Africa (8)	Non-Africa (20)	All (28)
MII	1.375060***	1.397727***	1.406895 ***
KAO	0.025405**	-0.007782	0.006219
ERSI	0.564631***	0.554627***	0.525071 ***

Note: *** 1%, ** 5%, * 10%.

Table 1 shows the findings for the trilemma theory. Based on the entire sample, all three trilemma variables exhibit significant positive coefficients with the exception of capital mobility (KAO) as indicated in column 3. This finding supports the evidence of the trilemma constraint among the three policy variables, as in line with other previous findings such as Aizenman *et al.* (2013); Aizenman *et al.* (2009) and Steiner (2017).

In addition, the trilemma constraint is strongly valid for the sub-sample of African economies, in which all trilemma variables have significant positive coefficients as shown in column 1 of Table 1. However, no existence of trilemma constraint is established for non-African emerging countries as indicated in column 2. The reason is that capital mobility has an insignificant negative coefficient.

The result of the augmented model that includes interventions is presented in Table 2. The coefficient of intervention has a positive and insignificant influence, reflecting the tighten trilemma constraint for the entire sample as well as the sub-sample.

Put differently, the larger the weighted sum of trilemma variables, the weaker the response of central banks' intervention to net capital flows. The intervention is very crucial in expanding the policy space of the trilemma constraint. The interventions make the trilemma constraint tight for both African- and non- African emerging countries. This suggests that central banks intervene in order to reinforce private capital flows. Thus, the weighted sum of trilemma objective is small compared to the absence of intervention.

Table-2. Pooled Regression Result of Augmented Trilemma of Emerging Markets

	Africa (8)	Non-Africa (20)	All (28)
MII	1.371927***	1.389833***	1.402154***
KAO	0.024992**	-0.007400	0.006498
ERSI	0.572016***	0.561161***	0.529718***
INTER	0.001686	4.46E-05	5.11E-05

Note: *** 1%, ** 5%, * 10%.

5. CONCLUDING REMARKS

This study empirically examines the trade-off between exchange rate stability, monetary independence and capital mobility. In addition, it explores an augmented model to determine the role of foreign exchange market interventions in relaxing the macroeconomic trilemma constraint. Using the portfolio balance model, the study explores a panel data set of 30 countries for the period 1980-2014 to test the hypothesis of trilemma constraint, and investigate whether interventions tighten or widen the policy space of the trilemma.

Its results support the evidence of trilemma constraint for both the full sample and the sub-sample of African emerging markets. However, the sub-sample of non-African emerging countries invalidates the hypothesis of trilemma. On the other hand, the findings show that foreign exchange interventions insignificantly tighten the trilemma constraint, implying that the weighted average of trilemma variables is smaller when the central bank interventions occur.

These outcomes include two major conclusions. First, central banks do not have the capacity to loosen the trilemma trade-off. Second, the motive of the central bank intervention is to strengthen private capital flows. However, the frequency of the interventions is limited by the available resources in the hands of the central banks.

The findings of the study are not in line with the conclusion of Steiner (2017). It finds that capital controls cannot be substituted with foreign exchange market intervention because the intervention does not improve monetary independence and the stability of the exchange rate. Therefore, interventions could not be a more reliable instrument than capital controls. This implies that the relax of trilemma constraint cannot be achieved through depending only on interventions as a reliable instrument. Other instruments such as institution quality, need to be given more attentions.

This study is incapacitated by absence of sufficient data that could cover the entire developing countries as well as expanding the time dimension. Most of the employed indices are computed on a yearly basis. This makes it extremely difficult to explore high frequency data in forms of quarterly data. These limitations are to be addressed in the future research.

APPENDIX

Table-A.1. Ranking by Exchange Rate Stability Index (ERSI)

Rank	Country	Country Code	ERSI (Mean)	ERSI (Std)
1	Egypt	EGY	0.795925	0.294985
2	Jordan	JOR	0.744286	0.293753
3	Venezuela	VEN	0.724777	0.375498
4	Bangladesh	BGD	0.695104	0.251704
5	Ecuador	ECU	0.653061	0.382036
6	Jamaica	JAM	0.562191	0.270992
7	Pakistan	PAK	0.547638	0.234834
8	Malaysia	MYS	0.525672	0.264809
9	Thailand	THA	0.520548	0.238014
10	Morrocco	MAR	0.51932	0.145223
11	Ghana	GHA	0.507605	0.308228
12	Argentina	ARG	0.497083	0.379271
13	Colombia	COL	0.494667	0.290017
14	Singapore	SGP	0.481705	0.120555
15	Nigeria	NGR	0.469297	0.322778
16	India	IND	0.462196	0.214598
17	Tunisia	TUN	0.457011	0.110168
18	Korea	KOR	0.439632	0.212362
19	Sri Lanka	LKA	0.429406	0.199254
20	Philippines	PHL	0.415566	0.205775
21	Mexico	MEX	0.407318	0.255569
22	Botwana	BWA	0.399126	0.129569
23	Chile	CHL	0.375221	0.199886
24	Kenya	KEN	0.342503	0.130417
25	Israel	ISR	0.335492	0.108386
26	Mauritius	MUS	0.329774	0.091545
27	Brazil	BRA	0.293422	0.23545
28	Turkey	TUR	0.277747	0.112056

Source: http://web.pdx.edu/~ito/Chinn-Ito_website.htm

Table-A.2. Ranking by Chinn-Ito Index (KAOPEN)

Rank	Country	Country Code	KAO (Mean)	KAO (Std)
1	Singapore	SGP	2.306231	0.263101
2	Jordan	JOR	0.859205	1.514102
3	Malaysia	MYS	0.837236	1.255042
4	Jamaica	JAM	0.595988	1.476756
5	Botwana	BWA	0.542616	1.475664
6	Israel	ISR	0.511006	1.509245
7	Mexico	MEX	0.462791	1.093701
8	Mauritius	MUS	0.402265	1.583975
9	Ecuador	ECU	0.179621	1.065039
10	Egypt	EGY	-0.01844	1.826938
11	Kenya	KEN	-0.03181	1.259117
12	Chile	CHL	-0.23428	1.749997
13	Korea	KOR	-0.24445	0.725099
14	Venezuela	VEN	-0.31247	1.380674
15	Sri Lanka	LKA	-0.33687	0.77816
16	Thailand	THA	-0.33883	0.431168
17	Argentina	ARG	-0.3973	1.204851
18	Philippines	PHL	-0.46715	0.659332
19	Turkey	TUR	-0.77313	0.623726
20	Tunisia	TUN	-1.06734	0.342949
21	Colombia	COL	-1.08232	0.814732
22	Brazil	BRA	-1.08308	0.939101
23	Nigeria	NGR	-1.08603	0.513595
24	India	IND	-1.18876	0
25	Pakistan	PAK	-1.20893	0.119343
26	Morrocco	MAR	-1.21873	0.432015
27	Bangladesh	BGD	-1.37012	0.45659
28	Ghana	GHA	-1.49116	0.43823

Source: http://web.pdx.edu/~ito/Chinn-Ito_website.htm

Table-A. 3. Ranking by Monetary Independence Index (MII)

Rank	Country	Country Code	MII (Mean)	MII (Std)
1	Nigeria	NGR	0.574492	0.127634
2	Jamaica	JAM	0.552939	0.142605
3	Brazil	BRA	0.551955	0.181928
4	Ecuador	ECU	0.543078	0.132342
5	Kenya	KEN	0.537445	0.201489
6	Colombia	COL	0.520519	0.149724
7	Mexico	MEX	0.501026	0.206604
8	Turkey	TUR	0.500553	0.109384
9	Chile	CHL	0.500131	0.166139
10	Morrocco	MAR	0.495194	0.130221
11	Venezuela	VEN	0.492438	0.144461
12	Israel	ISR	0.481184	0.145407
13	Egypt	EGY	0.480213	0.16154
14	Sri Lanka	LKA	0.476744	0.141621
15	Singapore	SGP	0.476324	0.128711
16	Bangladesh	BGD	0.469916	0.103697
17	Pakistan	PAK	0.46523	0.127325
18	India	IND	0.46463	0.158772
19	Jordan	JOR	0.463647	0.205341
20	Ghana	GHA	0.461846	0.184875
21	Tunisia	TUN	0.451401	0.147265
22	Botwana	BWA	0.450071	0.162537
23	Korea	KOR	0.445044	0.115082
24	Malaysia	MYS	0.439782	0.112316
25	Philippines	PHL	0.436841	0.178531
26	Mauritius	MUS	0.433908	0.14896
27	Argentina	ARG	0.423057	0.118394
28	Thailand	THA	0.373821	0.200815

Source: http://web.pdx.edu/~ito/Chinn-Ito_website.htm

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