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Abstract

The gender gap in firm productivity is the widest in Africa, and evidence on the determinants of this variation remains thin. We exploit a harmonized firm-level survey dataset of 46 African countries over the period 2006-2018 to explain the productivity gender differential and identify the association pathways. Special focus is placed on the behavior with respect to innovation and technology adoption and dealing with market inefficiencies and institutional barriers. We construct five composite indices to reflect the categories of productivity determinants and apply mean and quantile decomposition approaches. Our estimates indicate a significant productivity differential by the gender of entrepreneur in Africa, specifically in the Northern and Eastern regions. Interestingly, the differential is not induced by educational nor entrepreneurial abilities but rather by women being more negatively affected by institutional barriers, such as corruption and perceptions about it, and market inefficiencies, such as the lack of access to finance. These results can be explained by gender-based behavioral differences and institutional structures, which can as well affect women's selection of business activity, making their firms less likely to benefit from some innovation and technology adoption activities.

Keywords: Productivity; gender gap; innovation; technology adoption; access to finance; perceived rule of law; Africa.
JEL Classifications: D24, L20, M5.

1. Introduction

Gender gaps in productivity performance are the widest for African firms and, worryingly, the gap is even widening in some African countries, especially in the East African region.[3] There is no consensus in the literature on firm performance along the gender of the manager or even the owner. The available evidence on the impact on firm performance, as measured by sales or profits, is mixed. Several studies report that female-owned firms have lower sales (Coleman, 2007; Loscocco & Robinson, 1991; Sabarwal & Terrell, 2008) and lower profits (Bosma et al., 2004; Robb & Wolken, 2002); but other studies find no differential in firm performance by the owner's gender (Kepler & Shane, 2011; Watson, 2002). Some studies even find that firms with female owners or managers perform better in terms of both sales and profits than firms that are owned or managed by men (Coleman, 2007; Hashimzade & Rodionova, 2013).

Similarly, as measured by productivity, the evidence on the impact of gender on firm performance is inconclusive and limited as well. A recent study by Flabbi et al. (2019) shows that the interaction between female chief executive officers (CEOs) and the share of female workers employed in the Italian manufacturing sector has a significant positive impact on sales per employee, value added per employee, and TFP. This finding is based on the presumption that executives are better equipped to assess the skills of employees of the same gender. On the contrary, using data from 26 developed and developing countries in Eastern Europe and Central Asia, Sabarwal & Terrell (2008) find that female entrepreneurs have a significantly smaller scale of operations (measured by sales revenues), are less efficient in terms of TFP, but generate the same amount of profit per unit of revenue as men. Another strand of the literature (e.g., Gui-Diby et al., 2017) reveals that gender is not a core determinant of productivity level, suggesting that female entrepreneurship per se does not strongly nor directly affect productivity differences.

While the literature on gender productivity differentials appears voluminous, the available evidence mostly draws from firms in developed economies, whereas evidence from developing countries, particularly Africa, remains scant. Moreover, evidence on the association pathways is not provided within a unified framework, with micro studies typically focusing on one or two dimensions, and the gender dimension is rarely incorporated. No empirical evidence could be identified from the existing literature on the determinants of firm-level gender productivity differential in Africa in the manufacturing or services sectors.

This study fills a gap in the literature by estimating the level of TFP differential by gender across Africa, with special focus on North Africa and East Africa, and is the first to provide empirical evidence on the association pathways via which various firm-level TFP determinants affect the observed differential within a unified framework. We collapse the available micro data and construct variables and indices reflecting the categories of productivity determinants, with the aim of identifying which category is driving the gender differential in productivity in developing countries, especially Africa ones. Thus, our aims are threefold: first, to assess if a productivity differential exists between male- and female-managed firms in Africa as a whole

[3] Source: Authors' computations based on World Bank Enterprise Surveys. See subsection 3.4 for further details.

and in each of its five regions; second, to estimate the contribution of diverse categories of TFP determinants, specifically innovation, human capital, market inefficiency, and physical and institutional infrastructure barriers to the estimated gap, focusing on the Northern and Eastern regions, where the gap is pervasive; and third, to investigate the possibility of heterogeneity of firm behavior at different points of the productivity distribution.

Our empirical framework draws from the recent literature on the firm-level production function that acknowledges "management" as an important input, and therefore incorporates the type of management practice both as an independent input in the firm's production function along with traditional inputs and as a determinant of TFP (Bender et al., 2018). However, as we lack survey data on the management practices of African firms, we incorporate the gender of the manager (rather than the owner) instead in the production function. We apply mean- and quantile-based decomposition approaches based on a perfectly-harmonized dataset of 37,699 firms in 46 African countries over the 2006-2018 period. Further, multiple correspondence analysis (MCA) is used to construct five composite indices reflecting the five broad categories of productivity determinants.

Our estimates confirm the presence of a significant productivity differential by the gender of entrepreneur in Africa, specifically in the North and East. Interestingly, we provide novel and consistent evidence that this differential is mainly driven by women entrepreneurs being more negatively affected by or, simply, "vulnerable" to institutional barriers, such as corruption and perceptions about it, and market inefficiencies, such as the lack of access to finance. No evidence is obtained from Africa to support the hypothesis that women entrepreneurs have less educational or entrepreneurial abilities that could be inducing the productivity differential. We expect the findings of this paper to inform policy toward unleashing the productivity potential of developing countries and Africa in particular by addressing gender-specific barriers to entrepreneurship, suggesting that the priority should be to address gender-based behavioral differences as well as existing institutional structures, which can also affect women's selection of business activity, making their firms less likely to benefit from some innovation and technology adoption activities.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature; section 3 describes the data sources and MCA and provides some descriptive analyses; section 4 lays out the econometric model and the identification strategy; section 5 discusses our key findings; and section 6 concludes.

2. Literature review

2.1 Gender productivity differential

Few studies report on the gender differential in firm-level TFP in developing countries and the evidence provided is mixed. Drawing from data on informal firms in 14 developing countries, Chowdhury (2012) finds that female ownership has significant negative associations with total sales and labor productivity, but a significant positive association with the number of female workers employed by the firm.

Contrast to these findings, Williams & Kedir (2018) find that firms that are women-owned or jointly owned by men and women in South Africa perform better in terms of real annual sales growth and annual productivity growth than those owned solely by men. The study does not explicitly explain the reported association, but argues that it could partly reflect country context, as some of the conventional reasons for the underperformance of women entrepreneurs are not present in South Africa. These reasons include financial exclusion from formal loans, poorer education, and cultural and family responsibilities, which appear to obstruct women's entrepreneurship (FinScope South Africa, 2010; Kenge, 2016; Small Business Project, 2013). Small Business Project (2013) further supports these results for South Africa by testing the hypothesis of women's lower appetite for risk. The study finds that women owners in South Africa are 6 percent more likely than men to indicate an aspiration for firm growth, tend to be moderately open as men to risk, and are not more risk-averse than men.

Innovation and TFP. Innovation is generally found to have a positive impact on firm TFP (e.g., Aiello & Ricotta, 2016). Overall, firm decisions to conduct innovative activities are likely to be jointly dependent on firm-level factors such as manager's education and management practices, both possibly affected by gender, workforce skills, as well as local spillovers. Firm decisions depend also on business environment factors affecting incentives and risk-return considerations.

While the literature on innovation has rapidly expanded, few studies attempt to explain gender disparities in managerial decisions about innovation and technology adoption, and the evidence provided on whether female-led firms are more or less prone than male-led firms to undertake innovative activities is mixed. Pelger (2011) shows that women in German small- and medium-sized enterprises (SMEs) indicate to a lesser extent aspiring and growth-orientated investment goals like sales increase, innovation/R&D, or implementation of new products. Similarly, drawing from data on South Korean new ventures, Marvel et al. (2015) find that innovation is a gendered process with systematic differences regarding individual education type, interfirm network ties, and new firm regional location.

On the contrary, Ritter-Hayashi et al. (2016) report a direct positive effect of gender diversity in 15 developing countries in South Asia, the Middle East, and Africa on firms' likelihood to innovate as well as a positive effect of having a female top manager. The study also shows that gender diversity increases the likelihood to innovate for firms operating in countries with rising levels of women's economic opportunity on the one hand and decreases the innovation likelihood for firms operating in countries that are at the low end of providing women's economic opportunity on the other hand.

Institutional barriers and TFP. It is well established in the literature that corruption adversely affects, at the macro level, the efficiency levels at which economies perform (Salinas-Jimenez & Salinas-Jimenez, 2006) and economies' TFP (Kéïta, 2017); and, at the micro level, the efficiency and productivity of firms, be it measured by the gross value added per worker, capital-labor ratio, or TFP (Bó & Rossi, 2007; De Rosa et al., 2013; Giordano & Lopez-Garcia,

2018; Kato & Sato, 2014).[4] However, few studies investigated the gender differential effects of corruption on firm efficiency. In their study of 14 Central and Eastern European countries, Hanousek et al. (2016) find that a highly corrupt environment has an adverse effect on firm efficiency. This effect is stronger for firms run by a female CEO, who, for several reasons, has a lower propensity to engage in corruption (Bertrand, 2011; Croson & Gneezy, 2009; Levin et al., 1988).

Trentini & Koparanova (2017) provides contrary evidence on the role of corruption in explaining employment growth in 31 Central and Eastern European countries. Although they confirm that bribing has a negative impact on firm growth in general, a significant gender differential in terms of a positive growth impact of bribing on female-owned firms is detected, suggesting that informal payments can represent a means to smooth management and improve performance of female-owned firms.

A recent study by Wellalage et al. (2019) provides similar evidence from South Asian SMEs, as bribery is found to be more effective in terms of credit access when used by female SME owners.

2.2 Gender effect pathways

The causal pathways underlying firm gender productivity differential are generally threefold: men and women tend to behave differently; men and women can have different talents and perspectives; and women may face barriers that arise from existing institutional structures, both formal and informal.

In terms of *behavior,* Croson & Gneezy (2009) identified robust differences between men and women in risk, social, and competitive preferences. They argue that (i) women are more risk averse and suggest a list of possible mechanisms behind this finding, including emotions, overconfidence, as well as framing; (ii) women's social preferences are different than men's as women are generally more sensitive to social signals in determining appropriate behavior; and finally, (iii) women's preferences for competitive situations are lower than men's, both in purely competitive situations and in bargaining settings. Higher risk aversion of women has been particularly documented by several studies (e.g., Bertrand, 2011; Charness & Gneezy, 2012; Faccio et al., 2016; Orobia et al., 2011).

Most of these behavioral differences can interact with firm-level TFP determinants and affect a firm's performance through the gender of its manager. For example, firms run by a female CEO may be reluctant to engage in criminal activities such as bribery (Dollar et al., 2001; Swamy et al., 2001) due to factors such as higher risk-aversion, less overconfidence (Barber & Odean, 2001; Deaux & Farris, 1977; Lundeberg et al., 1994), or more pro-social attitudes than men (Alesina & Giuliano, 2011; Eckel & Grossman, 1998).

[4] In some exceptions, though, few studies find that bribery is positively associated with productivity, supporting the "greasing the wheels" hypothesis of bribery as a factor that reduces transaction costs (e.g., Herrera and Kouamé, 2017).

The evidence so far on the gender-based differences in *talents and perspectives* is mixed. Examining how the attributes of female directors differ from those of males, Hillman et al. (2002) find that female directors in the United States are more likely to come from non-business backgrounds and are more likely to hold advanced degrees. Similarly, findings from a study in the United Kingdom reveal that women are more likely to bring international diversity to their boards and to possess an MBA degree (Singh et al., 2008).

However, evidence from these studies contradicts the findings reported by other studies that women lack adequate human capital for entrepreneurship. For example, Gottschalk & Niefert (2013) find that, compared to males, female entrepreneurs in German start-up firms have a lower level of formal education and less professional experience. Similarly, Fairlie & Robb (2009) find that female-owned firms in the United States are less successful than male-owned ones as women have less prior work experience in a similar business as well as in a family business.

An interplay of *behavioral* differences and differences in terms of *talents and perspectives* can further affect firm performance by, for example, driving women to self-select themselves into certain sectors or industries. These sectors or industries mostly have characteristics that explain lower firm performance, such as being more competitive, implying lower profits. In general, women are reportedly concentrated in low-performing sectors such as retail sales and services (Bardasi et al., 2011; Carter & Shaw, 2006) but are less likely to operate business in high-technology sectors (Anna et al., 2000; Gottschalk & Niefert, 2013; Loscocco & Robinson, 1991; Singh et al., 2001). Fairlie & Robb (2009), however, find that gender differences in industry distributions do not significantly explain gender gaps in firm performance in the United States. Another example of behavioral differences is given by Morsy et al. (2019) that women entrepreneurs in Africa are more likely to self-select themselves out of the credit market due to low *perceived* creditworthiness compared with their male counterparts.

Finally, we expect *institutional barriers* to women, especially in developing countries, to affect the performance of female-managed firms. Formal institutional determinants identified in the literature include formal gender equality recognized by law, labor market legislation, tax legislation, as well as child care infrastructure. Informal institutional influences on female entrepreneurship include discrimination against women in the workplace, traditional attitudes, religious beliefs, entrepreneurship seen as a male activity, society's attitude towards women and employment, and family values (Aidis et al., 2007; Brixiová & Kangoye, 2015).

The gender-based differences in behavior, talents and perspectives, together with these institutional structures, may influence both the ability and willingness of women managers to behave, which can ultimately impact firm performance. Take, for example, the empirical evidence that female-led firms perform worse than male-led firms in some contexts as the former use less startup capital (Brixiová & Kangoye, 2015; Fairlie & Robb, 2009; Orobia et al., 2011). Potential effects can also be observed with respect to innovation and technology

adoption as well as behavioral responses to corruption, each critical to firm productivity, or specifically TFP, and can explain gender gaps in firm performance.

3. Data and descriptive statistics

3.1 Data sources

We exploit a harmonized firm-level dataset from the World Bank's ES[5], which covers 37,699 firms in 46 African countries over the period 2006-2018, out of which 6,097 firms are in North Africa and 8,212 firms are in East Africa. The firms covered in the survey are drawn from the manufacturing and services sectors according to each's relative contribution to GDP in each country. Formal (registered) firms with five or more employees are targeted for interview. The ES is answered by business owners and top managers. It provides a rich set of information that enables us to construct an array of firm-level TFP determinants pertaining to innovation and technology adoption, human capital, market efficiency, physical infrastructure, institutional infrastructure, and sector's and firm's attributes.

We merge these determinants with firm-level TFP estimates obtained from the Enterprise Analysis Unit of the World Bank Group. Besides TFP, we use another estimate of productivity in the form of a factor ratio: (log) sales per worker. This estimate is more robust and is also available for non-manufacturing firms.

3.2 TFP determinants

Our key policy variable is the gender of the manager. Our formal model accounts for various firm-level behaviors pertaining to factors that affect firm-level TFP. These factors are grouped into five broad categories, which are innovation, human capital, market efficiency, physical infrastructure, and institutional infrastructure. We identify the most relevant measures of each category of determinants and use MCA to construct a set of composite indices, grouping these measures by category.

Innovation. Technological progress or improvements in TFP was initially identified by the Solow neoclassical growth model as the key determinant of growth in the long run. While Solow identified technological progress or improvements in TFP as the key determinant of growth in the long run, he did not provide any explanation of what determines it. This was rather explained within the framework of the Romer endogenous technological change model that argued that TFP growth is determined by the invention of new technologies, driven by, for example, the number of workers engaged in R&D. Here technological progress is endogenous, i.e., determined by the actions of economic agents, represented by firms in our context. The fact that most technologies are utilized worldwide, not just where invented, suggests a model in which the ability to adopt (precisely, learn about the usage of) new technologies should play a key role in determining TFP.

[5] The ES is conducted using stratified sampling and contain weights—based on this information—that take care of the varying probabilities of selection across different strata.

We acknowledge that, in the context of Africa, technology adoption is more relevant than innovation. Thus, we control for factors that determine firm's ability to adopt new technologies using the use of technology licensed from a foreign-owned company, the use of e-mail to communicate with clients and suppliers, and having its own website as proxies. Other included key innovation measures, based on fewer number of observations, are: product innovation (whether the firm introduced new products/services over the last three years), process innovation (whether the firm introduced new/significantly improved process during the last three years), and R&D expenditure (whether the firm spent on R&D during the last fiscal year).

Human capital. We include human capital factors that are found to have a significant impact on firm performance in general and TFP in particular (Miller & Upadhyay, 2000). Although there is consensus in the literature that there is a positive association between educational attainment and productivity, Barro (2001) shows in a study of around 100 countries that the quality of education for male students is significantly related to economic growth—but not for female students. A possible explanation is that female workers are less incorporated in markets than male workers, implying that many countries can raise productivity if female workers are successfully participating in the labor market.

We include two main measures of human capital: the years of experience working in this sector the top manager has and whether formal training programs were provided for permanent, full-time employees in the last fiscal year[6]. The observations of the percentage of full-time workers who completed high school or have university degree are not statistically sufficient, and hence we construct a complementary measure based on subjective assessment of how much of an obstacle to the firm's operations "inadequately educated workforce" was reported: very severe, major, moderate, minor, or no obstacle.

Market efficiency. A growing number of studies indicate that market efficiency is associated with variation in productivity levels across countries and firms (e.g., Chanda & Dalgaard, 2008; Jerzmanowski, 2007). Several indicators are included to reflect the degree of efficiency in the output, labor, and financial markets in which firms operate.

We consider four indicators to reflect the output market's efficiency. The first is a measure of the ease with which entrepreneurs start businesses and obtain licenses and permits according to government regulations, based on how much of an obstacle "business licensing and permits" was reported. We assume that high business freedom to enter the market, as reflected by the ease of obtaining business licensing and permits, entails more efficiency in the output market. The second is a measure of the degree of intensity of competition, specifically the number of competitors a firm's main product/product line face. The higher the degree of competition, the higher we expect the degree of market efficiency. We additionally include a dummy variable of whether the firm competes against unregistered or informal firms to capture the degree of

[6] This is a measure of labor market's efficiency as well since it is argued that the higher the level of education and training, the higher is the level of flexibility in the labor market. Again, here, market efficiency and flexibility are associated with each other, as flexibility leads to rapid market clearing through the interaction between the wage rates, demand, and supply of labor.

informality in the output market. A fourth indicator is included to reflect the negative effect of market informality based on how much of an obstacle "practices of competitors in the informal sector" was reported.

With respect to the labor market, we construct a measure that reflects restrictive labor market regulations, based on whether they affected decisions of hiring or firing permanent workers, specifically how much of an obstacle "labor regulations" was reported. Finally, we measure the financial market efficiency reflected by the ability of the financial sector to respond to demand by providing high-quality products and services at the lowest cost[7]. Our main measure is a dummy variable reflecting whether a firm has a line of credit or loan from a financial institution. We construct an alternative measure based on how much of an obstacle "access to finance" was reported. We expect the lack of access to finance to be negatively correlated with TFP, not only because firms will scale down operations but also due to the high cost of informal loans and the fact that being financially constrained will induce firms to substitute (low-skilled) labor for physical capital (Cull et al., 2007).

Physical infrastructure. Physical infrastructure stock is generally found to have a positive external impact on growth in general and TFP in particular, for example, by allowing firms to invest in more productive machineries (e.g., Canning & Pedroni, 2008; Straub, 2008). Gorden (2013) argues that the potential growth of even the advanced economies will be significantly limited by a number of headwinds, among which are energy-related constraints, holding their growth below the pace which innovation would otherwise make possible.

We include three measures of the quality of physical infrastructure drawing from whether three facets of infrastructure and services were reported as very severe, major, moderate, minor, or no obstacles to the firm's current operations, namely: electricity, telecommunications, and transport. These obstacles impose both direct (operating) and indirect costs to firm performance and limit firm prospects for reaching their full productivity potential. Complementarily, we exploit two continuous measures of the quality of power supply: the number of power outages experienced in a typical month in the last fiscal year and losses as a percentage of annual sales in the last fiscal year due to power outages.

Institutional infrastructure. There is strong empirical evidence that the quality of governance—as reflected by political stability, the rule of law, bureaucratic quality, the absence of corruption, among others—is positively correlated with TFP and growth (e.g., Barro, 1991; Chanda & Dalgaard, 2008). We construct a measure of perceptions of political stability based on subjective assessment of how much of an obstacle "political instability" was reported. Perception of the rule of law is captured by responses of entrepreneurs to whether they believe the court system is fair, impartial, and uncorrupted. Another relevant indicator is based on how much of an obstacle "courts" was reported. To measure bureaucratic quality, we report the percentage of senior management time spent in dealing with government regulations. We also include three measures of the institutional quality of "business environment" drawing from to

[7] See the definition of financial market efficiency by the World Bank/the International Monetary Fund (2005).

what extent the following three facets were regarded as obstacles to the firm's current operations: customs and trade regulations, tax administrations, and access to land. Regarding corruption, we report the percent of total annual sales paid in informal payments and, complementarily, how much of an obstacle "corruption" was reported. We further include a dummy variable of whether a gift/informal payment was requested in any of the tax officials' inspections.

Sector and firm attributes. Several factors can drive women entrepreneurs to self-select into specific sectors or industries that are mostly associated with certain characteristics that explain lower firm performance, such as being more competitive.

To account for the relevance of firm characteristics, especially how friendly to gender diversity various sectors are, we include the sector the firm operates in as well as a set of firm's attributes, mainly: firm size, location, ownership structure, age, export orientation, and legal status. Other attributes include whether the firm holds an internationally-recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor.

3.3 Multiple correspondence analysis

We use a multivariate statistical method, specifically MCA, to construct five composite indices of the five broad categories of TFP determinants rather than making a priori assumptions and selecting one variable as a proxy for each category or including all relevant variables additively. The use of such indices enables us to reduce the dimensionality of our dataset and allows the available data on firm-level TFP determinants to manifest itself in determining the relevant variables and optimal weights assigned to each variable in each category of determinants. The indices are also designed to capture the complex interaction between different determinants as we expect the variables in each category to be inter-correlated.

We follow the steps discussed by Asselin & Anh (2008), Ezzrari &Verme (2013), and Njong & Ningaye (2008) to apply MCA on the available TFP measures. The ES questions included in each index category (domain) is based on theoretical and empirical evidence (see section 3.2). We recognize that the indices may be limited by the information availed by the ES and can be further improved if some extra questions are integrated in the questionnaire. However, capturing the inertia of a set of variables (characteristics) in a single dimension by a composite MCA index deals with the drawbacks of additive indicators, such as treating all the characteristics as equal, which can be misleading especially in the context of Africa.

We describe all the dimensions extracted from the MCA in Appendix A (see Table A.1), but our constructed indices are obtained from the first dimensions of inertia since they explain the highest variability in the data. We transparently list the variables used in the MCA along with their respective weights in the Appendix (see Table A.2). The variables are defined and revised if necessary to ensure that the monotonicity axiom is satisfied. That is, if any firm improves its performance with respect to one variable, we should expect the composite index to improve and vice versa [see Asselin (2009) for further details]. Moreover, all variables are normalized to render them comparable. The relative contributions of the relevant variables to each

respective composite index, known as the discriminatory measures, are presented in the Appendix (see Table A.3). Quantitative variables, such as top manager's years of experience, are initially transformed to qualitative categorical-ordinal variables.

Unlike the standard principal component analysis (PCA), variables in the MCA do not need to follow a normal distribution, which makes the latter an appropriate approach for our variables, as most of them are categorical—ordinal, not nominal (Asselin, 2009). Besides, while PCA determines the set of weights that explain the largest variation in the original variables, MCA goes further to dichotomize and weight the modalities of the original variables instead of the variables themselves (Njong & Ningaye, 2008).

3.4 Descriptive statistics

Two-sample t-tests are used to examine whether the mean productivity of male- and female-managed firms differ significantly (see Appendix A, Table A.4). We find that female-managed firms underperform male-managed firms in Africa in general and in the two regions of North and East Africa. However, no significant difference in TFP performance is captured for the whole world. Comparing Africa to the rest of the world's regions, the gender productivity differential appears to be the widest in the continent (Figure A.1). More worryingly, exploring the evolution of the differential in selected African countries, we find that it has been widening in some countries, especially in the East African region, with the productivity of male-managed firms increasing and that of female-managed ones decreasing (Figure A.2).

We also use two-sample tests of proportions to examine whether and to what extent the proportions of firms reporting on specific TFP determinants differ significantly by the gender of top manager (Figure A.3). The most significant differences are observed with respect to innovation and technology adoption and in opposite directions. Surprisingly, defeating the hypothesis of women's higher risk aversion, female-managed firms perform better with respect to activities that are more related to firm's ability to *innovate,* specifically product innovation, process innovation, and spending on R&D, while male-managed firms perform better with respect to activities that are more related to firm's ability to *adopt* new technologies. In terms of market efficiency, Figure A.3 indicates that a significantly higher proportion of female-managed firms reported "access to finance" as a severe obstacle to their operations, where a lower proportion of female-managed firms appear to have a line of credit/loan from a financial institution. In parallel, female managers appear to have significantly poorer perceptions of the rule of law than male managers reflected by their belief that the court system is fair, impartial, and uncorrupted. Women managers are also more prone to pressure from public officials to engage in corrupt behavior, where significantly higher proportion of female-managed firms reported that a gift/informal payment was requested in any of the inspections/meetings by tax officials.

4. Empirical approach

4.1 General framework

Firm-level TFP is estimated within the general framework of the Cobb-Douglas production function given by equation (1), where the output of firm i in sector s and economy e, Y_{ise}, is a

function of inputs of capital (K_{ise}), labor (L_{ise}), and materials (M_{ise}); and a firm's efficiency of production (TFP), A_{ise}, is measured as the fraction of output that cannot be directly attributed to the utilized inputs.

$$Y_{ise} = A_{ise} K_{ise}^{\alpha_k} L_{ise}^{\alpha_l} M_{ise}^{\alpha_m} \qquad (1)$$

Equation (1) is transformed into the generalized specification of the translog production function (below), which approximates the constant elasticity of substitution (CES) production function with a second-order Taylor polynomial (Pavelescu, 2011) and accounts for a number of n inputs I.

$$ln\, Y_{ise} = c_s + \sum_{j=1}^{n} \alpha_j \,.\, ln\, I_j + \left(\frac{1}{2}\right) . \sum_{j=1}^{n} \sum_{k=1}^{n} \beta_{jk} \,.\, ln\, I_j \,.\, ln\, I_k + FE_{inc} + FE_e + FE_{yr} + \varepsilon_{ise} \qquad (2)$$

Revenue-based TFP estimates are then computed as the residual term, $\hat{\varepsilon}_{ise}$, of the transformed production function, together with income-level, economy, and year fixed effects, denoted by FE_{inc}, FE_e, and FE_{yr}, respectively, as given by equation (3). c_s is a constant term that in its simplest form equals ln A_{ise}.

$$\widehat{TFP}_{ise} = \hat{\varepsilon}_{ise} + \hat{c}_s + \widehat{FE}_{inc} + \widehat{FE}_e + \widehat{FE}_{yr} \qquad (3)$$

We rely on two specifications of the production function. The first uses Y_{ise}, based on which $TFPY_{ise}$ is obtained [$n = 3$ in equation (2)]. The second specification replaces Y_{ise} with firm-level value added, VA_{ise}, while removing the materials' input variable (M_i) from the right-hand side (RHS) of equation (1) ($n = 2$). A second TFP measure, $TFPVA_{ise}$, is obtained based on this specification.[8] The underlying assumption of both specifications is that output's elasticities with respect to inputs are equal across economies in the same income groups (The World Bank, 2017).

This framework falls within the "reductionist" or "residual" classical approach to explaining productivity differences across firms. More sophisticated versions of this approach recognize that firm heterogeneity can explain (part of) the difference in productivity that remains after accounting for differences in traditional inputs such as labor and capital. Such heterogeneity can be induced, for instance, by the human capital of the firm's CEO (e.g., Lucas, 1978) and/or the quality of management of the firm as reflected by its adopted management practices (e.g., Bender et al., 2018).

[8] The two specifications of the production function along with a comprehensive description of the estimation methodology is provided online at: www.enterprisesurveys.org.

One relatively straightforward but often overlooked determinant is the gender of the CEO or manager (rather than the owner's). Our main hypothesis is that gender differences in behavior, talents and perspectives, and encountered formal and informal institutional barriers, are likely to affect firm heterogeneity, and therefore TFP, both directly and indirectly through other TFP determinants and even adopted management practices. If so, we can explicitly express A_{ise} as $A_{ise}(\boldsymbol{Gender}_{ise}; D_{ise})$ to reflect that a firm's TFP is determined by the gender of the manager ($\boldsymbol{Gender}_{ise}$) and a vector D_{ise} of all other TFP determinants pertaining to innovation, human capital, market efficiency, physical infrastructure, as well as institutional infrastructure, among others. As such, and assuming that TFP is a linear function of the gender of the manager and other determinants, we can express it as follows:

$$ln(A_{ise}(\boldsymbol{Gender}_{ise}; D_{ise})) = a_0 + a_g \boldsymbol{Gender}_{ise} + a_d D_{ise} + a_z Z_{ise} + \epsilon_{ise}, \quad (4)$$

where a_0 is the mean firm-level TFP and ϵ_{ise} represents the stochastic element of TFP.

Now we combine equations (2) and (4), and since the gender of the manager is our key policy variable and firm-level TFP is the outcome variable of interest, we further specify the equation for TFP as indicated below to estimate the productivity differential between female- and male-managed firms:

$$TFP_{ise} = \gamma_0 + \gamma_g \boldsymbol{Gender}_{ise} + \gamma_d D_{ise} + \gamma_z Z_{ise} + u_{ise}; \quad (5)$$

where $TFP_{ise} = ln\, Y_{ise} - \sum_{j=1}^{n} \alpha_j \,.\, ln\, I_j - \left(\frac{1}{2}\right) . \sum_{j=1}^{n} \sum_{k=1}^{n} \beta_{jk} \,.\, ln\, I_j \,.\, ln\, I_k$ [from equations (2) and (3)]; Z_{ise} is a vector of firm and sector characteristics that we control for along with year and country dummies; u_{ise} is a random error term; γ_0 is constant; and γ_g, γ_d, and γ_z are unknown parameters to be estimated. As we hypothesize the presence of a TFP differential based on the manager's gender, we expect $\gamma_g \neq 0$.

Equation (5) is initially estimated by pooled OLS for the (pooled) sample to investigate the existence of a gender-based TFP gap in Africa as a whole and in the continent's five regions.

4.2 Blinder-Oaxaca decomposition of mean gender productivity differential

To identify what explains observed TFP differences, we decompose the mean differences in TFP between male- and female-managed firms, based on linear regression models, in a counterfactual manner known in the literature as the Blinder-Oaxaca decomposition (Blinder, 1973; Oaxaca, 1973). We re-estimate equation (5) by the gender of the manager as follows:

$$TFP_{ise\boldsymbol{g}} = X'_{ise\boldsymbol{g}} \gamma_x + u_{ise\boldsymbol{g}}, \quad (6)$$

where $\boldsymbol{g} \in \{m, f\}$, $X_{ise\boldsymbol{g}}$ is a vector that contains all predictors ($D_{ise\boldsymbol{g}}$ and $Z_{ise\boldsymbol{g}}$) and a constant, $\gamma_{\boldsymbol{x}}$ contains the slope parameters and the intercept, and $u_{ise\boldsymbol{g}}$ is the gender-specific random error assumed to be $iid(0, \sigma^2)$.

Based on equation (6), the mean difference in TFP between male- and female-managed firms can be expressed as

$$MD = E(TFP_{ise\boldsymbol{m}}) - E(TFP_{ise\boldsymbol{f}}) = E(X_{ise\boldsymbol{m}})'\gamma_{\boldsymbol{m}} - E(X_{ise\boldsymbol{f}})'\gamma_{\boldsymbol{f}}. \quad (7)$$

Following Daymont & Andrisani (1984) and Jones & Kelley (1984), and as illustrated by Jann (2008), we rearrange equation (7) to obtain a "three-fold" decomposition of the mean TFP difference so that each component has a meaningful interpretation in the context of this study:

$$MD = \left[E(X_{ise\boldsymbol{m}}) - E\left(X_{ise\boldsymbol{f}}\right)\right]'\gamma_{\boldsymbol{f}} + E(X_{ise\boldsymbol{f}})'(\gamma_{\boldsymbol{m}} - \gamma_{\boldsymbol{f}}) + [E(X_{ise\boldsymbol{m}}) - E(X_{ise\boldsymbol{f}})]'(\gamma_{\boldsymbol{m}} - \gamma_{\boldsymbol{f}}). \quad (8)$$

The first summand on the RHS of equation (8) is the portion of the TFP gap accounted for by gender differences in the levels of observable characteristics assessed with the coefficients of female managers (endowment effect). This helps understand whether and to what extent the estimated gaps are due to differences in the *levels* of innovation and technology adoption activities, human capital endowments, inefficiency in the markets in which their firms are concentrated, and incurred physical and institutional infrastructure barriers. The second is the fraction of the gap accounted for by gender differences in "coefficients" using the means of female managers as a standard (coefficient or structural effect). This helps understand whether and to what extent the gaps are due to differences in the *returns* to these characteristics between both groups. For example, which group of managers is more likely to benefit from innovation and technology adoption activities? Which group is more vulnerable to institutional barriers? The third summand is an interaction term that reflects differences in both the levels of and returns to these observables (interaction effect).

4.3 Gender productivity differentials across the productivity distribution

Finally, we account for the possibility of heterogeneity of firms' behavior along the TFP distribution instead of just comparing the averages of male- and female-managed firms. The aim is to investigate whether there are significant differences in the endowments and the returns to these endowments between both groups of firms at specified points (e.g., percentiles) of the productivity distribution.

To do so, we use re-centered influence functions (RIF) as suggested by Firpo et al. (2009) to obtain the (modified) decomposition estimates. This mainly involves an unconditional quantile regression procedure providing the Blinder-Oaxaca decomposition estimates at each specified point of the TFP distribution. Such approach is known in the literature as RIF-Decomposition

or Blinder-Oaxaca decomposition of outcome distributional differences and has been applied by a growing number of studies (e.g., Aguilar et al., 2015; Kilic et al., 2015).

5. Results and discussion

5.1 Baseline estimates of gender productivity differential

We initially examine whether there are differences in firm-level TFP by the gender of manager in Africa as a whole and separately for each of its regions. Table 1 presents the results of the baseline regressions of TFP on the manager's gender. We find significant differences in TFP performance between male- and female-managed firms in Africa in general and in North and East Africa in particular.

5.2 Decomposition estimates of mean gender productivity differential

5.2.1 Using MCA indices

We employ the Blinder-Oaxaca decomposition technique to explore the association pathways of the observed gender TFP differences. We decompose the estimated TFP gap by the gender of manager using five MCA indices that reflect the five broad categories of TFP determinants (Table 2). This provides an indication of the categories driving the gap.

In the whole sample of Africa, the mean of the TFP estimate is 2.479 for male-managed firms and 2.194 for female-managed firms, yielding a significant TFP gap of 0.285 (see column 1). The gap widens as we use our imputed TFP estimates, amounting to a significant difference of 0.652 (see columns 3 and 5). The mean of the log sales per worker is 9.608 for male-managed firms and 9.305 for female-managed firms, yielding a significant gap of 0.303 (see column 7).

In the first-row panel of Table 2, we report the TFP gap divided into three parts, reflecting the effect of the gender differences in endowments, coefficients, and their simultaneous effect on the gender gap in TFP. The results of the three TFP estimates indicate that the gap is driven by differences in coefficients rather than endowments (see columns 1, 3, and 5). The significant overall increases of 0.393, 0.539, and 0.652 in columns 1, 3, and 5, respectively, show that differences in coefficients account for *all* of the gap regardless of the TFP estimate used. In parallel, we find that female managers in Africa have the same characteristics as their male counterparts. Only using labor productivity (log sales per worker) do we observe significant differences in endowments between male- and female-managed firms, especially with respect to the firm's age (see column 7). Interestingly, we observe that the behavior of female managers with respect to innovation and technology adoption reduces the observed gap. This is suggested by a higher endowment level of innovation for female managers as opposed to male managers, captured by the decrease of 0.030 in the MCA composite index of innovation (see column 7).

In columns 2, 4, and 6 of Table 2, we quantify the change in the TFP of female-managed firms when applying the coefficients of male-managed firms to the characteristics of the former for all explanatory variables. The results indicate that institutional infrastructure barriers have the highest negative association with the TFP performance of female-managed firms, both in terms of significance and magnitude, as reflected by the reported increases of 1.334, 1.515, and 1.526, using the three estimates of TFP. This finding suggests that women managers are more

adversely affected by institutional barriers, such as corruption and perceptions about it, as opposed to men managers, despite the fact that both groups face the same level (endowment) of barriers (see columns 1, 3, and 5). The results as well indicate that women managers are more likely to benefit from innovation and technology adoption than men, as indicated by the decreases of 0.175, 0.623, and 0.679 (see columns 2, 4, and 6).

5.2.2 Using proxies of TFP determinants

The next step is to identify how female managers behave with respect to specific TFP indicators of determinants, focusing on those of innovation and institutional infrastructure barriers. To do so but without overfitting our model, proxies of each category of TFP determinants are used. Table 3 reports the Blinder-Oaxaca decomposition estimates of gender TFP differential using our proxies of interest. The results confirm our findings reported earlier (Table 2) that male and female managers behave differently, with female managers being more likely to innovate and adopt new technologies, though, insignificantly (Table 3, see columns 1, 3, 5, and 7). The returns to such activities vary significantly between male- and female-managed firms. While the use of foreign-licensed technology, website ownership, and R&D spending have higher returns for male-managed firms, the returns to the use of e-mail to communicate with clients and suppliers and to product innovation are higher for female-managed firms.

The results provide evidence that women's lower returns are neither due to educational nor entrepreneurial ability (see human capital endowments in columns 1, 3, 5, and 7). This is intuitive because women who venture into entrepreneurship, which is still regarded in some settings as a male-dominated activity, are as capable as or even more capable than men in these settings, with less capable women more likely to shy away from managing a business.

The observed lower returns may be partly due to women being concentrated in different sectors and industries than men. In our sample, only 39 percent of female managers work in the manufacturing sector as opposed to 61 percent in services. And even in the services sector, women are concentrated in low-return businesses with, for instance, 21 percent of female managers working in the wholesale and retail subsectors as opposed to 14 percent of male managers. Part of the effect as well may be due to women being concentrated in small-size businesses. In a small-size firm, for instance, e-mail marketing may be deemed a cost-effective marketing strategy. Our data shows that more than two thirds of female managers work in small-size firms versus about half of male managers. The variation intensifies if we consider large firms where only 8 percent of female managers are concentrated as opposed to a double figure of 16 percent of male managers. Another part of the effect is due to women managing firms that are younger than firms men manage. Our data shows that while only 15 percent of the firms that men manage in Africa are young (age < 5 years), 21 percent of the firms that women manage are so. Also, 37 percent and 47 percent of the firms that men and women manage, respectively, have an age of 10 years or less.

Therefore, it appears that businesses, industries, and sectors in which male managers are concentrated, as well as the attributes of the firms they manage, make it more likely for their firms to benefit more from some activities such as the use of foreign-licensed technology and

R&D spending, while the domains where women managers work are likely to benefit more from other activities such as the use of e-mail to communicate with clients and suppliers. This hypothesis is reinforced by earlier evidence on the relationship between some firm attributes, such as firm's size, and the association of some innovation activities with productivity growth. One example is Rochina-Barrachina et al. (2010) who find that although the implementation of process innovations resulted in extra productivity growth for small-size and large firms alike, the observed growth was more persistent for large firms versus small ones.

Our results trigger an investigation into the mechanisms that underlie women's selection of business activity as well as what factors can possibly be resulting in women managing less competitive firms in terms of attributes. For instance, what roles do prevailing gender norms or competing demands on women's time play? Moreover, can women's selection of business activity be prompted by gender-specific constraints such as access to credit and start-up capital (Bardasi, 2008)?

Table 3 shows that the lack of access to finance is significantly associated with higher negative returns for the TFP of female-managed than male-managed firms, thus widening the gender gap in TFP as reflected by the reported increases of 0.122 and 0.165 (see columns 4 and 6). This suggests that women managers are more adversely affected by being financially constrained as opposed to men managers, reinforcing the fact that the former are more likely to view "access to finance" as a severe obstacle to their firms' operations (see columns 1, 3, 5, and 7). It can be that, even if the same amount of financial resources is made available for female and male managers, banks fail to offer diverse financial products that are tailored to women's preferences and constraints. So, even if we assume that both groups have the same level (endowment) of access to finance; if female managers had the same returns (coefficients) to being financially constrained as their male counterparts, we would expect the TFP of the firms managed by the former to increase by 0.093, 0.122, 0.165, or 0.077, based on the TFP estimate used.

Further, we find that negative perceptions about the presence and intensity of corruption are significantly associated with a higher negative effect on the TFP of female-managed firms as compared to male-managed firms, hence widening the observed TFP gap (see columns 2, 4, and 6). Specifically, women's perception of the viability of the rule of law, captured by their responses to whether they believe the court system is fair, impartial, and uncorrupted, appears to have higher returns (coefficients) for the TFP of their firms than for that of male-managed ones.

One plausible explanation is that, given that women are generally less confident and more risk averse (Nekby et al., 2008), a poor perception of the rule of law is likely to have a greater influence on their decisions (not) to invest and innovate, among others, compared to their male counterparts. Thus, while there is consensus that the perceived rule of law influences private investment decisions in developing economies (Biglaiser & Staats, 2010; Vu Le & Rishi, 2010), the influence is greater on female managers due gender differences in risk, social, and competitive preferences, among others.

Another explanation that reinforces our first is that as survey responses are largely driven by expectations (Yates et al., 2019), it can be that women managers have higher expectations of the returns to the viability of the rule of law (as opposed to other productivity determinants), implying higher negative returns for the TFP of their firms if these expectations are unfulfilled. Our data additionally shows that women managers are more prone to pressure from public officials to engage in corrupt behavior, where 15 percent of female managers reported that a gift/informal payment was requested in any of the inspections/meetings by tax officials as opposed to 10 percent of male managers.

These findings are consistent with evidence from Ethiopia and Nigeria that investment climate constraints such as crime, corruption, and access to finance, have a higher adverse impact on women than men (Bardasi, 2008).

5.2.3 North Africa and East Africa

Like all gender issues, there is no one-size-fits-all story for the gender gap in TFP in Africa. We examine what explains the gap in the two African regions for which significant gaps are detected: North Africa and East Africa. The results are provided in Tables 4 and 5 for the two regions, respectively. In North Africa, the TFP gap arising from differences in the returns to the lack of access to finance as well as poor perceptions about the rule of law is statistically significant, as both determinants exhibit a consistent negative association, with the returns to innovation and technology adoption being significantly higher in general for male managers (Table 4).

In East Africa, however, the gap appears to be mainly driven by significantly lower returns to innovation and technology adoption activities for female- versus male-managed firms, although female managers are significantly more likely to use a foreign-licensed technology (endowment) based on some specifications. The results also show that female-managed firms in East Africa are significantly more harmed by competition against unregistered or informal firms and, interestingly, by political instability.

Recognizing the important role played by the firm's owner with respect to some of our TFP determinants of interest, we decompose the TFP differential by the gender of *owner* rather than *manager* and report the results for Africa in Table 6 and for the regions of North and East Africa in Table 7. The gender gap in TFP significantly persists in Africa when comparing female- to male-owned firms, but instead of being attributed to negative returns to the perceived (poor) rule of law, it appears to be partly driven by negative returns to the lack of access to finance (Table 6). This result is intuitive as managers (not owners) are the ones who are typically engaged with the court system, public officials, etc.; so, it is their perceptions that matter.

Using sales per worker, Table 6 also shows that all innovation and technology adoption activities except website ownership are associated with lower returns for female- versus male-owned firms. Firm and sector attributes are influential here: operating in the services sector,

being a large firm, and being a (big) exporter are significantly associated with higher returns for male-owned firms, while firm's age is significantly associated with higher returns for female-owned firms. The gap persists in both North and East Africa, despite being insignificant in the latter, with the majority of reported determinants being significantly influential, but in opposite directions, which warrants further investigation (Table 7).

5.3 Decomposition estimates of outcome distributional differences

Finally, to investigate the possibility of heterogeneity of firms' behavior at different points of the productivity distribution, we report the RIF decomposition estimates of TFP differential by the gender of manager in Africa obtained within a quantile regression framework (Table 8). Our estimates indicate that while significant gender-based TFP gaps are observed for both the 15th and 85th quantiles, the TFP differential at the former is attributable to both differences in observable characteristics and returns. At the 85th quantile, female-managed firms appear to be better endowed compared to male-managed firms, but the productivity of the former appears to be significantly limited by lower returns to R&D spending and higher negative effect of being financially constrained.

Overall, our results provide evidence that there is a significant firm-level TFP differential by the gender of manager in Africa, and that the observed gap is mainly attributed to differences in unobservable characteristics (the *unexplained* part)—as reflected by differences in returns to observable characteristics or endowments (coefficients)—rather than differences in the observable characteristics or endowments themselves (the *explained* part). Among all the characteristics, the use of foreign-licensed technology, R&D spending, the lack of access to finance, and the perceived rule of law have the strongest power in the *unexplained* part of the TFP differential.

If women managers are more likely to innovate or adopt new technologies and have higher returns for specific activities, but are more negatively affected credit constraints regardless of firm size and by persistent institutional barriers, then improving women managers' access to finance and addressing the institutional barriers they face along with their perceptions about these barriers can unleash the TFP of their firms, inducing substantial productivity gains in the continent, especially in the Northern and Eastern regions.

6. Conclusion

Africa experienced strong economic growth over the past decade—an average of 5 percent a year, but gender gaps in TFP performance persist, hampering the continent's realization of its full growth and job-creation potentials and perpetuating massive efficiency and welfare losses. More worryingly, the continent has the widest gender productivity gap worldwide and the gap has even widened in some African countries.

This study is one of the few attempts, if not the only one, providing comprehensive analysis of productivity performance by gender in developing-country settings, especially African ones. We find a significant productivity differential by the gender of entrepreneur in the continent and, specifically, in the North and East. Our estimates indicate that this differential is mainly

driven by women entrepreneurs being more adversely affected by or more "vulnerable" to institutional barriers, such as their perceptions of the rule of law, and market inefficiencies, such as the lack of access to finance. We also detect differences in the *returns* to the use of foreign-licensed technology and R&D spending, which primarily reflect the concentration of women in specific business activities. Interestingly, differences in the *endowments* of TFP determinants between male and female managers, such as educational and entrepreneurial abilities, or between their respective firms, such as the *levels* of encountered physical and institutional infrastructure barriers, do not appear to contribute to the observed differential.

The question now becomes: What induce these differences in the returns? The first causal pathway underlying the observed gender productivity differential is that men and women tend to behave differently. Behavioral differences may result in women entrepreneurs being more negatively hampered by some barriers. If, for instance, women are generally less confident and more risk averse, a poor perception of the rule of law is likely to have a greater influence on their decisions (not) to invest and innovate, among others, compared to their male counterparts. Also, the fact that women's preferences for competitive situations are lower than that of men may explain the concentration of women entrepreneurs in less competitive sectors, which may explain the reported lower returns to some activities. Gender-based behavioral differences can additionally affect firm performance through adopted management practices, which warrants an investigation in the African context.

The second causal pathway underlying the observed gap is that women may face barriers that arise from existing institutional structures, both formal and informal. These barriers—whether formal, such as child care infrastructure, or informal, such as entrepreneurship seen as a male activity or family values—can affect women's selection of business activity and induce their concentration in low-performing sectors/subsectors, which, again, can possibly explain the reported lower returns to some innovation and technology adoption activities.

Our results rule out the third causal pathway that men and women entrepreneurs have different talents and perspectives.

Direct policy implications stem from our findings of how various TFP determinants may affect male and female entrepreneurs differently, allowing well-targeted and evidence-based interventions in favor of women entrepreneurs. If women entrepreneurs are more likely to innovate and adopt new technologies and have higher returns for some activities, but are more negatively affected by being financially constrained regardless of firm size and by institutional barriers, then improving women' access to finance and addressing the institutional barriers they face together with their perceptions about these barriers can unleash the productivity of their firms.

Specifically, more gender-inclusive financial ecosystems should be put in place, ensuring, among others, the incorporation of a gender perspective in the design of financial products as well as outreach strategies. In parallel, strengthening women's access to justice, especially in fragile contexts, is instrumental in unlocking the productive potential of their firms. Moreover,

promoting women's role in justice service delivery not only better serve the needs of women entrepreneurs but also can enhance their perception of the rule of law. Supplementary policies should address the mobility barriers, be they of legal or social nature, which prevent women entrepreneurs from moving to higher-return sectors and subsectors.

Our findings encourage an enquiry into two main directions. First, a careful investigation is needed of the causal pathways explaining differences between men and women in terms of *unobservable* characteristics, such as behavioral differences and encountered institutional structures, both formal and informal. Second, future research needs to explore the additional mechanisms that underlie women's selection of business activity, which can be associated with lower returns to some activities by their firms. For example, what roles do prevailing gender norms or competing demands on women's time play? Also, can women's selection of business activity be prompted by gender-specific constraints such as access to credit or start-up capital?

Addressing gender-specific barriers to entrepreneurship and leveraging the full productive potential of all economic actors—male and female—represent a significant opportunity to unleash Africa's and, generally, other developing countries' productive potential.

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Table 1: Baseline estimates of gender differential in TFP

	Africa	North Africa	West Africa	East Africa	Central Africa	South Africa
Female top	-0.315**	-0.330*	-0.181	-0.768**	0.024	-0.097
manager	(0.153)	(0.181)	(0.240)	(0.342)	(0.190)	(0.269)
Constant	3.613***	2.408***	3.284***	2.911***	2.717***	3.693***
	(0.402)	(0.079)	(0.414)	(0.181)	(0.153)	(0.279)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are reported in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix).

Table 2: BO decomposition estimates of firm-level TFP differential by gender of *manager* in Africa using *MCA composite indices*

	TFP (Y)		TFP (Y) imputed		TFP (VA) imputed		Log sales per worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OVERALL								
Male-managed firms	2.479***		1.958***		3.037***		9.608***	
Female-managed firms	2.194***		1.475***		2.454***		9.305***	
Difference	0.285**		0.483***		0.582***		0.303***	
Endowments (Explained)	0.082		-0.000		0.159		0.162**	
Coefficients (Unexplained)	0.393**		0.539***		0.652***		0.162*	
Interaction	-0.190		-0.056		-0.229		-0.021	
EXPLANATORY VARIABLES	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained
TFP determinants (MCA indices)								
Innovation	-0.021	-0.175	-0.019	-0.623*	-0.022	-0.679*	-0.030*	0.032
Human capital	-0.031	0.502*	-0.007	0.070	0.048	-0.437	-0.005	0.116
Market inefficiency	-0.004	0.329	0.003	-0.267	0.006	-0.442	-0.021	-0.579**
Physical infrastructure barriers	-0.052	-0.645*	-0.035	-0.587	-0.019	-0.173	0.018	0.413
Institutional infrastructure barriers	0.037	1.334**	0.045	1.515**	0.045	1.526*	0.000	-0.104
Controls								
In capital city	-0.013	-0.127*	-0.001	-0.019	-0.000	0.155	0.010	-0.131*
Share of foreign ownership	-0.035	-0.065	-0.071	-0.159*	-0.033	-0.104	0.000	0.006
Age of firm	0.030	-0.451***	-0.008	-0.171	-0.002	-0.273	0.057**	-0.318***
Direct exports share of sales	0.014	0.050	0.009	0.052	-0.025	-0.086	-0.004	0.027
Constant		0.743		3.448*		2.401		-1.194
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other sector/firm attributes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of observations	4,603		7,347		7,347		14,215	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Other sector/firm attributes include sector of operation, firm size, legal status, etc.

Table 3: BO decomposition estimates of firm-level TFP differential by gender of *manager* in Africa using *proxies of determinants*

	TFP (Y)		TFP (Y) imputed		TFP (VA) imputed		Log sales per worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OVERALL								
Male-managed firms	2.511***		1.968***		2.526***		9.737***	
Female-managed firms	2.122***		1.548***		1.933***		9.598***	
Difference	0.389**		0.420*		0.593***		0.139	
Endowments (Explained)	0.010		-0.190		-0.185		-0.045	
Coefficients (Unexplained)	0.467**		0.446*		0.652***		0.040	
EXPLANATORY VARIABLES	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained
TFP determinants (Proxies)								
Innovation								
Use of foreign-licensed technology	-0.012	0.405	-0.014	0.888**	-0.017	1.038**	-0.026	0.848*
Use of e-mail	0.039	-0.270*	0.024	-0.193	0.010	-0.332*	-0.010	-0.071
Website ownership	-0.071	0.303*	-0.039	0.356	-0.044	0.399**	-0.080	0.485*
Product innovation	-0.006	-0.457*	-0.020	-0.561*	-0.015	-0.470	0.008	-0.322
Process innovation	-0.008	0.175	-0.010	0.317	-0.016	0.448	-0.003	-0.035
R&D spending	-0.038	0.696*	-0.025	0.708*	-0.018	0.627	-0.056	0.928**
Human capital								
Top manager experience years (Ref: 21+)								
16-20	-0.005	-0.108	-0.003	-0.032	-0.005	-0.097	0.005	-0.100
11-15	-0.005	-0.002	0.006	-0.015	0.003	-0.002	-0.002	-0.009
6-10	0.008	0.057	0.066	0.227*	0.038	0.134	-0.021	-0.073
0-5	0.003	-0.018	-0.009	0.043	0.002	-0.001	0.003	-0.019
Formal training programs provided	0.003	-0.937***	-0.009	-0.753*	-0.010	-0.671*	-0.007	-0.652*
Market inefficiency								
Competition against informal firms	-0.024	0.120	-0.036	0.060	-0.024	-0.073	-0.020	-0.447**
"Access to finance" as a severe obstacle	0.063	0.093	0.051	0.122*	0.062	0.165**	0.045	0.077
Physical infrastructure barriers								
"Electricity" as a severe obstacle	0.047	0.048	-0.001	-0.103	0.010	-0.059	0.035	0.102
Institutional infrastructure barriers								
"Political instability" as a severe obstacle	-0.008	-0.095	-0.011	-0.139	-0.011	-0.234	-0.011	-0.170
Courts uncorrupted (Ref: Strongly agree)								
Tend to agree	0.004	0.239*	0.003	0.256	0.003	0.342**	-0.004	-0.049
Tend to disagree	-0.090	0.147**	-0.119	0.245**	-0.135*	0.280***	-0.006	0.046
Strongly disagree	0.082	0.239**	0.134	0.392***	0.105	0.388***	0.009	0.068
"Access to land" as a severe obstacle	0.004	-0.031	0.005	-0.003	0.005	-0.006	0.009	0.026
"Corruption" as a severe obstacle	-0.004	0.021	-0.001	-0.011	-0.012	-0.111	0.012	0.019
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of observations	3,651		5,364		5,364		6,216	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Controls include sector, firm size, share of foreign ownership, firm age, and export orientation. Other firm attributes are included in labor productivity estimations (whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor).

Table 4: BO decomposition estimates of TFP differential by gender of *manager* in *North* Africa using *proxies of determinants*

	TFP (Y)		TFP (VA)		TFP (Y) imputed		TFP (VA) imputed		Log sales per worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
OVERALL										
Male-managed firms	2.471***		2.636***		1.959***		2.513***		9.838***	
Female-managed firms	2.079***		2.494***		1.467***		1.847***		9.756***	
Difference	0.392**		0.143		0.492*		0.666***		0.082	
Endowments (Explained)	0.140		-0.209		-0.097		-0.126		-0.075	
Coefficients (Unexplained)	0.515**		0.346*		0.543*		0.751**		0.055	
EXPLANATORY VARIABLES	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.
TFP determinants (Proxies)										
Innovation										
Use of foreign-licensed technology	-0.013	0.517	-0.014	0.808*	-0.001	1.252*	-0.001	1.209*	-0.015	0.799
Use of e-mail	0.012	-0.181	0.060	-0.334**	0.024	-0.165	0.036	-0.427*	0.006	-0.148
Website ownership	-0.015	0.117	-0.112	0.279	-0.008	0.215	-0.039	0.361	-0.130	0.565*
Product innovation	-0.024	-0.591	-0.019	-0.578	-0.044	-0.596	-0.041	-0.660	-0.005	-0.543
Process innovation	-0.018	0.314	-0.031	0.363	-0.012	0.422	-0.021	0.724*	-0.002	-0.053
R&D spending	-0.062	1.055	-0.002	0.319	-0.046	1.024	-0.029	0.738	-0.071	1.160*
Human capital										
Top manager experience years (Ref: 21+)										
16-20	0.000	-0.091	-0.000	-0.047	0.000	-0.001	0.000	-0.050	0.011	-0.079
11-15	-0.048	0.024	-0.045	0.034	-0.007	0.025	-0.001	0.012	-0.004	-0.005
6-10	0.078	0.207	0.041	0.187	0.116	0.346*	0.097	0.266	-0.007	-0.048
0-5	0.004	-0.027	0.013	-0.071	-0.014	0.048	0.002	-0.002	0.007	-0.026
Formal training programs provided	0.002	-1.002**	0.001	-0.186	-0.003	-0.702	-0.002	-0.317	-0.006	-0.622
Market inefficiency										
Competition against informal firms	-0.045	0.204	0.013	-0.223*	-0.096	0.266	-0.060	0.050	-0.017	-0.484**
"Access to finance" as a severe obstacle	0.090	0.158*	0.130	0.261**	0.082	0.193*	0.090	0.229*	0.061	0.120*
Physical infrastructure barriers										
"Electricity" as a severe obstacle	0.061	0.080	0.051	0.051	0.020	-0.055	0.030	-0.012	0.040	0.110
Institutional infrastructure barriers										
"Political instability" as a severe obstacle	-0.005	-0.085	-0.010	-0.156	-0.006	-0.097	-0.009	-0.229	-0.021	-0.268*
Courts uncorrupted (Ref: Strongly agree)										
Tend to agree	0.012	0.355**	0.004	0.172	0.019	0.459*	0.018	0.452*	-0.010	-0.124
Tend to disagree	-0.098	0.144*	-0.154*	0.237**	-0.235*	0.303*	-0.237*	0.306**	0.003	0.007
Strongly disagree	0.110	0.299**	-0.002	0.076	0.232	0.573**	0.158	0.478**	0.007	0.052
"Access to land" as a severe obstacle	0.002	-0.031	-0.001	0.016	0.007	-0.022	0.004	-0.011	0.012	0.021
"Corruption" as a severe obstacle	-0.012	-0.051	-0.022	-0.130	-0.016	-0.124	-0.024	-0.219	0.022	0.078
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No	No	No	No	No	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of observations	1,945		1,945		2,397		2,397		3,166	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Controls include sector, firm size, share of foreign ownership, firm age, and export orientation. Other firm attributes are included in labor productivity estimations (whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor).

Table 5: BO decomposition estimates of TFP differential by gender of *manager* in *East* Africa using *proxies of determinants*

	TFP (Y)		TFP (VA)		TFP (Y) imputed		TFP (VA) imputed		Log sales per worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
OVERALL										
Male-managed firms	3.001***		3.363***		2.253***		2.908***		9.174***	
Female-managed firms	2.189***		2.852***		1.995***		2.271***		9.480***	
Difference	0.812**		0.511		0.258		0.637***		-0.306	
Endowments (Explained)	-0.189		-0.047		-0.191		-0.239		-0.604*	
Coefficients (Unexplained)	0.723*		0.520		0.082		0.558***		-0.443	
EXPLANATORY VARIABLES	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.	Exp.	Unexp.
TFP determinants (Proxies)										
Innovation										
Use of foreign-licensed technology	-0.234	1.902***	-0.118	0.753	-0.154	0.386*	-0.205	0.478*	-0.271*	0.530**
Use of e-mail	0.002	-0.125	-0.029	0.359	-0.031	-0.201	-0.007	-0.288	0.002	-0.095
Website ownership	0.039	-0.314	-0.033	0.055	-0.003	-0.260	0.000	-0.078	-0.019	0.113
Product innovation	0.339	-0.877**	0.089	-0.063	0.050	-0.302**	0.018	-0.121	-0.008	0.310*
Process innovation	0.171	0.497**	0.241	0.568	0.011	0.013	0.032	0.111	-0.002	0.014
R&D spending	0.077	0.695**	0.030	0.445	0.029	0.386	0.017	0.273	0.003	-0.045
Human capital										
Top manager experience years (Ref: 21+)										
16-20	-0.191	-0.378*	-0.030	-0.039	-0.039	-0.095	-0.034	-0.092	-0.036	-0.127
11-15	-0.239	-0.344*	0.051	0.275	-0.319	-0.599**	-0.160	-0.306	-0.093	-0.218
6-10	-0.002	-0.253**	0.001	0.064	0.001	-0.150	0.001	-0.172*	-0.004	0.008
0-5	0.030	0.062	-0.314	0.281*	-0.023	0.071	-0.008	0.046	-0.018	0.024
Formal training programs provided	-0.001	-0.279	0.008	0.141	0.082	-0.100	0.023	-0.280	-0.128*	-0.600**
Market inefficiency										
Competition against informal firms	0.075	0.497*	0.152	1.170**	0.061	0.042	0.036	0.107	-0.010	-0.315
"Access to finance" as a severe obstacle	-0.500	-0.695*	-0.334	-0.531	0.016	-0.161	0.016	-0.138	-0.033	0.121
Physical infrastructure barriers										
"Electricity" as a severe obstacle	0.021	-0.009	-0.076	0.005	0.174*	-0.139*	-0.001	-0.022	0.048	0.005
Institutional infrastructure barriers										
"Political instability" as a severe obstacle	0.053	0.123*	-0.003	0.033	-0.058	0.069	-0.052	0.068	0.001	-0.002
Courts uncorrupted (Ref: Strongly agree)										
Tend to agree	0.160	-0.534**	0.141	-0.405	0.047	-0.168	0.074	-0.232	-0.093	0.241
Tend to disagree	0.018	-0.277*	0.013	-0.206	-0.020	-0.146	-0.044	-0.308	0.101	0.392*
Strongly disagree	-0.137	-0.431*	-0.060	-0.230	0.005	-0.184*	0.003	-0.134	0.013	0.114
"Access to land" as a severe obstacle	-0.045	0.275*	0.018	-0.086	-0.036	0.070	0.049	-0.047	0.070	-0.052
"Corruption" as a severe obstacle	0.033	0.067	-0.005	-0.019	-0.062	0.113	-0.034	0.067	-0.031	0.065
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No	No	No	No	No	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of observations	577		577		1,107		1,107		1,175	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Controls include sector, firm size, share of foreign ownership, firm age, and export orientation. Other firm attributes are included in labor productivity estimations (whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor).

Table 6: BO decomposition estimates of TFP differential by gender of *owner* in Africa using *proxies of determinants*

	TFP (VA)		Log sales per worker	
	(1)	(2)	(3)	(4)
OVERALL				
Male-managed firms	2.696***		9.740***	
Female-managed firms	2.308***		9.056***	
Difference	0.387**		0.683***	
Endowments (Explained)	0.099		0.435**	
Coefficients (Unexplained)	0.521***		0.419**	
Interaction	-0.233		-0.171	
EXPLANATORY VARIABLES	Explained	Unexplained	Explained	Unexplained
TFP determinants (Proxies)				
Innovation				
Use of foreign-licensed technology	0.016	0.707	0.017	1.128***
Use of e-mail	-0.006	-0.100	0.067	0.348**
Website ownership	-0.001	-0.140	-0.077	-0.425**
Product innovation	0.004	0.169	0.008	0.029
Process innovation	-0.058	0.238	-0.023	0.149
R&D spending	0.029	1.187	0.011	0.618**
Human capital				
Top manager experience years (Ref: 21+)				
16-20	0.045	-0.059	0.009	-0.048
11-15	-0.030	0.027	0.031	-0.043
6-10	-0.005	0.092	-0.018	-0.064
0-5	-0.002	0.024	-0.011	-0.037
Formal training programs provided	-0.014	-0.678	0.007	0.093
Market inefficiency				
Competition against informal firms	0.002	-0.144	-0.010	-0.342***
"Access to finance" as a severe obstacle	0.083	0.171*	0.051	0.110**
Physical infrastructure barriers				
"Electricity" as a severe obstacle	0.016	-0.059	0.006	-0.012
Institutional infrastructure barriers				
"Political instability" as a severe obstacle	0.058	-0.121	0.054	-0.087
Courts uncorrupted (Ref: Strongly agree)				
Tend to agree	-0.014	0.143	-0.006	-0.018
Tend to disagree	0.031	0.010	0.058	-0.027
Strongly disagree	-0.001	0.060	-0.006	0.043
"Access to land" as a severe obstacle	0.000	-0.006	-0.024	-0.045
"Corruption" as a severe obstacle	0.005	0.002	-0.016	0.073
Controls				
Sector (Ref: Manufacturing)				
Services			-0.017	0.194**
Firm size (Ref: Small)				
Medium	0.039	-0.143	-0.000	0.005
Large	-0.008	-0.005	-0.057**	0.039*
Share of foreign ownership	-0.056	-0.047	0.074	0.169
Age of firm	0.074	-0.294	0.055	-0.227*
(Big) exporter	0.004	-0.040	-0.040	0.110**
Constant		3.070***		0.909
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Other firm attributes	No	No	Yes	Yes
No of observations	3,554		6,050	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Other firm attributes include whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor.

Table 7: BO decomposition estimates of TFP differential by gender of *owner* in *North* and *East* Africa using *proxies of determinants*

	North Africa				East Africa			
	TFP (VA)		Log sales per worker		TFP (VA)		Log sales per worker	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OVERALL								
Male-managed firms	2.645***		9.839***		3.326***		9.231***	
Female-managed firms	2.212***		9.257***		3.192***		8.998***	
Difference	0.433**		0.582***		0.134		0.233	
Endowments (Explained)	-0.303		0.110		-1.889		-0.030	
Coefficients (Unexplained)	0.579***		0.488**		-0.217		-0.233	
EXPLANATORY VARIABLES	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained	Explained	Unexplained
TFP determinants (Proxies)								
Innovation								
Use of foreign-licensed technology	0.096**	2.164**	-0.070**	-1.030*	0.063	-0.789***	-0.219	0.136
Use of e-mail	-0.002	-0.170	0.033	0.199	0.031	-0.694**	0.014	-0.127
Website ownership	-0.022	-0.775*	-0.112	-0.571**	0.042	5.821***	0.066	0.364
Product innovation	-0.051	-0.383	0.011	-0.085	-0.837	1.432**	-0.053	0.291**
Process innovation	-0.190	0.998***	-0.025	0.188	-2.269*	-6.438***	-0.040	-0.171
R&D spending	0.023	0.960	0.039	1.325**	-0.069	-5.306***	-0.023	-0.404
Human capital								
Top manager experience years (Ref: 21+)								
16-20	-0.025	0.009	-0.004	0.006	-0.869	-1.284**	0.013	0.032
11-15	-0.033	0.010	-0.031	0.008	0.422	-0.352*	-0.144	-0.375
6-10	0.232	0.576*	0.059	0.068	-0.249	-1.296**	-0.001	0.002
0-5	0.001	0.037	-0.011	-0.026	0.693***	-0.181	0.079	-0.016
Formal training programs provided	0.044	1.051**	0.051	0.897**	0.487	4.054***	0.159*	0.890**
Market inefficiency								
Competition against informal firms	-0.003	-0.115	0.009	-0.273**	-0.259	-1.322***	-0.074	-0.581*
"Access to finance" as a severe obstacle	0.063	0.158	0.040	0.130*	0.380*	0.435**	0.032	0.082
Physical infrastructure barriers								
"Electricity" as a severe obstacle	0.010	-0.059	0.006	-0.005	-0.055**	-0.009	0.019	0.016
Institutional infrastructure barriers								
"Political instability" as a severe obstacle	-0.010	-0.002	0.072	-0.116*	0.045	0.115*	0.040	-0.040
Courts uncorrupted (Ref: Strongly agree)								
Tend to agree	0.001	0.080	0.007	0.074	0.755**	-0.518**	-0.126	0.082
Tend to disagree	-0.156*	0.047	0.154*	-0.045	-0.048	0.974*	0.070	0.014
Strongly disagree	0.014	-0.013	-0.012	0.034	-0.073	-1.143**	0.000	0.088
"Access to land" as a severe obstacle	0.028	0.074	-0.025	-0.054	-0.145	0.857	0.010	-0.001
"Corruption" as a severe obstacle	0.095	-0.262*	-0.024	0.079	0.812*	-0.536	-0.026	0.022
Controls and country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	Yes	No	No	Yes	Yes
No of observations	1,893		3,074		560		1,147	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Controls include sector, firm size, share of foreign ownership, firm age, and export orientation. Other firm attributes are included in labor productivity estimations (whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor).

Table 8: RIF decomposition estimates of TFP differential by gender of *manager* in Africa using *proxies of determinants*

	TFP (Y) 15th percentile		TFP (Y) 85th percentile	
	(1)	(2)	(3)	(4)
OVERALL				
Male-managed firms	1.829***		3.571***	
Female-managed firms	0.948***		3.093***	
Difference	0.881***		0.477***	
Endowments (Explained)	0.424**		-0.447**	
Coefficients (Unexplained)	0.457***		0.925***	
EXPLANATORY VARIABLES	Explained	Unexplained	Explained	Unexplained
TFP determinants (Proxies)				
Innovation				
Use of foreign-licensed technology	-0.009	0.547	-0.010	0.078
Use of e-mail	0.146	-0.732***	-0.003	-0.305
Website ownership	-0.041	0.347	-0.063	0.361
Product innovation	0.000	-0.024	0.002	0.411
Process innovation	-0.012	0.161	0.003	-0.299
R&D spending	-0.019	0.344	-0.036	0.894*
Human capital				
Top manager experience years (Ref: 21+)				
16-20	-0.001	-0.038	-0.002	-0.062
11-15	0.025	-0.017	-0.095	0.191**
6-10	0.109	0.156**	-0.008	0.056
0-5	0.002	-0.002	0.005	-0.045
Formal training programs provided	0.003	-1.086***	0.002	-0.816**
Market inefficiency				
Competition against informal firms	-0.032	0.172	0.019	-0.227
"Access to finance" as a severe obstacle	0.016	0.022	0.062	0.047*
Physical infrastructure barriers				
"Electricity" as a severe obstacle	0.076	0.082*	0.011	0.002
Institutional infrastructure barriers				
"Political instability" as a severe obstacle	-0.024	-0.148	0.000	-0.125
Courts uncorrupted (Ref: Strongly agree)				
Tend to agree	0.002	0.122	-0.004	-0.140
Tend to disagree	-0.040	0.101	-0.002	0.093
Strongly disagree	0.081	0.133***	-0.031	0.002
"Access to land" as a severe obstacle	0.003	-0.034	-0.001	0.011
"Corruption" as a severe obstacle	-0.008	-0.058	-0.029	-0.101
Controls				
Firm size (Ref: Small)				
Medium	-0.030	-0.163	0.078	0.329***
Large	0.040	-0.119**	-0.039	0.027
Share of foreign ownership	0.053	0.032**	-0.163	-0.098***
Age of firm	0.054	-0.614***	0.044	-0.446
(Big) exporter	0.024	0.058	-0.027	-0.050**
Constant		-0.185		2.693
Year dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Other firm attributes	No	No	No	No
No of observations	3,651		3,651	

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). Other firm attributes include whether the firm holds an internationally recognized quality certification and whether the firm's financial statements were checked and certified by an external auditor.

Appendix A: Data and descriptive statistics

Table A.1: MCA: Burt/adjusted inertias

Category	Dimension	Preliminary			Final		
		Principal inertia	Percentage	Cumulative percentage	Principal inertia	Percentage	Cumulative percentage
Innovation	Dim 1	0.0561	71.57	71.57	0.0561	71.57	71.57
	Dim 2	0.0071	9.01	80.58	0.0071	9.01	80.58
Human capital	Dim 1	0.0041	49.16	49.16	0.0031	100.00	100.00
	Dim 2	0.0014	16.37	65.53	0.0000	0.00	100.00
	Dim 3	0.0001	1.44	66.97	0.0000	0.00	100.00
	Dim 4	0.0001	0.65	67.62			
	Dim 5	0.0000	0.07	67.70			
	Dim 6	0.0000	0.02	67.72			
Market inefficiency	Dim 1	0.0362	57.09	57.09	0.0447	57.71	57.71
	Dim 2	0.0094	14.87	71.96	0.0118	15.28	72.98
	Dim 3	0.0034	5.30	77.27	0.0040	5.18	78.16
	Dim 4	0.0018	2.87	80.13	0.0015	1.90	80.07
	Dim 5	0.0007	1.07	81.20	0.0009	1.21	81.27
	Dim 6	0.0001	0.20	81.40	0.0000	0.01	81.28
	Dim 7	0.0000	0.01	81.41			
	Dim 8	0.0000	0.00	81.41			
Physical infrastructure barriers	Dim 1	0.0499	62.10	62.10	0.0499	62.10	62.10
	Dim 2	0.0083	10.28	72.38	0.0083	10.28	72.38
	Dim 3	0.0045	5.61	77.98	0.0045	5.61	77.98
	Dim 4	0.0019	2.33	80.31	0.0019	2.33	80.31
	Dim 5	0.0009	1.16	81.47	0.0009	1.16	81.47
	Dim 6	0.0002	0.19	81.66	0.0002	0.19	81.66
	Dim 7	0.0001	0.07	81.74	0.0001	0.07	81.74
Institutional infrastructure barriers	Dim 1	0.0448	58.54	58.54	0.0448	58.54	58.54
	Dim 2	0.0135	17.66	76.19	0.0135	17.66	76.19
	Dim 3	0.0038	4.99	81.19	0.0038	4.99	81.19
	Dim 4	0.0028	3.70	84.89	0.0028	3.70	84.89
	Dim 5	0.0011	1.49	86.37	0.0011	1.49	86.37
	Dim 6	0.0002	0.28	86.66	0.0002	0.28	86.66
	Dim 7	0.0001	0.13	86.79	0.0001	0.13	86.79
	Dim 8	0.0000	0.05	86.84	0.0000	0.05	86.84
	Dim 9	0.0000	0.01	86.86	0.0000	0.01	86.86
	Dim 10	0.0000	0.00	86.86	0.0000	0.00	86.86
	Dim 11	0.0000	0.00	86.86	0.0000	0.00	86.86

Source: Authors' computations

Table A.2: MCA: Modality weights

Category	Variable	Modality	Dimension 1	
			Preliminary	Final
Innovation	Use of foreign-licensed technology	Yes	2.095	2.095
		No	-0.339	-0.339
	Use of e-mail to communicate of clients and suppliers	Yes	0.809	0.809
		No	-1.188	-1.188
	Website ownership	Yes	1.081	1.081
		No	-0.731	-0.731
	Product innovation	Yes	1.430	1.430
		No	-0.843	-0.843
	Process innovation	Yes	1.301	1.301
		No	-0.950	-0.950
	R&D spending	Yes	2.276	2.276
		No	-0.482	-0.482
Human capital	High-school completion (% of full-time workers	81-100	1.419	
		61-80	-0.312	
		41-60	-0.803	
		21-40	-0.460	
		0-20	-1.262	
	Top manager experience years	20+	1.071	1.261
		15-20	0.374	0.740
		10-15	0.312	-0.058
		5-10	-0.616	-0.875
		<5	-1.469	-1.410
	Formal training programs provided	Yes	1.746	1.652
		No	-0.663	-0.605
	How much of an obstacle: Inadequately educated workforce	No obstacle	0.503	
		Minor	-1.121	
		Moderate	-0.617	
		Major	0.735	
		Very severe	2.515	
Market inefficiency	How much of an obstacle: Business licensing and permits	Very severe	1.731	1.305
		Major	1.356	1.348
		Moderate	0.990	0.983
		Minor	0.423	0.376
		No obstacle	-1.217	-1.241
	Number of competitors main product/product line face	None	0.333	
		1	-0.634	
		2-5	-1.372	
		5+	-2.190	
	Does this firm compete against unregistered or informal firms?	Yes	0.842	0.756
		No	-1.467	-1.338
	How much of an obstacle: Practices of competitors in informal sector	Very severe	1.542	1.265
		Major	1.263	1.276
		Moderate	0.524	0.665
		Minor	-0.252	-0.137
		No obstacle	-2.068	-1.907
	How much of an obstacle: Labor regulations	Very severe	1.765	1.240
		Major	1.635	1.697
		Moderate	1.131	1.233
		Minor	0.374	0.444
		No obstacle	-1.048	-1.068
	Have a line of credit/loan from a financial institution	No	0.049	0.017
		Yes	-0.178	-0.066
	How much of an obstacle: Access to finance	Very severe	1.147	0.944
		Major	0.853	0.863
		Moderate	0.585	0.582
		Minor	-0.299	-0.179
		No obstacle	-1.694	-1.699
Physical infrastructure barriers	Number of power outages (per month)	10+	0.959	0.959
		5-10	0.408	0.408
		<5	-1.035	-1.035
		None	-1.005	-1.005
	Losses due to power outages (% of sales)	10+	1.419	1.419
		5-10	0.629	0.629
		<5	-0.223	-0.223

Category	Variable	Modality	Dimension 1	
			Preliminary	Final
		None	-1.529	-1.529
	How much of an obstacle: Electricity	Very severe	1.280	1.280
		Major	0.827	0.827
		Moderate	-0.100	-0.100
		Minor	-1.134	-1.134
		No obstacle	-2.503	-2.503
	How much of an obstacle: Telecommunications	Very severe	1.089	1.089
		Major	1.133	1.133
		Moderate	0.899	0.899
		Minor	0.434	0.434
		No obstacle	-0.872	-0.872
	How much of an obstacle: Transport	Very severe	1.125	1.125
		Major	0.994	0.994
		Moderate	0.592	0.592
		Minor	-0.069	-0.069
		No obstacle	-1.116	-1.116
Institutional infrastructure barriers	How much of an obstacle: Political instability	Very severe	0.981	0.981
		Major	0.983	0.983
		Moderate	0.934	0.934
		Minor	0.693	0.693
		No obstacle	-1.426	-1.426
	Court system is fair, impartial, and uncorrupted	Strongly disagree	0.673	0.673
		Tend to disagree	0.309	0.309
		Tend to agree	-0.327	-0.327
		Strongly agree	-0.794	-0.794
	How much of an obstacle: Courts	Very severe	2.260	2.260
		Major	2.072	2.072
		Moderate	1.658	1.658
		Minor	0.885	0.885
		No obstacle	-1.199	-1.199
	Time spent in dealing with government regulations (%)	10+	0.979	0.979
		5-10	0.297	0.297
		<5	-0.273	-0.273
		None	-0.395	-0.395
	How much of an obstacle: Customs and trade regulations	Very severe	1.757	1.757
		Major	1.612	1.612
		Moderate	1.066	1.066
		Minor	0.263	0.263
		No obstacle	-1.241	-1.241
	How much of an obstacle: Tax administrations	Very severe	1.495	1.495
		Major	1.422	1.422
		Moderate	0.727	0.727
		Minor	-0.093	-0.093
		No obstacle	-1.782	-1.782
	How much of an obstacle: Access to land	Very severe	1.088	1.088
		Major	1.000	1.000
		Moderate	0.781	0.781
		Minor	0.379	0.379
		No obstacle	-0.893	-0.893
	Total annual sales paid in informal payments (%)	10+	1.542	1.542
		5-10	1.276	1.276
		<5	0.778	0.778
		None	-0.393	-0.393
	How much of an obstacle: Corruption	Very severe	1.523	1.523
		Major	1.064	1.064
		Moderate	0.707	0.707
		Minor	-0.095	-0.095
		No obstacle	-1.891	-1.891
	A gift/informal payment requested in any of tax officials' inspections	Yes	1.446	1.446
		No	-0.281	-0.281

Source: Authors' computations

Table A.3: MCA: Discriminatory measures of variables

Category	Variable	Contribution (%)	
		Preliminary	Final
Innovation	Use of foreign-licensed technology	11.8	11.8
	Use of e-mail to communicate of clients and suppliers	16.0	16.0
	Website ownership	13.2	13.2
	Product innovation	20.1	20.1
	Process innovation	20.6	20.6
	R&D spending	18.3	18.3
	Total	100	100
Human capital	High-school completion	30.5	
	Top manager experience years	18.8	50.0
	Formal training programs provided	29.0	50.0
	How much of an obstacle: Inadequately educated workforce	21.6	
	Total	100	100
Market inefficiency	How much of an obstacle: Business licensing and permits	17.1	19.0
	Number of competitors main product/product line face	5.5	
	Does this firm compete against unregistered or informal firms?	17.6	16.9
	How much of an obstacle: Practices of competitors in informal sector	26.9	27.6
	How much of an obstacle: Labor regulations	15.5	18.5
	Have a line of credit/loan from a financial institution	0.1	0.0
	How much of an obstacle: Access to finance	17.0	18.1
	Total	100	100
Physical infrastructure barriers	Number of power outages (per month)	16.7	16.7
	Losses due to power outages (% of sales)	23.4	23.4
	How much of an obstacle: Electricity	32.2	32.2
	How much of an obstacle: Telecommunications	13.6	13.6
	How much of an obstacle: Transport	14.1	14.1
	Total	100	100
Institutional infrastructure barriers	How much of an obstacle: Political instability	12.9	12.9
	Court system is fair, impartial, and uncorrupted	2.8	2.8
	How much of an obstacle: Courts	18.3	18.3
	Time spent in dealing with government regulations (%)	2.7	2.7
	How much of an obstacle: Customs and trade regulations	14.2	14.2
	How much of an obstacle: Tax administrations	16.1	16.1
	How much of an obstacle: Access to land	7.1	7.1
	Total annual sales paid in informal payments (%)	4.2	4.2
	How much of an obstacle: Corruption	17.5	17.5
	A gift/informal payment requested in any of tax officials' inspections	4.1	4.1
	Total	100	100

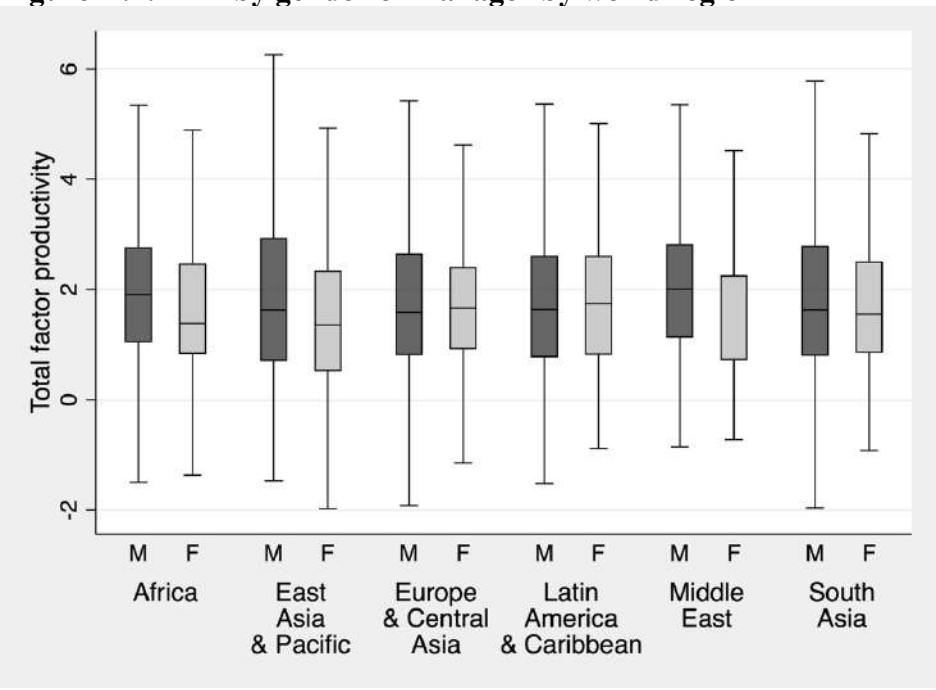
Source: Authors' computations

Table A.4: Two-sample t-tests of firms' TFP by gender of top manager

	Male-managed firms	Female-managed firms	Difference
North Africa	2.444	2.142	0.302*
	(0.058)	(0.165)	
West Africa	2.964	2.762	0.202
	(0.088)	(0.234)	
East Africa	2.996	2.258	0.738**
	(0.121)	(0.294)	
Central Africa	2.605	2.556	0.049
	(0.130)	(0.131)	
South Africa	2.670	2.581	0.089
	(0.190)	(0.192)	
Africa	2.486	2.224	0.265*
	(0.052)	(0.136)	
World	2.611	2.588	0.023
	(0.056)	(0.206)	

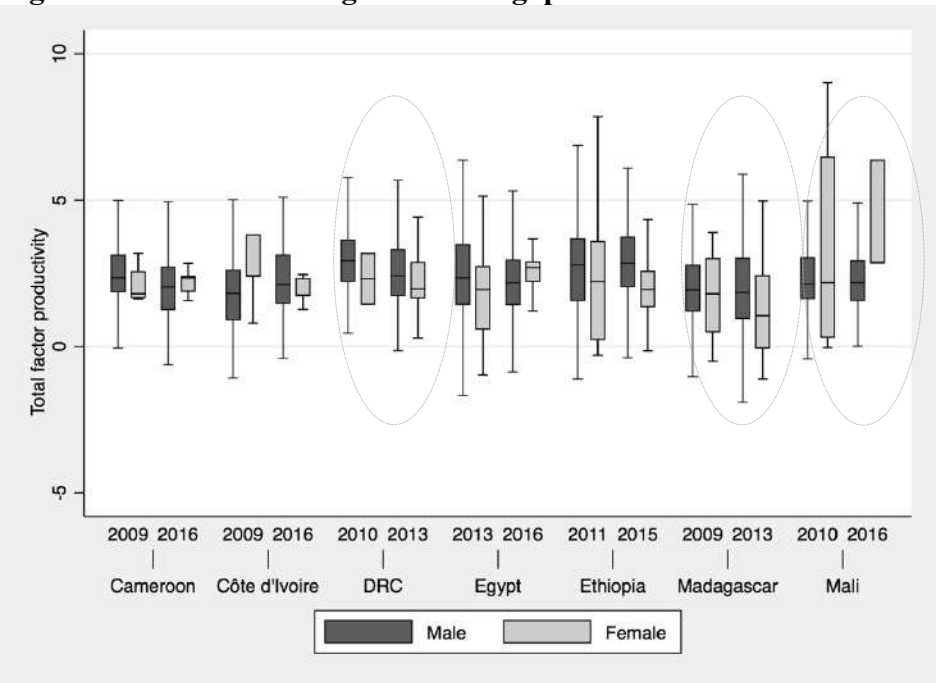
Standard errors are reported in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Survey weighted data are used (Stata's svy prefix). TFP is estimated using output Y_i.

Figure A.1: TFP by gender of manager by world region



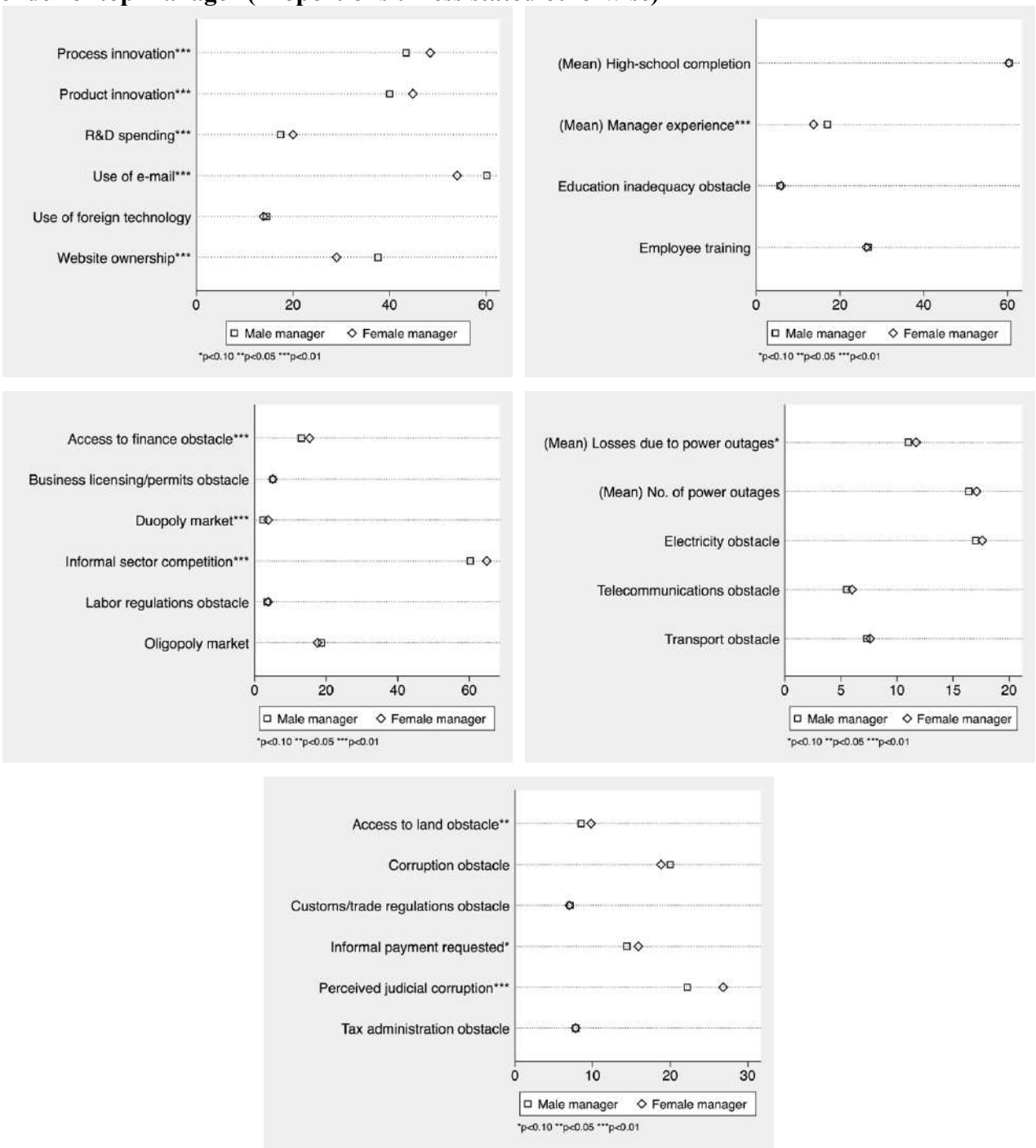
Source: Authors' computations based on World Bank Enterprise Surveys

Figure A.2: Evolution of gender TFP gaps in selected African countries, 2009-2016



Source: Authors' computations based on World Bank Enterprise Surveys

Figure A.3: Two-sample tests of proportions of firms reporting on TFP determinants by gender of top manager (Proportions unless stated otherwise)



Source: Authors' computations based on World Bank Enterprise Surveys