Financial Openness and macroeconomic volatility Africa: Evidence from the Finite Mixture-of-Regression*

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ABSTRACT

Using cross-country panel data from 46 African countries, the paper revisits the relationship between capital flows and macroeconomic volatility in Africa by relaxing the assumption that all African countries follow a single unique macroeconomic volatility regime. It uses the finite mixture-of-regressions approach to explore the possibility that macroeconomic volatilities of different countries can be classified into different regimes/classes and the impact of capital flows on macroeconomic volatility may differ depending on the class that a country belongs to. We find that the macroeconomic volatilities of these African countries can be *optimally* classified into two regimes, and the impact of capital flows on macroeconomic volatility is significantly different between these two classes; in one of the classes financial openness significantly reduces macroeconomic volatility, while in the other in does significantly increases macroeconomic volatility. Further analysis show that factors such as trade openness and financial development increases the probability of countries being in the regime where capital flows decrease volatility. The policy implication of this is that countries that need to reap the growth-benefits associated with external capital, while at the same time preserving macroeconomic stability should undertake trade, financial and institutional reforms.

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INTRODUCTION

The role of financial openness in promoting economic development in emerging and developing countries has been recognized in many studies (see Chari and Henry, 2004; Levine, 2005; Galindo *et al*., 2007; Abiad, *et al*, 2008; Kose, 2009). Literature suggests several channels through which financial openness influence economic development and this depends on the type of capital flow that a country receives. For example, foreign direct investment (FDI) is often associated with the transfer of managerial expertise and productive technology, both of which are key to stimulating economic development. Similarly, portfolio capital flows may provide short term funding of balance of payment deficits and it's a crucial source of foreign exchange for developing and emerging markets. Furthermore, it is also recognized that financial openness may positively contribute economic development through promoting savings and investment (see McKinnon, 1973 and Shaw, 1973), providing the scope of better diversification of risk (see Obstfeld, 1994), promoting efficient reallocation of capital (see Galindo, *et al*., 2007; Abiad, *et al*, 2008).

Sadly, the empirical experiences of countries such as those in Asia and Latin America in the 1990s suggests that the benefits of financial openness may come at the cost of macroeconomic instability and as the economy is left exposed to external shocks. Macroeconomic instability often result in substantial welfare losses (Loayaza, *et al*, 2007; Ramey and Ramey, 1995). It is for this reason that a debate has since emerged on whether financial openness on macroeconomic volatility. Despite widespread literature on this debates, there does not seem to be consensus. Some empirical studies document that financial openness promotes macroeconomic stability (see for example, Odior and Banuso, 2011; De Nicolo and Juvenal, 2010). At least two theoretical arguments have been suggested to explain this negative relationship between financial openness and macroeconomic volatility. One argument is that access to external finance can facilitate consumption-smoothing, which in turn enhances macroeconomic stability (Agénor, 2003). Another argument is that financial openness are associated with better institutions and corporate governance which are likely to yield a stable macroeconomy (De Nicolo and Juvenal, 2010).

However, other empirical studies find that financial openness increases macroeconomic volatility. This literature suggests a number of channels through which financial openness can destabilize the macroeconomy. First, capital flows can cause shocks in the real exchange rate and inflation which

are then transmitted into the real economy through instabilities in real wages and the fiscal policies (Fidzgerald, 2008). Secondly, financial openness can leave the economy vulnerable to reversal in capital flows which may increase macroeconomic volatility and precipitate crises (Aguiar and Gopinath, 2007; Alleyne and Mecagne, 2014). This is especially the case with portfolio capital and short-term debt investments fall into this category – hot money - sensitive to changes in global economic condition (Alleyne and Mecagne, 2014). Emerging market countries are particularly vulnerable to these episodes that have been observed in countries/regions such as Asia and Latin America.

Another strand of literature attempts to bridge the gap between these two opposing views by examining the conditions under which financial openness causes instability. This is the idea pursued in studies such as Kose, *et al*. (2003), Broner and Rigobon (2004), and Alfaro, *et al*. (2004). Kose, *et al*. (2003) and Broner and Rigobon (2004), for example, found that capital flows the impact of financial flows depends on the level of development – developing countries are more volatile than flows to developed countries and this volatility can be accounted for by contagion and persistence of flows. Levchenko (2004) shows that financial openness increases consumption volatility countries where a developed financial system that promotes risk-pooling across agents is not available. Alfaro, *et al*. (2004) and Ahmed and Suardi (2009) show that capital flows increase macroeconomic volatility only in countries with poor institutions and failure. Kose *et al*. (2009) argue that the impact of financial openness on macroeconomic volatility depends on the composition of capital flows. They argue, FDI flows, which are less prone to sudden reversals are more likely to promote stability, while debt flows, which are mainly pro-cyclical and volatility are likely to exacerbate macroeconomic volatility.

Empirical studies often any one of two approaches to examine the conditions under which financial openness increases/decreases macroeconomic volatilities is different across countries. The first approach involves introducing heterogeneity in the coefficients of capital flows by interacting the proxy of capital flows with the proxies of the variables that is a potential source of these differences (e.g. institutional quality, financial development, level of development). However, a major concern with this approach is that it ignores potential heterogeneities imposed that may arise from other regressors (Konte, 2015). The second approach involves dividing the countries into different groupings depending on, for example, their level of economic development, resource endowment,

regional or sub-regional locations, the quality of institutions, etc. However, apart from being subjective, these *ex ante* classifications are not based on testing the statistical properties of the data. Van Dijk *et al*. (2011) notes that such arbitrary *ex ante* classification is problematic since it is not based on testing the statistical properties of the data. Furthermore, such classification, may result in the elimination of some homogenous elements across countries that may be of interest to explore.

Therefore, it is important to ensure that a statistically-driven methodology that account for all the factors that induce potential cross-country heterogeneities, while at the same time preserving some of the homogeneities across countries is employed. This study attempt to bridge the gap in the literature on financial openness and macroeconomic volatility by using a methodology that addresses the aforementioned issues. Specifically, we use the Finite Mixture-of-Regressions (FMM) approach. The FMM has been mainly applied in growth-studies and is a semi-parametric technique that is based on the idea that a panel data series that constitute a dependent variable in a regression[1] can be classified into more than one class/regime depending on some statistical properties of data. Therefore, the FMM enables us to model the unobserved heterogeneity in the impact of financial openness on macroeconomic volatility, and relax the assumption this relationship is uniform across countries.

Although this approach has not been literature on financial openness and macroeconomic volatility, it has been applied in other areas, especially in the area of economic growth. Owen et al. (2009) and Bos *et al*. (2010), for example show that growth does not follow a single, unique regime that is similar across countries. Similarly, Konte (2015) use a sample of 91 countries to document that countries follow different growth regimes, and the impact of commodity prices on growth differs depending on the regime that a country follows. It is therefore important to explore this idea in the context of growth. *A prior*, we believe that, as is the case with growth, macroeconomic volatility is also likely to follow more than one regime since they both derive from the Gross Domestic Product (GDP).

Our empirical analysis is based on a sample of 46 Africa countries. The analysis is done in three steps. First we determine the number of classes that the macroeconomic volatilities can best be

[1] In our case this dependent variable is the macroeconomic volatilities of different countries.

classified into based on some goodness-of-fit tests. Once these classes are done, we examine whether determinants of macroeconomic volatility differ between/across these classes. We then determine the probability of each of the 46 countries belonging in the different classes. Finally, we examine the determinant of membership of countries to the identified classes. The determinants of the probabilities can be interpreted as the conditions that determine the heterogeneity in the impacts of financial openness across countries.

Our findings suggest that the macroeconomic volatilities of African countries can be classes into two unique growth-regimes. Fifty percent of the countries in our sample is in the first class, while the remaining are in the other class. We find that capital flows are only associated with an increase in macroeconomic volatility for countries in the first class. However, an improvement in the quality of institutions can significantly reduce the impact of capital flows on macroeconomic volatility in these countries. We believe that accounting for these heterogeneities in the impact of financial openness on macroeconomic volatility can yield dividend in terms of sharper policy implications. For example, in our case, further analysis of the classes suggest that countries that carry out reforms that are aimed at improving the quality of institutions, the depth of the financial system and the openness to trade have a better chance of belonging in the class where financial openness promotes macroeconomic stability. Policy inventions that then target trade and financial reforms can have much sharper outcomes.

The remainder of the paper is organized as follows. Section 2 presents some statistical evidence that suggests that it cannot be described using one regime. Section 3 discusses the data and the empirical methodology. Section 4 presents and discusses the empirical findings. Section 5 concludes the paper and highlights the policy implications and areas for further research.

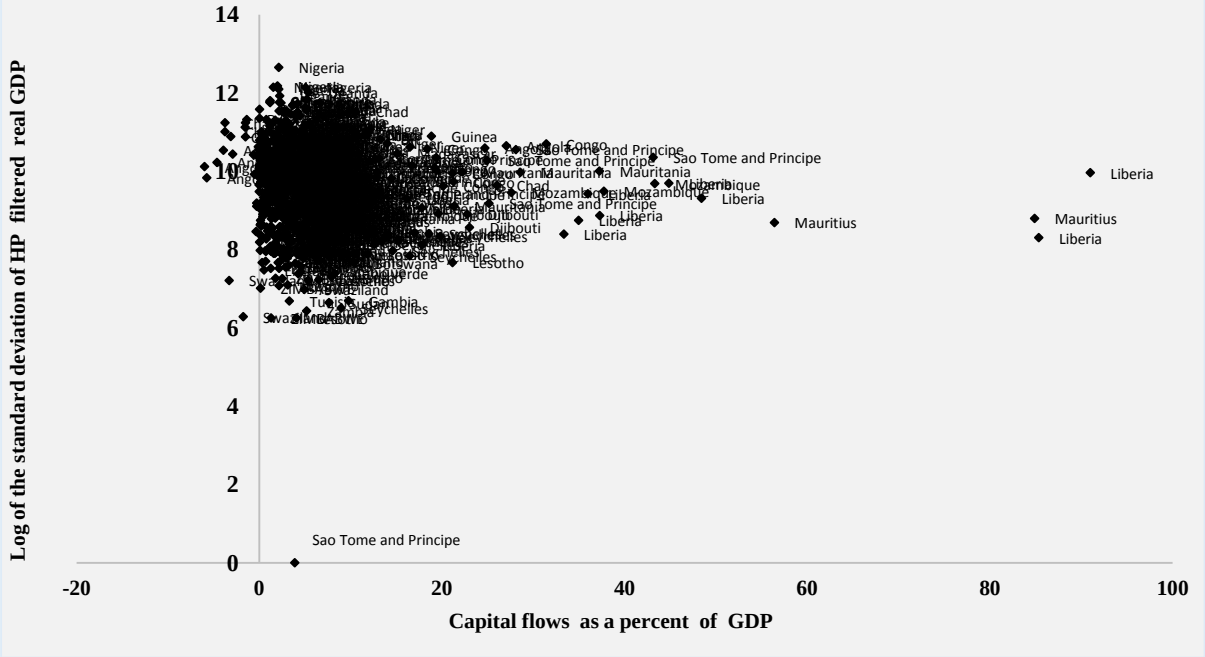
2. CHECKING FOR *A PRIORI* CLUSTERS

To lay foundation to our conditional clustering analysis using the finite mixture-of-regressions, we begin by simple correlation analysis of key variables of interest to see if they could suggest evidence of unconditional clustering in the data. Figure 1 shows the correlation plot of the proxy for macroeconomic volatility (i.e. standard errors of HP filtered GDP) on the vertical axis and the proxy of financial openness on the horizontal axis. The figure does not seem to suggest that there is a systematic relationship between macroeconomic volatility and financial openness series along

certain groups of countries, e.g. countries in the similar sub-regional groupings, similar level of development, or countries with similar resources endowment (i.e. oil exporting and mineral rich). As such, arbitrarily clustering the countries according to sub-region, resource endowment or level of developed may not lead to meaningful analysis.

Figure 1, however, does suggest that there are possible heterogeneity in the relationship between financial openness and GDP volatility across countries that should not be ignored. Although it is difficult to determine the exact number of cluster, aggregating the sample as a pool to measure the impact of financial openness on macroeconomic volatility may lead to biased and inconsistent results, and misleading policy conclusions. Therefore, this study will use an econometric technique, the FMM, that can determine the exact number of clusters/ latent classes, and analyse whether the impact of financial openness on macroeconomic volatility differ across the identified latent classes. In Section 3, we elaborate on this FMM technique, and discuss how it can enable us to determine the number of latent classes, and examine which countries lie in each of these latent classes.

Figure 1: Panel correlation between proxies of financial openness and the proxy of macroeconomic volatility for African countries (2000-2013)



3. DATA AND METHODOLOGY

3.1 Data and Variables

Our sample comprises of 49 African countries. We use annual data for the period 2000 – 2013. This period is ideal as it considers some of the longest periods of growth for Africa. It also coincides with an increase in increase in foreign capital, especially in resource rich African countries to tap into the high international commodity prices. Furthermore, during this period, Africa experienced the longest period of increase in exports earning.

Since we analyse the impact of capital flows on the business cycle volatility, our main dependent variables of interest include the volatility of HP Filtered series for the following macroeconomic variables: GDP, Investment, Private Consumption, and Private + Government Consumption. Data on these macroeconomic variables were obtained from the World Bank's World Development Indicators (WDI) Database. The explanatory variable of interest is financial openness. In the current study, we employ *de facto* measures of financial openness, based on the actual flow of foreign direct investment and portfolio investments. The advantage of such *de facto* measures over the *de jure* measures (i.e. measure based on whether countries have legal restriction of capital flows or not) is that this measure indicates the realized level of capital flows. Data on foreign direct and portfolio investments were also sourced from the WDI. Literature is mixed with regards to the impact of capital flows on macroeconomic volatility. On the one hand, capital flows improve macroeconomic stability through providing means of smoothing consumption and reducing investment constraints. On the other hand, it could increase macroeconomic volatility through capital reversals, especially during times of crises. We also control for measures of capital flows volatility. Higher capital flow volatilities are likely to propagate macroeconomic volatility directly, especially for countries with poor in structural and institutional environment.

Following the extant literature (see for example, Deaton and Miller, 1996, Acemoglu *et al*., 2003; Raddatz, 2007; Loayza and Raddatz, 2007), we also control for a number of structural, institutional and macroeconomic determinants of macroeconomic volatility. These structural determinants that are controlled for are trade openness and the extent of financial development. These structural features determine the extent to which the economy is able to absorb shocks both the internal and external environment. A developed and sophisticated financial system that is able to facilitate

smooth reallocation of resources can go a long way in smoothing domestic and external shocks resulting in a significant reduction on the impact of these shocks on the macroeconomy. The access of consumers to a developed financial system enables them to smooth-out their consumption patterns overtime, thereby reducing general macroeconomic volatility. Indeed an empirical study by Loayza and Raddatz (2006) show that a deeper financial system can bring up to 1.5 percentage points reduction in the impact of shocks on the macroeconomy. On the other hand, literature is mixed on the impact of trade openness on macroeconomic volatility. To the extent that trade may result in specialization along areas of comparative advantage, it may heighten macroeconomic volatility if the international prices of the commodity specialized in fluctuates (Easterly, Islam, and Stiglitz, 2000). However, whether trade openness will increase volatility depends on the nature of shocks and patterns of specialization that it promotes. Trade openness that promotes intra-industry specialization across country, increasing trade in intermediate inputs may result in improved macroeconomic stability (Razin and Rose, 1994).

The role of quality institutions in taming macroeconomic volatility through facilitating a stable policy environment has been underscored in studies such as Acemoglu *et al*. (2003). Tang, *et al*. (2008) shows that weak institutions reduce technical change, particularly by reducing the accumulation of physical and human capital. Low pace of technical change, then, undermine the capacity of a countries to add value to their products and diversify their economies, which in turn makes their economies vulnerable to shocks.

The macroeconomic factors that we control for are those that are particularly relevant for monetary and fiscal policies. There is both theoretical basis and ample empirical evidence suggesting that fiscal and monetary policy can either increase or decrease macroeconomic volatility. Macroeconomic policies that are characterized by volatile and pro-cyclical public spending, and unstable inflation are bound to increase macroeconomic volatility. Studies such as Fatás and Mihov (2006), Loayza et al. (2006) indeed show that fiscal spending volatility is positively associated with volatility in output growth. Similarly, poor and unsound monetary policies, may amplify inflation volatility which is then filtered into macroeconomic fluctuations through undermining the ability of consumers and firms to formulate long-term plans on consumption and investment. Romer and Romer (2002) and Bernanke (2004) note that the high growth and growth

volatilities that were experienced in the 1970s were underpinned by unsound monetary policies. In what follows, we now discuss the methodology.

3.2 ECONOMETRIC TECHNIQUE

3.2.1 The Baseline Regression

We begin by estimating a baseline panel parametric regression assuming that the macroeconomic volatilities of all countries in the sample follow a single process. We specify the model as follows:

$$\sigma_{c,t}^{M} = \beta_0 + \beta_1 Capital\ Flows + \beta_k \mathbf{X_{c,t}} + \varepsilon_{i,t} \qquad (1)$$

In equation (1), *c* and *t* are subscripts for cross-sectional and time series units, $\sigma_{c,t}^{M}$ denotes a measure of macroeconomic volatility (i.e. GDP volatility, consumption volatility, or investment volatility), β_0 is a country-specific intercept, and $\varepsilon_{i,t}$ is an independently and identically distributed error term. As usual, it is assumed that $\varepsilon_{i,t} \sim N(0, \sigma^2)$. **X** is a vector of determinants of the structural, institutional and macroeconomic determinants of macroeconomic volatility discussed above, other than capital flows.

The main coefficient of interest is β_1, and it measures the average marginal impact of capital flows on macroeconomic volatility. The coefficient is only appropriate if all countries included in the sample follow a single unique macroeconomic volatility process. We hypothesize that countries are unlikely to follow a single unique macroeconomic volatility regime. We believe that this is the case given a number of emerging studies that show that GDP growth of different countries do not necessarily follow a single unique regime. Since our measures of macroeconomic volatility are related to GDP growth, it is reasonable to believe that they are also likely to follow a single unique regime across country. For this reason, the impact of capital flows on macroeconomic volatility may vary depending on the macroeconomic volatility regime that a country belongs to.

Unfortunately, the hypothesis that the impact of capital flows on macroeconomic volatility may vary across countries depending on the regime that a country belongs to has not been adequately explored. Existing empirical attempts to address this hypothesis are based on dividing countries into groups depending on variables such as institutional quality, level of economic development, level of financial development, etc. and then assessing whether the impact of capital flows on

macroeconomic volatility differs across these groups or interacting these variables with the measures of financial openness (see for example, Kose, *et al*., 2003; Broner and Rigobon, 2004). Most of these studies indeed find that the impact of financial openness on macroeconomic volatility may vary across countries once these factors are controlled. However, this approach has some limitation. Firstly, the approach only focuses on specific variables of interest, leaving out the role of other variables on differential coefficients of financial openness across countries. Secondly, the classification of countries into groups is often arbitrary, and is not driven by any meaningful statistical tests. Even where classifications are based on due statistical tests, Tan (2010) shows that such classification often lack appropriate asymptotic properties necessary to infer for the existence of threshold variables and their values. It is in this context that an emerging trend in the growth literature is to use the mixture-of-regression approach to explore the idea that the growth rates of countries may follow different regimes, and the impact of different determinants of growth may differ across these regimes (see Konte, 2013). In this study, we use the bias-adjusted mixture-of-regression to examine whether this is also the case for macroeconomic volatility. In what follows, we now discuss the bias-adjusted mixture-of-regression.

3.2.2 The mixture-of-regressions

The mixture-of-regressions is a semi-parametric method, which can be used to examine whether a dependent variable follows different regimes/processes across different cross sectional units. In this study, we use the three-step mixture-of-regressions. This has at least two advantages over the one-step mixture-of-regressions. First, regime-profiling in the one step mixture-regressions is sensitive to addition or removal of a variable, an issue that is addressed in the bias-adjusted mixture-regressions. Second, using the bias-adjusted mixture-regression, it is possible to separate between the determinants of macroeconomic volatility and those of that are important in determining regime membership. In the bias-adjusted three-step mixture-regressions, the following steps are sequentially followed;

Step 1: We estimate the latent class of the baseline regression model and determine the number of regimes/latent classes.
Step 2: We estimate the posterior assignment probabilities using the estimated parameters from the first step.
Step 3: We examine the determinants of the probability of a country belonging to a certain regime where capital flows have a negative influence on macroeconomic volatility.

Without loss of generality, we specify the mixture-of-regressions model as follows:

$$f(\sigma_{c,t}^{M} | Capital\ Flows, \mathbf{X}; \Theta) = \sum_{k=1}^{K} \pi_k f_k(\sigma_{c,t}^{M} | Capital\ Flows, \mathbf{X}; \beta_k, \sigma_k) \quad (2)$$

where*k* denote the optimal number of regimes/latent classes and is unknown *a prior,* and is determined using some goodness of fit criteria, such as the Bayesian Information Criterion (BIC) and Correction Akaike Information Criterion (CAIC). The parameter Θ denotes the vector of all parameters of the mixture distribution, π_k is the probability that country *i*belongs to latent regime *k*, where, $0 \leq \pi_k \leq 1$ and $\sum_{k=1}^{K} \pi_k = 1$, $f(\sigma_{c,t}^{M} | Capital\ Flows, \mathbf{X}; \beta_k, \sigma_k)$ is the conditional density of the macroeconomic volatility in the regime *k*, β_k and σ_k are parameters in latent regime *k*. We assume that $f_k(.)$ follows a Gaussian distribution. All the remaining variables are as defined earlier.

If the optimal *k = 1*, then the macroeconomic volatilities of all countries follow a similar regime. In this regard, equation (2) reduces to equation (1). If the optimal *k > 1*, then the macroeconomic volatilities of different countries do not belong in the same regime. For illustration purposes, let's suppose *k=K*, then it is possible to write equation (2) as follows:

$$\begin{aligned}
\sigma_{c,t}^{M} &= \beta_{01} + \beta_{11} Capital\ Flows + \beta_{m1} \mathbf{X_{c,t}} + \varepsilon_1, \qquad \varepsilon_1 \sim N(0, \sigma^2) \\
\sigma_{c,t}^{M} &= \beta_{01} + \beta_{12} Capital\ Flows + \beta_{m2} \mathbf{X_{c,t}} + \varepsilon_2, \qquad \varepsilon_2 \sim N(0, \sigma^2) \\
&\vdots \\
\sigma_{c,t}^{M} &= \beta_{0K} + \beta_{1K} Capital\ Flows + \beta_{mK} \mathbf{X_{c,t}} + \varepsilon_K, \qquad \varepsilon_K \sim N(0, \sigma^2)
\end{aligned} \quad (3)$$

In equation (4) scenario, the error terms ε_1, ε_2 and ε_K are assumed to be independent. Given that the regime process that macroeconomic volatility follows, differs across countries, it is expected that the impact of capital flows on macroeconomic volatility, as reflected in coefficient β_{1k} vary across the different *K* regimes. A Wald test of differences in coefficients can be used to formally test whether the coefficients of capital flows and those of other control variables are indeed different across latent regimes.

The parameters in equations (2) can be estimated using the Expectation-Maximization (EM) algorithm of Dempster *et al*. (1977). This two-step algorithm utilizes the joint densityof the macroeconomic volatility and the latent classesk_i. The two-steps are performed in an alternating basis and they can be described as follows. In the first step, called the E-Step, the expected values of the full data log-likelihood function with respect to the latent classes k_i, for *i = 1, 2, ...N*, given

the macroeconomic volatility series, and the current values of the model parameters. In the second step, (M-step), the expected value of the full data log-likelihood is maximized with respect to the model parameters (van Diyk,*et al*., 2011). Since the EM algorithm maximizes the log-likelihood function, the resulting estimates are equal to the Maximum Likelihood estimates (van Diyk,*et al*., 2011). The standard errors of the estimates are estimated using second derivative of the log-likelihood function.

Formally, the full data likelihood function is given by

$$l(\mathcal{P},\mathcal{K},\theta)=\prod_{i=1}^{N}\left(\prod_{k=1}^{K}\left(f_k(.)\prod_{t=1}^{T}\frac{1}{\sigma_i}\phi\left(\varepsilon_{i,t}^{k}/\sigma_i\right)\right)^{I[k_i=k]}\right) \quad (5)$$

Where $\mathcal{P}=\{\{\sigma_{c,t}^{M}\}_{t=1}^{T}\}_{n=1}^{N}$ and $\mathcal{K}=\{k\}_{i=1}^{K}$, and $\phi(.)$ is the probability density function of a standard normal random variable and is a vector containing all the parameters of the model. The error term for country *i* that belongs to cluster *k*at time *t* is given by:

$$\varepsilon_{it}^{k}=(\sigma_{c,t}^{M})-\mathbf{x}_{i,t}^{'}\beta_k \quad (6)$$

where $\mathbf{x}_{i,t}^{'}$ is the (mx1)vector with all the regressors in equation (2), β_k contains the parameters for cluster *k*.

The expectation of the full data log-likelihood function with respect to $\mathcal{K}/\mathcal{P}$, θ(i.e. the E-step) is given by

$$L(P;\theta)=\sum_{i=1}^{N}\left(\sum_{k=1}^{K}\hat{\pi}_{i,k}\left(\ln\pi_k+\sum_{t=1}^{T}-\frac{1}{2}\ln\sigma_i^2-\frac{1}{2}\ln 2\pi-\frac{(\varepsilon_{i,t}^{k})^2}{2\sigma_i^2}\right)\right) \quad (7)$$

where $\hat{\pi}_{i,k}$ is the conditional probability that a country belongs in class k and is given by

$$\hat{\pi}_{i,k}=\frac{\pi_k\prod_{t=1}^{T}\frac{1}{\sigma_i}\phi(\varepsilon_{i,t}^{k}/\sigma_i)}{\sum_{l=1}^{K}\pi_l\prod_{t=1}^{T}\frac{1}{\sigma_i}\phi(\varepsilon_{i,t}^{l}/\sigma_i)} \quad (8)$$

In the M-step, equation (5) is maximized with respect to parameters β_k, π_k, $k=1,...,K$ and σ_i^2 for $i=1,....,N$. The maximization is performed in two sequential steps. In the first step, the log-likelihood is maximized over β_k while the other parameters are kept constant. In this maximization process, the $\sqrt{\hat{\pi}_{i,t}}/\sigma_i$ is used as the weight to ensure that countries with higher $\hat{\pi}_{i,t}$

have larger weights in estimating β_k, while those whose σ_i is larger have smaller weight since they are noise and they have less information about β_k.

Once, the M-step is completed, a new variance of the error term as follows:

$$\sigma_i^2 = \frac{1}{T}\sum_{t=1}^{T}\sum_{k=1}^{K}\hat{\pi}_{i,k}(\varepsilon_{i,t}^k)^2 \quad (9)$$

for $i = 1,...,N$. The mixing proportions are updated by averaging the conditional class membership probabilities as follows:

$$\pi = \frac{1}{N}\sum_{i=1}^{N}\hat{\pi}_{i,k} \text{ , for } k = 1,...,K \quad (10)$$

The second step in the three-step mixture-of-regression analysis is to determine the optimal *k,* we follow the standard approach in the relevant literature, where we use the BIC and the CAIC. The BIC is a well-known in the relevant literature, while the CAIC is based on downward-adjusting the Akaike Information Criteria (AIC), to correct for the excess penalty that the AIC imposes in mixture models (seeBozdogan,1994, van Dyk, 2012). Bozdogan (1987) shows that the CAIC is very close to the BIC, and these two information criteria outperform the AIC in large samples. More formally the CAIC is computed as follows:

$$CAIC = -2\ln f(y/\hat{\theta}_k) + \frac{2kn}{n-k-1} \quad (4)$$

Where $\ln f(y/\hat{\theta}_k)$ is the log likelihood under the alternative hypothesis, k is the total number of parameters and n is the number of observations.

In the third step, we examine the determinants the determinants of countries latent regime membership. Since our concern is to examine what countries should do to minimize impact of capital flows on macroeconomic volatility, we are concerned with the membership class where capital flows have a negative effect on volatility. Let suppose κ^p be the probability that a country belongs in a macroeconomic volatility regime in which capital flows have a negative impact, we create a dummy variable D_{κ^p}, such that

$$D_{\kappa^p} = \begin{cases} 1 \;\; if \;\; \kappa_p \geq 0.5 \\ 0 \;\; if \;\; \kappa_p < 0.5 \end{cases} \quad (11)$$

We then estimate a multivariate Logit regression to determine the determinants of D_{κ^p} as follows.

$$p = Prob(D_{\kappa^p} = 1, \omega_i) \quad (12)$$

More specifically, this probability can be expressed as follows:

$$p = \frac{1}{1+\exp(-\omega_i)}, \quad where\ \omega_i = \delta_0 + \delta_1 Z_i + \varepsilon_i \quad (13)$$

where *Z* is a vector of the determinants of the *p*. In what follows, we now present the results.

3. EMPIRICAL RESULTS

4.1 Evidence from the Baseline Regression with one Latent Class

We begin by estimating the baseline parametric model with one latent class. We use different estimators, including the pooled estimator, random effects, fixed effects, instrumental variable (IV), and the systems General Methods of Moments (GMM). In the systems GMM we estimate a dynamic specification of equation (1) to account for the fact that macroeconomic volatility may be persistent. In the IV, capital flows and financial development are instrumented for using some lagged measures of institutional quality such as rule of law, regulatory quality and corruption. The other endogenous variables are instrumented with their past lags. The results are reported in Table 1.

In all the specification and across all the estimators, all the coefficients of the proxy of financial openness (i.e. capital flows as a percentage of GDP) are positive. The majority of coefficients are statistically significant. Thus, if we assume that all the countries follow a single regime, we would conclude that financial openness significantly increases macroeconomic volatility in Africa. When we control for measures of governance, the signs of the coefficients are mixed. However, when we interact the measure of institutional quality and the proxy of financial openness, the coefficients are negative and significant. This suggests that countries with better quality institutions may reduce the impact of capital flows on macroeconomic volatility.

Most of the coefficients of trade openness are also negative and significant, suggesting that countries that carry out trade reforms may use trade to smooth the macroeconomic shocks. However, when controlled for the structure of trade using measures such as the number of export products, concentration and diversification index, the results suggest that the structure of trade does not have an impact on macroeconomic volatility. This might be because most countries do have well diversified exports. However, financial development does not seem to have an influence

on macroeconomic volatility. The results also suggest that a move of the composition of GDP towards the services sectors significantly improve the economy's resilience to shocks.

The sign of coefficients of the measure of inflation, the GDP deflator are positive and significant as expected. This is consistent to the literature suggesting that inflation does causes uncertainty. We also control for measures of capital flow volatility, and these does not seem to have an impact on macroeconomic volatility. In the results from the dynamic specification, the lagged dependent variable is positive and significant suggesting that macroeconomic volatility is persistent. All the statistics for the tests of endogeneity and exogeneity of instruments are as expected.

Table 1: Basic Model with one Latent Class

	(OLS)	(OLS)	(RE)	(RE)	(FE)	(FE)	(IV)	(IV)	(System GMM)	(System GMM)
					Dependent Variable: Volatility of GDP					
Capital Flow to GDP	0.0216*	0.0199*	0.0216*	0.0199*	0.0188	0.0164	0.768**	1.135	0.032**	0.031**
	(0.0115)	(0.0110)	(0.0115)	(0.0110)	(0.0125)	(0.0121)	(0.337)	(3.291)	(0.015)	(0.014)
Governance	-0.0340	0.577***	-0.0340	0.577***	0.168	0.995***	-0.317***	-7.451	0.125	-0.925***
	(0.270)	(0.211)	(0.270)	(0.211)	(0.306)	(0.233)	(2.152)	(12.77)	(0.176)	(0.652)
Governance x Capital	-0.029**	-0.030**	-0.029**	-0.030**	-0.0251	-0.0256*	-0.825**	-0.027**	-0.021	-0.023
flow to GDP	(0.015)	(0.013)	(0.015)	(0.013)	(0.0161)	(0.0142)	(0.366)	(0.011)	(0.022)	(0.019)
Trade Openness	-0.0055	-0.007*	-0.0055	-0.007*	0.00076	0.0004	-0.051***	-0.0052	0.0144	0.0171*
	(0.0038)	(0.0039)	(0.0038)	(0.0039)	(0.0043)	(0.0048)	(0.0108)	(0.110)	(0.0094)	(0.0096)
Financial Development	0.00097	0.0028	0.00097	0.0028	0.0027	0.0043	-0.030***	0.124	0.0045	0.0071
	(0.0036)	(0.004)	(0.0036)	(0.004)	(0.0041)	(0.0045)	(0.0115)	(0.191)	(0.006)	(0.006)
Service Value Added	-0.0381***	-0.0447***	-0.0381***	-0.0447***	-0.0324**	-0.0408***	-0.0817	-0.497	-0.0329	-0.0364
	(0.0105)	(0.00997)	(0.0105)	(0.00997)	(0.0121)	(0.0122)	(0.0617)	(0.601)	(0.0251)	(0.0284)
No. of Export Products	0.174	0.226	0.174	0.226	0.0554	0.106	0.700	3.274	-0.0114	-0.141
	(0.196)	(0.219)	(0.196)	(0.219)	(0.219)	(0.243)	(0.498)	(3.418)	(0.282)	(0.316)
GDP Deflators	0.00083***	0.00088***	0.00083***	0.00088***	0.00085***	0.0009***	-0.143	0.0903	0.0029	0.00311
	(0.00011)	(0.00010)	(0.00011)	(0.0001)	(0.0001)	(0.00011)	(0.0881)	(0.205)	(0.0067)	(0.0073)
Vol of Capital Flow	-0.00004		-0.00004		-0.00004		0.00754*		-0.0002	
	(0.0001)		(0.00011)		(0.000109)		(0.00413)		(0.0001)	
Vol of FDI		0.0302		0.0302		0.0296		-5.997		-0.00448
		(0.0347)		(0.0347)		(0.0350)		(9.700)		(0.0452)
Volatility of Terms of		-0.0204		-0.0204		-0.0178		19.56		-0.0368
Trade		(0.0211)		(0.0211)		(0.0214)		(16.89)		(0.0335)
Lagged Dep. Variable									0.183***	0.182***
									(0.043)	(0.044)
Trend	YES	NO	YES	NO	YES	NO	NO	NO	YES	NO
Constant	23.77***	23.67***	23.77***	23.67***	23.48***	23.37***	24.70***	46.24		
	(1.107)	(1.167)	(1.107)	(1.167)	(1.182)	(1.238)	(3.828)	(57.50)		
N	643	611	643	611	643	611	601	573	551	524
R-squared	0.28	0.34	0.28	0.34	0.28	0.34				
AR(1)									-5.71(0.00)	-5.45(0.00)
AR(2)									-1.61(0.11)	-1.26(0.21)
Hansen 1									34.52(1.00)	34.63(1.00)
Hansen 2									36.43(0.99)	37.25(0.99)

Note: Robust standard errors in parenthesis; *, **, *** denotes 10%, 5% and 1% levels of significance, respectively.

4.2 Evidence from the Mixture-of-Regressions

Next we estimate a finite-mixture-of-regression models with different number of latent classes in order to choose the one with the best goodness of fit (i.e. the lowest BIC and CAIC). We estimate two models. The difference in the two models is that, in Model 1 we control for the volatility of total capital flows, while in Model 2, we control for the volatility of FDI. A key issue in this procedure is to determine the maximum possible latent classes. Following previous literature (see Konte, 2013; Owen and Temesvary, 2014; Flachaire *et al*., 2014), we assume a maximum of four latent classes. Table 2 reports the BICs and the CAIC of models with different latent class. It is notable that the mixture-of-regression model with two latent regimes is the most optimal as it has the lowest BIC and CAIC. The model with one latent class has the highest BIC and CAIC suggesting that there is some heterogeneity in the data that should not be ignored.

Table 2: Goodness of fit tests

	Model 1		Model 2	
No. of Latent Classes	**CAIC**	**BIC**	**CAIC**	**BIC**
k = 1	2890	2950	2736	2802
k = 2	**2588**	**2868**	**2565**	**2794**
k = 3	2670	2877	2598	2827
k = 4	2797	2926	2643	2871

To that end, we estimate a mixture-of-regressions model with two latent (i.e. *k=2*), and the results are reported in Table 3. The first two columns report the results for the Model 1, while the second two columns report the results for Model 2. We also test whether the estimated coefficients of all the explanatory variables included are different across the two latent classes. The last two columns report the Wald Test statistics for differences in coefficients. In both Model 1 and Model 2, 50 percent of the countries are in latent class 1, while the remaining ones are in regime 2.

The coefficients of the proxy of financial openness are clearly different across the two latent classes. In Model 1, the results show that, for countries in the first regime, capital inflows significantly increase macroeconomic volatility, while for those in regime 2, capital flows have no impact on macroeconomic volatility. In Model 2, FDI flows have a positive and significant impact on macroeconomic volatility for countries in regime 1, while it has a negative and significant impact on macroeconomic volatility for countries in regime 2. The Wald test statistics show that for both Model 1 and Model 2, the coefficients of the proxies of financial openness significantly differ between regime 1 and regime 2.

In relation to the coefficients of the other control variables, the results from both Model 1 and Model 2 suggest that the volatility in both proxies of financial openness significantly increases macroeconomic volatility for countries in the first regime, while it decreases macroeconomic volatility for countries in the second regime. The Wald test statistics suggest that these coefficients are significantly different between the two regimes in both models. Surprisingly, the coefficients of the proxy of institutional quality are positive, but they are only significant for countries in the second regime. However, when we interact institutional quality with a measure of financial openness, the coefficients are negative, suggesting that countries with better quality institutions are likely to minimise the impact of financial openness on macroeconomic volatility. However, the coefficients are only significant for countries in the first regime, implying that on average, these countries have better institutions than those in second regime.

In both models, the coefficients of trade openness are negative and significant across both latent classes. The Wald test statistic suggests that there are no statistically significant differences in the coefficients of trade openness across regimes. This suggests that countries that undertake trade reforms to make themselves more open to trade are likely to smooth macroeconomic shocks. Surprisingly, when we analyse the role of the structure of trade in macroeconomic volatility, the results are not that interesting. When we use trade diversification and trade concentration indexes as the proxies of the structure of trade, most of the coefficients are positive, but not statistically significant.[2] When we control for the number of export products, the coefficients are positive, but are only significant in second regime. Theoretically, it is expected that trade diversification will improve resilience to shocks. However, our results might be because the export products of most African countries, though many, are only primary commodities. Like in the case of trade openness, the coefficients of the proxy for the contribution of services to GDP are negative and significant, and there are no statistically significant differences in these coefficients across the regimes. This suggests that countries that diversify towards the modern sectors have a chance to smooth shocks and is consistent with the literature on structural transformation (see Elhiraika, 2014).

Financial development has a negative and significant effect on macroeconomic volatility for countries in the second regime, while for the countries in the first regime, it has no significant

[2] These results are not reported, but are available on request.

impact. The Wald test statistic suggests differences in coefficients across the two regimes for both models. The negative coefficients for countries in the second regime are expected given that a deep financial system that facilitate smooth lending and borrowing can help agents to smooth investment and consumption shocks. We also control for terms of trade, but all the coefficients are not statistically significant. As expected high inflation as proxied by the GDP Deflator amplifies macroeconomic shocks. Finally, the results suggest that there is a significant trend for countries in first regime, but not for countries in the second regime.

In general, the results suggest that there is some heterogeneity in the process of macroeconomic volatility across countries. Ignoring these heterogeneities will result in misspecification as the impact of capital flows on macroeconomic volatility differ across these different classes. For, instance, as Table 1 shows, if one assumes that the macroeconomic volatility process is similar across countries, they will mistakenly conclude that financial openness amplifies macroeconomic volatility. On the other hand, if the heterogeneities in the macroeconomic data are taken into account, the conclusion will be that financial openness can, in fact, reduce macroeconomic volatility, depending on the regime that drives the macroeconomic volatility process of a particular country. This applies to most of the determinants of macroeconomic volatility. In what follows, we now examine which countries have the higher probability of being in the second regime, where financial openness can improve the resilience of countries to shocks.

Table 3: Mixture-of-Regression Model Estimations

Dependent Variable: Volatility of HP Filtered GDP					Wald Test	
	Model 1		Model 2		Model 1	Model 2
Variables	Component1	Component2	Component1	Component2		
Capital flow as % of GDP	0.083***	0.026	0.088***	-0.021**	3.66	19.04
	(0.019)	(0.034)	(0.022)	(0.009)	(0.05)	(0.00)
Volatility of Capital Flow	0.0004***	-0.0003***			17.09	
	(0.0001)	(0.0001)			(0.00)	
Volatility of FDI			0.122*	-0.138*		6.30
			(0.066)	(0.083)		(0.02)
Institutions	0.439	2.357**	0.0882	2.142***	4.42	6.79
	(0.421)	(1.182)	(0.421)	(0.758)	(0.04)	(0.01)
Institutions x Volatility of Capital Flow	-0.067***	-0.039			0.37	
	(0.023)	(0.038)			(0.54)	
Institutions x Volatility of FDI			-0.008***	-0.0005		7.86
			(0.0012)	(0.002)		(0.01)
Trade Openness	-0.0261***	-0.0201**	-0.028***	-0.028***	0.46	0.26
	(0.0035)	(0.008)	(0.0038)	(0.0046)	(0.49)	(0.62)
Financial Development	0.0055	-0.037***	0.0071*	-0.032***	23.53	54.48
	(0.0042)	(0.0067)	(0.0039)	(0.0042)	(0.00)	(0.00)
Service value added to GDP	-0.0366**	-0.0595***	-0.0368**	-0.0626***	0.95	0.75
	(0.0157)	(0.0197)	(0.0164)	(0.0134)	(0.33)	(0.39)
No. of Products	0.0239	1.275***	-0.0497	1.217***	18.32	8.46
	(0.197)	(0.181)	(0.245)	(0.243)	(0.00)	(0.00)
GDP Deflator (%)	0.0015***	0.0008***	0.0017***	0.0057**	8.09	14.71
	(0.0003)	(0.0001)	(0.0002)	(0.003)	(0.00)	(0.00)
Volatility of Terms of Trade	0.0173	-0.0403	0.0383	-0.0648	0.96	0.98
	(0.0336)	(0.0395)	(0.0732)	(0.049)	(0.33)	(0.33)
Trend	-0.0680**	0.0205			4.51	
	(0.0330)	(0.0238)			(0.03)	
Constant	24.74***	23.03***	24.16***	24.63***		
	(1.224)	(1.086)	(1.619)	(1.163)		
Observations	643	643	611	611		

Note: Robust standard errors in parenthesis; *, **, *** denotes 10%, 5% and 1% levels of significance, respectively.

Next we classify the countries into the two different macroeconomic volatility regimes using the posterior probabilities. These probabilities are presented in Table 4. For both models, the countries are equally distributed in the two regimes. Except for two countries (Burundi and Madagascar), all the countries do not shift from one to another when we change the proxy of financial openness from total capital flows to FDI. For Model 1, seventeen percent of the countries are close to the cut-off probability of 50 percent of belonging to a regime, while for Model 2, the percentage of such countries is fourteen percent. Without pre-empting the analysis of the drivers of country membership in each regime, we describe how the countries are distributed across the two regimes.

Surprisingly, Africa's largest economy by real GDP, Nigeria is in second regime, while South Africa, which has the most industrialized economy, most financially developed African economy

is in the first regime. The first latent class is mostly composed of countries from North Africa, Southern Africa, and Central Africa. More specifically, four of the six North Africa countries, eight of the twelve Southern African countries, and four of the seven central African economies in our sample are in the first regime. On the other hand, seven of the eight East African countries, seven of the ten West Africa economies in our sample are in the second regime. The distribution of the countries across the two groups does not seem to be related to resource-richness or level of developed. The first contains 45% resource rich countries while class 2 has 46%.

To formalize the analysis and to get more intuition into the drivers of membership to these regimes, we analyse the role of different factors in determining the probability of being in the regime 2 where financial openness has reduces macroeconomic volatility. The nature of our analysis is such that the factors that increase the probability of being in regime 2 are those that decrease the probability of being in group. Equation (13) is used for this analysis and in vector $\boldsymbol{Z}$, we include a host of variables such as dummies for regional trends (i.e. trends for Central, East, North, Southern and West African regions), governance/institutional quality dummies for resource endowment, trade openness, governance/institutional quality, financial development, measures of the structure of trade and measures of financial openness.

The results are reported in Table 5. The results suggest that only class membership is significantly influenced by changes in measures of trade openness and financial development. Both factors increase the probability of being in the regime where financial openness diminishes macroeconomic shocks. These results are consistent with studies that show that interacting the impact of financial openness on macroeconomic volatility can be indirect and non-linear through financial development ((Kose, *et al*, 2009 and references therein). Theoretically the role of financial development in smoothing shocks in a financially open economy can be explained by its ability to facilitate borrowing to smooth shocks. This can significantly reduce shocks during times of capital flow reversals. Similarly, trade openness can also facilitate smoothening of shocks because it offers countries the opportunity to easily export, especially if shocks are associated with the weakening of the currency.

It is noted that, good governance, as measured by countries having their measures of control of corruption, regulatory quality, adherence to rule of law, effectiveness of the government, and

promoting monitoring and accountability being above some certain threshold also increases the probability of being in the regime where financial openness is volatility-reducing. However, all the coefficients of good governance are not statistically significant. The latter is expected as most African countries still have some work to do to improve the capacity of their institutions.

All the other factors decrease the probability of being in the regime where financial openness is volatility-reducing, although their coefficients are not significant. It is interesting to note resource-richness decreases the probability of being in the regime where financial openness decreases volatility. The coefficients for all the measures of dummy variables for resource endowment (i.e. resource-rich_both – representing countries with both oil and precious minerals, resource rich– for countries with either oil or precious metals, oil rich– representing countries that are only rich in oil, and minerals rich – representing countries that are only rich in minerals) are all negative, although they are not significant. The negative coefficients are expected given that resources-richness often results in the Dutch disease, especially in many African countries where political and economic institutions are weak. It is also important to note that the dummies for regional trend are not statistically significant. Generally, these results suggest that studies that analyse the impact of various factors on macroeconomic volatility of African countries by arbitrarily dividing the countries according to sub-regions, resource endowment, without due statistical tests on the process of macroeconomic volatility are bound to be mistaken.

Table 4: Classification of the countries

Model 1				Model 2			
Class 1	**Probability**	**Class 2**	**Probability**	**Class 1**	**Probability**	**Class 2**	**Probability**
Algeria	0.97	Angola	0.80	Algeria	0.97	Angola	0.83
Benin	0.70	Burkina Faso	0.65	Benin	0.71	Burkina Faso	0.67
Botswana	1.00	Burundi	0.51	Botswana	1.00	Cabo Verde	0.55
Cameroon	0.54	Cabo Verde	0.52	Burundi	0.54	Chad	0.72
CAR	0.51	Chad	0.72	Cameroon	0.53	Côte D'Ivoire	0.89
Comoros	0.55	Côte D'Ivoire	0.85	CAR	0.54	DRC	0.74
Congo	0.60	DRC	0.73	Comoros	0.57	Gabon	0.90
Egypt	0.52	Eritrea	0.69	Congo	0.53	Guinea	0.71
Ethiopia	0.68	Gabon	0.89	Egypt	0.55	Kenya	0.72
Ghana	1.00	Guinea	0.72	Ghana	1.00	Madagascar	0.52
Guinea-Bissau	0.60	Kenya	0.70	Guinea-Bissau	0.62	Malawi	0.58
Lesotho	0.91	Malawi	0.55	Lesotho	0.85	Mauritania	0.52
Libya	0.99	Mauritania	0.51	Libya	1.00	Mauritius	0.58
Madagascar	0.53	Mauritius	0.56	Mali	0.56	Morocco	0.59
Mali	0.59	Morocco	0.55	Mozambique	0.94	Niger	0.57
Mozambique	0.94	Niger	0.57	Seychelles	0.51	Nigeria	0.88
Seychelles	0.59	Nigeria	0.86	South Africa	0.52	Rwanda	0.66
South Africa	0.74	Rwanda	0.64	Sudan	1.00	Sao Tome and Principe	0.55
Sudan	1.00	Sao Tome and Principe	0.51	Swaziland	1.00	Senegal	0.76
Swaziland	1.00	Senegal	0.70	Tunisia	0.84	Tanzania	0.89
Tunisia	0.86	Tanzania	0.88	Zambia	0.95	Togo	0.61
Zambia	0.93	Togo	0.58	Zimbabwe	0.84	Uganda	0.91
Zimbabwe	0.86	Uganda	0.89				

Table 4: Determinants of Latent Class Membership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Governance	0.187	0.241	0.243	0.208	0.184	0.236	0.238	0.204
	(2.38)	(2.34)	(2.34)	(2.37)	(2.36)	(2.32)	(2.32)	(2.35)
East Africa	0.006	-0.008	-0.009	0.003	0.006	-0.008	-0.009	0.003
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
North Africa	-0.129	-0.128	-0.128	-0.129	-0.139	-0.138	-0.138	-0.139
	(0.124)	(0.124)	(0.124)	(0.124)	(0.125)	(0.125)	(0.125)	(0.125)
Southern Africa	-0.074	-0.068	-0.074	-0.040	-0.067	-0.061	-0.067	-0.034
	(0.067)	(0.073)	(0.067)	(0.077)	(0.067)	(0.073)	(0.067)	(0.076)
West Africa	-0.005	-0.025	-0.029	0.0027	-0.006	-0.026	-0.030	0.0015
	(0.049)	(0.056)	(0.047)	(0.059)	(0.049)	(0.056)	(0.047)	(0.060)
Financial Development	0.029***	0.030***	0.030***	0.030***	0.030***	0.031***	0.030***	0.031***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Trade Openness	0.047***	0.047***	0.047***	0.048***	0.048***	0.048***	0.048***	0.047***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Volatility of Terms of Trade	-0.009	-0.0076	-0.0077	-0.008	-0.009	-0.007	-0.008	-0.008
	(0.013)	(0.013)	(0.013)	(0.013)	(0.0131)	(0.013)	(0.013)	(0.013)
No. of Export Products	-0.589	-0.574	-0.580	-0.543	-0.600	-0.583	-0.588	-0.553
	(0.485)	(0.487)	(0.485)	(0.487)	(0.484)	(0.486)	(0.485)	(0.487)
Exchange rate volatility	-2.64e-07	-2.60e-07	-2.61e-07	-2.57e-07	-2.66e-07	-2.60e-07	-2.51e-07	-2.48e-07
	(1.3e-05)	(1.3e-05)	(1.3e-05)	(1.3e-05)	(1.3e-05)	(1.09e-05)	(8.85e-06)	(1.27e-05)
Capital Flows to GDP	-0.015	-0.014	-0.014	-0.014				
	(0.018)	(0.018)	(0.018)	(0.018)				
FDI					-8.6e-05	-8.8e-05	-8.9e-05	-8.4e-05
					(0.0001)	(0.0001)	(0.0001)	(0.0001)
Resource Rich_Both	-0.292				-0.289			
	(0.177)				(0.178)			
Resource Rich		-0.00915				-0.0082		
		(0.0498)				(0.050)		
Oil Exporting			-0.0130				-0.0122	
			(0.0676)				(0.0676)	
Mineral Rich				-0.0560				-0.0544
				(0.0623)				(0.0623)
Observations	425	425	425	425	425	425	425	425
Number of code	31	31	31	31	31	31	31	31

Note: Robust standard errors in parenthesis; *, **, *** denotes 10%, 5% and 1% levels of significance, respectively.

4. CONCLUSIONS

We re-examine the relationship between financial openness and macroeconomic volatility by relaxing the assumption that countries follows a single unique macroeconomic volatility process. The study contributes to the growing studies, especially in the growth-literature that reject the hypothesis that all countries follow a single, unique regime. We show that this also applies to the macroeconomic volatility of African countries.

Specifically, using a mixture-of-regressions approach to endogenously account for the heterogeneities in the data, we show that the macroeconomic volatilities of African countries follow two heterogeneous regimes. In both our models, the results show that the samples of

countries used in this study are equally distributed in the two regimes. Analysing the impacts of financial openness and other factors on macroeconomic volatility, we recognise that they differs across these two regimes. For countries in the second regime, financial openness can significantly reduce macroeconomic volatility, while for those in regime 1, it increases macroeconomic volatility. Thus, ignoring the heterogeneities in the macroeconomic volatility data may lead to the erroneous conclusion that financial openness is bad for developing countries as it contributes to the amplification of macroeconomic shocks. Heterogeneities across the two regimes are also observed in the impact of factors such as volatility in capital flows, financial development, institutional quality, and inflation on macroeconomic volatility.

We estimated the probabilities of countries belonging in the two growth regimes, and then analysed the determinants of these probabilities using a conditional logit model. We find that financial development and trade openness are the only factors that significantly increase the probability of being in the regime where capital flows reduces macroeconomic volatility.

The findings of this study have a number of interesting implications. Firstly, it is clear that assuming that the macroeconomic volatilities of all countries follow a single unique regime may lead to both methodological and policy mistakes. For example, in our case, following the single-regime hypothesis, a mistaken policy decision that is likely to be reached is the need to control capital flows as they increases macroeconomic volatility. Such a policy decision will as a consequence ensure that countries will miss out on some of the macroeconomic, technological and institutional benefits of capital flows. As we have seen this policy conclusion would only apply to a subset of the countries.

Another policy implication regards the type of policies that can be undertaken to insure that countries benefit from financial openness, while reducing the risk that openness may trigger macroeconomic shocks. While we do not claim that we have an exhaustive answer, our study suggest that reforms that are aimed at improving financial intermediation, trade openness, and governance should be among these policies. We also believe that reforms that are aimed at improving fiscal management and those that reduce labour market frictions might also be important. Unfortunately unavailability of data, we could not explore whether these factors play a role in driving the probability of being in the regime where capital flows are volatility-reducing.

Thus, pending the availability of rich data, we believe that the issue relating to what complementary reforms are necessary facilitate the volatility reducing effect of financial openness constitutes an interesting issue for further research.

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Appendix 1

Oil exporters: are those with oil exports at least 20 per cent higher than their oil imports and include: Algeria, Angola, Cameroon, Chad, Congo Republic, Côte d'Ivoire, Congo DRC, Equatorial Guinea, Gabon, Ghana, Libya, Niger, Nigeria and Sudan.

Oil importers include: Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Central African Republic, Comoros, Djibouti, Egypt, Eritrea, Ethiopia, The Gambia The, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe.

Mineral rich countries: Mineral rich countries are those where mineral exports account for more than 20 per cent of total exports and include: Algeria, Benin, Botswana, Burkina Faso, Central African Republic, Congo DRC, Djibouti, Equatorial Guinea, Eritrea, Guinea, Lesotho, Liberia, Mali, Mauritania, Madagascar, Mozambique, Namibia, Niger, Rwanda, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Zambia and Zimbabwe.

Mineral poor countries include: Angola, Burundi, Cameroon, Cabo Verde, Chad, Comoros, Congo, Côte d'Ivoire, Egypt, Ethiopia, Gabon, The Gambia, Ghana, Guinea-Bissau, Kenya, Libya, Malawi, Mauritius, Morocco, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Somalia, Swaziland, Tunisia and Uganda