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# Financial Development, Institutions and Economic Growth: Evidence from Sub-Saharan Africa

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## Abstract

The paper investigates the effect of financial development on economic growth conditional on the level of institutional quality for a panel of 21 Sub-Saharan African countries for the period 1986-2010. A standard growth regression is estimated with linear interaction between financial development and institutional quality. Our findings indicate that financial development has not significantly contributed to SSA economic growth, contrary to the significant positive effect of institutional quality. The interaction effect of both financial and institutional development is positive but insignificant. This evidence suggest the existing institutions has not enhanced the finance-growth relationship in the region. Therefore, improving institutions relevant to the financial sector is desired.

**Keywords:** Financial development, Institutions, Economic growth, Sub-Saharan Africa.

**JEL Classifications:** C23, G21, O16, O55

## 1 Introduction

The much ado about Africa's recent growth performance has rekindled interest among economists and policy experts in understanding the underlying factors despite her stagnant structural fundamentals.<sup>1</sup> So far, the list includes: investment, private sector access to credit, government effectiveness (institutions), exports and share of agriculture value added; albeit their relative stagnation as indicated by statistical analysis (Mijiyawa, 2013). In terms of institutional quality and financial sector performance, Sub-Saharan African (SSA) countries are making inroads with significant improvement in the institutional environment and financial deepening. Differences in

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<sup>1</sup>Africa has experienced recovery in her growth performance since 1995 after decades of stagnation from 1974.

institutional quality and financial development can have significant impact on economic growth. Hence, World Bank emphasizes on building effective institutions and promoting financial sector development as priorities both in the now and future.<sup>2</sup>

From growth empirics, one strand of the literature emphasizes the importance of financial development (see [Levine, 2005](#)) while the other centres on the role of institutions on economic growth (see [Acemoglu and Johnson, 2005](#)). Recently, both strands of the growth literature have been combined to investigate the effect of financial development on economic growth conditional on a country's institutional quality. The central thesis involves examining the interaction between institutions and finance on growth since both factors can be either complements or substitutes. So far, evidence of such interaction is mixed and inconclusive. While [Demetriades and Law \(2006\)](#) and [Anwar and Cooray \(2012\)](#) found that finance and institutions are complements, [Ahlin and Pang \(2008\)](#) and [Compton and Giedeman \(2011\)](#) showed that both factors are substitutes in the growth process. Such can be traced to the use of heterogeneous cross-country samples of both developed and developing countries without considering their individual and region-specific economic characteristics, which can have significant influence on the outcome, and thus, a generalization of policy prescriptions that is of little relevance to the latter since the former have a well-developed financial sector and good institutions. To circumvent this, a region-specific analysis involving homogeneous countries with similar economic fundamentals, culture and history is necessary so as to derive policy implications for the region (and the countries that belong to it) as in [Anwar and Cooray \(2012\)](#) for South Asia.

This paper examines the interaction effect between financial development and institutions on economic growth within the context of SSA countries. The interest in SSA is motivated by two reasons. First, the uneven levels of financial development and institutional quality in the world necessitates the use of a sample of countries from a geographic region with homogeneity in terms of real per capita GDP, financial development and institutions. Second, SSA countries have reformed their economic system since the late 1980s with the objective of promoting growth through improved efficiency in the financial sector and for institutional development. It is expedient to document the progress achieved by linking reforms with economic performance. For this purpose, a standard growth regression model is estimated with a sample of 21 SSA countries for the period 1986-2010 using panel data techniques of ordinary least squares (OLS) and *system* generalized method of moments (SYS-GMM) for dynamic panel analysis.

The evidence suggest that institutional quality rather than financial development has contributed significantly to the growth performance of SSA countries. However, their interaction effect, although positive (which suggest that both factors are complements) is statistically insignificant. As such, the existing institutional quality has not enhanced the finance-growth relationship in the region.

The remainder of the paper proceeds as follows. Section 2 provides a literature survey on

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<sup>2</sup>see the 2002 *World Development Report* on 'Building institutions for market'

the links between financial development, institutions and economic growth. Section 3 details the empirical methodology and data for the analysis; while the empirical results and concluding remarks are contained in Section 4 and 5 respectively.

## 2 Links Between Finance, Institutions and Growth

An extensive literature exist on the relationship between finance and economic growth. The crux of the finance-growth nexus is that better-functioning and deepened financial sector accelerates economic growth.<sup>3</sup> From a theoretical standpoint, financial institutions and markets facilitates the efficiency of the savings-investment process. Financial intermediaries arises to mitigate the effect of financial frictions — particularly, information and transaction costs — which distort the allocation of resources to productive investment opportunities. [Levine \(2005\)](#) maintains that finance influences economic growth by ameliorating these frictions through five traditional functions. These functions include: acquiring information about investment for efficient allocation of capital; risk amelioration; monitoring and exerting corporate governance control on both managers and firms respectively; mobilizing and pooling savings; and facilitating exchange of goods and services. The efficiency to which these functions are accomplished influences savings and investment decisions, which in turn, determines economic growth.<sup>4</sup> At the empirical level, researchers agree that a positive relation exist between finance and economic growth. Cross-country studies based on cross-sectional and panel data analysis suggest that finance helps to predict growth (see [King and Levine, 1993](#); [Levine and Zervos, 1998](#); [Levine et al., 2000](#); [Beck et al., 2000](#); [Khan and Senhadji, 2003](#); [Hassan et al., 2011](#); [Zhang et al., 2012](#)), while similar conclusion is also reached by country-specific studies that employ time-series analysis (see [Demetriades and Hussein, 1996](#); [Odedokun, 1996](#); [Christopoulos and Tsionas, 2004](#); [Luintel et al., 2008](#)). Studies have equally shown that financial development contributes to economic growth in SSA (see [Ghirmay, 2004](#); [Agbetsiafa, 2004](#); [Akinlo and Egbetunde, 2010](#)), whereas, [Demetriades and James \(2011\)](#) found that the finance-growth relationship in the region is a loose one: at best, finance follows growth; at worst, there is an insignificant long-run link between the two.<sup>5</sup>

Despite the plethora of empirical evidence, the direction of causality remains a reference point for disagreement with mixed conclusion as causality varies between countries and regions.<sup>6</sup> For example, [Hassan et al. \(2011\)](#) found a two-way causality between finance and growth in all regions of the world except SSA and East Asia and Pacific, while causality runs from growth to finance in South Asia and SSA supporting the hypothesis that growth leads to finance in developing

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<sup>3</sup>[\(Levine, 1997, 2005\)](#) provides an excellent survey of both the theoretical and empirical literature.

<sup>4</sup>Additionally, financial intermediaries are more efficient in providing evaluation and monitoring services by identifying and investing in credit-worthy and productivity-enhancing projects.

<sup>5</sup>The worst case scenario is obtained when financial development is measured using bank credit while the best-case scenario occurs when measured by liquid liabilities which only indicates the size of bank balance sheets.

<sup>6</sup>Three directions of causality can be identified from the finance-growth literature. First, the causal direction from finance to growth which supports the supply-leading hypothesis; while the second runs from growth to finance emphasizing the demand-following hypothesis. Third, is a bi-directional causality which runs from finance to growth in the early stages of development, and later stages from growth to finance.

countries because of the increasing demand for financial services. On the other hand, [Acaravci et al. \(2009\)](#) found a bi-directional causality for a panel of 24 SSA countries.<sup>7</sup> Such variation in causality is deemed to reflect institutional differences across countries.<sup>8</sup> [Arestis and Demetriades \(1997\)](#) and, [Demetriades and Law \(2006\)](#) maintain that such varying causal relationships may reflect differences in the quality of finance, which in turn, is determined by the quality of institutions (such as financial regulation and the rule of law). Therefore, the proposition “more finance, more growth” holds little applicability as corruption in the banking system or political interference, may divert credit to unproductive or even wasteful activities. In fact, the alternative, “better finance, more growth”, is more embracing when the financial system is embedded within a sound institutional framework. Financial development reverberates not only from the market forces but through political and property rights institutions which are necessary in financing contracts ([Marcelin and Mathur, 2014](#)). Hence, our hypothesis that the contribution of financial development to long-run economic growth is determined in part by the quality of a country’s institutions.

In recent decades, institutions as a fundamental cause of economic growth has received accelerated interest among researchers and policy experts. The evidence suggest that a country’s institutional framework is crucial in determining her economic performance ([Knack and Keefer, 1995](#); [Hall and Jones, 1999](#); [Acemoglu et al., 2001](#); [Acemoglu and Johnson, 2005](#); [Rodrik et al., 2004](#); [Akpan and Effiong, 2012](#); [Nawaz, 2015](#)). For example, [Acemoglu et al. \(2001\)](#) used European settler mortality rates to instrument for institutions and, found large effects of institutions on income per capita. [Nawaz \(2015\)](#) found that improvement in institutions leads to accelerated growth. A country’s institutional framework — consisting of formal and informal rules — constitutes the “rules of the game” that shapes interactions at the political, social and economic spheres as well as the behaviour of economic agents in a society. Institutions establishes the incentive structure, which if good, reduces transactions cost, uncertainty and promotes production efficiency. This in turn, facilitates investment in human and physical capital, technological innovations and advancement, private sector development, all of which contributes to economic growth. In other words, strong institutions are associated with increasing levels of real income per capita since they shape overall condition for investment and growth. Institutions such as secured property rights, better contract enforcement, strong rule of law, control of corruption, political stability etc. are seen to support a country’s growth process.<sup>9</sup>

Furthermore, there is also an established literature that links legal institutions with financial development.<sup>10</sup> Well-functioning financial markets depends on legal institutions that can adequately enforce financial contracts so as to prevent obstacles to financial intermediation ([Fergusson,](#)

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<sup>7</sup>see [Acaravci et al. \(2009\)](#) for a survey of the finance-growth literature for SSA.

<sup>8</sup>The divergence in the trend of financial development in most cases is caused by the quality of institutions across countries. Cross-country variations in institutional quality affects financing options and firms’ ability to access external finance ([Marcelin and Mathur, 2014](#)). Therefore, the ability of financial intermediaries to resolve information and transaction costs reflects a country’s overall institutional quality.

<sup>9</sup>Developing countries inability to design a strong institutional framework is the reason for the prevalence of their weak institutions and underdevelopment.

<sup>10</sup>[Beck and Levine \(2005\)](#) and [Fergusson \(2006\)](#) provide an excellent survey of the literature on legal institutions and financial development.

2006). Whereas, better institutions can facilitate access to finance by overcoming the effects of information and transaction cost, the converse can also be expected when institutions are weak. Securing property rights and contract enforcement by the legal system places a constraint against government expropriation — hence determining the quality of the financial market (Demirguc-Kunt and Maksimovic, 2002; Levine, 2005). On the theoretical front, La Porta et al. (1997, 1998) argues that legal origin that spread across the world through colonization and imitation had considerable effects on the level of financial development. The argument is that British (common law) legal traditions were conducive to the protection of property rights and hence financial development unlike that of the French.<sup>11</sup> Rajan and Zingales (2003) and Beck et al. (2003) emphasize the role of interest groups in the financial development process.<sup>12</sup> For instance, incumbent interest groups (political elites) with their market (political) power may retard financial development by preventing the adoption of better institutions if future competition reduces their rents or limit their power. Roe and Siegel (2011) argues for the role of political stability for financial sector development. Empirically, studies have shown that legal institutions clearly contributes to financial sector development (see Djankov et al., 2005; Chinn and Ito, 2006; Huang, 2010). For SSA, McDonald and Schumacher (2007) found that legal institutions and information sharing have deeper effects on financial development. Anayiotos and Toroyan (2009) found that institutional factors affect financial depth and access to financial services more than asset quality and profitability.

Following these strands of literature, researchers now acknowledge that financial development can indirectly influence economic growth through institutional development as a conditioning variable. In other words, the institutional quality channel is another path through which financial development can influence economic performance. The literature on the joint effect that finance and institutions have on economic growth is nascent and still developing. So far, existing studies have reached mixed conclusions. Demetriades and Law (2006) examined the interaction between finance, institutions on economic development for a sample of 72 countries for the period 1978-2000 using cross-sectional and panel approaches. Concentrating on bank-based financial development measures and an aggregate measure of institutional quality, they found that financial development has larger effects on GDP per capita within a sound institutional framework. Their findings is more potent for middle-income countries. However, for poor countries with low institutional quality, they conclude that finance may not deliver the desired impact on economic development except through improvement in institutions. Hence, the proposition that “better finance, more growth” is more applicable than “more finance, more growth”.

Ahlin and Pang (2008) considered the same issue with particular focus on an aspect of institutional quality namely, corruption control, whether both are complements or substitutes

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<sup>11</sup>The French legal tradition was relatively weak in private property rights protection as it emphasized the power of the state over the individual and making the judiciary redundant. The British system, however, sort to protect individual private property rights against the crown. Hence, countries that adopted the British legal traditions over that the French are tend to have better financial markets.

<sup>12</sup>This is the political view of financial development. The thesis is that non-democratic states use their political power to restrict entry or competition for continuous rents extraction for existing financial development (such as banks).

in the growth process. They found both finance and corruption control to be substitutes. Here, the marginal benefit of improving financial development is greater when a country has higher corruption levels than at lower levels. Thus, when corruption falls, the effect on growth is higher in an economy with low levels of financial development than in a financially developed economy. Such outcome is because higher corruption levels is associated with higher burden for less financially developed country than developed ones. [Compton and Giedeman \(2011\)](#) considered a sample of 90 countries from 1970 to 2004 to investigate whether the state of institutions impacts on the finance-growth nexus. Using both bank and stock market measures of financial development, their evidence showed that for the case of bank-based measures, the interaction with institutions is negative. This means that the effect of banking development on growth is smaller in countries with strong institutions than those with weak institutions. For stock market development, their interaction with institutions is insignificant, meaning that its effects on growth is independent of a country's level of institutions. Lastly, [Anwar and Cooray \(2012\)](#) concentrated on the case of South Asia for the period 1970-2009. Measuring institutional quality with Freedom House political and civil liberties and Polity IV democracy index, they found that institutions enhances the impact of finance on growth as both factors are complements in the growth process for South Asia.

From the foregoing, examining the interaction effect between finance and institutions on economic growth becomes expedient especially from the perspectives of other regions in the world with similarities in institutional quality, level of financial development and economic performance across its constituent countries. This study makes a contribution to the literature by focussing specifically on SSA countries given their similarities in economic performance, financial development and state of institutions. This is relevant for future policy directions depending on whether institutions and finance are complements or substitutes in SSA growth process. Complementarity of these factors would suggest policies targeted at simultaneously improving both institutional quality and financial development, whereas substitutability would imply focussing on a single factor per time.

### 3 Econometric Strategy

#### 3.1 Model Specification

To explore the relationship between finance, institutions and economic growth, we consider as a starting point, the direct effect of finance on economic growth by specifying a standard growth regression model as below:

$$Growth_{i,t} = \gamma Income_{i,t-1} + \beta' \mathbf{X}_{i,t} + \psi_1 Finance_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t} \quad (1)$$

where *Income* denotes the (logarithm) level of GDP per capita, and *Growth* is its growth rate, *Finance* captures financial development indicators.  $\mathbf{X}_{i,t}$  is a matrix of control variables, *i* stands

for a country and  $t$  represents a time period.  $\mu_t$  is time dummies to account for time-specific effects,  $\eta_i$  is an unobserved country-specific effects and  $\varepsilon_{i,t}$  is an idiosyncratic error term.

Since our main hypothesis is to examine the effects of financial development on economic growth conditional on the level of institutional quality, we augment Eq.(1) with an institutional variable (*Institutions*) and interact both indicators of financial development and institutional quality, and then test for the significance of the interaction coefficient. In order to ensure that the interaction term does not proxy for finance or institutions, we add these variables separately into the regression as follows:

$$\begin{aligned} Growth_{i,t} = & \gamma Income_{i,t-1} + \beta' \mathbf{X}_{i,t} + \psi_1 Finance_{i,t} + \psi_2 Institutions_{i,t} \\ & + \psi_3 [Finance_{i,t} \times Institutions_{i,t}] + \eta_i + \mu_t + \varepsilon_{i,t} \end{aligned} \quad (2)$$

From Eq.(2), emphasis is on the statistical significance of the interaction coefficient  $\psi_3$ . Depending on its sign, it can be inferred whether finance and institutions are complements or substitutes in the growth process. A negative coefficient will indicate that financial development is more effective in boosting economic growth in countries with weak institutions. In other words, a negative interaction (i. e.  $\psi_3 < 0$ ) provides evidence of substitutability between finance and institutions. On the other hand, a positive interaction (i. e.  $\psi_3 > 0$ ) would imply that the growth effects of finance are enhanced in a strong institutional environment, thus supporting the complementarity of finance and institutions.

Eq.(2) can be estimated by OLS. However, neither does OLS eliminate the unobservable country-specific effects nor does it deal with possible endogeneity in the regressors. For growth models with dynamic panel specification, the generalized-methods-of-moments (GMM) estimators of [Arellano and Bond \(1991\)](#), [Arellano and Bover \(1995\)](#) and [Blundell and Bond \(1998\)](#) is far superior to other panel data estimators. The GMM panel estimators controls for both time and country-specific effects while using appropriate lags of the regressors as instruments to address the endogeneity problem. Eq.(2) can be written in its compact form with  $y_{i,t}$  as the logarithm of the real per capita GDP and  $\mathbf{X}_{i,t}$  as a set of regressors that include an indicator of both finance and institutions, their interactions and other control variables as below:

$$y_{i,t} - y_{i,t-1} = (\gamma - 1)y_{i,t-1} + \beta' \mathbf{X}_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

Alternatively, Eq.(3) can be rewritten as follows:

$$y_{i,t} = \gamma y_{i,t-1} + \beta' \mathbf{X}_{i,t} + \eta_i + \mu_t + \varepsilon_{i,t} \quad (4)$$

The presence of country-specific effects  $\eta_i$  makes the fixed effects (within-group) estimators biased and inconsistent because it is correlated with the lagged dependent variable  $y_{i,t-1}$ . [Arellano and Bond \(1991\)](#) proposed the following first-difference equation to eliminate the country-specific effect:



$$\begin{aligned}
y_{i,t} - y_{i,t-1} &= \gamma(y_{i,t-1} - y_{i,t-2}) + (\mathbf{X}_{i,t} - \mathbf{X}_{i,t-1})' \beta \\
&\quad + (\mu_t - \mu_{t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1})
\end{aligned} \tag{5}$$

However, this introduces a new endogeneity bias. First, the new error term,  $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ , is correlated with the lagged dependent variable,  $(y_{i,t-1} - y_{i,t-2})$ . Second, regressors are correlated with the lagged error term,  $\varepsilon_{i,t-1}$ . The *differenced* GMM (DIF-GMM) estimators uses as intruments, lagged values (two or more) of the regresors under two moment conditions: (i) the idiosyncratic error term  $\varepsilon_{i,t}$  is not serially correlated; (ii) the regressors in  $\mathbf{X}_{i,t}$  are weakly exogenous. These moment conditions can be written as follows:

$$\begin{aligned}
E[y_{i,t-s}, (\varepsilon_{i,t} - \varepsilon_{i,t-1})] &= 0 \quad \forall s \geq 2; t = 3 \dots T \\
E[\mathbf{X}_{i,t-s}, (\varepsilon_{i,t} - \varepsilon_{i,t-1})] &= 0 \quad \forall s \geq 2; t = 3 \dots T
\end{aligned} \tag{6}$$

Blundell and Bond (1998) argues that the GMM (DIF-GMM) estimator suffers from weak instruments as the data becomes highly persistent. Weak instruments lead to serious finite sample bias as such the variance of the coefficients become asymptotically large. The SYS-GMM estimator is more efficient in handling the weak instruments problem (Arellano and Bover, 1995; Blundell and Bond, 1998). It combines both the equations in levels and first-difference as a system, while utilizing a larger sets of instruments. The instruments for the level equations are the lagged differences of the regressors. The validity of the additional instruments requires additional moment conditions: the first differences of the regressors in Eq.(4) are uncorrelated with the country-specific effects  $\eta_i$ . The moment conditions for the levels equations are as follows:

$$\begin{aligned}
E[(y_{i,t-s} - y_{i,t-s-1}), (\mu_i + \varepsilon_{i,t})] &= 0 \quad \forall s = 1; t = 3 \dots T \\
E[(\mathbf{X}_{i,t-s} - \mathbf{X}_{i,t-s-1}), (\mu_i + \varepsilon_{i,t})] &= 0 \quad \forall s = 1; t = 3 \dots T
\end{aligned} \tag{7}$$

The validity of the SYS-GMM estimator depends on two specification tests. First, the Hansen test for over-identification restrictions which test the overall instrument validity under the null hypothesis that the instrumented variables are exogenous and uncorrelated with the disturbance term.<sup>13</sup> Its follows a  $\chi^2$  distribution with the degrees of freedom equal to the degree of over-identification  $J-K$ , where  $J$  and  $K$  are the number of instruments and endogenous variables respectively . If the null hypothesis is not rejected, then the instruments are adjudged valid. Second is the Arellano-Bond test for serial correlation. The null hypothesis is that both the first and second order autoregressive disturbance terms in the first-difference equation are uncorrelated. However, the difference disturbance term is not allowed to be second-order autocorrelated except for the first-order; otherwise, the assumption of the GMM estimators becomes violated.

As a caveat, careful attention to limit the instruments' count is required to avoid excessive

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<sup>13</sup>We present the Hansen test statistic which is robust to heteroskedasticity and autocorrelation and not the Sargan test statistic.

instrument proliferation issues such as over-fitting, weakened tests for over-identifying restrictions, biased two-step variance estimators and imprecise estimates of the optimal weighting matrix (Roodman, 2009a,b; Beck et al., 2014). Hence, we use only two to three lags instead of all available lags of the instruments. Further, we use the two-step GMM which is asymptotically more efficient than the one-step. In addition, Windmeijer (2005) methodology is employed to obtain robust standard errors while correcting for finite-sample bias in the two-step variance-covariance matrix.<sup>14</sup>

## 3.2 Data

In this study, we use panel data from a sample of 21 Sub-Saharan African countries for the period 1986-2010.<sup>15</sup> This period coincides with era of both economic and institutional reforms in the region. Since 1986, majority of SSA countries have implemented a series of economic liberalization programmes for deepening the financial markets and also shifted towards democratization of her legal and political institutional frameworks for greater access and, checks and balances. As typical of cross-growth regressions, the data is averaged over a 5-year non-overlapping periods to reduce the effects of business cycles.<sup>16</sup>

Financial development is measured using only bank-based indicators.<sup>17</sup> First is *private credit*, measured as domestic credit to private sector by deposit money banks relative to GDP. This bank development measure captures the allocation of credit in the financial system. It excludes credit issued to governments, government agencies and public enterprises and the central banks. Overall, it measures the depth of financial intermediation.<sup>18</sup> The second is *liquid liabilities ( $M_2/GDP$ )*, measured as currency plus demand and interest bearing liabilities of banks and other financial intermediaries relative to GDP. It captures the broad coverage of financial intermediation activities across various financial institutions (central banks, deposit money banks and other financial institutions) relative to the economy's size. The assumption is that the size of the financial sector is positively associated with financial services.

For institutional quality, we use two notable measures in the literature: the Economic Freedom of the World (*Freedom*) index from Fraser Institute and the *Polity2* score from Polity IV Project. The *Freedom* index captures the degree of economic freedom underlying five aggregate components (areas) ranging from government size, legal system and property rights, sound money, regulation and freedom to trade internationally (Gwartney et al., 2013). Its importance anchors on the characterization of a country's effort towards securing private property protection, contract enforcement and a stable macroeconomic environment; and is measured on a scale of 1 (least free)

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<sup>14</sup>The two-step GMM estimation is performed using Stata command, *xtabond2*.

<sup>15</sup>The selected countries include: Benin, Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo Republic, Cote d' Ivoire, Gabon, Ghana, Kenya, Madagascar, Malawi, Mali, Mauritius, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Togo.

<sup>16</sup>The five-year average for the period 1986-2010 are 1986-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010. In sum, five data points are utilized for each country.

<sup>17</sup>The measures are preferred over stock market development measures because SSA financial system is predominantly bank-based and stock markets are still being developed.

<sup>18</sup>This is the most widely used measure of finance in cross-country literature on finance and growth.

to 10 (most free) and is available for 152 countries in a five year intervals from 1970 and annually since 2005. The Polity IV project provides a characterization of regimes at a specific time as reference to the institutionalization of democracy. We use the *Polity2* score which is derived from the combination of both the democracy and autocratic indices based on a 21-point scale ranging from -10 (strongly autocratic) to 10 (strongly democratic) as a measure of a country’s level of democratic institutions.

GDP per capita (constant 2005 US dollars) is used to compute the growth rate.<sup>19</sup> Our control variables include: log of initial (or lagged) GDP per capita to capture possible convergence effect; *inflation* defined as the change in GDP price deflator which controls for macroeconomic stability and price distortions; *investment* captures the extent of physical capital accumulation and is defined as gross fixed capital formation relative to GDP; *openness* to international trade, defined as the sum of imports and exports relative GDP. With the exception of the institutional quality indices, the data for other variables are obtained from World Bank’s *World Development Indicators*.

**Table 1** and **Table 2** present the summary statistics and correlation matrix of the variables used in the analysis respectively. As shown in the tables, the mean of the GDP per capita growth is approximately 3 percent and the standard deviation is quite large. Every other variables exhibit reasonable variation across time and countries. For the institutional quality measures, the mean for Polity2 and Freedom are 5.6 and 0.8 respectively, which indicates the quality of institutions in the SSA countries. With reference to their measurement scale, it means that institutions in the region are not fully democratic and are partly free. For the financial development indicators, their average contribution to total output does not exceed 30 percent. Particularly, an average of 21 percent for domestic credit to private sector indicates low financial intermediation in terms of access to finance for long-term investment. In terms of correlation, the GDP per capita growth is positively correlated with all other variables except inflation, which is negative. This means, that macroeconomic instability is detrimental to economic growth. The two financial development indicators have high positive correlation. For example, the correlation between the private credit and liquid liabilities is 0.858. For institutional quality indicators, the Polity2 and Freedom indices are positive correlated at 0.612.

## 4 Estimation Results

### 4.1 Main Results

The estimation of Eq.2 is performed using both OLS and SYS-GMM estimators and the results are presented in **Table 3** and **Table 4** respectively. For the estimations, GDP per capita growth (*Growth*) is the dependent variable and we use *Private Credit* as the main financial development

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<sup>19</sup>This is defined as the change in log of GDP per capita

Table 1: Summary statistics

Variables	<i>N</i>	Mean	SD	Min	Max	Sources
GDP per capita growth	105	0.0283	0.1172	-0.3359	0.3154	Author's calculation
GDP per capita	105	1416.367	1899.808	147.649	7158.09	WDI
Inflation	105	10.8502	13.0002	-3.2115	88.1103	WDI
Trade Openness	105	66.3401	25.8289	23.8765	138.6164	WDI
Investment	105	17.8317	6.9602	3.0629	37.6475	WDI
Private Credit	105	20.6285	26.0106	2.5313	156.6705	WDI
Liquid Liabilities	105	26.9893	16.7545	8.7161	99.0238	WDI
Polity2	105	0.8781	5.8297	-9	10	Polity IV Project
Freedom	105	5.6183	0.8427	3.5	7.9	<a href="#">Gwartney et al. (2013)</a>

Note: *N* is the number of observation from 21 SSA countries for the 5-years averages sample period 1986-2010. All variables remain as defined. WDI is World Bank World Development Indicators.

Table 2: Correlation Matrix

	1	2	3	4	5	6	7	8	9
1 Growth	1.000								
2 Initial Income	0.163 (0.137)	1.000							
3 Inflation	-0.094 (0.392)	-0.227*	1.000						
4 Investment	0.449* (0.000)	0.396* (0.000)	-0.224* (0.021)	1.000					
5 Trade openness	0.420* (0.001)	0.538* (0.000)	-0.092 (0.349)	0.608* (0.000)	1.000				
6 Private Credit	0.139 (0.205)	0.472* (0.000)	-0.240* (0.013)	0.235* (0.015)	0.143 (0.144)	1.000			
7 Liquid Liabilities	0.284* (0.008)	0.452* (0.000)	-0.095 (0.333)	0.296* (0.002)	0.348* (0.000)	0.858* (0.000)	1.000		
8 Polity2	0.428* (0.000)	0.101 (0.360)	-0.080 (0.416)	0.265* (0.006)	0.214* (0.028)	0.315* (0.001)	0.512* (0.000)	1.000	
9 Freedom	0.486* (0.000)	0.495* (0.000)	-0.322* (0.001)	0.416* (0.000)	0.398* (0.000)	0.532* (0.000)	0.655* (0.000)	0.612* (0.000)	1.000

Notes: \* indicates significant at 0.05 level. The variables remain as defined in [Table 1](#) and expressed in natural logarithm except for Polity2, Freedom and Inflation.

indicator. Following a stepwise process, we start with a baseline model that includes only the chosen control variables for a standard growth model (i.e. *Initial income, inflation, investment and trade openness*). Next, we introduce the proxies for both financial development and institutional quality to gauge their direct effects on economic growth; and lastly, augment the model with their interaction. The discussion follows the two estimation approaches for the purpose of comparison, although the SYS-GMM is much preferred since it addresses endogeneity issues.

Table 3: OLS regression with Private credit

	(1)	(2)	(3)	(4)	(5)	(6)
Initial Income	-0.014 (0.01)	-0.020 (0.01)	-0.026* (0.01)	-0.011 (0.01)	-0.030** (0.01)	-0.020 (0.01)
Inflation	-0.000 (0.00)	-0.000 (0.00)	0.001 (0.00)	-0.000 (0.00)	0.001 (0.00)	-0.000 (0.00)
Investment	0.081** (0.03)	0.076** (0.03)	0.057* (0.03)	0.050 (0.03)	0.063* (0.04)	0.052 (0.03)
Trade Openness	0.094* (0.05)	0.103* (0.05)	0.081* (0.05)	0.109** (0.04)	0.078* (0.05)	0.112** (0.04)
Private credit		0.015 (0.02)	-0.021 (0.01)	-0.012 (0.01)	-0.106 (0.10)	-0.024 (0.02)
Freedom			0.076*** (0.01)		0.034 (0.05)	
Polity2				0.010*** (0.00)		-0.002 (0.01)
Private credit*Freedom					0.014 (0.02)	
Private credit*Polity2						0.004 (0.00)
Constant	-0.496*** (0.14)	-0.515*** (0.14)	-0.682*** (0.12)	-0.488*** (0.12)	-0.423 (0.31)	-0.413*** (0.13)
Observations	84	84	84	84	84	84
R-squared	0.246	0.255	0.403	0.378	0.409	0.398

Note: see also note for Table [Table 2](#). Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 level.

As a starting point, we consider the estimated effects of the control variables as shown in column (1) of [Table 3](#) and [Table 4](#) respectively. Initial Income is negatively signed thus showing evidence of conditional convergence among SSA countries. The convergence effect holds across all estimation results as other variables are incorporated, although it is insignificant in majority of the models. However, the convergence rate is much lower in the SYS-GMM (between -0.001 and -0.030) than in OLS (between -0.011 and -0.030). Inflation as a proxy for macroeconomic stability is consistently negative across all the estimation except in column (4) of both [Table 3](#) and [Table 4](#). The negative coefficient is consistent with the argument that macroeconomic instability is deleterious to economic growth of SSA countries. Higher inflation increases uncertainty and risk in the economy which can adversely reduce long-term investment. Investment is positive and statistically significant in the case of SYS-GMM and for OLS with exception of column

(4) and (6). This is consistent with standard growth theory that emphasizes the importance of investment through physical capital accumulation in accelerating economic growth. Trade openness is statistically significant only with OLS in Table 3 and not with SYS-GMM.

Table 4: SYS-GMM regression with Private credit

	(1)	(2)	(3)	(4)	(5)	(6)
Initial Income	-0.0116 (0.01)	-0.0138 (0.02)	-0.0213 (0.02)	0.0008 (0.01)	-0.0302* (0.02)	-0.0177 (0.02)
Inflation	-0.0003 (0.00)	-0.0003 (0.00)	-0.0000 (0.00)	0.0001 (0.00)	-0.0003 (0.00)	-0.0003 (0.00)
Investment	0.1144** (0.05)	0.1150** (0.05)	0.0981* (0.05)	0.0986** (0.04)	0.1119** (0.05)	0.0999** (0.04)
Trade Openness	0.0163 (0.06)	0.0175 (0.07)	0.0386 (0.06)	0.0251 (0.05)	0.0363 (0.04)	0.0380 (0.05)
Private credit		0.0044 (0.02)	-0.0206 (0.02)	-0.0170 (0.01)	-0.2001* (0.12)	-0.0317* (0.02)
Freedom			0.0533** (0.02)		-0.0330 (0.06)	
Polity2				0.0070*** (0.00)		-0.0079 (0.01)
Private credit*Freedom					0.0301 (0.02)	
Private credit*Polity2						0.0056 (0.00)
Constant	-0.2834 (0.23)	-0.2859 (0.24)	-0.5605*** (0.18)	-0.3989** (0.16)	-0.0321 (0.37)	-0.2519 (0.17)
Observations	84	84	84	84	84	84
Wald Chi <sup>2</sup>	63.34	79.42	92.32	162.07	149.76	320.71
AR(1) (p-value)	0.064	0.063	0.063	0.064	0.069	0.080
AR(2) (p-value)	0.666	0.706	0.418	0.732	0.329	0.525
Hansen test (p-value)	0.302	0.288	0.278	0.364	0.318	0.377

Note: see also note for Table 2. Dependent variable is real per capita GDP growth. Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 levels respectively. All regressions includes both country-specific effects and time-period effects. Model specifications statistics includes Wald Chi<sup>2</sup>, *P*-values of Hansen test for over-identifying restrictions, AR(1) and AR(2) test of the disturbance error terms.

Turning to the financial development indicator included in column (2), private credit although positive, is statistically insignificant in both OLS and SYS-GMM estimations. As such, financial development has not stimulated growth at least in the short-run for SSA countries. The result is consistent with [Demetriades and Law \(2006\)](#) for low-income countries and [Demetriades and James \(2011\)](#) when finance is measured using bank credit for SSA countries. What factors explains such an outcome? First, majority of SSA economies are driven by natural resource endowments (e.g. oil) which generates foreign exchange for economic management. Secondly, SSA is characterized by low levels of financial development. As the dominant financial sector, the banking system accounts for majority of the financial assets and liabilities; and is prone to excess liquidity, preference for government securities and short-term lending with maturity period of less than a year. These factors in addition to low income levels, a large informal sector, infrastructural weakness to

mention a few, inhibits the effectiveness of the capital accumulation and technological innovation channels through which finance contributes to growth. Also, the result raises concerns on the success of financial reforms so far implemented. Such if any, may be conditional on the existing institutional quality as emphasized by World Bank studies that information problems and weak contract enforcements rather than savings mobilization are the binding constraint on financial deepening in SSA (Demetriades and James, 2011).

The measures of institutional quality – Freedom and Polity2 indices – are introduced in columns (3) and (4) of Table 3 and Table 4 respectively. The coefficients of both indices are positively signed and statistically significant. This is consistent with the empirical literature on institutions and growth (see Acemoglu et al., 2001; Akpan and Effiong, 2012; Nawaz, 2015). Hence, the quality of institutions is crucial in explaining the economic performance of SSA, as countries with better institutions are likely to experience improved economic progress in contrast to those with weak institutions. For emphasis, the inclusion of the indices does not significantly alter previous results in columns (1) and (2) for both OLS and SYS-GMM regressions except for the change in the sign of the financial variable from positive to negative. A look into their association in Table 2 shows a low correlation value of 0.214 and 0.398 for Polity2 and Freedom indices respectively. Hence, the change in sign might be unrelated to issues of multicollinearity.

Next, the interaction term between finance and the institutional indices are introduced and reported in columns (5) and (6) respectively for Table 3 and Table 4. As a recall, the interaction term depending on its coefficient sign, is useful in gauging whether finance and institutions are complements or substitutes for growth; whereas its insignificance (irrespective of the sign) would imply that the finance-growth relationship is not conditioned by institutional quality. In Table 3, the OLS estimates of the interaction terms are positively signed, suggesting the complementarity of both factors; however, they are insignificant. Again, the financial variable (*private credit*) maintains the same negative sign as obtained in column (2). Across these regressions, both finance and institutional variables are insignificant when their interaction is included.

The SYS-GMM regressions in Table 4 is similar to that of the OLS in Table 3. Both interaction terms are positive but insignificant. The only exception being that *private credit* is statistically significant when interaction terms are included and endogeneity issues controlled for in the regression. Such may suggest that institutions alleviates the negative impact of finance, thus making it relevant in the growth process. However, much importance is not attached to this findings until further verification through robust checks. In terms, of the sign of the interaction coefficient estimates, our findings is consistent with Demetriades and Law (2006) and Anwar and Cooray (2012) but contrary to Compton and Giedeman (2011). Its statistical insignificance suggest that the impact of financial development on growth performance in SSA countries is invariant across different levels of institutional quality. In other words, the existing institutional quality has not enhanced the finance-growth nexus in the region. This outcome is not surprising given that majority of SSA countries have weak institutions. In most circumstances, the institutions required for efficient functioning of the financial sector is characterized by weak contractual frameworks.



Property rights (including those of the creditors) are ill-defined with weak enforcement mechanism as the judicial system lacks credibility and independence while being controlled by the government in power. Hence, the combination of weak institutions and low financial development would inhibit future growth prospects. For the validity of the SYS-GMM regressions, the Hansen test for over-identifying restrictions and the serial correlation Arellano-Bond test are not rejected. The instruments are exogenous and uncorrelated with the disturbance error term and second order serial correlation is absent. Therefore, the estimates are consistent and satisfactory.

## 4.2 Robustness Analysis

To ascertain the robustness of the empirical results above, Eq. 2 is modified in two ways. First, an alternative measure of financial development is used, as the result could be sensitive to different proxies as seen with Demetriades and James (2011). Second, South Africa as the largest economy in the region with higher per capita income, developed financial sector and better institutional quality is excluded to curtail its influence on the result.<sup>20</sup>

In place of *private credit*, *liquid liabilities* is used as the alternative indicator of financial development. The results for both OLS and SYS-GMM regressions are reported in Table A1 and Table A2 in the Appendix. The result is invariant with earlier results. The financial development indicator is positively significant in the OLS regression (column 1, Table A1) only. Introducing the institutional indices renders it insignificant with a negative sign. Meanwhile, the institutional indices maintain their positive and significant impact on growth. However, both the financial and institutional measures become insignificant upon introducing their interaction terms albeit the latter being positive and insignificant.

The estimation result when South Africa is excluded is reported in Table A3 and Table A4 for only SYS-GMM regressions for both indicators of financial development respectively. Again, there is no significant variation as earlier results are robust irrespective of whether South Africa is excluded or not and the proxy measures for financial development.<sup>21</sup> Therefore, the results are generally robust.

## 5 Concluding Remark

This paper examined the effect of financial development on economic growth conditional on a country's institutional quality for a panel of 21 SSA countries for the period 1986-2010. Our research was motivated by the mixed evidence from the empirical literature on the interaction effect of financial development and institutions on economic growth as obtained from an heterogeneous sample of both developed and developing countries. We argued that a region-specific analysis

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<sup>20</sup>Due to the periods covered, consideration is not given to Nigeria's GDP rebasing which has seen her emergence as the largest economy in SSA.

<sup>21</sup>The same results is obtained for OLS regression. Hence, it is not reported but available on request.

involving countries with homogeneity in economic fundamentals, culture and history was necessary for relevant policy implications. Further, linking SSA reforms with economic performance for both financial sector and institutional capacity was expedient. For this purpose, a standard growth regression model was estimated using both OLS and SYS-GMM panel data techniques along with two measures each of financial development and institutional quality.

The results indicate that financial development has not impacted on SSA growth performance. While not surprising, financial development in the region is generally low with a dominant banking system and characterized by excess liquidity, holdings of government securities, short-term lending etc. Implicitly, it suggest that financial sector reforms has not achieved the desired deepening of the financial system let alone contribute to economic growth. On the other hand, institutions has a significant positive impact on economic growth in SSA. Good institutions facilitates property rights protection, constrains government and other interest groups and ultimately creates a conducive economic climate for market interaction among economic agents in a society. Hence, current efforts on building effective institutional capacity should be intensified for the sustainability of the region's economic recovery. Meanwhile, the interaction between financial development and institutions on economic growth, although positive (i.e. both factors are complements) is statistically insignificant. Since financial development is low, and the existing institutions are weak and inadequate for enforcing financial contracts and alleviating information problems, as their combination undermines future growth prospects.

Taken as a whole, the results implies that the effect of financial development conditional on existing institutional quality on SSA economic growth is non-existent. Therefore, policy drive of government should be tailored towards the financial sector and institutional development. In fact, efforts should target improving the set of institutions relevant to the financial system for free flow of information, enforcing contracts and property rights protection.

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## Appendix

Table A1: OLS regression with Liquid liabilities

	(1)	(2)	(3)	(4)	(5)
Initial Income	-0.023*	-0.031**	-0.014	-0.032**	-0.024*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Inflation	-0.000	0.001	-0.000	0.001	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Investment	0.076**	0.054*	0.048	0.057*	0.049
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Trade Openness	0.092*	0.095**	0.117**	0.092*	0.118**
	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)
Liquid Liabilities	0.048**	-0.026	-0.013	-0.118	-0.037
	(0.02)	(0.03)	(0.03)	(0.16)	(0.03)
Freedom		0.075***		0.026	
		(0.02)		(0.08)	
Polity2			0.009***		-0.015
			(0.00)		(0.02)
Liquid Liabilities*Freedom				0.015	
				(0.02)	
Liquid Liabilities*Polity2					0.007
					(0.00)
Constant	-0.565***	-0.669***	-0.485***	-0.356	-0.355**
	(0.14)	(0.13)	(0.12)	(0.55)	(0.15)
Observations	84	84	84	84	84
R-squared	0.279	0.395	0.375	0.398	0.395

Note: see also note for Table 2. Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 level.

Table A2: SYS-GMM regression with Liquid liabilities

	(1)	(2)	(3)	(4)	(5)
Initial Income	-0.0168 (0.01)	-0.0260 (0.02)	-0.0062 (0.01)	-0.0309 (0.02)	-0.0230 (0.02)
Inflation	-0.0003 (0.00)	-0.0001 (0.00)	-0.0000 (0.00)	-0.0003 (0.00)	-0.0002 (0.00)
Investment	0.1152** (0.05)	0.0940* (0.05)	0.0965** (0.04)	0.1066** (0.05)	0.0968*** (0.04)
Trade Openness	0.0128 (0.06)	0.0505 (0.06)	0.0355 (0.05)	0.0455 (0.06)	0.0470 (0.05)
Liquid Liabilities	0.0360 (0.04)	-0.0086 (0.05)	-0.0088 (0.04)	-0.2422 (0.24)	-0.0401 (0.05)
Freedom		0.0462* (0.03)		-0.0772 (0.13)	
Polity2			0.0066*** (0.00)		-0.0224 (0.02)
Liquid Liabilities*Freedom				0.0372 (0.04)	
Liquid Liabilities*Polity2					0.0091 (0.01)
Constant	-0.3215 (0.24)	-0.5533*** (0.18)	-0.3443* (0.19)	0.2888 (0.80)	-0.1984 (0.19)
Observations	84	84	84	84	84
Wald Chi	95.63	94.9	203.62	154.6	307.23
AR(1) (p-value)	0.068	0.063	0.063	0.062	0.076
AR(2) (p-value)	0.826	0.514	0.829	0.491	0.655
Hansen test (p-value)	0.248	0.257	0.337	0.283	0.292

Note: see also note for Table 2. Dependent variable is real per capita GDP growth. Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 levels respectively. All regressions includes both country-specific effects and time-period effects. Model specifications statistics includes Wald Chi<sup>2</sup>, *P*-values of Hansen test for overidentifying restrictions, AR(1) and AR(2) test of the disturbance error terms.



Table A3: SYS-GMM regression with Private credit excluding South Africa

	(1)	(2)	(3)	(4)	(5)	(6)
Initial Income	-0.0241 (0.02)	-0.0246 (0.02)	-0.0363 (0.02)	-0.0054 (0.02)	-0.0380* (0.02)	-0.0161 (0.02)
Inflation	-0.0005 (0.00)	-0.0006 (0.00)	-0.0003 (0.00)	-0.0003 (0.00)	-0.0004 (0.00)	-0.0005 (0.00)
Investment	0.1107** (0.05)	0.1142** (0.05)	0.0938** (0.05)	0.1049** (0.04)	0.1076** (0.05)	0.1062** (0.04)
Trade	0.0385 (0.07)	0.0368 (0.07)	0.0692 (0.06)	0.0350 (0.06)	0.0556 (0.06)	0.0329 (0.06)
Private credit		-0.0040 (0.02)	-0.0393* (0.02)	-0.0237 (0.02)	-0.1830 (0.14)	-0.0313 (0.02)
Freedom			0.0648*** (0.02)		-0.0112 (0.08)	
Polity2				0.0070*** (0.00)		-0.0082 (0.01)
Private credit*Freedom					0.0253 (0.02)	
Private credit*Polity2						0.0057 (0.00)
Constant	-0.2861 (0.23)	-0.2754 (0.25)	-0.5800*** (0.19)	-0.3916** (0.17)	-0.1355 (0.47)	-0.2932* (0.16)
Observations	80	80	80	80	80	80
Wald Chi	56.36	68.2	79.08	145.2	157.25	223.16
AR(1) (p-value)	0.064	0.064	0.064	0.064	0.070	0.081
AR(2) (p-value)	0.753	0.728	0.431	0.757	0.334	0.522
Hansen test (p-value)	0.286	0.29	0.306	0.401	0.356	0.361

Note: see also note for Table 2. Dependent variable is real per capita GDP growth. Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 levels respectively. All regressions includes both country-specific effects and time-period effects. Model specifications statistics includes Wald Chi<sup>2</sup>, *P*-values of Hansen test for overidentifying restrictions, AR(1) and AR(2) test of the disturbance error terms.

Table A4: SYS-GMM regression with Liquid liabilities excluding South Africa

	(1)	(2)	(3)	(4)	(5)
Initial Income	-0.0229 (0.02)	-0.0369 (0.03)	-0.0090 (0.02)	-0.0432 (0.03)	-0.0252 (0.03)
Inflation	-0.0004 (0.00)	-0.0002 (0.00)	-0.0003 (0.00)	-0.0004 (0.00)	-0.0004 (0.00)
Investment	0.1158** (0.05)	0.0875* (0.05)	0.0999*** (0.04)	0.1008** (0.05)	0.1003*** (0.04)
Trade Openness	0.0233 (0.07)	0.0760 (0.08)	0.0408 (0.07)	0.0761 (0.07)	0.0533 (0.07)
Liquid Liabilities	0.0303 (0.05)	-0.0274 (0.06)	-0.0157 (0.05)	-0.2739 (0.24)	-0.0464 (0.06)
Freedom		0.0559* (0.03)		-0.0735 (0.13)	
Polity2			0.0066*** (0.00)		-0.0224 (0.02)
Liquid Liabilities*Freedom				0.0390 (0.04)	
Liquid Liabilities*Polity2					0.0091 (0.01)
Constant	-0.3098 (0.25)	-0.5538*** (0.19)	-0.3887** (0.19)	0.3014 (0.79)	-0.2015 (0.19)
Observations	80	80	80	80	80
Wald Chi	80.61	87.48	188.31	191.44	258.19
AR(1) (p-value)	0.066	0.061	0.062	0.060	0.075
AR(2) (p-value)	0.839	0.509	0.842	0.508	0.676
Hansen test (p-value)	0.257	0.282	0.352	0.336	0.315

Note: see also note for Table 2. Dependent variable is real per capita GDP growth. Robust standard errors in parentheses. \*\*\*, \*\*, \* denotes significance at 0.10, 0.05 and 0.01 levels respectively. All regressions includes both country-specific effects and time-period effects. Model specifications statistics includes Wald Chi<sup>2</sup>, *P*-values of Hansen test for over-identifying restrictions, AR(1) and AR(2) test of the disturbance error terms.