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The Productivity Gaps of Female-Owned Firms: Evidence from Ethiopian Census Data

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Abstract

This paper provides new empirical evidence on the relative productivity disadvantage of female-owned firms compared to male-owned firms. We rely on a large panel of Ethiopian manufacturing firms based on an annual census run by the Central Statistical Agency of Ethiopia (CSA) over 2003-2009. Our preferred estimation shows a 12.5 percentage point gap in total factor productivity between female- and male-owned firms. This result is in line with most previous findings for other developing countries and is robust to using matched samples and controlling for potential endogeneity through IV estimation. Moreover, drawing on a recent approach developed by Combes *et al.* (2012) we are able to dig deeper into some of the mechanisms affecting firm productivity distributions. We empirically demonstrate that the productivity distribution of female firms is not only left-shifted but also less dilated compared to the corresponding male distribution, especially in Addis Ababa. In addition, low-productivity female firms are less likely to exit the market, resulting in longer left distribution tails compared to male firms.

Keywords: Firms; Productivity distribution; Gender gap.
JEL Codes: L26; J16

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0. Introduction

Closing the gender gap has become an imperative in global development circles. While much progress has been recorded under the Millennium Development Goals, the recently established Sustainable Development Goals (SDGs) call for renewed efforts to reduce gender discrimination and increase empowerment, with a stronger emphasis on the promotion of a more active role for women as decision makers and owners of economic resources. As a matter of fact, in many developing countries, including in Sub-Saharan Africa (SSA), gender issues relating to the extent and nature of women's participation in productive activities, the allocation of women into specific sectors and types of jobs, and high gender inequality in the labour market remain pressing (Hallward-Driemeier, 2011; Juhn *et al.*, 2014). Also, much is still unknown about which and how discriminatory practices and institutional constraints to which women are subjected influence their entrepreneurial capabilities.

The literature on gender, entrepreneurship, and firm performance generally shows evidence of significant gender gaps both at market entry (i.e., women are less likely to become entrepreneurs) as well as in several dimensions of female-owned firms' performance (World Bank, 2012; Marques, 2015). In the context of SSA, it has been reported that women's economic participation is generally high compared to other developing regions, but concentrated in lower opportunity activities (Hallward-Driemeier, 2011). In addition, many SSA countries present challenging institutional environments for women. However, only limited attention has been devoted to investigating the role of female ownership as a determinant of firms' performance in the SSA region and the few studies that exist provide mixed results. This lack of systematic evidence may be attributed to the type and quality of the data used as well as the definition of female ownership adopted(Aterido and Hallward-Driemeier, 2011). Furthermore, there is very little evidence on the underlying factors of the gender performance gap in firm ownership, if any.

This paper aims at addressing some of above issues. We rely on a large panel of Ethiopian manufacturing firms based on an annual census run by the Central Statistical Agency (CSA) of Ethiopia over 2003-2009. The case of Ethiopia is particularly interesting for a number of reasons. Over the last decades, the country has experienced sustained economic growth, spurred by large infrastructural investments, waves of

trade liberalization and industrial policies supporting the growth of the manufacturing sector and the structural transformation of the economy(World Bank, 2015), aimed at fostering broader economic participation and enhancing productivity. Importantly, Ethiopia is still characterized by large gender gaps in the labour market. According to the World Economic Forum's Gender Gap Index, the country performs relatively poorly (ranked 109th out of 144 countries in 2016), to a large extent due to low scores for 'economic participation and opportunity'.[1] A recent report by the ILO (2015)adds that only 22% of managers in the country are women, which puts Ethiopia in the group of worst-performing countries in this specific dimension. That notwithstanding, recent efforts such as the combined reforms in the family code and in community-based land registration are have already brought measurable improvements in women participation in economic activities and welfare(Hallward-Driemeier and Gajigo, 2015; Kumar and Quisumbing, 2015).

The objective of our empirical analysis is twofold. First, along the lines of existing studies on the topic, we aim at understanding whether and to what extent female- owned firms in the Ethiopian manufacturing sector exhibit a performance gap compared to their male-owned counterparts. We do so taking total factor productivity as our measure of firm performance. Unlike the extant literature on other developing countries, which mostly relies on survey data and includes a large number of small and informal firms, we base our analysis on census data (thus avoiding problems of sample representativeness) and consider the universe of the formal firms in the Ethiopian manufacturing sector. To our knowledge, we are the first to employ firm census data from an SSA country for these purposes. The richness of our dataset with respect to firm ownership allows us to check the robustness of female-male firm productivity differences to alternative definitions of female ownership, based either on capital shares or on the number of female owners. In addition, we account for the potential endogeneity of female ownership with an instrument that combines information on the historic diffusion of plough-based agricultural practices among the prevailing ethnic groups in proximity to each firm's location (see Alesina *et al.*, 2013) with a variable measuring the exogenous variation of female ownership at the regional level(as in Flabbi *et al.*, 2016).

[1] See http://reports.weforum.org/global-gender-gap-report-2016/economies/#economy=ETH.

Second, in the last part of the paper we look beyond average productivity gaps and try to motivate some of the previous results showing how male- and female- owned firms have different productivity distributions. Specifically, we draw on an quantile-based empirical strategy originally developed by Combes *et al.* (2012)to study the various channels through which agglomeration affects productivity. This allows us to evaluate in which ways the shape of the productivity distribution differs according to the gender of firm owners. More specifically, we use the Combes et al. (2012) approach to formally distinguish between three distributional 'transformations', i.e., the shift, dilation and truncation of the productivity distribution of female-owned firms *relative* to that of male-owned firms. Our assumption is that if female-owned firms show a systematic, across-the-board productivity gap, due to the characteristics of their production process and/or the technology adopted, we should observe a significant leftward shift and perhaps reduced dilation of the productivity distribution of female-owned firms vis-à-vis the corresponding distribution of male-owned firms. In addition, we expect to see a relative left truncation of female firm productivity distributions (i.e., more exit), especially in cases where tougher firm selection is likely, such as in more competitive industries or larger agglomerations.

Our results show a consistent productivity gap for female-owned firms, varying between 10 to 50 percentage points (p.p.), depending on the exact specification and definition of female ownership adopted (with the larger the level of control over the firm, the stronger the gap). Our preferred estimation shows a 12.5 p.p. difference in productivity, which is more or less in line with previous findings on larger, formal firms in other SSA countries (Aterido and Hallward-Driemeier, 2011), but lower compared to other studies that include smaller, informal firms (Jones, 2012; Nordman and Vaillant, 2014). Our analysis shows that lower capital intensity and smaller size; lower access to finance; allocation into less productive labour-intensive and female worker-dominated industries; as well as higher exposure to competition are among the mechanisms explaining (part of) this productivity gap. These results are robust to variations in the measure of productivity, to using a control sample of male firms selected on the basis of matching estimators, and to controlling for potential endogeneity by means of IV estimation.

Next, we provide new insights based on the observed effects of female ownership on the distribution of firm productivity. In the full sample we find evidence of a significant leftward shift and lower dilation of the female firm productivity distribution compared to the male distribution, but no signs of relative truncation. We then consider a sample confined to firms in the capital region, Addis Ababa, where more than half of the manufacturing establishments in our sample are located, and show that this strengthens the economic significance of the above findings. Taken together, our results suggest that female-owned firms are systematically less productive (left shift) and more homogeneous (lower dilation) in terms of productivity than male-owned firms. There is only a relatively small number of very productive female firms that coexist with a much larger group of much less productive establishments. Interestingly, the latter group includes a long tail of firms that do not exit the market, despite their low productivity, even in more competitive settings. This result, though surprising, is consistent with related evidence of larger survival probabilities among female-owned firms in Ethiopia(Shiferaw, 2009).

The remainder of the paper is structured as follows. Section 1 reviews the literature on the gender gap in firm performance, with a focus on developing countries. Section 2 introduces the data and methodology. Sections 3 and 4 present the regression results and results on firm productivity distributions, respectively. Section 5 concludes.

1. Literature review

Our paper contributes to a large and growing literature on differences in performance, and productivity in particular, between female- and male-owned firms. A good part of this literature concerns industrialised rather than low-income countries, and micro- and small entrepreneurs rather than larger enterprises (see Klapper and Parker, 2011 for a more complete overview). Rosa *et al.* (1996) and Bosma *et al.* (2004) find, respectively, that UK and Dutch female-owned businesses underperform vis-à-vis male-owned businesses in terms of different output measures. Fairlie and Robb (2009) report comparable findings for the US, whereas Kepler and Shane (2007) show that gender-based performance differences in US firms disappear once industry sectors and individual-level factors are controlled for. Similarly, Du Rietz and Henrekson (2000)

conclude that there is little female underperformance in Swedish firms conditional on other factors.

The evidence for transition and developing countries seems to be mixed too. In their study of Eastern European and Central Asian firms, Sabarwal and Terrell (2008) identify a statistically significant but economically small female-male gap in total factor productivity (TFP), driven by firms located in non-EU countries. According to Bruhn (2009), medium-sized and large female-owned companies in Latin America are equally productive as their male-owned counterparts, although productivity differences by gender are significant when only the smallest firms are considered. Using cross-country comparable data on formal enterprises from the World Bank Enterprise Surveys, Bardasi *et al.* (2011) observe gender-based TFP differences in Eastern Europe and Central Asia and in Latin America, but not in Sub-Saharan Africa; conform an earlier study focusing on Africa (Bardasi *et al.*, 2007). Conversely, African country-specific evidence suggests lower female firm productivity in Ghana (Jones, 2012) and Madagascar (Nordman and Vaillant, 2014). Aterido and Hallward-Driemeier (2011) argue that the definition of what constitutes a 'female business' and the distinction between ownership and control matter a lot in assessing productivity differences. Combining information from World Bank Enterprise Surveys with follow-up interviews of entrepreneurs in five African countries, they find no significant gender gaps in productivity when the standard 'female participation in ownership' (based on capital shares) is used. However, when the actual primary decision-maker is female, firms do exhibit significantly lower productivity. This latter result seems consistent with what recently shown by Flabbi et al. (2016b) on a cross section of Latin American and Caribbean firms in which they are able to isolate the role of women in executive positions, finding little or no evidence of lower performance in companies lead by women.

Several factors have been advanced to explain the female-male firm productivity gaps that one observes in some of the just-mentioned and other studies. They can be broadly classified into two main categories: differences in the kind of businesses that women and men own/run, and differences in the characteristics of male and female

entrepreneurs (World Bank, 2012).[2] First of all, in many countries, female businesses are concentrated in sectors characterised by small scale, low growth, low technology and capital, and intense competition. This sorting of female business could in turn reflect women's preferences, for example, on childcare and household production, and/or external conditions, like credit constraints, property rules or social norms that are unfavourable to women. External constraints are deemed to be particularly important and tend to be more explicit in developing countries (see Sabarwal and Terrell, 2008; Bardasi *et al.*, 2011; Klapper and Parker, 2011 and references therein).[3] Second, female entrepreneurs may be disadvantaged in terms of education, experience and other skill-related traits that are positively linked to productivity. For example, in their study of Sub-Saharan Africa, Aterido and Hallward-Driemeier (2011) demonstrate that single women but not men operate relatively less productive firms. They conjecture that this has to do with cultural practices in the region that imply lesser access to assets for daughters. Also, joining a family business or having a father with an entrepreneurial background is found to boost the productivity of sons' enterprises but not of daughters', perhaps because of sons being more likely to be trained on the job by their families (Aterido and Hallward-Driemeier, 2011). Since our own dataset lacks detailed information on individual business owners' characteristics we can only test hypotheses related to the first line of arguments, with respect to differences in business types between female and male entrepreneurs.

Only a few previous studies have looked at the question of heterogeneity in firm productivity by gender in the context of Ethiopia. An analysis of World Bank Enterprise Survey data for Ethiopia by Bardasi and Getahun (2009) finds an overall negative effect of female business ownership on productivity, with statistical significance depending on the productivity specification used. Bardasi and Getahun (2009) further document how the productivity of female firms is disproportionally reduced by constraints related

[2] The World Bank (2012) also list a third category of explanations, related to differences between men and women in the returns to both business and entrepreneur characteristics, but finds little evidence to support it. Arguably, 'women are as efficient as men in production when given access to the same inputs' (World Bank, 2012, pp. 203-204).

[3] In practice it is often difficult to neatly distinguish preferences from external factors. Some of women's 'preferences' for particular business strategies may be strongly influenced by social norms of which activities are acceptable for them to engage in (Field *et al.*, 2010). On the other hand, an 'external' factor such as a lack of credit could be due to lower demand for credit by women themselves, because of greater risk aversion and a lesser focus on growth (Watson *et al.*, 2009), in addition to credit rationing on the supply side (Presbitero *et al.*, 2014).

to macro-economic instability, access to and the cost of finance, and crime. Rijkers and Costa (2012) use data from the World Bank's Rural investment Climate Pilot Survey of the rural non-farm sector in Ethiopia's Amhara region to show that enterprises run by female managers are significantly less productive than those run by men. The estimated productivity disadvantage is reduced by half once differences in firm size, sector and input usage are accounted for, but remains economically and statistically significant. Rijkers *et al.* (2010) consider surveys of manufacturing firms in rural Amhara and in 14 major urban centres spread over seven Ethiopian regions. Only in rural areas female management is associated with lower productivity, and the association disappears when constraints to the availability of utilities, transport and credit are included as controls.

2. Data and descriptive analysis

This paper uses firm-level data from Ethiopia over the period 2002/3-2008/9. Data come from the annual census of Large and Medium Manufacturing firms, which covers all firms that employ at least 10 workers and employ electricity in their production process. All firms need to comply with Central Statistical Agency (CSA) requirements, and the census is therefore representative of more structured, and formal, firms in the country.

This dataset, in various guises, has been employed in the past to study firm growth, survival and structural change (Bigsten and Gebreeyesus, 2007; Shiferaw, 2009; Söderbom, 2012); the role of exporting and trade liberalisation on productivity(Bigsten and Gebreeyesus, 2009; Bigsten *et al.*, 2016); returns to capital in formal vs. informal firms(Siba, 2015); job creation, job destruction and skill-biased technological change(Shiferaw and Bedi, 2013; Haile *et al.*, 2016), and road infrastructure and firm entry(Shiferaw *et al.*, 2015), among other topics; but never to evaluate gender-based productivity differences. We believe the dataset's extensive coverage of medium and large manufacturing enterprises and rich details on ownership structure make it particularly suitable for our purposes.

The dataset includes detailed information on output, capital, labour and other inputs for all firms. In addition, it provides precise information on the location of firms by their

region and town of origin, and in some cases up to their district (*kebele*). It also contains data on the industry of firm activity, up to the 4-digits ISIC revision 3 classification.

Crucially, the census is endowed with details on the ownership structure of each firm. Constructing a good gender-based measure of ownership from firm-level data is not trivial. Most studies have used a generic measure of female participation in the ownership of a firm, i.e., a dummy that equals one if *any* woman is among the owners (Qian, 2016). While this perfectly fits the case of sole-owned firms, it may be a less precise measure of female ownership in firms with multiple owners, including larger ones. Some studies, on the other hand, have had the advantage of using purposely collected survey data including specific questions related to the effective control of women in the decision-making process (see Aterido and Hallward-Driemeier, 2011 on SSA firms; and Presbitero *et al.*, 2014 on Latin American firms). Unfortunately, our own dataset on the Ethiopian manufacturing sector does not contain any information on firms' ultimate decision-makers, to the extent that they are different from the owners. Rather, our data allows us to construct a measure of female ownership based on the share of control of women both in terms of a firm's current capital and on the composition of the board[4]. Our preferred measure of female ownership is based on a restrictive definition, i.e. whether women holds at least 50% of the current capital of firms. It is on the basis of such definition that we present some preliminary descriptive statistics and run our baseline regressions. Alternative definitions of female ownership will be used as robustness checks later on in the paper.

Whereas the number of firms surveyed increased substantially over the period considered, from 916 in 2003 to 1,913 in 2009, the share of female-owned firms remained fairly stable, around 12.5% (Table 1)[5].

TABLE 1 HERE

[4] Sekkat *et al.* (2015)demonstrate that developing country firms with women among their shareholders are more likely to have a female CEO too. For African firms it is found that the higher the female ownership share, the stronger its effect is on the likelihood of a female CEO.

[5] This share raises to 29% of the total sample if we consider a less restrictive definition (i.e., at least one woman in the board) and decreases to 7.2% in case female ownership is defined as 100% of capital being held by women.

Compared to their male-owned counterparts, female-owned firms are generally more concentrated, both geographically (almost 60% in the administrative region of Addis Ababa) and, especially, at the sectoral level (about 50% among bakery, cement and furniture) (cf. Tables A1 & A2 in the Appendix). In addition, and in correspondence with existing evidence from other developing countries, including in SSA, female firms are smaller in size, less capital intensive and less internationalized compared to male owned firms. Moreover, on average they employ larger shares of female workers overalland of *skilled* female workers (Table 2).

TABLE 2 HERE

2.1 Productivity estimates

The main indicator used to measure the relative performance of male- and female-owned firms in this paper (as in the literature) is productivity. We focus on Total Factor Productivity (TFP), productivity indicator widely employed in the literature on heterogeneous firms(Melitz, 2003; Helpman *et al.*, 2004).

The production function is assumed to take the form of a standard Cobb-Douglas:

$$Y_{it} = A_{it} L_{it}^{\alpha_L} K_{it}^{\alpha_K} M_{it}^{\alpha_M}, \qquad \alpha_L, \alpha_K, \alpha_M > 0 \tag{1}$$

where Y_{it} represents the output, L_{it}, K_{it}, M_{it} the inputs in the form of labour, capital and intermediate inputs, A_{it} is the Hicks-neutral efficiency level, which represents the TFP of firms. At the level of firms, A includes not easily measurable factors, such as R&D stocks, technology, quality and marginal efficiency(Del Gatto *et al.*, 2011).

Transforming (1) into logarithms allows one to introduce a linear estimation of the production function (where small letters represent logs):

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + v_{it} + \varepsilon_{it} \tag{2}$$

where the error term has two components, v_{it}, which represents the level of productivity of the firm, and ε_{it}, the i.i.d. component which is uncorrelated with input choices. v_{it}

represents the key variable to be computed after having estimated (2) and solved for $\hat{\omega}_{it}$ as the standard Solow residual:

$$\hat{\omega}_{it} = \hat{v}_{it} + \hat{\beta}_0 = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it} \quad (3)$$

Taking in consideration that $\hat{\omega}$ is observed by firms and influences their choice of inputs, making the error term correlated with the dependent variables in (2) and thus the coefficients of a standard OLS model biased, alternative methods to estimate TFP have been proposed in the literature(see Del Gatto *et al.*, 2011; Van Beveren, 2012 for reviews), including fixed effects and system-GMM(Wooldridge, 2009). More consistent approaches include those adopting semi-parametric estimators using proxies to correct for the unobservable productivity shocks and the potential simultaneity bias in the choice of input levels. In what follows, we focus on the approach proposed byOlley and Pakes (1996), which controls not only for the just-discussed simultaneity bias, but also for the potential selection bias resulting from the relationship between productivity shocks and the probability of firms to exit the market, which would otherwise bias the coefficient of capital downward if not properly accounted for. More specifically, the method of Olley and Pakes (1996) solves the simultaneity bias by using investment to proxy for unobserved time-varying productivity shocks, while the selection problems are addressed using survival probabilities.

Estimates of TFP functions have been run separately for each industry identified by its 4-digit code. Output is measured by value added, labour by the number of skilled and unskilled employees, capital has been calculated through the perpetual inventory method assuming an annual discount rate of 5%, while intermediate inputs are proxied by the sum of all the costs related to the inputs used in the production process. Variables reported in monetary terms have been deflated using Ethiopia's GDP deflator, obtained from the IMF, with 2005 as a base year.

3. Regression results

First of all, we are interested in evaluating whether the productivity gap that has been found in most existing studies on female-owned firms is also confirmed in the context of our census data on Ethiopian medium- and large-sized manufacturing firms.

Importantly, our identification strategy is based on within-industry variation in productivity according to the ownership of firms. Within firms changes in ownership are rare over the period considered and do not provide sufficient variation to interpret the effect of a switch from male to female ownership on productivity.

Table 3 summarizes the main results of a set of unconditional regressions linking female ownership to TFP.

TABLE 3 HERE

The results confirm extant evidence from other developing countries and show that, depending on the specification adopted, the gender productivity gap in Ethiopia ranges from 14 to 50 p.p., with an unconditional gap of 29 p.p in a specification including a full set of industry, region and year fixed effects.

Three main things stand out from these preliminary estimates. First, the size of the gap is largely dependent on the definition of female ownershipThis is consistent with the large variability of findings found in the studies surveyed in Section 1, and it shows once more how relevant the definition of female ownership is(see also Aterido and Hallward-Driemeier, 2011). In fact, the size of the gap in our preferred definition of female ownership based on majority share of firm capital lies in between a broader definition based on the presence of at least one woman among the owners (column 4), to the most restrictive one, i.e., fully female owned firms (column 5). Second, considering that differences between female- and male-owned firms may be non-random, we adopt a matching algorithm to select a subsample of firms sharing similar characteristics except for their ownership, using coarsened matching techniques(Iacus *et al.*, 2012), so as to constrain firms to be exactly matched on industry and region. Even in this case, results (column 3) point to a (be it statistically weaker) significant productivity gap of about 13 p.p, half of the baseline value in column 2. Third, results are robust to the adoption of labour productivity (measured as the log of real value added per employee) as the dependent variable, instead of estimated TFP.

Having analysed the unconditional relation between female ownership and productivity, we now move the analysis further and try to improve our understanding of the gender productivity gap. We do this in two main ways. First, we add some additional control variables likely to affect productivity levels, which are typically used in heterogeneous firms models. These include firms' size, proxied by the log number of total employees; the age of the firm, i.e., the log number of years since its first establishment; capital intensity, measured as the log of the ratio of fixed assets to the number of employees; and two dummies controlling for the status of firms as exporters and/or importers. Second, we attempt to explore the main mechanisms leading to lower productivity of female-owned firms by interacting our variable of interest with a range of firm- and industry-specific factors.

The results are reported in Table 4. All standard controls behave as expected, in accordance with the provisions of heterogeneous firms models(Helpman *et al.*, 2004). Previous evidence on the productivity gap is confirmed. The inclusion of firm-specific controls reduces the economic size of the gap to 12.5 p.p., but its statistical significance remains high. Interestingly, when we run the same regression on the matched sample of firms sharing similar characteristics (column 2, Table 4) the female ownership coefficient remains basically unchanged, strengthening our confidence on the economic relevance of this finding.

TABLE 4 HERE

In the remaining columns (3-8) of Table 4, we explore some of the potential mechanisms at stake by adding selected interaction terms. Consistent with the motivations advanced by the existing literature, we show that capital intensity and firm size play an important role in explaining the gender productivity gap. Once they are interacted with the female ownership dummy (*fem*kl* and *fem*lemp*), in fact, the coefficient of the latter loses its significance or even turns positive (columns 3-4). Against the general finding of capital intensity as a major determinant of productivity, the result looks reversed in the context of female-owned firms. This is consistent with the estimates reported in column 8, where an industry level measure of labour intensity (the variable *labour_intensity*, constructed from our census data by calculating each 4-digit industry's share of total wages over capital) is interacted with female ownership

(*fem*labour_intensity*). This confirms that firms in more labour-intensive industries are less productive on average, but also that – within such a group - female-owned firms show a productive advantage. Conversely, we do not find strong evidence on the role of access to finance. Our proxy is a dummy (*ir*) taking the value of 1 if the firm reports positive values of interests paid(as in Shiferaw, 2016, which uses the same census data). While we show that firms that access finance display higher productivity, the interaction term (*fem*ir*) turns (slightly) negative but is not statistically significant, meaning that female-owned firms able to access credit are at least no less productive than male firms. On the other hand, the role of female workers within the firm (*n_female_male*) seems to be important. The interaction term (*fem*n_female_male*) appears to indicate that the productivity gap can largely be attributed to those female-owned firms employing a large share of female workers, a factor that in itself is found to be negatively correlated to productivity. This result looks opposite of what Flabbi *et al.* (2016) have recently found in a panel of Italian manufacturing firms. In their theoretical setting they claim that female executives are better at processing information on female workers, resulting in reduced discrimination (e.g., in wages) and, ultimately, improved firm performance (due to better matching of skilled female workers) when the share of female workers is higher. This does not seem to be the case of Ethiopia. Rather, our result likely derives from a clustering of female workers and owners in low-productivity activities (Juhn *et al.*, 2014; Kucera and Tejani, 2014).

A last finding is related to the role of agglomerations and competition. When we add a coefficient measuring firms' *agglomeration*, computed counting the number of firms operating in the same 4-digit industry and town for any given year, as in Siba *et al.* (2012), we find that the female productivity gap is further exacerbated in larger agglomerations of firms sharing the same specialization, suggesting that a mechanism based on more fierce competition is at play. Again, this looks coherent with the existing literature, which reports greater aversion of female owners towards competition and risk.

3.1 Endogeneity

To be sure, one might argue that the just-observed productivity gap can be largely explained away by the self-selection of female-owned firms into lower-productivity activities and/or their over-concentration among smaller and less capital-

intensive/internationalized firms, implying endogeneity of our key right-hand variable. To account for such potential endogeneity biases, we check the robustness of our main results with an IV approach.

We construct an external instrument starting from historical data on the ethnic composition of Ethiopian society, using the log distance (in km) of each town in our sample to the nearest prevailing ethnic group with a tradition of plough use in agriculture. This strategy is motivated by findings from recent work by Alesina *et al.* (2013), who show that societies that traditionally practiced plough agriculture -rather than shifting cultivation -developed a strict specialization of production along gender lines, which in turn generated social norms that nowadays still have predictive power for lower participation by women in economic and political spheres.

Given the time-invariant nature of this historical variable, we combine it with an additional indicator that, as in Flabbi *et al.* (2016), assumes the existence of an exogenous trend in the distribution of female firm ownership across Ethiopian regions over time. We construct this indicator in two steps. First, retrieving earlier-period information from the same Ethiopian census, we calculate the average fraction of female owned firms in each region over the years 1996-2000. Using the pre-2000 average share as a starting point should guarantee the exogeneity of the initial conditions. We then calculate the same indicator for each region and year over our sample, and– as in Flabbi *et al.* (2016)– compute the annual growth rates of these fractions for all the years from 2003 to 2009. Such growth rates are then multiplied with the base period average share and finally multiplied with the distance coefficient to form our external instrument.

Table A3 in the Appendix reports the IV regression estimates. The instrument passes well the first stage, where it is positive and significant. The second-stage results again confirm the existence of a significant productivity gap, which now increases up to 19.6 p.p..

4. Results on firm productivity distributions

In this section we present results based on applying the methodology developed by Combes *et al.* (2012)to a study of the effects of female ownership on different moments of the firm productivity distribution.

Using data on French firms, Combes et al. (2012) find that firms residing in larger cities tend to be more productive. They argue that this observation could be explained by 'firm selection' where larger cities are thought to harden competition and, therefore, only allow the survival of the most competitive. Another possible explanation is 'agglomeration economies', whereby the presence of large numbers of diverse firms facilitates interaction among them and boosts their productivity. Empirically then, the productivity distribution of firms in large cities may display left-truncation because the presence of tough competition (i.e., firm selection) will force weaker firms to exit the market. Conversely, the presence of strong firm interaction (i.e., agglomeration economies) should lead to a right-ward shift in the productivity distribution. In addition, one could expect the most competitive firms to take most advantage of agglomeration, thereby increasing their productivity more than proportionally. In the latter case, the productivity distribution will be dilated. Combes et al. (2012) present a nested model of 'selection' and 'agglomeration economies' that enables us to empirically test and interpret the relative truncation, shift and dilation of firm productivity distributions.

For instance, let us consider two TFP distributions F_i (e.g., for male-owned firms) and F_j (e.g., for female-owned firms). Further assuming that the male TFP distribution (F_i) can be determined by altering a cumulative density function ($\tilde{F}$), where the latter distribution is dilated by a factor D_i , right shifted by a factor A_i and left-truncated by a share $S_i \in [0,1)$ of its values, distribution F_i can be expressed as:

$$F_i(\phi) = max\left\{0, \frac{\tilde{F}\left(\frac{\phi - A_i}{D_i}\right) - S_i}{1 - S_i}\right\}$$

Similarly, if the female TFP distribution (F_j) can be obtained by altering the same cumulative density function ($\tilde{F}$), with dilation by a factor $D_j \neq D_i$, a right shift by factor $A_j \neq A_i$ and left truncation by a share $S_j \neq S_i$ of its values, then distribution F_j will be given as:

$$F_j(\phi) = max\left\{0, \frac{\tilde{F}\left(\frac{\phi - A_j}{D_j}\right) - S_j}{1 - S_j}\right\}$$

Moreover, if we let

$D \equiv \frac{D_i}{D_j}, \quad A \equiv A_i - DA_j,$ and $S \equiv \frac{S_i - S_j}{1 - S_j}$.

then the male-owned firms' TFP distribution (F_i) results from shifting the female owned firms TFP distribution (F_j) by A, dilating it by D and left-truncating it by a share S of its values, if $S_i > S_j$. That is:

$$F_i(\phi) = max\left\{0, \frac{F_j\left(\frac{\phi - A}{D}\right) - S}{1 - S}\right\}$$

Given our previous results on the productivity gap, the TFP distribution of female-owned firms will likely be left-shifted relative to the male distribution (A<0). Besides such an across-the-board productivity disadvantage, we may also assume relatively stronger homogeneity in productivity among female firms, due to their concentration in low-productivity industries and their lower scale and capital intensity, which should result into a less dilated TFP distribution than for male-owned firms. Finally, if it is true that female-owned firms are more affected by competition and so more likely to be driven out of the market, we should also find their distribution to be more left-truncated (S>0).

Table 5 presents the parameters for relative shift (A), dilation (D) and truncation (S) of female- vs. male-owned firm productivity distributions estimated using Combes et al.'s (2012) quantile approach.

TABLE 5 HERE

In the first row of Table we observe a value for A of about -0.185, which is also highly significant. This implies that to move from the male to the female TFP distribution in our sample of firms one needs to shift the first distribution leftwards (cf. Figure A1 in the Appendix). Specifically, it indicates that the productivity distribution for female-owned firms shows a decrease in mean productivity of ($e^{-0.185}$-1), which is about 16.9%,

when compared to male-owned firms. This is comparable with the unconditional difference in the productivity gap from our baseline regressions in column 1 of Table 3. Moreover, the first row and second column of Table 5 shows a value of D<1, meaning that the female firms' TFP distribution is indeed less dilated than the male distribution. This is a relevant property, since it reflects the specificity of the group of female-owned firms, which appear to be less likely to diversify and take advantage of productivity spill-overs arising from different sources, including technology, agglomeration effects and market opportunities. Finally, we do not find significant evidence for truncation, meaning that female firms are not more likely to exit compared to male firms. This latter finding is somewhat in line with the results of a survival analysis based on our Ethiopian census data (Shiferaw, 2009). While it is hard to explain the exact mechanisms with the data at hands, a possible interpretation may be a more cautious approach to business by female owners, making them less likely to embark on risky decisions that can push firms out of the market. Still, the high gender discrimination in the Ethiopian labour market perhaps provides an incentive for women to keep running their own business also at very low levels of productivity.

In the following rows of Table 5 we replicate the same approach but now comparing female and male firms according to their location. More specifically, we distinguish among those based in the neighbourhood of the capital from the others, motivated by the very strong presence of manufacturing firms in the Addis region and by the related literature emphasizing the productivity advantages of being located in larger agglomerations. Whether this also applies to the context of Ethiopia, a country characterized by large regional inequality, and affects female-male productivity gaps remains to be seen, however. In row 2 we first run an exercise that is similar to the one implemented in the original work by Combes et al. (2012). Similar to their findings, our results point to a strong productivity advantage for firms (either male- or female-owned) located near the capital, most likely because of agglomeration effects. Still, however, the case of Addis looks somewhat peculiar. The stronger agglomeration effect is not accompanied by a larger dilation, like in the sample of denser France cities found by Combes et al. (2012), meaning that the productivity advantage seems not to be disproportionally enjoyed by the most productive firms, but is rather distributed more equally. Finally, we find no evidence of stronger firm selection in Addis. On the contrary – and somewhat surprisingly – exit of less productive firms seems more likely

in other regions. Importantly, the same dynamics are found if we confine the sample to female-owned firms only, with those in Addis being on average more productive, but less likely to (row 3, Table 5).

In the remaining rows of Table 5 we compare the distributions of female- and male-owned firms according to their location. By doing so, we show that the effects found for the main sample are strongest in the case of Addis (cf. Figure A2), but much more tenuous in the other regions. Despite having shown that female firms in Addis are on average more productive compared to female firms located elsewhere (cf. Figure A3), we also find that they are less likely to enjoy the agglomeration advantages of being located in the capital than male-owned firms. Some of the other features of the shape of the distribution may help to explain this finding. First, the lower dilation of the TFP distribution means that there are relatively few highly productive female firms, as compared to male ones. Second, the – admittedly very small – statistically significant value of S seems to suggest that one of the reasons of female-owned firms' lower average productivity is the longer left tail of the productivity distribution, due to their stronger capacities to survive.

5. Conclusions

Our findings may have important policy implications for a country – like Ethiopia – currently embarked on a process of structural transformation. Productivity growth is crucial in that process but cannot be completely achieved unless the whole distribution, including that of female-owned firms, shifts rightwards. Targeting the productivity growth of female firms could be relevant also in terms of resource allocation, in view of their greater homogeneity. The literature on resource misallocation shows that it tends to be worse in the case of persistent productivity gaps among firms, resulting in lower aggregate productivity and weighing on overall economic growth (Hsieh and Klenow, 2009).

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Tables

Table 1. Distribution of Firms, by ownership

year	N. of firms	% of female owned
2003	797	12.99%
2004	838	13.87%
2005*	672	9.80%
2006	978	12.83%
2007	1155	12.03%
2008	1475	12.88%
2009	1675	12.44%

Source: Authors' elaborations on CSA manufacturing census data
*In 2005 (Ethiopian year 1997), the Census has been run as a representative survey.

Table 2. Basic characteristics of firms, by ownership

Variable	Male owned	Female owned
N of employees	87.667	34.637
Sales (log)	13.810	13.011
Value Added (log)	13.740	12.931
Fixed assets on Empl (log)	9.385	8.689
Female/male workers	0.571	0.825
Female/male skilled	0.565	0.838
Exporter (dummy)	0.049	0.017
Importer (dummy)	0.678	0.594
Foreign (dummy)	0.044	0.003

Source: Authors' elaborations on CSA manufacturing census data

Table 3. Results, basic OLS estimator

	(1)	(2)	(3)	(4)	(5)	(6)
	50% own	50% own	50% own. (Matched sample)	Any female participation in ownership	100% ownership	labour productivity
female_ownership50	-0.213***	-0.292***	-0.127*			-0.194***
	(0.0661)	(0.0484)	(0.0674)			(0.0423)
female_owned				-0.140***		
				(0.0302)		
female_ownership100					-0.513***	
					(0.0631)	
Constant	10.19***	10.21***	9.660***	10.24***	10.21***	10.51***
	(0.0248)	(0.0606)	(0.181)	(0.0608)	(0.0606)	(0.0582)
Industry effects	N	Y	Y	Y	Y	Y
Region effects	N	Y	Y	Y	Y	Y
Year effects	N	Y	Y	Y	Y	Y
Observations	7,727	7,726	1,790	7,726	7,726	7,828
R-squared	0.001	0.655	0.576	0.654	0.657	0.341

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Results, basic OLS with controls and interaction terms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lage	0.103***	-0.121	0.101***	0.104***	0.103***	0.0745***	0.104***	0.110***
	(0.0275)	(0.0845)	(0.0275)	(0.0274)	(0.0275)	(0.0281)	(0.0275)	(0.0258)
lempl	0.392***	0.463***	0.390***	0.389***	0.370***	0.404***	0.393***	0.384***
	(0.0147)	(0.0477)	(0.0145)	(0.0141)	(0.0149)	(0.0149)	(0.0147)	(0.0130)
lfix_ass_empl	0.0547***	0.0365	0.0689***	0.0550***	0.0473***	0.0504***	0.0546***	0.0520***
	(0.00905)	(0.0379)	(0.0103)	(0.00899)	(0.00909)	(0.00893)	(0.00907)	(0.00860)
female_ownership50	-0.125***	-0.125**	0.369**	-0.207	-0.122**	-0.0259	-0.0793	-0.128***
	(0.0447)	(0.0618)	(0.157)	(0.172)	(0.0555)	(0.0580)	(0.0540)	(0.0417)
exporter	0.342***	0.526**	0.342***	0.344***	0.353***	0.329***	0.344***	0.341***
	(0.0745)	(0.217)	(0.0743)	(0.0744)	(0.0744)	(0.0744)	(0.0751)	(0.0726)
importer	0.271***	0.230***	0.268***	0.270***	0.265***	0.267***	0.273***	0.245***
	(0.0329)	(0.0866)	(0.0329)	(0.0329)	(0.0328)	(0.0329)	(0.0329)	(0.0316)
fem*kl			-0.0563***					
			(0.0182)					
fem*empl				0.0281				
				(0.0523)				
fem*ir					-0.000862			
					(0.0864)			
ir					0.185***			
					(0.0289)			
fem*share_n_female						-0.109**		
						(0.0473)		
n_female_male						-0.0683**		
						(0.0307)		
fem*industry_aggl							-0.449*	
							(0.242)	
industry_aggl_empl							-0.0159	
							(0.0729)	
fem*lab_intensity								0.143**
								(0.0682)
labour_intensity								-0.238***
								(0.0655)
Constant	7.887***	8.369***	7.766***	7.889***	7.961***	7.987***	7.883***	7.978***
	(0.131)	(0.509)	(0.139)	(0.131)	(0.131)	(0.133)	(0.132)	(0.127)
Industry effects	Y	Y	Y	Y	Y	Y	Y	Y
Region effects	Y	Y	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	7,546	1,784	7,546	7,546	7,546	7,530	7,546	7,544
R-squared	0.719	0.626	0.720	0.719	0.721	0.722	0.719	0.751

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5. Results, productivity distribution

#	Category/sector	A	D	S	R2	obs
1	Total Factor Productivity - male vs female (full sample)	-0.18535***	0.88071	-0.00295	0.94816	7574
		(0.192)	(0.040)	(0.092)		
2	Total Factor Productivity - Addis Ababa vs Other regions	1.40845**	0.57335***	-0.78743***	0.85779	7574
		(0.150)	(0.029)	(0.101)		
3	Total Factor Productivity (Female) - Addis Ababa vs Other regions	1.43369	0.42081***	-1.53184***	0.91249	893
		(0.212)	(0.042)	(0.124)		
4	Total Factor Productivity - male vs female (Excluding Addis Ababa)	-0.02318***	0.943***	0.002649***	0.48739	3908
		(0.157)	(0.029)	(0.122)		
5	Total Factor Productivity - male vs female (Addis Ababa)	-0.35953**	0.87042***	-0.003033***	0.9682	3667
		(0.062)	(0.016)	(0.045)		

Bootstrap standard errors in parenthesis (using 50 replications)
*** p<0.01, ** p<0.05, * p<0.1
Notes: Results are based on a quantile approach developed by Combes et al. (2012).
A: estimated value of the shift parameter, Aˆ , or 0 if shift=0.
D: estimated value of the dilation parameter, Dˆ , or 1 if dilation=0.
S: estimated value of the truncation parameter, Sˆ , or 0 if truncation=0.
R2: measure of the goodness of fit R2 = 1-M(Aˆ , Dˆ , Sˆ)/M(0, 1, 0) .

Appendix

Table A1. Distribution of firms by region (% on total)

	Male owned	Female owned
addis ababa	47.51	58.49
oromia	16.73	14.76
s.n.n.p.r.	10.9	5.63
tigray	10.12	4.15
amhara	9.72	10.79
dire dawa	1.98	3.04
harari	1.5	1.94
somalie	0.62	0.28
afar	0.47	0.37
gambela	0.24	0.46
benshangul	0.21	0.09

Source: Authors' elaborations on CSA manufacturing census data

Table A2. Distribution of firms by industry* (% on total)

ISIC rev. 3	Industry	Male owned	Female owned
15	Manufacture of food products and beverages	25.59	37.33
26	Manufacture of other non-metallic mineral products	18.54	25.9
36	Manufacture of furniture; manufacturing n.e.c.	16.4	8.85
22	Publishing, printing and reproduction of recorded media	5.93	7.56
20	Manufacture of wood and of products of wood and cork, except furniture	2.06	3.13
25	Manufacture of rubber and plastics products	5.02	3.13
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	5.72	2.86
28	Manufacture of fabricated metal products, except machinery and equipment	6.27	2.86
24	Manufacture of chemicals and chemical products	4.84	2.67
17	Manufacture of textiles	3.1	2.03
18	Manufacture of wearing apparel; dressing and dyeing of fur	2.62	1.38
29	Manufacture of machinery and equipment n.e.c.	0.42	1.01
21	Manufacture of paper and paper products	0.97	0.92
27	Manufacture of basic metals	1.16	0.18
34	Manufacture of motor vehicles, trailers and semi-trailers	1.16	0.18
16	Manufacture of tobacco products	0.09	0
30	Manufacture of office, accounting and computing machinery	0.01	0
31	Manufacture of electrical machinery and apparatus n.e.c.	0.11	0

Source: Authors' elaborations on CSA manufacturing census data
*Industries are reported here at the 2-digit level of the ISIC classification (revision 3), but they are originally at the 4-digit level

Table A3. IV regression

	(1) First stage	(2) Second stage
lage	0.0132***	0.0436
	(0.00338)	(0.0285)
lempl	-0.00404***	0.406***
	(0.00138)	(0.0158)
lkl	0.000730	-0.00669
	(0.000798)	(0.00989)
exporter	-0.0195***	0.377***
	(0.00585)	(0.0782)
importer	0.00238	0.266***
	(0.00379)	(0.0354)
iv	1.436***	
	(0.0107)	
female_ownership50		-0.198***
		(0.0491)
Constant	0.00222	10.40***
	(0.0186)	(0.262)
Industry effects	Y	Y
Region effects	Y	Y
Year effects	Y	Y
Observations	6,877	6,877
R-squared	0.883	0.707

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure A1. Firm productivity, full sample

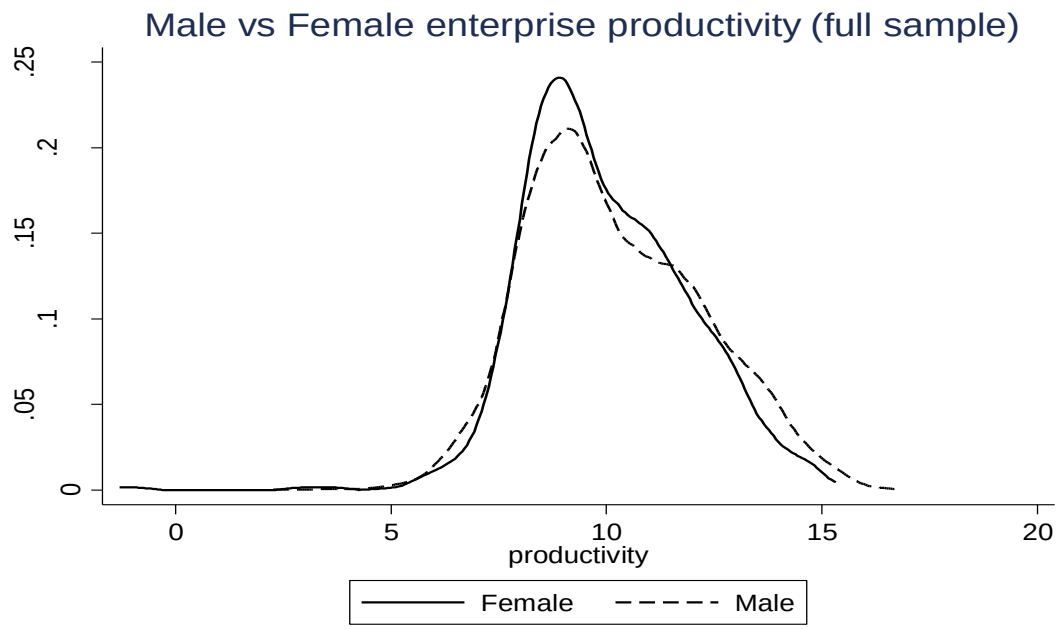

Figure A2. Firm productivity, Addis Ababa

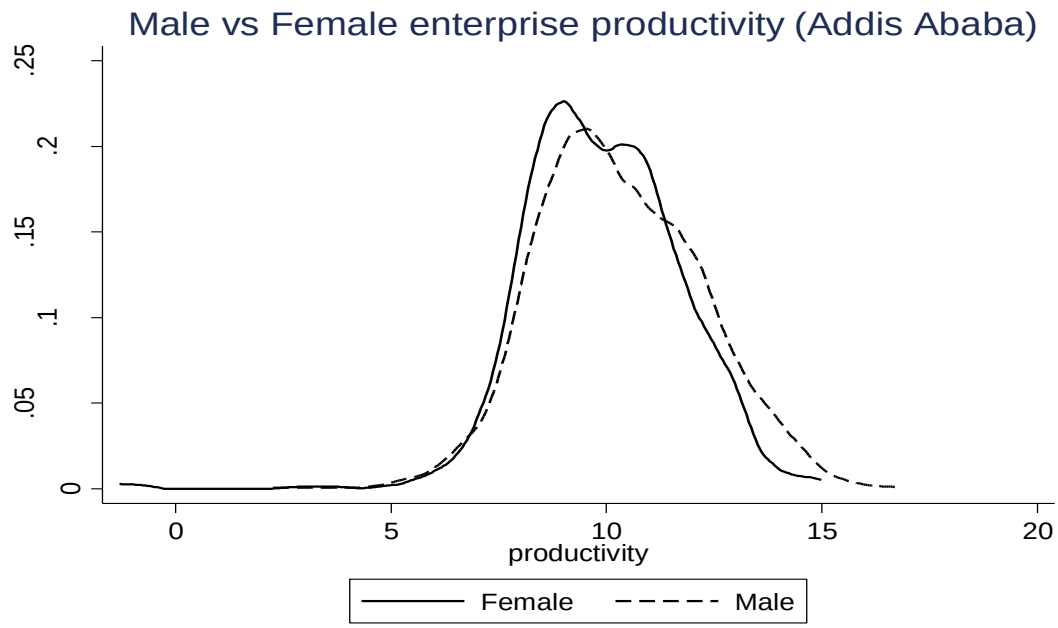

Figure A3. Female firm productivity