Aggregate Effects of Gender Gaps in the Labor Market: A Quantitative Estimate

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This paper examines the quantitative effects of gender gaps in entrepreneurship and workforce participation. We simulate an occupational choice model with heterogeneous agents in entrepreneurial ability. Gender gaps in entrepreneurship affect negatively both income and aggregate productivity, since they reduce the entrepreneurs’ average talent. Specifically, the expected income loss from excluding 5 percent of women is 2.5 percent, while the loss is 10 percent if they are all employers. We find that gender gaps cause an average income loss of 15 percent in the OECD, 40 percent of which is due to entrepreneurship gaps. Extending the model to developing countries, we obtain substantially higher losses, with significant variation across regions.

I. Introduction

Although recent decades have witnessed a significant drop in gender gaps in many countries, the prevalence of gender inequality is still high, especially in the developing world. These gaps are apparent in several dimensions, including education, political representation, and bargaining in-
side the household. In the labor market, women typically receive lower wages, are underrepresented in most occupations, work fewer hours than men, and have less access to productive inputs (see, e.g., Blau and Kahn 2007, 2013; Olivetti and Petrongolo 2008, 2014; Klasen and Lamanna 2009).

One important aspect of gender inequality in the labor market that has not been much studied in the literature is the low presence of women in entrepreneurial activities. The World Bank (2001) estimates that, in developed countries, the average incidence of females among employers is less than 30 percent. According to OECD (2014), across the 27 EU countries, only 25 percent of business owners with employees are women, only 3 percent of chief executive officers are women, and the percentage of females on boards is only 18 percent. In OECD countries, the proportion of sole-proprietor enterprises owned by women is between 20 percent and 40 percent. Studies looking at developing countries find much larger gender gaps. Macchiavello, Menzel, and Woodruff (2014), for example, analyze the garment industry in Bangladesh and find that four of every five production workers in this industry are women, while just over one in 20 supervisors is a woman. In their experiment, they show that, after receiving adequate training, women are as likely as men to keep their job but less likely to be tried out or promoted.

Everything else equal, a better use of women’s potential in the labor market is likely to result in greater macroeconomic efficiency. When there are no frictions to agents’ labor choices, for example, the most talented people typically organize production carried out by others, and as a result, they can spread their ability advantage over a larger scale. From this point of view, obstacles to women’s access to entrepreneurship reduce the average ability of a country’s entrepreneurs, affecting negatively the way production is organized in the economy and, hence, reducing its market output.

The objective of this article is to examine the quantitative effects of gender gaps in entrepreneurship and labor force participation on aggregate productivity and income per capita. We first develop an occupational choice model that illustrates the negative impact of gender inequality on resource allocation and, as a result, on aggregate productivity and income per capita. Our theoretical framework is an extension of the span-of-control model of Lucas (1978). We add two new elements to his model. First, we consider a third occupation, namely, self-employment, on top of employers and workers, as in Gollin (2008). Second, we introduce several

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1 A report by Cranfield University (2014) states that the United Kingdom has made more progress in reducing these gaps than other EU countries: in 2014, 20 percent of all directors of UK companies on the Financial Times Stock Exchange 100 were females, up from 12.5 percent in 2010. The proportion of executive directors in these companies was 7 percent up from 5.5 percent in 2010.

2 Elborgh-Waytek et al. (2013) also argue that gender inequality may have negative macroeconomic effects. Barsh and Yee (2012) claim that the employment of women on an equal basis would allow companies to make a better use of talent.
exogenous frictions that affect only women. In the model, agents are endowed with entrepreneurial talent drawn from a random distribution and choose their occupation on the basis of this talent. While men are unrestricted in their labor market choices, women’s choices are limited, which leads to an inefficient allocation of talent across occupations and reduces aggregate productivity as well as income per capita.

Quantitatively, the model predicts that if all women were excluded from entrepreneurship, income per capita would fall by 10 percent in the short run because of the fall in the average talent of entrepreneurs. In the long run, when the capital stock is adjusted to the new productivity level, income per capita would fall by 11 percent. If all women were excluded from the labor force, on the other hand, output per capita would fall by almost 47 percent in the short run, when the capital stock is fixed, and by 50 percent in the long run, when capital per worker is readjusted. It is worth noting that in the model we abstract from the decision to participate in the labor market; that is, we assume that all agents work in some occupation unless they are not “allowed” to do so. Henceforth, our exercise calculates only market output losses, although in reality women not participating in the labor market are likely to generate some production in the household sector. We omit household production in the model to keep the analysis as simple as possible but also because of the lack of data.³

In the cross-country analysis, we use the model to quantify the effects of the existing labor market gender gaps in a large sample of both developed and developing economies. The benchmark model prediction for the sample of OECD countries is an average income loss of 15 percent due to entrepreneurship and participation gender gaps, almost 40 percent of which is due to gender gaps in entrepreneurship. The model is then extended to incorporate out-of-necessity entrepreneurs, that is, agents who choose self-employment as their occupation because they have no better job choices. We use this extended version of the model to quantify the effects of the gender gaps in a sample of developing countries, for which it has been documented that self-employment (and out-of-necessity self-employment) is much more prevalent than in rich countries.⁴ The model with out-of-necessity self-employed predicts larger average income losses for the sample of developing countries, with significant variation across geographical regions. In the Middle East and North Africa, the average income loss due to gender gaps is almost 38 percent, about a fifth of which is due to the occupational gender gaps, while in Central Asia the average income loss is about 10 percent, with 70 percent of the loss generated by the occupational gender gaps. Merging the two samples, we find that there is an inverse-U relationship between the level of development of a country

³ In what follows we will refer to “restrictions” to women in the labor market, although, once again, we do not know with certainty to what extent these restrictions reflect women’s optimal choices.

⁴ See the Global Entrepreneurship Monitor survey (http://www.gemconsortium.org; Brush et al. 2011; Poschke 2013) for a detailed characterization of this type of entrepreneurs.
and its income losses caused by all the gender gaps—entrepreneurship
and labor force participation—while there is a negative relationship
between the development level and the income losses caused only by
gender gaps in entrepreneurship. These results are consistent with the
observed U-shaped relationship between development and female labor
force participation (see, e.g., Goldin 1995).

The origins of these labor market frictions could be very diverse, and in
this paper, we do not aim to identify whether they are due to pure discrim-
ination or they reflect women’s optimal choices taking into account their
alternatives. In 2010, the OECD launched its Gender Initiative to analyze
specific barriers that women face in the labor market, as well as to imple-
ment policies that promote gender equality in OECD countries and
beyond (OECD 2012, 2014; see also http://www.oecd.org/gender/data).
The barriers identified in their study can be broadly classified in different
categories. First, women are often less likely than men to borrow money
in order to finance a business (Eurostat 2008).5 Second, informational or
cultural factors may also create barriers for women who wish to become
entrepreneurs. For example, shareholders are less likely to appoint women
as managers because of a lack of data on women’s performance as entre-
preneurs. Similarly, young women and women out of the labor force often
lack accurate information about entrepreneurship as a viable and attrac-
tive career for them. Third, women’s preferences for part-time work and a
better work-like balance, in combination with an inflexible labor market,
lead women to run smaller firms and earn less than their male counter-
parts, which could partly explain why the labor force participation of
women is below that of men in most countries.6 Fourth, women often seem
to lack the necessary confidence in their skills to become entrepreneurs.7
Moreover, as a result of all the previous barriers, women tend to have less
experience than men when they start up a business, which may explain
their lower earnings as entrepreneurs. One additional natural reason why
women may be underrepresented in the labor market is the existence of
gender gaps in education for young women. In recent decades, however,
education gender gaps have substantially shrunk in most countries, as
shown in Becker, Hubbard, and Murphy (2010a, 2010b), which document
and explore the causes of an unprecedented increase in higher education
in the last 40 years all over the world, especially for women. Their study
shows that, nowadays, in most high-income countries and in many lower-

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5 According to Cole and Mehran (2009), women in the United States are more likely to be
discouraged from applying for loans for fear of rejection, although there is some evidence
showing that, once they do so, they do not have a higher rejection rate than their male
counterparts.

6 A related issue is that, in many countries, government policies tend to focus on helping
start-ups and small firms. While this may indeed help women to run their own firms, it makes
them less likely to create relatively large firms.

7 Coleman and Robb (2012) claim that this may in part be explained by women’s lack of
familiarity with finance and accounting practices.
income ones, there are indeed more women than men who complete tertiary education. Parro (2012) examines the evolution of the gender gap in education in a large sample of developed and developing countries between 1950 and 2005. He finds that gender inequality in education increased between 1950 and 1975 and decreased between 1975 and 2005. Using long-run data (1800–2010), Morrison and Murtin (2009) construct a new database on historical educational attainment with a sample of 74 countries for the period 1870–2010 and conclude that educational attainment accelerated in the second half of the twentieth century and that there has been some convergence in educational attainment in a sample of developed countries. In terms of gender, they find that in most Asian and African countries, the educational takeoff has closed the gender gap. Only sub-Saharan Africa and India currently lag behind other countries in terms of gender gaps between female and male education. In view of our analysis, one would expect that these improvements should have translated into less gender gaps in the labor market.8

The remainder of the article is organized as follows. In Section II, we briefly discuss the existing literature linking labor gender inequality and economic growth, with an emphasis on papers most closely related to our work. The benchmark theoretical model is presented in Section III. The numerical simulations and the cross-country results for the OECD sample are described in Section IV. Section V presents the extended model for developing countries and shows the simulation results for the non-OECD sample. Finally, Section VI presents conclusions.

II. Literature Review

The empirical literature on the relationship between economic growth and gender inequality is quite extensive.9 This literature has reached some consensus on the fact that there is a positive effect of increases in income per capita on gender equality and, more relevant to our paper, a negative effect of gender inequality on economic growth. Some studies show a negative effect of gaps in the labor force participation on a country’s economic performance (Klasen and Lamanna 2009; Thévenon et al. 2012; see also data from the International Labor Organization described in fn. 27). More commonly, though, gender gaps in education have been emphasized as a growth deterrent (Barro and Lee 1993; Dollar and Gatti 1999;

8 In spite of the fact that gender differences in education have narrowed substantially in recent decades, girls are still often subject to education biases that make them less inclined to study fields in which individuals are more likely to eventually become entrepreneurs. The OECD (2013), e.g., reports that women have a higher probability of obtaining degrees in health and humanities, but they are underrepresented in the so-called STEM fields of study (science, technology, engineering, and mathematics).

9 See, e.g., Goldin (1990), Dollar and Gatti (1999), Tzannatos (1999), or Klasen (2002). Cuberes and Teignier (2014) provide a comprehensive review of the empirical and theoretical literature on this topic.
These gaps may have a direct effect on growth, but they may also operate through the labor market channels that we study in this paper. In particular, as explained above, less educated women, or biases in women’s education, can lead to lower female labor force participation and the underrepresentation of women in entrepreneurship.

In the theoretical literature, several studies focus on explaining the effects of economic growth on different gender gaps, for example, Becker and Lewis (1973), Galor and Weil (1996), Greenwood, Seshadri, and Yorukoglu (2005), Doepke and Tertilt (2009), Fernandez (2009), and Ngai and Petrongolo (2013). Other papers have focused on the reverse effect, that is, the impact of gender inequality on growth. These theories are, in most cases, based on the fertility and children’s human capital channels, as in Galor and Weil (1996) and Lagerlöf (2003). Galor and Weil, for example, argue that an increase in women’s relative wage increases the cost of raising children, which lowers population growth, increases children’s education levels, and leads to higher labor productivity and growth.

Our paper differentiates from these theoretical articles in two ways: first, we calibrate and simulate our theoretical framework in order to be able to produce reasonable estimates of the costs associated with specific gender gaps. Second, we focus on a relatively ignored mechanism through which gender inequality reduces aggregate productivity, namely, the talent pool channel.

With respect to the first point, Cavalcanti and Tavares (2015) construct a growth model based on Galor and Weil (1996) in which there is exogenous wage discrimination against women. When they calibrate their model using US data, they find very large effects associated with these wage gaps: a 50 percent increase in the gender wage gap in their model leads to a decrease in income per capita of a quarter of the original output. Their results also suggest that a large fraction of the actual difference in output per capita between the United States and other countries is indeed generated by the presence of gender inequality in wages. We depart from this paper in that our focus is on the misallocation of talent and resources caused by gender inequality.

Related to the second contribution, Esteve-Volart (2009) also develops a model of occupational choice and talent heterogeneity. Her paper finds that labor market discrimination leads to lower average entrepreneurial talent and slower female human capital accumulation, which in turn has a negative impact on technology adoption, innovation, and economic growth. The model, however, is used to derive qualitative results but not to carry out numerical exercises.

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10 Lagerlöf (2006) calibrates the Galor-Weil model but does not provide a quantitative estimate of the productivity costs associated with a decrease in gender inequality.
To our knowledge, the only existing paper that incorporates a quantitative analysis and considers the talent pool channel is Hsieh et al. (2013). Their paper uses a Roy model to estimate the effect of the changing occupational allocation of white women, black men, and black women between 1960 and 2008 on US economic growth and finds that the improved allocation of talent during this period accounts for 17–20 percent of growth. Our paper differs from theirs in several dimensions. First, we explicitly add self-employment as a possible occupation in the model, which is particularly important to model the behavior of developing countries. Second, we study the effects of gender inequality in the labor market in a large sample of countries rather than just focusing on the US economy. Finally, our theoretical framework is substantially different from theirs in that we emphasize, although in a static framework, the span-of-control element of agents who run firms.  

III. Benchmark Model

In this section, we present a general equilibrium occupational choice model in which agents are endowed with a random entrepreneurship skill that determines their optimal occupation. The model is based on the span-of-control framework of Lucas (1978), with the extension of self-employment as a possible occupational choice. In the benchmark model, agents choose to work as either employers, self-employed, or workers, while in the extended model presented in Section V, we introduce the possibility of having the so-called out-of-necessity self-employed, in line with the literature claiming that in developing countries self-employment is the only possible alternative for some agents.

A. Model Setup

The economy we consider has a continuum of agents indexed by their entrepreneurial talent \( x \), drawn from a cumulative distribution \( F \) that takes values between \( B \) and \( \infty \). We assume that the economy is closed and that it has a workforce of size \( N \) and \( K \) units of capital. Labor and capital are inelastically supplied in the market by consumers, in exchange for a wage rate \( w \) and a capital rental rate \( r \), respectively. These inputs are then combined by firms to produce a homogeneous good. Agents decide to become either firm workers, who earn the equilibrium wage rate \( w \)—which we assume to be independent of their entrepreneurial talent—or entrepreneurs, who earn the profits generated by the firm they manage.  

Our paper also relates to several recent papers that use the span-of-control model of Lucas (1978) to study the effects of financial frictions and other cross-country differences on the misallocation of resources and productivity (see, e.g., Antunes, Cavalcanti, and Villamil 2008; Amaral and Quintin 2010; Erosa, Koreshkova, and Restuccia 2010; Buera, Kaboski, and Shin 2011; Bhattacharya, Guner, and Ventura 2013; Buera and Shin 2013).

In what follows we will refer to an entrepreneur as someone who works as either an employer or a self-employed.
An agent with entrepreneurial talent or productivity level $x$ who chooses to become an employer and hires $n(x)$ units of labor and $k(x)$ units of capital produces $y(x)$ units of output and earns profits $\pi(x) = y(x) - r k(x) - w n(x)$, where the price of the homogeneous good is normalized to one. As in Lucas (1978) and Buera and Shin (2011), the production function is given by

$$y(x) = x(k(x)^a n(x)^{1-a})^\eta,$$

(1)

where $\alpha \in (0, 1)$ and $\eta \in (0, 1)$. The parameter $\eta$ measures the span of control of entrepreneurs, and since it is smaller than one, the entrepreneurial technology involves an element of diminishing returns. On the other hand, an agent with talent $x$ who chooses to become self-employed uses the amount of capital $\tilde{k}(x)$, produces $\tilde{y}(x)$ units of output, and earns profits $\tilde{\pi}(x) = \tilde{y}(x) - \tilde{r} \tilde{k}(x)$. The technology he or she operates is

$$\tilde{y}(x) = \tau x \tilde{k}(x)^{\alpha \eta},$$

(2)

where $\tau$ is the self-employed productivity parameter. One interpretation of this parameter is that self-employed workers have to spend a fraction of their time on management tasks, which would imply that $\tau$ is equal to the fraction of time available for work to the power $(1 - \alpha)\eta$. As explained below, we estimate this parameter to match the average fraction of self-employed in the data.

**B. Agents’ Optimization**

1. Employers

Employers choose the units of labor and capital they hire in order to maximize their current profits $\pi$. The optimal numbers of workers and capital stock, $n(x)$ and $k(x)$, respectively, depend positively on the productivity level $x$, as equations (3) and (4) show:

$$n(x) = \left[ x \eta (1 - \alpha) \left( \frac{\alpha}{1 - \alpha} \right)^{\eta \left( \frac{1 - \alpha}{\eta} \right) - 1} \right]^{\eta / (1 - \eta)},$$

(3)

$$k(x) = \left[ x \eta \left( \frac{1 - \alpha}{\alpha} \right)^{\eta (1 - \alpha) - 1} \frac{\eta (1 - \alpha) - 1}{\eta (1 - \alpha) - 1} \right]^{(1 - \eta) / (1 - \alpha)}.$$  

(4)

2. Self-Employed

When we solve for the problem of a self-employed agent with talent $x$ who wishes to maximize his or her profits, we find

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13 The consumption good produced by the self-employed and the capital they use is the same as the one in the employers’ problem. However, it is convenient to denote them $\tilde{y}$ and $\tilde{k}$ to clarify the exposition.
\[ \tilde{k}(x) = \left( \frac{\tau x \alpha \eta}{r} \right)^{1/(1-\alpha)} . \]  

(5)

3. Occupational Choice

Figure 1 displays the shape of the profit functions of employers (\( \pi_e(x) \)) and self-employed (\( \pi_se(x) \)) along with wages earned by workers as a function of talent \( x \).\(^{14}\) The figure also shows the relevant talent cutoffs for the occupational choices. Here we present the equations that define these thresholds: the first one, \( z_1 \), defines the earnings such that agents are indifferent between becoming workers and self-employed, and it is given by

\[ w = \tau z_1 \tilde{k}(z_1)^\alpha - r \tilde{k}(z_1) . \]  

(6)

If \( x \leq z_1 \), agents choose to become workers, while if \( x > z_1 \), they become self-employed or employers. The second cutoff, \( z_2 \), determines the choice between being a self-employed and an employer, and it is given by

\[ \tau z_2 \tilde{k}(z_2)^\alpha - r \tilde{k}(z_2) = z_2 x(k(z_2)^\alpha n(z_2)^{1-\alpha})^\gamma - r k(z_2) - wn(z_2) \]  

(7)

so that if \( x > z_2 \), an agent wants to become an employer.

C. Female Labor Market Frictions

Our model assumes that men and women are identical in all dimensions except that women face several exogenous restrictions on their occupational choices. The first constraint we impose is that only a fraction \( \mu \) of them can freely choose their occupation, while a fraction \( 1 - \mu \) are excluded from employership. Out of the latter group of women, a fraction \( \mu_o \) have the possibility of becoming self-employed, while a fraction \( 1 - \mu_o \) are also excluded from self-employment. As a result, a fraction \( (1 - \mu)(1 - \mu_o) \) of women are shut out from entrepreneurship, that is, both employership and self-employment, and can only become workers.\(^{15}\)

Note that, in this setup, we are not allowing for the possibility of women being excluded from self-employment but not from employership, since we think that whichever are the barriers women face to become self-employed, they should apply even more strongly to become an employer.\(^{16}\)

\(^{14}\) In order to construct this figure we are implicitly using values for the parameters \( \tau, \alpha, \) and \( \eta \), such that the three occupations are chosen in equilibrium.

\(^{15}\) Figure A1 in App. A shows the optimal occupation choices of women given the frictions they face.

\(^{16}\) In terms of the parameters of the model, if \( \mu = 1 \), then the value of \( \mu_o \) does not affect the occupational choices of women.
Finally, the third friction we introduce is that only a fraction $\lambda$ of women are allowed to participate in the labor market, while a fraction $1 - \lambda$ of randomly selected women are excluded from all the possible occupations in the labor market.\(^{17}\) Again, this friction may reflect discrimination or other supply factors, but it might also reflect differences in optimal choices of women or other demand factors. Since our model does not incorporate a household sector, women who do not participate in the labor market produce zero output. Because of this, the income loss due to the $\lambda$ gender gap estimated by our model is actually a (formal) market output loss, which is likely to be larger than the total output loss because of the potential production taking place inside the household when women do not participate in the labor market.\(^{18}\)

Because of the way we introduced these gender gaps into the model, all women face the same ex ante probability of being excluded from participation and entrepreneurship. This would be the right modeling choice if some women were banned from entrepreneurship or work because of pure discrimination, if some of them did not have access to education or credit, if some of them had a strong preference for child care or other

\(^{17}\) We say that women excluded from the labor force are randomly selected because their talent is drawn from the same distribution as the rest of the population.

\(^{18}\) To the extent that entrepreneurship gaps affect negatively the labor market participation return of women, a model with household production and endogenous female participation is likely to predict larger output losses due to the introduction of $\mu$ and $\mu_0$ gender gaps.
forms of home production, or if some lacked the accurate information about entrepreneurship options. Admittedly, the aggregate impact would be larger if more talented women were less likely to be excluded, which would be the case if these distortions affected women’s earnings in the form of a fixed cost or a wedge. It could also be the case, however, that more talented women were more likely to get excluded, which would be the case if, for example, they had a higher propensity to marry richer men and, as a result, they were also more likely not to participate in the labor market or to choose part-time work.\(^\text{19}\)

D. Competitive Equilibrium

We assume that women represent half of the population in the economy and that there is no unemployment. Moreover, any agent in the economy can potentially participate in the labor market, except for the restrictions on women described above. Under these assumptions, in equilibrium, the total demand for capital by employers and self-employed must be equal to the aggregate capital endowment (in per capita terms) \(k\):

\[
k = \frac{1}{2} \left[ \int_{x_{l}}^{x_{h}} k(x) d\Gamma(x) + \int_{x_{l}}^{x_{h}} \tilde{k}(x) d\Gamma(x) \right] + \frac{\lambda}{2} \left\{ \mu \int_{x_{l}}^{x_{h}} k(x) d\Gamma(x) + [\mu + (1 - \mu)\mu_g] \int_{x_{l}}^{x_{h}} \tilde{k}(x) d\Gamma(x) \right\} + (1 - \mu)\mu_g \int_{x_{l}}^{x_{h}} \tilde{k}(x) d\Gamma(x),
\]

where the term in brackets represents the demand for capital by male entrepreneurs and the term in braces is the demand for capital by female entrepreneurs, which has three components, each of them multiplied by the fraction of women in the labor force, \(\lambda/2\). The first one represents the capital demand by female employers, that is, those with enough ability to be employers and who are allowed to be so, while the second and third terms represent the demand by female self-employed; the second term shows the demand for capital by women who have the right ability to be self-employed and are allowed to work as such; and the third term shows the demand from women who become self-employed because they are excluded from employership.\(^\text{20}\)

Similarly, in the labor market, the total demand for workers must also be equal to its total supply:

\(^{19}\) Note also that by assuming perfect substitutability between male and female labor, we may underestimate the effects of the gender gaps. Most likely, women provide a different type of labor than men and have a comparative advantage in different sectors.

\(^{20}\) The functions \(\tilde{k}(\cdot)\) and \(k(\cdot)\) are defined in eqq. (4) and (5).
where the upper terms represent the total labor demand and the lower ones the total labor supply. The first term is the labor demand by male employers and the second one corresponds to the labor demand by female employers, that is, those women with enough ability to be employers who are allowed to participate in the labor market and to choose their occupation freely. The first term of the labor supply shows the fraction of men who choose to become workers, while the second one shows the fraction of female workers. The latter is composed of the fraction of females who want to be workers as well as the fraction of females who have enough ability to be employers or self-employed but are excluded from both occupations. For these groups of women, the only option is to become workers.\textsuperscript{21}

In this economy, aggregate production per capita, which is the sum of output by male employers and self-employed, as well as output by female employers and female self-employed, is

\[
y = \frac{Y}{N} = \frac{1}{2} \left[ \int_{z_1}^{\infty} y(x) d\Gamma(x) + \int_{z_2}^{\infty} \tilde{y}(x) d\Gamma(x) \right] + \frac{\lambda}{2} \left[ \mu \int_{z_1}^{\infty} y(x) d\Gamma(x) + \mu \int_{z_2}^{\infty} \tilde{y}(x) d\Gamma(x) \right] + (1 - \mu) \mu_o \int_{z_1}^{\infty} \tilde{y}(x) d\Gamma(x),
\]

where \( y(x) \) and \( \tilde{y}(x) \) are defined in equations (1) and (2), respectively.

A competitive equilibrium in this economy is a pair of cutoff levels \((z_1, z_2)\), a set of quantities \([n(x), k(x), \tilde{k}(x)]\) for all \( x \), and prices \((w, r)\) such that equations (3)–(9) are satisfied; that is, agents choose their occupation optimally, entrepreneurs choose the amount of capital and labor to maximize their profits, and all markets clear.

\textit{E. Comparative Statics}

In this subsection we show qualitatively how the agents’ occupational choices are affected by exogenous changes in the two entrepreneurship gender gaps, namely, the fraction of women who are excluded from emp-

\textsuperscript{21} The function \( n(\cdot) \) is defined in eq. (3).
ployership \((1 - \mu)\) and the fraction of those women who are also “excluded” from self-employment \((1 - \mu_o)\). Figure 2 shows the change in the talent thresholds \((z_1, z_2)\) when \(1 - \mu\) and \(1 - \mu_o\) become positive.

1. An Increase in the Employership Gender Gap \((\downarrow \mu)\)

A decrease in \(\mu\) initially generates a decline in the number of employers and hence a decrease in the labor demand and the equilibrium wage, which decreases the cutoff \(z_1\). Everything else equal, this results in an increase in profits for the remaining employers, which reduces also the cutoff \(z_2\). The effect on the demand for capital is ambiguous since the demand from employers declines but that of the self-employed increases. If the demand for capital actually decreases, the cost of renting capital goes down, so both self-employed’s and employers’ profits increase and, hence, both cutoffs \(z_1\) and \(z_2\) decrease further.

2. An Increase in Self-Employment Gender Gaps \((\downarrow \mu_o)\)

A decrease in \(\mu_o\) (given \(\mu < 1\)) generates a decline in the number of self-employed and hence an increase in the labor supply, which in turn drives wages down. As in the previous case, this has a direct negative effect on the cutoff \(z_1\) as well as an indirect negative effect on the cutoff \(z_2\), through its effect on the employers’ profit function. As before, whether the demand for capital increases or decreases is a quantitative question since there is a negative effect from the drop in self-employed and a positive one from the rise in employers.

![Figure 2.—Qualitative effects of \(\mu\) and \(\mu_o\) gaps](image-url)
IV. Benchmark Model Numerical Results

In this section, we simulate the benchmark model to calculate the income effects of the gender gaps in the labor market discussed in the previous section. We first describe the parameterization of the model and calculate the maximum possible effects of these gaps. Then we estimate the gender gaps and quantify their effects using data from OECD countries. In Section V we extend the model to make it more suitable for developing countries, and we then use data from non-OECD countries to quantify effects of the gender gaps on these countries.

A. Skill Distribution

To simulate the model, we use a Pareto function for the talent distribution, as in Lucas (1978) and Buera et al. (2011). In particular, the cumulative distribution of talent is given by

\[ \Gamma(x) = 1 - B^x x^{-\rho}, \quad x \geq 0, \]  

(11)

where \( \rho, B > 0 \).

B. Model Parameterization

Table 1 shows the parameter values used in the model simulations. The parameter \( B \) of the talent distribution is normalized to 1, while the parameter \( \eta \) is taken from Buera and Shin (2011).\(^{22}\) The capital-output elasticity parameter \( \alpha \) is set to 0.114 in order to match the 30 percent capital income share observed in the US data. Since entrepreneurs’ profits are considered capital income, we set \( \alpha \eta + (1 - \eta) \) equal to 30 percent as in Buera and Shin (2011). The parameter \( \rho \) of the talent distribution is set to 6.5 to minimize the distance between the actual and the predicted fraction of employers in the OECD countries, which is 4.5 percent on average. Similarly, the self-employed relative productivity parameter \( \tau \) is chosen to match the fraction of self-employed workers in the OECD countries, which is 10.8 percent on average.

The cross-country dispersion in the share of employers and self-employed workers is not negligible, with 10th–90th interpercentile ranges of 2.3 and 3.17, respectively. This dispersion can obviously not be generated by the parameterization of \( \rho \) and \( \tau \). As explained in Section IV.D, however, the gender gaps \((\mu, \mu_s, \lambda)\) are country specific, and they do generate some variation across countries in the predicted entrepreneurship rates. These gaps partly explain the dispersion in entrepreneurship across countries, with a correlation between actual and predicted shares of 10 per-

\(^{22}\) Buera and Shin (2011) choose \( \eta \) to match the top 5 percent income share in the United States, which is 30 percent. This is a reasonable approximation given that the top earners are entrepreneurs both in the model and in the US data.
cent in the case of employers and 6.7 percent in the self-employed workers case. To give an idea of the model goodness of fit for the OECD sample, the average absolute deviation between the model and the data is 44 percent for the share of employers and 61 percent for the self-employed share.

When computing the numerical results in the next two subsections, we distinguish between the short run and the long run. In the short run, capital is taken as constant and therefore is not affected by the introduction of the gender gaps \((m, m_0, l)\); in the long run, on the other hand, the capital stock takes its steady-state value and therefore is negatively affected by the introduction of the gender gaps.\(^{23}\) To compute the steady-state capital stock, we assume a gross interest rate of 0.125, which is consistent with a depreciation rate of 0.075 and an intertemporal discount factor of 0.05 in a continuous-time model.\(^{24}\) Given that the output elasticity to the capital stock is only \(a_\eta = 0.09\), the long-run results do not differ much from the short-run ones.

### C. Income Effects from Gender Gaps

Table 2 shows the effect on (market) income per worker caused by the introduction of the different gender gaps considered in this paper. As stated above, women are assumed to be identical to men in all dimensions, so in the absence of gender gaps, their occupational choices would be the same as those of males. When the gender gaps \((\mu, \mu_0, \lambda)\) are introduced, however, the efficient allocation is distorted, and as a result, there is a decline in aggregate income per worker and per capita.

The first row shows that if all women were excluded from employership \((\mu = 0)\) but not from self-employment \((\mu_0 = 1)\), the income per capita loss

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\(^{23}\) The value for the stock of capital used in the short run is irrelevant, since the income loss predicted by the model due to the introduction of gender gaps is not affected by its value.

\(^{24}\) The intertemporal discount factor we use is similar to the one proposed by Cooley and Prescott (1995), while the value for the depreciation rate is roughly an average of values found in the literature, e.g., 0.048 in Cooley and Prescott (1995) and 0.1 in Christiano, Eichenbaum, and Evans (2005).
would be 7.1 percent in the short run and 8.6 percent in the long run. In the second row we see that if all women were excluded from becoming entrepreneurs (\(\mu = 0\) and \(\mu_o = 0\)), that is, both employers and self-employed, income per worker would fall by 10.1 percent in the short run and 11 percent in the long run. Naturally, the largest effect on (market) income per capita occurs when all women are excluded from the labor market (\(\lambda = 0\)), which, given our assumptions, is equivalent to reducing the labor force by 50 percent. As we can see in the third row of the table, in this case, income per capita falls by almost 47 percent in the short run and 50 percent in the long run.

D. Cross-Country Results: OECD Sample

In this section, we use labor market data for 33 OECD countries for the year 2010 to quantify the income effects of the observed gender gaps.\(^{25}\) The variables used are labor force participation by gender, fraction of employers (or self-employed with employees) by gender, and fraction of own-account workers (or self-employed without employees) by gender, which we denote as self-employed in our paper. Although, in line with the theoretical literature, one could have expected low gender gaps in the labor market in OECD countries compared to the rest of the world, these gaps are still sizable in many cases, as we will see in the next subsection.

1. Country-Specific Gender Gaps

For each country in our sample, we compute the parameters associated with the gender gaps (\(\mu, \mu_o, \lambda\)) comparing the male and female data on labor force participation, share of employers, and share of self-employed. The numerical results for each OECD country are presented in Appendix B. The parameter \(\lambda\), which denotes the fraction of women not excluded from the labor force, is computed as the ratio of the female labor force

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\(^{25}\) OECD (2014), “Gender Equality: Gender Equality in Entrepreneurship,” OECD Social and Welfare Statistics (database), http://www.oecd.org/gender/data/.
relative to the male labor force. The average labor force participation gender gap, defined as $1 - \lambda$, is 0.22; that is, out of every 100 men who participate in the labor market, there are only 78 women doing so. This gap ranges from 0.61 in Turkey to 0.08 in Iceland, Finland, and Norway. Similarly, the parameter $\mu$ is computed as the share of female employers—defined as female employers over female employment—over the share of male employers. The parameter $\mu_e$ is inferred from the data to match the female share of self-employment relative to the male one, given the value of $\mu$. The entrepreneurship gender gap, defined as the fraction of women “excluded” from both employership and self-employment, is calculated as $(1 - \mu)(1 - \mu_e)$, and it is equal to 0.43 on average, ranging from 0.69 in Ireland to 0 in Chile. Finally, the employership gender gap, defined as the fraction of women excluded from employership but not from self-employment, is calculated as $(1 - \mu)\mu_e$ and is equal to 0.18 on average, ranging from 0.53 in Turkey to 0 in Ireland and Poland.

2. Cross-Country Results

The cross-country results for the OECD sample are summarized in table 3, which shows the effects of introducing all the gender gaps analyzed—the $(\mu, \mu_e, \lambda)$ gaps—and the effects of introducing the occupational gender gaps to employership and self-employment—the $(\mu, \mu_e)$ gaps—both in the short run, when the capital stock is fixed, and in the long run, when the capital stock takes its steady-state value. Countries are classified in four groups depending on their total income loss: countries above the 75th percentile, countries between the 50th and 75th percentiles, countries between the 25th and 50th percentiles, and those below the 25th percentile. As is apparent from the table, not surprisingly, the long-run costs for each group are substantially larger than the short-run ones. The table also reveals that the fraction of the total income losses represented by the restrictions on entrepreneurship represents about 40 percent of the total income loss, with the remaining loss being generated by the gaps in labor force participation.

The costs for each OECD country are presented in Appendix B. The average income loss due to the gender gaps in this sample of countries is 15.4 percent in the long run and 14.1 percent in the short run, while the income loss due to gender gaps in employership and self-employment is 5.7 percent in the long run and 5 percent in the short run. The countries with the largest average total losses in the long run are Turkey (33.1 percent), Mexico (25.5 percent), and Italy (21.2 percent), while Iceland (9.2 percent), Norway (9.7 percent), and Finland (9.7 percent) display the
smallest losses. The countries with the largest average losses generated by distortions in entrepreneurship in the long run are Israel (7.4 percent), Turkey (7.3 percent), and Estonia (7.2 percent). Chile (2.7 percent), Australia (3.5 percent), and Poland (4.7 percent) display the smallest losses associated with distortions in entrepreneurship.

V. Extension: Out-of-Necessity Self-Employment

A. Model with Out-of-Necessity Self-Employment

In this section, we present and simulate an extended version of the model to make it more suitable for developing countries, which display a much larger fraction of self-employed workers than developed countries.\(^{27}\) One possible explanation for this difference is the existence of the so-called out-of-necessity entrepreneurs, who choose this occupation because they had no other occupational choices apart from taking advantage of a business opportunity.\(^{28}\) To capture this phenomenon, in the extended model, a fraction \(1 - \theta\) of both males and females are not allowed to become workers, and as we can see in figure A2 in Appendix A, they choose to become self-employed.

The agents’ optimization problem and occupation map in this version of the model is exactly the same as the one discussed in Section III. However, the market-clearing conditions are now different to reflect the new restrictions in the labor market. The capital market-clearing condition can be written as

\[\text{TABLE 3} \quad \text{Average Income Losses from Gender Gaps—OECD Sample}\]

| Percentile       | Short-Run Income Loss (%) Due to \((\mu, \mu_o)\) | Long-Run Income Loss (%) Due to \((\mu, \mu_o, \lambda)\) |
|------------------|---------------------------------|---------------------------------|
| Top 25%          | 5.06 19.7                        | 5.72 21.5                       |
| 50th–75th percentile | 4.88 13.8                      | 5.47 15.1                       |
| 25th–50th percentile | 5.20 12.5                       | 5.80 13.7                       |
| Bottom 25%       | 5.17 9.61                       | 5.77 10.6                       |

\(^{27}\) According to the data, the overall fraction of self-employed (own-account workers in the International Labor Office [ILO] data set) is less than 11 percent in OECD countries and almost 35 percent in developing countries. Data from the ILO, Key Indicators of the Labour Market (KILM, 8th ed.), are available at http://www.ilo.org/global/statistics-and-databases/research-and-databases/kilm/lang-en/index.htm.

\(^{28}\) Using data from the Global Entrepreneurship Monitor survey, Poschke (2013) finds that necessity entrepreneurs represent almost 50 percent of all entrepreneurs in non-OECD countries.
where the upper term is the demand for capital by men and the lower term is the women’s demand for capital. Compared to equation (8), the demand for capital now has two new components: the last terms in the first and second lines, which correspond to the capital demand for male and female out-of-necessity self-employed. A fraction \(1 - \theta\) of males with ability below \(z_1\) become self-employed since they would like to be workers but are not allowed to do so and choose their second-best option. Moreover, a fraction \(1 - \theta\) of females with ability below \(z_1\) would like to work, but since they are excluded from this occupation, they choose to become out-of-necessity self-employed if they are eligible to do so, that is, if they are not excluded from entrepreneurship.\(^{29}\) These out-of-necessity self-employed demand the optimal amount of capital given their talent or ability. Similarly, the labor market-clearing condition is given by

\[
\frac{1}{2}\left[\int_{z_1}^{\infty} n(x) \, d\Gamma(x) \right] + \frac{\lambda}{2} \mu \left[\int_{z_1}^{\infty} n(x) \, d\Gamma(x) \right] = \frac{1}{2} \theta \Gamma(z_1) + \frac{\lambda}{2} \theta \left[\Gamma(z_1) + (1 - \mu)(1 - \mu_o)[1 - \Gamma(z_1)]\right],
\]

where the first line represents the aggregate labor demand and the second line represents the aggregate labor supply. Compared to equation (9), the only difference here is that the labor supply terms are multiplied by the parameter \(\theta\), given that a fraction \(1 - \theta\) of both males and females are not allowed to become workers.

B. **Extended Model Numerical Results**

To simulate the extended model, we use the talent distribution function described in equation (11) and the parameter values of table 1 used in the simulations of the benchmark model. Table 4 shows the effects of the occupational gaps on income per capita when the parameter \(\theta\) is smaller than one, that is, when at least a fraction of agents who want to be workers are not allowed to do so. Interestingly, the effect of the employership gap

\(^{29}\) Note that since the entrepreneurship fraction is \((1 - \mu)(1 - \mu_o)\), a fraction \(1 - (1 - \mu)(1 - \mu_o) - \mu + (1 - \mu)\mu_o\) are not excluded from self-employment.
decreases with the friction, since a fall in $v$ reduces the general equilibrium effect of the $m$ gap on the wage rate and, hence, reduces the negative effect on the aggregate productivity of entrepreneurs. The effect of the entrepreneurship gap, however, increases with $v$, given that excluding females from employership and self-employment implies excluding from the labor force a fraction $(1 - \theta)(1 - \mu)(1 - \mu_o)$ of them, as we can see in figure A2 in Appendix A.

C. Cross-Country Results: Non-OECD Sample

In this section, we use labor market data for 106 non-OECD countries from the ILO (KILM) for the latest available year. As in Section IV.D, the variables used are the country’s labor force participation, fraction of employers (or self-employed with employees), and fraction of own-account workers (self-employed without employees) by gender, which we denote as self-employed in our paper.31 As before, for each country, we then compute the gender gap parameters $(\mu, \mu_o, \lambda)$ comparing the male and female data on labor force participation, share of employers, and share of self-employed. The parameter $\theta$ is jointly estimated with the other parameters to match the fraction of self-employed in each country. The numerical results for non-OECD countries are presented in Appendix C.

The average cross-country results obtained are summarized in table 5, where the countries are split into seven geographic regions: Central Asia (6), East Asia and the Pacific (13), Europe (13), Latin America and the Caribbean (26), Middle East and North Africa (13), South Asia (7), and sub-Saharan Africa (28).32 For each region, columns 1 and 3 show the

| TABLE 4 |
| --- |
| POTENTIAL INCOME LOSSES FROM GENDER GAPS |
| | Short Run (%) | Long Run (%) |
| | $\theta = .75$ | $\theta = .25$ | $\theta = .75$ | $\theta = .25$ |
| Due to highest possible employership gap $(\mu = 1, \mu_o = 0 ; \mu = 1, \lambda = 1)$ | 6.1 | 3 | 7.4 | 3.7 |
| Due to highest possible entrepreneurship gap $(\mu = 1, \mu_o = 1 \rightarrow \mu = 0, \mu_o = 0; \lambda = 1)$ | 17 | 33.5 | 18.6 | 36.1 |

30 Intuitively, a fall in $\theta$ reduces the supply of workers, and as a result, the introduction of the $m$ gap creates a smaller fall in the equilibrium wage. This limits the incorporation of less talented employers and, hence, limits the fall in aggregate productivity.

31 In KILM, the category “self-employed” is subdivided into four groups: employers, own-account workers, members of producers’ cooperatives, and contributing family workers. Given the definition of each of these groups, we have decided that the most sensible choice was to use own-account workers to represent the self-employed in our model and assume that members of producers’ cooperatives and contributing family workers are workers.

32 We follow the World Bank in assigning each country to a region, with the exception of countries that belong in the Europe and Central Asia group. We split this into two geographical regions, Europe and Central Asia, since we believe that the labor markets in these two regions are very different. The numbers in parentheses indicate the number of countries assigned to each region.
average income loss (in the short and long run, respectively) due to the occupational gender gaps, \((\mu, \mu_o)\), while columns 2 and 4 show the average income loss due to all the gender gaps \((\mu, \mu_o, \lambda)\). Our results suggest the existence of remarkable differences across regions in income losses due to gender gaps, especially in those generated by the female labor participation gap. The region with the largest income loss is the Middle East and North Africa, where, according to our estimates, the total income loss is 35 percent in the short run and 38 percent in the long run, a fifth of which is due to the occupational choice gaps. South Asia has the second-largest income losses due to gender gaps, 23 percent in the short run and 25 percent in the long run, almost 40 percent of which is due to occupational gaps. Central Asia, on the other hand, is the region with the lowest total income loss due to gender gaps, 9 percent in the short run and 10.1 in the long run, almost 70 percent of which is due to occupational gaps.

Appendix C contains the results for all countries in the non-OECD sample, together with the country-specific parameter estimates. The average \(\theta\) is 0.75, indicating that 25 percent of agents who want to be workers end up being self-employed instead. The average \(\mu\) is 0.44, the average \(\mu_o\) is 0.54, and the average \(\lambda\) is 0.74. The average income loss from all gender gaps is 16.05 percent in the short run and 17.53 percent in the long run, while the average income loss due to occupational gaps is 5.8 percent in the short run and 6.5 percent in the long run. These figures are higher than for the sample of OECD countries, although the fact that we use different versions of the models to calculate the costs in each group suggests that this comparison should be taken cautiously.

With respect to the long-run total income losses from gender gaps, Yemen, Saudi Arabia, Syria, Qatar, and Iran are the countries with the largest ones, all of them over 40 percent, while Ghana, Liberia, and Rwanda are the countries with the smallest figures, all of them around 1 percent. With respect to the long-run income losses due to occupational
gender gaps, Bangladesh, Burkina Faso, and Pakistan are the countries with the largest ones, all of them above 17 percent, while Lesotho, Nepal, Rwanda, and Bhutan are the countries with the smallest ones, in all cases around 1 percent.

After merging the OECD and the non-OECD, we summarize the results in figures 3 and 4. Figure 3 shows the long-run total income loss due to gender gaps of each country in a world map, where we can see that the largest losses are in the Middle East and Northern Africa, South Asia, and Latin America. Figure 4, on the other hand, plots the income losses against GDP per capita in 2010. The first plot shows that there is an inverse-U relationship between the level of development of a country and the total income loss caused by the gender gaps, while the second plot shows a negative relationship between the development level and the income losses caused by the gender gaps in entrepreneurship. This suggests that the inverse U in the first plot is mostly driven by the U-shaped relationship between development and female labor force participation discussed, for example, in Goldin (1995).33

VI. Conclusion

This paper presents an occupational choice model and uses it to quantify the effects of gender gaps in the labor market on aggregate productivity and income per capita. Our numerical results show that gender gaps in entrepreneurship have significant effects on the allocation of resources and thus on aggregate productivity, while the gap from labor force participation has a large effect on income per capita. Specifically, if no woman worked as an employer or a self-employed, our benchmark model predicts that income per worker would drop by around 10 percent in the short run and 11 percent in the long run, while if the labor force participation of women was zero, income per capita would decrease by almost 47 percent in the short run and 50 percent in the long run. When we carry out the country-by-country analysis, we find that there are important differences across countries and geographical regions. Gender inequality creates an average income loss of 14 percent in the short run and 15.4 percent in the long run for the OECD sample and an average income loss of 16 percent in the short run and 17.5 percent in the long run for the sample of developing countries. On average, 44 percent of those losses are due to

33 Countries at different stages of their development process differ in many aspects, including the optimal choices of women in the labor market. In this sense, the interpretation of our gender gaps may not be the same across countries in different income groups, and as a result, the comparison between OECD and non-OECD should be made with caution. An alternative to comparing gender gaps in a cross section of countries at different stages of development would be to use time-series or panel data to compare these gaps—and their costs for one or several countries over time. An endogenous growth model in which we introduce gender gaps in the labor market would be the appropriate conceptual tool in that case since it would allow us to analyze the two-directional link between gender inequality and economic growth. We leave this for future research.
gender gaps in occupational choices. The region with the largest income loss due to gender inequality is the Middle East and North Africa, with an average income loss of 38 percent in the long run, followed by South Asia and Latin America and the Caribbean, with long-run income losses of 25 percent and 17.3 percent, respectively.

Our results suggest that the costs associated with gender gaps in the labor markets are substantial. As explained in OECD (2014), there are several public policies that can increase gender equality in the labor market: fostering a gender-neutral legal framework for business; reducing administrative burdens on firms and excessive regulatory restrictions; ensuring equal access to finance for female and male entrepreneurs, and
pair relevant financing schemes with support measures such as financial literacy, training, mentoring, coaching, and consultancy services; and increasing access to support networks, including professional advice on legal and fiscal matters. A recent example of a country that has implemented some of these policies is Norway, where in 2006, its government established a quota system that made it mandatory for companies to have at least 40 percent of women on their boards (Bertrand et al. 2014). Other countries have now implemented regulations that force companies listed on the stock exchange to comply with Corporate Governance Codes. In view of our findings, public policies along these lines may increase efficiency in the labor market and result in substantial gains in productivity and, potentially, women’s welfare.

As discussed before, in this paper, we abstract from modeling the decision of agents to participate in the labor force, as well as any differential aspect in the occupational choices of women. An interesting extension would be to introduce a household production sector in the model, which is likely to lead to a division of labor between husbands and wives, as in Becker (1981). This would obviously reduce the welfare effects of the labor force participation gender gap, although it would also reduce the female value of participating in the labor market and, hence, the optimal female labor supply. Similarly, we also abstract from sectoral differences in terms of female labor intensity, which seem to exist in the real world. Taking into account the imperfect substitution of male and female labor, together with the differences in female labor intensity by sector, would probably raise the losses predicted by the model. On the other hand, if one assumed that women have less entrepreneurial talent than men—perhaps because of gender gaps in education—then our framework is likely to overestimate the negative impact of gender gaps in entrepreneurship on aggregate income.

Appendix A

Occupational Choice Maps of Women

Figures A1 and A2 illustrate how women’s constraints are linked to their talent draw and what they imply in terms of their occupational choice. Figure A1 shows the occupational choice map of women in the benchmark model, while figure A2 shows the one in the extended model with necessity entrepreneurs.
Figure A1.—Occupational choice map of women—benchmark model. Color version available as an online enhancement.

Figure A2.—Occupational choice map of women—extended model. Color version available as an online enhancement.
### Appendix B

**TABLE B1**

**Cross-Country Results: OECD Sample (2010)**

| Variable | Country       | 1     | 2     | 3     | 4     |
|----------|---------------|-------|-------|-------|-------|
|           | Australia     | .62   | .02   | .81   | 3.18  |
|           | Austria       | .40   | .50   | .80   | 4.57  |
|           | Belgium       | .39   | .24   | .78   | 5.08  |
|           | Canada        | .38   | .35   | .87   | 4.98  |
|           | Chile         | .64   | 1.00  | .63   | 2.25  |
|           | Czech Republic| .36   | .22   | .73   | 5.44  |
|           | Denmark       | .30   | .21   | .87   | 6.02  |
|           | Estonia       | .24   | .39   | .83   | 6.34  |
|           | Finland       | .35   | .25   | .92   | 5.49  |
|           | France        | .32   | .25   | .83   | 5.74  |
|           | Germany       | .38   | .34   | .80   | 5.03  |
|           | Greece        | .39   | .36   | .69   | 4.93  |
|           | Hungary       | .48   | .20   | .79   | 4.31  |
|           | Iceland       | .39   | .20   | .92   | 5.10  |
|           | Ireland       | .31   | .00   | .77   | 6.27  |
|           | Israel        | .23   | .32   | .85   | 6.56  |
|           | Italy         | .41   | .26   | .64   | 4.81  |
|           | Japan         | .29   | .23   | .70   | 6.06  |
|           | Korea         | .39   | .27   | .68   | 5.04  |
|           | Luxembourg    | .41   | .57   | .76   | 4.42  |
|           | Mexico        | .38   | .70   | .54   | 4.51  |
|           | Netherlands   | .35   | .36   | .91   | 3.51  |
|           | Norway        | .36   | .23   | .92   | 5.42  |
|           | Poland        | .50   | .00   | .75   | 4.33  |
|           | Portugal      | .41   | .31   | .83   | 4.77  |
|           | Slovak Republic| .43  | .59   | .76   | 4.26  |
|           | Slovenia      | .41   | .03   | .81   | 5.20  |
|           | Spain         | .49   | .04   | .77   | 4.36  |
|           | Sweden        | .50   | .32   | .91   | 5.82  |
|           | Switzerland   | .40   | .12   | .81   | 5.19  |
|           | Turkey        | .19   | .65   | .39   | 6.28  |
|           | United Kingdom| .40   | .17   | .81   | 5.65  |
|           | United States | .38   | .14   | .82   | 5.37  |

Note.—Variable 1: Short-run income loss due to occupational gender gaps (%); variable 2: short-run total income loss due to gender gaps (%); variable 3: long-run income loss due to occupational gender gaps (%); variable 4: long-run total income loss due to gender gaps (%).

### Appendix C

**TABLE C1**

**Cross-Country Results: Non-OECD Sample**

| Country | Year | Region | \( \theta \) | \( \mu \) | \( \mu_o \) | \( \lambda \) | 1     | 2     | 3     | 4     |
|---------|------|--------|-------------|---------|-----------|-------------|-------|-------|-------|-------|
| ATG     | 2001 | LAC    | 1.00        | .51     | .34       | .99         | 3.86  | 4.18  | 4.34  | 4.69  |
| ARG     | 2011 | LAC    | .92         | .46     | .40       | .72         | 4.89  | 16.30 | 5.49  | 17.85 |
| ARM     | 2011 | CA     | .79         | .31     | .78       | .95         | 5.35  | 7.24  | 6.20  | 8.24  |
| AZE     | 2008 | CA     | .57         | .19     | 1.00      | .98         | 3.99  | 4.81  | 4.82  | 5.71  |
| BHR     | 2010 | MENA   | 1.00        | .29     | .00       | .26         | 6.51  | 36.00 | 7.14  | 58.76 |
| Variable | Country | Year | Region | $\theta$ | $\mu$ | $\mu_o$ | $\lambda$ | 1 | 2 | 3 | 4 |
|----------|---------|------|--------|---------|-------|---------|---------|---|---|---|---|
| BGD 2005 | SA | .25 | .36 | .00 | .61 | 21.25 | 31.10 | 23.09 | 33.60 |
| BRB 2004 | LAC | 1.00 | .25 | .27 | .94 | 6.49 | 8.99 | 7.26 | 9.98 |
| BLR 2009 | EU | 1.00 | .46 | .27 | .99 | 4.35 | 4.91 | 4.87 | 5.48 |
| BLZ 2005 | LAC | .90 | .53 | .48 | .53 | 4.11 | 23.69 | 4.64 | 25.77 |
| BTN 2011 | SA | .69 | .83 | 1.00 | .90 | .82 | 5.20 | .98 | 5.76 |
| BOL 2009 | LAC | .72 | .41 | .74 | .85 | 9.48 | 11.28 | 5.70 | 12.53 |
| BWA 2010 | SSA | 1.00 | .66 | 1.00 | .85 | 2.09 | 8.83 | 2.49 | 9.83 |
| BRA 2009 | LAC | .87 | .48 | .30 | .78 | 5.42 | 14.30 | 6.04 | 15.67 |
| BRN 1991 | EAP | 1.00 | .38 | .34 | .48 | 5.02 | 26.50 | 5.65 | 28.76 |
| BGR 2011 | EU | 1.00 | .47 | .23 | .89 | 4.31 | 8.75 | 4.80 | 9.64 |
| BFA 2006 | SSA | .41 | .32 | 1.00 | .10 | 16.66 | 16.66 | 18.17 | 18.17 |
| KHM 2008 | LAC | .48 | .73 | .00 | 1.00 | 6.40 | 6.40 | 7.01 | 7.01 |
| CMR 2001 | SSA | .47 | .53 | 1.00 | .97 | 1.88 | 3.33 | 2.24 | 3.83 |
| CPV 2000 | LAC | .72 | .41 | .74 | .85 | 4.98 | 11.28 | 5.70 | 12.53 |
| TCD 1993 | SSA | .47 | .33 | .54 | 1.00 | 11.27 | 11.27 | 12.42 | 12.42 |
| COL 2011 | SSA | .59 | .48 | .86 | .71 | 6.31 | 16.00 | 4.17 | 17.58 |
| CRI 2011 | LAC | .92 | .45 | .56 | 1.00 | 4.52 | 20.08 | 5.14 | 21.94 |
| CIV 2002 | SSA | .48 | .63 | .27 | .91 | 6.78 | 10.40 | 7.46 | 11.40 |
| HRV 2011 | EU | .98 | .51 | .44 | .84 | 3.93 | 10.53 | 4.45 | 11.63 |
| DJI 1996 | MENA | .81 | .68 | 1.00 | .55 | 1.78 | 21.67 | 2.12 | 23.63 |
| DOM 2001 | LAC | .80 | .53 | .22 | .70 | 5.74 | 17.58 | 6.35 | 19.18 |
| DMA 2010 | LAC | .56 | .75 | .00 | .91 | 9.63 | 12.88 | 10.53 | 14.06 |
| ECU 2011 | SSA | .73 | .44 | .97 | .64 | 3.25 | 18.45 | 3.86 | 20.26 |
| EGY 2011 | MENA | 1.00 | .17 | .83 | .25 | 6.06 | 36.34 | 7.17 | 39.22 |
| SLV 2011 | LAC | .83 | .59 | 1.00 | .71 | 2.34 | 14.86 | 2.79 | 16.36 |
| ETH 2005 | SSA | .47 | .25 | .25 | 1.00 | 14.79 | 14.79 | 16.21 | 16.21 |
| FJI 2008 | EAP | .79 | .57 | .00 | .52 | 6.51 | 25.52 | 6.91 | 27.66 |
| GAB 2005 | SSA | .61 | .55 | 1.00 | .72 | 2.14 | 14.30 | 2.56 | 15.75 |
| GEO 2010 | CA | .60 | .26 | .40 | 1.00 | 10.57 | 10.57 | 11.72 | 11.72 |
| GHA 2010 | SSA | .41 | .74 | 1.00 | .10 | .91 | 10.9 | 1.09 | 1.09 |
| GRD 1998 | LAC | .94 | .62 | .74 | .68 | 2.66 | 16.41 | 3.08 | 17.98 |
| GTM 2004 | LAC | .78 | .45 | 1.00 | .54 | 3.06 | 23.03 | 3.67 | 25.14 |
| HND 2010 | LAC | .67 | .69 | 1.00 | .57 | 1.51 | 20.48 | 1.80 | 22.34 |
| HKG 2011 | EAP | 1.00 | .32 | .06 | .92 | 6.08 | 9.20 | 6.68 | 10.08 |
| IND 2010 | SA | .32 | .33 | .60 | .42 | 9.33 | 30.63 | 10.35 | 33.15 |
| IDN 2009 | EAP | .48 | .34 | .43 | .76 | 10.42 | 18.99 | 11.52 | 20.75 |
| IRN 2008 | MENA | .71 | .15 | .51 | .23 | 9.83 | 38.14 | 11.02 | 41.05 |
| JAM 2011 | LAC | .63 | .62 | .16 | .86 | 6.38 | 11.92 | 7.02 | 13.04 |
| KAZ 2011 | CA | .79 | .69 | 1.00 | .95 | 1.66 | 3.72 | 1.98 | 4.23 |
| KWT 2011 | MENA | 1.00 | .81 | .00 | .50 | 1.55 | 23.95 | 1.71 | 25.99 |
| KGZ 2006 | CA | .67 | .44 | .44 | .81 | 7.04 | 14.38 | 7.84 | 15.79 |
| LAO 2005 | EAP | .44 | .44 | .94 | .81 | 10.83 | 13.83 | 15.10 | 15.10 |
| LVA 2011 | EU | 1.00 | .49 | .32 | 1.00 | 4.05 | 4.05 | 4.55 | 4.55 |
| LBN 2007 | MENA | .81 | .14 | .21 | .57 | 11.07 | 32.92 | 12.22 | 35.55 |
| LSO 1999 | SSA | .27 | .10 | .78 | .78 | .00 | 9.97 | .00 | 10.90 |
| LBR 2010 | SSA | .45 | .77 | 1.00 | 1.00 | .86 | 8.86 | 1.02 | 1.02 |
| LTU 2011 | EU | 1.00 | .39 | .41 | 1.00 | 4.86 | 4.86 | 5.50 | 5.50 |
| MAC 2011 | EAP | 1.00 | .33 | .06 | .97 | 5.94 | 6.93 | 6.53 | 7.62 |
| MKD 2010 | EU | .95 | .60 | .00 | .87 | 4.95 | 18.26 | 5.43 | 19.87 |
| MGT 2010 | SSA | .48 | .32 | 1.00 | .80 | 12.75 | 12.75 | 14.00 | 14.00 |
| MWI 1987 | SSA | .29 | .08 | 1.00 | 1.00 | 3.01 | 3.01 | 3.65 | 3.65 |
| MYS 2011 | EAP | .95 | .35 | .30 | .57 | 5.96 | 23.13 | 6.67 | 25.18 |
| Country | Year | Region | Variable 1 | Variable 2 | Variable 3 | Variable 4 |
|---------|------|--------|------------|------------|------------|------------|
| MDV     | 2006 | SA     | 1.00       | 0.24       | 1.00       | 5.14       |
| MLI     | 2006 | SSA    | 0.51       | 0.45       | 0.76       | 4.84       |
| MLT     | 2011 | EU     | 1.00       | 0.34       | 0.90       | 5.94       |
| MUS     | 2011 | SSA    | 0.99       | 0.29       | 0.27       | 6.05       |
| MDA     | 2011 | EU     | 0.77       | 0.50       | 0.25       | 6.37       |
| MNG     | 2011 | EAP    | 0.84       | 0.49       | 0.33       | 5.55       |
| MAR     | 2008 | MENA   | 0.75       | 0.24       | 0.29       | 10.08      |
| MOZ     | 2003 | SSA    | 0.35       | 0.18       | 0.49       | 1.12       |
| NAM     | 2011 | SSA    | 0.92       | 0.63       | 1.00       | 2.20       |
| NPL     | 2001 | SA     | 0.44       | 0.97       | 1.00       | 10.81      |
| NER     | 2005 | SSA    | 0.20       | 0.50       | 1.00       | 13.84      |
| OMN     | 2010 | MENA   | 1.00       | 0.59       | 1.71       | 5.14       |
| PAK     | 2008 | SA     | 0.66       | 0.02       | 0.28       | 15.49      |
| PAN     | 2011 | LAC    | 0.78       | 0.60       | 0.03       | 5.76       |
| PRY     | 2010 | LAC    | 0.77       | 0.45       | 1.00       | 3.07       |
| PER     | 2011 | LAC    | 0.72       | 0.39       | 0.90       | 4.03       |
| PHL     | 2008 | EAP    | 0.74       | 0.46       | 0.66       | 4.86       |
| QAT     | 2004 | MENA   | 1.00       | 0.12       | 0.00       | 8.50       |
| ROM     | 2011 | EU     | 0.87       | 0.43       | 0.11       | 6.87       |
| RUS     | 2008 | EU     | 1.00       | 0.61       | 0.55       | 2.84       |
| RWA     | 1996 | SSA    | 0.45       | 0.81       | 1.00       | 7.22       |
| LCA     | 2000 | LAC    | 0.77       | 0.42       | 0.51       | 6.03       |
| STP     | 1991 | SSA    | 0.85       | 0.24       | 0.97       | 4.86       |
| SAU     | 1992 | MENA   | 1.00       | 0.10       | 1.11       | 8.49       |
| SEN     | 2011 | SSA    | 0.76       | 0.20       | 1.00       | 4.62       |
| SRB     | 2011 | EU     | 0.87       | 0.52       | 0.00       | 5.85       |
| SGP     | 2011 | EAP    | 1.00       | 0.47       | 0.08       | 4.51       |
| ZAF     | 2011 | SSA    | 1.00       | 0.37       | 0.86       | 4.33       |
| LKA     | 2011 | SA     | 0.71       | 0.23       | 0.45       | 9.34       |
| KNA     | 2001 | LAC    | 1.00       | 0.36       | 0.30       | 5.27       |
| VCT     | 2008 | LAC    | 1.00       | 0.46       | 0.57       | 4.01       |
| SUR     | 1998 | LAC    | 0.95       | 0.25       | 0.24       | 7.33       |
| SWZ     | 1997 | SSA    | 0.98       | 0.79       | 1.00       | 1.26       |
| SYR     | 2011 | MENA   | 0.73       | 0.21       | 0.03       | 13.13      |
| TJK     | 2009 | CA     | 0.52       | 0.18       | 0.69       | 8.68       |
| TZA     | 2011 | SSA    | 0.56       | 0.33       | 0.93       | 3.99       |
| THA     | 2011 | EAP    | 0.70       | 0.38       | 0.46       | 7.39       |
| TTO     | 2005 | LAC    | 0.96       | 0.50       | 0.24       | 4.40       |
| TUN     | 1994 | MENA   | 0.88       | 0.27       | 0.37       | 7.45       |
| UGA     | 2003 | SSA    | 0.33       | 0.49       | 0.53       | 7.92       |
| UKR     | 2011 | EU     | 0.96       | 0.62       | 0.96       | 2.41       |
| URY     | 2010 | LAC    | 0.89       | 0.47       | 0.58       | 4.45       |
| VEN     | 2011 | LAC    | 0.76       | 0.34       | 0.86       | 4.66       |
| VNM     | 2004 | EAP    | 0.52       | 0.43       | 0.30       | 9.90       |
| YEM     | 2010 | MENA   | 0.78       | 0.43       | 1.00       | 3.20       |
| ZMB     | 2000 | SSA    | 0.55       | 0.33       | 0.36       | 10.54      |
| ZWE     | 2002 | SSA    | 0.67       | 0.56       | 1.00       | 9.22       |

Note.—Country codes are from Penn World Tables (https://pwt.sas.upenn.edu/). Year is the latest year for which ILO data are available. Region is the World Bank region (EAP: East Asia and Pacific; EU: Europe; CA: Central Asia; LAC: Latin America and the Caribbean; MENA: Middle East and North Africa; SA: South Asia; SSA: sub-Saharan Africa). Variable 1: short-run income loss due to occupational gender gaps (%); variable 2: short-run total income loss due to gender gaps (%); variable 3: long-run income loss due to occupational gender gaps (%); variable 4: long-run total income loss due to gender gaps (%).
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