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VOLATILITY OF CAPITAL FLOWS IN EMERGING AFRICAN ECONOMIES

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ABSTRACT

This study examines the empirical nature of capital flows in some selected African countries –i.e. South Africa, Morocco, Egypt and Botswana. In addition it also investigate empirically such issues of sudden stops and reversals. The study has employed the widely used Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model and considers the Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH), which was tailored to empirically examine absolute and relative magnitudes of the flows in these economies. Moreover, it detailed the volatile nature of capital flows in these countries, including the identification of periods of sudden stops and reversals as well as measuring the extent of their historical volatilities. Thus, revealed some interesting results, such as strong evidence of persistence in capital flow volatility for all the countries under investigation and that the volatility does not indicate a tendency of reversal to its previous mean. Furthermore, it identify that, the previous information of each capital component (foreign direct investment and portfolio flows) demonstrates a strong effect on the behaviour of capital flow volatility across all the countries under review. Additionally, conforming to a priori, the study revealed that portfolio investment is more volatile than the foreign direct investment (FDI) for all countries. Further, it discover inherent asymmetries in the volatility behaviour which is underpinned by the large information asymmetries in most capital market in these countries. This finding is presumed by the consistency of the EGARCH over other ARCH models. Overall, the study indicates that FDI is the most volatile flow in Botswana, South Africa, Egypt and Morocco, in that order. While PINV is most volatile in South Africa, it is followed by Egypt, Botswana and Morocco respectively.

INTRODUCTION

Following the global implementation of the Washington consensus[1], the important aspect of which was financial liberalization aimed to promote free capital mobility, a number of African countries have reformed their economies in order to benefit from the significant global capital flows. Many countries in the continent of Africa have liberalised their trade and exchange regimes, including opening up their capital accounts and placing a number of incentives aimed at attracting foreign investments. Consequently, Africa has attracted a relatively good share of global capital flows, especially since the early 1980s, due to the international efforts that have been taken, around that period, in this regard, through both multilateral and bilateral financing.

[1] For details, see Palley (2009).

As noted by the BIS's Committee on Global Financial System (BIS, 2009), however, a key feature that capital flows have historically shared is their responsiveness to the cyclical development of the originating countries, and hence their volatility. The preferment of opening up capital account in the last two decades, interacting with a number of factors, has led to the increased volatility of global capital flows. During the last decades, therefore, the continent has also witnessed capital flows that have been volatile in nature. These flows reduce drastically in late 2001, but surged all the way through to 2006, prior to the period of global financial crisis (UNCTAD, 2013; AfDB, 2013; OECD, 2014; and UNDP, 2015). Jose and Massa (2009) maintain that net foreign direct investment (FDI) to Africa gradually increased from US$13 billion in 2004 to around US$33 billion in 2007. Portfolio equity flows also rose steeply to about US$15 billion in 2006. They also identify that the flow of bonds swiftly increased by US$7.1 billion between 2006 and 2007. These rising flows, however, dropped drastically, and the capital flows to the African region dropped drastically during the crisis period of 2008-2009 (AfDB, 2015; OECD, 2015 and UNDP, 2015), but surged again in the aftermath of the crisis.

Alleyne and Mecagni (2014) observe that sub-Saharan African frontier markets benefited more from the surge in private capital flows after the crisis, with Ghana and Nigeria as the main beneficiaries. These capital flows did not come without a price, chiefly in the form of complication of economic management, especially given the nature of economic and financial development in the region. One of the key concerns of the policymakers in the recipient economies is managing the economic consequences of the volatile flows. The magnitude and volatility of these flows can affect the receiving economy in a number of ways. Firstly, the magnitude of the flows, relative to the economy's abortive capacity, can significantly affect the domestic monetary and financial conditions when such flows are monetized and thereby raising inflationary pressures or financial instability (Broto, Díaz-Cassou&Aitor, 2011). Secondly, the monetisation of the associated foreign exchange directly raises foreign exchange market pressure, thereby necessitating authorities to sterilise the extent to which it depends on the exchange regime in operation.
Thirdly, the domestic assets markets could also be significantly affected, especially if such capital flows are portfolio in nature.

Fourthly, and lastly, depending on the extent and effectiveness of a monetary authority's responses, the volatility of these flows creates uncertainties in the economy's foreign exchange and assets market. Capital flows could, therefore, complicate macroeconomic management in the small, open, emerging economies of Africa as monetary authorities are often constrained to respond in ways that mitigate the expected impact (especially if such flows are portfolio related). This is especially so in the context of African economies where monetary policy is already complicated by the openness of the capital account, subsisting with some form exchange rate fixity (Opperman, 2016).This study is to provide an empirical analysis of the behaviour of capital flow volatility experience of the selected counties in the last three decades. In addition, it answers whether the capital flows of the African emerging economies are volatile and what happened to the country's flows during major global economic events. It also, examines the magnitude and volatilities of each type of capital flows (in absolute and relative terms) into the countries during the last three decade. In examining the volatile nature of the capital flows, such issues such as sudden stops and reversals have also been empirically addressed. The study presents an Introduction, literature review, methodology, data, results and interpretation of the findings, conclusions, lastly reference and appendix.

LITERATURE REVIEW

The concept of capital flow is often used in literature, and may have become relatively common in recent times, especially with the increasing integration of financial markets across countries and continents (Arias *et al*., 2013). The rising spate of globalization, which encourages the mobility of both capital assets and financial investment, may have accentuated the concept of capital flow. A number of studies, such as Broner*et al.* (2011) and Bluedorn*et al.* (2011), conceptualize capital flow based on IMF's manual on balance of payments and international investment[2]. According to the manual, as cited in Bluedorn*et al*. (2011), capital flow is referred to as the cross-border financial transactions (for the purpose of investment, trade or business production, including the flow of capital within corporations in the form of investment capital, capital spending on operations and research and developments) recorded in external financial accounts of countries. The external financial account records, on a net basis, the financial flows stemming from transactions that produce a change in the assets and liabilities of residents, in comparison to non-residents. Such assets and liabilities are broken down into the categories of direct investment, portfolio investment, other investments and a change in reserve assets. By this definition, therefore, items such as FDI and portfolio investment all constitute capital flows.

Similarly, based on what constitutes capital, changes in items like portfolios, foreign direct investment, bank loans and other international investments are captured in the external capital account. As such, all these constitute capital flow. As adopted in Forster (2014), Arias *et al.* (2013), Arora *et al.* (2012) and Kose*et al.* (2003), it may be concluded that changes in the financial transaction reflected in the external accounts of respective countries or economies constitute capital flow. In line with most studies in the literature, such as Alfaro (2007), Rangasamy*et al.* (2013), Forster (2014) and Schwab *et al.* (2015), the present study operationally adopts the IMF's conceptualization to measure capital flow as cross border financial transactions, which strictly comprise of financial assets such as foreign direct investment, portfolio investment (which is further divided into equity and debt), and bank transactions, such as international bank lending (and also categories of capital assets as the main component of capital flow). In dealing with flow variables over a time dimension, it is imperative to delineate the direction of the flow. As such, the concept of capital flow appears to be somewhat ambiguous. This is because it does not signify the direction of movement of the capital. Signifying the direction of movement (inflow or outflow) might not only be critical to the changes in liabilities' standings in the capital account,

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[2]The balance of payments and international investment position manual (BPM6) is the latest and revised edition of IMF's manual on financial account implemented in 2008.

but it could also be reflected on the relative value of countries' domestic currencies (via, for instance, the demand and supply of foreign exchange). Following Broner*et al.* (2011), capital inflow represents the increase or decrease in foreigner's holdings of domestic assets. This means that capital inflows are capital assets that are held by foreign agents and the changes (increases or decreases) could be determined by the perceived economic interest[3] of the foreign agents. Similarly, this concept can be viewed from a market model perspective. That is, the foreign holdings in terms of increase (or decrease) of domestic capital assets constitute changes in foreign demand for domestic assets. By extension, this implies that a rise in the demand for domestic assets by non-residents could invariably mean an increase in the capital inflow.

Broner*et al*. (2011) went on to conceptualize capital outflow, and distinguish it from capital inflow, as representing foreign capital assets holdings by domestic agents. Furthermore, their definition justifies the signs (positive or negative) which could be recorded in the external financial capital account. They conceived an increase in the foreign assets' holding by domestic economic agents to reflect positive entries in the external financial capital accounts of countries[4]. Analogously, a negative entry in the capital account implies a capital inflow. Therefore, to operationalize the dual opposite concept within the premises of this study, consideration is given only to the flow characteristics of the capital assets in terms of magnitude over the time dimension. This means that the reflection of the sign incorporated in the external financial accounts is less relevant, at least for the purpose of this study. The literature tends to distinguish between *gross* and *net* flows because the two concepts have different implications on macroeconomic management, depending on the state of the recipient economy. For instance, although Alfaro *et al.* (2007) argue that there is only a little empirical difference in the measurement of the two concepts because both are almost unidirectional from rich core economies to peripheral economies, they are distinctively different concepts. In that, gross capital flows are the sum of absolute values and, therefore, they are always positive. According to Alfaro *et al*. (2007), net capital flow, in contrast, is measured as a change in liabilities which could bear either positive or negative magnitude. This suggests that, as much as they could be similar in terms of behaviour across economies, they could yet have different implications on the international reserves and balance of the external capital account and, by extension, the exchange rate[5] of the related economies. Arias *et al.* (2013), who were inspired by the distinction made by De-Gregorio (2012), raise concerns about the dissimilarities between the concepts in terms of policy implication on economies. They point out that the management gross and net capital flow have distinct and varying effects on macroeconomic stability, exchange rates and financial stability.
De Gregorio (2012), in distinguishing the two concepts, considers the difference in terms of macroeconomic effect that countries that are predisposed to issues relating to

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[3]Noting that the economic interests which could include a number of factors could be attributed to the push or pull factors.

[4] This study expects that the changes in the capital inflow or outflow could be volatile, which could also transmit to volatility in the respective countries exchange rates.

[5]The transmission of the capital account changes forms the core aspect of this study.

pressures on the exchange rate, international reserves' depletion (weak external reserve buffers) or other macroeconomic variables should, therefore, pay emphasis to net capital flow. This argument was partly based on the observation that net capital flow is the counterpart of current account deficit, which further warrants the definition of the current account of the balance of payments as "the change in the net asset position of an economy". Gregorio (2012) expounds that for economies that have concerns with issues relating to financial stability, gross capital flow must be prioritised. This position also conforms to earlier arguments by Bario and Disyatat (2011) and Kraay (1998).The dynamic nature of the literature on capital flows has led to one of the liveliest debate**s** in economic history, which is centred on studying the behaviour of net capital flows that many studies term as volatile and pro-cyclical in nature (Kamisky*et al*., 2005; Contessi, 2013). Studies conducted in emerging and developed economies portray the extreme nature of these patterns. These types of patterns are associated with a significant fall in capital flows that are usually accompanied by a crisis. The erratic behaviour of these patterns inspires the use of the term 'sudden stops' by researchers[6]. The concept of sudden stops was introduced in the work of Dornbusch *et al*. (1995), who quotes a famous banker's statement that "it is not speed that kills, it is the sudden stop". They apply this idea in the framework of currency crises and the collapses following unsuccessful stabilization policies.

The literature on the analytical framework of the concept of a sudden stop is associated with the work of Calvo (1998), where sudden stops are described as sharp slowdowns in net capital inflows. He developed the mechanism through which sudden stops in international credit flows can fetch financial and balance of payments crises. The study concludes that sudden stops can cause bankruptcy and destruction of human capital and local credit channels. Calvo (1998) maintains that large current account deficits can be dangerous depending on how they are financed and that increases in the marginal propensity to spend on non-tradeable goods increase the negative impact of the flows stops. In addition, short-term financing has the tendency of contributing to the large slowdown in capital inflows.   Further, Calvo *et al*. (2004) analyse the empirical features of sudden stops and the relevance of balance-sheet paraphernalia in the probability of sudden stops' manifestation. Real exchange rate instabilities, complemented by sudden stops, are often associated with emerging markets. Openness, combined with domestic liability dollarization, is a key determinant of the occurrence of sudden stops.

Additionally, the following qualify the sudden stop concept's operational process:

1) Observation of annual drops in capital flows within two or more standard deviations below its sample mean.
2) The episodes of sudden stops are only be considered finished when the annual change in capital flows surpasses one standard deviation below its sample mean.

[6]Dornbusch*et al*. (1995); G. Calvo (1998); Jeasakul (2005); Edwards (2005) and Hutchison &Noy (2002).

3) To divide the period, the beginning of a sudden stop time is determined by the initial period the annual variation in capital flows falls to one standard deviation below the mean.

Similarly, Jeasakul (2005) maintains that the condition of capital flows qualifies as a sudden stop if the domestic economy's access to international capital markets drops due to sudden falls in the private foreign citizen's supply of capital. Edwards (2005) also states that sudden stops of capital inflows are a situation whereby the flow of capital coming into a country is reduced significantly within a very short time. Cavallo and Frankel (2008) corroborate that for the stops to capture a global component and qualify as systemic sudden stops, it has to occur in conjunction with a strident increase in interest rate spreads. Hutchison and Noy (2002) advocate the use of current account reversal to capture reversals of capital flows, and stress that for a condition to qualify as sudden stops, it must cover events in which a country simultaneously encounters a current account reversal, coupled with an above 3% GDP increase in comparison to a currency crisis.

Similarly, Guidotti*et al*. (2003a) stress that sudden stops are based on large reversals of the capital account and are associated with output retrenchments. They further postulate that a situation to only qualify as reversal is if the country standard deviation of capital account drops by 2% below its mean sample, in addition to 5% GDP appreciation. Edwards (2007) also states that for sudden stops to occur, a country must receive capital inflows in its region's third quartile two years prior and net capital inflows a 5% decline in GDP. Reinhart and Reinhart 2009) maintain that the mirror images of the traditional sudden stops measure are capital flow "bonanzas" or "surges", a condition that qualifies as a sharp increase in net capital inflows. Faucette (2005) and Cowan and Gregorio (2007) advocate for the need to traditionally include capital flight in the study of sudden stops due to the fact that domestic residents send money abroad. The studies employ the standard approach techniques to define sudden stops. Faucette (2005) and Cowan and Gregorio (2007) further divide sudden stop into two: 1) true sudden stops, which is a situation whereby gross capital inflows drop more than the gross capital outflows increase, and 2) sudden flight, an event whereby gross capital outflows increase while gross capital inflows decrease. More recently, Forbes and Warnock (2012a) define sudden stop incidences as periods that are associated with marked slowdowns in net capital inflows. Mondoza (2016) states that important empirical regularities are integral parts of sudden stops and that international capital flow reversals mirror both net exports' unexpected increases and the current account imbalances. Production and absorption declines and that means corrections in asset prices. Many studies have been carried out to ascertain the determinant, impact and behaviour of sudden stops, mostly in emerging markets, although there are very few with large samples that include developing countries. Calderón and Kubota (2014), using annual data in a sample of 82 countries over the period 1970–2007, argue that the determinants of sudden stops may not be similar across all countries. The study posits that countries with higher shares of foreign direct investment are less prone to inflows-driven sudden stops, whereas the opposite is true for outflows-driven sudden stops. The study also identifies that when the economy of international investors is growing, it will be less likely to stop them from taking their capital back home, especially when the world interest rate is lower. Additionally, domestic agents will be more willing to invest abroad if the macroeconomic performance – high inflation – of the domestic economy is poor; the financial system is weak, and there are current account surpluses. The research also observes that increases in financial flow often makes a domestic country more vulnerable to sudden stops caused by either local or global investors. Calvo*et al*. (2013) discuss the effects of sudden stops on economic performance using the new taxonomy regression of sudden stops, which is comprised of seven categories. Their definition of categorization is based on the behaviour of gross and net capital flows. They found that the most destabilising form of sudden stops is the ones in net flows that are associated with reductions in gross inflows. The destabilizing nature of these flows is far more than those flows where surges in gross outflows dominate. Additionally, gross inflows sudden stops do not lead to a sharp contraction in net flows that may be disruptive, including sudden stops that are driven by other flows such as banking flows.

For Edwards (2007), the two areas of external crises that have received considerable attention during the last few years are sudden stops of capital inflows and current account reversals. He examines the extent to which capital mobility affects countries' degree of vulnerability to external crises. Using the parameters of countries' declining growth during the crisis, the extent to which capital mobility determines the depth of the external crisis is analysed. He argues that there is no evidence suggesting that countries with higher capital mobility will have a high probability of crisis than countries with lower mobility. He further suggests that once crises occur, countries with higher capital mobility tend to face a higher cost in terms of growth decline. In a similar research Bordo (2006) uses descriptive statistics to compare capital flows, current account reversals, and financial crises during the previous crises period, with the recent experiences. The study analyses the incidence of crises and measured their effects on real output losses. Bordo (2006) also considers the influence of openness to trade and currency mismatches on the pattern of sudden stops and financial crises. He found strikingly similar patterns across both eras of globalisation. According to this study, the current pattern of sudden stops and financial crises in emerging markets has great resonance with events in the first era of globalisation. The pre-1914 sudden stops were associated with significant output losses comparable with the recent events, such that their effects differed considerably depending on a country's economic circumstances.

Furthermore, Efremidze*et al*. (2009) uses the annual data of 25 emerging market countries from 1990 to 2003 in his empirical characterization of commonly used measures of international financial crises, particularly sudden stop and currency crises measure. The study discovers that sudden stops are more likely to pave the way for currency crises and that output costs will be higher when both crises occur simultaneously. It also posits that more than half of the sudden stops' episodes occur simultaneously with currency crises, and less than 60%of currency crises are accompanied by sudden stops. In their study, Benigno *et al*. (2015), using a sample of

70 countries comprising of middle- and high-income ones, describe the stylised facts' phases of extremely large capital inflows. The study classifies 155 events of large capital inflows and observes that these trials are usually accompanied by an economic boom, and often followed by a slump. Additionally, they opine that, during the period of large capital inflows, labour and capital shift out of the manufacturing sector. Accumulating reserves during this period seems to limit the degree of labour reallocation. It leads to larger credit booms and capital inflows during the incidents, which then increase the likelihood of sudden stops occurring during or immediately after the episode. Lastly, the strictness of the post-inflows recession is considerably associated with the extent of labour reallocation during the boom period, with more of a labour shift out of the manufacturing sector during inflows episodes that are associated with a sharper contraction in the repercussion of the episode. Other studies in the behaviour of capital flow volatility, particularly in the African region, were IMF (2014) that observes the nature of portfolio to sub-Sahara African countries and concludes that the volatility of portfolio flows to the region is relatively small compared to the emerging and developing countries in the other parts of the world. The study further attests that the financial market in the sub-Sahara African region is shallow and capital flow volatility has the ability to affect it tremendously. Thus, the countries within the region need to develop a framework capable of managing vulnerabilities more than the other developing and emerging economies in the rest of the continent.

In another study, entitled 'The Determinate and Consequences of Private Capital Flows in Sub-Saharan Africa', Opperman (2016) discloses that global liquidity is among the major factors that lower FDI volatility for the middle-income countries of the region. The study also finds the global liquidity and global risk to be among the significant drivers of FDI volatility. Additionally, Opperman (1996) posits that global risk increases portfolio equity volatility with the quality of macroeconomic policies and financial openness found to be an important pull factor in lowering portfolio equity volatility in the region. Moreover, financial openness and its depth lowers cross-border bank lending volatility. In contrast, for low-income countries (LICs), global liquidity lowers cross-border bank lending volatility while the quality of macroeconomic policies is an important pull factor in lowering volatility. The study concludes that, due to the importance of global push factors in determining private capital flow volatility in the region, the countries should pursue policies such as the effective monitoring of capital flows, better trained and qualified staff, and greater sub-Saharan African country representation in international financial institutions to enable broader policies capable of strengthening their ability to deal with volatile episodes.

IMF (2017) studies the volatility of capital flow to the emerging countries with the quarterly panel data of 65 countries that include South Africa, Morocco and Egypt. The study discovers that the literature on the aspect of capital volatility is scarce. The study shows that the volatility of all the capital instruments is susceptible to sessions, which are rising sharply during global shocks like the quantitative easing taper outburst episode. This also attests to the fact that capital flow volatility has been and remains a challenge for policy makers. In line with the findings of Opperman (2016), the IMF

(2017) regression results also suggest that push factors can be more important than pull factors in explaining volatility and illustrating that the characteristics of volatility can be different from those of the flows levels. Overall, the literature of capital flow volatility is scanty, particularly for emerging and developing economies (IMF, 2017). The ones available can be categorised into two, i.e. those that contribute theoretically (Martin & Rey, 2006; Bacchetta& Van Wincoop, 1998) and others that attempt to differentiate the nature of capital flow volatility between emerging and developed economies (Rigobon&Broner, 2005). In spite of the scarcity of capital volatility literature, almost all of the existing studies in that area have been conducted in a panel format and this would not allow the researcher to give attention to the peculiarity of individual countries in the study sample. This study attempts to fill the gap by conducting an individual country research regarding the capital flow volatility in the sample countries. At the time of compiling this research, to the best of the researcher's knowledge, there was no study on capital flow volatility that was conducted in the comparative nature of this type.

METHODOLOGY

This section describes the methodological approach to examining the empirical nature of capital flows in the selected countries. The first key issue under examination is the absolute and relative magnitudes of the flows in these economies. The second issue relates to the analysis of the volatile nature of capital flows in these countries, including the identification of periods of sudden stops and reversals as well as the measure of the extent of their historical volatilities.

Magnitudes of Capital Flows in the Selected Economies

To examine the absolute and relative magnitudes of the flows in these economies, the historical ratios of the various component of capital flows to such important indicators as the real GDP, total exports, total reserves, and total foreign currency deposits in the DMBs are presented. These ratios help reveal the extent of vulnerabilities of these countries to crises resulting from sudden-stops. The trend examination and cross-country comparison help introduce the dynamics of these flows and form the foundation for chapters four and five.

Capital Flows Volatility and Sudden Stops

To examine the nature and extent of the volatility of capital flows in these economies, three separate but interrelated steps are taken. In the first step, Calvo's (1998) methodology is used to identify the historical episodes of sudden stops in each of these countries. Using an events' matching approach, the behaviour of key economic variables around the identified periods of sudden stops are examined. This provides preliminary evidence on the potential implications of capital flow volatility on the macroeconomics, and hence the need for policy responses aimed at its mitigation.

The chapter employs the EGARCH model to estimate the conditional volatile of the various components of capital flows in the selected countries.

Empirical Model for Historical Volatility of Capital Flows
Unlike the empirical evidence obtain in literature, as found in Oppermanet *al*. (2017), Li and Rajan (2015), Brotoet *al*. (2011), Neumann *et al*. (2009), Poshakwale and Pérez (2008), there are more concerns in differentiating the nature of capital volatility between developed and emerging economies or attesting the impact of financial integration on capital volatility. This study examined the nature of capital flow volatility experience by selected countries during the period of the study. The study also interrogated the foundation of the widely-used GARCH model and considered the EGARCH. The consideration of a variant of the GARCH follows from the fact that the EGARCH allows and accounts for asymmetries of good and bad news on the returns of capital assets. Similarly, unlike the GARCH model which assumes that only the magnitude of unanticipated excess returns on capital investment determines the varianceσ_t^2, the EGARCH not only incorporates this magnitude but also internalizes the direction of the returns as it also accounts for volatility. Similarly, the GARCH could be held liable for misleading outcomes due to its persistent volatility that might linger for an infinite period. Hence, the result of GARCH estimates may effectively change the volatility structure of the market. Therefore, given the aforementioned superiority of EGARCH over the GARCH model, the study specifies the conditional mean equation and the conditional variance equation consistent with the EGARCH model. The conditional mean equation is specified according to the following law of motion:

$$fpi_t = \Psi_t + \beta' fpi_{t-1} + \varepsilon_t \quad (1)$$
$$fdi_t = \omega_t + \lambda' fdi_{t-1} + \epsilon_t \quad (2)$$

The conditional mean equations in 1 and 2 imply that the current foreign portfolio investment (fpi_t) and the foreign direct investment (fdi_t) depend on past investment and information (good and bad news about portfolio and direct investment respectively).

$$\varepsilon_t | \Omega_{t,\varepsilon} \sim iid(0, \sigma_{t,\varepsilon}^2)$$
$$\epsilon_t | \Omega_{t,\epsilon} \sim iid(0, \sigma_{t,\epsilon}^2)$$

$\sigma_{t,\varepsilon-j}^2and\Omega_{t,\epsilon}$ are the information sets upon which the residuals of portfolio and direct investment depend respectively are conditioned. The conditional variance equation is presented in equation 3.3 and 3.4 respectively.

$$\log(\sigma_{t,\varepsilon}^2) = \gamma + \sum_{j=1}^{q} \xi_{j,\varepsilon} \left| \frac{\varepsilon_{t-j}}{\sqrt{\sigma_{\varepsilon,t-j}^2}} \right| + \sum_{j=1}^{q} \zeta_{j,\varepsilon} \frac{\varepsilon_{t-j}}{\sqrt{\sigma_{\varepsilon,t-j}^2}} + \sum_{i=1}^{p} \mu_i \log(\sigma_{\varepsilon,t-i}^2) \quad (3)$$

$$\log(\sigma_{t,\epsilon}^2) = \varphi + \sum_{j=1}^{q} \xi_{j,\epsilon} \left| \frac{\epsilon_{t-j}}{\sqrt{\sigma_{\epsilon,t-j}^2}} \right| + \sum_{j=1}^{q} \zeta_{j,\epsilon} \frac{\epsilon_{t-j}}{\sqrt{\sigma_{\epsilon,t-j}^2}}$$
$$+ \sum_{i=1}^{p} \pi_i \log(\sigma_{\epsilon,t-i}^2) \qquad (4)$$

The EGARCH specification 3 and 4 bear an exponential leverage effect, and hence the estimates will be consistently positive. Similarly, the specification also accounts for the existence of a threshold effect in the portfolio investment. The hypothesis that follows is that$\zeta_j < 0$, when good news about portfolio (positive shocks) generate less volatility than bad news (negative shocks).

Contagion Effects of Capital Flows Volatility

The various measures of conditional volatility are examined for correlation amongst themselves in order to examine the hypothesis of contagion amongst the selected emerging economies. The dynamic conditional correlation (DCC) is employed to examine whether capital flow volatility has been contagious in the selected countries. The theoretical basis is that because it originates from the core, events in the core countries are likely to simultaneously affect all the destinations at the periphery. However, because of the possibility of domestic (destination specific factors) source of stops, co-movements may not be perfect. In the extreme case where country specific factors are the sole cause of volatility, there will be zero correlation. In the other extreme, there will be perfect correction.

Data

The data to be used for this study are quarterly data spanning from 1990q1 to 2016q1 for the sample of all the countries (Botswana, Egypt, Morocco and South Africa). The samples of the countries used in the study are constrained by the availability of data within the sampled period (particularly the FDI quarterly for Botswana, Egypt and Morocco). Data on gross domestic capital formation, gross domestic product, foreign reserves and exports were obtained from the World Bank's World Development Indicators of 2018. Annual data on foreign capital inflows, including foreign direct investment and portfolio investment inflows were obtained from the International Monetary Fund's International Financial Statistics. However, due to the paucity of the data FDI annual series for Botswana, Egypt and Morocco were converted to quarterly series with the aid of EVIEWS software, to ensure the use of high frequency, which gives better volatility estimates[7].The measurement of capital flow in each of the sampled countries was restricted to two categories of capital namely, foreign portfolio investment (FPI) and foreign direct investment (FDI). These are used as the major components of capital flows. All capital measured were indexed into US dollars. The justification of this indexation resides in the global benchmarking of international

[7] For works that used quarterly data, see Alhassan and Kilishi (2016); Opperman (2016); Brafu-Insaidoo and Biekpe (2011); Broto, Diaz-cassou and Erce (2011), Mendoza (2010) and Alaba (2003).

transactions in the US dollar. The next section presents the results and the discussion of the results.

Results and Interpretations

Magnitudes of Capital Flows in the Selected Economies

To examine the magnitude of cash flows in the selected economies, the ratio of foreign direct and portfolio investments to exports, gross domestic capital formation (GDCF), gross domestic products (GDP) and foreign reserves were estimated. The descriptive statistics of the estimates are presented in table 1. The results show that, on average, Egypt has the highest net FDI to export, GDCF and foreign reserve ratios, while South Africa is the least. In contrast, South Africa has the largest portfolio investment to export, GDCF and foreign reserve ratios. This is followed by Botswana and Egypt. Meanwhile, Botswana has the largest FDI-GDP and portfolio investment-GDP ratios. In summary, South Africa and Botswana are more vulnerable to capital flows' fluctuations because they have larger magnitudes of portfolio investment flows export, GDCF and foreign reserve ratios than the ratios of FDI to those variables. The reason for this is that portfolio investment is more volatile than the FDI.

Table 1: Descriptive statistics of ratios of capital flows to some macroeconomic variables

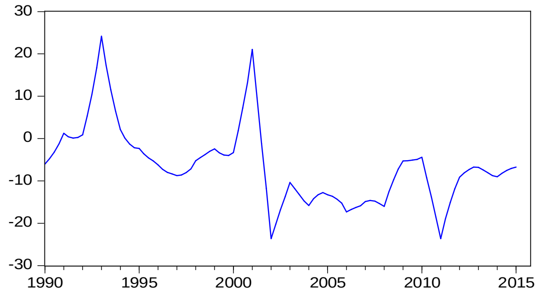
Ratios	Botswana			Egypt		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
FDI-export ratio	-3.17	-2.90	4.50	-8.59	-6.97	7.38
FDI- GDCF ratio	-6.33	-7.21	9.03	-11.82	-5.98	13.41
FDI-GDP ratio	-1.86	-1.76	2.49	-1.56	-0.82	1.65
FDI-Foreign reserve ratio	-3.02	-2.71	3.97	-13.15	-7.02	12.33
PI-export ratio	3.48	1.38	4.08	0.71	0.92	4.19
PI-GDCF ratio	8.38	3.66	10.02	0.91	0.99	5.400
PI GDP ratio	2.14	0.81	2.61	0.13	0.13	0.88
PI-foreign reserve ratio	3.60	1.08	4.49	1.28	1.14	6.85

Ratios	Morocco			South Africa		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
FDI-export ratio	-5.78	-5.68	2.56	-1.28	-0.33	3.09
FDI-GDCF ratio	-7.07	-6.48	3.91	-3.53	-0.96	9.59
FDI-GDP ratio	-1.76	-1.68	0.87	-0.41	-0.10	0.97
FDI-Foreign reserve ratio	-11.83	-10.45	5.73	-5.82	-3.13	27.65
PI-export ratio	-0.68	-0.15	1.59	-4.80	-4.85	5.45
PI-GDCF ratio	-0.75	-0.20	1.59	-9.20	-11.11	13.31
PI -GDP ratio	-0.20	-0.04	0.51	-1.41	-1.52	1.70
PI-Foreign reserve ratio	-1.38	-0.44	2.74	-35.75	-26.82	49.75

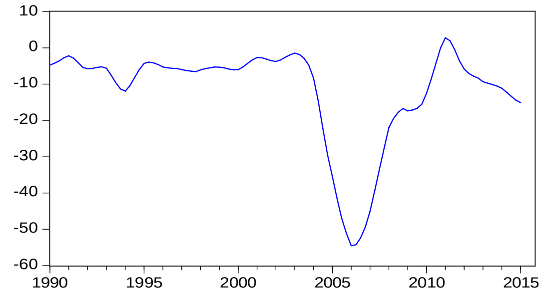
Note: FDI= Foreign Direct Investment, PI = Portfolio Investment, GDCF= Gross Domestic Capital Formation, GDP= Gross Domestic Product. Source: Author's Computation.

Similarly, the trend analysis of the ratios of the components of capital flows and some selected macroeconomic variables (export, GDCF, GDP and foreign reserves) are presented in the figures below. The results indicate that the most fluctuating era of FDI-export ratios was from 2001 to 2006, while that of portfolio investment-export is 2000 to 2010 for all the countries. However, the FDI-export ratio is less vulnerable to shocks than the portfolio investment-export. Comparatively, South Africa has the most vulnerable trend of the series. Similarly, the ratios are relatively stable before 2006 for all the countries. Succinctly, the trend of the series shows that the period before 2000 is stable. In summation, 2000 to 2016 fluctuates more than 1986 to 1999. South Africa is shown to be the most vulnerable followed by Botswana, Egypt and Morocco accordingly. Therefore, the large magnitudes of fluctuations, particularly during the period after 2000, constitute serious cause for concern when sudden stops occur.

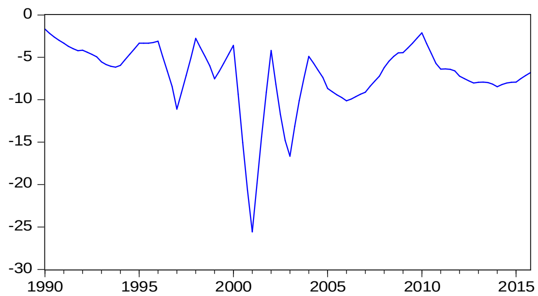
FDI-Export Ratio of Botswana



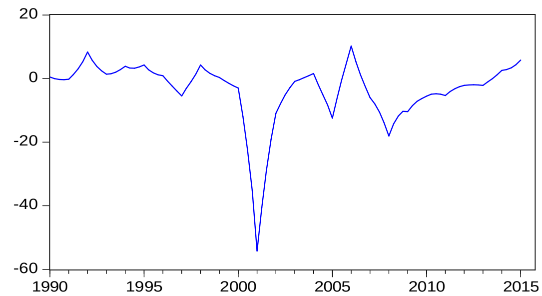
FDI-Export Ratio of Egypt



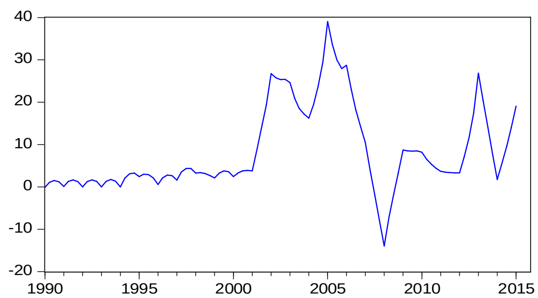
FDI-Export Ratio of Morocco



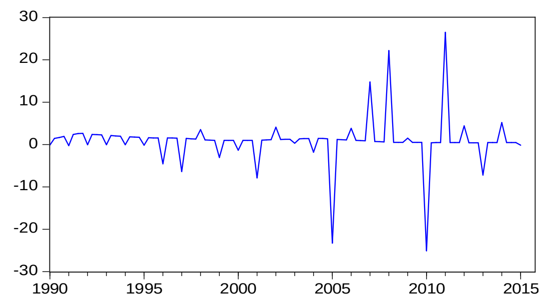
FDI-Export Ratio of South Africa



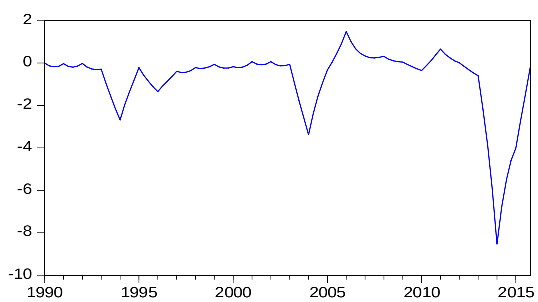
Portfolio Investment-Export Ratio of Botswana



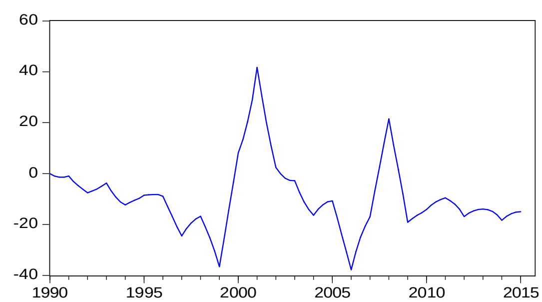
Portfolio Investment-Export Ratio of Egypt



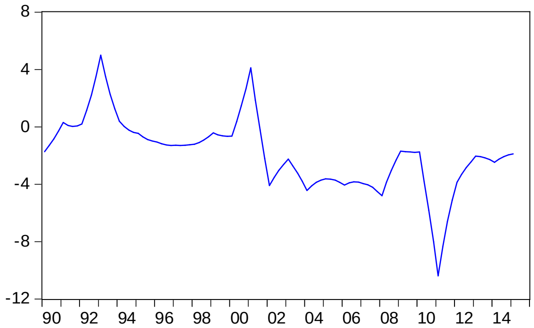
Portfolio Investment-Export Ratio of Morocco



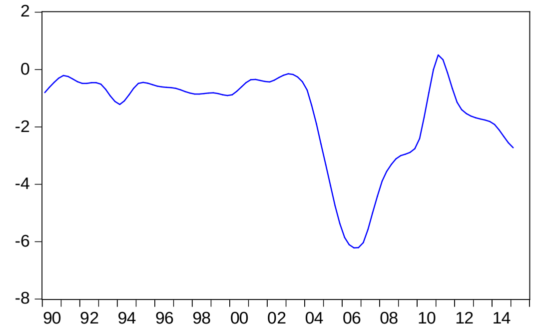
Portfolio Investment-Export Ratio of South Africa



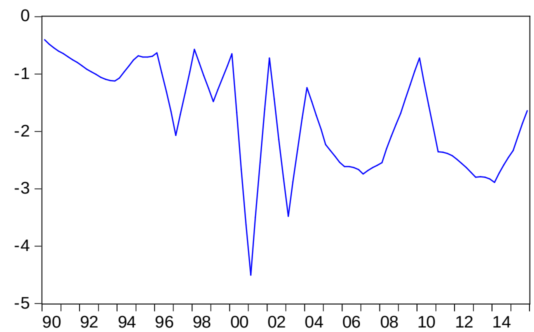
FDI-GDP ratio of Botswana



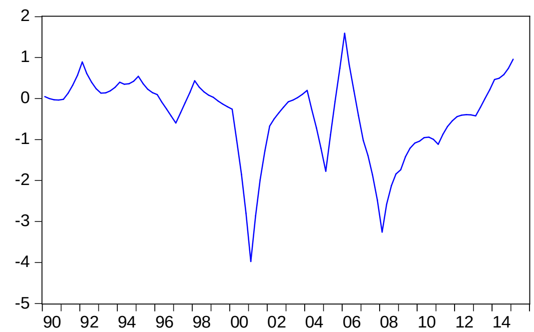
FDI-GDP ratio of Egypt



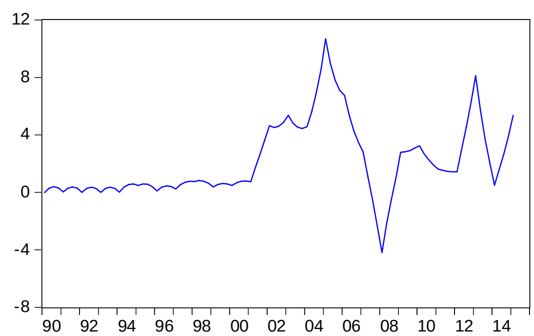
FDI-GDP ratio of Morocco



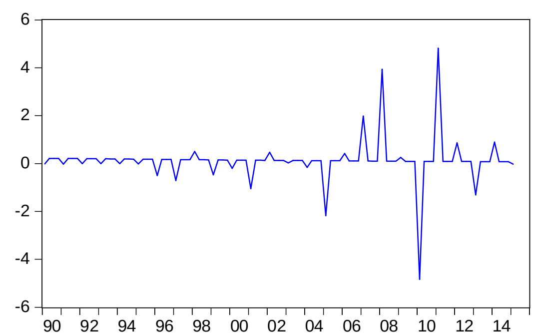
FDI-GDP ratio of South Africa



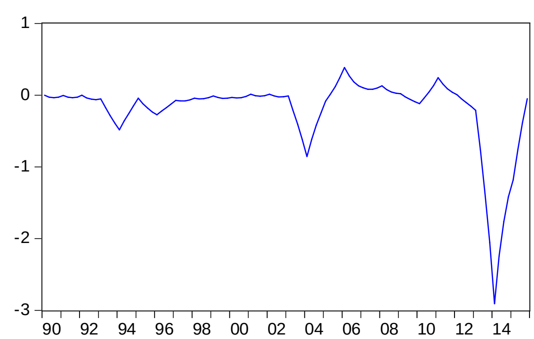
Portfolio investment-GDP ratio of Botswana



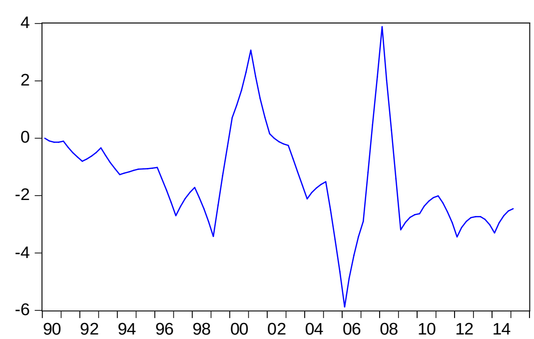
Portfolio investment-GDP ratio of Egypt



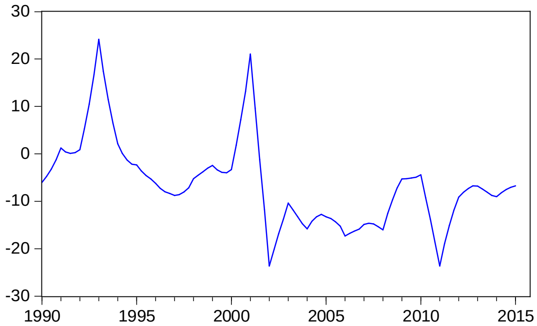
Portfolio investment-GDP ratio of Morocco



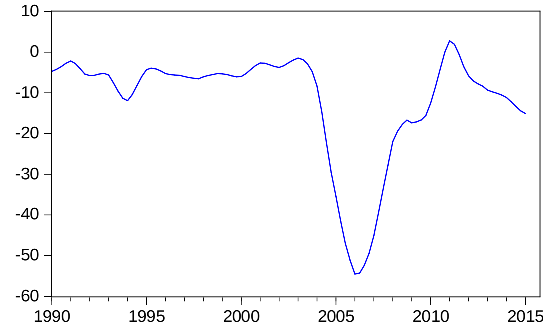
Portfolio investment-GDP ratio of South Africa



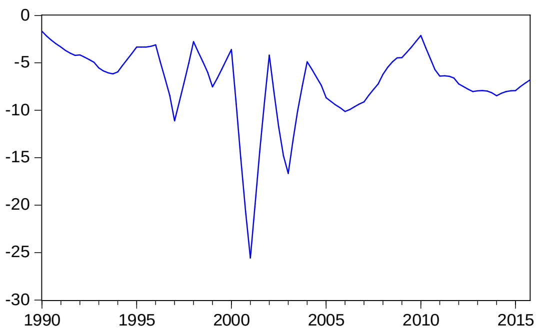
FDI-GDCF ratio of Botswana



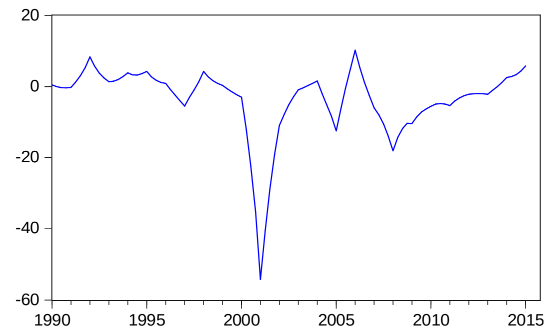
FDI-GDCF ratio of Egypt



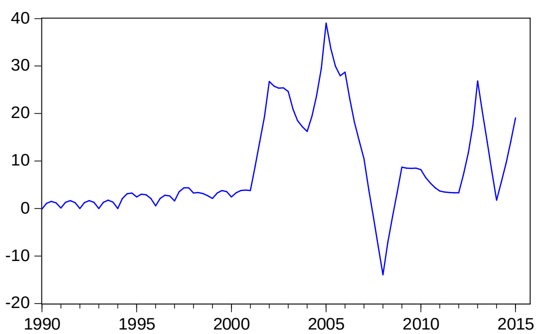
FDI-GDCF ratio of Morocco



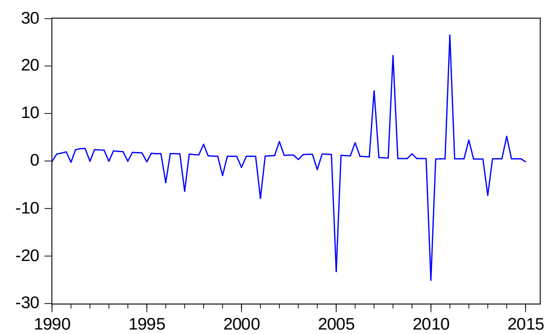
FDI-GDCF ratio of South Africa



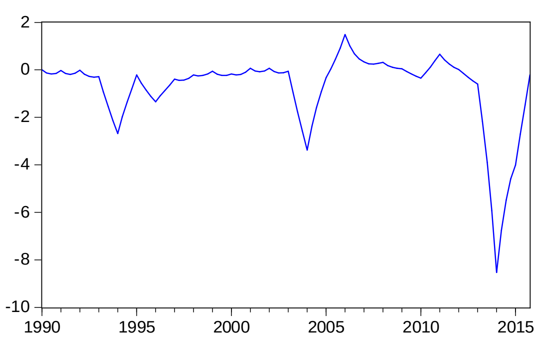
Portfolio investment- GDCF ratio of Botswana



Portfolio investment- GDCF ratio of Egypt



Portfolio investment- GDCF ratio of Morocco



Portfolio investment- GDCF ratio of South Africa

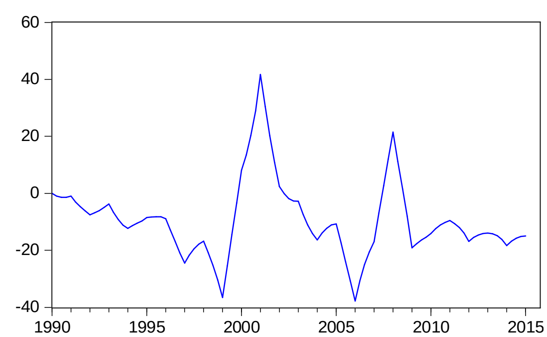


Figure 1: Fluctuations magnitude

Capital Flows Volatility and Sudden Stops

The periods at which sudden stops occur in each country, for each measure of capital flows, are identified and the results are shown in table 2. Sudden stop corresponds to the lowest deviation from trends observed in two consecutive quarters. The results indicate that sudden stops in capital flows occur in all the countries from 2000 to 2003, except the sudden stop in portfolio investment of South Africa which occurred in 1996 (immediately after apartheid).

Table 2: Identification of sudden stops

Measure of capital flows	Sudden stop (Lowest deviation from trend)	Period
Foreign direct investment of Botswana	-3.88	2001q2
Portfolio investment of Botswana	-1.68	2003q4
Foreign direct investment of Egypt	-3.86	2001q2
Portfolio investment of Egypt	-3.4	2003q4
Foreign direct investment of Morocco	-3.4	2000q4
Portfolio investment of Morocco	-1.28	2001q2
Foreign direct investment of South Africa	0.20	2001q1
Portfolio investment of South Africa	-3.2	1996q1

Source: Author's computation.

Historical Volatility of Capital Flows in Emerging African Economies

The result of the ARCH test for both EFDI and EPINV in Egypt is presented in table 3. The results show the presence of arch effect in both variables. This is indicated by both the F-statistic (207.094) and the nR^2 statistic (67.4), which are significant at 1% level. This implies that both EFDI and EPINV are highly volatile in Egypt. Hence, the volatility models are used for estimation. The result of the ARCH test for the MFDI and MPFINV in Morocco is also contained in table 3. It indicates the presence of ARCH effect in both variables. The F-statistic of MNFDI is 401.760 and nR^2 is 81.67058, with probability values 0.0000 respectively. Similarly, the F-statistic of PFINV is 111.3841 and nR^2 is 53.74662 with probability values 0.0000 respectively. This implies that both foreign direct investment and portfolio investment are volatile in Morocco.

Table 3: Result of ARCH test

TEST	EFDI	EPFINV	MNFDI	MPFINVs	BFDI	BPFINV	SNFDIS	SPFINV
F-statistics	207.09 (0.0000)	0.15 (0.6977)	401.74 (0.000)	111.38 (0.000)	167.62 (0.000)	272.68 (0.000)	148.69 (0.000)	189.03 (0.000)
nR^2 statistics	67.43 (0.00)	0.15 (0.6941)	81.67 (0.000)	53.75 (0.000)	62.71 (0.000)	73.02 (0.000)	59.91 (0.000)	65.43 (0.000)

Note: Probability values in parenthesis.
Source: Author's computation.

EFDI= Foreign direct investment for Egypt, MNFDI=Foreign direct investment for Morocco, BFDI=Foreign direct investment for Botswana, SNFDI= Foreign direct investment for South Africa,
EPINV= Portfolio investment for Egypt, MPFIN= Portfolio investment for Morocco,
BPFIN= Portfolio investment for Botswana, SPFINV= Foreign direct investment for South Africa.

Similarly, the F-statistics and nR^2 statistics for BFDI are 167.6204 and 62.71028 respectively, while the F-statistics and nR^2 statistics for BPFINV are 272.6764 and73.02323 respectively. All the statistics are highly significant at 1% (as indicated by the P-value, 0.000). This implies that both BFDI and BPFINV are highly volatile. Further, both the F-statistic (148.6947) and the nR^2 statistic (59.91491) for SNFDI with 0.0000 P-value are statistically significant at 1% level. Similarly, F-statistic (148.6947) and the nR^2-statistic (59.91491), for SPFINV with 0.0000 P-value, are statistically significant at 1% level. This indicates the existence of ARCH effects in foreign direct investment and portfolio investment in South Africa. That is, both variables are volatile.

Table4: Estimates of volatility models of FDI and FPI for Egypt

Estimates of foreign direct investment for Egypt				
VARIABLES	**ARCH**	**GARCH**	**TARCH**	**EGARCH**
Mean equation				
Constant	-86206104 (0.5650)	-86206104*** (0.0000)	-86206104*** (0.0041)	-86200667*** (0.0000)
ENFDI (-1)	0.985604*** (0.0000)	1.000269*** (0.0000)	1.003582*** (0.0000)	1.003316*** (0.0000)
Variance equation				
Constant	2.02E+17*** (0.0008)	1.96E+17** (0.0156)	1.96E+17*** (0.0012)	7.453249*** (0.0041)
ARCH term	0.636157 (0.1343)	2.067818** (0.0490)	1.459290*** (0.0008)	2.203436*** (0.0000)
GARCH term		-1.017634*** (0.0000)	-0.990590*** (0.0000)	0.847052*** (0.0000)
Threshold term			0.088210 (0.4051)	
Asymmetric term				-0.155624 (0.6681)
Model selection criterion				
SIC	42.73749	42.21534	42.32014	41.75051
Estimates of portfolio investment for Egypt				
VARIABLES	**ARCH**	**GARCH**	**TARCH**	**EGARCH**
Mean equation				
Constant	2.18E+08 (0.1669)	2.18E+08 (0.6264)	2.18E+08 (0.5713)	2.18E+08*** (0.0000)

ENPFINV (-1)	-0.020382 (0.3981)	-0.006784 (0.9979)	-0.007359 (0.9201)	-0.002298*** (0.0000)
Variance equation				
Constant	2.55E+18*** (0.0000)	2.50E+18 (0.5341)	2.50E+18 (0.1396)	42.43091*** (0.0000)
ARCH term (-2)	-0.022332*** (0.0000)	-0.030447 (0.5128)	-0.003559 (0.9728)	-0.730282*** (0.0000)
GARCH term		0.359559 (0.7311)	0.357401 (0.4686)	0.002553 (0.8199)
Threshold term			-0.029955 (0.7702)	
Asymmetric term				-0.507107** (0.0466)
Model selection criterion				
SIC	45.30435	45.51245	45.51133	44.09720

*** and ** indicate 1% and 5% level of significance, while () denotes p-values respectively.
Source: Author's computation.

Having found the evidence of volatility in the EFDI and EPINV series, as shown by the result of the ARCH test, the symmetric and the asymmetric ARCH and GARCH models are used for the estimation of the series. The results, containing both the mean equations and the variance equations of the models for EFDI, are presented in table 4. In the mean equation, the lag term of EFDI is statistically significant at 1% level in all the models. This implies that the average FDI in Egypt is affected by its volatility. Also, the results show that the ARCH term is positive and highly significant in all the models (ARCH, GARCH, TARCH and EGARCH). This confirms the presence of volatility in FDI of Egypt. The results of all the models further reveal that the volatility FDI in Egypt is non-mean reverting (the sum of the ARCH and GARCH coefficients is greater than 1). This means that the effect of shock on the FDI is permanent. That is, whenever a shock occurs, the FDI does not return to its previous averages before the shock but rather the trend of its fluctuation changes permanently. Fundamentally, shocks create permanent effects on FDI in Egypt. Meanwhile, the coefficients of the threshold term and the asymmetric (exponential) term are statistically insignificant. This means there is no asymmetry in the effect of shocks on EFDI. That is, positive and negative shocks have equal magnitudes of effect on the volatility of FDI in Egypt. Although all the models are statistically viable, the exponential GARCH (EGARCH) model outperformed all other models because it has the least SIC value. Hence, it is the best model for the estimation of FDI volatility in Egypt. The lower part of table 4 depicts the estimates of the volatility of PINV in Egypt. The coefficient of ENPFINV (-1) in the mean equation is statistically significant only in the EGARCH model. This shows that the expected average of portfolio investment (PINV) is affected by the volatility of PINV in Egypt. Further, the parameters of all the variables are statistically insignificant for all the models, except the EGARCH model. Meanwhile, the sum of the ARCH and GARCH coefficients is less than 1 for all the models, meaning that the variance of the PINV series is not mean reverting. Therefore, the portfolio investment (PINV) in Egypt is temporarily prone to shocks. The parameter estimate (-0.507107) of the asymmetric term of the EGARCH model is negative and significant at 5% level. This shows that negative (or positive) shocks decrease (or increase) the volatility of portfolio investment (PINV) in Egypt more than positive (or negative) shocks of the same magnitude. Comparing the models using the Schwarz Information Criterion (SIC), the EGARCH is the best model because it gives the smallest (44.09720) SIC value. Thus, EGARCH is the best model for portfolio investment (PINV) volatility in Egypt. Therefore, portfolio investment (PINV) is significantly volatile in Egypt and there is asymmetry in the effect of shocks on the volatility.

Table 5: Estimates of volatility models of FDI and FPI for Morocco

Estimates of foreign direct investment for Morocco

VARIABLES	**ARCH**	**GARCH**	**TARCH**	**EGARCH**
Mean equation				
Constant	-75737542	-75737542*	-75737542*	-75737541***
	(0.1956)	(0.0838)	(0.0905)	(0.0000)
MNFDI (-1)	0.965949***	0.974340***	0.972474***	0.946944***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variance equation				
Constant	3.64E+16***	3.61E+16**	3.61E+16	3.442133
	(0.0053)	(0.0475)	(0.1303)	(0.5864)
ARCH term	0.544794	0.667342*	0.563879	1.147937
	(0.3108)	(0.0794)	(0.2487)	(0.1423)
GARCH term		-0.351389	-0.329902	0.881662***
		(0.2645)	(0.6089)	(0.0000)
Threshold term			0.130807	
			(0.8385)	
Asymmetric term				0.054893
				(0.8288)
Model selection criterion				
SIC	41.12936	41.03352	41.08638	40.70796

Estimates of Portfolio investment for Morocco

VARIABLES	ARCH	GARCH	TARCH	EGARCH
Mean equation				
Constant	-12954479	-12954500***	-12954501**	-6586055***
	(0.7675)	(0.0000)	(0.0191)	(0.0000)
PFINV (-1)	0.787487***	0.999482***	1.017126***	0.738531***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variance equation				
Constant	2.41E+16***	2.35E+16***	2.35E+16***	5.810210*
	(0.0000)	(0.0000)	(0.0003)	(0.0806)
ARCH term	0.815769	0.849992***	1.238069	1.828222***
	(0.2245)	(0.0087)	(0.1423)	(0.0003)
GARCH term		-0.998402***	-0.694985***	0.805866***
		(0.0000)	(0.0000)	(0.0000)
Threshold term			0.441388	

			(0.1294)	
Asymmetric term				0.261252 (0.4373)
Model selection criterion				
SIC	40.28655	39.57851	39.77566	38.46247

Note: ***, ** and * indicate 1%, 5% and 10% level of significance, while () denotes p-values respectively.
Source: Author's computation.

The ARCH test shows the presence of volatility in the FDI of Morocco. Therefore, the symmetric and asymmetric models were used for the estimation and evaluation of the volatility of FDI in Morocco (MFDI). The result is presented in table 5. The coefficient of the MFDI (-1) in the mean equation is highly (1%) statistically significant for all the models (ARCH, GARCH, TARCH and EGARCH). This implies that the volatility of MFDI has a significant impact on the average of the foreign direct investment in Morocco. In the variance equation, the ARCH term is significant in only the GARCH model. Similarly, the GARCH term is significant only in the EGARCH model. This shows that the volatility of FDI in Morocco is limited. Although it is volatile, the volatility does not significantly affect the variance of the series. However, the sum of the ARCH and GARCH terms is little less than 1 in all the models, except the EGARCH model. This implies that the volatility of FDI is persistent in Morocco. That is, it takes a long-term period to revert to its previous average when a shock occurs. In fact, the EGARCH model shows that it is permanent. Meaning, it does not revert to its previous average after a shock occurs. Nevertheless, both the coefficients of threshold and asymmetric terms are statistically insignificant. This implies that leverage effect and asymmetric effect do not have a significant impact on the volatility of FDI in Morocco. Essentially, the effects of positive and negative shocks on the volatility of FDI are the same in Morocco. Meanwhile, the EGARCH has the least SIC value (40.70796), and hence, it is the best among all the models.

Similarly, the lower portion of table 5 shows the results of both the symmetric and asymmetric models for the volatility of portfolio investment in Morocco (MPINV). The coefficient of the lag value of the MPIMV (MPINV (-1)) is significant at 1% for all the models. This shows evidence that the average portfolio investment in Morocco is affected by its volatility. Also, the results indicate the existence of ARCH and GARCH effects in the variance process. It also indicates a non-mean reverting process for all the estimated models (i.e. the sum of the ARCH and GARCH terms is greater than 1 in all the models). This is consistent with the result of the pre-estimation ARCH LM test. For instance, the sum of the ARCH and GARCH effect for GARCH is 1.848394 while that of EGARCH is about 4.99. Both are greater than 1. This is an indication of evidence that the shocks have a permanent effect on the volatility of portfolio investment in Morocco. The EGARCH indicates greater degrees of persistence of the volatility. Further, the TARCH shows that the coefficient of the threshold effect (0.441388) is statistically insignificant. This means leverage effects are not important for the volatility of portfolio investment in Morocco, but, the coefficient (0.261252) of the asymmetric term is positive and insignificant and therefore positive shock reduces the volatility of portfolio investment in Morocco equally as negative shocks of the same size. Comparatively, the SIC value (38.46247) of the EGARCH is the least so the model appears to give a better fit than other models. That is, the EGARCH (1, 1) is superior to the other models when dealing with the volatility of portfolio investment in Morocco.

Table 6: Estimates of volatility models of FDI and FPI for Botswana

Estimates of Foreign Direct Investment for Botswana				
VARIABLES	**ARCH**	**GARCH**	**TARCH**	**EGARCH**
Mean equation				
Constant	-13779903 (0.4412)	-13779905 (0.3171)	-13779791 (0.1147)	-13779906*** (0.0038)
BNFDI (-1)	0.941626*** (0.0000)	0.969132*** (0.0000)	0.975861*** (0.0000)	0.867538*** (0.0000)
Variance equation				
Constant	5.30E+15*** (0.0000)	5.24E+15*** (0.0000)	5.24E+15*** (0.0000)	22.21668*** (0.0000)
ARCH term	0.495796 (0.2147)	0.593797** (0.0271)	1.497584** (0.0232)	1.682659*** (0.0000)
GARCH term		-0.362226** (0.0331)	-0.764088*** (0.0000)	0.346077*** (0.0000)
Threshold term			-0.033805 (0.9722)	
Asymmetric term				-0.367164 (0.2180)
Model selection criterion				
SIC	39.09450	39.01521	38.93309	38.89771
Estimates of Portfolio investment for Botswana				
VARIABLES	ARCH	GARCH	TARCH	EGARCH
Mean equation				
Constant	22189575 (0.5541)	22189630 (0.4326)	22189630 (0.3830)	19846101*** (0.0043)
BNPFINV (-1)	0.920314*** (0.0000)	0.959214*** (0.0000)	0.958528*** (0.0000)	0.927424*** (0.0000)
Variance equation				
Constant	8.99E+15*** (0.0014)	8.81E+15** (0.0228)	8.81E+15** (0.0399)	21.20362*** (0.0000)
ARCH term	0.663065 (0.3401)	0.666653*** (0.0094)	0.650595** (0.0152)	1.719859** (0.0171)
GARCH term		-0.068370 (0.3374)	-0.347181* (0.0980)	0.388519*** (0.0077)
Threshold term			0.079743 (0.7925)	
Asymmetric term				-0.270989 (0.6535)
Model selection criterion				
SIC	39.63608		39.54815	39.10440

Note: ***, ** and * indicate 1%, 5% and 10% level of significance, while () denotes p-values respectively.
Source: Author's computation.

The result of the ARCH LM test shows that FDI and PFINV are highly volatile in Botswana. Hence, volatility models have been used in the analysis of the FDI and PINV in Botswana and the result for FDI is contained in table 6. In the mean equations, the coefficient of the lagged FDI is significant at 1% level in all the models. This infers that the mean process (average) values of FDI in Botswana are significantly affected by shocks. This means that the average level of FDI in Botswana is vulnerable to shocks. The coefficients of the ARCH and GARCH terms in the variance equations of all the models are statistically significant at 5% level. This denotes the importance of the volatility on the variance process of the FDI in Botswana. Meanwhile, the sum of the ARCH and GARCH terms in the GARCH model is slightly less than 1, but more than 1 in the TARCH and EGARCH models. The former implies that the effect of shocks on the volatility of FDI in Botswana is highly persistent, while the later implies that the effect of the shocks is permanent so shocks on FDI in Botswana have a lasting effect in Botswana. However, the coefficients of the threshold and asymmetric terms are statistically insignificant. This means that there is no asymmetry in effect of shocks on the volatility of FDI in Botswana, so positive and negative shocks of the same scale have equal effects on the FDI in Botswana. Also, leverage effects are not important. In comparison, the EGARCH model has the smallest value of SIC (38.89771), so it is the best model for the estimation of the volatility of FDI in Botswana. Moreover, to capture the ARCH effect in the portfolio investment of Botswana (BNPFINV), GARCH models and the extensions (TARCH and EGARCH) were estimated. Table 7 contains the results. The estimates of ARCH and GARCH parameters for all the models show evidence of volatility in portfolio investment of Botswana. Also, all the models reveal that the variance process is slow mean reverting since the sums of the ARCH and GARCH coefficients are slightly less than 1 for all other models and greater than 1 for the EGARCH model. This means a persistence of volatility in portfolio investment of Botswana as shocks occur. The estimated asymmetric models (TARCH and EGARCH) indicate that both threshold (leverage) and asymmetric effects are statistically insignificant in the modelling of the volatility, so the effects of positive and negative shocks of equal magnitude on portfolio investment are the same in Botswana. It shows that the effect of positive shock on the volatility of portfolio investment in Botswana is not greater than that of the negative shocks of equal magnitude. Nonetheless, with the use of SIC criterion, EGARCH provides the best fit.

Table 7: Estimates of FDI and PFI for South Africa

Estimates of foreign direct investment for South Africa				
VARIABLES	**ARCH**	**GARCH**	**TARCH**	**EGARCH**
Mean equation				
Constant	-55338607	-55338608	-55338608	-55338577
	(0.8002)	(0.7147)	(0.6367)	(0.3010)
SNFDIS (-1)	0.881810***	0.963485***	0.918135***	0.865048***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variance equation				
Constant	9.67E+17***	9.56E+17***	9.56E+17***	15.80495**
	(0.0003)	(0.0028)	(0.0000)	(0.0283)
ARCH term	0.640766	0.883466*	0.678976**	1.483032***
	(0.2067)	(0.0540)	(0.0143)	(0.0001)
GARCH term		-0.475272**	-0.815265***	0.584788***
		(0.0194)	(0.0000)	(0.0013)
Threshold term			0.318715	
			(0.4793)	
Asymmetric term				-0.249567
				(0.3249)
Model selection criterion				
SIC	44.34129	44.23206	44.15306	43.90187
Estimates of Portfolio investment for South Africa				
Variables	ARCH	GARCH	TARCH	EGARCH
Mean equation				
Constant	-4.22E+08	-4.22E+08	-4.22E+08	-3.89E+08**
	(0.3854)	(0.3471)	(0.3456)	(0.0147)
SNPFINV (-1)	0.940718***	0.919210***	0.926220***	0.944496***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variance equation				
Constant	3.13E+18***	3.10E+18***	3.10E+18**	30.84603***
	(0.0001)	(0.0039)	(0.0361)	(0.0000)
ARCH term	0.575607	0.692570	0.757379	1.302144***
	(0.2377)	(0.1743)	(0.3925)	(0.0002)
GARCH term		-0.111454	-0.118971	0.244264***
		(0.5894)	(0.7612)	(0.0006)
Threshold term			-0.091407	
			(0.9257)	
Asymmetric term				0.044496
				(0.8663)
Model selection criterion				
SIC	45.46569	45.42078	45.46702	45.18655

Note: ***, ** and * indicate 1%, 5% and 10% level of significance, while () denotes p-values respectively.
Source: Author’s computation.

It is shown in the result of the ARCH test that SNFDI is highly volatile. Thus, the volatility models (ARCH, GARCH, TARCH and EGARCH) have been used for the analysis of the series. The result is displayed in table 7. The estimates of the mean equation indicate that the coefficient of lagged SNFDI (SNPFINV (-1)) is positive and statistically significant at 1% level in all the models. This shows that volatility affects the average values of FDI in South Africa. The estimates of the variance equation equally show that the ARCH and GARCH terms are statistically significant for the GARCH, TARCH and EGARCH models. This confirms the volatility, which means that foreign direct investment in South Africa is vulnerable to shocks. Also, the sum of the ARCH and GARCH terms is greater than 1, so the effect of shocks on the SNFDI is not mean reverting (permanent), but the threshold and asymmetry terms are insignificant. This means that the volatility spill over mechanism is symmetric. That is, investors are equally prone to positive shocks in comparison to negative shocks.

Comparing the model by the SIC values, the EGARCH model has the smallest SIC value (43.90187). Hence, it is the best model for the estimation of the volatility of foreign direct investment in South Africa. To investigate the volatility of portfolio investment in South Africa (SNPFINV), the symmetric ARCH and GARCH models and their asymmetric versions (TARCH and EGARCH) were employed for the estimation and the result is presented in the lower part of table 7. The estimated parameter of the SNPFINV (-1) in the mean equation is highly significant for all the models. This shows that the average level of SNPFINV is significantly affected by its volatility. Essentially, the average value of portfolio investment in South Africa (SNPFINV) is prone to shocks. Similarly, the presence of volatility is indicated in the variance process of the portfolio investment in South Africa (SNPFINV), but only for the EGARCH model. This is demonstrated by the statistical significance of the ARCH and GARCH terms in the EGARCH model. Further, the result shows that the sum of the ARCH and GARCH terms is greater than 1. This denotes the permanent nature of the effect of shocks on portfolio investment in South Africa (SNPFINV). Once shocks occur, the portfolio investment in South Africa (SNPFINV) changes without reverting to its level before the change. The threshold and asymmetry terms are statistically insignificant. This is an indication that leverage effects are unimportant and the effect of positive and negative news (shocks) of equal magnitude on portfolio investment in South Africa (SNPFINV) are the same. Investors are equally prone to positive and negative news about portfolio investment in South Africa (SNPFINV). The result of the EGARCH model supersedes that of all other models as compared by the SIC value (45.18655).

Table 8: Comparative analysis of volatilities of foreign direct investment and portfolio investment for all the countries

Volatility of Foreign Direct Investment				
	Botswana	Egypt	Morocco	South Africa
Mean	1.70E+18	2.01E+17	6.17E+15	1.15E+18
Median	1.20E+16	1.09E+17	4.33E+16	9.95E+17
Maximum	9.86E+18	5.70E+17	1.95E+17	2.17E+18
Minimum	-1.93E+18	3.16E+16	-2.46E+15	4.13E+17
Std. Dev.	3.16E+18	1.78E+17	5.89E+16	6.25E+17
Observations	100	100	100	100
Volatility of Portfolio Investment				
	Botswana	Egypt	Morocco	South Africa
Mean	8.29E+18	2.29E+18	5.68E+16	4.51E+18
Median	8.27E+16	2.39E+18	5.62E+16	2.48E+18

Maximum	9.28E+18	2.56E+18	6.31E+16	1.55E+19
Minimum	7.93E+15	1.90E+18	5.28E+16	-3.55E+17
Std. Dev.	3.53E+18	2.07E+17	2.99E+16	4.66E+18
Observations	100	100	100	100

Source: Author's computation.

To compare the volatility of each one of the variables with the others across the four countries, the volatility series of each of the variables are estimated using the EGARCH model. The EGARCH was used because it was found to be the best among all the estimated models of the two variables for all the countries. This was shown by the SIC values in the previous subsection. The estimated volatility series are then compared with the use of descriptive statistics. The result is presented in table 8 and the graphs. The results indicate that the mean and standard deviation of the volatility of the net foreign direct investment (NFDI) are less than the mean and the standard deviation of the volatility of portfolio investment (NPFINV) for all the countries. This means that portfolio investment is more volatile than the foreign direct investment in all the countries. Meanwhile, the comparison between the countries shows that both variables are most volatile in Botswana and then followed by South Africa, Egypt and Morocco, in that order. This implies that capital investment in Botswana is the most volatile, while capital investment in Morocco is the least volatile among the four countries.

Table 9: Comparative analysis of volatilities of foreign direct investment (FDI) and portfolio investment (PINV) for all the countries

VARIABLES	EGYPT	MOROCCO	BOTSWANA	S. AFRICA
Mean equation				
Constant	-86200667***	-75737541***	-13779906***	-55338577
	0.0000	0.0000	(0.0038)	(0.3010)
Lag of FDI	1.003316***	0.946944***	0.867538***	0.865048***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Variance equation				
Constant	7.453249***	3.4421	22.21668***	15.80495**
	(0.0041)	(0.5864)	(0.0000)	(0.0283)
ARCH term	2.203436***	1.1479	1.682659***	1.483032***
	(0.0000)	(0.1423)	(0.0000)	(0.0001)
GARCH term	0.847052***	0.881662***	0.346077***	0.584788***
	(0.0000)	(0.0000)	(0.0000)	(0.0013)
Asymmetric term	-0.1556	0.0549	-0.3672	-0.2496
	(0.6681)	(0.8288)	(0.2180)	(0.3249)
Conditional volatility	1.9065	1.8284	4.6472	3.8472
SIC Value	41.7505	40.7080	38.8977	43.9019
VARIABLES	**EGYPT**	**MOROCCO**	**BOTSWANA**	**S. AFRICA**
Mean equation				

Constant	2.18E+08*** (0.0000)	-6586055*** (0.0000)	19846101*** (0.0043)	-3.89E+08** (0.0147)
Lag of PFINV	-0.002298*** (0.0000)	0.738531*** (0.0000)	0.927424 (0.0000)	0.944496*** (0.0000)
Variance equation				
Constant	42.43091*** (0.0000)	5.810210* (0.0806)	21.20362*** (0.0000)	30.84603*** (0.0000)
ARCH term	-0.730282*** (0.0000)	1.828222*** (0.0003)	1.719859** (0.0171)	1.302144*** (0.0002)
GARCH term	0.002553 (0.8199)	0.805866*** (0.0000)	0.388519*** (0.0077)	0.244264*** (0.0006)
Asymmetric term	-0.507107** (0.0466)	0.261252 (0.4373)	-0.270989 (0.6535)	0.044496 (0.8663)
Conditional volatility	12.6023	1.8855	7.9996	23.0853
SIC Value	44.09720	38.46247	39.10440	45.18655

Source: Author's computation.

To compare the volatility of each one of the variables with the other variables across the four countries, the conditional volatility each of the variables is calculated using the estimates of the variance equations of the EGARCH model. The formula used is as follows:

$$Conditional\ volatility\ (\delta^2) = \sqrt{\frac{constant}{1 - arch\ term - garch\ term}}$$

The EGARCH was used because it is the best among all the models in all the variables. This was shown by the SIC values in the previous subsection. The estimated volatility series are then compared. The results presented in table 9 indicate that the conditional volatilities of FDI for Egypt, Morocco, Botswana and South Africa are 1.9065, 1.8284, 4.6472 and 3.8472 respectively, while the conditional volatilities of portfolio investment are 12.6023, 1.8855, 7.9996 and 23.0853 respectively. This implies that PFINV is more volatile than FDI in all the countries. Meanwhile, the comparison between the countries shows that FDI is most volatile in Botswana, followed by South Africa, Egypt and Morocco, in that order. In contrast, PINV is most volatile in South Africa, followed by Egypt, Botswana and Morocco, in that order. This implies that capital investment in Morocco is the least volatile among the four countries. Similarly, capital investment in South Africa is also very volatile.

CONCLUSION AND RECOMMENDATION

An attempt to investigate the behaviour of capital flow volatility across the selected African countries revealed some interesting and compelling results. Having subjected the series to some competing volatility estimation for both portfolio and FDI flow, the study concludes that:

- There is strong evidence of persistence in capital flow volatility for all the countries under investigation and the volatility does not indicate a tendency of reversal to its previous mean.
- Past information has a strong effect on the behaviour of capital flow volatility across all the countries under review.
- Conforming to *a priori*, the study reveals that portfolio investment is more volatile than the FDI for all countries.
- There are inherent asymmetries in the volatility behaviour which is underpinned by the large information asymmetries in most capital market in these countries. This finding is deduced by the consistency of the EGARCH over other ARCH models.
- The study indicates that FDI is the most volatile flow in Botswana, South Africa, Egypt and Morocco, in that order. While PINV is most volatile in South Africa, it is followed by Egypt, Botswana and Morocco respectively.

Overall, the study examined the empirical nature of the different types and components of capital flows, as well as their volatilities in the four selected emerging African economies. The study also found significant evidence of capital flows volatility and strong evidence of persistence in the flow's volatility in all the selected countries. Thus, with these findings in mind, the study examines the behaviour of exchange rate volatility in the selected countries.

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Appendix

Appendix A1: Result of Botswana net capital volatility: evidence from FDI

1. **Result of mean equation model**

Dependent Variable: BNFDI

Method: Least Squares

Date: 02/04/20 Time: 15:17

Sample (adjusted): 1990Q2 2016Q1

Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13779905	11575021	-1.190486	0.2367
BNFDI(-1)	0.949330	0.031483	30.15347	0.0000

R-squared	0.902704	Mean dependent var	-2.31E+08
Adjusted R-squared	0.901711	S.D. dependent var	2.89E+08
S.E. of regression	90695777	Akaike info criterion	39.50372
Sum squared resid	8.06E+17	Schwarz criterion	39.55582
Log likelihood	-1973.186	Hannan-Quinn criter.	39.52480
F-statistic	909.2320	Durbin-Watson stat	0.807787
Prob(F-statistic)	0.000000		

Plots of net volatility

The plots of the residual indicate evidence of heteroskedasticity: a period of high volatility is succeeded by another period of high volatility. Similarly, a period of low volatility is followed by a period of low volatility.

We proceed by verifying the presence of arch effect by conducting the test:

2. **Test result confirms the presence of arch effect**

Heteroskedasticity Test: ARCH

F-statistic	167.6204	Prob. F(1,97)	0.0000
Obs*R-squared	62.71028	Prob. Chi-Square(1)	**0.0000**

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/04/20 Time: 15:15
Sample (adjusted): 1990Q3 2016Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.65E+15	1.36E+15	1.212290	0.2283
RESID^2(-1)	0.795992	0.061482	12.94683	**0.0000**

R-squared	0.633437	Mean dependent var	8.13E+15
Adjusted R-squared	0.629658	S.D. dependent var	2.07E+16
S.E. of regression	1.26E+16	Akaike info criterion	77.00676
Sum squared resid	1.55E+34	Schwarz criterion	77.05919
Log likelihood	-3809.835	Hannan-Quinn criter.	77.02797
F-statistic	167.6204	Durbin-Watson stat	1.845046
Prob(F-statistic)	0.000000		

Result of variance equation(s)

i. **Arch (1)**

Dependent Variable: BNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/18 Time: 15:34
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 22 iterations
Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-13779903	17891170	-0.770207	0.4412
BNFDI(-1)	0.941626	0.051616	18.24308	0.0000
	Variance Equation			
C	5.30E+15	8.73E+14	6.066477	0.0000
RESID(-1)^2	0.495796	0.399620	1.240669	0.2147
R-squared	0.902607	Mean dependent var		-2.31E+08
Adjusted R-squared	0.901613	S.D. dependent var		2.89E+08
S.E. of regression	90740901	Akaike info criterion		38.99029
Sum squared resid	8.07E+17	Schwarz criterion		39.09450
Log likelihood	-1945.515	Hannan-Quinn criter.		39.03247
Durbin-Watson stat	0.801316			

ii. Garch (1,1)

Dependent Variable: BNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:35
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 21 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-13779905	13773752	-1.000447	0.3171
BNFDI(-1)	0.969132	0.037424	25.89569	0.0000
	Variance Equation			
C	5.24E+15	1.00E+15	5.218197	0.0000
RESID(-1)^2	0.593797	0.268647	2.210327	0.0271
GARCH(-1)	-0.362226	0.169973	-2.131079	0.0331
R-squared	0.902064	Mean dependent var		-2.31E+08
Adjusted R-squared	0.901065	S.D. dependent var		2.89E+08
S.E. of regression	90993459	Akaike info criterion		38.88495
Sum squared resid	8.11E+17	Schwarz criterion		39.01521
Log likelihood	-1939.247	Hannan-Quinn criter.		38.93766
Durbin-Watson stat	0.817554			

iii. Tarch (1,1,2)

Dependent Variable: BNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:38
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 65 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) +
C(6)*RESID(-2)^2*(RESID(-2)<0) + C(7)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-13779791	8734789.	-1.577576	0.1147
BNFDI(-1)	0.975861	0.032468	30.05565	0.0000
	Variance Equation			
C	5.24E+15	9.37E+14	5.590031	0.0000
RESID(-1)^2	1.497584	0.659560	2.270580	0.0232
RESID(-1)^2*(RESID(-1)<0)	-0.033805	0.971276	-0.034805	0.9722
RESID(-2)^2*(RESID(-2)<0)	0.936487	0.652184	1.435924	0.1510
GARCH(-1)	-0.764088	0.055234	-13.83374	0.0000

R-squared	0.901555	Mean dependent var	-2.31E+08
Adjusted R-squared	0.900551	S.D. dependent var	2.89E+08
S.E. of regression	91229436	Akaike info criterion	38.75073
Sum squared resid	8.16E+17	Schwarz criterion	38.93309
Log likelihood	-1930.536	Hannan-Quinn criter.	38.82453
Durbin-Watson stat	0.818596		

iv. **Egarch (1,1,1)**

Dependent Variable: BNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/18 Time: 15:42
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 67 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-13779906	4763060.	-2.893078	0.0038
BNFDI(-1)	0.867538	0.022429	38.67970	0.0000

	Variance Equation			
C(3)	22.21668	2.213026	10.03905	0.0000
C(4)	1.682659	0.368333	4.568308	0.0000
C(5)	-0.367164	0.298045	-1.231907	0.2180
C(6)	0.346077	0.063990	5.408263	0.0000

R-squared	0.891789	Mean dependent var	-2.31E+08
Adjusted R-squared	0.890685	S.D. dependent var	2.89E+08
S.E. of regression	95647686	Akaike info criterion	38.74140
Sum squared resid	8.97E+17	Schwarz criterion	38.89771
Log likelihood	-1931.070	Hannan-Quinn criter.	38.80466
Durbin-Watson stat	0.677746		

Appendix A2: Result of Botswana net capital volatility: evidence from portfolio

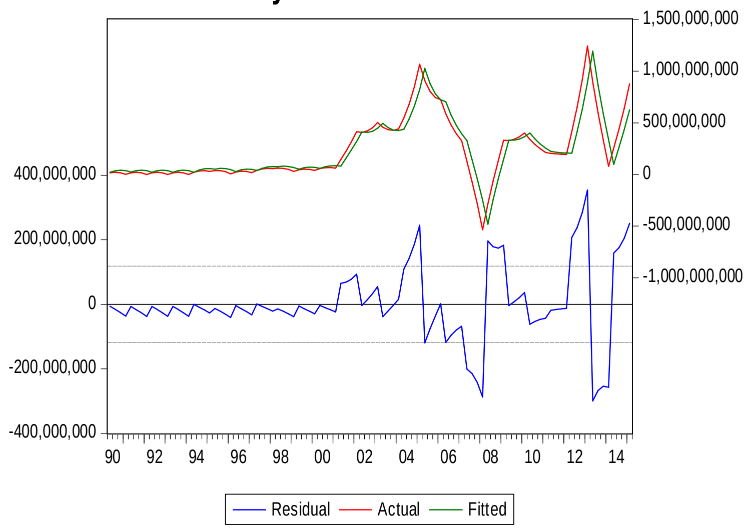
1. **Result of mean equation model**

Dependent Variable: BNPFINV
Method: Least Squares
Date: 02/04/20 Time: 15:46
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	22189630	14931773	1.486068	0.1405
BNPFINV(-1)	0.942486	0.039198	24.04453	0.0000

R-squared	0.855059	Mean dependent var	2.42E+08
Adjusted R-squared	0.853580	S.D. dependent var	3.09E+08
S.E. of regression	1.18E+08	Akaike info criterion	40.03224
Sum squared resid	1.37E+18	Schwarz criterion	40.08434
Log likelihood	-1999.612	Hannan-Quinn criter.	40.05333
F-statistic	578.1394	Durbin-Watson stat	0.854397
Prob(F-statistic)	0.000000		

2. **Plot of net volatility**



3. **Test result of Presence of ARCH**

Heteroskedasticity Test: ARCH

F-statistic	272.6764	Prob. F(1,97)	0.0000
Obs*R-squared	73.02323	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/04/20 Time: 15:49
Sample (adjusted): 1990Q3 2016Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.28E+15	1.48E+15	1.544833	0.1256
RESID^2(-1)	0.874972	0.052987	16.51292	0.0000

R-squared	0.737608	Mean dependent var	1.38E+16
Adjusted R-squared	0.734903	S.D. dependent var	2.52E+16
S.E. of regression	1.30E+16	Akaike info criterion	77.05968
Sum squared resid	1.63E+34	Schwarz criterion	77.11211
Log likelihood	-3812.454	Hannan-Quinn criter.	77.08090
F-statistic	272.6764	Durbin-Watson stat	1.782389
Prob(F-statistic)	0.000000		

4. **Result of variance equation(s)**

i. ARCH 1,0

Dependent Variable: BNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:50

Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 26 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	22189575	37507932	0.591597	0.5541
BNPFINV(-1)	0.920314	0.091554	10.05210	0.0000
	Variance Equation			
C	8.99E+15	2.81E+15	3.196374	0.0014
RESID(-1)^2	0.663065	0.695082	0.953938	0.3401
R-squared	0.854303	Mean dependent var		2.42E+08
Adjusted R-squared	0.852817	S.D. dependent var		3.09E+08
S.E. of regression	1.18E+08	Akaike info criterion		39.53187
Sum squared resid	1.37E+18	Schwarz criterion		39.63608
Log likelihood	-1972.594	Hannan-Quinn criter.		39.57405
Durbin-Watson stat	0.833981			

ii. GARCH 1,2

Dependent Variable: BNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:51
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 24 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*GARCH(-2)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	22189630	28278588	0.784680	0.4326
BNPFINV(-1)	0.959214	0.054775	17.51202	0.0000
	Variance Equation			
C	8.81E+15	3.87E+15	2.276609	0.0228
RESID(-1)^2	0.666653	0.256862	2.595369	0.0094
GARCH(-1)	-0.068370	0.071271	-0.959297	0.3374
GARCH(-2)	-0.345018	0.231895	-1.487819	0.1368
R-squared	0.854629	Mean dependent var		2.42E+08
Adjusted R-squared	0.853146	S.D. dependent var		3.09E+08
S.E. of regression	1.18E+08	Akaike info criterion		39.34259

Sum squared resid	1.37E+18	Schwarz criterion	39.49890
Log likelihood	-1961.129	Hannan-Quinn criter.	39.40585
Durbin-Watson stat	0.864592		

iii. **TARCH (1,2,1)**

Dependent Variable: BNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:55
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Failure to improve Likelihood after 19 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*GARCH(-1) + C(7)*GARCH(-2)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	22189630	25433227	0.872466	0.3830
BNPFINV(-1)	0.958528	0.062901	15.23872	0.0000
	Variance Equation			
C	8.81E+15	4.29E+15	2.054703	0.0399
RESID(-1)^2	0.650595	0.268064	2.427018	0.0152
RESID(-1)^2*(RESID(-1)<0)	0.079743	0.303130	0.263066	0.7925
GARCH(-1)	-0.062392	0.219262	-0.284554	0.7760
GARCH(-2)	-0.347181	0.209820	-1.654666	0.0980

R-squared	0.854664	Mean dependent var	2.42E+08
Adjusted R-squared	0.853181	S.D. dependent var	3.09E+08
S.E. of regression	1.18E+08	Akaike info criterion	39.36578
Sum squared resid	1.37E+18	Schwarz criterion	39.54815
Log likelihood	-1961.289	Hannan-Quinn criter.	39.43959
Durbin-Watson stat	0.864265		

iv. EGARCH (1,2,1)

v.

Dependent Variable: BNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 15:56
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 51 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1)) + C(7)
*LOG(GARCH(-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	22189625	4671452.	4.750048	0.0000
BNPFINV(-1)	0.966621	0.050412	19.17442	0.0000
	Variance Equation			
C(3)	0.590966	1.344050	0.439691	0.6602
C(4)	0.532455	0.298764	1.782189	0.0747
C(5)	0.155600	0.151196	1.029134	0.3034
C(6)	0.638009	0.644890	0.989331	0.3225
C(7)	0.336379	0.632282	0.532009	0.5947
R-squared	0.854164	Mean dependent var		2.42E+08
Adjusted R-squared	0.852675	S.D. dependent var		3.09E+08
S.E. of regression	1.18E+08	Akaike info criterion		38.88571
Sum squared resid	1.38E+18	Schwarz criterion		39.06807
Log likelihood	-1937.285	Hannan-Quinn criter.		38.95951
Durbin-Watson stat	0.867624			

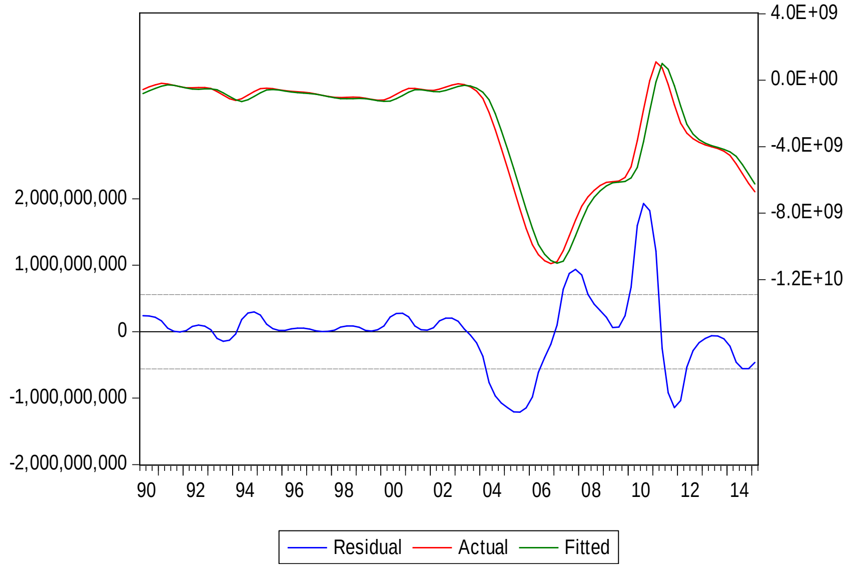
Appendix B1: Result of Egypt net capital volatility: evidence from FDI

1. Result of mean equation model

Dependent Variable: ENFDI
Method: Least Squares
Date: 02/04/20 Time: 07:14
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-86206104	73975079	-1.165340	0.2467
ENFDI(-1)	0.990249	0.017880	55.38229	0.0000
R-squared	0.969038	Mean dependent var		-2.77E+09
Adjusted R-squared	0.968722	S.D. dependent var		3.16E+09
S.E. of regression	5.59E+08	Akaike info criterion		43.14261
Sum squared resid	3.07E+19	Schwarz criterion		43.19472
Log likelihood	-2155.131	Hannan-Quinn criter.		43.16370
F-statistic	3067.198	Durbin-Watson stat		0.195312
Prob(F-statistic)	0.000000			

2. Plot of net volatility



3. Test result of the presence of ARCH effect

Heteroskedasticity Test: ARCH

F-statistic	207.0944	Prob. F(1,97)	0.0000
Obs*R-squared	67.42099	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/18/18 Time: 07:16
Sample (adjusted): 1990Q3 2016Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.55E+16	4.12E+16	1.347536	0.1809
RESID^2(-1)	0.824704	0.057308	14.39077	0.0000
R-squared	0.681020	Mean dependent var		3.09E+17
Adjusted R-squared	0.677732	S.D. dependent var		6.53E+17
S.E. of regression	3.71E+17	Akaike info criterion		83.76522
Sum squared resid	1.33E+37	Schwarz criterion		83.81765
Log likelihood	-4144.379	Hannan-Quinn criter.		83.78644
F-statistic	207.0944	Durbin-Watson stat		1.005013
Prob(F-statistic)	0.000000			

5 Result of variance equation

i. ARCH 1,0

Dependent Variable: ENFDI

Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:19
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 30 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-86206104	1.50E+08	-0.575399	0.5650
ENFDI(-1)	0.985604	0.027233	36.19144	0.0000
	Variance Equation			
C	2.02E+17	6.03E+16	3.340234	0.0008
RESID(-1)^2	0.636157	0.424801	1.497542	0.1343
R-squared	0.969001	Mean dependent var		-2.77E+09
Adjusted R-squared	0.968685	S.D. dependent var		3.16E+09
S.E. of regression	5.60E+08	Akaike info criterion		42.63329
Sum squared resid	3.07E+19	Schwarz criterion		42.73749
Log likelihood	-2127.664	Hannan-Quinn criter.		42.67546
Durbin-Watson stat	0.194308			

ii. GARCH 1,3

Dependent Variable: ENFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:21
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 66 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*GARCH(-2) +
C(7)*GARCH(-3)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-86206104	15797745	-5.456861	0.0000
ENFDI(-1)	1.000269	0.000999	1001.592	0.0000
	Variance Equation			
C	1.96E+17	8.12E+16	2.418400	0.0156
RESID(-1)^2	2.067818	1.050498	1.968417	0.0490
GARCH(-1)	-1.017634	0.075323	-13.51025	0.0000
GARCH(-2)	0.149688	0.032654	4.584121	0.0000
GARCH(-3)	0.167782	0.087574	1.915901	0.0554
R-squared	0.968865	Mean dependent var		-2.77E+09

Adjusted R-squared	0.968547	S.D. dependent var	3.16E+09
S.E. of regression	5.61E+08	Akaike info criterion	42.03298
Sum squared resid	3.08E+19	Schwarz criterion	42.21534
Log likelihood	-2094.649	Hannan-Quinn criter.	42.10679
Durbin-Watson stat	0.196023		

iii. TARCH 1,3,1

Dependent Variable: ENFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:22
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 46 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*GARCH(-1) + C(7)*GARCH(-2) + C(8)*GARCH(-3)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-86206104	30073224	-2.866540	0.0041
ENFDI(-1)	1.003582	0.005568	180.2410	0.0000
	Variance Equation			
C	1.96E+17	6.05E+16	3.242195	0.0012
RESID(-1)^2	1.459290	0.435625	3.349879	0.0008
RESID(-1)^2*(RESID(-1)<0)	0.088210	0.105954	0.832525	0.4051
GARCH(-1)	-0.990590	0.011343	-87.33365	0.0000
GARCH(-2)	0.130767	0.008006	16.33426	0.0000
GARCH(-3)	0.117627	0.004060	28.96966	0.0000

R-squared	0.968731	Mean dependent var	-2.77E+09
Adjusted R-squared	0.968412	S.D. dependent var	3.16E+09
S.E. of regression	5.62E+08	Akaike info criterion	42.11172
Sum squared resid	3.10E+19	Schwarz criterion	42.32014
Log likelihood	-2097.586	Hannan-Quinn criter.	42.19607
Durbin-Watson stat	0.195822		

iv. EGARCG 1,3,1

Dependent Variable: ENFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:24
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 89 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1)) + C(7)

*LOG(GARCH(-2)) + C(8)*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-86200667	10939949	-7.879439	0.0000
ENFDI(-1)	1.003316	0.003365	298.1952	0.0000
	Variance Equation			
C(3)	7.453249	2.595408	2.871707	0.0041
C(4)	2.203436	0.508172	4.336006	0.0000
C(5)	-0.155624	0.362977	-0.428744	0.6681
C(6)	0.847052	0.189103	4.479324	0.0000
C(7)	-0.128705	0.347636	-0.370228	0.7112
C(8)	0.041075	0.204049	0.201302	0.8405

R-squared	0.968743	Mean dependent var	-2.77E+09
Adjusted R-squared	0.968424	S.D. dependent var	3.16E+09
S.E. of regression	5.62E+08	Akaike info criterion	41.54210
Sum squared resid	3.10E+19	Schwarz criterion	41.75051
Log likelihood	-2069.105	Hannan-Quinn criter.	41.62645
Durbin-Watson stat	0.195846		

Appendix B2: Result of Egypt net capital volatility: evidence from portfolio

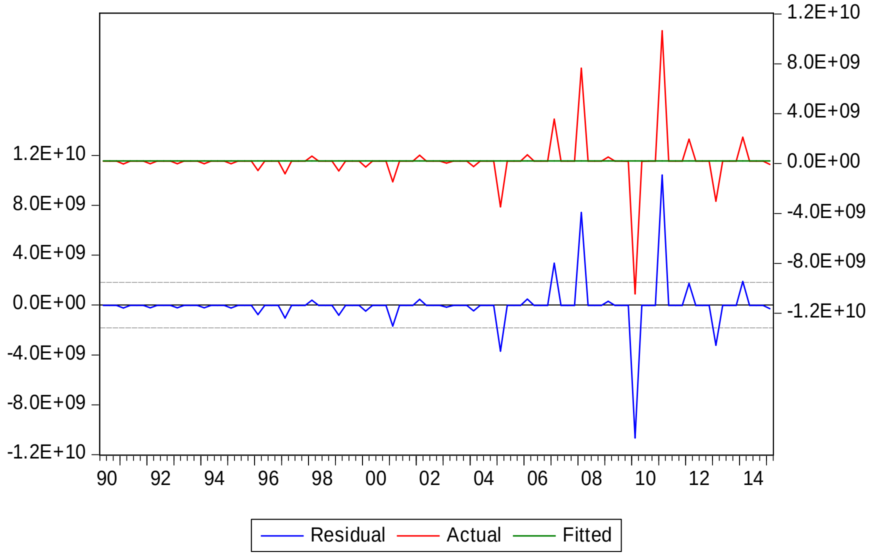
1. **Result of mean equation model**

Dependent Variable: ENPFINV
Method: Least Squares
Date: 02/04/20 Time: 07:28
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.18E+08	1.84E+08	1.187908	0.2377
ENPFINV(-1)	0.000296	0.101020	0.002932	0.9977

R-squared	0.000000	Mean dependent var	2.18E+08
Adjusted R-squared	-0.010204	S.D. dependent var	1.82E+09
S.E. of regression	1.82E+09	Akaike info criterion	45.50707
Sum squared resid	3.26E+20	Schwarz criterion	45.55917
Log likelihood	-2273.354	Hannan-Quinn criter.	45.52816
F-statistic	8.60E-06	Durbin-Watson stat	1.999780
Prob(F-statistic)	0.997667		

2. **Plot of net volatility**



3. **Test result presence of ARCH effect**

Heteroskedasticity Test: ARCH

F-statistic	0.151784	Prob. F(1,97)	0.6977
Obs*R-squared	0.154672	Prob. Chi-Square(1)	0.6941

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/04/20 Time: 07:30
Sample (adjusted): 1990Q3 2016Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.43E+18	1.71E+18	1.998653	0.0484
RESID^2(-1)	-0.039526	0.101454	-0.389595	0.6977

R-squared	0.001562	Mean dependent var	3.30E+18
Adjusted R-squared	-0.008731	S.D. dependent var	1.67E+19
S.E. of regression	1.67E+19	Akaike info criterion	91.38527
Sum squared resid	2.71E+40	Schwarz criterion	91.43769
Log likelihood	-4521.571	Hannan-Quinn criter.	91.40648
F-statistic	0.151784	Durbin-Watson stat	2.003274
Prob(F-statistic)	0.697690		

4. **Result of variance equation**

i. ARCH 5,0

Dependent Variable: ENPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:33
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments

Failure to improve Likelihood after 25 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*RESID(-3)^2
+ C(7)*RESID(-4)^2 + C(8)*RESID(-5)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.18E+08	1.58E+08	1.382250	0.1669
ENPFINV(-1)	-0.020382	0.024119	-0.845051	0.3981
	Variance Equation			
C	2.55E+18	1.31E+17	19.50362	0.0000
RESID(-1)^2	-0.002721	0.035953	-0.075670	0.9397
RESID(-2)^2	-0.022332	0.001016	-21.97241	0.0000
RESID(-3)^2	-0.022317	0.001018	-21.92800	0.0000
RESID(-4)^2	0.054050	0.013742	3.933064	0.0001
RESID(-5)^2	-0.019556	0.007761	-2.519686	0.0117

R-squared	-0.000434	Mean dependent var	2.18E+08
Adjusted R-squared	-0.010642	S.D. dependent var	1.82E+09
S.E. of regression	1.83E+09	Akaike info criterion	45.09594
Sum squared resid	3.26E+20	Schwarz criterion	45.30436
Log likelihood	-2246.797	Hannan-Quinn criter.	45.18029
Durbin-Watson stat	1.958447		

ii. GARCH 5,1

Dependent Variable: ENPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:34
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 28 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*RESID(-3)^2
+ C(7)*RESID(-4)^2 + C(8)*RESID(-5)^2 + C(9)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.18E+08	4.48E+08	0.486849	0.6264
ENPFINV(-1)	-0.006784	2.526036	-0.002686	0.9979
	Variance Equation			
C	2.50E+18	4.02E+18	0.621733	0.5341
RESID(-1)^2	-0.030447	0.046520	-0.654504	0.5128
RESID(-2)^2	-0.023004	0.046807	-0.491469	0.6231
RESID(-3)^2	0.026733	0.073176	0.365328	0.7149
RESID(-4)^2	0.049436	0.036942	1.338188	0.1808
RESID(-5)^2	-0.024751	0.045135	-0.548372	0.5834

GARCH(-1)	0.359559	1.046203	0.343680	0.7311

R-squared	-0.000051	Mean dependent var	2.18E+08
Adjusted R-squared	-0.010255	S.D. dependent var	1.82E+09
S.E. of regression	1.82E+09	Akaike info criterion	45.27799
Sum squared resid	3.26E+20	Schwarz criterion	45.51245
Log likelihood	-2254.899	Hannan-Quinn criter.	45.37288
Durbin-Watson stat	1.985625		

iii. TARCH 5,1,2

Dependent Variable: ENPFINV

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 02/04/20 Time: 07:37

Sample (adjusted): 1990Q2 2016Q1

Included observations: 100 after adjustments

Convergence achieved after 35 iterations

Presample variance: backcast (parameter = 0.7)

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*RESID(-2)^2 + C(7)*RESID(-3)^2 + C(8)*RESID(-4)^2 + C(9) *RESID(-5)^2 + C(10)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.18E+08	3.86E+08	0.566199	0.5713
ENPFINV(-1)	-0.007359	0.073365	-0.100305	0.9201
	Variance Equation			
C	2.50E+18	1.69E+18	1.477156	0.1396
RESID(-1)^2	-0.003559	0.104487	-0.034061	0.9728
RESID(-1)^2*(RESID(-1)<0)	-0.029955	0.102560	-0.292071	0.7702
RESID(-2)^2	-0.022187	0.030469	-0.728203	0.4665
RESID(-3)^2	0.006586	0.043089	0.152859	0.8785
RESID(-4)^2	0.053213	0.025693	2.071092	0.0384
RESID(-5)^2	-0.049129	0.030576	-1.606780	0.1081
GARCH(-1)	0.357401	0.493102	0.724801	0.4686

R-squared	-0.000059	Mean dependent var	2.18E+08
Adjusted R-squared	-0.010264	S.D. dependent var	1.82E+09
S.E. of regression	1.82E+09	Akaike info criterion	45.25081
Sum squared resid	3.26E+20	Schwarz criterion	45.51133

Log likelihood	-2252.541	Hannan-Quinn criter.	45.35625
Durbin-Watson stat	1.984476		

iv. EGARCH 5,1,3

Dependent Variable: ENPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 07:39
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 30 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(6)*ABS(RESID(-3)
/@SQRT(GARCH(-3))) + C(7)*ABS(RESID(-4)/@SQRT(GARCH(-4))) +
C(8)*ABS(RESID(-5)/@SQRT(GARCH(-5))) + C(9)*RESID(-1)
/@SQRT(GARCH(-1)) + C(10)*RESID(-2)/@SQRT(GARCH(-2)) + C(11)
*RESID(-3)/@SQRT(GARCH(-3)) + C(12)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.18E+08	2045754.	106.7324	0.0000
ENPFINV(-1)	-0.002298	0.000196	-11.72921	0.0000
	Variance Equation			
C(3)	42.43091	0.465336	91.18336	0.0000
C(4)	-0.730282	0.022305	-32.74090	0.0000
C(5)	-1.463826	0.321901	-4.547437	0.0000
C(6)	-0.801304	0.304285	-2.633400	0.0085
C(7)	0.544449	0.130161	4.182882	0.0000
C(8)	-2.173611	0.269248	-8.072906	0.0000
C(9)	0.179050	0.181248	0.987874	0.3232
C(10)	-0.507107	0.254820	-1.990064	0.0466
C(11)	-0.082851	0.219609	-0.377267	0.7060
C(12)	0.002553	0.011218	0.227624	0.8199

R-squared	-0.000007	Mean dependent var	2.18E+08
Adjusted R-squared	-0.010211	S.D. dependent var	1.82E+09
S.E. of regression	1.82E+09	Akaike info criterion	43.78458
Sum squared resid	3.26E+20	Schwarz criterion	44.09720

Log likelihood	-2177.229	Hannan-Quinn criter.	43.91111
Durbin-Watson stat	1.994593		

Appendix C1: Result of Morocco net capital volatility: evidence from FDI

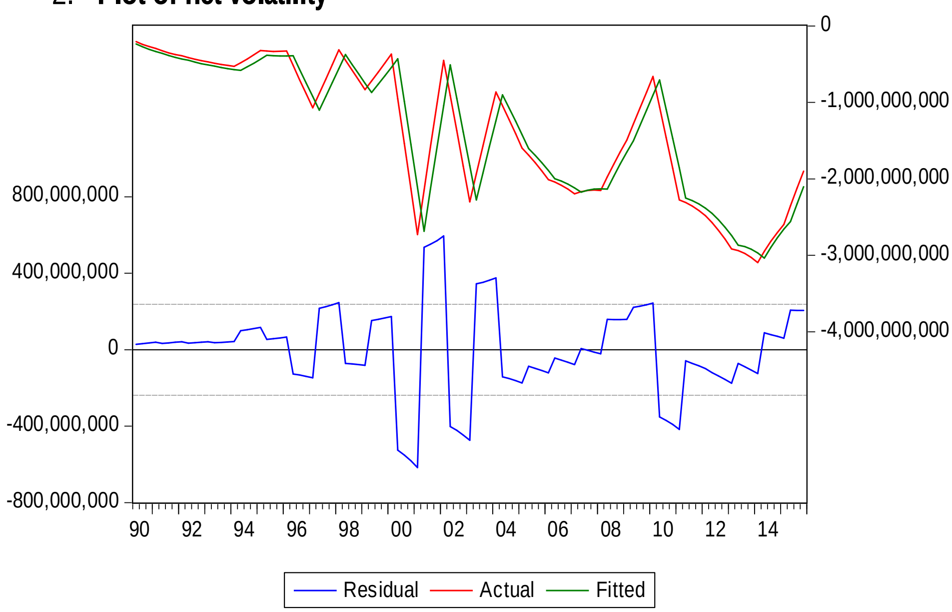
1. **Result of mean equation model**

Result: FDI
Dependent Variable: MNFDI
Method: Least Squares
Date: 02/04/20 Time: 22:23
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-75737542	42848380	-1.767571	0.0802
MNFDI(-1)	0.956474	0.026501	36.09258	0.0000

R-squared	0.928046	Mean dependent var	-1.37E+09
Adjusted R-squared	0.927334	S.D. dependent var	8.82E+08
S.E. of regression	2.38E+08	Akaike info criterion	41.43127
Sum squared resid	5.71E+18	Schwarz criterion	41.48243
Log likelihood	-2131.710	Hannan-Quinn criter.	41.45199
F-statistic	1302.674	Durbin-Watson stat	0.824651
Prob(F-statistic)	0.000000		

2. **Plot of net volatility**



3. **Test result presence of ARCH effect**

Heteroskedasticity Test: ARCH

F-statistic	401.7360	Prob. F(1,100)	0.0000
Obs*R-squared	81.67058	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/04/20 Time: 22:24
Sample (adjusted): 1990Q3 2015Q4
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.34E+15	4.78E+15	1.324849	0.1882
RESID^2(-1)	0.893332	0.044570	20.04335	0.0000

R-squared	0.800692	Mean dependent var	5.60E+16
Adjusted R-squared	0.798699	S.D. dependent var	9.21E+16
S.E. of regression	4.13E+16	Akaike info criterion	79.37842
Sum squared resid	1.71E+35	Schwarz criterion	79.42989
Log likelihood	-4046.300	Hannan-Quinn criter.	79.39926
F-statistic	401.7360	Durbin-Watson stat	1.996257
Prob(F-statistic)	0.000000		

4. **Result of variance equation**

i. ARCH 1,0

Dependent Variable: MNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 22:25
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 20 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-75737542	58516773	-1.294288	0.1956
MNFDI(-1)	0.965949	0.038579	25.03831	0.0000
	Variance Equation			
C	3.64E+16	1.31E+16	2.790984	0.0053
RESID(-1)^2	0.544794	0.537504	1.013563	0.3108

R-squared	0.927742	Mean dependent var	-1.37E+09
Adjusted R-squared	0.927026	S.D. dependent var	8.82E+08
S.E. of regression	2.38E+08	Akaike info criterion	41.02704

Sum squared resid	5.74E+18	Schwarz criterion	41.12936
Log likelihood	-2108.893	Hannan-Quinn criter.	41.06849
Durbin-Watson stat	0.828460		

ii. GARCH 1,1

Dependent Variable: MNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/04/20 Time: 22:26
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Failure to improve Likelihood after 22 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-75737542	43803631	-1.729024	0.0838
MNFDI(-1)	0.974340	0.024768	39.33835	0.0000
	Variance Equation			
C	3.61E+16	1.82E+16	1.981394	0.0475
RESID(-1)^2	0.667342	0.380407	1.754285	0.0794
GARCH(-1)	-0.351389	0.314925	-1.115788	0.2645

R-squared	0.926963	Mean dependent var	-1.37E+09
Adjusted R-squared	0.926240	S.D. dependent var	8.82E+08
S.E. of regression	2.40E+08	Akaike info criterion	40.90562
Sum squared resid	5.80E+18	Schwarz criterion	41.03352
Log likelihood	-2101.640	Hannan-Quinn criter.	40.95743
Durbin-Watson stat	0.826167		

iii. TARCH 1,1,1

Dependent Variable: MNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/21/20 Time: 22:27
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Failure to improve Likelihood after 15 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-75737542	44745043	-1.692647	0.0905
MNFDI(-1)	0.972474	0.026674	36.45757	0.0000
	Variance Equation			

C	3.61E+16	2.38E+16	1.512727	0.1303
RESID(-1)^2	0.563879	0.488829	1.153529	0.2487
RESID(-1)^2*(RESID(-1)<0)	0.130807	0.641883	0.203787	0.8385
GARCH(-1)	-0.329902	0.644736	-0.511686	0.6089

R-squared	0.927178	Mean dependent var	-1.37E+09
Adjusted R-squared	0.926457	S.D. dependent var	8.82E+08
S.E. of regression	2.39E+08	Akaike info criterion	40.93290
Sum squared resid	5.78E+18	Schwarz criterion	41.08638
Log likelihood	-2102.044	Hannan-Quinn criter.	40.99506
Durbin-Watson stat	0.827130		

iv. EGARCH 1,1,1

Dependent Variable: MNFDI
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/21/20 Time: 22:28
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 61 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-75737541	12769994	-5.930899	0.0000
MNFDI(-1)	0.946944	0.008869	106.7657	0.0000
	Variance Equation			
C(3)	3.442133	6.326670	0.544067	0.5864
C(4)	1.147937	0.782364	1.467268	0.1423
C(5)	0.054893	0.253915	0.216186	0.8288
C(6)	0.881662	0.180935	4.872810	0.0000

R-squared	0.927738	Mean dependent var	-1.37E+09
Adjusted R-squared	0.927023	S.D. dependent var	8.82E+08
S.E. of regression	2.38E+08	Akaike info criterion	40.55449
Sum squared resid	5.74E+18	Schwarz criterion	40.70796
Log likelihood	-2082.556	Hannan-Quinn criter.	40.61665
Durbin-Watson stat	0.813996		

Appendix C2: Result of Morocco net capital volatility, evidence from portfolio

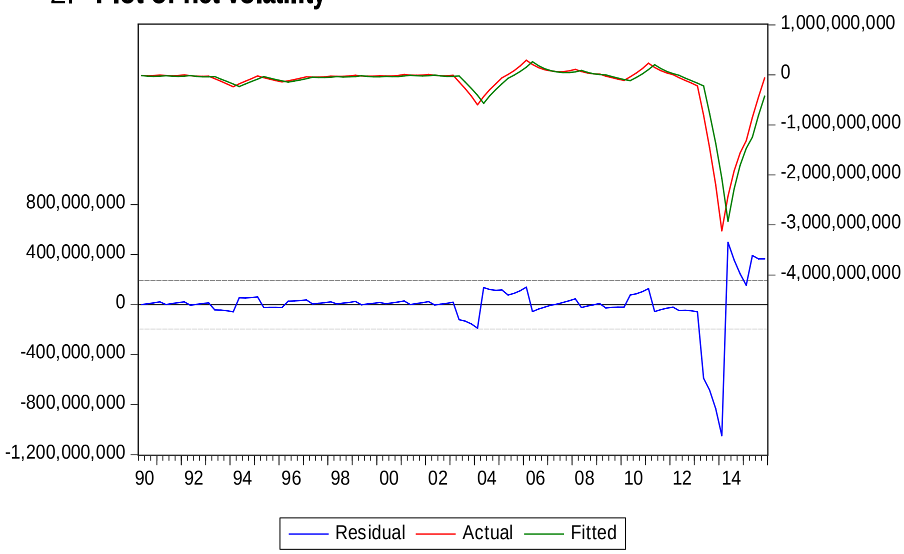
1. Result of mean equation model

Dependent Variable: MNPFV
Method: Least Squares
Date: 05/21/20 Time: 22:30
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12954501	20208632	-0.641038	0.5229
MNPFV(-1)	0.934325	0.035378	26.40953	0.0000

R-squared	0.873507	Mean dependent var	-1.89E+08
Adjusted R-squared	0.872255	S.D. dependent var	5.42E+08
S.E. of regression	1.94E+08	Akaike info criterion	41.01961
Sum squared resid	3.79E+18	Schwarz criterion	41.07077
Log likelihood	-2110.510	Hannan-Quinn criter.	41.04033
F-statistic	697.4630	Durbin-Watson stat	0.819327
Prob(F-statistic)	0.000000		

2. Plot of net volatility



3. Test result presence of ARCH effect

Heteroskedasticity Test: ARCH

F-statistic	111.3841	Prob. F(1,100)	0.0000
Obs*R-squared	53.74662	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2

Method: Least Squares
Date: 05/21/20 Time: 22:31
Sample (adjusted): 1990Q3 2016Q4
Included observations: 102 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.11E+16	1.00E+16	1.107138	0.2709
RESID^2(-1)	0.727367	0.068919	10.55387	0.0000

R-squared	0.526928	Mean dependent var	3.71E+16
Adjusted R-squared	0.522197	S.D. dependent var	1.42E+17
S.E. of regression	9.79E+16	Akaike info criterion	81.10240
Sum squared resid	9.58E+35	Schwarz criterion	81.15387
Log likelihood	-4134.222	Hannan-Quinn criter.	81.12324
F-statistic	111.3841	Durbin-Watson stat	1.890648
Prob(F-statistic)	0.000000		

4. **Result of variance equation**

i. ARCH 1,0

Dependent Variable: MNPFV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/21/20 Time: 22:32
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 23 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-12954479	43820099	-0.295629	0.7675
MNPFV(-1)	0.787487	0.077209	10.19946	0.0000
	Variance Equation			
C	2.41E+16	4.60E+15	5.248525	0.0000
RESID(-1)^2	0.815769	0.671589	1.214685	0.2245

R-squared	0.849291	Mean dependent var	-1.89E+08
Adjusted R-squared	0.847799	S.D. dependent var	5.42E+08
S.E. of regression	2.11E+08	Akaike info criterion	40.18423
Sum squared resid	4.51E+18	Schwarz criterion	40.28655
Log likelihood	-2065.488	Hannan-Quinn criter.	40.22567
Durbin-Watson stat	0.619383		

ii. GARCH 1,3

Dependent Variable: MNPFV

Method: ML - ARCH (Marquardt) - Normal distribution

Date: 05/21/20 Time: 22:34
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 60 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*GARCH(-2) +
C(7)*GARCH(-3)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-12954500	2959610.	-4.377097	0.0000
MNPFV(-1)	0.999482	0.002004	498.7424	0.0000
	Variance Equation			
C	2.35E+16	5.30E+15	4.433634	0.0000
RESID(-1)^2	0.849992	0.324123	2.622435	0.0087
GARCH(-1)	-0.998402	0.005872	-170.0151	0.0000
GARCH(-2)	0.066236	0.142539	0.464688	0.6422
GARCH(-3)	0.070838	0.139934	0.506221	0.6127

R-squared	0.868739	Mean dependent var	-1.89E+08
Adjusted R-squared	0.867439	S.D. dependent var	5.42E+08
S.E. of regression	1.97E+08	Akaike info criterion	39.39945
Sum squared resid	3.93E+18	Schwarz criterion	39.57851
Log likelihood	-2022.072	Hannan-Quinn criter.	39.47197
Durbin-Watson stat	0.837614		

ii. TARCH 1,3,1

Dependent Variable: MNPFV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/21/20 Time: 22:35
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 57 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) +
C(6)*GARCH(-1) + C(7)*GARCH(-2) + C(8)*GARCH(-3)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-12954501	5528712.	-2.343132	0.0191
MNPFV(-1)	1.017126	0.009694	104.9223	0.0000
	Variance Equation			
C	2.35E+16	6.57E+15	3.581139	0.0003
RESID(-1)^2	1.238069	0.843789	1.467274	0.1423
RESID(-1)^2*(RESID(-1)<0)	0.441388	0.291054	1.516518	0.1294
GARCH(-1)	-0.694985	0.168539	-4.123580	0.0000
GARCH(-2)	0.139533	0.141860	0.983599	0.3253
GARCH(-3)	-0.175695	0.124164	-1.415022	0.1571

R-squared	0.865807	Mean dependent var	-1.89E+08
Adjusted R-squared	0.864478	S.D. dependent var	5.42E+08
S.E. of regression	1.99E+08	Akaike info criterion	39.57102
Sum squared resid	4.02E+18	Schwarz criterion	39.77566
Log likelihood	-2029.908	Hannan-Quinn criter.	39.65391
Durbin-Watson stat	0.833411		

iv. EGARCH 1,3,2

Dependent Variable: MNPFV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/21/20 Time: 22:37
Sample (adjusted): 1990Q2 2016Q4
Included observations: 103 after adjustments
Convergence achieved after 134 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*RESID(-2)/@SQRT(GARCH(
-2)) + C(7)*LOG(GARCH(-1)) + C(8)*LOG(GARCH(-2)) + C(9)
*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-12954475	834329.7	-15.52681	0.0000
MNPFV(-1)	0.732540	0.026195	27.96535	0.0000

Variance Equation

C(3)	1.776999	1.849712	0.960689	0.3367
C(4)	3.189616	0.370453	8.610043	0.0000
C(5)	0.652780	0.325263	2.006930	0.0448
C(6)	-0.850168	0.164683	-5.162454	0.0000
C(7)	1.127430	0.054555	20.66585	0.0000
C(8)	0.098335	0.034214	2.874080	0.0041
C(9)	-0.344926	0.045416	-7.594771	0.0000

R-squared	0.827778	Mean dependent var	-1.89E+08
Adjusted R-squared	0.826073	S.D. dependent var	5.42E+08
S.E. of regression	2.26E+08	Akaike info criterion	38.36424
Sum squared resid	5.15E+18	Schwarz criterion	38.59446
Log likelihood	-1966.759	Hannan-Quinn criter.	38.45749
Durbin-Watson stat	0.527755		

Appendix D1: Result of South Africa net capital volatility, evidence from FDI

1. **Result of mean equation model**

Dependent Variable: SNFDIS

Method: Least Squares

Date: 02/18/20 Time: 08:04

Sample (adjusted): 1990Q2 2016Q1

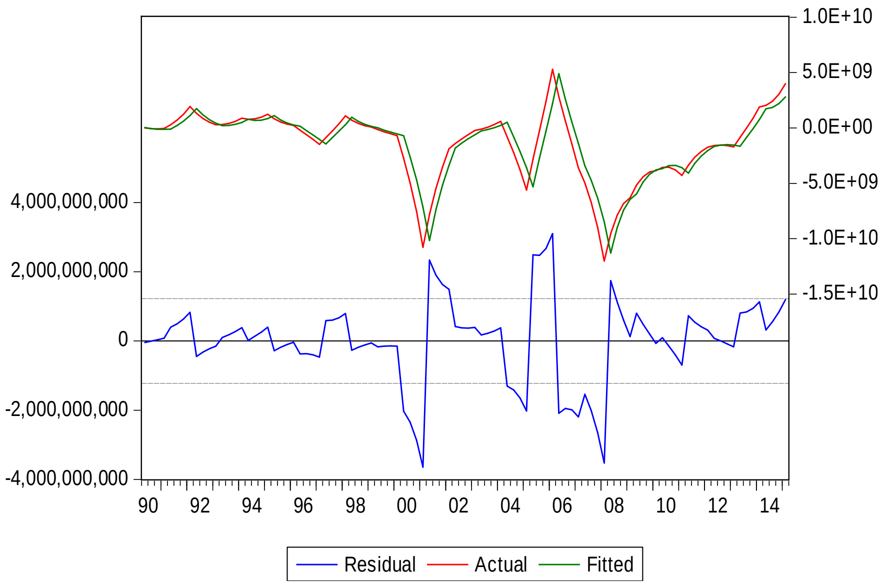
Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-55338608	1.36E+08	-0.408207	0.6840
SNFDIS(-1)	0.936084	0.039370	23.77665	0.0000

R-squared	0.852260	Mean dependent var	-1.44E+09
Adjusted R-squared	0.850753	S.D. dependent var	3.17E+09
S.E. of regression	1.23E+09	Akaike info criterion	44.71023
Sum squared resid	1.47E+20	Schwarz criterion	44.76233
Log likelihood	-2233.511	Hannan-Quinn criter.	44.73131
F-statistic	565.3293	Durbin-Watson stat	0.903434

Prob(F-statistic)	0.000000

2. **Plot of net volatility**



3. **Test Result presence of ARCH effect**

Heteroskedasticity Test: ARCH

F-statistic	148.6947	Prob. F(1,97)	0.0000
Obs*R-squared	59.91491	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/18/20 Time: 08:05
Sample (adjusted): 1990Q3 2015Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.43E+17	1.93E+17	1.772401	0.0795
RESID^2(-1)	0.776734	0.063698	12.19404	0.0000

R-squared	0.605201	Mean dependent var	1.49E+18
Adjusted R-squared	0.601131	S.D. dependent var	2.67E+18
S.E. of regression	1.68E+18	Akaike info criterion	86.79338
Sum squared resid	2.75E+38	Schwarz criterion	86.84581
Log likelihood	-4294.273	Hannan-Quinn criter.	86.81460
F-statistic	148.6947	Durbin-Watson stat	1.914551
Prob(F-statistic)	0.000000		

4. **Result of variance equation**

i. ARCH 1,0

Dependent Variable: SNFDIS
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:07
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 14 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-55338607	2.19E+08	-0.253142	0.8002
SNFDIS(-1)	0.881810	0.075102	11.74143	0.0000
	Variance Equation			
C	9.67E+17	2.68E+17	3.603957	0.0003
RESID(-1)^2	0.640766	0.507516	1.262554	0.2067

R-squared	0.848752	Mean dependent var	-1.44E+09
Adjusted R-squared	0.847209	S.D. dependent var	3.17E+09
S.E. of regression	1.24E+09	Akaike info criterion	44.23708
Sum squared resid	1.51E+20	Schwarz criterion	44.34129
Log likelihood	-2207.854	Hannan-Quinn criter.	44.27926
Durbin-Watson stat	0.841754		

ii. GARCH 1,1,

Dependent Variable: SNFDIS
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:08
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 28 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-55338608	1.51E+08	-0.365508	0.7147
SNFDIS(-1)	0.963485	0.039835	24.18674	0.0000
	Variance Equation			
C	9.56E+17	3.20E+17	2.983541	0.0028
RESID(-1)^2	0.883466	0.458428	1.927163	0.0540
GARCH(-1)	-0.475272	0.203306	-2.337719	0.0194

R-squared	0.851366	Mean dependent var	-1.44E+09
Adjusted R-squared	0.849850	S.D. dependent var	3.17E+09

S.E. of regression	1.23E+09	Akaike info criterion	44.10180
Sum squared resid	1.48E+20	Schwarz criterion	44.23206
Log likelihood	-2200.090	Hannan-Quinn criter.	44.15452
Durbin-Watson stat	0.921193		

iii. TARCH 1,1,2

Dependent Variable: SNFDIS
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:10
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 21 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) +
C(6)*RESID(-2)^2*(RESID(-2)<0) + C(7)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-55338608	1.17E+08	-0.472283	0.6367
SNFDIS(-1)	0.918135	0.049641	18.49565	0.0000
	Variance Equation			
C	9.56E+17	2.33E+17	4.110584	0.0000
RESID(-1)^2	0.678976	0.277075	2.450509	0.0143
RESID(-1)^2*(RESID(-1)<0)	0.318715	0.450561	0.707374	0.4793
RESID(-2)^2*(RESID(-2)<0)	0.683029	0.443846	1.538888	0.1238
GARCH(-1)	-0.815265	0.091290	-8.930468	0.0000

R-squared	0.851877	Mean dependent var	-1.44E+09
Adjusted R-squared	0.850365	S.D. dependent var	3.17E+09
S.E. of regression	1.23E+09	Akaike info criterion	43.97070
Sum squared resid	1.47E+20	Schwarz criterion	44.15306
Log likelihood	-2191.535	Hannan-Quinn criter.	44.04451
Durbin-Watson stat	0.886677		

iv. EGARCH 1,1,1

Dependent Variable: SNFDIS
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:11
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 45 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-55338577	53508194	-1.034208	0.3010
SNFDIS(-1)	0.865048	0.034555	25.03404	0.0000
	Variance Equation			
C(3)	15.80495	7.208897	2.192422	0.0283
C(4)	1.483032	0.382591	3.876285	0.0001
C(5)	-0.249567	0.253521	-0.984405	0.3249
C(6)	0.584788	0.182430	3.205545	0.0013

R-squared	0.846251	Mean dependent var	-1.44E+09
Adjusted R-squared	0.844682	S.D. dependent var	3.17E+09
S.E. of regression	1.25E+09	Akaike info criterion	43.74556
Sum squared resid	1.53E+20	Schwarz criterion	43.90187
Log likelihood	-2181.278	Hannan-Quinn criter.	43.80882
Durbin-Watson stat	0.816855		

AppendixD2: Result of South Africa net capital volatility, evidence from portfolio

1. **Result of mean equation model**

Dependent Variable: SNPFINV

Method: Least Squares

Date: 02/18/20 Time: 08:13

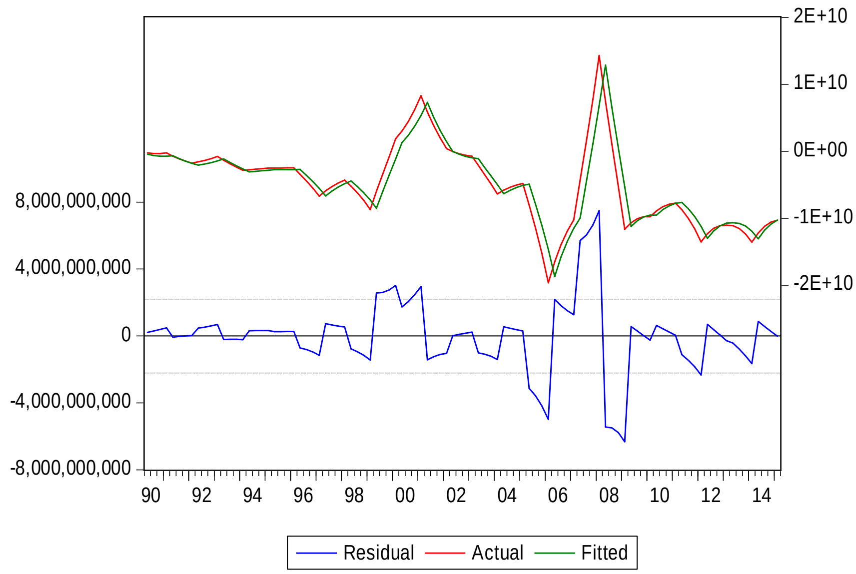
Sample (adjusted): 1990Q2 2016Q1

Included observations: 100 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.22E+08	2.80E+08	-1.508424	0.1347
SNPFINV(-1)	0.930894	0.037281	24.96939	0.0000

R-squared	0.864166	Mean dependent var	-4.72E+09
Adjusted R-squared	0.862780	S.D. dependent var	5.95E+09
S.E. of regression	2.20E+09	Akaike info criterion	45.88532
Sum squared resid	4.76E+20	Schwarz criterion	45.93743
Log likelihood	-2292.266	Hannan-Quinn criter.	45.90641
F-statistic	623.4706	Durbin-Watson stat	0.781237
Prob(F-statistic)	0.000000		

2. **Plot of net volatility**



3. **Test result presence of ARCH effect**

Heteroskedasticity Test: ARCH

F-statistic	189.0305	Prob. F(1,97)	0.0000
Obs*R-squared	65.42666	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/18/18 Time: 08:14
Sample (adjusted): 1990Q3 2016Q1
Included observations: 99 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.99E+17	6.95E+17	1.294859	0.1984
RESID^2(-1)	0.812958	0.059129	13.74884	0.0000

R-squared	0.660875	Mean dependent var	4.81E+18
Adjusted R-squared	0.657379	S.D. dependent var	1.08E+19
S.E. of regression	6.31E+18	Akaike info criterion	89.43369
Sum squared resid	3.86E+39	Schwarz criterion	89.48612
Log likelihood	-4424.968	Hannan-Quinn criter.	89.45490
F-statistic	189.0305	Durbin-Watson stat	1.999943
Prob(F-statistic)	0.000000		

4. **Result of variance equation**
   i. ARCH 1,0

Dependent Variable: SNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:15
Sample (adjusted): 1990Q2 2016Q1

Included observations: 100 after adjustments
Convergence achieved after 16 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.22E+08	4.86E+08	-0.868031	0.3854
SNPFINV(-1)	0.940718	0.064132	14.66839	0.0000
	Variance Equation			
C	3.13E+18	8.24E+17	3.797782	0.0001
RESID(-1)^2	0.575607	0.487443	1.180871	0.2377

R-squared	0.864011	Mean dependent var	-4.72E+09
Adjusted R-squared	0.862624	S.D. dependent var	5.95E+09
S.E. of regression	2.21E+09	Akaike info criterion	45.36148
Sum squared resid	4.77E+20	Schwarz criterion	45.46569
Log likelihood	-2264.074	Hannan-Quinn criter.	45.40366
Durbin-Watson stat	0.787221		

ii. GARCH 1,1

Dependent Variable: SNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:16
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Failure to improve Likelihood after 14 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.22E+08	4.49E+08	-0.940291	0.3471
SNPFINV(-1)	0.919210	0.060195	15.27060	0.0000
	Variance Equation			
C	3.10E+18	1.07E+18	2.884799	0.0039
RESID(-1)^2	0.692570	0.509851	1.358376	0.1743
GARCH(-1)	-0.111454	0.206499	-0.539733	0.5894

R-squared	0.863947	Mean dependent var	-4.72E+09
Adjusted R-squared	0.862559	S.D. dependent var	5.95E+09
S.E. of regression	2.21E+09	Akaike info criterion	45.29052
Sum squared resid	4.77E+20	Schwarz criterion	45.42078
Log likelihood	-2259.526	Hannan-Quinn criter.	45.34324
Durbin-Watson stat	0.772064		

iii. TARCH 1,1,1,

Dependent Variable: SNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:17
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Failure to improve Likelihood after 9 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-1)^2*(RESID(-1)<0) +
C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.22E+08	4.47E+08	-0.943184	0.3456
SNPFINV(-1)	0.926220	0.051187	18.09478	0.0000
	Variance Equation			
C	3.10E+18	1.48E+18	2.095706	0.0361
RESID(-1)^2	0.757379	0.885661	0.855157	0.3925
RESID(-1)^2*(RESID(-1)<0)	-0.091407	0.979825	-0.093289	0.9257
GARCH(-1)	-0.118971	0.391445	-0.303927	0.7612

R-squared	0.864131	Mean dependent var	-4.72E+09
Adjusted R-squared	0.862745	S.D. dependent var	5.95E+09
S.E. of regression	2.20E+09	Akaike info criterion	45.31071
Sum squared resid	4.76E+20	Schwarz criterion	45.46702
Log likelihood	-2259.536	Hannan-Quinn criter.	45.37398
Durbin-Watson stat	0.777831		

iv. EGARCH

Dependent Variable: SNPFINV
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 02/18/20 Time: 08:18
Sample (adjusted): 1990Q2 2016Q1
Included observations: 100 after adjustments
Convergence achieved after 34 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5)
*RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.22E+08	91533640	-4.610427	0.0000
SNPFINV(-1)	0.960076	0.018657	51.45851	0.0000
	Variance Equation			

C(3)	5.296745	3.361308	1.575799	0.1151
C(4)	1.080204	0.471398	2.291492	0.0219
C(5)	0.038475	0.208017	0.184961	0.8533
C(6)	0.852245	0.085056	10.01984	0.0000

R-squared	0.862799	Mean dependent var	-4.72E+09
Adjusted R-squared	0.861399	S.D. dependent var	5.95E+09
S.E. of regression	2.22E+09	Akaike info criterion	44.72853
Sum squared resid	4.81E+20	Schwarz criterion	44.88484
Log likelihood	-2230.426	Hannan-Quinn criter.	44.79179
Durbin-Watson stat	0.794272		