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Long-term effects of population growth on aggregate investment dynamics: selected country evidence for Africa

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Long-term effects of population growth on aggregate investment dynamics: selected country evidence for Africa

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Abstract

Purpose – Our generation is witnessing the greatest demographic transition and Africa is at the heart of it. There is mounting concern over corresponding rising unemployment and depleting per capita income. I examine the issues in this paper from a long-run perspective by assessing the relationships between population growth and a plethora of investment dynamics: public, private, foreign and domestic investments.

Design/methodology/approach – Vector autoregressive models in the perspectives of vector error correction and short-run Granger causality are used.

Findings – 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.

Practical implications – Mainstream positive linkage of population growth to investment growth in the long-term should be treated with extreme caution. Policy orientation should not be blanket, but contingent on country-specific trends and tailored differently across countries. The findings stress the need for the creation of a conducive investment climate (and ease of doing business) for private and foreign investments. Family planning and birth control policies could also be considered in countries with little future investment avenues.

Originality/value – The objective of this study is to provide policy makers with some insights on how future investment opportunities could help manage rising population growth and corresponding unemployment.

JEL Classification: C30; J00; O10; O40.
Keywords: Productivity; Investment; Human capital; Causality; Africa.

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1. Introduction

The emergence and prominence of Africa in the world as one of the continents with the highest demographic growth rate with a population projected to double by 2036 from 2009 and represent 20% of the world by 2050 (UN, 2009), represents an important geo-economic concern to policy-makers, social scientists and researchers. The concern is even more crucial with soaring unemployment rate and rising economic emigration (Tom, 2006; Asongu, 2013a). These issues have reignited renewed interest in the problem of long-run investment opportunities.

The continuous expansion of demography really raises important policy questions about the exhaustion of investment opportunities needed to accommodate soaring unemployment owing to population explosion. It has been substantially documented that, socioeconomic unrests that have marked the African geopolitical landscape in recent years have been largely due to high unemployment rates (Mohammad, 2011; Sakbani, 2011). Economists and policymakers in effect may no longer be thinking about the outer limits of capital accumulation and demand-side advantages of population growth. The spectacular growth of the African population, coupled with the substantially documented investment needs of the African continent[2] raise important policy questions about the sources of future investment opportunities that would manage unemployment.

By seeking to address the concern about long-run employment opportunities, this paper has a twofold contribution to the African development literature. Firstly, the long-run focus of the analysis adequately calibrates the projected demographic concerns in the distant future. Secondly, by examining the connections between demographic changes and investment dynamics, I am able to provide the investment trends that policy makers need to

[2] See recent studies in the African business literature that have focused on factors determining investment (Rolfe & Woodward, 2004; Alagidede, 2008; Bartels et al., 2009; Tuomi , 2011; Kolstad & Wiig, 2011; Darley, 2012; Asongu, 2012). Also see recent literature on business strategies for achieving sustainable development in Africa (Rugimbana, 2010; Dimba, 2010; Mensah & Benedict, 2010; Oseifuah, 2010) that has been followed by a plethora of studies on entrepreneurship (Gerba, 2012; Singh et al., 2011).

focus-on in order to tackle potential long-term unemployment[3]. The distinction among investment types in the analysis tackles important questions on government (public versus private investment) and openness (foreign versus domestic investment) policies.

2. Population growth, investment and economic growth: theory and evidence

2.1 The concern for population growth and need for investment in Africa

There has been growing concerns over Africa's population growth and corresponding rising unemployment rate (Asongu, 2013b). According to Asongu, with the African population projected to double by 2036 from 2009, many proponents have it that, if stringent investment policies are not put in place, socio-economic issues related to rising unemployment and decreasing per capita income could significantly motivate social unrests, brain drain and/or illegal migration.

Consistent with Asongu & Jingwa (2012, p.146), our generation is experiencing the greatest demographic change ever, with Africa at its center. According to the United Nations (2009) estimates, in the post colonial era (in the neighborhood of the 1970s), there were two Europeans for every African. By the time those born in the 1970s go on retirement (most probably by 2030) it is estimated that, there would be two Africans for every European. These statistics make Africa the fastest growing continent with its population projected to represent 20% of the world by 2050 (UN, 2009; Asongu, 2013b). Therefore, it is a relevant concern to investigate how this soaring population could be accommodated without bitter economic implications in the future. A point on which many analysts (directly or indirectly) agree (as a step to addressing the growing concerns raised above) is the thesis that Africa needs other forms of investments owing to the failed privatization projects (Rolfe & Woodward, 2004;

[3]It is an established consensus that, the three main things Africa needs are investment, investment and investment (Dangote Group, 2008; IMF Survey, 2009).

Alagidede, 2008; Bartels et al., 2009; Tuomi , 2011; Kolstad & Wiig, 2011; Darley, 2012; Asongu, 2012). Dangote Group (2008) has reiterated that Africa needs investments not aid. It has decried the rejection of commodities from African companies by multinationals and urged African companies to target inter-African trade (Asongu, 2013b). The position of this pressing investment need is supported by a recent IMF Survey (April 2009) in which many analysts believe foreign donors should focus more on investment avenues in Africa, than on aid (Asongu, 2013b). The basis for this recommendation is that, development assistance and aid would improve per capita income, but sustainable investment could benefit the continent more in the long-term. Though private and foreign investments in Africa have increased over the past years[4], rising unemployment rates remain bleak. With structural adjustment policies imposed by the International Monetary Fund and the World Bank (requiring liberalization, privatization and meandering toward market based economies in the 1980s), we should naturally expect foreign and private investments to have a positive incidence on population growth at the expense of public investment.

Consistent with Asongu (2012, 2013b), a strand of current issues in African business has focused on the need to improve Africa's share of foreign direct investment (FDI). Rolfe & Woodward (2004) have assessed the Zambian experience of attracting foreign investment through privatization. The results have shown that, despite increased foreign-investment during the 1990s, the economy has stagnated. They conclude that, having sold-off its state assets, Zambia like the case of other sub-Saharan African (SSA) countries must endeavor to attract investment via other channels. Much recently, Bartels et al. (2009) have investigated the reason SSA's share of FDI has persistently averaged 1% of global flows and concluded that the FDI 'location decision' in SSA is influenced strongly by policy issues[5]. As a broad

[4] Foreign capital investments for example have surged from $15 billion in 2000 to $87 billion in 2007 (Asongu, 2013b).

[5] "*Motivated by the intuition that location decision and perceptions of investors are very instructive in policy making, they have analyzed a survey of perceptions, operations and motivations of 758 foreign investors in 10*

extension of this analysis, using microdata and firm interviews to explore the role of FDI drivers in South Africa, Tuomi (2011) has used a micro level analysis (that enables specification of the investment climate constraints) and has also found the draw-backs to investment to be centered around wrong-policy. A position that has been recently confirmed by Kolstad & Wiig (2011) and Darley (2012) in their investigations of Chinese FDI in Africa and how to increase SSA's share of FDI respectively. Three insights relevant to the context of this study could be drawn from the above literature: (1) the need for alternative sources of investment beside FDI; (2) the important role of policy making bodies in determining investment flows (Asongu, 2013b) and; (3) the soaring demography that could lead to social unrests in the absence of employment opportunities.

2.2 Population growth, human capital investments and investment opportunities

In this section, I discuss the linkages among population growth, human capital investment and investment opportunities in three strands. The first strand examines the debate on the relations among population growth, human capital and investment opportunities; the second discusses the relationship between population growth and investment opportunities while the third covers the debate on linkages between population growth and economic development.

It is essential in the first strand to discuss how population explosion would be accommodated by future investment dynamics because among the striking regularities, it is evident in aggregate cross-country data (whether investigated cross-sectionally or over-time) that, there are inverse associations between fertility rate and 'per capita incomes, schooling levels, survival rates and indicators of human capital'. As a general rule, high-income countries have been (and are) characterized by low fertility and high-levels of human capital

SSA countries. Their results demonstrate that, the provision of transaction cost-reducing information on industries and markets on the one hand and utility services to investors on the other hand , before and after a firm's FDI decision are significant factors" (Asongu, 2013b).

(Rosenzweig, 1990; Asongu, 2013b). As a matter of fact, those countries that have experienced high rates of per capita income growth have also experienced relatively rapid declines in fertility and increase in human capital levels[6]. Therefore, it could be inferred that, declines in fertility and increases in human capital levels move in tandem with economic development. Such aggregate relationships by themselves do not reveal very much about the determinants of economic prosperity and human capital investments. It has been well documented that the decreasing rate of population growth was one of the major contributing causes for the failure of the American economy to recover fully from depression in the 1930s (Rosenson, 1942). It is probably factual that, in a boom period of rapid expansion and soaring population, a sudden decrease in the rate of population growth would tend to make investors more cautious. Accordingly, an increasing rate of population growth might influence investors to be pessimistically inclined to feel that, such an increase will cause more absolute unemployment and economic hardship in a country, leading to less profitable investment prospects. Conversely, with an increasing rate of population, expectations of entrepreneurs change as they tend to believe certain investments to be profitable. As investors increase their optimism, unemployment and investment decreases and increases respectively.

In the second strand, there are several ways in which population growth might influence investment (Sweezy, 1940). Firstly, via its effect on the propensity to consume. Secondly, through its effect on the composition of aggregate consumer demand. Thirdly, by means of supply of labour. Fourthly, as an essential part of a certain broader phenomenon which in turn vitally affects investment.

[6] It is widely believed that, as income grows, families tend to prefer the quality of children to their quantity. Borrowing from Hasan (2010), per capita growth in China tends to lower population growth. He quotes the Becker hypothesis in supporting his findings: "…*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). This explanation is consistent with the nexus between birth rate and production volatility (Pommeret & Smith, 2005).

Firstly, a population containing a high proportion of dependents may be estimated to have a comparatively high propensity to consume. To a considerable extent, this factor cuts both ways (from a population perspective). While a rapidly growing population has a high proportion of children, a stationary population has a high proportion of people beyond working age. However, from sociological and political perspectives, the two situations differ considerably. Accordingly, a high proportion of dependency from the older age group represents more of a problem for the public than a high proportion of children. Moreover, during the transition period from rapid growth to complete stability, the population goes through a threshold in which the combined proportion of dependents is at a minimum.

Secondly, the incidence of population growth on the composition of total consumer demand is important for investment opportunity. In fact, a growing population of necessity directs a comparatively large proportion of its expenditure towards commodities which require relatively heavy capital outlays for their production (Asongu, 2013b).

Thirdly, up till now I have been considering the effect of population growth on the demand for commodities and therefore, indirectly on the outlets for investment seeking funds. More direct is the incidence of population growth on the labour supply. Indeed, this is the dimension in the concern that has interested classical economists and the usual treatment stems directly from their work.

Fourthly, the preceding points have been attempting to know what the effects of population growth on investment and employment would be. From a broader view, the link between population growth and investment is an essential part of a certain broader phenomenon. Therefore, it is scarcely possible to conceive this linkage as occurring in isolation because; they are intimately bound with other factors (like technological change and progress in health care).

The third strand which discusses linkages between population growth and economic development has been an issue of much heated debate. Whereas some proponents view positive demographic change as an instigator of long-term growth, others express ambivalence over this relationship. The contribution of population growth to economic development has been investigated in many studies. Azomahou & Mishra (2008) in reexamining the impact of age dynamics on economic prosperity through age-structured population for the OECD[7] and non OECD countries have shown that the economies grew mostly due to the stock of human capital between 1960 and 2000. In relative terms, findings reveal non OECD countries are likely to enjoy higher economic prosperity than their OECD counterparts. Moreover, the age-dynamics dimension of the study substantiates the consensus that, age-structured population especially the work force is important in explaining disparities in growth between OECD and non OECD countries. Before Azomahou & Mishra, Hondroyiannis & Papapetrou (2005) a study on the relationship between fertility and output in eight European countries (using panel cointegration analysis) had established some interesting results.

3. Data and Econometric methodology

3.1 Data

I assess a sample of 38 African countries with data from African Development Indicators of the World Bank (2010) for the period 1977 to 2007. The limitation to these 38 countries is based on constraints in data availability. Aggregate investment dynamics include: Gross Private Investment (*Private Ivt*); Foreign Direct Investment (*FDI*); Gross Public Investment (*Public Ivt*) and; Gross Domestic Investment (*GDI*). Factor productivity variables are: Gross Fixed Capital Formation (*GFCF*) and Population growth rate (*pop*) for physical capital and human capital respectively. Whereas the first five variables are in ratios of GDP,

[7] OECD: Organization for Economic Co-operation and Development.

population growth is in annual growth rate. The definition of all variables in percentages and ratios of GDP eases comparability. The thirty-eight countries constituting the initial dataset are subsequently trimmed-down due to constraints in the cointegration theory[8]. Therefore, in the analysis, constituent countries of the panel-base differ as I move from one form of investment type to another. The inclusion of physical capital (or fixed capital formation) in the analysis has a twofold justification: firstly, it is in line with the mainstream aggregate production investment specification[9] and; secondly, it serves as a control variable for robustness checks (in the verification of the 'capital led investment' nexus).

3.2 Methodology

The estimation strategy typically follows recent African literature on the investment-population nexus (Asongu, 2013b), investment-finance nexus (Asongu, 2013c) and mainstream literature on assessing the effects of monetary policy variables on economic activity (Starr, 2005; Nogueira, 2009). Employment of the technique requires unit root and cointegration tests that examine the stationary properties and long-term relationships (equilibriums) respectively. In these assessments, the Vector Error Correction Model (VECM) is employed for long-run effects while simple Granger causality is applied for short-term effects. While application of the former model requires that the variables exhibit unit roots in

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

[9] Starting with the aggregate investment production function:

$$I = AK^{\alpha}W^{\beta} \quad \text{(A)}$$

where **I** is the investment variable, **A** is total factor productivity, **K** is capital stock, and **W** is the labour composite, which is determined by the rate of population growth . I can re-write Eq. A in the natural log form in per capita income terms as:

$$\log I = \theta + \alpha \log K + \beta \log W \quad \text{(B)}$$

In the investment production function, physical capital is appreciated by gross fixed capital formation and human capital by population growth rate.

As hypothetically specified in Eq. (A), there is a positive relationship between stated productivity factors and investment types. This theoretical lay-out is similar to the positive dependence of aggregate production (GDP) on mentioned productivity factors and is supported empirically by many authors (Hondroyiannis & Papapetrou, 2005; Azomahou & Mishra, 2008). Concerning short-run effects, I do not expect the results to be significant because, I hypothetically assume population growth should affect investment dynamics only in the long-term.

levels and have a long-term relationship (cointegration), the latter is employed on the condition that variables do not exhibit unit roots (or are stationary).

4. VAR estimations

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

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 by the AIC. 'c' and 'ct': 'constant' and 'constant and trend'; respectively. n.a: not applicable; n.s.a: not specifically applicable owing to issues in degrees of freedom.

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 by the AIC. 'c' and 'ct': 'constant' and 'constant and trend'; respectively. n.a: not applicable; n.s.a: not specifically applicable owing to issues in degrees of freedom.

4.1 Derivation of integrated variables from country-specific unit root tests

4.1.1 Country-specific unit root tests

Since the analysis is based on the cointegration theory, I first test for stationarity in the variables using the standard Augmented Dickey Fuller (ADF)[10] test. It is not worthwhile laying too much emphasis on the mechanics of the unit root tests because it is widely applied and constitutes only an exploratory analytical dimension of the study. Optimal lag selection for goodness of fit in model specification is in accordance with the recommendations of Liew (2004). Tables 1-2 above present the unit root test results. Country-specific variables with stationary properties that are consistent with the cointegration theory are presented in bold. The choice of these countries depends on specific selection criteria; outlined in Section 4.1.2 below.

4.1.2 Derivation of first orderly integrated variables

Based on results obtained from country-specific unit root tests (in Tables 1-2), 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) in level series and be first orderly integrated (first differenced stationary);

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

In light of the above, the following asymmetric panels (presented in Table 3) are derived.

[10] Dickey & Fuller (1979).

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

Asymmetric Panels					
Investment dynamics				Productivity factors	
Panel A	Panel B	Panel C	Panel D	Panel E	Panel F
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).

4.2 Long run estimators

For long-run causality, let us consider investment (y) and human capital (x), such that:

$$y_t = \beta_{y0} + \beta_{yy1} y_{t-1} + ... + \beta_{yyp} y_{t-p} + \beta_{yx1} x_{t-1} + ... + \beta_{yxp} x_{t-p} + v_t^y \quad (1)$$

$$x_t = \beta_{x0} + \beta_{xy1} y_{t-1} + ... + \beta_{xyp} y_{t-p} + \beta_{xx1} x_{t-1} + ... + \beta_{xxp} x_{t-p} + v_t^x \quad (2)$$

I adopt the subscript convention that β_{xyp} represents the coefficient of investment (y) in the equation for human capital (x) at lag p. Given that I am dealing with bivariate analysis, the two equations above are replicated for investment and physical capital (k). The error terms in Eqs (1) and (2) represent the y_t and x_t that are related to past values of the two variables: the unpredictable "innovation" in each variable.

From intuition, human capital is exogenous to investment. An investor would prefer the cost of labour as a production factor before a decision to invest in a given region. The cost of labour is determined by its availability. From common sense and some extend economic theory (demand and supply), countries with high growth rates in working force would 'ceteris

paribus' have low working wage. It follows that, growth in work force should lead to cheaper labour cost, more investment and consequently higher economic growth. In the same vein, physical capital naturally should increase investment. When the investment variable and capital indicators of the VAR are cointegrated, I use the following vector error-correction (VEC) to estimate short-run adjustments to the long-run equilibrium.

$$\Delta y_t = \beta_{y0} + \beta_{y1}\Delta y_{t-1} + ... + \beta_{yp}\Delta y_{t-p} + \gamma_{y1}\Delta x_{t-1} + ... + \gamma_{yp}\Delta x_{t-p} - \lambda_y\left(y_{t-1} - \alpha_{\grave{a}} - \alpha_1 x_{t-1}\right) + v_t^y \quad (3)$$

$$\Delta x_t = \beta_{x0} + \beta_{x1}\Delta y_{t-1} + ... + \beta_{xp}\Delta y_{t-p} + \gamma_{x1}\Delta x_{t-1} + ... + \gamma_{xp}\Delta x_{t-p} - \lambda_x\left(y_{t-1} - \alpha_{\grave{a}} - \alpha_1 x_{t-1}\right) + v_t^x \quad (4)$$

where $y_t = \alpha_0 + \alpha_1 x_t$ is the long-run cointegrating relationship between the two variables and λ_y and λ_x are the error-correction parameters that measure how y (investment) and x (human capital) react to deviations from the long-run equilibrium. At equilibrium, the value of the error correction term (ECT) is zero. When this term is non-zero, it implies investment and capital (human and physical) have deviated from the long run equilibrium. Hence, the ECT helps each variable to adjust and partially restore the equation (cointegration) relation. I shall replicate the same models (1 to 4) for the other investment types and capital in all countries under consideration. Similar deterministic trend assumptions used for cointegration tests will be applied and goodness of fit (in model specification) is based on the AIC[11] (Liew, 2004).

4.3 Cointegration tests and VECM

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), I choose to use Johansen (1995a, 1995b) because it has more desirable properties: 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), I shall report both but based our

[11] Akaike Information Criterion.

decisions only on the trace statistics in a bid to obtain more robust results (Cheung and Lai, 1993). Consistent with Ahking (2001), I argue that when a deterministic trend[12] 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. 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 extent economic theory help us in understanding that, even if I had not the intention of including a constant in the co-integration equation, the presence of any I(1) variables in the VEC require an intercept in the model. As justified above, the cointegration model will have only an intercept in the CE[13] (level) and none in the VAR (first difference) equations. The choice of the maximum lag length is the discretion of the researcher. While I have borrowed from Gries et al. (2009) in the choice of the maximum lag length, the use of the AIC to derive optimal lags is consistent with Liew (2004), since observations are less than 60.

Tables 4, 5, 6 and 7 reveal that, 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 in 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 in level; I(0). Where the r =0 (e.g Capital for Zambia in Table 4), the processes are all I(1) and not cointegrated. However, cointegration occurs (e.g Capital for Ghana in Table 4) when "r" is between zero and the number of endogenous variables (0<r<n).

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

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**

Notes: (***), (**) 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 the AIC and the maximum (Max) lag length is three. Lmax: Maximum Eigen value test. AIC: Akaike Information Criterion.

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

Notes: (***), (**) 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 the AIC and the maximum (Max) lag length is three. Lmax: Maximum Eigen value test. AIC: Akaike Information Criterion.

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
Ivory Coast	Labour	3(3)	0	0.492	26.444***	18.973**
			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
Congo R	Labour	3(3)	0	0.459	21.750**	12.308
			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
Gambia	Labour	3(3)	0	0.424	19.492*	13.255
			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
Ghana	Labour	3(3)	0	0.646	30.674***	21.836***
			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
Malawi	Labour	3(3)	0	0.481	19.901*	18.402**
			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
Sudan	Labour	3(3)	0	0.289	16.487	9.564
			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*
Swaziland	Labour	3(3)	0	0.411	19.550*	14.846*
			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
Tunisia	Labour	3(1)	0	0.240	10.931	6.319
			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
Zambia	Labour	3(3)	0	0.836	30.763***	27.175***
			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*

Notes: (***), (**) 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 the AIC and the maximum (Max) lag length is three. Lmax: Maximum Eigen value test. AIC: Akaike Information Criterion.

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***
Ivory Coast	Labour	3(3)	0	0.433	25.053***	15.905**
			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
Congo R	Labour	3(3)	0	0.307	13.973	10.304
			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
Ghana	Labour	3(3)	0	0.567	32.995***	23.455***
			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

Malawi	Labour	3(3)	0	0.354	13.585	12.246
			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
South Africa	Labour	3(3)	0	0.197	9.077	6.610
			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
Sudan	Labour	3(3)	0	0.358	18.572*	12.416
			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*
Swaziland	Labour	3(3)	0	0.429	24.837***	15.727*
			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
Tunisia	Labour	3(2)	0	0.280	12.157	9.536
			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
Zambia	Labour	3(3)	0	0.628	31.961***	27.749***
			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

Notes: (***), (**) 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 the AIC and the maximum (Max) lag length is three. Lmax: Maximum Eigen value test.

4.4 Simple Granger causality

The VAR is also a natural framework for assessing Granger causality. Let me consider the two variable system in Eqs (1) and (2). The first equation models investment (y) as a linear function of its own past values, plus past values of human capital (x). If human capital Granger causes y, then some or all the lagged x values have non-zero effects: lagged x affects yt conditional on the effects of lagged y. Hence, testing for Granger causality in Eqs (1) and (2) amounts to testing the joint blocks of coefficients to see if they are zero. The null hypothesis of Eq. (1) is the position that, *population growth (human capital)* does not Granger cause investment. A rejection of this null hypothesis is captured by the significant F-statistics, which is the Wald statistics for the joint hypothesis that estimated parameters of lagged values

equal zero. Optimal lag selection for goodness of fit is in line with the recommendations of Liew (2004)[14]. I have already discussed why I think these variables are exogenous in Section 4.2.

Whereas in mainstream literature the Granger causality model is applied on variables that are stationary (in levels for the most part), within the framework of this study, I am applying this test to all 'investment and capital' pairs in 'first difference' equations for three reasons: (1) ensure comparability; (2) consistency with application of the model to stationary variables and; (3) robustness checks in case I might have missed-out something in the unit root test specifications.

[14] "*The major findings in the current simulation study are previewed as follows. First, these criteria managed to pick up the correct lag length at least half of the time in small sample. Second, this performance increases substantially as sample size grows. Third, with relatively large sample (120 or more observations), HQC is found to outdo the rest in correctly identifying the true lag length. In contrast, AIC and FPE should be a better choice for smaller sample. Fourth, AIC and FPE are found to produce the least probability of under estimation among all criteria under study. Finally, the problem of over estimation, however, is negligible in all cases. The findings in this simulation study, besides providing formal groundwork supportive of the popular choice of AIC in previous empirical researches, may as well serve as useful guiding principles for future economic researches in the determination of autoregressive lag length"* (Liew, 2004, p. 2).

Table 8: Causality analysis

Countries	Goodness of Fit		**Labour** led (causes) **FDI**		**Capital** led (causes) **FDI**	
	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]
Benin	n.a	n.a	n.a	n.a	n.a	n.a
Ivory Coast	3(3)/3(1)	3(3):1/3(1) :0	1.600	**-0,007*** (-4,250)**	0.750	n.c
Congo Rep.	3(3)/3(1)	3(3):0/3(1) :0	1.662	n.c	0.181	n.c
Gambia	3(3)/3(1)	3(3):0/3(3) :0	1.003	n.c	0.807	n.c
Ghana	3(2)/3(3)	3(3):0/3(3) :1	0.049	n.c	3.853**	-2.459** (-2.377)
Malawi	n.a	n.a	n.a	n.a	n.a	n.a
South Afri	n.a	n.a	n.a	n.a	n.a	n.a
Sudan	n.a	n.a	n.a	n.a	n.a	n.a
Swaziland	n.a	n.a	n.a	n.a	n.a	n.a
Zambia	3(3)/3(1)	3(3):0/3(1) :0	0.791	n.c	1.761	n.c

Countries	Goodness of Fit		**Labour** led (causes)**GDI**		**Capital** led(causes) **GDI**	
	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]
Benin	3(2)/3(2)	3(3) :0/3(3) :0	0.107	n.c	0.479	n.c
Ivory Coast	3(2)/3(1)	3(3) :0/3(1) :1	0.036	n.c	0.450	0.090 (0.069)
Congo Rep.	n.a	n.a	n.a	n.a	n.a	n.a
Gambia	3(2)/3(2)	3(3) :0/3(3) :1	3.426**	n.c	0.376	-3.579* (-1.795)
Ghana	3(3)/3(1)	3(3) :0/3(1) :1	0.844	n.c	0.443	-0.374 (-0.846)
Malawi	3(1)/3(2)	3(3) :0/3(1) :1	0.202	n.c	1.885	0.422*** (3.776)
South Afri	3(3)/3(2)	3(3) :1/3(1) :0	1.519	**0.001* (2.019)**	0.009	n.c
Sudan	3(3)/3(3)	3(3) :0/3(3) :0	2.616*	n.c	6.278***	n.c
Swaziland	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) :1	1.399	**0.0001*** (6.077)**	0.307	-0.311 (-1.059)

	Goodness of Fit		**Labour** led (causes) **PubI**		**Capital** led(causes) **PubI**	
Ivory Coast	3(2)/3(1)	3(3) :1 /3(2) :1	0.209	**-0.001*** (-4.594)**	4.745**	0.203*** (4.176)
Congo Rep.	3(2)/3(1)	3(3) :0 /3(1) :0	0.266	n.c	0.288	n.c
Gambia	3(3)/3(3)	3(3) :1 /3(1) :0	1.210	0.003 (1.406)	0.843	n.c
Ghana	3(3)/3(3)	3(3) :0 /3(3) :0	2.377	n.c	2.826*	n.c
Malawi	3(3)/3(1)	3(3) :1 /3(1) :0	0.751	0.001 (0.151)	0.041	n.c
South Africa	n.a	n.a	n.a	n.a	n.a	n.a
Sudan	3(2)/3(1)	3(3) :0 /3(1) :0	0.000	n.c	0.414	n.c
Swaziland	3(3)/3(2)	3(3) :1 /3(3) :0	1.720	**0.010*** (3.896)**	0.380	n.c
Tunisia	3(1)/3(1)	3(3) :0 /3(1) :1	0.049	n.c	4.311*	-0.260 (-0.975)
Zambia	3(2)/3(1)	3(3) :1 /3(1) :0	2.553	**-0.010*** (-4.846)**	0.695	n.c

	Goodness of Fit		**Labour** led(causes) **PriI**		**Capital** led (causes) **PriI**	
	3(2)/3(2)	3(3) :0/3(2) :1	1.279	n.c	4.826**	0.207 (0.840)
	3(2)/3(1)	3(3) :0/3(2) :1	0.222	n.c	0.022	-0.220*** (-4,191)
	3(3)/3(1)	3(3) :1/3(1) :0	0.438	**-0.012*** (-4.748)**	0.813	n.c
	3(3)/3(1)	3(3) :0/3(1) :0	2.328	n.c	0.001	n.c
	3(3)/3(3)	3(3) :0/3(3) :0	0.287	n.c	0.284	n.c
	3(2)/3(1)	3(3) :0 /3(1) :0	0.476	n.c	1.809	n.c
	3(1)/3(1)	3(1) :0/3(1) :0	0.618	n.c	2.811	n.c
	3(2)/3(1)	3(3) :0/3(1) :0	1.748	n.c	0.092	n.c
	3(3)/3(2)	3(3) :1/3(3) :0	1.160	**0.008*** (4.234)**	0.711	n.c
	n.a	n.a	n.a	n.a	n.a	n.a

[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 the AIC. s.l and n.a indicate "stationary in level" and "not applicable" respectively. 1st dif:First difference. Max: Maximun. CE: Cointegrating Equation. n.c: no cointegration. FDI: Foreign Direct Investment. PriI: Private Investment. PubI: Public Investment. GDI: Gross Domestic Investment. AIC: Akaike Information Criterion. Rep: Republic. Afr: Africa.

4.5 Discussion of results, policy implications, caveats and future directions

4.5.1 Discussion and policy implications

The significant cointegration results demonstrate that in the long-term, permanent changes in capital (human and/or physical) affect permanent changes in investment dynamics and vice-versa. For every cointegrated 'investment-capital' pair, I have proceeded to examine short-term dynamics. Table 8 above reveals the results of the causality analysis. While Panel A and Panel B present the findings of FDI and domestic investment respectively, Panel C and Panel D report those of public investment and private investment respectively. Whereas the VECM is specified in levels equations, Granger causality is in first difference representation. Optimal lag selection for goodness of fit in the VAR models is by the AIC with three maximum lags. The F-statistics is for the joint significance of lagged values of independent variables. The ECTs denote short-term adjustments to the cointegration (long-term) relationships. It is worth laying emphasis on the fact, physical capital is used as a control variable for robustness checks in order to control for the 'physical capital-led investment hypothesis (nexus)'. From the table it could be observed that in the long-term, population would: decrease FDI in Ivory Coast, diminish private investment in the Congo Republic and, improve private investment in Swaziland. Moreover, population growth decreases public investment in Ivory Coast and Zambia but not in Swaziland and, domestic investment increases in Sudan and Zambia with positive demographic change. In the short-run, only Ghana and Swaziland experience changes in domestic investment with demographic fluctuations. Not unexpected, there is overwhelming absence of significant short-term causalities (which confirms my expectation that demographic changes have long-run economic effects for the most part).

Accordingly, I expected all investment dynamics (opportunities) to increase with population, with more significant population growth elasticities of private and foreign

investments (in comparison to public investment). This difference in expectations draws from the effects of structural adjustment policies. In other words, policies imposed by the IMF and World Bank in the mid 1980s (that glorified privatization and liberalization and cautioned a reduced influence of governments in the running of the economies) are expected to substantially reduce public investment in comparison to private investment.

The following elaborate discussions pertain to country-specific findings. (1) Elasticities for Ivory Coast have unexpected negative signs with regard to foreign and public investments. These could be explained from global economic and foreign investment standpoints. From a global view, public investment has decreased since the 1970s. Whereas per capita income grew 82% in the 1960s (reaching a peak of 360%), it also shrank respectively by 28% and 22% in the 1980s and 1990s (GlobalTenders, 2013). The 1994 devaluation of the CFA franc only further depreciated public investment values. Hence, this decrease in public investment with respect to population growth is quite comprehensive. Looking at the foreign investment perspective, the substantial evidence of diminishing FDI (which constitutes between 40-45% of the total capital of Ivorian firms) could be explained through the key role played by France (which contributes around the neighborhood of 55-60% of the total capital in Ivorian firms). At the turn of the millennium, Ivorian political crisis spurred anti-French sentiments which have led to a massive exodus of French citizens and correspondingly, FDI outflows from the country. (2) The positive elasticities in public and private spending for Swaziland could be elucidated from its substantial spending in the 1990s. A great chunk of the increased spending could be traceable to current expenditures related to wages, transfers and subsidies (which ultimately improve conditions for population growth in the absence of birth control policies). Accordingly, Swaziland has one of the highest levels of public spending in the African continent, with a wage bill of over 15% of GDP (representing more than 55% of public spending). (3) In Zambia, depletion of public spending and increase

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

The following could be noted as regards policy implications. (1) Ivory Coast should consider serious reforms in a bid to create a positive atmosphere for the attraction of foreign investments. Accordingly, the same recommendation applies for private investment. If nothing is done, based on the empirical weight of the findings, it is likely that the country would face even more political instability due to rising unemployment (as the unemployed youth cold recourse to crime and factional interests) which would seriously compromise national unity, peace and security. (2) Swaziland should adopt public spending reduction measures. As I have earlier emphasized, over 55% of its public spending is on wage bills. In the long-run, the government cannot accommodate rising unemployment by constantly increasing its wage bill. The fact that her coffers are already running dry today should serve as a warning signal. Hence, policy measures that target the substitution of public investment for private and foreign investments will substantially be beneficial to the kingdom in a distant future. (3) Zambia should continue on its path of reforms, giving priority to foreign and private investments. Broad policy recommendations for sampled countries include: the need for measures that encourage family planning and creation of an appealing investment climate (and ease of doing business) for private and foreign investments.

4.5.2 Caveats and future directions

As far as I know, the absence of literature dedicated to examining the bearing of demographic change on investment dynamics makes my results less comparable. However

my findings are broadly consistent with the need for other forms of investments documented in the African business (Rolfe & Woodward, 2004; Alagidede, 2008; Bartels et al., 2009; Tuomi , 2011; Kolstad & Wiig, 2011; Darley, 2012; Asongu, 2012) and recent population (Asongu, 2013b) literature. In this study, I have only considered demographic determinants of aggregate investment dynamics. However in the real world, investment is endogenous to a complex set of variables. From a broad viewpoint, the link between population growth and investment is an essential part of a certain wider phenomenon. It is scarcely possible to conceive this linkage as occurring in isolation because; they are intimately bound with other factors (like progress in health care and technological change). Therefore, it would be interesting to replicate the analysis in a multivariate VAR context.

Another future research direction could entail analyzing the human capital factor in productivity from an age-dynamic perspective, so that a better account of investment-factor productivity with respect to age-structured work-force is brought to light. Accordingly, my analysis is entirely limited to the quantity of labour force. However, I believe a parallel analysis based on the quality of labour force with parameters like 'type of secondary education' and 'health care' (among others), could provide more insights into this phenomenon. It could be quite challenging to measure skills, so we recommend Lall (1990) for a unique opportunity to provide first-hand account by building a proxy using school attainments at the primary and secondary levels (or any other proxy) in future analysis (Asongu, 2013b).

5. Conclusion

The objective of this study was to provide policy makers with some insights on how future investment opportunities could help manage rising population growth and corresponding unemployment. In the assessing the population-investment nexus, I have used vector autoregressive models. The findings have established that, 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.

The following implications have resulted from the findings: (1) Ivory Coast should consider serious reforms in a bid to create a positive atmosphere for the attraction of foreign and private investments; (2) Swaziland should adopt public spending reduction initiatives and policy measures designed to target the substitution of public investment for private and foreign investments will substantially be beneficial to the kingdom in the long-term; (3) Zambia should continue on its path of reforms, giving priority to foreign and private investments and; (4) broad policy recommendations for sampled countries include, the need for measures that encourage family planning and the creation of an appealing investment climate (and ease of doing business) for private and foreign investments. It would be interesting to replicate the analysis in a multivariate VAR context because I have only considered demographic determinants of aggregate investment dynamics. Another future research direction could entail analyzing the human capital factor in productivity from an age-dynamic perspective so that a better account of investment-factor productivity with respect to age-structured work-force is brought to light.

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