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Abstract

Using Johansen and Granger-causality models on data from 1977 to 2007, we investigate long-term effects of population growth on investment. Main findings are, in the long-run, population growth will: (1) decrease foreign and public investments in Ivory Coast; (2) increase public and private investments in Swaziland; (3) deplete public investment but augment domestic investment in Zambia; (4) diminish private investment and improve domestic investment in the Congo Republic and Sudan respectively. For policy implications, the positive linkage of population growth to investment growth in the long-term should be treated with extreme caution. Family planning and birth control policies could also be considered in countries with little future investment avenues.

JEL Classification: C30; J00; O10; O40.

Keywords: Productivity; investment; human capital; causality; Africa.

1. Motivation

With respect to the World Bank (WB), our generation is experiencing the greatest demographic change in the history of mankind with Africa at its center. In the early 1970's, there were two Europeans for one African, but it is projected that by 2030 there would be two Africans for every European. The African population is projected to double by 2036 and represent 20% of the world's population by 2050(UN Worlds Population Prospects 2009). These statistics make the continent the fastest growing in the world. Concern over this rapid growth presents an important geo-economic concern to policy-makers, researchers and social

scientists. The main issues resulting there-from are, depleting per capita income and rising unemployment.

In an attempt to probe into the issue of unemployment, many analysts believe the three most important things Africa needs are investment, investment and investment (Dangote Group, 2008; IMF Survey, 2009). Dangote Group (2008) has unequivocally emphasized that Africa needs investment not aid. It has lamented over the rejection of products from Africa by multinationals and urged companies in Africa to focus more on inter-African trade. This corporate policy counsel is shared by many analysts on economic concerns in the continent. In a recent IMF survey (April, 2009), analysts overwhelmingly expressed the need for foreign donors to focus more on investment avenues in Africa than on aid. This confirms the largely established sentiment that aid has short-run effects while sustainable investment could have much longer-term impacts. Like effects of sustainable investment, population growth is also seen to affect economic growth for the most part in the distant future. By the same token, there could be a long-run equilibrium between these two entities.

In a bid to address growing concerns over how African demographic changes would be dealt with, it is imperative to investigate how long-term investments would accommodate rising unemployment: the object of this paper. Results we shall provide could have very crucial policy implications; as they would account for which investment types (public, private, domestic or foreign) could best contribute to decreasing unemployment rate, concurrently with population growth.

To achieve these: we shall test for stationary properties of univariate series at country specific levels; derive first-orderly integrated variables on which their cointegration properties with productivity variables would be investigated; then based on long term equilibrium results obtained from cointegration tests, we shall either investigate causality relations by simple

Granger(short run) or Vector Error Correction Models(VECMs). Lastly, we shall discuss empirical results before providing their policy implications.

2. Literature review

The influence of demographic changes on economic growth remains quite a controversial agenda in the literature of development economics. While some authors firmly establish a positive association of population growth with economic growth (Hondroyiannis and Papapetrou, 2005; Azomahou and Mishra, 2008), the question of why poor countries are trapped in a vicious cycle of high birth rates and low growth rates is quite puzzling.

The contribution of population growth to economic development has been subject to many studies in literature. Very recently, Azomahou and Mishra (2008) revisited the impact of age dynamics on economic growth through age-structured population for both OECD and non OECD countries. Findings reveal that between 1960 and 2000, mentioned economies developed mostly thanks to the stock of human capital. They further reflect that in comparative terms, non OECD countries are likely to experiene higher birth rates than their OECD counter parts. The contribution of age-dynamics in their work is captured from the fact that, work force is important in explaining differences in growth between the two set of countries. From this study, we could infer: countries with higher work force would potentially experience higher growth rates than those with lower work force. At a much earlier epoque, Hondroyiannis and Papapetrou(2005) in a study on the link between fertility and output in eight European countries found out that, increase in output would be associated with higher fertility rate. Judging from their panel study based on data obtained from 1960 to 1998, one could confirm their forecast today. In fact over the last decade, most European countries have experienced low fertility and growth rates.

As earlier emphasized, contrary to the positive association of high birth rate with high growth rate, an explanation as to why poor countries with high population growth remain trapped in a cycle of poverty could be found in classical and modern theories. Malthusian and neo-Malthusian theories explain this negative association through the depletion of per capita income. This could vividly be understood as a direct consequence of the population increasing faster than GDP. A recent explanation to the negative association between growth and birth rates could be seen from Pommeret and Smith(2005). They conclude that growth rates are negatively correlated with birth rates because of productivity volatility that affect both rates. In a much recent study on trends from China, Hasan(2010) explains this negative link from an 'income-growth led family-growth' nexus. His findings reveal, increasing per capita growth in China tends to lower population growth. To quote him in verbatim: "...as per capita income increases, families turn to prefer quality over quantity of children. The resultant increase in the cost of bearing and rearing children would induce smaller family size and lead to decline in fertility"(page 360).Contrary to the situation in China, developing and underdeveloped countries in Africa are experiencing a demographic explosion.

With the population projected to double by 2036 and represent about 20% of the world demography by 2050, Africa is the fastest growing continent. The concern of how to manage issues resulting from this growth is of paramount importance in geo-economic as well as national policies. It is well established that the continent best needs investment in order to provide employment to rising work force resulting from these demographic changes (Dangote Group, 2008; IMF Survey, 2009). Therefore, the effort of this study shall focus on evaluating how investment types (public, private, domestic and foreign) shall be affected by population growth in the long-run. Understandably, we should expect population growth elasticities of all categories of investments to be positive; with private and foreign investments more responsive than public investment. Our expectations are founded on projected effects of

structural adjustment policies imposed on African countries by the International Monetary Fund (IMF) and World Bank (WB) in the 1980's[1]. Thus, one should expect public investment to be less sensitive to demographic change than private and foreign investments.

The contribution of this work to literature could be summarized in the following :(1) we provide analyses on direct linkages between investment and population growth(contrary to abundant 'demographic change-growth' literature; (2) usage of a plethora of investment indicators provide a somewhat robust account of aggregate investment dynamics on the palaver; and (3) goodness of fit of models based on Vector Autoregression(VAR) processes is ensured by the most appropriate optimal lag selection criteria(contrary to arbitrary and discretional lag choices).

3. Model and theoretical framework

Lets us start with an aggregate investment production function:

$$I = AK^{\alpha}W^{\beta} \qquad (1)$$

where **I** is the investment variable, **A** is total factor productivity, **K** is capital stock, and **W** is the labour composite, which is representative of population growth rate. Hence, we could re-write equation (1) in the natural log form in per capita terms as:

$$\log I = \theta + \alpha \log K + \beta \log W \qquad (2)$$

In equation 2, physical capital (K) is still measured by gross fixed capital formation and human capital (W) by population growth rate. To take account of the time series nature of our study, we can hence re-reformulate equation (2) in per capita form for each country with'**t**' running from 1 to n:

$$\log I_t = \alpha_t + \alpha \log k_t + \psi_t \log w_t \qquad (3).$$

[1] To stretch this point, structural adjustment implied adopting economic measures that could favor; liberalization, privatization, progression towards market-based economies and reduction of public (government) role in economic activities.

It is interesting to state channels via which human capital could ameliorate investment. An investor for instance would consider the cost of labour as a production factor before deciding on where to invest. Since the cost of labour is determined by its availability, from common sense and to some extend economic theory (demand and supply), countries which have high growth rates in working force would 'ceteris paribus' experience low working wage. In the same vein, growth in work force should lead to cheaper labour cost, more investment and of course higher economic growth. This implies, in compliance with our hypothetical model (see equation 3), there should be is a positive long-term relationship between mentioned productivity factors and investment types. If we were to further suppose, aggregate production (GDP) is significantly endogenous to investment, then one could be impelled to infer that, our model is supported empirically by "population-growth economic-growth" literature (Azomahou and Mishra, 2008; Hondroyiannis and Papapetrou, 2005). Regarding short-run linkages, we don't expect results to be significant because, we hypothetically assume population growth should impact investment dynamics only in a distant future

4. Data and Econometric methodology

4.1 Data

Data is got from the World Bank's African Development indicators. Our limitation to a span between 1977 and 2007 is based on availability of data and timing of structural adjustment policies imposed on African countries. Selected variables for investment dynamics include: Gross Foreign Direct Investment (*FDI*); Gross Public Investment (*Public Ivt.*); per capita Gross Private Investment (*Private Ivt.*); and Gross Domestic Investment (*GDI*). Factor productivity indicators are Gross Fixed Capital Formation (GFCF) for physical capital and Population growth rate (pop) for human capital. Initially, our database is made up of 38 countries, but it is gradually trimmed down to investment dynamic panels due to constraints in

the cointegration theory[2]. Since our prime concern is to evaluate how human capital affects investment dynamics, the other productivity proxy (physical capital) should serve as a control variable for robustness check.

4.2 Causality estimations

With respect to the Engle-Granger methodology (1987), short run estimations and long run estimators will be derived by simple Granger causality and Vector Error Correction (VEC) models respectively.

4.2.1 Short run estimations

Suppose we consider a basic bivariate finite-order VAR model. As presented in equations (4) and (5) below, short-run (simple) granger causality consists of evaluating, how respectively , past values of physical capital (k) and human capital (w) could help past values of FDI in explaining present values of FDI. Since application of this requires stationary univariate series, for comparative reasons, its application will be on first differenced series. Consequently, resulting VAR models are:

$$\Delta FDI_t = \sum_{j=1}^{p} \lambda_j \Delta FDI_{t-j} + \sum_{j=0}^{q} \delta_j' \Delta k_{t-j} + \varepsilon_t \quad (4)$$

$$\Delta FDI_t = \sum_{j=1}^{p} \lambda_j \Delta FDI_{t-j} + \sum_{j=0}^{q} \delta_j' \Delta w_{t-j} + \varepsilon_t \quad (5)$$

$$\Delta k_t = \sum_{j=1}^{p} \lambda_j \Delta k_{t-j} + \sum_{j=0}^{q} \delta_j' \Delta FDI_{t-j} + \varepsilon_t \quad (6)$$

$$\Delta w_t = \sum_{j=1}^{p} \lambda_j \Delta w_{t-j} + \sum_{j=0}^{q} \delta_j' \Delta FDI_{t-j} + \varepsilon_t \quad (7)$$

[2] For long-run elasticities to be estimated for a given country, factor productivity proxies must be integrated in the first order and cointegrated with investment variables. While integration requires exhibition of unit root at level series (and therefore stationarity at first differenced series), cointegration necessitates showing that, permanent changes in factor productivity variables affect investment proxies and vice versa.

With regard to our theoretical lay-out, VAR models relevant to our study are (4) and (5). Equations (6) and (7) are indicative of FDI granger causing physical capital and human capital respectively. The later sets of equations reflect the effects of investment dynamics on capital (physical and human); which is not what our research agenda aims to investigate (see equation 1). The null hypothesis of (4) consists of testing for zero restrictions in the VAR models and is captured by the F-statistic: which is the Wald statistics for the joint hypothesis that parameters of lagged values of either 'w' or 'k' equals zero. Optimal lag selection is ensured by the AIC (Khim and Liew, 2004).

4.2.2 Long run estimators

In a bid to illustrate short-run dynamics associated with the long-run equilibrium, let's consider foreign direct investment (FDI), physical capital (k), and human capital (w), with no lagged difference, such that:

$$FDI_t = \beta k_t \tag{8}$$

$$FDI_t = \beta w_t \tag{9}$$

The following VECMs result from equations (8) and (9):

$$\Delta FDI_t = \alpha(FDI_{t-1} - \beta k_{t-1}) + \varepsilon_{1,t} \tag{10}$$

$$\Delta k_t = \alpha'(k_{t-1} - \beta FDI_{t-1}) + \varepsilon_{2,t} \tag{11}$$

$$\Delta FDI_t = \alpha''(FDI_{t-1} - \beta w_{t-1}) + \varepsilon_{3,t} \tag{12}$$

$$\Delta w_t = \alpha'''(w_{t-1} - \beta FDI_{t-1}) + \varepsilon_{4,t} \tag{13}$$

As was the case with short-run causality, long-run models that should be relevant to our research objectives are (10) and (12). The right hand terms represent the Error Correction

Terms (ECTs). At equilibrium, this term has a zero value. When the ECT is not zero, it implies FDI and either 'k' or 'w' have deviated from the long-run equilibrium or cointegration relation. Thus, ECTs adjust each variable and partially restore the equation relation. The speeds of these adjustments are determined by α and α'' for physical and human capital respectively. Equations (10 and 12) will be replicated to all remaining investment dynamics (private, public and domestic investments). The same deterministic trend assumptions and optimal lag selection criterion used for cointegration tests shall be applied.

4.3 Derivation of integrated variables from country specific unit root tests

4.3.1 Country specific unit root tests

In our quest to apply the cointegration theory, we shall first endeavour to test for stationary properties at country level. In doing so, we correct for serial correlations using Augmented Dickey Fuller (ADF) test. We do not elaborate on the mechanics of the unit root test because it is widely applied and constitutes only an exploratory venture of our study. However, as we have pointed-out earlier, what is imperative to note in the specification of the VAR process is that, optimal lag selection for goodness of fit is based on Akaike Information Criterion (AIC). Our choice of this criterion is guided by Khim and Liew(2004) who demonstrate that when observations are less than 60, the AIC and Final Prediction Error(FPE) are best at specifying optimal lags. Unit root test results are presented on tables 1 and 2. Variables of countries whose stationary properties match expectations of the cointegration

theory are seen in bold and could be retained as first orderly integrated. Their usage in our study would depend on a given selection criteria (see *4.3.2*).

4.3.2 Derivation of first orderly integrated variables

Based on results obtained from country unit root tests (see tables 1 and 2), our choice of countries that are first orderly integrated (in bold) will be guided by the following criteria:

-both factor productivity variables (human and physical capital) must exhibit unit root (non stationary) at level series and be first orderly integrated (first differenced stationarity);

-at least one investment proxy must be also non stationary at level series and first differenced stationary.

Applying above selection process to all countries resulted in the derivation of six variable panels below (see table 3).

Table 3: Derivation of countries with first orderly integrated variables: I (1)

Asymmetric Panels					
Investment dynamics				Productivity factors	
Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6
FDI	Private Ivt	Public Ivt	Domestic Ivt.	Labour(Pop)	Capital(GFCF)
	-Benin			-Benin	-Benin
-Ivory Coast	-Ivory Coast	- Ivory Coast	-Ivory Coast	-Ivory Coast	-Ivory Coast
-Congo Rep.	-Congo Rep.	-Congo Rep.	-Congo Rep.	-Congo Rep.	-Congo Rep.
-Gambia	-Gambia	-Gambia		-Gambia	-Gambia
-Ghana	-Ghana	-Ghana	-Ghana	-Ghana	-Ghana
	-Malawi	-Malawi	-Malawi	-Malawi	-Malawi
	-South Afri.		-South Afri.	-South Afri.	-South Afri.
	-Sudan	-Sudan	-Sudan	-Sudan	-Sudan
	-Swaziland	-Swaziland	-Swaziland	-Swaziland	-Swaziland
		-Tunisia	-Tunisia	-Tunisia	-Tunisia
-Zambia		-Zambia	-Zambia	-Zambia	-Zambia

Source (authors synthesis)

An investment type and factor productivity variables could have a linear combination that is stationary (cointegrated).

Table 1: ADF Statistics for country specific unit root tests (1997-2007)

Countries	Foreign Investment				Private Investment				Public Investment			
	Level		First difference		Level		First difference		Level		First difference	
	c	ct	c	ct	c	ct	c	ct	c	ct	c	ct
Algeria	-2.992*	-13.13***	n.a	n.a	-2.501	-3.190	-2.956*	-2.881	-1.777	-1.722	-3.716***	-3.708**
Benin	-4.806***	-5.956****	n.a	n.a	**-0.900**	**-2.553**	**-3.814****	**-3.838****	-3.690**	-3.647*	n.a	n.a
Botswana	-2.248	-3.547*	-7.304***	-7.171***	-2.583	-3.022	-3.336**	-3.410*	-3.128**	-2.069	-4.336**	-6.079***
Burundi	-4.417***	-4.305**	n.a	n.a	-2.058	-2.071	-5.711***	-5.590***	-1.853	-2.751	-6.145***	-6.005***
Cameroon	-2.403	-2.402	-10.66***	-10.44***	-5.180***	-4.311***	n.a	n.a	-2.177	-3.007	-3.088**	-3.035
CAR	-1.049	-10.39***	-4.223***	-3.894**	-4.222***	-4.124**	n.a	n.a	-3.464**	-3.930**	-6.938***	-7.195***
Chad	-3.702**	-3.308	-3.171**	-2.717	-1.612	-2.545	-2.695*	-2.528	-2.073	-2.340	-4.316***	-4.802***
Côte d'Iv.	**-2.133**	**-2.661**	**-7.098*****	**-6.970*****	**-2.328**	**-2.256**	**-9.711*****	**-4.365****	**-1.554**	**-2.008**	**-4.955*****	**-4.949*****
Congo R.	**-0.995**	**-2.079**	**-4.660*****	**-3.639***	**-1.748**	**-1.229**	**-8.228*****	**-8.494*****	**-3.324****	**-3.264**	**-3.281****	**-3.416***
Egypt	-2.062	-0.858	-3.385**	-3.555*	-2.594	-2.515	-3.056**	-3.021	-1.186	-4.171**	-5.739***	-5.584***
Burkina F.	-7.635***	-8.338***	n.a	n.a	-1.712	-3.022	-4.802***	-4.638***	-1.475	-2.443	-5.919***	-5.814***
Gabon	-2.721*	-2.651	-7.243***	-7.198***	-1.983	-2.889	-2.800*	-2.778	-4.625***	-4.566***	-4.625***	-4.566***
Gambia	**0.319**	**-1.888**	**-13.361*****	**-14.000*****	**-2.064**	**-2.457**	**-5.060*****	**-4.938*****	**-2.877***	**-3.129**	**-4.660*****	**-4.515*****
Ghana	**-0.593**	**-3.096**	**-4.776*****	**-4.920*****	**0.755**	**-4.865*****	**-5.705*****	**-5.817*****	**-2.364**	**-2.330**	**-3.498****	**-3.353***
Guinea	-2.849*	-2.826	-3.801**	-3.726*	-1.801	-1.707	-4.392***	-4.348***	-0.576	-3.438*	-6.727***	-7.292***
Kenya	-3.966***	-4.701***	n.a	n.a	-1.314	-1.356	-5.578***	-5.762***	-1.653	-1.541	-4.276***	-4.251**
Lesotho	-3.119**	-3.198	-6.795***	-6.697***	-1.279	-1.125	-4.190***	-4.385***	-2.052	-2.386	-4.038***	-3.837**
Madagascar	-0.990	-5.213***	-5.053***	-4.906***	2.056	0.336	-6.365***	-3.985**	-3.245**	-3.573*	-3.861***	-3.732**
Malawi	-3.424**	-3.992**	n.a	n.a	**-2.014**	**-1.946**	**-5.941*****	**-5.832*****	**-2.570**	**-1.980**	**-4.908*****	**-5.806*****
Mali	-2.813*	-3.646**	n.a	n.a	-3.742**	-4.841***	n.a	n.a	-2.649*	-4.355**	n.a	n.a
Morocco	-1.434	-8.603***	-15.199***	-14.922***	0.116	-2.320	-5.022***	-3.875**	-3.817***	-2.959	-4.956***	-5.706***
Mozambique	-1.924	-2.610	-4.535***	-4.469**	-1.833	-1.553	-10.486***	-5.564***	-3.034**	-3.288*	n.a	n.a
Mauritania	-5.683***	-4.794***	n.a	n.a	-0.970	-3.269	-3.309*	-3.542	-6.762***	-0.261	-3.444**	-5.162**
Mauritius	-4.188***	-4.414***	n.a	n.a	-2.866*	-2.898	-2.969**	-2.890	-1.758	-1.485	-5.223***	-5.525***
Namibia	-2.836*	-4.079**	n.a	n.a	-1.616	-3.869**	-6.721***	-6.651***	-3.784***	-2.956	-7.717***	-8.387***
Niger	-3.577**	-3.468*	n.a	n.a	0.153	-1.056	-4.371***	-5.146***	-4.232***	-3.347*	n.a	n.a
Rwanda	-0.721	0.281	n.s.a	n.s.a	-1.006	-1.843	-3.741**	-3.635*	-1.871	-2.323	-4.951***	-4.991***
South Africa	-4.072***	-4.210**	n.a	n.a	**-3.233****	**-1.215**	**-4.555*****	**-5.331*****	-3.401**	-8.925***	n.a	n.a
Senegal	-1.771	-5.327***	-10.147***	-10.042***	-2.394	-3.358*	-6.470***	-6.367***	2.193	0.471	-6.622***	-7.693***
Seychelles	1.173	-0.584	-1.721	-2.221	-2.627	-2.862	-5.399***	-5.324***	-4.070***	-3.752**	n.a	n.a
Sierra Leone	-4.986***	-5.432***	n.a	n.a	-2.146	-1.253	-7.489***	-8.351***	-3.457**	-3.403*	n.a	n.a
Sudan	-0.836	-1.999	-2.515	-3.193	**-2.471**	**-3.074**	**-5.591*****	**-5.461*****	**-1.052**	**0.267**	**-3.515****	**-4.469*****
Swaziland	-3.953***	-3.932**	n.a	n.a	**-1.882**	**-4.716*****	**-5.570*****	**-5.739*****	**-3.237****	**-2.996**	**-10.754*****	**-10.734*****
Togo	-3.275**	-3.206	-10.037***	-11.202***	-1.356	-2.764	-5.607***	-5.556***	-3.688**	-4.169**	n.a	n.a
Tunisia	-3.638**	-4.201**	n.a	n.a	-5.087***	-4.992***	n.a	n.a	**-1.952**	**-1.650**	**-3.872*****	**-3.810****
Uganda	0.745	-1.647	-5.071***	-5.564***	-0.430	-3.607*	-6.531***	-6.354***	-3.537**	-3.585*	n.a	n.a
Zambia	**-1.646**	**-4.351****	**-5.833*****	**-5.627*****	-0.799	-1.606	-1.674	-1.922	**-1.576**	**-1.389**	**-3.872****	**-3.697***
Zimbabwe	-2.124	-2.381	-6.413***	-4.171***	-2.862*	-2.986	-5.288***	-5.098***	-3.448**	-3.547*	n.a	n.a

*, **, *** denote significance at 10%, 5% and 1% respectively. Maximum lag is 3 and optimal lags are chosen via AIC. 'c' and 'ct': 'constant' and 'constant and trend' ;respectively. n.a: not applicable; n.s.a: not specifically applicable.

Table 2: ADF Statistics for country specific unit root tests continued (1997-2007)

Countries	Domestic Investment				Physical Capital				Human Capital			
	Level		First difference		Level		First difference		Level		First difference	
	c	ct	c	ct	c	ct	c	ct	c	ct	c	ct
Algeria	-2.853*	-1.465	-2.901*	-6.147***	-2.624	-2.100	-5.992***	-6.502***	-1.632	-1.825	-1.960	-2.123
Benin	-3.406**	-3.549*	n.a	n.a	**-0.717**	**-8.603*** **	**-8.045*** **	**-7.778*** **	**-2.097**	**-1.344**	**-8.902*** **	**-9.263*** **
Botswana	-2.574	-2.745	-3.820***	-3.853**	-2.888*	-3.550*	n.a	n.a	-0.539	-2.806	-1.763	-1.494
Burundi	-1.390	-2.703	-7.960***	-7.813***	-1.747	-1.941	-6.800***	-6.687***	-3.580**	-3.681**	n.a	n.a
Cameroon	-2.231	-1.670	-6.562***	-6.797***	-4.582***	-3.918**	n.a	n.a	2.257	-0.558	-1.089	-2.448
CAR	-3.458**	-3.552*	n.a	n.a	-3.774***	-3.772**	n.a	n.a	-1.119	-2.339	-2.514	-3.093
Chad	-1.557	-3.646**	-4.374***	-4.340**	-1.641	-3.094	-3.893***	-3.801**	-1.072	0.594	-0.015	-0.760
Côte d'Iv.	**-1.831**	**-1.479**	**-4.469*** **	**-4.746*** **	**-1.786**	**-1.467**	**-5.279*** **	**-5.810*** **	**-1.166**	**-4.242** **	**-3.326** **	**-3.098**
Congo R.	**-2.626***	**-2.931**	**-4.527*** **	**-4.436*** **	**-2.607**	**-3.058**	**-4.552*** **	**-4.471*** **	**-1.131**	**-1.214**	**-2.813***	**-2.882**
Egypt	-1.577	-3.397*	-4.159***	-4.080**	-2.112	-3.309*	-5.121***	-4.995***	-1.567	-3.334*	-2.155	-1.737
Burkina F.	-2.607	-2.591	-6.795***	-6.659***	-2.440	-2.540	-7.057***	-6.987***	-1.916	0.279	-1.268	-2.452
Gabon	-4.679***	-5.192***	n.a	n.a	-3.604**	-4.003**	n.a	n.a	-1.755	-2.397	-1.461	-0.971
Gambia	-6.293***	-6.443***	n.a	n.a	**-2.970***	**-2.951**	**-4.710*** **	**-5.053*** **	**-1.143**	**-1.553**	**-1.063**	**-6.523*** **
Ghana	**0.693**	**-2.689**	**-6.230*** **	**-6.482*** **	**0.518**	**-4.130** **	**-5.783*** **	**-5.936*** **	**0.689**	**-7.314*** **	**-4.253*** **	**-13.654*** **
Guinea	-1.089	-2.281	-4.313***	-4.529***	-1.099	-2.429	-4.427***	-4.576***	-2.126	-2.591	-1.858	-1.834
Kenya	-2.951*	-4.360***	n.a	n.a	-4.559***	-4.264**	n.a	n.a	-1.286	-3.203	-2.379	-2.347
Lesotho	-1.418	-1.062	-5.029***	-5.079***	-1.358	-0.959	-5.260***	-5.012***	0.247	-2.079	-1.439	-1.615
Madagascar	-0.666	-1.844	-6.443***	-6.589***	-0.175	-1.294	-4.984***	-5.086***	-2.804*	-1.276	-1.420	-2.755
Malawi	**-2.743***	**-2.721**	**-7.796*** **	**-8.042*** **	**-2.353**	**-2.173**	**-6.527*** **	**-6.812*** **	**-1.506**	**-2.249**	**-3.115** **	**-3.083**
Mali	-1.727	-3.703**	-8.364***	-8.225***	-1.755	-3.714**	-8.390***	-8.256***	-1.425	-4.472***	-2.688*	-2.515
Morocco	-2.197	-2.636	-6.075***	-4.151**	-2.414	-2.845	-5.605***	-3.953**	9.587	17.212	6.654	-1.825
Mozambique	-2.632*	-2.994	-4.386***	-4.814***	-2.632*	-2.994	-4.386***	-4.814***	-2.199	-2.247	-2.074	-1.976
Mauritania	-1.798	-1.725	-8.590***	-8.442***	-4.263***	-4.263**	n.a	n.a	-3.352**	-0.473	0.722	1.593
Mauritius	-3.148**	-3.078	-2.572	-2.499	-3.964***	-4.241**	n.a	n.a	-2.106	-2.215	-5.884***	-5.787***
Namibia	-3.792***	-3.797**	n.a	n.a	-2.748*	-3.426*	n.a	n.a	-2.247	-2.351	-1.532	-1.050
Niger	-3.687**	-1.413	-2.927*	-3.957**	-1.011	-2.356	-3.214**	-4.414***	-1.786	1.899	0.707	0.138
Rwanda	-0.843	-1.908	-9.900***	-10.020***	-1.551	-2.661	-5.820	-6.028***	-2.588	-2.565	-2.479	-2.425
South Africa	**-1.838**	**-1.486**	**-4.575*** **	**-4.814*** **	**-1.545**	**-0.106**	**-3.000** **	**-3.665** **	**-0.780**	**-2.345**	**-3.921*** **	**-4.218** **
Senegal	-0.531	-1.005	-6.304***	-6.651***	-0.934	-2.539	-6.392***	-6.316***	-1.544	-3.545*	-2.427	-2.277
Seychelles	-3.149**	-3.003	-7.251***	-7.308***	-3.135**	-2.985	-7.066***	-7.132***	-5.342***	-5.282***	n.a	n.a
Sierra Leone	-2.127	-1.534	-8.211***	-9.493***	-1.738	-1.628	-8.488***	-9.725***	-2.472	-2.335	-2.380	-2.424
Sudan	**-1.201**	**-3.519***	**-5.354*** **	**-4.802*** **	**-1.478**	**-1.779**	**-5.843*** **	**-5.873*** **	**-1.686**	**-2.757**	**-2.758***	**-2.813**
Swaziland	**-3.978*** **	**-2.327**	**-5.158*** **	**-5.353*** **	**-2.999** **	**-2.337**	**-5.143*** **	**-4.751*** **	**0.105**	**-2.112**	**-1.506**	**-9.394*** **
Togo	-2.172	-2.227	-6.221***	-6.728***	-3.531**	-3.238*	n.a	n.a	-2.367	-3.489*	-2.521	-2.461
Tunisia	**-2.402**	**-4.300** **	**-5.484*** **	**-5.354*** **	**-2.379**	**-2.936**	**-3.847*** **	**-3.797** **	**-0.958**	**-4.634*** **	**-5.188*** **	**-5.083*** **
Uganda	-0.160	-4.807***	-6.668***	-6.541***	-0.819	-3.649**	-4.977***	-4.866***	-2.961*	-3.015	-1.804	-1.834
Zambia	**-2.827***	**-1.636**	**-4.750*** **	**-6.064*** **	**-1.222**	**-2.265**	**-5.203*** **	**-5.980*** **	**1.468**	**-1.659**	**-10.479*** **	**-11.040*** **
Zimbabwe	-2.347	-2.318	-5.426***	-5.378***	-3.385**	-3.358*	n.a	n.a	-2.016	-0.994	-4.318***	-0.505

*, **, *** denote significance at 10%, 5% and 1% respectively. Maximum lag is 3 and optimal lags are chosen via AIC. 'c' and 'ct': 'constant' and 'constant and trend' ;respectively. n.a: not applicable; n.s.a: not specifically applicable

4.4 Cointegration tests

Long run equilibrium relationships between sequences could be determined by various methods. Compared to cointegration tests proposed by 'Engle and Granger' (1987) and 'Stock and Watson' (1988), we choose to use Johansen (1995a, 1995b) because it has more desirable properties; withstanding the fact that all tested variables are treated as endogenous. This method consists of testing restrictions imposed by cointegration on the VAR in the series. Between the two tests at our disposal (trace statistics and maximum Eigen value), we shall report both but based our decisions only on the trace statistics in a bid to obtain more robust results (Cheung and Lai, 1993). Borrowing from Ahking (2001), we argue that when a deterministic trend[3] is included in the co-integration model, results are less favorable. However, robust results are obtained with the exclusion of a linear deterministic trend in the model. This is logical in the perspective that, the cointegration model is based on the difference of the series which has been de-trended in the stationary process. Beyond this fact, Johansen (1995b) on the one hand, and Hansen and Juselius (1995) on the other hand, have cautioned on a model based on the absence of a linear trend[4]. As justified above, our cointegration model will have only an intercept in the cointegration (level) and none in the VAR (first difference) equations.

As tables 4, 5, 6 and 7 illustrate, paired majority of variables exhibiting unit root fail to demonstrate the existence of long-run equilibrium (cointegration). In some cases (e.g Labour for Zambia on Table 4), where the cointegration rank(r) is equal to the number endogenous variables, the cointegration vector is invertible and the processes are all stationary at level; I(0). Where the r =0(e.g Capital for Zambia on Table 4), the processes are all I(1)

[3] Consistent with deterministic components in time series, but less relevant from the visual-graphical perspective of our dataset.

[4] They argue that, the minimum deterministic component in the model could be a constant in the co-integrating space to account for differences in measurement units. Logic and common sense, and to some extend economic theory help us in understanding: even if we hadn't the ambition of including a constant in the co-integration equation, the presence of any I(1) variables in the VEC requires the presence of an intercept in the model.

and not cointegrated. However, cointegration occurs (e.g Capital for Ghana on Table 4) when "r" is between zero and the number of endogenous variables (0<r<n).

Table 4: Cointegration test for Foreign Investment-factor Productivity

Countries	Variables	Model Sp. Max(AIC)	Rank of CE	Eigen Value	Trace test	Lmax test
	Capital	3(1)	0	0.189	10.838	6.286
			1	0.140	4.551	4.551
	Labour	3(3)	0	0.453	23.173***	16.926***
Ivory Coast			1	0.199	6.2473	6.247
	Capital	3(3)	0	0.615	49.512***	26.727***
	Labour		1	0.422	22.785***	15.368***
			2	0.232	7.416	7.416
	Capital	3(1)	0	0.154	6.870	4.879
			1	0.066	1.991	1.991
	Labour	3(3)	0	0.232	8.919	7.157
Congo R			1	0.063	1.762	1.762
	Capital	3(3)	0	0.348	18.596	11.553
	Labour		1	0.182	7.043	5.449
			2	0.057	1.593	1.593
	Capital	3(3)	0	0.417	14.820	11.349
			1	0.152	3.471	3.471
	Labour	3(3)	0	0.226	9.316	6.942
Gambia			1	0.084	2.373	2.373
	Capital	3(3)	0	0.822	53.711***	36.317***
	Labour		1	0.484	17.394	13.902
			2	0.153	3.491	3.491
	Capital	3(3)	0	0.497	22.760**	19.275**
			1	0.117	3.484	3.484
	Labour	3(3)	0	0.329	15.976	11.176
Ghana			1	0.157	4.800	4.800
	Capital	3(3)	0	0.699	55.447***	33.627***
	Labour		1	0.442	21.820**	16.344**
			2	0.177	5.476	5.476
	Capital	3(1)	0	0.354	13.537	12.708
			1	0.028	0.828	0.828
	Labour	3(3)	0	0.749	50.993***	37.375***
Zambia			1	0.396	13.618***	13.618***
	Capital	3(3)	0	0.771	66.031***	39.799***
	Labour		1	0.458	26.232***	16.564**
			2	0.300	9.667**	9.667**

Note that 'n.a' denotes the invalidity of the test because level series of variable is not stationary at least, at 1% or 5% significance level for both 'intercept' and 'intercept and trend categories. (***),(**) and (*) respectively depict; a very strong hypothesis against H0(P<0.01), moderate evidence against H0(0.01<=P<0.05), and suggestive evidence against H0(0.05<=P<0.1); on the number of co-integrating equations (CE). The test was conducted with the assumption of a restricted constant in the CE and no trend in both the CE and VAR equations. Optimal lags are based on AIC, and their maximum (Max) lag lengths three. Lmax: Maximum Eigen value test.

Table 5: Cointegration test for Private Investment-factor Productivity

Countries	Variables	Model Sp. Max(AIC)	Rank of CE	Eigen Value	Trace test	Lmax test
	Capital	3(2)	0	0.724	25.313***	21.930***
			1	0.180	3.382	3.382
	Labour	3(3)	0	0.549	24.524**	12.743
Benin			1	0.521	11.781**	11.781**
	Capital	3(3)	0	0.903	75.176***	37.360***
	Labour		1	0.783	37.817***	24.499***
			2	0.564	13.318***	13.318***
	Capital	3(2)	0	0.444	24.089**	17.061**
			1	0.215	7.027	7.027
	Labour	3(3)	0	0.520	33.185***	20.580***
Ivory Coast			1	0.362	12.605***	12.605***
	Capital	3(3)	0	0.801	70.531***	45.250***
	Labour		1	0.465	25.280***	17.565**
			2	0.240	7.715*	7.715
	Capital	3(1)	0	0.362	15.475	9.909
			1	0.223	5.565	5.565
	Labour	3(3)	0	0.623	23.694**	19.547**
Congo R			1	0.187	4.147	4.147
	Capital	3(3)	0	0,662	41,378***	21.722*
	Labour		1	0,492	19,656*	13.574
			2	0,262	6,081	6.081
	Capital	3(1)	0	0.391	17.461	11.439
			1	0.230	6.021	6.021
	Labour	3(3)	0	0.518	16.789	15.346*
Gambia			1	0.066	1.443	1.443
	Capital	3(3)	0	0.696	38.411**	25.019**
	Labour		1	0.361	13.392	9.432
			2	0.171	3.958	3.958
	Capital	3(3)	0	0.340	13.419	8.756
			1	0.199	4.662	4.662
	Labour	3(3)	0	0.697	38.904***	25.133***
Ghana			1	0.480	13.771***	13.771***
	Capital	3(3)	0	0.736	55.076***	28.028***
	Labour		1	0.656	27.048***	22.411***
			2	0.198	4.637	4.637
	Capital	3(1)	0	0.258	15.603	8.969
			1	0.198	6.633	6.633
	Labour	3(3)	0	0.328	12.977	11.133
Malawi			1	0.063	1.844	1.844
	Capital	3(3)	0	0.565	37.154**	23.317**
	Labour		1	0.347	13.837	11.970
			2	0.064	1.866	1.866
	Capital	3(1)	0	0.951	92.856**	84.744***
			1	0.251	8.112*	8.112*
	Labour	3(1)	0	0.381	17.552	14.434*
South Africa			1	0.098	3.117	3.117
	Capital	3(3)	0	0.975	119.40***	103.42***
	Labour		1	0.390	15.985	13.848
			2	0.073	2.136	2.136
	Capital	3(1)	0	0.247	9.070	8.521
			1	0.018	0.548	0.548
	Labour	3(3)	0	0.328	17.197	11.138
Sudan			1	0.194	6.058	6.058
	Capital	3(3)	0	0.560	40.187**	23.004**
	Labour		1	0.361	17.183	12.540
			2	0.152	4.642	4.642
	Capital	3(3)	0	0.407	22.325**	14.666*
			1	0.239	7.659*	7.659*
	Labour	3(3)	0	0.505	25.299***	19.693**
Swaziland			1	0.181	5.605	5.605
	Capital	3(3)	0	0.655	47.835***	29.850***
	Labour		1	0.379	17.985	13.347
			2	0.152	4.638	4.6382

Note that 'n.a' denotes the invalidity of the test because level series of variable is not stationary at least, at 1% or 5% significance level for both 'intercept' and 'intercept and trend categories. (***),(**) and (*) respectively depict; a very strong hypothesis against H0(P<0.01), moderate evidence against H0(0.01<=P<0.05), and suggestive evidence against H0(0.05<=P<0.1); on the number of co-integrating equations (CE). The test was conducted with the assumption of a restricted constant in the CE and no trend in both the CE and VAR equations. Optimal lags are based on AIC, and their maximum (Max) lag lengths three. Lmax: Maximum Eigen value test.

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Table 6: Cointegration test for Public Investment-factor Productivity

Countries	Variables	Model Sp. Max(AIC)	Rank of CE	Eigen Value	Trace test	Lmax test
	Capital	3(2)	0	0.442	24.230**	16.955**
			1	0.221	7.275	7.275
	Labour	3(3)	0	0.492	26.444***	18.973**
Ivory Coast			1	0.234	7.471	7.471
	Capital	3(3)	0	0.798	70.039***	44.901***
	Labour		1	0.465	25.138***	17.530**
			2	0.237	7.608*	7.608*
	Capital	3(1)	0	0.362	15.475	9.909
			1	0.223	5.565	5.565
	Labour	3(3)	0	0.459	21.750**	12.308
Congo R			1	0.376	9.441**	9.441**
	Capital	3(3)	0	0.662	41.378***	21.722*
	Labour		1	0.492	19.656*	13.574
			2	0.262	6.081	6.081
	Capital	3(1)	0	0.391	17.461	11.439
			1	0.230	6.021	6.021
	Labour	3(3)	0	0.424	19.492*	13.255
Gambia			1	0.228	6.237	6.237
	Capital	3(3)	0	0.696	38.411**	25.019**
	Labour		1	0.361	13.392	9.432
			2	0.171	3.958	3.958
	Capital	3(3)	0	0.340	13.419	8.756
			1	0.199	4.662	4.662
	Labour	3(3)	0	0.646	30.674***	21.836***
Ghana			1	0.343	8.837*	8.837*
	Capital	3(3)	0	0.736	55.076***	28.028***
	Labour		1	0.656	27.048***	22.411***
			2	0.198	4.637	4.637
	Capital	3(1)	0	0.274	15.610	9.606
			1	0.181	6.003	6.003
	Labour	3(3)	0	0.481	19.901*	18.402**
Malawi			1	0.052	1.498	1.498
	Capital	3(3)	0	0.623	42.004***	27.357***
	Labour		1	0.364	14.647	12.687
			2	0.067	1.959	1.959
	Capital	3(1)	0	0.268	9.894	9.396
			1	0.016	0.497	0.497
	Labour	3(3)	0	0.289	16.487	9.564
Sudan			1	0.219	6.922	6.922
	Capital	3(1)	0	0.465	30.460	17.551
	Labour		1	0.271	12.909	8.887
			2	0.133	4.021	4.021
	Capital	3(3)	0	0.407	22.325**	14.666*
			1	0.239	7.659*	7.659*
	Labour	3(3)	0	0.411	19.550*	14.846*
Swaziland			1	0.154	4.704	4.704
	Capital	3(3)	0	0.655	47.835***	29.850***
	Labour		1	0.379	17.985	13.347
			2	0.152	4.638	4.638
	Capital	3(3)	0	0.653	28.579***	22.238***
			1	0.260	6.340	6.340
	Labour	3(1)	0	0.240	10.931	6.319
Tunisia			1	0.181	4.612	4.612
	Capital	3(3)	0	0.760	43.762***	30.033***
	Labour		1	0.352	13.728	9.132
			2	0.196	4.595	4.595
	Capital	3(1)	0	0.350	8.766	7.329
			1	0.081	1.436	1.436
	Labour	3(3)	0	0.836	30.763***	27.175***
Zambia			1	0.212	3.588	3.588
	Capital	3(3)	0	0.979	83.395***	58.118***
	Labour		1	0.669	25.277***	16.614**
			2	0.438	8.662*	8.662*

Note that 'n.a' denotes the invalidity of the test because level series of variable is not stationary at least, at 1% or 5% significance level for both 'intercept' and 'intercept and trend categories. (***),(**) and (*) respectively depict; a very strong hypothesis against H0(P<0.01), moderate evidence against H0(0.01<=P<0.05), and suggestive evidence against H0(0.05<=P<0.1); on the number of co-integrating equations (CE). The test was conducted with the assumption of a restricted constant in the CE and no trend in both the CE and VAR equations. Optimal lags are based on AIC, and their maximum (Max) lag lengths three. Lmax: Maximum Eigen value test.

.

Table 7: Cointegration test for Domestic Investment-factor Productivity

Countries	Variables	Model Sp. Max(AIC)	Rank of CE	Eigen Value	Trace test	Lmax test
	Capital	3(3)	0	0.494	32.612***	19.116**
			1	0.382	13.496***	13.496***
	Labour	3(3)	0	0.433	25.053***	15.905**
Ivory Coast			1	0.278	9.148**	9.148**
	Capital	3(3)	0	0.548	49.925***	22.271**
	Labour		1	0.439	27.653***	16.231**
			2	0.334	11.422**	11.422**
	Capital	3(1)	0	0.383	18.929*	14.528*
			1	0.136	4.400	4.400
	Labour	3(3)	0	0.307	13.973	10.304
Congo R			1	0.122	3.669	3.669
	Capital	3(3)	0	0.634	41.385***	28.176***
	Labour		1	0.256	13.209	8.305
			2	0.160	4.903	4.903
	Capital	3(3)	0	0.434	20.996**	15.946**
			1	0.165	5.049	5.049
	Labour	3(3)	0	0.567	32.995***	23.455***
Ghana			1	0.288	9.540**	9.540**
	Capital	3(3)	0	0.696	55.864***	33.343***
	Labour		1	0.417	22.521**	15.141*
			2	0.231	7.379	7.379
	Capital	3(1)	0	0.477	25.263***	19.459**
			1	0.175	5.803	5.803
	Labour	3(3)	0	0.354	13.585	12.246
Malawi			1	0.046	1.339	1.339
	Capital	3(3)	0	0.658	44.904***	30.115***
	Labour		1	0.368	14.789	12.872
			2	0.066	1.916	1.916
	Capital	3(1)	0	0.691	38.639***	35.259***
			1	0.106	3.380	3.380
	Labour	3(3)	0	0.197	9.077	6.610
South Africa			1	0.078	2.466	2.466
	Capital	3(1)	0	0.704	47.504***	36.523***
	Labour		1	0.214	10.981	7.261
			2	0.116	3.719	3.719
	Capital	3(1)	0	0.242	11.657	8.339
			1	0.104	3.317	3.317
	Labour	3(3)	0	0.358	18.572*	12.416
Sudan			1	0.197	6.156	6.156
	Capital	3(3)	0	0.629	39.705**	27.827***
	Labour		1	0.270	11.878	8.834
			2	0.103	3.044	3.044
	Capital	3(3)	0	0.641	36.887***	28.688***
			1	0.253	8.199*	8.199*
	Labour	3(3)	0	0.429	24.837***	15.727*
Swaziland			1	0.277	9.109*	9.109*
	Capital	3(3)	0	0.711	64.860***	34.793***
	Labour		1	0.521	30.067***	20.661***
			2	0.285	9.405**	9.405**
	Capital	3(2)	0	0.456	24.767***	17.691**
			1	0.216	7.0762	7.076
	Labour	3(2)	0	0.280	12.157	9.536
Tunisia			1	0.086	2.621	2.621
	Capital	3(2)	0	0.485	31.632	19.289
	Labour		1	0.280	12.343	9.548
			2	0.091	2.794	2.794
	Capital	3(3)	0	0.505	22.553***	21.139***
			1	0.046	1.413	1.413
	Labour	3(3)	0	0.628	31.961***	27.749***
Zambia			1	0.139	4.211	4.211
	Capital	3(3)	0	0.724	61.794***	36.102***
	Labour		1	0.483	25.692***	18.496**
			2	0.226	7.195	7.195

Note that 'n.a' denotes the invalidity of the test because level series of variable is not stationary at least, at 1% or 5% significance level for both 'intercept' and 'intercept and trend categories. (***),(**) and (*) respectively depict; a very strong hypothesis against H0(P<0.01), moderate evidence against H0(0.01<=P<0.05), and suggestive evidence against H0(0.05<=P<0.1); on the number of co-integrating equations (CE). The test was conducted with the assumption of a restricted constant in the CE and no trend in both the CE and VAR equations. Optimal lags are based on AIC, and their maximum (Max) lag lengths three. Lmax: Maximum Eigen value test.

Table 8: Causality analysis

Countries	Goodness of Fit		**Labour** led(cause) **FDI**		**Capital** led(cause) **FDI**		Goodness of Fit		**Labour** led(cause) **PriI**		**Capital** led(cause) **PriI**	
	1st dif.	Level	Short run (1st dif.)	Long run (Level)	Short run (1st dif.)	Long run (Level)	1st dif.	Level	Short run (1st dif.)	Long run (Level)	Short run (1st dif.)	Long run (Level)
	AIC	AIC:CE	F-Stats[a]	ECT(t-stats) º	F-Stats[a]	ECT(t-stats) º	AIC	AIC:CE	F-Stats[a]	ECT(t-stats) º	F-Stats[a]	ECT(t-stats) º
Benin	n.a	n.a	n.a	n.a	n.a	n.a	3(2)/3(2)	3(3) :0/3(2) :1	1.279	n.c	4.826**	0.207 (0.840)
Ivory Coast	3(3)/3(1)	3(3):1/3(1) :0	1.600	**-0,007*** (-4,250)**	0.750	n.c	3(2)/3(1)	3(3) :0/3(2) :1	0.222	n.c	0.022	-0.220*** (-4,191)
Congo Rep.	3(3)/3(1)	3(3):0/3(1) :0	1.662	n.c	0.181	n.c	3(3)/3(1)	3(3) :1/3(1) :0	0.438	**-0.012*** (-4.748)**	0.813	n.c
Gambia	3(3)/3(1)	3(3):0/3(3) :0	1.003	n.c	0.807	n.c	3(3)/3(1)	3(3) :0/3(1) :0	2.328	n.c	0.001	n.c
Ghana	3(2)/3(3)	3(3):0/3(3) :1	0.049	n.c	3.853**	-2.459** (-2.377)	3(3)/3(3)	3(3) :0/3(3) :0	0.287	n.c	0.284	n.c
Malawi	n.a	n.a	n.a	n.a	n.a	n.a	3(2)/3(1)	3(3) :0 /3(1) :0	0.476	n.c	1.809	n.c
South Afri	n.a	n.a	n.a	n.a	n.a	n.a	3(1)/3(1)	3(1) :0/3(1) :0	0.618	n.c	2.811	n.c
Sudan	n.a	n.a	n.a	n.a	n.a	n.a	3(2)/3(1)	3(3) :0/3(1) :0	1.748	n.c	0.092	n.c
Swaziland	n.a	n.a	n.a	n.a	n.a	n.a	3(3)/3(2)	3(3) :1/3(3) :0	1.160	**0.008*** (4.234)**	0.711	n.c
Zambia	3(3)/3(1)	3(3):0/3(1) :0	0.791	n.c	1.761	n.c	n.a	n.a	n.a	n.a	n.a	n.a

	Goodness of Fit		**Labour** led(cause) **PubI**		**Capital** led(cause) **PubI**		Goodness of Fit		**Labour** led(cause)**GDI**		**Capital** led(cause) **GDI**	
Ivory Coast	3(2)/3(1)	3(3) :1 /3(2) :1	0.209	**-0.001*** (-4.594)**	4.745**	0.203*** (4.176)	3(2)/3(2)	3(3) :0/3(3) :0	0.107	n.c	0.479	n.c
Congo Rep.	3(2)/3(1)	3(3) :0 /3(1) :0	0.266	n.c	0.288	n.c	3(2)/3(1)	3(3) :0/3(1) :1	0.036	n.c	0.450	0.090 (0.069)
Gambia	3(3)/3(3)	3(3) :1 /3(1) :0	1.210	0.003 (1.406)	0.843	n.c	n.a	n.a	n.a	n.a	n.a	n.a
Ghana	3(3)/3(3)	3(3) :0 /3(3) :0	2.377	n.c	2.826*	n.c	3(2)/3(2)	3(3) :0/3(3) :1	3.426**	n.c	0.376	-3.579* (-1.795)
Malawi	3(3)/3(1)	3(3) :1 /3(1) :0	0.751	0.001 (0.151)	0.041	n.c	3(3)/3(1)	3(3) :0/3(1) :1	0.844	n.c	0.443	-0.374 (-0.846)
South Africa	n.a	n.a	n.a	n.a	n.a	n.a	3(1)/3(2)	3(3) :0/3(1) :1	0.202	n.c	1.885	0.422*** (3.776)
Sudan	3(2)/3(1)	3(3) :0 /3(1) :0	0.000	n.c	0.414	n.c	3(3)/3(2)	3(3) :1/3(1) :0	1.519	**0.001* (2.019)**	0.009	n.c
Swaziland	3(3)/3(2)	3(3) :1 /3(3) :0	1.720	**0.010*** (3.896)**	0.380	n.c	3(3)/3(3)	3(3) :0/3(3) :0	2.616*	n.c	6.278***	n.c
Tunisia	3(1)/3(1)	3(3) :0 /3(1) :1	0.049	n.c	4.311*	-0.260 (-0.975)	3(1)/3(2)	3(2) :0/3(2) :1	1.299	n.c	2.104	-0.279 (-0.828)
Zambia	3(2)/3(1)	3(3) :1 /3(1) :0	2.553	**-0.010*** (-4.846)**	0.695	n.c	3(2)/3(1)	3(3) :1/3(1) :1	1.399	**0.0001*** (6.077)**	0.307	-0.311 (-1.059)

[a] (F-Stats) F-statistics (Wald statistics) test the significance of lagged values of the independent variables. ° (ECT/t-stats) Error Correction term and t-ratios. Asterisks indicate the following levels of significance :***, 1%; **; 5% and *; 10%. Maximum lag is 3 and optimal lags are chosen via AIC. s.l and n.a indicate "stationary at level" and "not applicable" respectively. 1st dif: First difference. Max: Maximum. CE: Cointegration Equation. n.c: no cointegration. FDI: Foreign Direct Investment. PriI: Private Investment. PubI: Public Investment. GDI: Gross Domestic Investment.

4.5 Panel causality analysis

Given cointegration results obtained, we have proceeded with estimating short term dynamics for each cointegrated pair. From table 8 it could be observed that, in the long-run, population growth will: decrease FDI investment in Ivory Coast, diminish private investment in Congo Republic and, improve private investment in Swaziland. Not unexpected, no short-run causality result is significant; this confirms our initial hypothesis that, demographic changes mostly have long-term economic effects. Also, population growth decreases public investment in Ivory Coast and Zambia but not in Swaziland; domestic investment crops up in Sudan and Zambia with population rise. In the short-term only Ghana and Swaziland turn to experience changes in domestic investment with positive demographic fluctuations.

5. Discussion of results and policy implications

5.1 Discussion of results

Understandably, all investment types should increase with population. However we expected population growth elasticities of private and foreign investments to be higher than that of public investment. The reason for this difference in expectation stems from structural adjustment policy effects. As we must have spelled-out earlier, in the mid 1980's most indebted African countries were imposed policies of privatization and liberalization, such as to gradually reduce the role of governments in the running of economies. It follows that, as these policies were implemented, public-investment influence on aggregate investment should have reduced over time as compared to private investments.

Elasticities for Ivory Coast have unexpected negative signs with respect to foreign and public investments. These could be explained from global economic and foreign investment perspectives. From a global point, public investments have decreased since the 1970's. While per capita grew 82% in the 1960's (reaching a peaks of 360%), it shrank by 28% and 22% in

the 1980s and 1990's respectively. The 1994 devaluation of the CFA franc only further depreciated public investment values. Thus the decrease in public investments with respect to population growth is quite understandable. On the other hand prospects of decrease in FDI (which constitutes between 40% and 45% of the total capital of Ivorian firms), could be explained through the key role France plays in contributing around 55% to 60% of the total capital of these Ivorian firms. At the turn of the Millennium, Ivorian political crisis spurred-up anti-French sentiment which led to a massive exodus of French citizens and investments from the country. This provides some explanation as to why FDI will decrease 7 times the rate of public investment for the same percentage increase in population.

Increase in public and private spending in Swaziland can somewhat be elucidated from considerable spending in the 1990's. Much of this increased spending was tilted to current expenditures related to wages, transfers and subsidies. Swaziland has one of the highest levels of public spending on the African continent, with a wage bill of over 15% of GDP, representing more than 55% of public spending.

Depletion of public spending and increase in domestic investment in Zambia with respect to population growth could be understood from structural adjustment reforms undertaking by the country in the 80's. By the mid-1980's Zambia with respect to GDP was one of the most indebted nations in the world. Austerity measures imposed by the IMF enabled it to decrease public spending and introduce more market-based economic policies. The New Economic Recovery Program of 1988 introduced with the influenced of the IMF was later reinforced by Chiluba's economic reforms from 1991 to 2001.

5.2 Policy Implications

Overall policy recommendations for sampled countries are: (1) birth control and family planning, especially in Ivory Coast that has suffered considerably from depleting per capita due to rising population and low GDP growth since the 1970's; (2) improvement of

private enterprise with policies that empower the working force to be less reliant on the public sector for employment.

For specific economic implications: (1) Ivory Coast should consider serious reforms so as to attract more foreign investments. Much should also be done in a bid to spur up private investments. If all goes to plan as empirically justified above, it is likely that the country faces even more political instability due to rising unemployment as unemployed youths could recourse to crime and factional interest which could seriously compromise national unity, peace and security; (2)Swaziland should adopt measures that would decrease public spending. As we have pointed out earlier, over 55% of its public spending is in the wage bill. The government cannot keep supporting rising unemployment by constantly increasing its wage bill. Therefore policies that work towards gradual replacement of public employment with private careers could largely benefit the kingdom in a distant future; (3)Zambia should continue on its path of reforms, giving much priority to foreign investment; (4) The Congo Republic should adopt policies that could improve private investment especially the feeling of investment security.

6. Conclusion

The role of Africa in world demographic change is primary and consequences on future investment dynamics could provide some insight on how unemployment, economic migration and other issues resulting there-from could be addressed. Using Johansen and Granger-causality models on data from 1977 to 2007, we have investigated effects of population growth on investment. Our study reinforces the lack of consensus over the impact of demographic change on economic growth. Empirical results have enabled us to infer: population growth in the post-independence era has for the most part depleted per capita income and significantly decreased living standards in most sampled countries. Projections seem to reveal very dire long-run consequences if measures are not taken to address

unemployment and economic migration issues resulting from the continents significant demographic increase. Main findings are, in the long-run, population growth will: (1) decrease foreign and public investments in Ivory Coast; (2) increase public and private investments in Swaziland; (3) deplete public investment but augment domestic investment in Zambia; (4) diminish private investment and improve domestic investment in the Congo Republic and Sudan respectively. For policy implications, the positive linkage between population growth and investment growth in the long-term should be treated with extreme caution, unless investment measures are adopted to utilize accruing work force. Family planning and birth control policies could also be considered in countries with little future investment avenues.

Future research could focus on age-dynamics in a bid to better account for investment-factor productivity with respect to age-structured work force. Seemingly, a parallel analysis based on the quality of labour; with parameters like health and type of secondary education; amongst others, could provide more understanding of this phenomenon.

References

Ahking, F. W. (2001) *Book Review: Measuring Business Cycles in Economic Time Series*. Indian Economic Review, Department of Economics, Delhi School of Economics, vol. 36(1), pages 304-306, January.

Azomahou, T., & Mishra, T. (2008) Age dynamics and economic growth: Revisiting the nexus in a nonparameric setting. *Economic Letters*, 99, pp.67-71.

Cheung, Y. W., & Lai, K. (1993) A fractional cointegration analysis of purchasing power parity . *Journal of Business and Economics Statistics*, 11, pp.103-112

Dangote Group (2008) 18th World Economic Forum on Africa Report. *Financial Nigeria Magazine* (June edition).

Dickey, D.A., & Fuller, W.A. (1979) Distributions of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, pp.427-31.

Engle, R.F. & Granger, C.W.J. (1987) Cointegration and Error-Correction: Representation, Estimation and Testing. *Econometrica 55* (March), pp. 251-276.

Gries, T., Kraft, M., & Meierrieks, D. (2009) Linkages between financial deepening, trade openness, and economic development: causality evidence from Sub-Saharan Africa. *World Development*, 37(12), pp.1849-1860.

Hasan, M. S. (2010) The long-run relationship between population and per capita income growth in Chin. *Journal of Policy Modeling*, 32, pp.355-372.

Hondroyiannis, G., & Papapetrou, E. (2005) Fertility and output in Europe: new evidence from panel cointegration analysis. *Journal of Policy Modeling*, 27, pp.143-156.

IMF (2009) Africa needs investment, not aid. *IMF Survey* (April)

Johansen, S. (1995a) Identifying restrictions in linear equations: with applications to simultaneous equations and cointegration. *Journal of Econometrics*, 69, pp.111-132.

Johansen, S. (1995b) *Likelihood based inference in cointegrated Vector Autoregressive Models*. Oxford, Oxford University Press.

Khim, V., & Liew, S. (2004) Which lag selection criteria should we employ? *Economics Bulletin*, 3(33), pp.1-9.

Pommeret, A., & Smith, W. T. (2005) Fertility, volatility and growth. *Economics Letters* 87, pp.347-353.

_____ (2009) Worlds Population Prospects. United Nations.

Stock, J. H., & Watson, M.W. (1988) Testing for common trends. *Journal of the American Statistical Association*, 83(404), pp.1097-1107.