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Full Length Article

# Financial constraints, firm productivity and cross-country income differences: Evidence from sub-Sahara Africa

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**Abstract**

Financial constraints have significant implications on firm productivity growth and cross-country income distribution. This study analyses the dynamics of firm productivity and cross-country income differences in a sample of 9 African countries using a stochastic frontier estimator on recent 2016 World Bank Enterprise Survey data. After controlling for firm heterogeneity, we find large dispersions in marginal revenue products of capital and labour and efficiencies between financially constrained and unconstrained firms. Financially constrained firms have 6.6 percent lower marginal revenue product of capital relative to unconstrained firms. Moreover, constrained firms are also more inefficient and less productive relative to unconstrained firms. Constrained firms are 15 percent less efficient due to borrowing constraints compared to unconstrained firms.



*JEL classification:* D24; D25; D33; L25; O47

*Keywords:* Financial constraints; Firm productivity; Misallocation

## 1. Introduction

> "*Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker*".
>
> (Paul Krugman, 1996, p.13)

A long-standing question that has eluded consensus among Economists in development literature is why do some countries enjoy higher living standards than others (?), what accounts for the disparities in wealth and income across-countries? A harmony in literature is that productivity matters, even after controlling for the changes in the quality and quantity of capital and labor (see, Bartelsman & Doms, 2000; Hall & Jones, 1999; Caselli, 2005; Bartelsman, Haltiwanger, & Scarpetta, 2009; Restuccia & Rogerson, 2008; Jones, 2015). However, the sources of cross-country productivity and income differences are a hotly contested debate among Economists and development policy researchers (Bartelsman & Doms, 2000; Syverson, 2011). While existing empirical evidence suggests that productivity significantly varies within firms and across-countries (see, for example, Acemoglu & Dell, 2010; Baily, Hulten, & Campbell, 1992, pp. 187−249; Bartelsman et al., 2009, 2013; Caselli, 2005; Syverson, 2004a; Tybout, 2000), Economists sharply disagree on the sources of cross-country firm productivity and income differences (see for instance: Syverson, 2011; Foster, Haltiwanger, & Syverson, 2008; Restuccia & Rogerson, 2008; Caselli & Feyrer, 2007).

On one hand, while some Economists posit that: weak institutions; misallocation; policy distortions; human capital;

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poor managerial practices; technological diffusion and adoption and market access, account for cross-country income and productivity differences (see, for example, Bloom, Eifert, Mahajan, McKenzie, & Roberts, 2013; Syverson, 2011; Bruhn, Karlan, & Schoar, 2010; Restuccia and Rogerson 2012; Banerjee & Moll, 2010; Scarpetta, Hemmings, Tressel, & Woo, 2002; Mankiw, Romer and Weill 1992; Romer, 1990; Beck, Demirguc-Kunt, & Maksimovic, 2001b; Beck, Demirguc-Kunt, & Maksimovic, 2001a).

A contrary view is that, credit constraints are the source of cross-country income and firm productivity gaps (see, for example, Midrigan & Xu, 2014; Hsieh & Klenow, 2009; Moll, 2014; Buera, Kaboski & Shin 2011; Buera & Shin, 2013; Restuccia & Rogerson, 2008; Aghion, Fally, & Scarpetta, 2007; Banerjee & Duflo, 2005; Bartelsman, Haltiwanger, & Scarpetta, 2013; Caselli, 2005, Demirguc-Kunt, & Levine, 2009). These inconsistencies are at the center of a heated discussion on the causes and consequences of cross-country firm productivity and income differences. Thus, there is a growing interest in understanding how financial constraints affect resource allocation, firm productivity and cross-country income variations.

Financing matters for firm productivity growth (see: Cooley & Quadrini, 2001; Rahaman, 2011; Demirguc-Kunt & Maksimovic, 1998; Beck, Demirguc-Kunt, Laeven, & Levine, 2008; Beck & Demirguc-Kunt, 2006; Clementi & Hopenhayn, 2002). Particularly, in frictionless, perfectly competitive markets where all firms have equal access to capital, the marginal productivities of inputs should equalize across all firms (Grossman, 1976; Grossman & Stiglitz, 1976). Although well-functioning financial markets improve capital allocation, evidence indicates that financial markets in developing countries are imperfect and underdeveloped; consequently, they impose frequent borrowing constraints on firms (see, Banerjee & Duflo, 2014; Ayyagari, Demirgüç-Kunt & Maksimovic 2008; Karlan & Morduch, 2009; De Mel, McKenzie, & Woodruff, 2008; Wurgler, 2000). For example, (Banerjee & Duflo, 2014), have investigated whether firms in India are credit constrained using a directed lending program. They find acute credit constraints among firms and very high marginal rates of return on capital among constrained firms. De Mel (2008), and Ayyagari, Demirguc-Kunt, and Maksimovic (2008), equally find financial constraint as an obstacle to firms' growth rate. They particularly find high variation in returns to capital across enterprises, with average annual returns ranging 55−63 percent among enterprises with funding constraints.

Credit constraints significantly affect firm productivity growth (see, Rahaman, 2011; Caselli, 2005; Bartelsman et al., 2009; Hsieh & Klenow, 2009; Bartelsman et al., 2013; Banerjee & Duflo, 2005 and Restuccia & Rogerson, 2008), and to a large extent these differences in productivity account for a sizeable variation in output per worker and cross-country income gaps (see, for example, Restuccia & Rogerson, 2013; Buera & Shin, 2013; Beck, Demirgüç-Kunt, & Levine, 2007; Clarke, Xu, & Zou, 2006; Beck, Demirguc-Kunt, & Levine, 2004; Claessens & Perotti, 2007; Alfaro, Charlton, & Kanczuk, 2008; Piketty, 1997).

A number of models have been advanced to account for the persistent variation in aggregate factor productivity (TFP) differences and income gaps across countries.[1] For an excellent survey of recent empirical literature, (see: Bartelsman et al., 2013; Hsieh & Klenow, 2009, Restuccia & Rogerson, 2013; Banerjee & Duflo, 2005; Buera & Shin, 2013; Buera, Kaboski & Shin, 2011; Erosa & Hidalgo, 2008). However, despite the intense discussions in literature, most studies have focused on advanced countries with limited research on low income countries particularly Africa, except for a few recent studies (see: Cirera, Fattal, Roberto, & Maemir, 2017 and Kalemli-Ozcan & Sorensen, 2012). Consequently, what accounts for large disparities in income and output per worker across firms in a number of African countries remains at best unknown. In this study, we analyze the role of financial constraints in firm productivity and cross-country income differences.

Particularly, we investigate how financing constraints affect firm productivity growth across heterogeneous in sub-Sahara Africa and the underlying channels through which financial constraints generate distortions that affect input (mis)allocation, TFP growth and income distribution. Further, the study examines the underlying causes and the channels through which credit constraints distort input allocations and how it affects firm productivity growth and income distribution.

Two potential channels that have occupied great attention in current literature are: credit constraints due to financial market imperfections, for instance collateral constraints, high capital costs, information asymmetries, weak property rights, and policy distortions induced by institutions. We evaluate the effects of credit constraints and policy distortions on capital misallocation and TFP losses in sub-Saharan Africa firms. We aim to show whether TFP differences and income gaps across sub-Sahara African are due to financing constraints, policy distortions and or firm specific characteristics? Further, we examine whether improvements in financing can improve aggregate productivity growth and income distribution in heterogeneous firms across Sub-Saharan Africa? We answer these questions in the lens of African growth and productivity puzzle using new firm data from World Bank Enterprise Survey 2016,[2] while drawing on literature from past and recent studies.

Our paper is an extension of a growing literature that explores the role of financing constraints in firm productivity growth and income distribution, (see, for example, Hsieh & Klenow, 2009; Restuccia & Rogerson, 2008, p. 2012; Midrigan & Xu, 2014; Buera, Kaboski & Shin 2011; Buera & Shin, 2013; Banerjee & Duflo, 2005; Moll, 2014; Banerjee & Moll, 2010; Bartelsman et al., 2013; Syverson, 2011; Caselli,

[1] Klenow and Rodríguez-Clare (1997), Caselli (2005), Bartelsman et al. (2013); Syverson (2011); Banerjee and Duflo (2005), Bloom et al. (2010), Tybout (2000), Prescott (1998), Lucas (1978), Acemoglu and Zilibotti (2001), Hulten (2001), Bartelsman and Doms (2000); Lagos (2006), Easterly and Levine (2001) and Mankiw, Romer, and Weil (1992), provide an insightful discussion of the sources productivity differences.

[2] https://www.enterprisesurveys.org, based on firm characteristics.

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2005 and,; Kalemli-Ozcan & Sorensen, 2012). Our study is related to (Hsieh & Klenow, 2009; Bartelsman et al., 2013; Kalemli-Ozcan & Sorensen, 2012; Cirera et al., 2017). However, we depart significantly from previous studies in three novel ways.

First, unlike previous studies that apply marginal productivity measures, in this paper we apply a stochastic frontier analysis to capture productivity losses and efficiency gains from reallocation and improvement in financial conditions. Secondly, we show that, the large dispersion in productivity among firms in Sub-Sahara Africa and the absence of many large and middle sized firms is due to productivity-selection-survival, red-tape (bureaucracy) and financial constraints. Particularly, "red tape" as an institutionally induced policy, distorts labour and capital allocation due to increase in time spent dealing with authorities and significantly lowers labor productivity. We find that a one percent reduction in time spent dealing with authorities would lead to a substantial reduction in bureaucracy (red tape) and increase in labour productivity by 1.9 Percent. Finally, we show that productivity differences across heterogeneous firms are generated by inter-firm reallocations through adjustment in market shares of more efficient firms or exit of unproductive firms. Overall, these findings contribute to an emerging body of literature on role of financing constraints on firm productivity and income distribution in Sub-Sahara Africa (Cirera et al., 2017; Kalemli-Ozcan & Sorensen, 2012).

After controlling for firm heterogeneities, we find lower marginal revenue productivity of capital (MRPK) in financially constrained firms relative to unconstrained firms. Firms facing financing constraint have a 6.6 percent lower return on capital compared to unconstrained firms. We also find large dispersions in marginal revenues between small, medium and large size firms pointing to misallocation of capital. Small and medium size firms have lower MRPK than large firms. Equally, we find that productivity is inversely correlated with firm age and size. An extra year of firm survival, leads to a loss in MRPK by 2 percent in large firms, 6.4 percent in small firms and 1.4 percent in medium size firms. Further, we find that financial constraints increase firm inefficiencies and productivity loss by 15 percent in constrained firms compared to unconstrained firms.

The remainder of the paper is structured as follows. Section 2 describes empirical and theoretical literature on financial constraints, policy distortions, capital misallocation and firm productivity losses. Section 3 describes the theoretical and empirical models, adopted in this analysis, while section 4 describes the methods and data and applied in the analysis. Section 5 presents the results, discussion and the conclusion.

## 2. Literature review

There is an active literature highlighting financing constraints as a barrier to firm productivity growth (See, for instance: Ayyagari et al., 2008; Beck, Demirguc-Kunt, & Maksimovic 2008; Beck, Demirguc-Kunt, Laeven & Levine, 2005; Erosa & Hidalgo, 2008; Aghion et al., 2007; Fazzari, Hubbard, & Petersen, 1988; Rajan & Zingales, 1998; Evans & Jovanovic, 1989; Clementi & Hopenhayn, 2002; Hurst & Lusardi, 2004) and in explaining cross-country income differences (Beck et al., 2007; Banerjee & Newman, 1993; Galor & Zeira, 1993; Aghion & Bolton, 1997; Banerjee & Duflo, 2005; Buera & Shin, 2013; Buera, Kaboski & Shin, 2011).

In perfectly competitive and informationally efficient financial markets where all firms have equal access to capital, and face same inputs prices, (see, for example, Fama, 1970, 1991; Grossman, 1976; Grossman & Stiglitz, 1976), the dispersions in marginal revenue productivities of capital and labour (MRPK and MRPL) should equalize and output is only gained through reallocation of inputs from inefficient firms with low marginal revenue products to firms with high MRP. However, due to market imperfections and information asymmetries (Stiglitz & Weiss, 1981; Stiglitz, 1989; Lambert and Verrecchia, 2010; and; Hughes, Liu, & Liu, 2007) have shown that market frictions tend to affect the firm's cost of capital which in-turn affect productivity growth, market selection and reallocation of inputs (Hopenhayn, 1992; Foster, Haltiwanger, & Krizan, 2006; Erosa & Hidalgo, 2008).

These constraints tend to propagate productivity differences across firms through reallocation or inputs (Baily et al., 1992, pp. 187−249; Bartelsman et al., 2009, 2013; Caselli, 2005; Syverson, 2004a; Tybout, 2000), or by occasioning entry barriers and exit of firms from industries (Aghion et al., 2007; Hopenhayn, 1992). Aghion et al. (2007), have shown that due to inefficiency in capital allocation, financing constraints tend to impede firms from equal access to capital, hence occasioning differences in investments, output and productivity across firms as well as entry and exit of firms.

Moreover, it's a well-known fact that financial markets, in many low income economies are characterized by frictions and underdevelopment, consequently firms face frequent credit constraints which impair productivity growth and also distorts efficient allocation of inputs. Armstrong, Core, Taylor, and Verrecchia (2011) and Lambert, Leuz, and Verrecchia, (2009), have investigated the effect of information asymmetries on the firm's cost of capital. They find a positive relationship between information asymmetry and firms' cost of capital, when markets are imperfect but no relation when markets approximate perfect competition.

Rajan and Zingales (1998), Caselli (2005), Bartelsman et al. (2013), Hsieh and Klenow (2009), and Wurgler (2000) using cross-country studies, were among the first to demonstrate that small firms in financially deprived industries tend grow faster than small firms in financially developed markets, an indication that financing constraints matter in firm productivity growth (see, Beck et al. 2008). Recently, many studies have identified financing constraint as a key impediment to firm productivity growth and a significant source of distortions, misallocation and major cause of productivity loss across firms (see for example, Aghion et al., 2007; Ayyagari et al., 2008; Beck, Demirguc-Kunt, Laeven & Levine 2005; Banerjee & Duflo, 2005; Buera, Kaboski & Shin 2011; Buera & Shin, 2013; Hsieh & Klenow, 2014; Kalemli-Ozcan & Sorensen, 2012; Midrigan & Xu, 2014; Moll, 2014; Musso

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& Schavio 2007; Restuccia & Rogerson, 2008, 2012, 2013; Syverson, 2011).

Jeong and Townsend (2007), for example, demonstrate that 70 percent of TFP growth in Thailand between 1970s−1990s can be attributed to improvement in the financial sector. Midrigan and Xu (2014) evaluates financing constraint on firm productivity and misallocation in U.S.A firms with plant level data. They show that TFP would rise twofold if poor countries were to improve access to credit to the level of USA. Buera, Kaboski, and Shin (2009), explore the outcomes of financial frictions on firm productivity, capital allocation and entrepreneurship. They observe substantial productivity differences arising from financial frictions that distort allocation of capital across heterogeneous firms causing misallocation and TFP losses. Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2015), study allocation of capital and productivity in Southern Europe using manufacturing data on Spanish firms from 1999 to 2012. They find a sizeable increase in TFP losses from capital misallocation and a significant dispersion in return to capital across firms due to financial frictions. Moll (2014), studies the effect of collateral constraint on capital allocation across-heterogeneous firms. He finds large productivity losses associated with financial frictions.

However, studies of (Albuquerque & Hopenhayn, 2004; Clementi & Hopenhayn, 2002; Cooley & Quadrini, 2001; Evans & Jovanovic, 1989; Fazzari et al., 1988; Hubbard, 1998; Jeong & Townsend, 2005, 2007; Musso & Schiavo, 2007), have shown that capital market-imperfections inflict financing constraints which impairs firms' investment decisions, amplify productivity losses and to a large extent distort efficient capital allocation due to market imperfections.

Fazzari, Hubbard and Petersen, Evans and Jovanovic, and Hubbard have examined the effect of financial constraints and credit market imperfection on firm's investment decisions and the cost of capital. They find a significant role of financial constraints. Further, Aghion and Bolton (1997), Piketty (1997), Galor and Zeira (1993), Banerjee and Newman (1993) and Banerjee and Duflo (2005) have shown that credit market imperfections affect income distribution and inequality especially in the presence of borrowing constraints. Studies of Hurst and Lusardi (2004) Evans and Jovanovic (1989), have also shown that liquidity constraints and capital market imperfections tend to inhibit entrepreneurship and perpetuate inequality among individuals, firms and across countries through selection and entry in production.

Other studies particularly (Caselli, 2005; Clementi & Hopenhayn, 2002; Cooley & Quadrini, 2001; Hurst & Lusardi, 2004), have also documented the effect of financing constraint on firm productivity growth and cross-country income differences. Equally, the role of improved financial markets in firm productivity growth has been extensively discussed in literature (see King & Levine, 1993; Levine, 1997, 2005; Rajan & Zingales, 1998; Wurgler, 2000). Studies of King and Levine, Levine, Rajan and Zingales, have especially shown that improved financial markets ameliorate financing constraints faced by firms, by facilitating efficient capital allocation through mobilizing savings, managing risks, and facilitating the trading of goods, services, and financial contracts.

Udry & Anagol (2006), measure capital returns in Ghana's informal economy. They find colossal annual returns ranging between 250 and 300% in new technology crop farming and 30−50% in traditional crop farming. They conclude that the dispersion in productivity across farms is due to binding financial constraints and market imperfections that impede the flow of capital to informal sector. De Mel et al. (2008), measure capital returns to Sri Lanka microenterprises using randomization to propagate shocks to capital. They find high average annual returns to capital ranging 55 to 63 percent across enterprises suggesting capital misallocation due to financial constraints.

De Mel et al. (2008), Midrigan and Xu (2014), Moll (2014), Udry & Anagol (2006), McKenzie and Woodruff (2008), Buera et al (2011), and Buera and Shin (2013), have observed large TFP differences across firms suggesting misallocation due to financial market imperfections. Udry & Anagol (2006), for example, measure capital returns to Ghana's informal economy. They find colossal annual gains ranging between 250 and 300% in new technology crop farming and 30−50% in traditional crop farming. They conclude that the dispersion in productivity across farms is due to binding financial constraints and market imperfections that impede the flow of capital to informal sector. De Mel et al. (2008), measure capital returns on Sri Lankan microenterprises using randomization to propagate shocks to capital. They find high average annual returns to capital ranging 55 to 63 percent across enterprises suggesting capital misallocation due to financial constraints.

McKenzie and Woodruff (2006, 2008), similarly estimate returns to capital in Mexican microenterprises. They find large dispersions in annual marginal returns ranging from 40 to 50 percent and 250 to 360 percent respectively and monthly return between 20 to 23 percent and 70 to 79 percent for financially constrained firms, suggesting misallocation of capital due to financial market imperfections, and firm characteristics. However, Caselli and Feyrer (2007) do not find any differences in returns to MPKs across countries and no evidence to support transnational credit frictions.

Although credit market imperfections play a significant role in firm productivity distortions, (Bartelsman & Doms, 2000; Foster et al., 2008; Hopenhayn, 1992; Jovanovic, 1982; Melitz, 2003), argue that rather than credit constraints, it's the reallocation of output or market shares from low productivity firms to more efficient counterparts through entry or exit that is driving aggregate productivity. They emphasize allocative and productive efficiency as the main sources of firm productivity differences rather than credit constraints.

### 2.1. Mechanisms and channels of propagation

There are several channels through which credit market imperfections propagate to affect firm productivity and income differences. One of the underlying channels through which financial market constraints affect firm productivity and

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income gaps is by imposing strong binding constraints on credit access by potential firms and entrepreneurs, which inhibit their entry and also propagate their exit from the market. Numerous studies particularly, (Fazzari and Petersen 1988; Jovanovic, 1982; Evans & Jovanovic, 1989; Buera, 2009a; Cooley & Quadrini, 2001; Aghion et al., 2007; Matsuyama, 2007; Clementi & Hopenhayn, 2002; Banerjee & Newman, 1993), have examined how financial market imperfections and credit constraints determine evolution of firms and entrepreneurship especially entry and exit from the market due to distortions in capital allocation and impediment in access to working capital by firms. Studies of (Aghion & Bolton, 1997; Galor & Zeira, 1993) have shown that credit market imperfections prevent the flow of funds to productive firms and entrepreneurs to undertake investments, which perpetuate inequality.

Financial market imperfections generate inequality in access to capital by firms due to barriers imposed by lenders such as prohibitive collateral requirements, high interest rates, short grace and repayment periods, which increase the cost of capital. For instance, Dabla-Norris, Townsend, Unsal and Ji (2015), find that the average collateral requirement for a loan in Philippines is 238 percent the size of the loan amount, higher than the requirements in other low-income countries like Uganda, Kenya and Mozambique. Likewise, micro-level evidence shows that borrowing and interest rate spreads faced by entrepreneurs in underdeveloped countries are large and extensively dispersed relative to developed countries, see (Fig. 1). Besides, collateral requirements as a percentage of loan size is extremely high in developing countries compared to developed countries. These constraints are more pronounced and severe among micro and small enterprise relative to medium and large sized firms (Beck, 2007; Beck & Demirguc-Kunt, 2006; Beck et al., 2001b; Beck et al, 2005, 2008, 2008; Beck et al., 2008).

Entry barrier, Aghion et al. (2007), have shown that credit constraints can act as a barrier to entry into the market by firms, by imposing high entry or sunk costs. They show that only productive firms with ability to borrow are selected into the market while small unproductive firms are forced to exit. Bellone, Musso, Nesta, Schiavo et al. (2008), Manova (2008) and Chaney (2013) also study the effect of credit and liquidity constraints on firm export behavior. They find that financially constrained firms are less likely to export due high entry costs in foreign markets which require high suck costs, and this affect firm productivity and growth. Evans and Jovanovic (1989), study entrepreneurship under financial constraint, they find that credit constraints impede potential entrepreneurs with high expected returns from undertaking businesses. Credit constraints also determine selection, entry and exit of firms in the market.

Another underlying channel through which credit market constraints affect firm productivity is through collateral constraints. Due to information opacity, weak legal institutions and difficulty in enforcement of contracts in developing countries, lenders are often inclined to impose large collateral requirements on assetless firms and entrepreneurs in order to access credit which sometime leads to credit rationing, crowding out “good” borrowers and hence distorting efficient allocation of capital. Besanko and Thakor (1987) and Steijvers and Voordeckers (2009) provide a rich empirical literature on collateral constraints and credit access. Moll (2014) has also shown that collateral constraints impose borrowing constraints on entrepreneurs without required security which leads to misallocation of capital and productivity losses in firms. Banerjee and Moll (2010) using

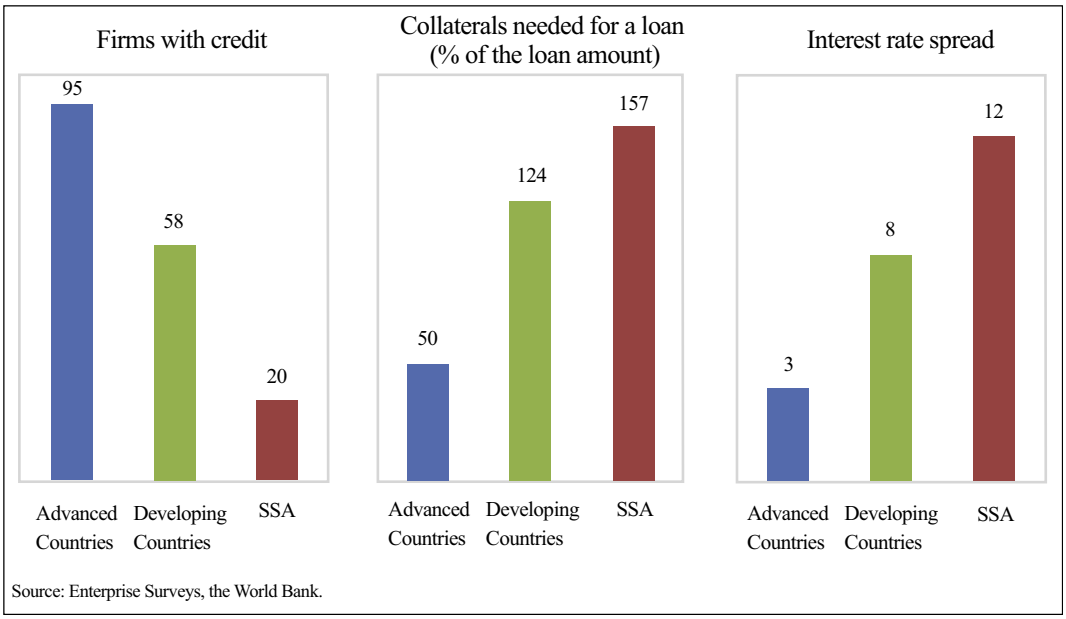


Fig. 1. Interest rate spreads and Collateral requirements across countries. Adopted from, Dabla-Norris et al. (2015).

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a simple model of capital accumulation with credit constraints illustrates how credit constraints lead to capital misallocation over intensive and the extensive margins. Dabla-Norris, Yan, Townsend, and Unsal (2015) using World Bank enterprise survey data, for example indicates that, collateral as a percent of the loan amount in the Philippines is 238.4, refer to Fig. 1 for illustration. However, Fafchamps (2004) argues that lack of regular income rather than collateral is the main reason why many firms and people are credit constrained and remain poor.

Another alternative channel through which financing constraints affect firm productivity growth is through misallocation of input across firms. Hsieh and Klenow (2009), Whited and Zhao (2015), Midrigan and Xu (2014) and Restuccia and Rogerson (2017), provide insightful empirical analysis of the effect of credit market imperfections on misallocation. Midrigan and Xu (2014) using plant level data for Colombia and South Korea to examine the effect of financing constraints on aggregate TFP, find large variability in plant-level output and differences in returns to capital across young and old plants. They also find large TFP losses in constrained firms compared to efficient firms without borrowing constraints. They conclude that firms facing binding credit constraints and high implicit external finance premium on average cause 55% TFP losses. Amaral and Quintin (2010), Greenwood et al. (2010) and Moll (2014), provide quantitative estimates of losses from financial frictions due to misallocation. For example, they find that, 80% of the TFP differences between US and Mexico and 50% of the variation between US and Colombia is due to finance frictions alone.

Buera, Kaboski & Shin (2011), using USA as a benchmark of well-functioning financial markets, find that 90 percent of distortions in capital allocation and differences in TFP between USA and Mexico, is due to the effect of financial frictions. They find sizable effects of financial frictions on aggregate level TFP, output per worker and across sectors as well as differences capital-output ratios. They show that financial development can explain 80 percent differences in output per worker between USA and Mexico.

Aside from the foregoing, another channel through which credit market frictions affect firm productivity and growth is property rights. Property rights might distort incentives for firms to, acquire credit, investment, transact, transfer, contract, use, sale, bequest and allocate resources, which leads to misallocation and inefficiency in production (Johnson, McMillan, & Woodruff, 2002; Besley & Ghatak, 2009). For example (Field 2005; Goldstein and Udry, 2008; Newman, Tarp, & van den Broeck, 2015), have shown that, lack of security of tenure inhibits investment and use of land as collateral to acquire finance or credit for investment. Goldstein and Udry (2008) investigate the effect of land rights on investment and agricultural productivity in Ghana. They find that insecurity of land tenure is associated with reduction in investment on land. Johnson et al. (2002), study the effect of property rights on access to external finance. They find that weak property rights lead to limited access to external finance especially in developing countries.

## 3. Methods and data

### 3.1. Methods

There are several theoretical and empirical models that have been proposed to analyze the underlying causes of cross country aggregate productivity and incomes differences over time. Among the notable ones include: Prescott (1998), Lucas (1978), Klenow and Rodríguez-Clare (1997), Foster, Haltiwanger, and Syverson (2005), Melitz (2003), Caselli (2005), Hsieh and Klenow (2009), Clementi and Palazzo (2016), and Adamopoulos et al. (2017). For example, Prescott (1998) and Klenow and Rodríguez-Clare (1997), models assume that rather than capital, it is TFP that determines cross country income variances, even if capital were extended to include human capital, intangible capital and organization capital. On the other hand, Caselli (2005), argues that cross-country variance in income can be explained by differences in efficiency although capital also matters. Acemoglu and Zilibotti (2001) provide evidence to show that a sizeable difference in TFP and output per unit of labor across countries is due to technology-skill mismatch. Like many models of firm productivity, in this paper, we combine two models: first, we use Hsieh and Klenow (2009) model for analyzing the extent and the sources of distortion and firms' resource misallocation. Secondly, we use the Stochastic Frontier Analysis for decomposition of the effects of financial constraints and to examine the effects of financial constraints on firms' efficiency gains from reallocations and improvement in financial conditions.

### 3.2. The Hsieh and Klenow model

We consider a model of production with heterogeneous firms. This model assumes two kinds of inputs: capital and labor with a constant and increasing-returns to scale. Like many new growth models in development literature, the model is a variant of monopolistic competition, originally proposed by (Dixit & Stiglitz, 1977) and extended by (Melitz, 2003; Hsieh & Klenow, 2009, among others), with slight modifications. This model is based on the works of Restuccia and Rogerson (2008); Foster et al. (2008) and Banerjee and Duflo (2005). The model is used to estimate the distortion touching (capital and labor) productivity and how resource misallocation reduces productivity. Based on Hsieh and Klenow (2009), we specify our model as a Cobb-Douglass form with a single output $Y$ produced by heterogenous firms. These firms produce different goods with different prices and use a Cobb-Douglass production type function. We aggregate firms in industries to produce the final output following a constant elasticity of substitution (CES) technology. The general specification of the model can take the form,

$$Y = \sum_{si}^{sN} \theta_s Y_s \tag{1}$$

where $\sum_i^N \theta_s = 1$ and $Y_s$ is the output of industry $s$.

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For each industry the production function can be written as:

$$Y_s = \left( \sum_{i=1}^{N} y_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (2)$$

The technology of each firm is written as:

$$Y_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i} \quad (3)$$

$A_i$, $K_i$ and $L_i$ are respectively; total physical productivity of capital and labor of firm $i$.

Hsieh and Klenow (2009) distinguishes distortion which affect output $\tau_Y$ from distortion that affect capital allocation $\tau_K$. Firms which are faced with financial constraints will have higher $\tau_K$ and unconstrained firms will have lower $\tau_K$ (see, for example Rajan & Zingales, 1998; Beck et al., 2008). In this study we focus on studying the distortions which affect capital allocation and occasioned by financial constraint. The profit function for each firm can then be written as follow:

$$\pi_i = (1-\tau_{y_i}) P_i y_i - w_i L_i - (1+\tau_{K_i}) R K_i \quad (4)$$

In this equation $P_i$ is a price of firm $i$ output, while $w_i$ and $R$ are wage and price of capital respectively. From this profit equation we derive the first order conditions of profit maximization.

$$MRPK_i = \frac{R(1+\tau_{K_i})}{1-\tau_{y_i}}, MRPL_i = \frac{w}{1-\tau_{y_i}} \text{ and}$$

$$\frac{K_i}{L_i} = \frac{\alpha_i}{1-\alpha_i} \frac{w}{R} \frac{1}{1+\tau_{Ki}}$$

Hsieh and Klenow (2009) show that:

$$MRPK_i = \frac{R(1+\tau_{K_i})}{1-\tau_{y_{si}}} = \alpha \frac{\sigma-1}{\sigma} \frac{P_{si} Y_{si}}{K_{si}} \text{ and } MRPL_i = \frac{w}{1-\tau_{y_{si}}}$$

$$= (1-\alpha) \frac{P_{si} Y_{si}}{L_{si}}$$

In frictionless, perfectly competitive markets where firms do not face distortions, the marginal revenue products of capital and labor would be equalized to their input prices for all firms. Nevertheless, if firms face distortions in the input markets, only the marginal revenue products of capital and labor after tax will be the same across firms (see, Cirera et al., 2017). The marginal revenue product of capital will be higher in firms that face financial constraints and lower in those that do not face constraints due to distortions and misallocation. We define two measures of inputs misallocation: The marginal product of capital ($MRPK_i$) and the marginal revenue product of labor $MRPL_i$. They measure the extent of dispersion of the marginal revenue products of capital and labor that is used to evaluate the level of misallocation.

### 3.3. The frontier analysis

The Stochastic Frontier Analysis measures production efficiency. The theoretical literature was stimulated by works of Koopmans (1951), Debreu (1951) and Shephard (1953) who are among the first authors in this area. Koopmans (1951) is among the first authors to define firm technical efficiency. However, it's Farrell (1957) who proposed the first empirical measure of productive efficiency. Based on the works of Koopmans (1951) and Debreu (1951), Farrell (1957) defines cost efficiency and its decomposition in terms of technical and allocative components. After Farrell (1957), many authors have investigated and extended his work. Among them include: Førsund and Hjalmarson (1974), Aigner, Lovell, and Schmidt (1977) and Färe, Grosskopf, and Lovell (1983). In frontier studies, the distance from the firm's efficient frontier is used for measuring a firm's performance Chen, Delmas, and Liberman, (2013). In empirical literature using frontier analysis, two models have been widely applied: The Data Envelopment Analysis (DEA) based on Charnes, Cooper, and Rhodes (1978) using linear programming method and the Stochastic Frontier Analysis (SFA) derived from Afriat (1972) and using econometric methods.

In this study we employ the later model. The Stochastic Frontier Analysis (SFA) which is built on the microeconomic concept of production function represented by the maximum achievable output assumed by a certain amount of inputs. The inefficiency is measured as the deviation from the maximum attainable output. The econometric models used for estimating this inefficiency/efficiency, have common characteristic of using a composite error term in the model. This term is the sum of the traditional symmetric and normal distributed error terms and asymmetric error term representing the deviation. A typical SFA model for cross-sectional data can be written as follow:

$$y_i = f(X_i;\beta) exp\{v_i - u_i\} \quad (5)$$

where, $f(X_i;\beta)$is the deterministic output common to all producers and $exp\{v_i - u_i\}$ is the error term which has two parts: $v_i$ is a symmetric and follows a normal distribution with zero mean, and $\boldsymbol{u_i}$ is an asymmetrically distributed "inefficiency" factor which is assumed to be positive. For the estimation of the model (5) we assume a Cobb−Douglas functional form for $f(X_i;\beta)$. Assuming the Cobb-Douglas functional form and applying the natural log in equation (4), it can be rewritten as below.

$$lny_i = lnf(X_i;\beta) + v_i - u_i \quad (6)$$

where, $\exp(-u_i)$ and $u_i$ are respectively, the efficiency and inefficiency measures.

### 3.4. Extent and sources of firms' resource misallocation

We use two analytical methods in this first part. For exploring the extent of misallocation among firms, we use the descriptive statistics and the kernel density dispersion plot of the MRPK and the MRPL. In the absence of capital distortion inputs are allocated to the firms according to their total factors productivity and firms would have equal marginal products of capital and labor. However, in the case of distortion and resource misallocation, resources are distributed to firms

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according to their capacity and access leading to spread in marginal productivity of capital and labor. After analyzing the extent of resources misallocation among firms, we use an OLS estimation to analyze the determinants of firms' resources misallocation. Therefore, we specify the two linear models with the natural logarithm of MRPK and MRPL as dependent variables and firm characteristics and institutional variables as explicative variables.

$$lnMRPK_i = \beta_0 + \sum_{i=1}^{7} \beta_i X_i + \varepsilon_i$$

$$lnMRPK_i = \beta_0 + \sum_{i=1}^{7} \beta_i X_i + \varepsilon_i$$

where $X_i$, $i = 1\ldots4$ are respectively financial constraint, Firm age, Managerial experience, Small firm, Medium firm, Red tape and competition.

### 3.5. The frontier function estimation method

In the empirical studies with stochastic frontier analysis, two mains groups of estimation methods have been used. The distribution-free approach and the Maximum Likelihood Estimators. The distribution-free approach presents however a downside for the cross-section data because the errors of the frontier function cannot be separated from the inefficiency effect of the model, and so it is not possible to allow for both inefficiency and the error terms in the model of Kumbhakar, Wang, and Horncastle (2015). Therefore, in this study we follow the maximum likelihood estimation method.

Before using the maximum likelihood for estimation, some key assumption must be made on the error terms $v_i$ and $u_i$. These assumptions include the distributions of $v_i$ and $u_i$ and their independence. The zero mean and normal distribution for the symmetric random error ($v_i \sim iid\, N(0, \sigma^2_{v_i})$) is not a source of debate in literature. Unlike$v_i$, the choice of the distribution of $u_i$ is the source of controversies. Many distributions have been proposed for the inefficiency error term. The half-normal distribution (Aigner et al., 1977), the truncated-normal (Stevenson (1980)) and the exponential distribution Meeusen and van den Broeck (1977), are among the distributions suggested in the literature. We adopt the exponential distribution proposed by Meeusen and van den Broeck (1977) in this study and the bellow assumption on the errors terms shall be meet before estimating.

i. $v_i$ and $u_i$ independent of each other and of the regressors.
ii. $v_i \sim iid\, N(0, \sigma^2_{v_i})$
iii. $u_i \sim iid\, N(\eta, \eta^2)$ , where $\eta > 0$

Another issue in estimating stochastic frontier framework is the problem of heteroscedasticity. Wang and Schmidt (2002) have shown that if the heteroscedasticity problem is not solved the stochastic frontier estimation may lead to unreliable estimates and inferences. Therefore, to take into account the heteroscedasticity problem in our estimation, we parametrize $\sigma^2_{v_i}$ and $\sigma^2_{u_i}$ as follow:

$$\eta^2 = \exp(Z_i\gamma) \text{ and } \sigma^2_{v_i} = \exp(Z_i w_{ui})$$

where $Z_i$ are explicative variables. Accordingly, with $f(X_i;\beta)$ a cobb-Douglas function, the model in equation (6) is rewriting as follow:

$$lny_i = lnA_i + lnK_i + lnL_i + v_i - u_i,$$

where, $A_i$, $K_i$, $L_i$ are respectively the total factors productivity, capital and labor.

$$v_i \sim iid\, N(0, \exp(Z_i w_{ui})) \text{ and } u_i \sim iid\, N(\eta, \exp(Z_i\gamma))$$

### 3.6. Determinants of inefficiency/efficiency

The stochastic frontier analysis model allows us to determine the factors that explain the inefficiencies captured in our model by the asymmetric error term $u_i$. In our study we would like to see if financial constraints are a source of firms' inefficiencies. Many authors including; Kumbhakar, Ghosh, and McGuckin (1991); Reifschneider and Stevenson (1991); Huang and Liu (1994); and Battese and Coelli (1995), have suggested estimation methods that allow the inclusion of the determinants of inefficiencies. In the early methods, authors have proposed models of two step estimation. They estimate the specific inefficiency measure for each observation in the first estimation, and then regresses the index on a vector of independent variables in the second estimation. However, other authors (Battese and Coelli (1995), Wang and Schmidt, (2002)) have identified biases in the estimates resulting from this procedure. Therefore, they propose innovative approaches using a one-step estimation to solve this problem. In this study, we use this last procedure by setting the distribution of $u_i$ as a function of explicative variables which are likely to influence the efficiency/inefficiency of firms. We adopt the specification of Coelli (1995), by specifying the mean of $u_i$ as a linear function of some independent variables. The mean of $u_i$ is written as follow:

$$\eta = Z_i\gamma$$

where; $Z_i$ is the vector of explanatory variables and $\gamma$ is the vector of the parameter to be estimated. Empirically, we specify the mean of the asymmetric errors term as follow:

$$\eta = \gamma_0 + \gamma_1 Z_1 + \gamma_2 Z_2 + \gamma_3 Z_3 + \gamma_4 Z_4,$$

where $Z_1$ , $Z_2$, $Z_3$, $Z_4$; are respectively Small size firm, financial constraint, firm age and harmful competition. $\gamma_i$, $i = 0\ldots4$ are the parameters to be estimated.

The stochastic model to estimate is empirically written as bellow:

$$lny_i = lnA_i + lnK_i + lnL_i + v_i - u_i$$

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$$u_i \sim iid\, N(\eta = \gamma_0 + \gamma_1 Z_1 + \gamma_2 Z_2 + \gamma_3 Z_3 + \gamma_4 Z_4,\ \exp(Z_i\gamma))$$

### 3.7. Data

In this study, we use cross-sectional data from World Bank Enterprise Surveys (2016) on Sub-Sahara African firms. World Bank Enterprise survey is a firm-level data. It covers a broad range of subjects such as firm characteristics, competition, institutions, and so on. The study uses a sample of 2257 firms from nine sub-Saharan African countries. These countries include, Cameroun, Benin, Togo, Mali, Guinea, Côte d'Ivoire, Lesotho, Swaziland and Zimbabwe. Our key variables include financial constraints, production (output), labor, and capital. The financial constraint is defined in the data as the extent to which access to finance is an obstacle for the firm (Aghion et al., 2007; Ayyagari et al., 2008; Banerjee & Duflo, 2014; Beck & Demirguc-Kunt, 2006; Beck, Demirguc-Kunt, & Maksimovic 2008; Beck, Demirguc-Kunt, Laeven & Levine 2005; Beck et al., 2008; Cooley & Quadrini, 2001; Demirguc-Kunt & Maksimovic, 1998; Hsieh & Klenow, 2009; Rahaman, 2011; Rajan & Zingales, 1998). We then recodify this variable in a dummy which takes 1 for constraint and 0 for unconstrained. The annual production of firm is not defined in the data. Therefore, we take total annual sales of each firm as a proxy of annual production. Labor is defined in the data as the total number of permanent employee of the firm. Finally, we take the net book value as the capital. The data being at firm level presents an advantage, but the weakness is that they have many missing data, which are not available for panel data study.

## 4. Empirical results and discussion

### 4.1. Results and discussion

In this section, we present the main results of the study. We begin by presenting the descriptive statistics, the extent and the determinants of the misallocation in the first model. In the second part we analyze the influence of firm characteristics and institutions on efficiency.

#### 4.1.1. Extent and sources of distortion and capital misallocation

*4.1.1.1. Extent of misallocation.* Before analyzing the relationship between financial constraint, misallocation of capital and firm productivity in this section, we examine the degree of misallocation of capital and labor in sub-Saharan Africa. The Table 1 presents the descriptive statistics such as the mean and standard deviation of the MRPK and the MRPL for the sample and the size of the firms. In absence of capital and labor misallocation, firms should have the same MRPK and MRPL and the standard deviation of MRPK and MRPL would tend to zero. The statistics presented in Table 1, show that the standard deviation for MRPK is lower compare to the MRPL. Their values are respectively 0.40 and 9 for MRPK and MRPL. This shows that the MRPK is less spread than MRPL among SSA firms indicating a large labor misallocation. These results are confirmed by (Fig. 2) panel d and (Fig. 3) panel d plots of the Kernel density for lnMRPK and lnMRPL. These results are backed by the findings of (Cirera et al., 2017; Tybout, 2000; McCullough; 2017) who find large labour productivity gaps in Sub-Sahara Africa firms. In fact, the Kernel density estimate is narrower for the MRPK. We extend the analysis by looking at the extent of input misallocation by firm sizes.

Table 1
Descriptive statistics.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **A: For all Sample** | | | | | |
| lnMRPK | 490 | 0.398565 | 0.47373 | −1.30962 | 3.233269 |
| lnMRPL | 2043 | 8.997218 | 2.015919 | 4.189772 | 15.99194 |
| **B: Small size firms** | | | | | |
| lnMRPK | 208 | 0.371021 | 0.486073 | −0.45684 | 3.233269 |
| lnMRPL | 2043 | 8.997218 | 2.015919 | 4.189772 | 15.99194 |
| **C: Medium size Firms** | | | | | |
| lnMRPK | 166 | 0.381099 | 0.401905 | −0.68155 | 1.353542 |
| lnMRPL | 580 | 9.193757 | 2.069796 | 4.189772 | 13.56009 |
| **D: Large firms** | | | | | |
| lnMRPK | 116 | 0.47295 | 0.538371 | −1.30962 | 1.806444 |
| lnMRPL | 298 | 9.376079 | 2.197544 | 5.094332 | 13.67736 |

### 4.2. Financial constraints and firm's inputs misallocation in SSA

In this subsection we look at the sources of firms' input misallocation. Among the obstacles faced by SSA firms, access to finances is remains a persistent and endemic problem (Beck, 2007; Ayyagari et al., 2008; Beck, Demirguc-Kunt, & Maksimovic 2008). In this part we explore the sources of firms' capital misallocation and specifically answer the following question: Do financial constraints constitute a source of misallocation? Table 2 presents the estimates of the OLS regression of lnMRPK and lnMRPL on firms' characteristics variables and institutional variables. The variables on firm characteristics include, firm size, age, managerial experience and financial constraints which is our key variable of interest. As institutional variables we include "Red tape" or bureaucracy and competition dummy. We find that among the firm characteristics, firm age, firm size and financial constraint are significantly correlated with lnMRPK. For the institutional variables none of them is significantly different from zero. Financial constraint is associated with negative coefficient equal to −0.066. This means that firms facing financing constraint have 6.6 percent lower MRPK than firms without financial constraints. Firm characteristics especially age and size (small and medium size) firms are negative and significantly associated with financing constraints (Beck, Demirgüç-Kunt and Maksimovic, 2005; Beck & Demirguc-Kunt, 2006; Loderer & Waelchli, 2010). This means that small firms and medium size firms have a lower marginal revenue product of capital than large firms. In addition, we find that an extra year of firm survival leads to a loss of 2% in marginal product of capital. This contradicts (Coad, Segarra, & Teruel, 2013) who find that firm productivity increases with age using Spanish

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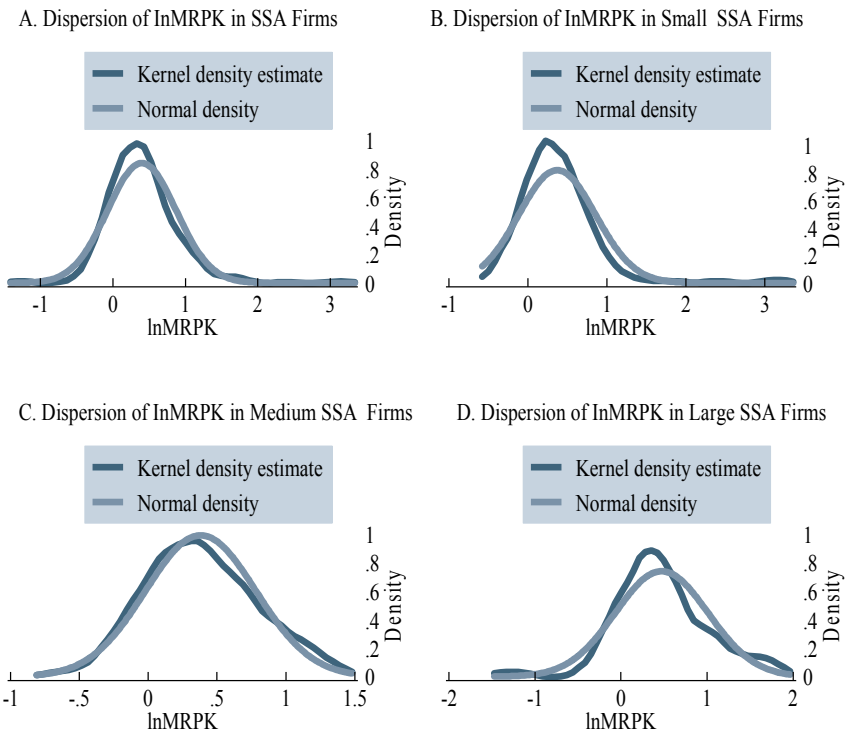


Fig. 2. Dispersion of lnMRPK in SSA firms.

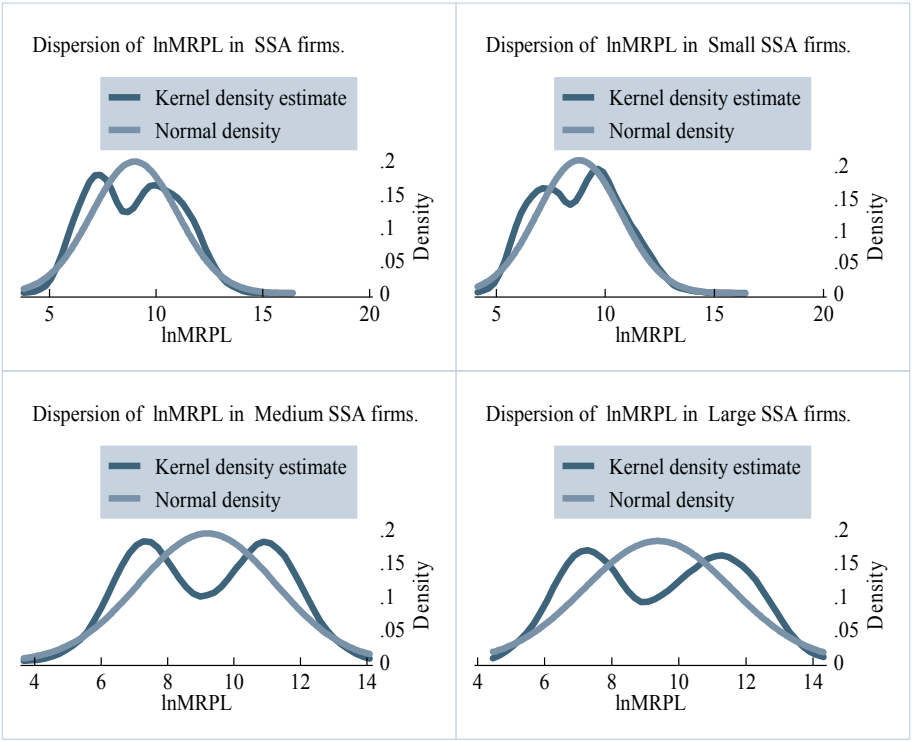


Fig. 3. Dispersion of lnMRPL in SSA firms.

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Table 2
Determinants of SSA firms misallocation.

| Variables | (1) | (2) |
|---|---|---|
| | lnMRPK | lnMRPL |
| Financial constraint | −0.0664 | −0.102 |
| | (0.0474) | (0.0975) |
| Firm age | −0.00271** | −0.0241*** |
| | (0.00110) | (0.00262) |
| Managerial exp | 0.000914 | 0.0437*** |
| | (0.00212) | (0.00451) |
| Small firm | −0.136** | −0.646*** |
| | (0.0600) | (0.139) |
| Medium firm | −0.0996* | −0.164 |
| | (0.0595) | (0.147) |
| Red tap | 0.000271 | 0.0194*** |
| | (0.00131) | (0.00219) |
| Harmful competition | −0.0544 | −0.0842 |
| | (0.0489) | (0.105) |
| Constant | 0.616*** | 8.886*** |
| | (0.0820) | (0.179) |
| Observations | 433 | 1656 |
| R-squared | 0.032 | 0.143 |
| Adj. R-squared | 0.0165 | 0.1398 |

*t* statistics in parentheses, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

Table 3
Stochastic frontier function estimates.

| Variables | (1) | (2) | (3) |
|---|---|---|---|
| | Frontier | etas | vsigmas |
| Small firm | | 0.748 | |
| | | (1.243) | |
| Financial constraint | | 15.06*** | |
| | | (3.786) | |
| Firm age | | 0.0645*** | |
| | | (0.0194) | |
| Harmful competition | | −0.196 | |
| | | (1.032) | |
| Lcapital | 0.729*** | | |
| | (0.0291) | | |
| Llabor | 0.513*** | | |
| | (0.0832) | | |
| LManagement experience | 0.337*** | | |
| | (0.130) | | |
| Constant | 3.254*** | −19.57*** | 1.242*** |
| | (0.483) | (3.595) | (0.0643) |
| Observations | 458 | 458 | 458 |
| Adj R-squared | 0.6935 | | |

*t* statistics in parentheses, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

data. The column 3 of Table 2 presents the results of the OLS estimates of the lnMRPL. Firm age, managerial experience, and small firm size are the characteristics which are significantly related to labor marginal revenue product. As in the MRPK, the coefficient of firm age and firm size is negative indicating old firms have lower MRPL. This findings are supported by (Loderer & Waelchli, 2010) who find that firm productivity tends to decline with old age. However, these results are disputed by findings of (Majumdar, 1997; Coad et al., 2013) for the case of Indian and Spanish firms, who find that ageing firms have higher levels of productivity, profits and lesser debt ratio. Unlike in the equation of lnMRPK, managerial experience is significantly related to higher lnMRPL and has a positive coefficient. Therefore, one year of increase in managerial experience can lead to a 4.7% increase in MRPL. However, the dummy variable for financial constraints is not significantly related to marginal revenue product of labor. Therefore, financial constraint in SSA only distorts capital allocation which leads to capital misallocation and a low marginal productivity of capital. Unlike MRPK, red tape as an institutional and policy variable is significantly and positively related to lnMRPL. This means that one percent increase in time spent in dealing with authorities distorts labour allocation and leads to lower labor productivity. A substantial reduction in bureaucracy would lead to a rise of the quantity of labor and increase in firms' marginal productivity of labour by 1.9%.

### *4.3. Effect of financial constraints on firm productivity*

In this part we analyze the determinants of firm efficiency specially the effect of financial constraint on firm efficiency in sub-Saharan African by using the stochastic frontier analysis. Before estimating the model, several confirmatory tests were made. Among these tests, we carried out a skewness test and the likelihood ratio test to determine whether it is worth to specify a stochastic frontier model. The results of the two tests certify the necessary evidence for specification of asymmetric error model. Therefore, the model is well specified, and we can interpret the results of estimation without any care about misspecification. Table 3 shows the results of the estimation of the stochastic frontier function and the estimates of the determinants of firms' inefficiency. In the second column of Table 3 we present the coefficients of the production function. The results show that the coefficients of the three inputs are all significantly and positively different from zero. The elasticity of capital with respect to output is equal to 0.739 and is the highest coefficient indicating that capital is more important than labor in the production of SSA firms. The sum of the three input coefficients is higher than 1 indicating increasing returns to scale. The column 3 of Table 3 shows the coefficients of the determinants of firms' inefficiencies. The results attest that financial constraint and firms' age are significantly and positively related to firms' inefficiencies. For instance, firms which face financial constraint have 15% higher inefficiencies than firms that do not face financial constraints. Financial constraint reduces then firms' efficiency. As noted by Fazzari et al. (1988) and Gilchrist et al. (2013), financial constrained firms' loss efficiency because they face high borrowing cost.

## 5. Conclusion

This study extends literature on the effects of financing constraints on firm productivity gaps and resource (mis)allocation in a sample of 9 Sub-Sahara Africa countries, using enterprise survey data form World Bank. The study evaluates

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the role of financing constraints and policy distortions in resource misallocation, TFP growth, and income changes. The study applies a stochastic frontier model to estimate productivity losses from policy distortions, financial constraints and efficiency gains from improvements in financial access. We find large TFP gaps amongst small, medium and large firms and between financially constrained and unconstrained firms. Financially constrained firms have 6.6 percent lower MRPK compared to unconstrained firms. We also find a large dispersion in MRPK among small, medium and large size firms. Small and medium size firms have lower MRPK compared to large firms, suggesting that financial constraint has more binding effects on small and medium firms compared to large size firms. Our results are consistent with Cirera et al. (2017), who find large productivity gaps between Cote d'Ivoire, Ethiopia, Ghana, and Kenya.

Besides, we find that productivity is negatively correlated with firm age and size. An extra year of firm survival could lead to an overall loss in MRPK by 2 percent and 6.4 percent in small firms as well as 1.4 percent in medium size firms. This finding contradict (Loderer & Waelchli, 2010; Coad et al., 2013). This could explain why there're many missing medium size firms in SSA and high death rate of small and mid-sized firms due to productivity-selection survival of firms and reallocation due to binding financial constraints and inefficiency. McKenzie and Paffhausen (2017) and Hsieh and Olken (2014), Tybout (2014), confirm these results. McKenzie and Paffhausen (2017), find 8.3 percent annual death rate for small firms within first five years of establishment and a 50 percent death rate after 6 years of establishment for richer countries but could be higher in poor countries especially SSA. Krueger (2013) and Hsieh and Olken (2014), also confirm "missing middle" firms or bimodal distribution of firms in developing countries. Foster et al. (2005) also find that reallocation occur due to exit of inefficient firms and productivity selection survival link. However, Caselli and Feyrer (2007) finds similar MPKs across countries and conclude that: *"there is no support for the view that international credit frictions play a major role in preventing capital flows from rich to poor countries. Lower capital ratios in these countries are instead attributable to lower endowments of complementary factors and lower efficiency, as well as to lower prices of output goods relative to capital"*.

Another robust finding from this study is that the elasticity of capital is 0.739 higher than labour indicating that capital is more productive than labour in SSA firms. The sum of elasticities of inputs is greater than indicating increasing returns to scale. Finally, we find financially constrained firms more inefficient compared to unconstrained firms. Financial constraints reduce firm productivity by 15 percent lower than unconstrained firms. We also find that "Red tape" as an institutionally induced policy distorts labour allocation due to increase in time spent dealing with authorities and significantly lowers labor productivity. One percent reduction in time spent dealing with authorities would lead to a substantial reduction in bureaucracy and increase in MRPL by 1.9 Percent.

These results have significant policy inferences on firm productivity in SSA. First, they show that reduction in "Red tape" or bureaucracy could significantly increase labour productivity in SSA firms. Secondly, firm productivity losses could significantly be minimized if access to finance is improved in SSA. Financial constraint could be the source of death of many small and medium firms in SSA. However, further research is needed to confirm this link. Further, results indicate that capital is more productive than labour in SSA firms. This could mean that if binding capital constraints are improved firms could significantly improve productivity.

## Conflict of interest

The authors report no conflict of interest.

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