The Digital Gender Gap and Entrepreneurship in Emerging Europe[1]

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Abstract

Theoretical studies on the digital gender divide and women's entrepreneurship that could inform policymaking in emerging market countries are scarce. This paper strives to reduce the gap in the literature with a model that links entrepreneurship to digital skills and productivity. The model illustrates that differences in digital skills, together with greater opportunity cost related to entrepreneurship incurred by women, can lead to gender gaps in entrepreneurial outcomes. The results are consistent with indicators from the World Bank Enterprise Surveys for European emerging markets. In terms of policies for emerging European countries, these should focus on strengthening the digital skills through increasing women's representation in science and technology, building confidence in own digital skills, and on easing women's time constraints.

JEL classification: J4, O3

Key words: Female entrepreneurship and productivity, gender gap, search model, digitization

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1. Introduction

Policymakers in both developed and developing countries have recognized the potential of women's entrepreneurship to contribute to growth, innovation and societal well-being. At the same time, the technological advances from information and communication technologies (ICT) have been transforming the world of work, with an increasing number of firms relying on ICT in their production, marketing and processes. This transformation has created new opportunities in the digital economy but also changes skills requirements (OECD and European Commission, 2017; McKinsey Global Institute, 2016; Kollmann et. al, 2016).

To seize these opportunities, entrepreneurs everywhere, including female entrepreneurs in Europe, need to possess adequate ICT skills. However, a study by the European Commission (2018) revealed that (i) the percentage of Europeans with ICT-related education is decreasing (ii) this is the case more for women than men. Differently put, not only is the overall level of ICT skills relatively low, but in addition the gap between men and women's participation in the digital sector in education, career and entrepreneurship has been widening. The Commission further underscored that the gender digital divide is a result of persistent beliefs about gender differences in technical capacities and about what is an appropriate role for each gender in the labor market.

Both topics of (i) of women's entrepreneurship and (ii) the digital gender divide have separately received wide attention among policymakers who launched measures to reduce the gender gap in digital access and skills.[2] In contrast, academic research on the digital gender divide and digital skill gaps has emerged more gradually and included works of Hargittai and Shafer, 2006; Helsper, 2010; Martínez-Cantos, 2016 and 2017, among others. Both academic and policy-oriented literature linking the digital divide with gender gaps in entrepreneurial outcomes has been particularly limited (exceptions include UNCTAD, 2014a). Moreover, the field of gender and entrepreneurship is yet to establish strong theoretical foundations; this applies also to the intersection of the digital divide, gender and entrepreneurship (Yadav and Unni, 2016).

Against this background, this paper contributes to closing the gap in the academic literature and examines gender differences in ICT-based entrepreneurship through a theoretical model that links entrepreneurship to digital skills and productivity. The paper thus complements the literature that has adopted the contextual approach to gender gaps in entrepreneurial outcomes. It shows that raising entrepreneurs' digital skills and lowering women's time constraint can facilitate productive women's entrepreneurship. When potential entrepreneurs have ICT skills that are required in a number of high productivity sectors or ICT skills that raise the overall productivity, they are more likely to open and run highly productive firms. Further, when the value of a potential business opportunity is high, the skilled entrepreneur will raise search intensity while being also more enticed to search for opportunities in the first place.

[2] Underscoring that globally 250 million less women than men were online in 2017, the G20 Digital Economy Ministerial Declaration (G20, 2017) placed bridging the digital gender divide and supporting the equitable participation of women and girls in the digital economy as a priority. Similarly, OECD (2018) pointed out that in 2018 around 300 mil. fewer women than men owned a smartphone.

The model captures the gender differences through several channels. First, women face greater challenges than men finding ICT-based business opportunities and turning them into firms because of their lower ICT skills, lower participation in professional networks, and often also because they have less confidence in their ICT abilities than men do (Babson College et al., 2012; European Parliament, 2018). Second, as women are underrepresented in studying math, engineering and ICT, they tend to be less equipped than men to open technology-based firms that require some knowledge in these areas. More broadly, women often also lack ICT skills that would raise overall productivity of their firms in other sectors. Third, with bearing a larger share of family responsibilities, women face more constraints on their time. Such constraints, together with cultural barriers, discourage them from ICT-based entrepreneurship.

The model developed in this paper reflects these facts and shows that in equilibrium a higher share of men will be engaged in high productivity (ICT-based) firms. The results of the model are also consistent with several stylized facts about female entrepreneurship in emerging Europe, such as gender differences in firm informality and utilization of ICT observed in recent (country level) World Bank Enterprise Survey aggregated data. The paper provides several recommendations that could encourage women to enter 'non-traditional', but more productive and profitable industries and sectors.

The remainder of the paper is organized as follows. Section 2 provides a brief overview of the literature gender gap in entrepreneurship and on the digital gender gap in Europe. Section 3 develops the theoretical model and derives the main results. Section 4 confronts the results with existing data from a group of European countries covered in World Bank Enterprise Surveys. Policy discussion and conclusions are in Section 5.

2. Gender differences in entrepreneurship and the digital gender divide in Europe

The literature on gender gaps in entrepreneurship (and on the digital gender gaps) is by and large empirical. Various empirical studies have identified characteristics of female entrepreneurship that distinguish it from male entrepreneurship, underscoring gender segmentation. Women tend to be concentrated in micro and small-scale enterprises as well as in basic services and other low-value added sectors while men are in larger firms and in manufacturing and other activities that tend to generate higher value added. These imbalances have implications for income, job security, and social protection (International Organization of Employers, 2008).

The empirical literature reports that in lower income women engage more often either in the informal sector or in the household sector activities while in higher income countries they may not enter the labor force (World Bank, 2012; Snyder, 2005). For example, Chen (2001) provides evidence that women entrepreneurs are more likely to operate in the informal sector. European Commission and OECD (2015) study finds a negative correlation between formal and informal start-up rates across EU countries, pointing to a substitution effect in the entrepreneur's choice between whether or not to register their firms. One of the factors that entrepreneurs take into account in decision whether to register is access credit. While credit constraint is a barrier for both men and women entrepreneurs, it is more binding for women, in part because of they own

fewer assets that can be used as collateral. In turn, credit constraints and related small-scale lower firm productivity and may reinforce informality. In line with the institutional approach to informality, evidence suggests that in high-gender bias European countries, female entrepreneurs are more likely to opt out of the loan application process (European Central Bank, 2015).

Some studies point to unadjusted (headline) productivity gap between female- and male-led enterprises (OECD and European Commission, 2017). Others have shown that, once controlled for the size of the firm, level of education, and the sector of activity, there appears to be much smaller difference in male-female productivity. For example, examining firm level data for 26 countries in Eastern and Central Europe and Central Asia while controlling for industry and country, Sabarwal and Terrell (2008) found that women entrepreneurs had smaller scales of operation, but generate similar levels of profits per revenue unit as men. Regarding drivers of the performance gap, Coleman (2007) posited that human capital, education and experience, were positively linked with profitability of women-owned firms. Recently, Guzman and Kacperczyk (2019, forthcoming) studied the entrepreneurial gender gap on the entire population of businesses in California and Massachusetts during 1995 – 2011. They found that the largest part of the performance gap stems from differences in the initial start-up orientation, which investors perceive as signal of growth potential. Once investors have stronger growth signals for both female-led and male-led comparable enterprises, the residual gap diminishes significantly.

In another stream of literature, separate from the entrepreneurship issues, the persistent digital gender divide has started to be systematically documented in various reports and empirical literature, correcting the initial lack of data in this area. Examples of this stream include Hafkin and Huyer (2007); UNCTAD (2014b); Intel (2013). This literature has shown that (i) women use ICT less than men due to both lower skills and access and (ii) when they use, they do so often for different (mostly social) purposes than men. Moreover, women entrepreneurs have less time to spend on their business or on improving their ICT skills, due to care-taking responsibilities and traditional division of labor within household (UNCTAD, 2014a).[3] As a result, in many countries, more men than women possess technological knowledge and skills needed to develop new techniques and start innovative economic activities needed for productive entrepreneurship.

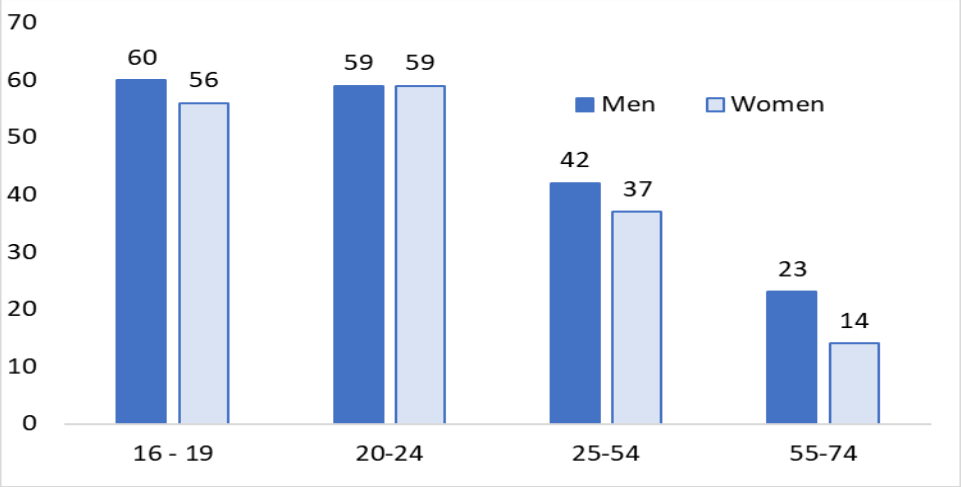
Turning to the literature on the digital gender gaps in Europe, Martínez-Cantos (2016 and 2017) finds that there are substantial differences between men and women in their capacity to carry out more complex and less generalized digital tasks, which were stable over the period from 2010 - 2014. Additionally, those gender gaps are even more marked in the highly educated groups, indicating that digital skills gaps by gender are sizeable and likely to persist at many levels of society, while 'ICT specialist' profiles are becoming more important for future employment opportunities. The author concludes that under this baseline, the ongoing digitization of work could not only reinforce the existing gender gaps in labor markets, but even widen them.

In addition, the Eurostat data show that the gender gap in the digital skills in the EU is not only wider for older age cohorts, but it has also wider for the ages 16 – 19 relative to the ages 20 – 24,

[3] Gaps in ICT usage seem to accompany pre-existing social and economic inequalities, implying that gender gaps in ICT use are likely to be larger in countries with greater overall gender inequality (Ono and Zavodny, 2005).

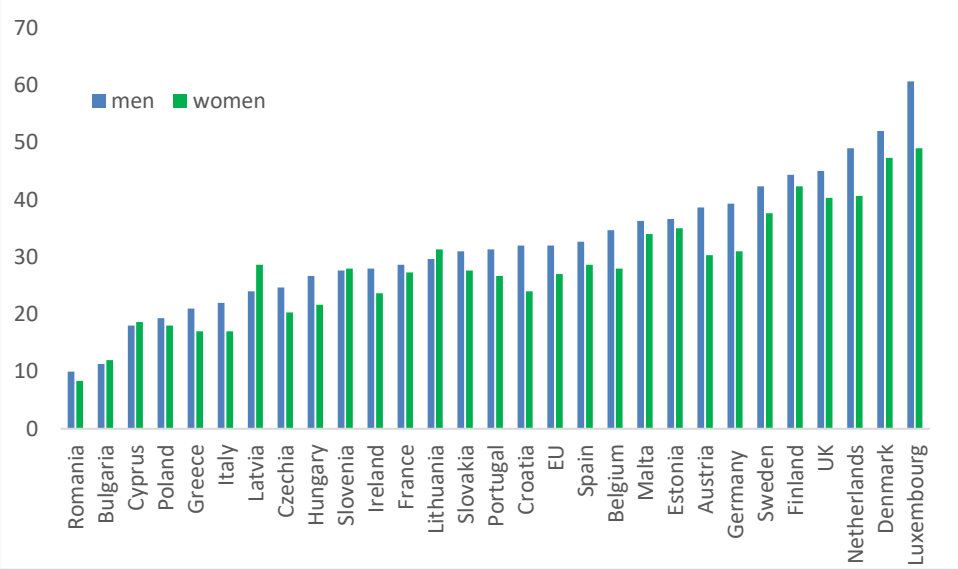
pointing to the gap's persistence (Figure 1a). This trend can be also observed in Hungary and the Slovak Republic. Notable is also the fact that in the Visegrad countries, the overall shares of people with higher than basic digital skills is below the EU average (Figure 1b). These countries also scored among the bottom ten EU countries on the Women in Digital Index 2019.[4]

Figure 1a. Share of EU population with above basic digital skills, by age and gender (% of relevant cohort, 2017)



Source: Eurostat.

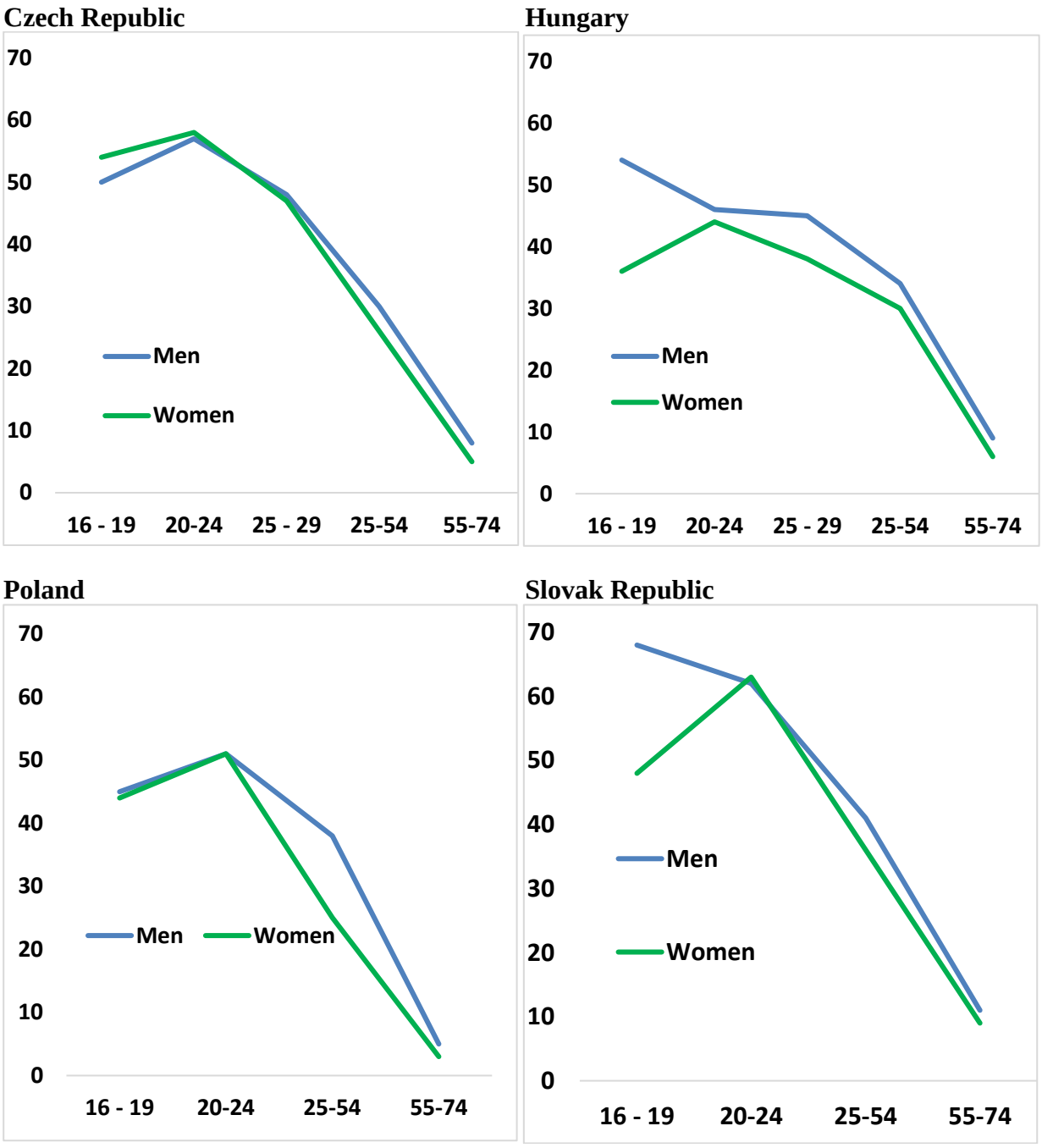
Figure 1b. Share of EU population with above basic digital skills, by country and gender (% of population of ages 16 - 74, av. of 2015 – 2017)



Source: Eurostat.

[4] The index measures the combination of women's use of the internet, internet user skills and ICT specialist skills (European Commission, 2019).

Figure 2. Share of population with above basic digital skills in the Visegrad countries by age and gender (% of relevant cohort in 2017)



Source: Eurostat.

In summary, the existing literature comprises mostly separate streams of empirical research, including surveys, while contributions of economic theory to the underlying causes of the gender gaps in entrepreneurship – including ICT-based entrepreneurship -- have been very limited. This paper strives to close this gap with a model linking the observed gender differences in entrepreneurial outcomes with women's lower skills (both the actual digital and entrepreneurial skills and perceived ones), greater time constraints, and other obstacles (cultural barriers) that women entrepreneurs may encounter. A theoretical model along these lines is presented below.[5]

3. The Model

The model that follows shows how that the level of skills among potential entrepreneurs combined with their responsibilities in the household sector impact their search for business opportunities in the formal sector. These factors also affect the share of the formal private sector in aggregate output as well as level of unemployment and productivity.

3.1 Economic environment

Agents. Consider a continuous time economy, where the population is normalized to one and consists of infinitely lived entrepreneurs and workers, with population sizes μ and $1-\mu$, respectively. All entrepreneurs and workers are endowed with one unit of time at every *t*, and have the same risk neutral preferences, $U_0 = E_0[\int_{t=0}^{\infty} e^{-rt}\, c_t dt]$, where c_t is consumption of a single good at t, and E_0denotes expectations at *t=0.* Workers are either employed in the private sector or unemployed and working in the household sector. Wages in the private sector, are equal to workers' alternative source of income, namely from the income in the household economy, b.

Entrepreneurs. Entrepreneurs either (i) work in the household sector (earning income *b*) and have a possibility to search for a business opportunity or (ii) they run a firm in the formal private sector. The business opportunity (firm) is of high productivity, z^h, when Internet and mobile technology is used and of low productivity, z^l, otherwise, where $z^h > z^l > 0$. A portion p of entrepreneurs have high skills to use Internet and communication technology (ICT) and portion $1-p$ of entrepreneurs have low ICT skills.

Firms are created through entrepreneurs' search effort x_i at a flow cost of $d(x_i) = x_i^2/2\gamma$ units of consumption good, where $i\epsilon\{s,u\}$ denotes entrepreneurs who are skilled and unskilled in ICT, respectively.[6] Parameter $\gamma > 0$ denotes the efficiency of search. The entrepreneurs of type i choose their effort levels x_i which then determine the arrival rate of a business opportunity, x_i, according to a Poisson process. For the type i entrepreneur, the arriving business opportunity has high productivity z^h with probability φ_i and low productivity z^l with probability $1-\varphi_i$, where

[5] The model builds on substantially extends version presented in Baliamoune-Lutz, Brixiová and Ncube (2014).
[6] Regarding notation, $\boldsymbol{S}$ stands for 'skilled' (high skilled) and $\boldsymbol{U}$ stands for 'unskilled' (low skilled) entrepreneurs.

$0 < \varphi_u < \varphi_s < 1$. Differently put, entrepreneurs with high ICT skills are more likely to find a highly productive business opportunity (requiring the usage of ICT or other skills that raise productivity) than entrepreneurs with low ICT and other relevant skills.[7]

An opportunity of type z^j, $j\epsilon\{h,l\}$, allows the entrepreneurs to produce output in the formal sector employing $n > 0$ workers, through a constant returns to scale production function $y^j = z^j n$. The profit in the firms with productivity j amounts to $\pi^j = z^j n - wn$. Firms (and jobs) are destroyed through firm-specific, idiosyncratic shocks arriving at rate δ, according to the Poisson process. The entrepreneurs then search for a new business opportunity.

To characterize the entrepreneurs' optimization problem, the value function approach is utilized. Omitting the time subscripts and denoting J_i and V_i to be the present discounted value of the income stream of an entrepreneur running a private firm, and an entrepreneur working in the household sector with a possibility to search for a business opportunity, respectively, the corresponding Bellman equations are:

$$rV_i = b + \ max[0; max_{x(i)}\left(-\frac{x_i^2}{2\gamma} - \sigma_i + x_i\left[\varphi_i\left(J_i^h - V_i\right) + (1-\varphi_i)\left(J_i^l - V_i\right)\right]\right)] + \dot{V}_i \qquad (1)$$

$$rJ_i^j = \pi^j \ + \delta(V_i - J_i^j) + \dot{J}_i^j \qquad (2)$$

where $i\epsilon\{s,u\}, j\epsilon\{h,l\}$, r is the discount rate, $\sigma_i > 0$, is the opportunity cost (disutility) of search, with unskilled workers facing greater disutility, that is $\sigma_u > \sigma_s > 0$. This parameter can be also interpreted as fixed cost of search.

The Bellman equation (1) reflects that the entrepreneur chooses between working in the household sector and possibly searching for business opportunities or working in the household sector without searching. If the entrepreneur working in the household sector chooses to search, the return on such search equals the net expected profit from running a business and the change of the value of searching for business opportunities, $\dot{V}_i$. Equation (2) states that the return on running a firm consists of expected profits minus the expected loss due to the firm's possible destruction plus the change of the value of $\dot{J}_i^j$.

According to (1), each entrepreneur i currently working in the household sector chooses whether to search for a business opportunity and how much effort to put into search. The entrepreneur searches for business opportunities in the formal sector when the payoff from such search exceeds the cost of search. Denoting $\xi_i \in \{0,1\}$ as the probability that the entrepreneur $i\epsilon\{s,u\}$ in the household sector searches for a business opportunity, the decision to search can be described by:

$$\xi_i = \begin{cases} 1 & if \quad \frac{x_i^2}{2\gamma} \geq \sigma_i \\ 0 & otherwise \end{cases} \qquad (3)$$

[7] The model could be applicable to entrepreneurship of other less skilled groups, such as rural workers.

When the entrepreneur i chooses search effort, x_i, the marginal cost of search equals to the expected marginal payoff, L_i:

$$\frac{x_i}{\gamma} = \varphi_i(J_i^h - V_i) + (1-\varphi_i)(J_i^l - V_i) = L_i \quad (4)$$

where L_i is the value of a random business opportunity to an entrepreneur with ICT skills i. The entrepreneur's search intensity, x_i, rises with the difference between the values of running a firm and searching, and hence with the level of productivity of a business opportunity, that is with the level of φ_i and z^j as well as with the efficiency of search, γ.

Labor market clearing conditions. At every $t \geq 0$, let m_{it}^v be the share of entrepreneurs with skills i in the household sector and m_{it}^j the entrepreneurs running a firm of productivity type *j*. The labor market clearing conditions for entrepreneurs with skills $i, i\epsilon\{s,u\}$ are described as:

$$p_i\mu = m_{it}^v + m_{it}^h + m_{it}^l \quad (5a)$$

where $p_s = p$ and $p_u = 1 - p.$*The* condition (5) states that all entrepreneurs with skills i , $p_i\mu$, are either working in the household sector or running a firm of productivity *j* in the formal sector. The aggregate (for all entrepreneurs) labor market clearing condition becomes:

$$\mu = m_{st}^v + m_{st}^h + m_{st}^l + m_{ut}^v + m_{ut}^h + m_{ut}^l \quad (5b)$$

The share of skilled entrepreneurs running high and low productivity firms evolves according to:

$$\dot{m}_{st}^h = x_{st}\varphi_s(p\mu - m_{st}^h - m_{st}^l) - \delta m_{st}^h \quad (6a)$$

$$\dot{m}_{st}^l = x_{st}(1-\varphi_s)(p\mu - m_{st}^h - m_{st}^l) - \delta m_{st}^l \quad (6b)$$

Similarly, the shares of unskilled entrepreneurs running high and low productivity firms are described by (7a) and (7b), respectively:

$$\dot{m}_{ut}^h = x_{ut}(1-\varphi_u)\left[(1-p)\mu - m_{ut}^h - m_{ut}^l\right] - \delta m_{ut}^h \quad (7a)$$

$$\dot{m}_{ut}^l = x_{ut}(1-\varphi_u)\left[(1-p)\mu - m_{ut}^h - m_{ut}^l\right] - \delta m_{ut}^l \quad (7b)$$

where the initial conditions are $m_{u0}^l = m_{u0}^h = m_{s0}^l = m_{s0}^h = 0$, that is there are no formal private firms in the initial period, *t = 0.* All entrepreneurs with skills i are in the household sector, that is $m_{s0} + m_{u0} = \mu$. Workers are either in the formal private firms or in the household sector:

$$(1-\mu) = N_t + N_{st} + N_{ut} \; . \quad (8)$$

where N_t is the share of workers in the household sector and N_{it}denotes the share of workers working for an entrepreneur with skills *i* in the formal sector.

3.2 Equilibrium – definition and characteristics

The *equilibrium* of this economy is the allocation of workers and entrepreneurs with digital skills i and the probability that entrepreneurs decide to search for business opportunities when at every t (i) each entrepreneur with skills *i* chooses whether to search for opportunities in the formal sector, ξ_{it}, and if so what effort to put into search, x_{it}; (ii) each worker chooses the allocation of labor, taking wages as given; and (iii) labor and product markets clear.

The equilibrium is described by m_{i0},N_0, and by $L_{it}, \xi_{it}, m_{it}^j, N_{it,}^j \ \ t \geq 0$, such that (3) – (8) are met. Suppressing the time subscript and letting $\pi_{ui} = \gamma L_i^2/2$ be the average 'profit' from search, the value of a business opportunity, L_i, to an entrepreneur $with\ skills\ i = \{s, u\}$ evolves as:

$$\dot{L}_i = (r + \delta)L_i + \pi_{ui} - \left[\varphi_i \pi^h + (1 - \varphi_i)\pi^l - (b - \sigma_i)\right] \quad (9)$$

Denoting m_i, $m_i = m_i^h + m_i^l$ as the total share of entrepreneurs with skills *i*, $i = \{s, u\}$ who are running firms, the law of motion describing this group can be written as:

$$\dot{m}_i = \gamma L_i(p_i \mu - m_i) - \delta m_i \quad (10)$$

where $m_{i0} = 0$, $p_s = p$ and $p_u = 1 - p$.
Steady state equilibrium

In the steady state, variables take on the same values in all time periods, that is $\forall\ t \geq 0$, $\dot{L}_i = \dot{m}_i = 0$ and $m_{it} = m_i^*$, $L_{hs} = L_s^*$, $\xi_{it} = \xi_i^*$, and $N_t = N^*$for $i = \{s, u\}$.

Proposition 1: *Let $\pi_{ui}^* \geq \sigma_i$ for every $i \epsilon \{s, u\}$. Then there exists a unique non-trivial steady state equilibrium $m_i^* > 0$, $L_i^* > 0$, such that*

$$m_i^* = p_i \mu \gamma L_i^* / (\gamma L_i^* + \delta) \quad (11)$$

$$L*_i = \frac{1}{\gamma}\left[-(r + \delta) + \sqrt{(r + \delta)^2 + 2\gamma[\varphi_i \pi^h + (1 - \varphi_i)\pi^l - (b - \sigma_i)]}\right] \quad (12)$$

Proof: We split the proof into two parts.

(i) Since $\dot{m}_i = 0$, from (10) we obtain $\gamma L_i(p_i \mu - m_i) = \delta m_i$. Solving this linear equation with respect to m_i^* we immediately deduce the equilibrium form in (11). Positivity of (11) follows directly from the technical assumptions of our model. Similarly, (12) can be obtained from (9) setting $\dot{L}_i = 0$. Since by assumption $\varphi_i \pi^h + (1 - \varphi_i)\pi^l + (b - \sigma_i) > 0$, we obtain $L_i^* > 0$ by considering the positive root.

(ii) Now let $H = \gamma L_i^*(p_i\mu - m_i) - \delta m_i$. First suppose that $m_i = 0$. Then $H = p_i\mu\gamma L_i^* > 0$. Second, when $m_i = p_i\mu$, then $H = -\delta p_i\mu < 0$. Since H is continuous and monotonically decreasing in m_i, ∃ unique $m_i^* \epsilon (0, p_i\mu]$ that satisfies (11) and (12). ■

Equilibrium conditions (11) and (12) show that the productive private sector is larger with higher expected profits. This is because when the value of a business opportunity L_i is low, entrepreneurs will lower search intensity or may stop searching for opportunities altogether, i.e. $\xi_i = 0$.

3.3 The market solution and inequality

In this section we show that due to their higher direct search cost and greater opportunity cost associated with search, unskilled entrepreneurs either opt out of searching for business opportunities more easily or put less effort into their search than skilled entrepreneurs. In the subsequent parts of the paper, we then discuss mitigating policies.

Proposition 2. *The 'cut-off' value of a business opportunity at which an entrepreneur $i\epsilon\{s,u\}$ chooses to search for business opportunities, $\hat{L}_i$, is higher for low-skilled (unskilled) than for high-skilled (skilled) entrepreneurs, that is $\hat{L}_u > \hat{L}_s > 0$.*

Proof. Assuming that the entrepreneur $i\epsilon\{s,u\}$ in the household sector searches for a business opportunity, that is $\xi_i = 1$, we set $\frac{x_i^2}{2\gamma} \geq \sigma_i$ according to (3) or, equivalently, $x_i^2/\gamma^2 \geq 2\sigma_i/\gamma$. Taking into account the relationship $x_i/\gamma = L_i$ following from (4), we obtain $L_i > \hat{L}_i$ where $\hat{L}_i = \sqrt{2\sigma_i/\gamma}$ *is* the 'cut-off' value of a business opportunity for an entrepreneur i. Since $\hat{L}_i$ is strictly increasing in σ_i and since $\sigma_u > \sigma_s > 0$, we deduce that $\hat{L}_u > \hat{L}_s > 0$.[8] ■

Proposition 2 shows that because of their lower opportunity cost related to market activities, high skilled entrepreneurs are more likely to search for business opportunities than low skilled entrepreneurs. As a result, a larger share of unskilled entrepreneurs ends up working as self-employed, in the household sector.

Proposition 3. *Let k_i^h be the steady state share of entrepreneurs with skills $i = \{s,u\}$in their respective populations that run highly productive firms, that is:*

$$k_s^h = m_s^{h*}/p\mu; \text{ and } k_u^h = m_u^{h*}/((1-p)\mu)$$

Further assume that the difference in expected profits of skilled and unskilled entrepreneurs exceeds the difference in their start-up cost, that is $(\varphi_s - \varphi_u)\pi^h - (\varphi_s - \varphi_u)\pi^l > \sigma_u - \sigma_s$. Then $k_s^h > k_u^h$.

[8] Negative values of L_i are not considered since they imply that no search for business opportunities would occur.

Proof. By equivalent modification of $(\varphi_s - \varphi_u)\pi^h - (\varphi_s - \varphi_u)\pi^l > \sigma_u - \sigma_s$ we obtain $\varphi_s\pi^h + (1-\varphi_s)\pi^l - (b-\sigma_s) > \varphi_u\pi^h + (1-\varphi_u)\pi^l - (b-\sigma_u)$

This condition together with (12) implies that $L_s^* > L_u^*$. Consequently, it follows from (4) that $x_s^* > x_u^*$, that is skilled entrepreneurs put more effort into their search for business opportunities than unskilled entrepreneurs. From the steady state value of $m_s^{h*} = p\mu\frac{\varphi_s x_s^*}{x_s^*+\delta}$ and (5) it follows that $k_s^h = \varphi_s x_s^*/(x_s^* + \delta)$ is the steady state share of skilled entrepreneurs that run highly productive firms. Similarly, $k_u^h = \varphi_u x_u^*/(x_u^* + \delta)$ *is the steady* state share of unskilled entrepreneurs that run highly productive firms. Note that k_i^h with $i = \{s, u\}$ is increasing in both φ_i and x_i^*. Since $x_s^* > x_u^*$and $\varphi_s > \varphi_u$, the previous fact implies that $k_s^h > k_u^h$. ■

Proposition 3 shows that in equilibrium a higher share of skilled entrepreneurs operates high productivity firms (utilizing ICT) than is the case for less skilled entrepreneurs. This result is due to greater aptitude of skilled entrepreneurs to business opportunities requiring ICT skills, raising pay-off to search. In turn, higher pay-off stimulates skilled entrepreneurs to put more effort than their unskilled counterparts into search for business opportunities.

4. Digital gender gaps in entrepreneurship in emerging Europe: discussion

4.1 Self-employment in the informal and/or household sector

Proposition 2 shows that because of higher expected profits, entrepreneurs with digital and other entrepreneurial skills will put more effort into searching for business opportunities than low skilled entrepreneurs. As a result, a larger share of unskilled entrepreneurs will be unemployed and/or self-employed in the informal sector or withdraw from the labor force altogether. This implies that a smaller share of women would be operating productive firms in the formal sector. as can be observed in several lower income countries in Europe and Central Asia.

4.2. Foreign technology transfer and use of ICT

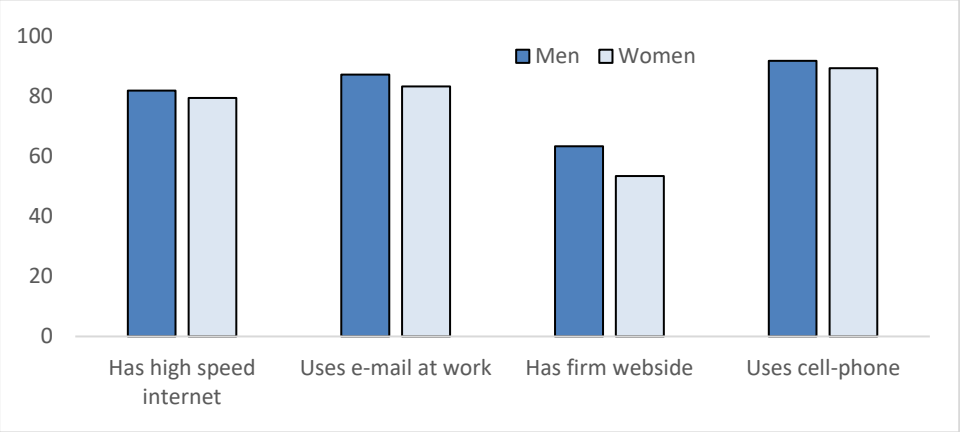
Proposition 3 shows that in equilibrium a higher share of skilled than unskilled entrepreneurs will end up operating high productivity firms (utilizing ICT, for example). In general, in emerging Europe, women entrepreneurs have lower digital skills, as the digital gender divide term indicates. Thus, based on the results of the model we expect a lower share of female-owned firms using ICT than among male-owned enterprises. Women also run firms with lower average share of foreign ownership (6.6% of women-run firms have some foreign ownership relative 8.1% men-run firms) and technology transfer from a foreign company (8.8% of women-run firms received such transfer relative to 15.8% of men-run firms)**.**

Again, in comparison to male-managed firms, female managed-firms are less likely to have their own website and use emails to interact with clients and suppliers. They are also less likely to have an internationally–recognized quality certification and use technology licensed from foreign companies. These observations point to a possibly significant gender barriers to use ICT including

skills. This is of concern since ICT skills, and e-skills in particular, are increasingly becoming part of requirements for today's productive employment and entrepreneurship.

Figure 3. Gender Differences in use of ICT

% of firms managed by male (or female) manager



Source: World Bank Enterprise surveys.

The aggregate numbers on utilization of ICT can hide substantial differences cross-country differences. Country information reveals that in emerging Europe, in majority of countries fewer women-managed firms than men-managed firms established website and were using e-mails. Moreover, the gender gaps are asymmetric – positive gender gaps tend to be smaller than negative ones. These factors are likely to lower productivity (Masurel, 2004).

5. Conclusions

The model developed in this paper suggests that differences in education and skills, including ICT skills together with greater opportunity cost of women's time, may help account for gender differences in entrepreneurial outcomes. In particular, the gap in ICT skills may also help explain why, relative to men, women are less likely to operate high-productivity enterprises. The model also shows that women entrepreneurs are more likely to end up mostly in the informal subsistence or household sector. Data from the World Bank Enterprise Survey data for a group of European emerging market economies are overall consistent with these predictions.

The key gender differences that have been identified, (i) women's low digital and other entrepreneurial skills as well as operating in low productivity firms mostly in the informal sector, require attention from policy makers. In the following sections we make some policy recommendations.

First, skills, in particular ICT skills, have been identified as a key factor in productive entrepreneurships along the lines of the following statement:

'With an estimated 500 million people entering the global workforce over the next decade, coming to grips with the technological challenge is crucial. Without being "plugged in", millions of women and men risk being left behind. Since women represent a significant majority of those who do not have access, there is a clear gender dimension to the technological divide... In addition, there is a gender gap across and within most countries: almost everywhere women lag behind men either in access to training or in the application of technology'.

Skills and Entrepreneurship: Bridging the Technology and Gender Divide, ILO 2008

Second, policymakers should identify the factors that may account for high share of female entrepreneurship in the informal sector, since informality has traditionally been associated with lower productivity and lower value added activities. This is in part due to lower access to credit and business information and networks when operating in the informal sector. Since women's lower skills are a major contributor to informal, rather than formal, entrepreneurial activity, promoting female education and skills development would help move female entrepreneurship more towards the formal sector. At the same time, and as our model shows, skill training alone may not be sufficient – the higher opportunity cost that women face when leaving household activities also need to be addressed to put female entrepreneurship on more equal footing.

In terms of education policies for women in emerging Europe, policymakers should identify: (i) why women in general have lower digital skills and technical attainments in most countries and (ii) why women are persistently under-represented in science and technology fields in secondary and tertiary education and in technical and vocational schools. Often, the gender gap is a result of socio-cultural factors that could be mitigated through policy and the right type of incentives. Some of these factors are the same as the ones affecting women's access to good jobs in the labor market, in spite of increases in women's share of the labor force in developing countries (Luci et al., 2012). Addressing traditions, laws and social norms that discourage women should be the focus of policies that aim at facilitating women's access to productive entrepreneurship.

Since women's entrepreneurial activities tend to interact with their housework, female entrepreneurship may have unique characteristics; and what works for male entrepreneurship may not necessarily work for female entrepreneurship. As our model and Ahl (2006) suggest, the approaches that have been trying to incentivize women in the same way as men may be ineffective for supporting women's entrepreneurship.[9] In fact, policies and policy reforms aimed at promoting entrepreneurship can sometimes have unexpected adverse effects (Iyigun and Rodrik, 2005). Some authors have asked whether policies should be designed differently for women entrepreneurs. For example, Drine and Grach (2010) examined data from a survey of 50 men and 50 women entrepreneurs in three Tunisian regions and found that the support services that were in place did not promote women's entrepreneurial activity. These and related issues could be also subject of further research for emerging Europe and other emerging market regions.

[9] Specifically, same financial incentives for men and women to participate in the entrepreneurial training may not be adequate for women to undertake it, given the higher barriers to entry associated with housework.

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