Does international financial integration increase the standard of living in Africa? A frontier approach

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Abstract

We investigate whether a higher financial integration with the rest of the world can help the African countries reduce their production inefficiency and/or push up their efficient frontier of production. We use two alternative empirical approaches based, respectively, on a stochastic frontier analysis and quantile regressions. We provide evidence of heterogeneous situations across countries and time. This paper proposes a new approach for defining, at the aggregate level, a link between financial openness and production efficiency. We show that one size does not fit all: international financial integration can increase or decrease African countries' standard of living.

Keywords: African countries, Financial openness, Stochastic frontier, Quantile regression.
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1. Introduction

This paper proposes an alternative view on the way we analyze the effects of financial integration on GDP per-capita in Africa. The papers traditionally focus on the effects on *growth*. However, higher growth rates do not necessarily have potential for reducing poverty. As shown in Figure A1 (World bank, 2018), many least developed countries recorded a positive growth rate in the last decade, but few of them have achieved the SDG (Sustainable Development Goal 8.1) target of 7% growth per year. Moreover, their GDP per-capita growths are clearly smaller than their economic growth. Even in the case of a virtuous circle in the financial integration/growth link, GDP per-capita can remain low relative to the level it could potentially reach. Thus, this paper investigates whether financial integration can help the African countries reach a higher level of GDP per-capita that corresponds to a more efficient production level. "Financial integration" is normally a phenomenon in which a country's financial market is closely linked to global or regional markets, induced by increasing cross-border capital flows as a form of foreign direct investment (FDI), portfolio investment and foreign claims. However, the role of external financing in Africa is not same as that of other regions because many of developing African countries receive also foreign aid and remittances. Thus, in our paper, financial integration is interpreted in a broader sense as a phenomenon induced by private capital inflows, aids, and remittances. Our concept of efficiency relates to production frontier which is usually considered in the microeconomic literature and that we apply here to a macroeconomic context. The questions examined here are the following. Does financial integration matter to enhance the African countries' boundaries of aggregate production performance? Is international financial integration a barrier that cannot be overlooked to scale-up production efficiency? To what extent does a facilitated access to international financial markets induce gains from reducing production gap inefficiencies?

Why does this paper focus on production efficiency? In the African countries, the growth rates are too volatile and subject to significant shifts over time. GDP per-capita provides a better indication of changes occurring in a country's standard of living (which is the key issue when countries are poor). From this standpoint, the outer limit of GDP per-capita can be considered as a proxy of the "macroeconomic" production frontier. This frontier is a structural indicator of how well a country is doing in elevating its standard of living.

The microeconomic works show that capital inflows promote higher productivity gains through a variety of channels: intra and inter-sectoral diffusion effects, imitation effects favoring incremental innovations, learning by doing (see, for example, Newman et al., 2015; Moran, 2011). In terms of efficiency, at the macroeconomic level, financial integration can promote a higher GDP per-capita in several ways. First, FDI can improve companies' know-how when they are carried out in the form of joint-ventures. Second, official development assistance (ODA, public transfers received from bilateral and multilateral donors) often include a technical assistance component leading to share experiences based on best practices. Third, remittances are used to pay for access to health or education, thereby

paving the way to an improvement of human capital and increasing total factor productivity. Thus, the production efficiency approach is a good way of capturing the compositional effects of productivity changes at the aggregate level.

Meanwhile, an increasing reliance on foreign capital can also reduce production efficiency. For instance, this happens when portfolio investment inflows outstrip the need of the real sector and result in negative externalities in terms of misallocation of resources (superfluous investment). Large flows of capital from foreign banks can surpass the optimal level of credit needed for production. FDI inflows can lead to crowding-out effects, if investments take place in sectors with rent-seeking activities (for example, in case of important natural and mineral resources). An increase in the share of foreign banks' assets out of total bank assets can strengthen the segmentation of credit markets, for example by facilitating the financing of companies already working with foreign partners to the detriment of local firms producing only for the domestic sector.

Since the literature traditionally focuses on growth, not much is known about the financial integration/production efficiency link. Our paper tries to fill this gap. To the best of our knowledge, no existing empirical research has examined this question in a macro-perspective for the African countries. Our proposed estimates aim to test two hypotheses. First, we investigate whether a higher financial integration shifts the economies' production frontier. Secondly, given their optimal frontier, we examine whether a higher financial integration helps the countries to close the gap to the frontier or equivalently to reduce the inefficiency scores. We propose estimates that allows for heterogeneous financial openness-production frontier nexus across countries, working with a panel of 45 African countries over the period 1996-2014. Our modeling strategy consists in the following steps.

We first explore which subsets of explanatory variables have significant effects on GDP per-capita (excluding the financial integration variables). In addition to physical capital, employment and human capital which are the basic inputs for production, there are many other potential explanatory variables that can affect the level of GDP per-capita (policy variables, institutional and governance variables, trade openness, terms of trade shocks, etc.) This raises a problem referred to as "model uncertainty" in the literature, meaning that the number of explanatory variables to select is not predefined. Further, the number of regressions with different combinations of explanatory variables is very high. To deal with this problem, we consider a Bayesian Model Averaging (BMA) technique. This tool has been widely used in the literature on growth empirics, but can also be used when the independent variable is the level of GDP (per-capita). Instead of the usual BMA techniques, we prefer the generalized BMA technique where a distinction is made between the focus variables (here the basic determinants of production like capital, labor and human capital) and the auxiliary variables (the other explanatory variables subject to uncertainty). Further, rather than the standard sequential approach based on pretest estimators, we consider the more robust one-step approach based on the Weighted Average Least-Squares (WALS) estimator. This first step of selecting the appropriate

potential determinants of GDP level is important to avoid omission bias in the production efficiency analysis. We find that GDP per-capita is significantly influenced by the sectoral composition of the GDP, demographic variables, policy variables and a few governance variables.

In a second step, we investigate the effect of financial integration on GDP using stochastic frontier models. Our benchmark model is a neoclassical linearized Cobb-Douglas equation with physical capital, employment and human capital as the basic inputs. The residual is defined as the sum of an error term plus an additional term that measures the shortfall from maximal GDP dictated by the explanatory variables (inefficiency term). We explore the relative importance of the non-financial variables and financial integration variables in reducing or increasing the inefficiency component of the residuals. This means that GDP inefficiency is assumed to change across time and countries according to the non-financial and financial integration variables. An alternative assumption, also investigated in the paper, is that financial integration can shift the production frontier itself. To explore this, we compare the frontiers obtained with and without the financial integration variables.

Our results show evidence of a systematic positive effect of international financial integration on GDP per-capita efficiency scores. First, very few financial integration variables exert an influence on the inefficiency gap. In a majority of countries, FDI inflows contribute to reduce inefficiency, but this positive effect is not shown in the poverty indicators. Second, portfolio equity/debt liabilities together with FDI liabilities drive the production frontiers upward. However, there is a high dispersion across countries. Easing the mobilization of international financial flows does not always strengthen a country's capacity to use a more efficient production technology leading to a higher GDP per-capita. They play against the dominant view that one size fits all. Policymakers cannot draw on the experience of their peers because close financial integration with the rest of the world can be harmful and a hindrance to increase real incomes. The observed heterogeneity in the financial integration/GDP efficiency links also implies that policymakers might be more cautious in moving further to achieve regional financial integration within Africa.

In a third step, we attempt to understand the observed heterogeneity across countries in terms of production efficiency behaviors. Production relationships (captured here by the vector of coefficients of the explanatory variables) are likely to vary at different levels of efficiencies. Maybe the countries with the highest efficiency scores make a better combination of "financial integration" with the other determinants of GDP than those with lower efficiency rates. One way of investigating this is to allow parameter heterogeneity in the GDP per-capita equation (which is not possible with the SPF approach). Quantile estimators thus provide us with a complete characterization of the conditional distribution of the frontier because they are robust to outliers in a panel data context. We find that ODA is the financial integration that does not help the countries catching-up with the most efficient ones - in terms of reaching the highest GDP per-capita.

The remainder of the paper is organized as follows. Section 2 presents recent trends on international financial integration in the African countries. Section 3 presents an analysis of the selection of potential determinants of GDP per-capita in Africa. Section 4 contains the stochastic frontier analysis. In Section 5, we present the results based on panel quantile regression. Finally, Section 6 concludes.

2. Financial globalization and standard of living in Africa: a puzzle

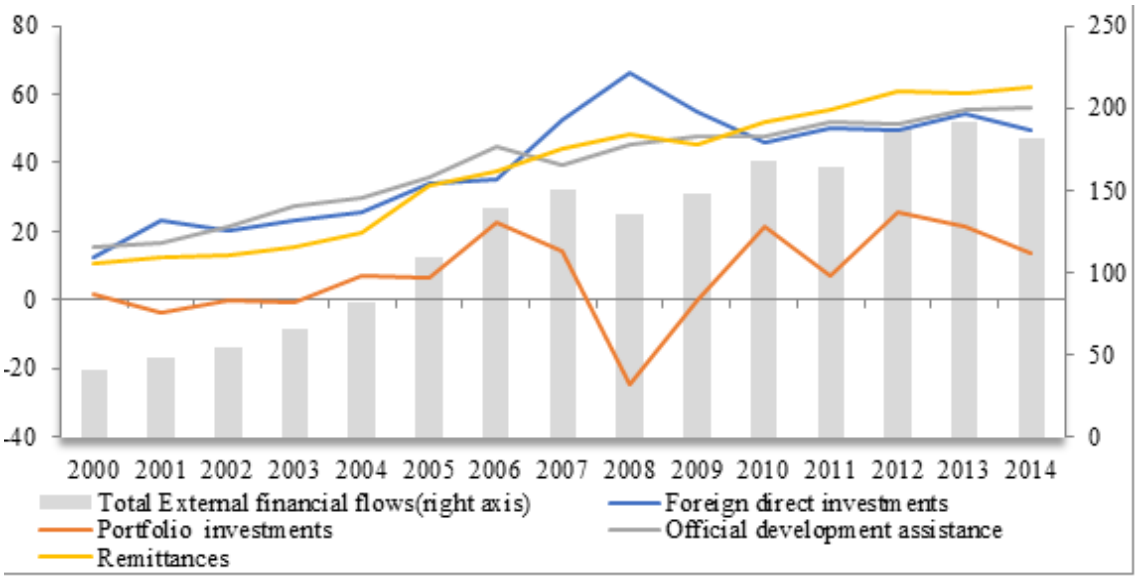
The traditional view of international financial integration in Africa is that it is weak, compared to other emerging countries in Asia or Latin America. The reasons are twofold. First, the level of financial markets development is still weak. This retards financial integration because of the lower performance of commercial banks and financial companies (Lensik and Meesters, 2014) and the weaker absorptive capacity of financial innovations (Ahmed and Mmolainyane, 2014, provide an example for Botswana). Second, financial markets are still fragmented because banks and financial institutions operate in oligopolistic markets. This does not facilitate access to credit (Beck and Honohan, 2008).

However, there is evidence that international financial inflows and cross-border financial transactions have strongly increased since the beginning 2000s. Recent research emphasize that financial globalization has good implications in terms of boosting the productivity in the manufacturing sector (see Okafor et al., 2017) and of favoring the adoption of reforms leading to higher macro-financial stability (Lane, 2016).

When we look at the composition of inflows (Figure 1 from the African Economic Outlook 2015) we see the growing importance of private capital flows, such as FDI, portfolio investments and remittances, but a decline in ODA. FDI (73.5 billion US dollars in 2015) increased five-fold between 2000 and 2012, becoming an important source of investment for Africa and accounting for roughly 20% of the gross fixed capital in this region.

Though the steep increase in FDIs was mainly caused by upsurges in raw materials (in 23 resource-producing countries they account for 70% of the overall FDIs), they began to diversify away from mineral resources to consumer goods and services. Furthermore, in addition to providing tied aid, donor countries are contributing to economic cooperation offered through trade and investment with emphasis placed on efficiency. As a result, between 2007 and 2009, a shift from aid to investment became clear, with the total value of external financial flows into Africa in the form of FDIs exceeding the total value of ODA.

Figure1: External financial flows to Africa, 2000-2014



Did higher international financial integration lead to higher standards of living? For purpose of illustration, we plot some graphs showing the correlation between two indicators of poverty and external liabilities (Figure 2). We consider a multidimensional poverty index (MDPI), taken from the UNDP database 2018. They are calculated for a group of 45 countries (see the list in Table A1). The MDPI measures the percentage of people that is multi-dimensionally poor (adjusted by the intensity of deprivation). This can be regarded as an indicator of the standard of living in terms of deprivation and includes several dimensions (income, low education, bad quality of works, bad housing conditions, social exclusion, etc.) The financial integration variables are the FDI, portfolio equity/debt liabilities, foreign claims, remittances, ODA and disbursements (all measured as share of GDP or GNI). We compute their average over the whole period.

Figure 2 shows that private capital inflows like FDI, portfolio equity/debt liabilities, foreign claims, and remittances appear to be negatively correlated with MDPI, suggesting that the financial integration seems to promote rising standards of living (namely, decreasing the MDPI) in the African countries. However, if we include a few outlier countries, this correlation is confirmed but weakly, because the relationship between financial integration and MDPI varies widely among countries. On the other hand, the public capital inflows like ODA and disbursements are positively correlated with it. Increasing poverty needs the external aids, which may be a reason of the positive correlation although we cannot understand the causality of this relationship at this stage. Traditionally, international financial integration has been a good thing to reduce poverty and raise the standard of living in the poor countries. The examples usually evoked are China and India. When the focus is on Africa, the results seem quite different. Though financial integration may have contributed to higher growth rates, the latter did not prevent the number of poor people from rising.

Figure 2: Financial integration and standards of living during 2006-2016

The decline in standards of living can be analyzed as the result of lower *potential* GDP per-capita. Indeed, the positive effects of financial integration are channeled by "supply-side" factors. For

instance, an increase in foreign capital inflows is expected to build up countries' productive capacity (through an increase in capital stock and human capital skills, an improvement of the structural transformation from agriculture-intensive to industry-intensive activities). This boosts potential GDP and therefore rises the standards of living. Moreover, international financial integration improves potential GDP through an increase in the number of firms that better perform because the access to credit is facilitated (higher market liquidity, lower premium than in domestic financial markets, lower barriers to entry). In section 4 and 5, we examine whether the international financial integration increased or reduced potential GDP per-capita in Africa (using production frontier as a proxy).

3. Selecting the potential determinants of the level of GDP per-capita

3.1. Specification of the empirical model

As a first step, we want to find a benchmark specification in which some basic determinants of GDP per-capita can be selected as potential explanatory variables that will be used in the next sections in frontier analyses.

The theoretical background underlying our econometric specification is based on three strands of the literature accounting for income differentials across countries.

One belongs to the tradition of the Neoclassical growth model. In the medium-to-long run, GDP per-capita is a function of physical capital, human capital, labor (employment, hours worked, working-aged population) and total factor productivity (TFP). In the next section, we shall measure TFP using production efficiency as a proxy.

Secondly, we also consider the literature on structural transformation. It belongs to the field of development economics and has its root in the seminal works of Lewis. Structural transformation is viewed as a way of upgrading an economy to higher productive activities. The process of transformation occurs by changes in the sectoral composition of the GDP, the improvement in trade structure, competitiveness, or more intensive modes of production (see, among others, Bah, 2011; Barrett et al., 2017; Duarte and Restruccia, 2010; Hausmann, et al. 2011; Herrendorf et al., 2015; Hidalgo et al., 2007; and Lin, 2012).

A third strand of the literature identifies developmental governance as a key factor for successful economic transformation. This refers to political governance strategies, good practices in administration for development, economic policy reforms (see Carraro and Karfakis, 2018; Mensah et al., 2016; and Mijiyawa, 2017).

Against this background, our specification is the following

$$y_{it} = \alpha + X'_{it}\beta + Z'_{it}\gamma + \epsilon_{it} \quad , \qquad i = 1, \cdots, N, \; t = 1, \cdots, T, \tag{1}$$

where the error term $\epsilon_{it} \approx i.i.d.(0, \sigma_\epsilon^2)$. Each variable is defined for country i and year t. The level of GDP per-capita, y_{it} (GDP divided by total population) is regressed on three basic

determinants of production that are in the vector X_{it} : the stock of physical capital per-capita, the ratio of total employment over total population and human capital (there are no data on the number of hours worked, so we use the years of schooling as a proxy). In the vector Z_{it} , we consider the following potential determinants of GDP (see the list in Table A2):

(1) Sectoral structure of the economy: shares of agriculture, industry and services in total GDP;
(2) Demographic factor: working-aged population;
(3) Policy variables: inflation, fiscal balance, trade openness, terms of trade,
(4) Financial development: changes in the share of credit out of total GDP, mobile cellular subscriptions (per 100 people);
(5) Governance and institutional variables: voice accountability, political stability, government effectiveness, regulation quality, rule of law, control of corruption.

The variables in y_{it} and X_{it} are measured in log. In the vector Z_{it} , the following variables are log transformed: terms of trade and working-aged population. α, β, γ are real parameters to be estimated.

3.2. Estimation and data

We estimate Equation (1) using a model-average approach. We compare two estimators: a Bayesian Model Averaging (BMA) and Weighted Average Least Squares (WALS)[3].

In Equation (1), X_{it} contains the so-called "focus" variables (those we absolutely want in the model) and the vector Z_{it} represents the "auxiliary" variables (those which are subject to uncertainty). Since the number of variables in Z_{it} is 16, the number of regressions with different subsets of combination of the auxiliary variables is 2^{16}=65536. Non informative priors are used for X_{it} and a multivariate Gaussian prior is used for Z_{it} .

For the BMA estimator, the final solution of the variables is based on the posterior inclusion probability (PIP). A variable in Z_{it} is considered to be significantly correlated with the level of GDP per-capita if the PIP is above the 0.8 threshold. The WALS estimator uses a preliminary orthogonal transformation of the data to ensure that the estimates are invariant to scale transformation and to improve accuracy of the estimator. The selection of the variables that are significantly linked to y_{it} is based on the t-ratio.

We consider 45 African countries over the period 1996-2014 (see Table A1 in Appendix). The choice of countries and years is dictated by the availability of data. Tables A2 in Appendix contains a detailed presentation of the data. We consider several sources. The basic determinants of GDP are

[3] For a detailed presentation of these estimators, see De Luca and Magnus (2011 and 2016).

taken from Penn World Table version 2.9 where data on real GDP, capital, employment, human capital are available for many countries in the world. We also collect data on terms of trade and trade openness. Macroeconomic policy variables, financial development variables, and governance indicators are taken from the World Development Indicators, the World Economic Outlook and the World Governance Indicators.

3.3. Results

Table 1 shows the regression coefficients, their standard error and the posterior probability inclusion (PIP) for the BMA estimator. We also report the results of the WALS estimator (estimated coefficient, their standard error, and t-ratio in the last three columns).

The PIP of the focus variables equals 1 because they are constrained to be in the list of explanatory variables in each regression. Physical capital and employment have the strongest effect on the level of GDP per-capita. A percentage increase in capital (per-capita) increases the probability that GDP per-capita ends by 0.41%, while a percentage increase in the employment-to-population ratio raises the probability of 0.49% decrease in the level of GDP per-capita. This explanatory variable is a good proxy to capture the capability of countries to create jobs that lead an increase in the level of GDP per-capita. A positive coefficient would signal a demographic dividend. Here, the negative sign suggests that, on average, the African countries still lack the positive effects of a rapidly growing population reflected by high dependency ratios (high percentage of dependent people aged 0 to 15). This is confirmed by the negative coefficient of the working-aged population.

Among the auxiliary variables, we find only but a few that are significantly correlated with the level of GDP per-capita. Among the sectoral structure variables, the share of industry has a positive effect on the level of GDP per-capita. The industrialization contributes to increasing the standard of living. Among the policy variables, the terms of trade are associated with lower GDP per-capita, thereby suggesting a vulnerability to external shocks. Inflation also affects the GDP per-capita negatively. Among the financial development variables, mobile cellular subscriptions used as a proxy of mobile banking penetration are positively correlated with the level of GDP per-capita. Very few governance and institutional variables have an effective influence on the level of GDP per-capita (government effectiveness and to a lesser extent regulation quality).

The last three columns with the WALS estimator confirm also these findings.

Table 1. BMA and WALS estimates

	BMA			WALS		
	Coef.	Std. Err.	PIP	Coef.	Std. Err.	t-ratio
Focus variables						
Intercept	4.467	0.22	1.00	4.20	0.22	19.01
Capital	**0.409**	0.01	1.00	**0.43**	0.01	29.15
Employment	**-0.490**	0.03	1.00	**-0.51**	0.03	-18.20
Human capital	**0.075**	0.04	1.00	**0.11**	0.04	2.52
Auxiliary variables						
Share (agriculture)	0.118	0.17	0.37	0.27	0.14	1.88
Share (industry)	**0.795**	0.15	1.00	**0.76**	0.14	5.55
Working-aged	**-1.115**	0.11	1.00	**-1.10**	0.11	-10.13
Inflation	**-0.284**	0.06	1.00	**-0.23**	0.06	-4.21
Fiscal balance	0.007	0.06	0.04	0.16	0.21	0.73
Trade openness	-0.015	0.04	0.14	-0.05	0.06	-0.75
Terms of trade	**-0.844**	0.12	1.00	**-0.78**	0.12	-6.28
Domestic credit	-0.006	0.03	0.07	-0.07	0.07	-0.93
Mobile subscription	**0.003**	0.0004	1.00	**0.003**	0.0004	7.25
Voice and accountability	-0.006	0.02	0.13	-0.03	0.03	-1.02
Political stability	0.0003	0.005	0.04	0.01	0.02	0.63
Governance effectiveness	**0.327**	0.05	1.00	**0.30**	0.05	5.67
Regulation quality	0.013	0.04	0.16	**0.10**	0.05	2.07
Rule of law	-0.017	0.04	0.21	-0.08	0.05	-1.46
Control of corruption	-0.003	0.02	0.07	0.02	0.04	0.42

4. Stochastic frontier analysis

The frontier approach is an alternative approach to the usual accounting decomposition of growth to measure the potential GDP level of a country. In this section, we argue that one reason why we may find little evidence of a correlation between international financial integration and potential GDP can be explained by the heterogeneity of the finance/GDP link across the African countries and across time. Higher inflows of capital reduce production inefficiency in some countries but increase it in other countries.

We investigate the role of financial integration variables in increasing GDP per-capita by examining two issues. One question is whether financial integration reduces the countries' distance to their GDP frontier. By analyzing changes towards the production frontier in section 4.1, we question

the capability of countries to reduce their inefficiency scores through a higher integration with the international financial markets. A second issue is whether financial globalization can help pushing the frontiers. This is important in a perspective of catching up with other countries in the world with higher levels of GDP per-capita. We compare the frontiers with or without financial integration variables in section 4.2.

Before going to the next section, we refer to the choice of the financial integration variables. Several indicators of financial integration have been proposed in the literature (for a survey, see Billio et al., 2017). Price-based indicators assume the law of one price when markets are integrated. We do not consider such indicators here because the asset market prices in Africa contain unobservable components related to liquidity risk premium which are difficult to measure. Other indicators are based on the correlation between saving and investment across countries. In integrated markets, firms easily receive loans from international capital market. This implies a weak correlation between domestic investment and saving (this is known as the Feldstein/Horioka hypothesis). We do neither consider this type of indicators for two reasons. Firstly, the Feldstein/Horioka hypothesis is based on the condition of real interest rate parity, which is not satisfied for many African countries. Secondly, investment and saving are endogenous. In the regressions, the variables in the vector Z_{it} are assumed to be weakly exogenous with respect to the set of coefficients of financial integration variables.

Our motivation is to consider various types of indicators reflecting the financial dependence of the African countries vis-à-vis the international capital markets: inter-banks loans and portfolio investment, international financial liabilities in equity and debt markets, indicators of capital account liberalization (inflows of foreign direct investment), remittance, and disbursements of foreign official transfers. So, we consider the following indicators of financial integration (the sources of data are presented in Table A2):

(1) FDI liabilities (stock) as share of GDP,
(2) Portfolio equity liabilities (stock) as share of GDP,
(3) Portfolio debt liabilities (stock) as share of GDP,
(4) Consolidated foreign claims of BIS reporting banks to GDP,
(5) Personal remittances received as share of GDP,
(6) Net ODA received as share of GNI,
(7) Disbursements on external debt (long-term + IMF disbursements) as share of GNI.

The choice of countries and years is dictated by the availability of data. So, we use panel data for 45 countries in case of (1) FDI, (4) foreign claims, and (6) ODA; for 44 countries except Seychelles in case of (7) disbursements; for 42 countries except Central African Republic, Chad, and Mauritania in case of (5) remittances; and for 37 countries except Central African Republic, Chad, Comoros,

Djibouti, Gambia, Guinea-Bissau, Mauritania, and Rwanda in case of (2) portfolio equities and (3) portfolio debts.

Table 2 shows the optimal lag, z-bar tilde statistics and p-values of Granger non-causality test between GDP per-capita (y) and financial integration variable (FI) in heterogeneous panel by Dumitrescu and Hurlin (2012). The optimal lags are determined based on the Bayesian information criteria. At 5% level of significance, the null hypothesis (FI does not Granger-cause y) can be rejected in case of FDI and portfolio equity investment, while the reverse null hypothesis (y does not Granger-cause FI) can be rejected in case of portfolio debt investment, foreign claims, ODA and disbursements. Thus, FDI and portfolio equity investment seem to have unidirectional causal relationship from FI to y, while portfolio debt investment, foreign claims, ODA and disbursements have unidirectional reverse causal relationship from y to FI. However, remittance does not have any causal relationship with y.

Table 2. Dumitrescu & Hurlin (2012) Granger non-causality test results

	H0: FI does not Granger-cause y			H0: y does not Granger-cause FI		
FI variables	optimal lag	z-bar tilde	p-value	optimal lag	z-bar tilde	p-value
FDI	1	11.45	0.00	1	7.05	0.06
Portfolio equities	1	4.24	0.03	1	5.37	0.07
Portfolio debts	1	3.18	0.10	4	6.03	0.00
Folaign claims	1	2.89	0.14	1	7.68	0.01
Remittances	1	2.57	0.16	1	5.83	0.12
ODA	1	2.69	0.11	1	10.78	0.00
Disbursements	1	0.65	0.60	1	7.46	0.01
Note: Bayesian Information criteria. P-values are computed using 100 bootstrap replications.						

4.1. The role of financial integration in reducing the distance to the frontier

We start with the following production frontier equation:

$$y_{it} = \alpha_i + X_{it}'\beta + v_{it} - u_{it} \ , \qquad i = 1, \cdots, 45, \ t = 1996, \cdots, 2014, \tag{2}$$

where y_{it} =*log*(GDP per-capita) in country i at time t, α_i is a country fixed effect, X_{it} is the vector of the basic determinants of production: *log*(physical capital/population), *log*(employment/population) and human capital. u_{it} is the (non-negative) inefficiency variable that measures the distance from the maximum level of GDP per-capita. It follows a truncated-Normal distribution $N_+(\mu_{it}, \sigma_u^2)$. $v_{it} \approx N(0, \sigma_v^2)$ is the error term. We assume that $u_{it} \perp (X_{it}, v_{it})$.

Let us define Z_{it} the vector of the auxiliary variables selected in the BMA and WALS analyses: share of industry in GDP, working-aged population, inflation, terms of trade, mobile subscription, and government effectiveness. Define FI_{it} as the vector of financial integration variables. Assuming that

the maximum level of GDP per-capita (the frontier) is dictated by X_{it}, the vector Z_{it} and FI_{it} enter as explanatory variables of μ_{it}:

$$\mu_{it} = k_0 + Z'_{it}k_1 + FI'_{it}k_2. \quad (3)$$

We want to know whether the inefficiency term diminishes (or increases) when countries become more financially integrated with the international markets. This amounts to comparing μ_{it} when $k_2 = 0$ and when $k_2 \neq 0$. In this section, it is not necessary to consider whether financial integration variables with the reverse causality ($y \rightarrow FI$) or without causality ($y \nleftrightarrow FI$) can be included as explanatory variables of μ_{it} in equation (3).

Equation (2) with (3) are estimated following the methodology by Greene (2005a, 2005b), proposing a robust way to deal with the incidental parameter problem due to unmeasured heterogeneity in the individual fixed effect coefficients. We also compute the inefficiency parameter $\lambda = \sigma_u/\sigma_v$. A significant λ indicates skewness of the distribution. The individual and mean inefficiencies are estimated using Jondrow et al. (1982)'s formula.

In Tables 3, we report the estimation of Equations (2) and (3) when $k_2 = 0$ (model with no-financial variables) and when $k_2 \neq 0$ (models with the financial integration variables included one by one). The basic determinants of production have significant coefficients in all regressions. Physical capital and human capital both contribute positively to the increase in GDP per-capita, while the ratio of employed people in total population has a negative effect.

Through the different regressions, we see that some auxiliary non-financial variables influence production inefficiencies. An increase in terms of trade, government effectiveness and mobile subscription reduces the inefficiency. Conversely, an increase in the share of industry increases inefficiency. The working-aged population and policy variables that are usually found in the literature to exert an effect on GDP growth such as inflation are not robust determinants of any improvement or deterioration in efficiency.

Turning to the financial integration variables, we find several interesting results. Firstly, the regressions show that only FDI liability stock and remittances significantly influence efficiency. FDI increases inefficiency, but the remittance reduces the inefficiency. Plots of the marginal effects of both variables across time and countries are shown respectively in Figure 3. The marginal effects are computed using Wang (2002)'s approach. They are based on the post-truncation mean of u_{it}.

Denoting $\Omega_{it} = (e_{it}, Z_{it}, FI_{it})$, where e_{it} is a vector of 1 and Ω_{it}^l the l^{th} element of Ω_{it} and k_l the coefficient associated to this variable, we have

$$\frac{\partial E(u_{it})}{\partial \Omega_{it}^l} = k_l \left\{1 - \nabla_{it}\frac{\phi(\nabla_{it})}{\Phi(\nabla_{it})} - \left[\frac{\phi(\nabla_{it})}{\Phi(\nabla_{it})}\right]^2\right\},$$

where $\nabla_{it} = \mu_{it}/\sigma_u$, $E(u_{it}) = \sigma_u[\nabla_{it} + \phi(\nabla_{it})/\Phi(\nabla_{it})]$, ϕ and Φ denote the Normal density and distribution function, respectively.

Table 3. Estimation results of Equations

	No fi. integration			Financial integration											
				FDI			Portfolio equity			Portfolio debt			Foreign claims		
	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio
Frontier															
Capital	0.29	***	17.68	0.30	***	17.79	0.39	***	20.74	0.40	***	19.99	0.36	***	20.36
Employment	-0.50	***	-20.1	-0.50	***	-20.24	-0.66	***	-23.86	-0.68	***	-23.34	-0.62	***	-24.23
Human capital	0.25	***	5.4	0.26	***	5.46	0.30	***	5.99	0.32	***	6.01	0.36	***	7.39
Inefficiency															
Non-financial variables															
Industry share	2.43	***	3.48	2.26	***	3.52	1.55	***	4.45	1.26	**	2.10	3.38	***	2.37
Working aged	0.01		0.01	-0.18		-0.25	0.46		0.84	0.46		0.54	1.85		1.28
Inflation	0.19		1.48	0.18		1.46	0.24	**	2.46	0.36	***	2.67	0.57	***	2.39
Terms of trade	-1.53	**	-2.11	-1.36	**	-2.00	-0.62		-1.28	-2.07	**	-2.30	-3.52	**	-1.99
Governance effectiveness	-1.20	***	-3.33	-1.22	***	-3.48	-1.75	***	-7.73	-2.10	***	-3.47	-2.60	***	-2.39
Mobile	-0.05	***	-3.25	-0.05	***	-3.37									
Financial variables															
FDI				**0.23**	***	2.47									
Portfolio equity							-5.68		-1.60						
Portfolio debt										0.57		0.58			
Foreign claims													-1.02		-0.89
σ_u	0.51	***	6.54	0.50	***	6.75	0.45	***	15.32	0.53	***	5.82	0.70	***	4.43
σ_v	0.08	***	15.36	0.08	***	15.43	0.08	***	14.39	0.08	***	13.66	0.08	***	15.11
λ	6.44	***	80.95	6.22	***	82.56	5.68	***	177.76	6.35	***	68.85	8.77	***	55.44
Note: *, **, ***: statistically significant at 10%, 5% and 1% level of confidence															

	No fi. integration			Financial integration								
				Remittance			ODA			Disbursement		
	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio
Frontier												
Capital	0.29	***	17.68	0.30	***	17.63	0.30	***	17.71	0.29	***	17.76
Employment	-0.50	***	-20.1	-0.50	***	-19.71	-0.50	***	-20.13	-0.49	***	-20.10
Human capital	0.25	***	5.4	0.24	***	4.90	0.25	***	5.40	0.23	***	4.96
Inefficiency												
Non-financial variables												
Industry share	2.43	***	3.48	1.35	***	2.79	2.39	***	3.49	2.73	***	3.36
Working aged	0.01		0.01	-0.48		-0.76	-0.08		-0.11	0.47		0.58
Inflation	0.19		1.48	0.13		1.25	0.20		1.59	0.24	*	1.76
Terms of trade	-1.53	**	-2.11	-1.72	***	-2.83	-1.69	**	-2.22	-1.55	**	-2.07
Governance effectiveness	-1.20	***	-3.33	-1.01	***	-3.71	-1.18	***	-3.30	-1.22	***	-3.27
Mobile	-0.05	***	-3.25	-0.04	***	-3.54	-0.05	***	-3.24	-0.05	***	-3.19
Financial variables												
Remittance				**-7.01**	**	-2.38						
ODA							0.65		0.92			
Disbursement										-2.45		-1.19
σ_u	0.51	***	6.54	0.44	***	7.23	0.51	***	6.55	0.53	***	6.42
σ_v	0.08	***	15.36	0.08	***	15.48	0.08	***	15.37	0.08	***	14.94
λ	6.44	***	80.95	5.30	***	84.33	6.38	***	80.84	6.91	***	82.68
Note: *, **, ***: statistically significant at 10%, 5% and 1% level of confidence												

Looking at the time averages in the left panel of Figure 3.1, the marginal effects associated with FDI stock liabilities seem to be positive. This illustrates the fact that, on average, FDI have been sources of higher under-performance, thereby implying an inefficient use of the basic and auxiliary factors of production under financial integration to reach the maximum level of GDP per-capita. However, the curve shows a decreasing trend, suggesting that the time inefficiency, conditioned by financial integration, has been decreasing over time especially since 2004. The right panel in Figure 3.1 indicates that the marginal effects associated with remittance seem to be negative. But the curve with an increasing trend shows that the time "efficiency", conditioned by remittance, has been decreasing over time since 2000s. The marginal effects across countries in Figure 3.2 in case of FDI indicate that Angola, Congo Democratic Republic, and Congo Republic are the outlier countries with highest under-performance. Even if these 3 countries are omitted, the marginal effects of the other countries vary widely in magnitude. In other words, one size does not fit all. Recent trend of financial integration associated with FDI appears to have some positive effect to reduce the degree of under-performance, especially in emerging African countries such as the countries on the right side of Figure 3.2.

Lastly, we measure the relative change in inefficiency by calculating the following difference

$$100 \times (E(u_{it}/FI_{it}, X_{it}, Z_{it}) - E(u_{it}/X_{it}, Z_{it}))/E(u_{it}/X_{it}, Z_{it}),$$

where $E(u_{it}/FI_{it}, X_{it}, Z_{it})$ and $E(u_{it}/X_{it}, Z_{it})$ are the estimates of inefficiencies computed using Jondrow et al. (1982)'s approach. We then compute the time and country averages.

Figure 3.1. Marginal effects across time, FDI (left panel) and remittances (right panel)

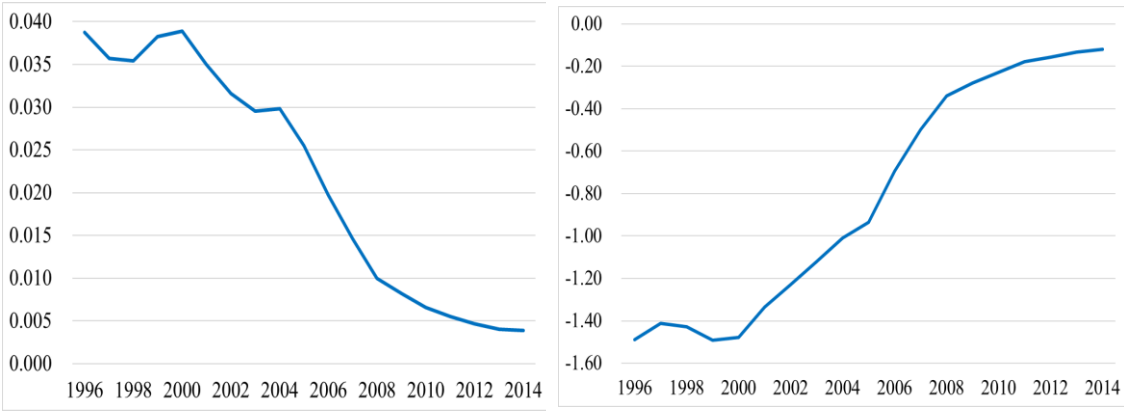
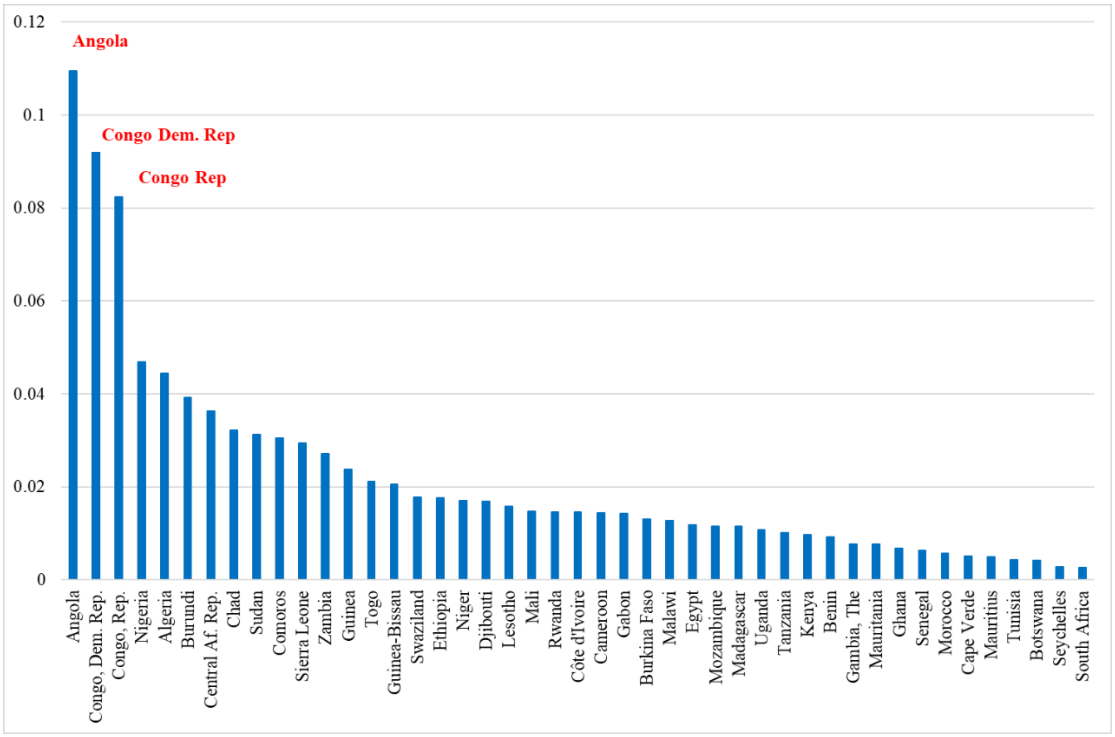


Figure 3.2. Marginal effects across countries, FDI



Looking first at country averages, Figure 4.1 shows that inefficiency diminishes after a higher financial integration for FDI liabilities in a greater proportion of countries (36 out of 45 countries). However, there exists the heterogeneity in magnitude of these changes. Clearly, Mauritius remains an outlier in the change in inefficiency. In Mauritius, FDI liabilities as a share of GDP increased by about 200 times after the global financial crisis, i.e., from average 12% (1996-2008) to average 2305% (2009-2014). Since Mauritius is regarded as a tax haven, one explanation of this inefficiency can be driven by the global liquidity poured into Mauritius over the post-crisis period. Thus, we calculate the time averages with and without Mauritius when the financial integration occurs through FDI liabilities in the left panel of Figure 4.2. The time averages with Mauritius (blue line) show that inefficiency increases, especially during the post-crisis period as we expected. However, those without Mauritius (red dashed line) indicate that inefficiency increases especially since 2005, which may be caused by over-investments into Africa because of price surges in raw materials, and by weak absorptive capabilities. Conversely, the right panel in Figure 4.2 indicates that remittance has been a source of improvement of technical efficiency over the whole period. The positive effect of remittance on technical efficiency are large over the period before the global financial crisis, but decreasing after the crisis.

Figure 4.1. Changes in inefficiency across countries, FDI

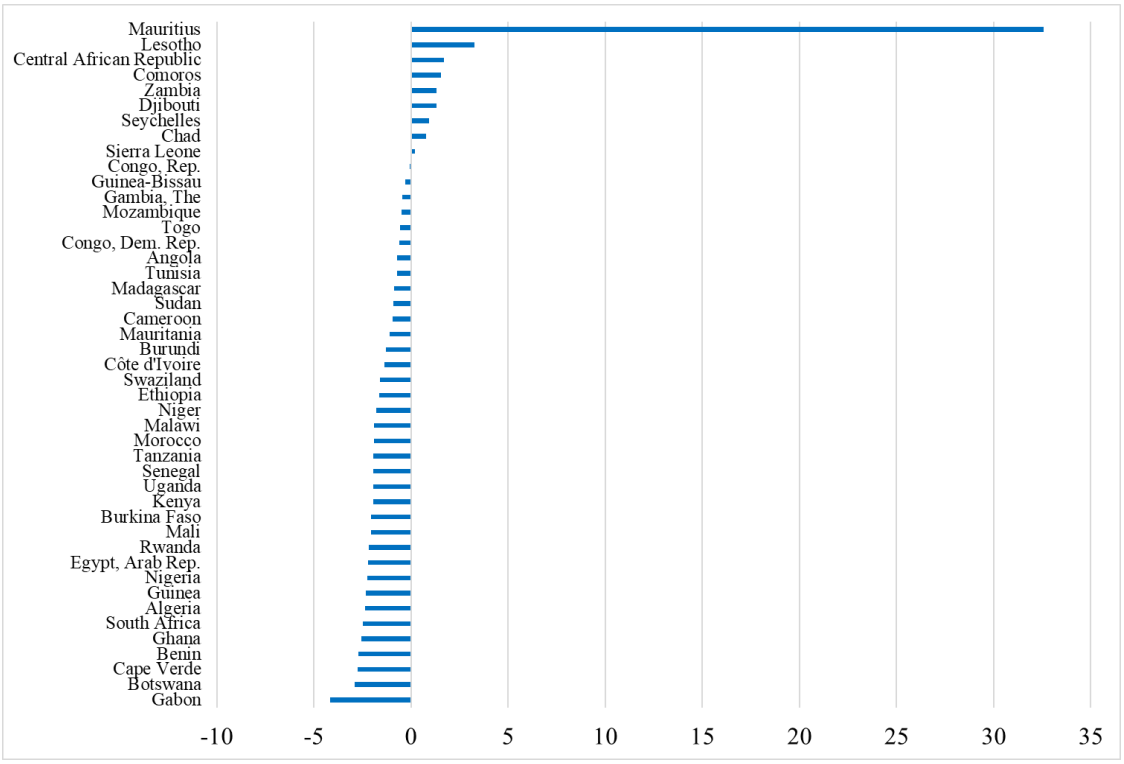
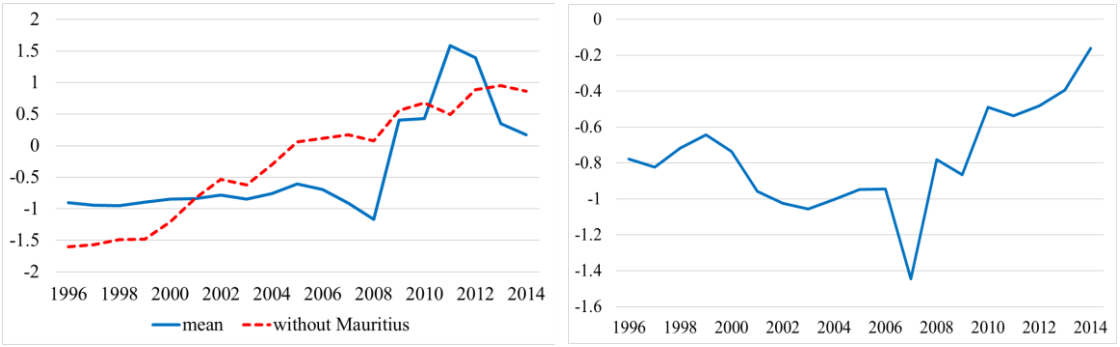


Figure 4.2. Changes in inefficiency across time, FDI (left panel) and remittance (right panel)



4.2. The role of financial integration in pushing the frontier

This section investigates the role of financial integration in moving the frontier, then the vector Z_{it} play the same role as the vector X_{it} in Equation (2). In this case, we compare two models:

$$y_{it} = \alpha_i + X'_{it}\beta + Z'_{it}\gamma + v_{it} - u_{it} \quad , \tag{4}$$

$$y_{it} = \alpha_i + X'_{it}\beta + Z'_{it}\gamma + FI'_{it}\delta + v_{it} - u_{it} \quad , \tag{5}$$

where $y_{it} = log$ (GDP per-capita) in country i at time t, α_i is a country fixed effect, X_{it} is the vector of the basic determinants of production. u_{it} is the inefficiency variable that measures the

distance from the maximum level of GDP per-capita. It follows a truncated-Normal distribution $u_{it} \approx N_+ (\mu, \sigma_u^2)$. We assume that $u_{it} \perp (X_{it}, Z_{it}, FI_{it}, v_{it})$. $v_{it} \approx N(0, \sigma_v^2)$ is the error term. We use the fixed-effects stochastic frontier models by Belotti and Ilardi (2018).

In Equation (4), the maximum level of GDP per-capita depends upon both X_{it} and Z_{it}. In Equation (5), the frontier moves when, in addition to X_{it} and Z_{it}, the financial integration variables FI_{it} are included in the list of explanatory variables. Among financial integration variables, shown by the Granger non-causality tests in Table 2, FDI and portfolio equity investment have unidirectional causal relationship ($FI \rightarrow$ y). So, we can use the fixed-effects stochastic frontier model with FDI and portfolio equity investment as financial integration variables (included one by one). Since remittance does not have any causal relationship (y $\nleftrightarrow FI$), we cannot use it as financial integration variable. Portfolio debt investment, foreign claims, ODA and disbursements have unidirectional reverse causal relationship (y $\rightarrow FI$), which requires the instrumental variable. In the first stage, the financial integration variable, FI_{it}, is regressed on the instrumental variables. As the candidates of instrumental variables, we use auxiliary variables which are not correlated with y (level of GDP per capita) in Table 1. In the second stage, we use the fixed-effects stochastic frontier model with the predicted values, $\widehat{FI_{it}}$, obtained from first regression in place of FI_{it}.

We now assess the marginal contribution of the financial integration variables to the maximum GDP per-capita amount. We investigate whether countries perform better when they are more financially integrated with the rest of the world. To this end, we examine the difference between the frontier estimated when $\delta \neq 0$ in Equation (5) from the efficiency level of GDP obtained under the constraint of $\delta = 0$ in Equation (4). The estimated coefficients of Equation (4) and (5) are shown in Table 4. When the auxiliary variables dictate the frontier, together with the basic factors of production (when they are not determinants of the inefficiency term), inflation, governance effectiveness, and mobile subscription are the three variables that carry statistically significant coefficients. Unsurprisingly, inflation negatively affects the efficient level of GDP per-capita, while the others affect positively. Amongst the financial integration variables, FDI liabilities, together with portfolio equity/debt liabilities have statistically significant effect on the efficient level of GDP per-capita. They are "pull factors" in the sense that they pull down the frontier, below the maximum level achieved when $\delta = 0$.

We graphically show the time average of frontiers estimated when $\delta = 0$ (dotted curve) and those computed when $\delta \neq 0$ (the financial variables are considered one by one) in Figure 5. The curves indicate that, portfolio equity/debt liabilities together with FDI liabilities, drive the efficient frontier up. Moreover, short-term private capital (portfolio equities and debts) contributes more to moving the frontier upward than long-term one (FDI), although we have to focus on the difference of the member countries, i.e., the former includes the relatively advanced 37 countries and the latter 45, respectively. By contrast, foreign bank claims, ODA, and disbursements lead to a retrenchment of efficient

production. One implication for economic policy is that private financial investments in the economies are better for production efficiency than public transfers. One explanation of the negative effect of debt issuance through foreign banks' loans can be that the drivers of capital flows to the economic sectors are missing.

Table 4. Estimation results of Equation (4) and (5)

	No fi. integration			Financial integration																	
				FDI			Portfolio equity			Portfolio debt			Foreign claims			ODA			Disbursement		
	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio	Coef.		z-ratio
Frontier																					
Capital	0.33	***	3.67	0.33	***	3.69	0.35	***	3.46	0.35	***	3.49	0.33	***	3.63	0.33	***	3.50	0.33	***	3.69
Employment	-0.55	***	-3.65	-0.55	***	-3.69	-0.58	***	-3.44	-0.57	***	-3.36	-0.55	***	-3.57	-0.55	***	-3.58	-0.55	***	-3.62
Human capital	0.19		1.23	0.19		1.26	0.20		1.24	0.18		1.26	0.19		1.23	0.19		1.22	0.18		1.18
Industry share	0.37		0.89	0.36		0.87	0.41		0.96	0.39		0.89	0.35		0.83	0.27		0.61	0.37		0.84
Working aged	0.15		0.40	0.19		0.50	0.23		0.62	0.09		0.22	0.15		0.40	0.17		0.45	0.17		0.48
Inflation	-0.25	***	-6.75	-0.25	***	-6.81	-0.25	***	-8.30	-0.27	***	-7.87	-0.24	***	-6.49	-0.24	***	-6.71	-0.25	***	-6.67
Terms of trade	0.06		0.37	0.07	**	0.41	0.10		0.46	0.06		0.28	0.06		0.35	0.06		0.37	0.08		0.44
Governance effectiveness	0.09	*	1.66	0.11	***	1.98	0.18	***	2.65	0.17	***	2.74	0.09		1.58	0.08		1.35	0.10	*	1.71
Mobile	0.002	**	2.30	0.002	***	2.51	0.003	**	2.55	0.003	***	2.76	0.002	**	2.32	0.002	**	2.32	0.002	**	2.27
Financial variables																					
FDI				-0.01	***	-3.57															
Portfolio equity							-0.19	***	-4.35												
Portfolio debt										-0.83	**	-2.01									
Foreign claims													-0.12		-0.37						
ODA																-2.27		-0.44			
Disbursement																			-4.90		-1.49
λ	2.84	***	2.59	2.83	***	2.63	2.54	***	2.66	2.61	***	2.75	2.79	***	2.53	2.80	***	2.59	2.80	***	2.46
Note: *, **, ***: statistically significant at 10%, 5% and 1% level of confidence																					

Figure 6 shows the distribution of the frontiers by countries. The dispersion of the different frontiers is low *within* each country, but there is a high dispersion *across* countries. The clustering of frontiers within each country suggests that the effects of financial integration in pushing up or down the frontier are incremental (not disruptive). The financial integration does not seem to change the distribution of GDP per-capita across countries. It is therefore not surprising that changes in the stochastic frontiers following higher financial integration does not impact the standard of living (measured here by the MDPI).

For purpose of illustration, the top panels and bottom left panel in Figure 7 are scatter plots of frontiers estimated with FDI and portfolio equity/debt liabilities (horizontal axis) versus MDPI (vertical axis). Contrary to our expectations, the dots lines that match these plots have a negative slope, thereby suggesting that the way financial integration changes the production frontiers has some positive effect on the standard of living. By contrast, in the bottom right panel of the same figure, we

see that the dots line seems to be horizontal (or the line with slightly positive slope) when we report the differences in inefficiency scores on the horizontal axis. The bottom right panel suggests that financial integration through FDI does not have enough power to modify the distance to the frontier.

Figure 5: Frontiers with financial integration: push and pull factors across time

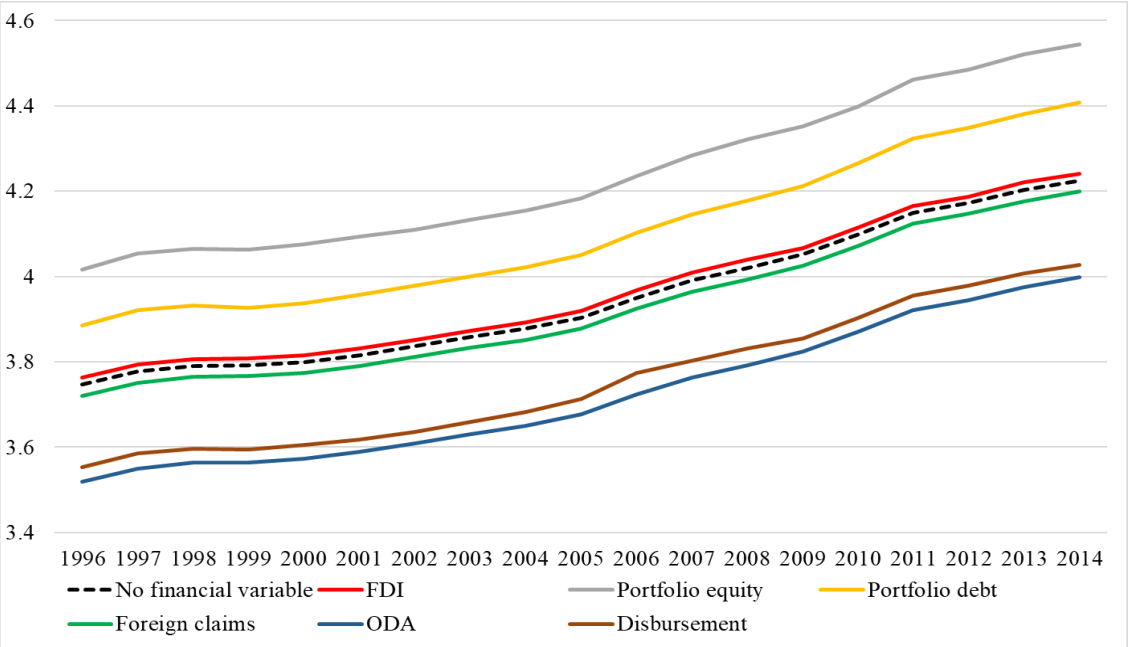
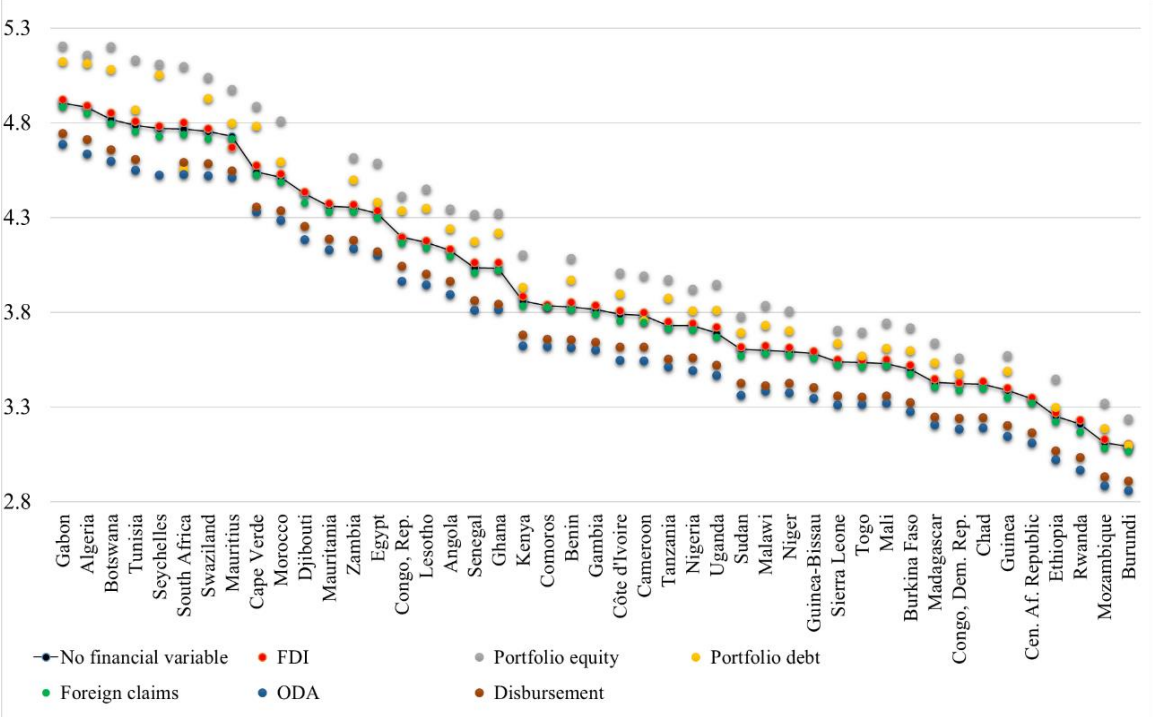
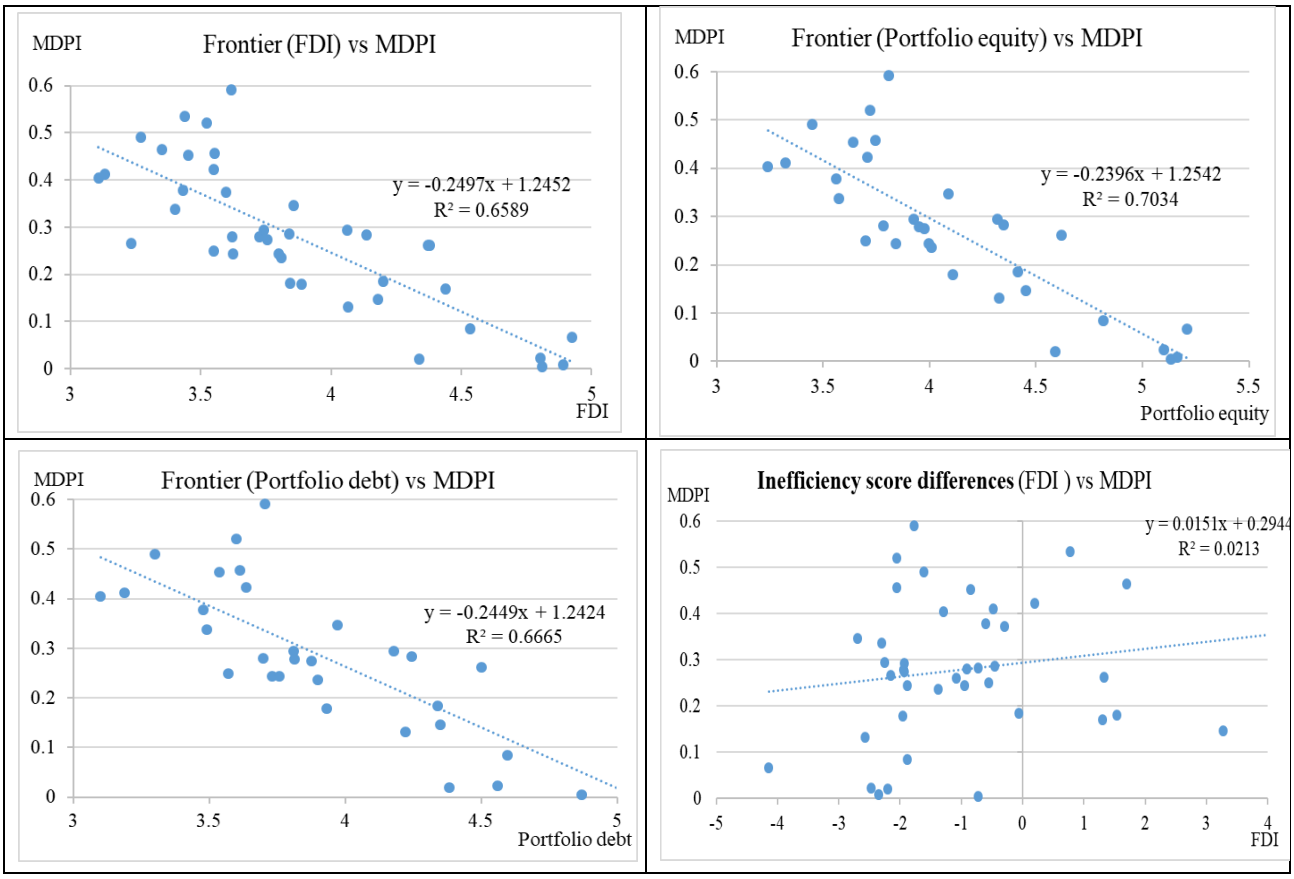


Figure 6: Frontiers with financial integration: push and pull factors across countries



The horizontal dots line corresponding to FDI in the bottom right panel in Figure 7 can be interpreted in two ways. Firstly, a country that reduces its productive inefficiency by receiving additional inflows of FDI does not manage to reduce multidimensional poverty. This happens for instance because FDI does not improve labor-intensive activities that should lead employment creation and eventually to poverty reduction. Moreover, equity market-driven production activities do not seem to trickle down to the poors. They target privileged groups of firms and households, without contributing to poverty alleviation. To say it differently, the efficiency gains achieved through higher amount of FDI does not seem to be pro-poor. An alternative interpretation is that the richest countries (those with the lowest MDPI) succeed better than the poorest countries (with the highest MDPI) do not to maximize the benefits of higher inflows of FDI in terms of GDP per-capita. The reason may be weak absorptive capabilities, for instance they lack minimum threshold stock of human capital.

Figure 7: Frontiers and inefficiency score differences versus MDPI



Our main findings from stochastic frontier analysis can be summarized as follows. First, very few financial integration variables exert an influence on the inefficiency gap. Only FDI inflows and remittances have significant impact on the inefficiency component of production. In many countries, FDI inflows contribute to reduce inefficiency, but this positive effect is not shown in the poverty

indicators. Second, portfolio equity/debt liabilities together with FDI liabilities drive the production frontiers upward. However, there is a high dispersion across countries. As a consequence, international financial integration does not change the distribution of GDP per-capita across countries. This means that financial integration cannot be associated with any catch-up dynamics between the African countries even if FDI and portfolio equity/debt liabilities are beneficial for the poors.

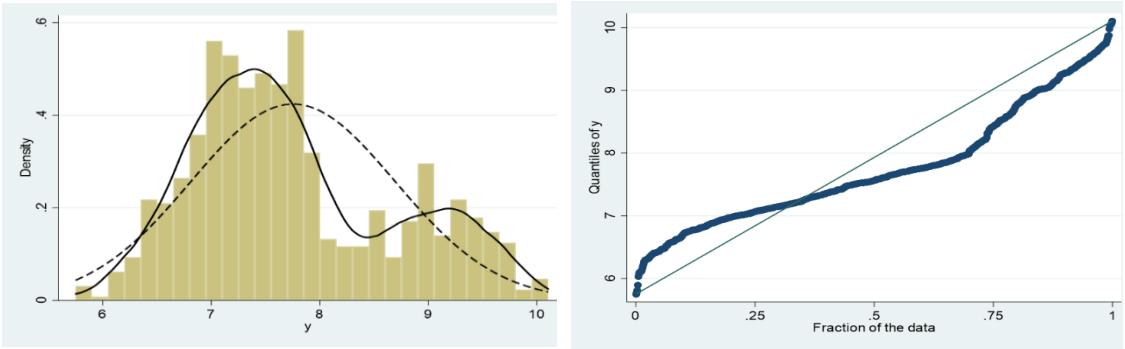
5. Quantile regression estimations

We now investigate quantile regression as an alternative approach for estimating the role of financial integration on GDP per-capita efficiency. Rather than assuming homogeneous slopes across countries and years, we use the information in the different percentiles of the conditional distribution of GDP per-capita.

Figure 8 displays the distribution of GDP per-capita for the entire sample of countries over the years (graph on the left). We use the Epachenikov kernel (which is optimal in a mean-square error sense) and also graph the normal distribution (dashed line) for purpose of comparison. The graph clearly shows that heterogeneity exists in the panel with bi-modality and many observations in the tails of the distribution. We complement this graph with a Q-Q plot (graph on the right). It shows substantive departure from normality (normal probability plots would be on the line). What the data highlight is a considerable heterogeneity across countries and time. This implies that the frontier estimates are likely to result in strong differences in the regression parameters of the GDP determinants at different quantiles. It is therefore restrictive to assume identical coefficients for countries and years.

The literature dealing with quantile regressions has attracted considerable attention and is vast. The reader can refer to the handbook edited by Koenker et al. (2017) for an overview of the topics that have been explored in this field of research. The estimator used here is based on Machado and Santos Silva (2018).

Figure 8 Distribution of GDP per-capita (left) and quantile-quantile plot (right)



Note: Solid line (Epachenikov kernel), Dashed line (Normal distribution) in the left panel.

We consider the following linear heteroscedastic model:

$$y_{it} = \alpha_i + X'_{it}\beta + \sigma(\delta_i + Z'_{it}\gamma)U_{it}, \quad (6)$$

where y is GDP per-capita, X is a vector of explanatory variables, $\sigma(.)$ is assumed to be the identity function (this assumption is made to keep the model tractable and amounts to restricting to a linear heteroscedastic specification, with $P[\delta_i + Z'_{it}\gamma > 0] = 1_i$). For simplicity, we also assume that Z_{it} =X_{it}. α_i and δ_i are the fixed effect coefficients in the mean and variance components of the regression. U_{it} is *i.i.d.* across *i* and *t*, and satisfies $U_{it} \perp X_{it}$, E(U)=0, E(|U|)=1.

We consider the following conditional quantile function:

$$Q_y(\tau|X_{it}) = \left(\alpha_i + \delta_i(\tau)\right) + X'_{it}\beta + X'_{it}\gamma\rho(\tau), \quad (7)$$

which can be considered as a shift $\alpha_i + X'_{it}\beta$ by the quantile of the error term distribution $F^{-1}(\tau)$, where $F(\tilde{y}) = \Pr(y \leq \tilde{y})$and for any 0<$\tau$<1, the τ^{th}quantile of y is $F^{-1}(\tau) = \inf \quad \tilde{y}: F(\tilde{y}) \geq \tau$.

The function $\rho(\tau)$ is defined by:

$\rho(A) = A\tau I(A \geq 0) - A(1-\tau)I(A < 0)$

where $I(.)$ is the Heaviside function. $\alpha_i(\tau) = \alpha_i + \delta_i(\tau)$ is the τ^{th} quantile fixed effect for country *i* and $\beta_i(\tau) = \beta + X'_{it}\gamma\rho(\tau)$ as a varying slope parameter for different values of τ.

To deal with the incident parameter problem due to the presence of the fixed effects, one can use a sequential estimation procedure based on method of moment quantile regressions (see Machado and Santos Silva (2018) for details). To estimate the production frontier, we consider the regression (6) at τ=0.9. Countries positioned at the top ten percent limit of the conditional distribution of GDP per-capita are thus considered as representing the efficient level of GDP per-capita.

An issue that quantile regressions allow to investigate is whether a country located far from the efficient level of GDP per-capita can exploit the positive effects of financial integration to reduce the distance from the frontier. We estimate Equation (6) with the vector X_{it} containing the same explanatory variable as in Tables 4. The financial integration variables are included in the list of regressors one by one. In our sample, four countries have their GDP per-capita level located in a percentile higher than or equal to τ=0.9: Botswana, Gabon, Mauritius, Seychelles, and South Africa. The efficient GDP per-capita is calculated as the average of the predicted values of the endogenous variable when τ=0.9, $\hat{y}(\tau=0.9)$. The efficiency score are then computed as the ratio of the predicted values at other percentiles and at (τ=0.1, 0.2, ..., 0.8) for each pair of (country, year). We finally compute the time and country averages.

Figure 9.1 shows the enfficiency scores ranked by countries when the financial integration variable is FDI liabilities (the other graphs with other financial variables are similar to this one). The average efficiency scores range from 0.8 in countries like Burundi, Mozambique, and Guinea to more than 1 for Tunisia and Algeria. They seem to be heterogeneous.

Figure 9.1. Efficiency scores across countries, FDI

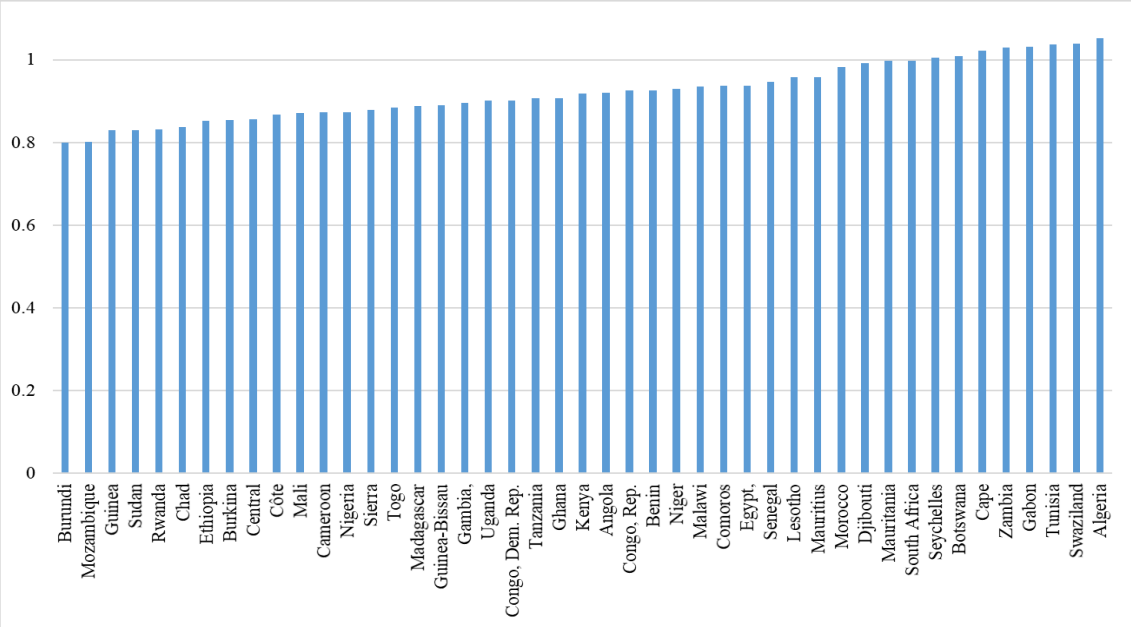


Figure 9.2 displays the efficiency scores across years for the regressions with different financial integration variables. They have a decreasing trend. Moreover, there is a remarkable variation between all the frontiers and the efficient GDP per-capita with ODA (this blue curve is **below** the others.) In the context of a process of catching up with living standards between the African countries, the ODA received from foreign countries does not play a decisive role.

Figure 9.2. Efficiency scores across times, FDI

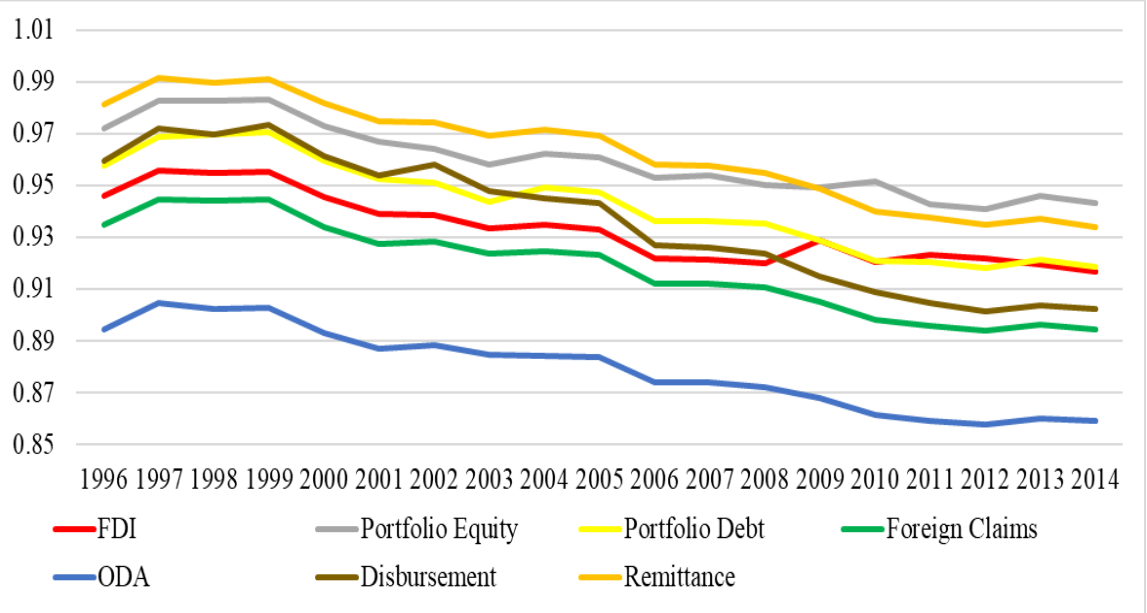
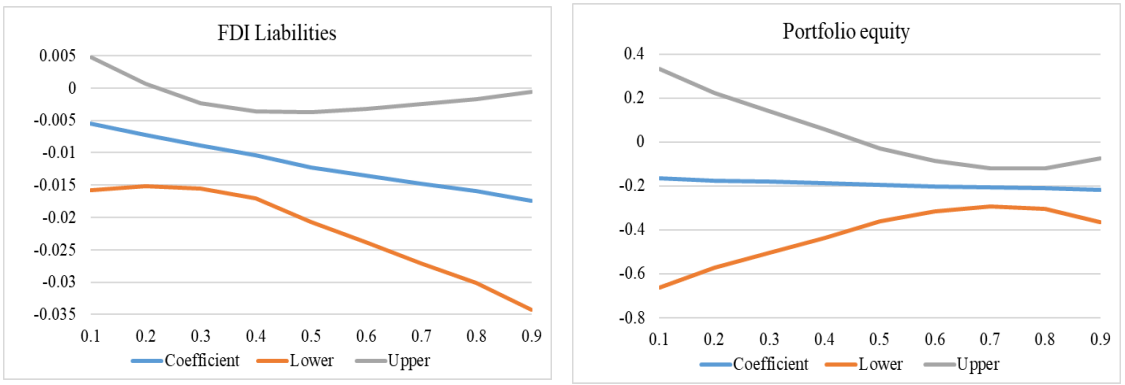


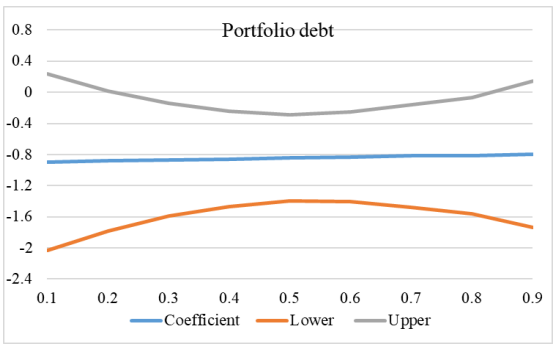
Figure 10 presents the estimated coefficients at all percentiles for the financial integration variables that were statistically significant in the regressions. We also graph the 95% confidence interval. We see changes in parameter estimates when moving up to the conditional distribution of GDP per-capita (by moving from τ=0.1 to τ=0.9) for FDI, banks' foreign claims and disbursements, while the coefficients remain roughly stable for portfolio equity/debt liabilities. ODA is not significant under any conditional distribution of GDP per-capita.

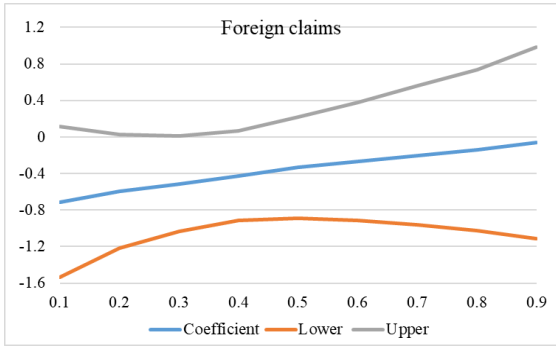
Financial integration variables exercise a negative influence on GDP per-capita. The negative impacts of banks' foreign claims and disbursements decrease as countries raise their GDP towards the efficient level, while those of FDI increase. An interesting finding is that financial integration variables do not exert a significant effect on GDP per-capita (0 is in the 95% confidence interval) under some conditional distribution of GDP per-capita: FDI at τ=0.1, portfolio equity liabilities at τ=0.1~0.4, portfolio debt investment at τ=0.1, 0.9, banks' foreign claims at τ=0.1, 0.4~9, and disbursement at τ=0.1, 0.8~9. And this contrasts with the other quantiles. This result suggests that financial integration serves as a "push factor" that help the countries catching-up with those on the efficient frontier by managing the inefficiencies related to the "misuse" of portfolio debt, banks' foreign claims and disbursements. Conversely, portfolio equity seems to serve as a "pull factor" as countries raise their GDP towards the efficient level.

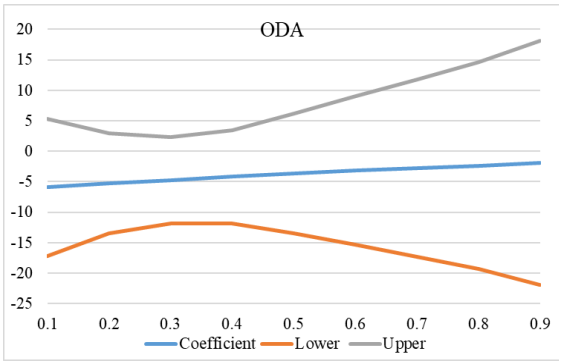
Quantile regressions therefore suggest that the financial integration variables do not have enough effect on moving up the frontier of the most efficient country. This goes in the same direction as the conclusions we obtained in the stochastic frontier models where we found that the displacements of frontiers were incremental. Our estimates highlight the fact that, in the context of a process of catching up of living standards between the African countries, the ODA received from foreign countries does contribute "less" than the private capital inflows. For many of them face difficulties in accessing international capital markets, loans and grants related to official transfers often fill the financing gap. However, the results suggest that a kind of foreign aids does not lead to pro-poor growth.

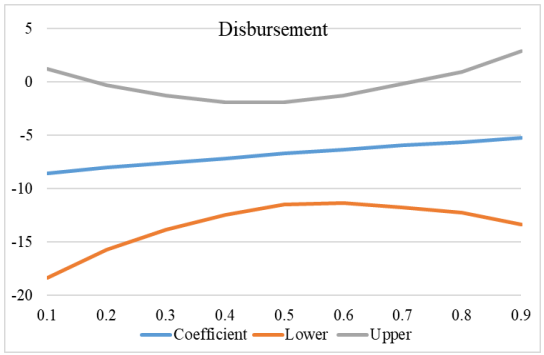
Figure 10: Estimates of financial integration coefficients across percentiles











6. Conclusion

The bulk of policy advices on financial integration recommends that the poor countries should open their capital account to foreign capital markets to boost their economic growth. The conditions under which this works have been thoroughly investigated in the literature. This paper has taken an alternative view, by looking at the effect of financial integration on production efficiency at the aggregate level. Does financial integration help a country reach its highest level of GDP per-capita? This question is as important as the issue of growth for the developing countries in Africa since it is the basis to account for countries' living standards.

This paper shows how observations derived from the growth literature do not necessarily extend to the level of GDP per-capita. First, very few financial integration variables exert an influence on the inefficiency gap. Only FDI inflows contribute to reduce inefficiency, but this positive effect is not shown in the poverty indicators. Second, portfolio equity/debt liabilities together with FDI liabilities drive the production frontiers upward. However, there is a high dispersion across countries. We also take into account the fact that the link between financial integration and GDP per-capita is a function with the distribution of heterogeneous characteristics of the countries. Quantile regressions are used with respect to parameter heterogeneity. Our findings confirm that financial integration does not have enough effect on moving up the frontier of the most efficient country. But again, the heterogeneity, i.e., difference among countries are seen.

Appendix

Table A1: List of countries

N	Country	N	Country	N	Country
1	Algeria	16	Egypt, Arab Rep.	31	Mozambique
2	Angola	17	Ethiopia	32	Niger
3	Benin	18	Gabon	33	Nigeria
4	Botswana	19	Gambia, The*	34	Rwanda*
5	Burkina Faso	20	Ghana	35	Senegal
6	Burundi	21	Guinea	36	Seychelles#
7	Cameroon	22	Guinea-Bissau*	37	Sierra Leone
8	Cape Verde	23	Kenya	38	South Africa
9	Central African Republic*+	24	Lesotho	39	Sudan
10	Chad*+	25	Madagascar	40	Swaziland(Eswatini)
11	Comoros*	26	Malawi	41	Tanzania
12	Congo, Dem. Rep.	27	Mali	42	Togo
13	Congo, Rep.	28	Mauritania*+	43	Tunisia
14	Cote d'Ivoire	29	Mauritius	44	Uganda
15	Djibouti*	30	Morocco	45	Zambia

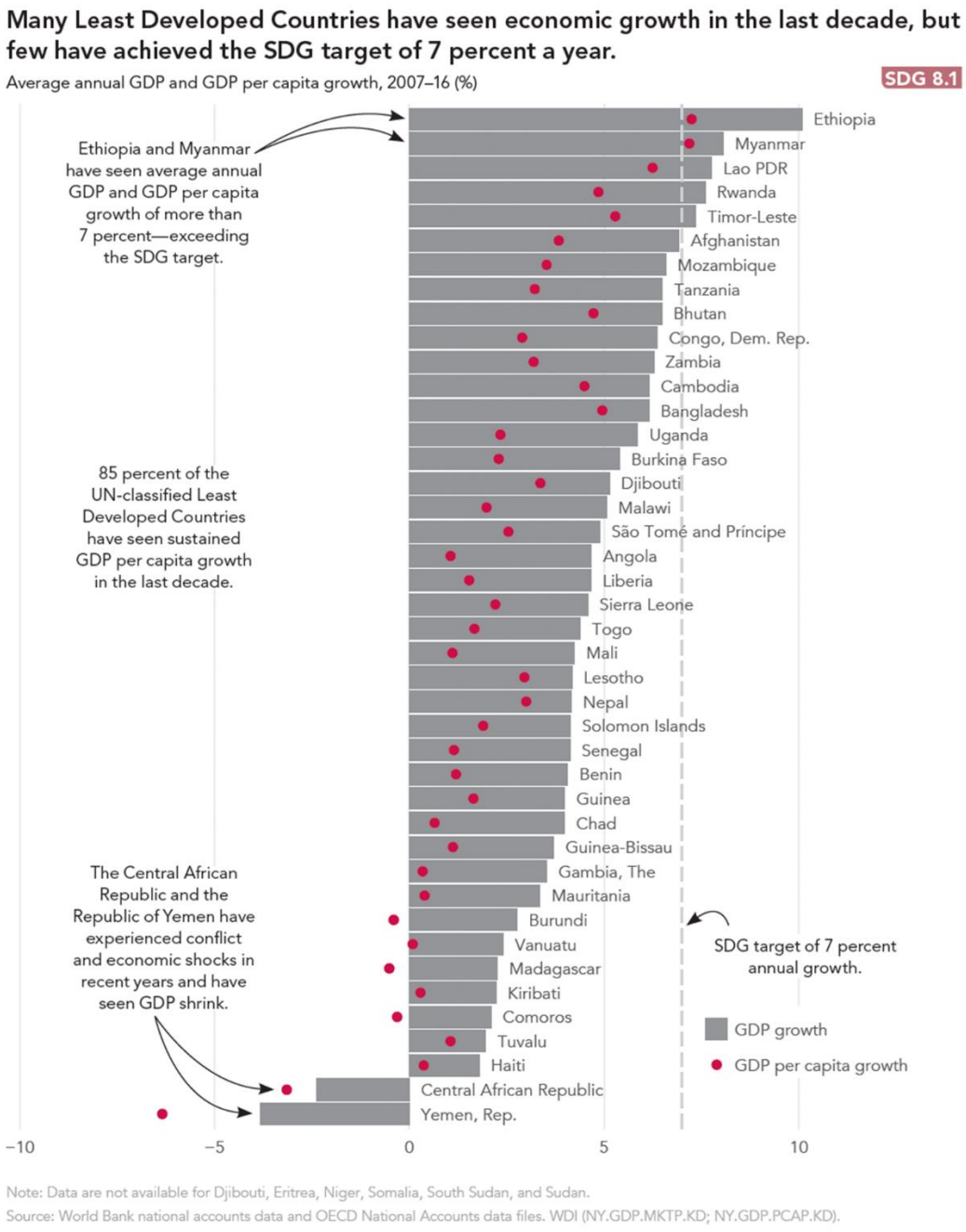
Note The lack of data availability: Portfolio equity and debts (*) Remittance (+) Disbursements (#)

Table A2. Data: Definition, category, data sources, and transformation

Category	Data source	Definition(raw data)	Tansformed data (V=raw data)
Basic determinant of production	PWT	Output-side real GDP at current PPPs (in mil. 2011US$)	Log natural (V*1000000)
Basic determinant of production	PWT	Capital stock at current PPPs (in mil. 2011US$)	Log natural (V*1000000)
Basic determinant of production	PWT	Number of persons engaged (in millions) LN	Log natural (V*1000000)
Basic determinant of production	PWT	Human capital index, based on years of schooling and returns to education	V
Structural variable	WDI	Agriculture, value added (% of GDP)	V/100
Structural variable	WDI	Industry, value added (% of GDP)	V/100
Structural variable	WDI	Services, etc., value added (% of GDP)	V/100
Structural variable	WDI	Age dependency ratio (% of working-age population)	V/100
Macroeconomic policies	WEO	Inflation, average consumer prices	Log Natural(1+V/100)
Macroeconomic policies	WEO	General government net lending/borrowing	V/100
Macroeconomic policies	PWT	Trade openness: {(csh_x: Share of merchandise exports at current PPPs)-(csh_m: Share of merchandise imports at current PPPs)}	V=(csh_x)-(csh_m)
Macroeconomic policies	PWT	Terms of trade: Log natural{pl_x(Price level of exports)/pl_m(Price level of imports)}	V=LN (pl_x)-LN(pl_m)
Financial development	WDI	Domestic credit to private sector (% of GDP)	V/100
Financial development	WDI	Mobile cellular subscriptions (per 100 people)	V
Governance and institutions	WGI	Voice and Accountability	V
Governance and institutions	WGI	Political Stability and Absence of Violence/Terrorism	V
Governance and institutions	WGI	Government Effectiveness	V
Governance and institutions	WGI	Regulatory Quality	V
Governance and institutions	WGI	Rule of Law	V
Governance and institutions	WGI	Control of Corruption	V
Financial integration	EWN	FDI liabilities (stock) as share of GDP	V=FDI/GDP(US$)
Financial integration	EWN	Portfolio equity liabilities (stock) as share of GDP	V=Portfolio equity/GDP(US$)
Financial integration	EWN	Portfolio debt liabilities (stock) as share of GDP	V=Portfolio debt/GDP(US$)
Financial integration	GFDD	Consolidated foreign claims of BIS reporting banks to GDP(%)	V/100
Financial integration	WDI	Personal remittances, received (% of GDP)	V/100
Financial integration	WDI	Net ODA received (% of GNI)	V/100
Financial integration	WDI	Disbursements on external debt, long-term + IMF (DIS, current US$) (% of GNI)	V=Disbursements/GNI(US$)

Note PWT: Penn world table V. 9.0, WDI: World development indicators, WEO: World economic outlook, WGI: World Governance Indicators, EWN: External wealth of nations by Lane and Milesi-Ferretti (2017), GFDD : Global Financial Development Database,

Figure A1. GDP and GDP per-capita growth



Source: World Bank (2018) Atlas of Sustainable Development Goals.

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