DOES GREEN INVESTMENT RAISE PRODUCTIVITY?[1]

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Abstract

Applying the dynamic generalized method of moments estimator to a panel of 46 African countries over the period of 1985 through 2007, we find that green investment lowers aggregate productivity growth. Indeed, on average, a one percent increase in our measure of green investment is associated with a 0.23 percentage point decline in productivity growth. To the best of our knowledge, this paper is the first to present aggregate evidence of the impacts of green investment on productivity.

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[1] This paper was initially titled "Growth Implications of Firm Level Productivity: The Role of Green Economy in our Sub-Saharan African Countries"

[2] International Monetary Fund. **The views in this paper should not be reported as representing the views of the IMF. The views expressed in this paper are those of the author and do not necessarily represent those of the IMF or IMF policy.**

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I. INTRODUCTION

Since the Brundtland Report (1987), the concept of sustainable development, defined as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, has been an important concern for policy makers and economists. The development strategies adopted by the now developed countries and the now emerging economies may have been, and may continue to be, detrimental to the environment. The levels of greenhouse gases and carbon dioxide in the atmosphere have risen considerably since the industrial revolution. Indeed, in 30 years, Earth resources have decreased by 30%.[4] Energy is responsible for more than 60% of the CO2 emitted into the atmosphere each year according to the International Plant Protection Convention (IPPC).

It is true that developed and emerging economies have succeeded in putting in place industrialized economies, stronger institutions, and better standards of living for their population. However, this development has had a toll on the climate to the point where 60% of the world ecosystem has been negatively affected. It is no longer a doubt that climate change is one of the most severe problems we are facing today. Therefore, the need to change over a low-carbon economy cannot be ignored.

The environmental economics literature has been particularly booming over the last decade. The recurrent theme is to what extent pollutants emissions vary with development. The potential adverse consequences of climate change, resulting in part from greenhouse emissions, have led to an ardent pursuit of transformative economic, social, and environmental policies geared toward a more sustainable development based on the so called Green Economy. The need for these policies can be particularly important in the context of economies in Africa. Indeed, the potential for the economies in many African countries to benefit from green investment is greater today than ever before. This is in part due to the availability of efficient and nascent green technologies, as well as policies that can be used to further the pursuit of sustainable development.

Before adopting these technologies and implementing greenhouse emission reduction policies, it is important to statistically know the nature of the relationship between green investment and economic activity. This is particularly important given that most African countries are developing countries in need of industrialization in their quest for higher standards of living. One important question to ask is whether green investment raises productivity growth?

There are multiple ways to answer this question. One way is to look at disaggregated data and analyze the relation between firm or sectoral green investment and productivity. However, the lack of firm and sectoral data on green investment in African countries makes statistical

[4] http://www.donnees-environnement.com/chiffres-climat.php#monde

analysis impossible. Another way is to do aggregate analysis by looking at the impacts of country level measures of green investment on economic growth.

In this paper, and due to data constraints, we adopt the later part. More specifically, we use country level ecological footprint as a measure of green investment and apply the Arellano and Bond dynamic one-step GMM estimator to statistically evaluate the impacts of green investment on economic growth. Ecological footprint is defined as "the demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources used and to absorb waste produced"[5]. Ecological footprint is an indicator reflecting national and global sustainable development. It shows the effect that people of a country have on the environment they live in and on natural resources. The rationale for using ecological footprint as a proxy for green investment is as follows. We interpret a decrease in this variable as a reduction in the aforementioned demand on the biosphere and this decrease would be synonymous to relieving the pressures on the environment which can be translated into lower carbon emission.

Applying the Arellano and Bond dynamic GMM estimator to a panel of 46 African countries over the period of 1985 to 2007, chosen based on data availability constraints; we find that green investment is detrimental to productivity growth. Indeed, a 1 percent increase in green investment (to be understood as a decline in the measure of ecological footprint) is associated with a 0.23 percentage point decline in productivity growth.

The result is more in line with the view that reducing the environmental impact of economic and social activity can be costly to growth. This is especially important in the case of African countries, the bulk of which are developing countries. The result highlights the tough choices facing these countries. On the one hand these countries need to comply with the Kyoto protocol and in so doing they may see their productivity growth suffer. On the other hand, not complying with humanity's needs for sustainable growth will spare these countries from growth losses, in their quest for industrialization, while putting the climate at a greater risk.

We structure this paper as follows. In the next section, we present a brief review of the literature. In section three, we discuss the methodology adopted as well as the data used. In section four, we present and discuss the results before concluding in section five.

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[5] Living planet report 2006 available on http://www.footprintnetwork.org/newsletters/gfn_blast_0610.html

II. LITERATURE REVIEW

The current models of economic development, arguably based on excessive consumption of non renewable natural resources have put a dent on the process of wealth creation. Face with this reality, environmental concerns have become a major focus of the international community. How to pursue development strategies while conserving the environment? The response to this critical question requires taking into account the role of the environment in models of long-term economic development.

The link between economic growth and the environment is now an integral part of economic research programs. Although there exist an abundant literature on the determinants of economic growth, the rapid socio-economic and environmental changes that the world faces has created the conditions for an avid research interests on this topic.

One strand of literature on economics of ecology argues that for a sustainable growth, the production models should be based on an optimal combination of human, physical, and natural capital. Another strand puts an emphasis on the role of natural capital in the process of wealth accumulation. This strand argues that the current development models lead to an increase in rural poverty -- the rationale being that the majority of the world population lives in rural areas. In rural areas, people are heavily dependent on natural capital and the depletion of this capital through the intensive use of the ecosystem is detrimental to their standards of living.

It is under these circumstances that a movement, now termed "green" economy or "green" growth, came into existence at a 1992 conference on environment and development in Rio. The United Nations Environment Programme (UNEP) defines "green" economy as an "economy that leads to improved standards of living while preserving the environment". This model puts an emphasis on the protection of the ecosystem, the efficient management of natural resources, and on job and wealth creation through investments that minimize CO2 emission and pollution.

These types of investments belong to the family of "socially responsible" investments. Such investments go beyond the concepts of rates of return in that they are also based on ethical, environmental, social and governance criteria.

However, these "green" investments pose serious challenges not only to industrialized countries but also to African countries. Many African countries rely heavily on agriculture, which is responsible for 30% of green house gas emission. Investing in environmentally friendly equipment requires heavy upfront costs and the transition from the existing mode of production to the new one requires complementary technical innovation as well as organizational transformation that may lead to a reboot of the entire economic system.

The literature on the link between investment (in human or physical capital) and growth is large. We will not do justice to this literature by attempting to regurgitate here what scholars have written on the topic. Nevertheless, the link between investment, in general, and growth is generally positive (Bouoiyour et al, 2009).

To the best of our knowledge, the literature on the link between green investment and growth does not abound. The few papers written on the topic can be put in two categories, one that finds a detrimental role of green investment on growth and another that argues that green investment is favorable to growth (Soparnot and Mathieu, 2006).

In the first category, the research focuses on types of investments and firm productivity. In this strand, green investment undertaken to satisfy environmental regulations have negative impacts on firm productivity. Econometric study of the private sector shows that 16 percent of the decline in productivity growth could be attribute to environmental regulations (Denison 1979). (Chritiansen and Haveman, 1981; Gollop and Roberts, 1983; Dufour, Lanoie and Patry, 1992). They argue that environmental regulations reduce countries' productivity because of the efficiency costs associated with implementing environmental regulations.

In the second category, green investment improves firm's competitiveness and profitability through the process of modernization, a socially responsible image, an access to new markets and a reduction of wasteful practices (Porter, 1991). Porter and Linde (1995) find that firms that invest in green technologies improve their international competitiveness. This is accomplished through the process of innovations that create efficient modes of production hence improving their productivity. In addition, Amara et al (1999), in their study of agricultural sector, find a positive link between efficient production techniques and the adoption of environmentally friendly techniques of production leading to reduction of water pollution and soil degradation. Another author, Turky (2003), show various ways in which green investment affect firm level performance. Using a survey of 33 Tunisian industrial firms, Turky finds the effect of green investment depends on firm's size, environmental technologies available, and the degree to which the firm is environmentally integrated.

There is an additional strand of literature which looks at the link between ecological degradation and environmental performance. The focus in this literature is mostly on the use of environmental impacts indicators such as carbon dioxide emissions, deforestation, loss of forest land, and water depletion among others.

For example, Ozler and Obach (2009) use the ecological footprint to identify the role of state and economic institution in environmental performance. They found that the more capitalist a state is, the greater its environmental impact is likely to be, even controlling for such factors as per capita GDP. They also find that the level of regulation in a state had a significant impact on its per capita ecological footprint.

In this study, we use ecological footprint as a proxy for green investment. Our paper differs from Ozler and Obach (2009) in that we use country-level aggregate data to estimate the impacts of green investment on productivity.

Given the emphasis on the role green investment on growth and given that many African countries are considering a transformation into a green economy, it is crucial to statistically evaluate the role of green investment in economic growth. Ideally, one would use data on firm level productivity and augment that with firm level measures of green investment to estimate the effect. However, the lack of firm level data on green investment limits this option. As an alternative, we analyze the effects of green investment on growth using aggregate data and applying appropriate econometric techniques. The next section describes the methodology adopted as well as the data used in the estimation.

III. METHODOLOGY AND DATA

1. Methodology

To estimate the effect of Green investment on productivity growth, we use the following specification:

$$y_{i,t} = \alpha + \beta_0 y_{i,t-1} + \sum_{i=1}^{K} \beta_i X_{k,i\,t} + \gamma GInv_{it} + \varepsilon_{it} \quad (1)$$

$$\varepsilon_{i,t} = \vartheta_i + \mu_{i,t} \ (2)$$

where the level of productivity, for country *i* and at time *t*, is assumed to be a function of its lagged value, a set of variables known to be its determinants ($X_{i,t}$), the level of Green Investment ($GInv_{i,t}$), and an error term ($\varepsilon_{i,t}$). The disturbance term presented in equation (2) is a function of a country time invariant effect (or fixed effect, ϑ_i) and an idiosyncratic time varying shock ($\mu_{i,t}$). We follow the existing literature and set the control variables to include inflation and government expenditures, trade openness, foreign direct investment, the quality of the labor force, female labor participation, and an institutional quality variable.

One can estimate equation (1) using ordinary least square (OLS). However, such approach would produce spurious results because of three potential problems. The first is reverse causation from productivity to the explanatory variables, the second is the presence of country specific time invariant effect that a simple OLS will not account for, and the third issue relate to the presence of lagged dependent variable on the left hand side. The latter issue pertains to the presence of auto-correlated errors. One way to deal with the first and second problems is the use of fixed effect instrumental variable regression whereby exogenous instruments are used. However, strictly exogenous variables are hard to come by. The third problem can also be accounted for by using lagged values of the autoregressive component in a modified representation of equation (1), which amounts to estimating equation (3).

$$\Delta y_{i,t} = \beta_0 \Delta y_{i,t-1} + \sum_{i=1}^{K} \beta_k \Delta X_{i,t}^{k} + \gamma \Delta GInv_{i,t} + \mu_{i,t} \quad (3)$$

However, estimating equation (3) is not free of pitfalls either. One would like to capture the dynamic relationship between the main explanatory variable and the dependent variable. This can be accomplished by applying the Arellano et al (1991, 1995). This estimator has the following advantages. First, it removes the country specific fixed effect through differencing. Second, it takes care of the potential parameter inconsistency that arises from simultaneity bias when lagged dependent values of the original regressors are used as instruments (Beck and Levine, 2004). Third, it takes care of simultaneity of productivity growth, in the case of this paper, and the determinants of productivity growth while controlling for country specific effect.

Given these advantages, we apply this dynamic panel generalized method of moments' estimator to a set of 46 African countries over the period of 1985-2007 to evaluate the effects of green investment on productivity growth, controlling for the known determinants of productivity. There are 7 known determinants of productivity that the existing literature uses (although the list presented here may not be exhaustive). These are macroeconomic indicators (inflation and government expenditures in percent of GDP), trade openness, foreign direct investment, the quality of the labor force, the participation of women in the labor force, and the quality of a country's institutions (Edwards, 1997; Barro, 2001; and Acemoglu et al., 2004). It is worth noting that there is no clear consensus in the literature whether these determinants each has a positive or negative effect on productivity. However, one would expect inflation to have a negative effect on productivity, government spending to go both ways depending on its composition, trade openness and/or foreign direct investment to have a positive effect through knowledge spillover and in the presence of complementary policies (Dollar and Kray, 2004), higher labor quality, good institutions, and a higher female labor participation to have a positive effects.

For our main explanatory variable, we are not aware of existing work that focuses on the aggregate effects of green investment on productivity. Therefore, we let the data tell us what the relationship is. At the aggregate level, green investment may or may not boost productivity depending on how such investment is implemented. If the investment improves the efficiency of production factors, we may experience a boost in productivity. If green investment is economically costly, productivity growth may suffer despite the potential ecological benefits of such investments.

In the next sub-section, we describe the data used in this paper.

2. Data

The main data we use come from two sources, the World Bank World Development Indicators (WDI) and the United Nations Environment Programme Global Environment Outlook. The macroeconomic variables (real GDP per worker, trade openness, foreign direct investment, female labor force participation, primary completion rate, government expenditures, and inflation) are from the first source, while data on CO2 emission and ecological footprint are from the second source. We augment this data with a variable that measures a country's institutional quality. This variable is from the Polity IV project and we use the measure of constraint on the executive as our proxy for institutional quality.

We use real GDP per worker as our measure of productivity and a country's ecological footprint as our measure of the extent to which the country implements green investment. Given that this second variable is the main focus of this analysis, it is worth describing it in detail and explaining our rationale for using it.

A country's ecological footprint is defined as its "demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources we use and to absorb our waste"[6] We argue that this measure is indicative of the degree of a country's green investment. A reduction of a country's ecological footprint is closely related, we argue, to how much green investment it undertakes. High green investment would translate into a lower ecological footprint and vice versa.

The ecological footprint is an aggregate measure of consumption, expressed in equivalent land area that is needed for food, resources, energy, and carbon dioxide emissions as a result of human activity.[7] Thus ecological footprint accounts for the necessary productive space required to sustain a country's total consumption and the assimilation of its waste, given the prevailing technology in use. Ecological footprint therefore does not account for potential technological advances in the future when generating footprint data in terms of equivalent land area (Wackernagel et al. (2005). However, we assume that since this static account presents a yearly picture of ecological demand and supply, it may capture annual changes in available technologies and management.

In the estimation, we use the deviation of a country's measure of ecological footprint from that of Africa to measure whether a country is operating above or below the threshold. We call this measure ecological footprint balance. If a country has ecological footprint surplus (deficit), it is operating above (below) the threshold and this is indicative of how low (high) its degree or level of green investment is relative to the continent's average.

All the macroeconomic indicators are in percent of GDP. The measure of CO2 emission is in per capita terms. Ecological footprint variable is produced in hectare per person.

Figure 1 plots period average levels of ecological footprint balance against growth rate of real GDP per capita. We focus on the period of 1985-2007 due to data availability constraints. As can be seen from the figure, the two are positively related. Figure 2 plots the average level of

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[6] http://www.footprintnetwork.org/newsletters/gfn_blast_0610.html

[7] Definition taken from the Global Footprint Network: http://www.footprintnetwork.org.

ecological footprint against real GDP per capita growth and there too we see a positive relationship. However, as mentioned in the methodology section, this positive relationship does not on its own tell us the direction of causation. It could be that higher growth of GDP per capita leads to a higher ecological footprint or that a higher ecological footprint leads to higher real GDP per capita growth. To accurately determine the relationship between the two, we need to apply appropriate techniques.

A look at table 1 reveals that countries with high ecological footprint are the biggest polluters. This should not come as a surprise, however, given that those countries that demand more resources tend to also produce higher proportions of green house gas emission.[8]

[8] Also, we find a strong and statistically significant relationship between ecological footprint and CO2 emission. Results are available upon request.

Figure 1.

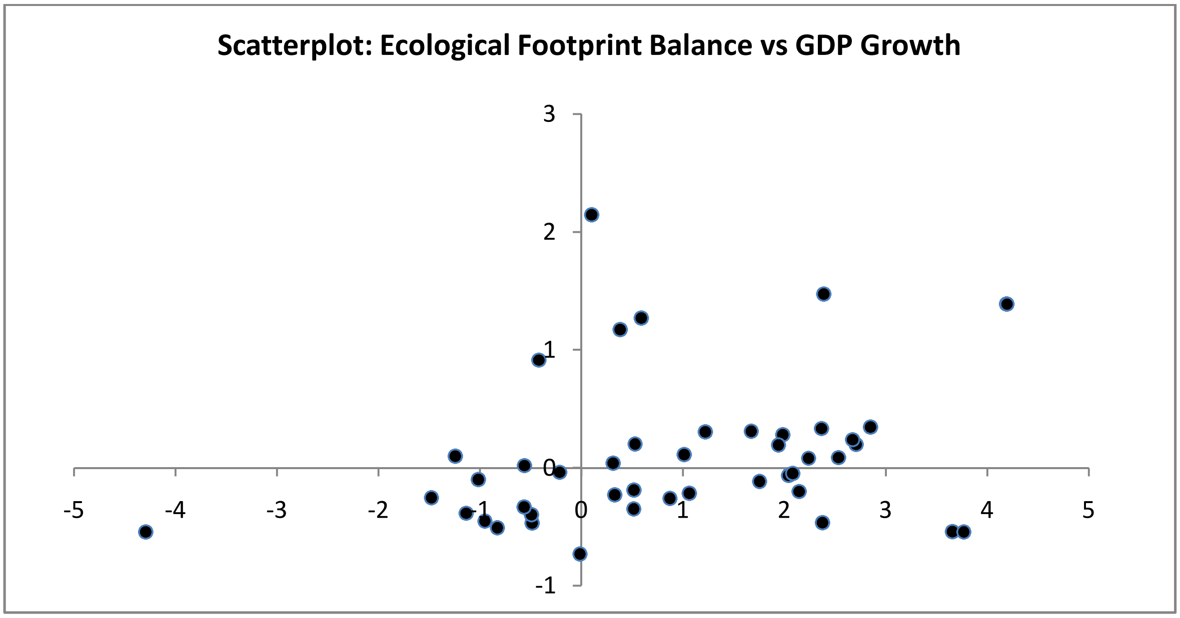

Figure 2.

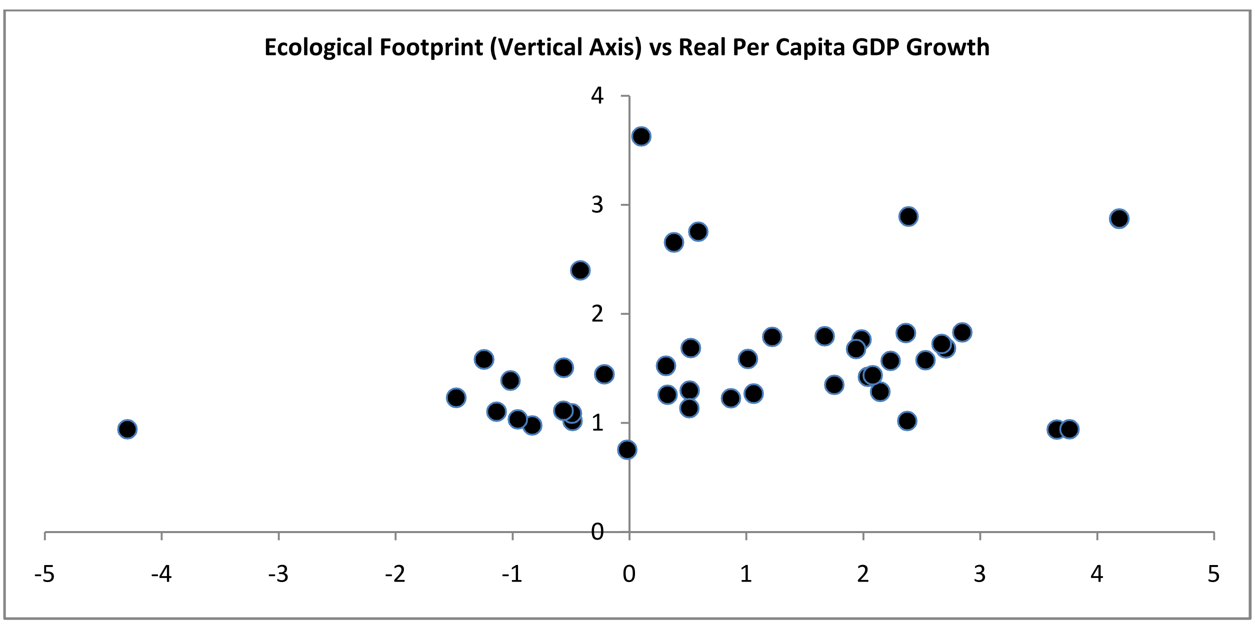

Table 1. Country averages (1985-2007): Growth Rate of Real GDP per capita, Ecological Footprint (EcoFP) and CO2 Emission per capita. EcoFP balance stands for the deviation of a country's ecological footprint from the continent's (a negative value implies that the country is below the continent's threshold). The countries are ranked by per capita CO2 emission in descending order.

Country	GDP Growth	EcoFP	EcoFP (Africa)	EcoFP (Balance)	CO2 Emission
Libya	**2.39**	**2.89**	**1.48**	**1.47**	**9.34**
South Africa	**0.38**	**2.66**	**1.48**	**1.17**	**9.08**
Gabon	**-0.21**	**1.45**	**1.48**	**-0.04**	**3.57**
Algeria	**0.31**	**1.52**	**1.48**	**0.04**	**3.52**
Botswana	**4.19**	**2.87**	**1.48**	**1.39**	**2.03**
Tunisia	**2.71**	**1.68**	**1.48**	**0.20**	**1.91**
Mauritius	**4.19**	**2.87**	**1.48**	**1.39**	**1.83**
Egypt, Arab Rep.	**2.24**	**1.57**	**1.48**	**0.08**	**1.64**
Zimbabwe	**-1.02**	**1.39**	**1.48**	**-0.10**	**1.25**
Morocco	**2.15**	**1.29**	**1.48**	**-0.20**	**1.13**
Mauritania	**0.59**	**2.75**	**1.48**	**1.27**	**0.93**
Namibia	**1.22**	**1.79**	**1.48**	**0.31**	**0.86**
Swaziland	**2.53**	**1.57**	**1.48**	**0.09**	**0.73**
Angola	**3.66**	**0.94**	**1.48**	**-0.54**	**0.70**
Nigeria	**2.04**	**1.42**	**1.48**	**-0.06**	**0.58**
Congo, Rep.	**-0.83**	**0.98**	**1.48**	**-0.51**	**0.50**
Cote d'Ivoire	**-1.48**	**1.23**	**1.48**	**-0.25**	**0.47**
Senegal	**0.53**	**1.69**	**1.48**	**0.20**	**0.42**
Ghana	**2.08**	**1.44**	**1.48**	**-0.05**	**0.31**
Kenya	**0.52**	**1.30**	**1.48**	**-0.19**	**0.27**
Zambia	**-0.49**	**1.02**	**1.48**	**-0.47**	**0.26**
Cameroon	**-1.14**	**1.10**	**1.48**	**-0.38**	**0.26**
Benin	**0.51**	**1.13**	**1.48**	**-0.35**	**0.23**
Togo	**-0.49**	**1.09**	**1.48**	**-0.40**	**0.22**
Gambia, The	**0.10**	**3.63**	**1.48**	**2.14**	**0.21**
Guinea-Bissau	**0.87**	**1.22**	**1.48**	**-0.26**	**0.21**
Sudan	**2.85**	**1.83**	**1.48**	**0.35**	**0.19**
Sierra Leone	**0.33**	**1.26**	**1.48**	**-0.23**	**0.17**
Guinea	**1.01**	**1.59**	**1.48**	**0.11**	**0.16**
Eritrea	**-0.56**	**1.11**	**1.48**	**-0.33**	**0.15**
Madagascar	**-0.56**	**1.50**	**1.48**	**0.02**	**0.11**
Niger	**-0.42**	**2.40**	**1.48**	**0.92**	**0.10**
Tanzania	**1.75**	**1.35**	**1.48**	**-0.12**	**0.10**
Rwanda	**2.38**	**1.02**	**1.48**	**-0.47**	**0.09**

Table 1. (Continued) Country averages (1985-2007): Growth Rate of Real GDP per capita, Ecological Footprint (EcoFP) and CO2 Emission per capita. EcoFP balance stands for the deviation of a country's ecological footprint from the continent's (a negative value implies that the country is below the continent's threshold). The countries are ranked by per capita CO2 emission in descending order.

Country	**GDP Growth**	**EcoFP**	**EcoFP (Africa)**	**EcoFP (Balance)**	**CO2 Emission**
Mozambique	**3.76**	**0.94**	**1.48**	**-0.54**	**0.08**
Burkina Faso	**1.99**	**1.76**	**1.48**	**0.28**	**0.08**
Malawi	**-0.02**	**0.75**	**1.48**	**-0.73**	**0.07**
Central African Republic	**-1.24**	**1.58**	**1.48**	**0.10**	**0.07**
Congo, Dem. Rep.	**-4.29**	**0.94**	**1.48**	**-0.54**	**0.07**
Ethiopia	**1.06**	**1.27**	**1.48**	**-0.22**	**0.07**
Uganda	**2.67**	**1.72**	**1.48**	**0.24**	**0.06**
Mali	**1.67**	**1.79**	**1.48**	**0.31**	**0.05**
Burundi	**-0.95**	**1.03**	**1.48**	**-0.45**	**0.04**
Chad	**2.37**	**1.82**	**1.48**	**0.34**	**0.02**
Lesotho	**1.94**	**1.68**	**1.48**	**0.19**	

IV. RESULTS

Table 2 presents the estimation results. In addition to the dynamic GMM estimator, we decided to also report the fixed and random effects estimation results for comparison purposes. We obtain more significant coefficients using a random effect estimator. This is not surprising given that random effect estimators lead to more efficiency. The green investment coefficient is significant in the random effect estimation while insignificant in the fixed estimation. We perform a Hausman specification test to determine whether the data favor fixed over random effect. The test result favors the alternative hypothesis that the two estimation results are not similar and therefore the coefficients under the fixed effect estimation are more consistent.

However, recall from the methodology section that applying the fixed effect estimation to the specification in this paper will produce spurious results since our model contains a lagged dependent variable. Therefore, we focus our analysis to the results obtained from using the Arellano and Bond one-step GMM estimator reported in column (1) of table 2.

The main coefficient of interest, Green Investment, is positive and significant at the 10% level. What this tells us is that a 1% decline of a country's level of ecological footprint from the continent's level will lead to a 0.23 percentage point decrease in productivity growth. This result is more in line with the view that green investment is costly in that it may lower growth. However, this result should be taken with caution since the variable we are using to measure green investment does not represent actual investments. Nevertheless, it is worth highlighting the potential risks of widespread green investments.

It could be that, as shown in Turky (2003) at the firm level, the benefits of green investments depend on the country's ability to efficiently adopt green technologies. For example, a country with a higher level of technological knowhow is better positioned to reap the benefits of green investments. One way to account for this is to introduce a measure of country specific technological capabilities and interact that with our measure of green investment to see whether the results change.[9]

Most of the control variables' coefficients have the expected sign and some are significant. Openness, measured as trade in percent of GDP, has a negative but insignificant effect. The effect is essentially zero highlighting the irrelevance of trade in productivity enhancement. Government expenditures enter with a negative sign also but the effect is statistically not different from zero. There is no consensus in the existing literature as to the true effect of government expenditures so this result should not come as a surprise. Foreign direct investment has a positive but insignificant effect. As in the government spending case, the role

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[9] We are in the process of integrating an NBER database of technology adoption constructed by Comin and Hobijn (2009b) with the data we have to check the validity of our assertion.

of FDI in growth is ambiguous as suggested by Alfaro et al. (2009). As for the measure of institutional quality, the Polity IV constraint on the executive has a positive but insignificant effect.

Table 2. Preliminary Results. Numbers in parenthesis below the coefficients are standard errors. The stars (3, 2, 1) correspond to significance at the 1, 5, and 10% level, respectively. We ran the estimation on a sample that covers the period of 1985-2007 for 46 African countries.

Dependent Variable: Productivity Growth			
	Dynamic GMM	Fixed Effect	Random Effect
	(1)	(2)	(3)
Lagged Productivity Growth	0.71***	-0.02	0.15**
	(0.0436)	(0.0541)	(0.0508)
Openness	-0.00	0.03	0.04*
	(0.0256)	(0.0193)	(0.0195)
Government Expenditures	-0.12	-0.06**	-0.06***
	(0.0877)	(0.0168)	(0.0163)
Foreign Direct Investment	0.16	0.00	-0.00
	(0.1171)	(0.0021)	(0.0021)
Inflation	-0.06*	-0.00	-0.01
	(0.0329)	(0.0272)	(0.0209)
Labor Quality	0.15**	0.06*	0.06*
	(0.0493)	(0.0225)	(0.0226)
Female Participation	0.78**	-0.75***	-0.75***
	(0.2895)	(0.1806)	(0.1732)
Institutional Quality	0.42	0.10	0.24*
	(0.2871)	(0.2012)	(0.1162)
Green Investment	0.23*	0.19	0.76*
	(0.1334)	(0.7156)	(0.3602)

The only control variables that significantly affect productivity growth are inflation, labor quality and female labor force participation. Inflation has the expected sign. Researchers have argued that higher inflation rates tend to negatively affect the economic performance of a country. High inflation rates are sources of macroeconomic instability which in turn is detrimental to growth. Labor quality, measured by primary completion rate, has a positive and significant effect on growth. This confirms existing findings that labor quality plays an important role in growth.[10] Female labor participation also has a positive and significant effect indicating the importance of integrating women in the labor force.

[10] It would be interesting to interact labor quality with FDI and trade openness to see whether results change.

V. CONCLUSION

This paper studies the impacts of green investment on productivity growth. Using data for 46 African countries and over the period of 1985 through 2007, we apply the Arellano and Bond one-step GMM estimator and find green investment to be detrimental to productivity growth. Indeed, a one percent increase in our measure of green investment, relative to continent's average, is associated with a significant 0.23 percentage point decline in productivity growth.

Given the enthusiasm surrounding the idea of green economy in many African countries, this significant result calls for a cautious approach in attempting large scale investments in green technologies. The result is more in line with the view that reducing the environmental impact of economic and social activity can be costly to growth. This is especially important in the case of African countries, the bulk of which are developing countries. The result highlights the tough choices facing these countries. On the hand these countries need to comply with the Kyoto protocol and in doing so, they may see their productivity growth suffer unwanted consequences. On the other hand, not complying with humanity's needs for sustainable growth will spare these countries from growth losses, in their quest for industrialization, while putting the climate at a greater risk.

We should mention that our result should be interpreted with caution. The variable we call green investment is a measure of countries ecological footprint. We argue that this variable is inversely related to a country's degree of green investment in that a higher level of ecological footprint is synonymous to a lower level of green investment. Realistically, this approach is debatable, which is why our results should be approached with caution.

We plan to complement the version of this paper with case studies a la Turky (2003) and look at firm and/or sectoral implications of green investment. To do so, we will analyze instances where firms or specific sectors in African countries adopted green technologies and evaluate the productivity outcomes.

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