Under the AEGIS of knowledge-intensive entrepreneurship: employment growth and gender of founders among European firms

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Abstract:

An increasing number of theoretical and empirical analyses address the role of innovation as one of the main sources of firm growth. More recently, studies have looked at the role of gender diversity as a possible determinant of innovation and entrepreneurial performance. However, the relationship between gender and employment growth—a dimension of entrepreneurial performance—still remains unexplored to a large degree. This paper contributes to the empirical literature on gender and entrepreneurial performance in several ways. First, it examines the role played by both innovation and gender ownership as determinants of employment growth rates of young, knowledge-intensive entrepreneurial (KIE) firms. Second, it investigates the indirect impact of contributing factors—such as the characteristics of the market, knowledge-based capital, and human capital—on employment growth. And third, it relies on a rich new cross-sectional data set on young, KIE firms across European Union (EU) countries. The data set contains information not only on the gender of the firm's founders but also on the market environment, business strategy, and innovative and economic performance of firms.

Keywords: innovation | entrepreneurship | employment growth | gender

Article:

Introduction

The relationship between gender and firm performance is a relatively new topic that has attracted considerable attention among policymakers. Most of the empirical studies look at the direct impact of gender on various measures of firm performance, such as productivity, size, and sales growth (Du Rietz and Henrekson 2000; Coad and Tamvada 2012; Bates et al. 2013; Coleman 2016), while another growing strand of research investigates the role of gender in the innovation process (Alsos et al. 2013; Teruel et al. 2015). The role of gender in a complete framework that relates firm performance to innovation has been neglected. It is however a potentially important factor as there is a common conception that women entrepreneurs are less innovative than male entrepreneurs, and this may be associated with an underperformance of

female-owned firms. This paper studies the impact of gender on employment growth controlling for the innovation activity of young and knowledge-intensive entrepreneurial firms.

Gender equality is a goal that has been accepted by many governments and international organizations. The commitment of the European Union (EU) to gender equality dates to 1957 when the principle of equal pay for equal work became part of the Treaty of Rome. Later on, the inclusion of gender mainstreaming[1] in 1999 required member states to consider the gender impact of all policies following agreed employment guidelines[2] of employability, adaptability, strengthening equal opportunities, and entrepreneurship.

Entrepreneurship, from agender perspective, is also atopic of policy importance across EU countries. More than adecade ago, and certainly well before the economic recession that plagued EU countries in the later 2000s, the Organization for Economic Cooperation and Development (OECD) noted (OECD 2004, p. 6):

> It is critically important to] improve the factual and analytical underpinnings of the role of women entrepreneurs in the [EU] economy … women entrepreneurs play an important role in the entrepreneurial economy, both in their ability to create jobs for themselves and to create jobs for others.

More recently, The World Bank echoed the sentiments of the OECD in this regard (Sattar 2012, p. 63):

> Entrepreneurship … is important from the perspective of job creation, private sector development, and wealth creation [in Central and Eastern Europe and Central Asia]. Women's participation in entrepreneurship can enhance the expansion of these economic goods and simultaneously lead to less inequality in the two largest subgroups in the population: men and women.

And, issues related not only to abetter understanding of gender entrepreneurship but also to attendant policies to enhance it, the OECD offered the following perspective (OECD 2014, p.21):

> Policy makers wishing to strengthen the economic impact of women entrepreneurs need abetter understanding of the factors contributing to the growth and success of female-owned firms … Policies that foster female entrepreneurship often come under the umbrella of programmes for small enterprises. However, they are likely to impact relatively strongly on women entrepreneurs, since most run small businesses. Amix of

[1] The strategy of mainstreaming is defined in the agreed conclusions of the Economic and Social Council, 1997/2, as "… the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality" (United Nations 1999, p.23).

[2] Employment guidelines are common priorities and targets for employment policies proposed by the Commission, agreed by national governments and adopted by the EU Council.

general policies for SMEs and instruments explicitly targeting women can be effective in prompting interest and entry into entrepreneurship.

One of the key actions part of the Europe 2020 flagship initiatives of the European Commission is promoting female entrepreneurship and self-employment, and the majority of member states have established some specific programs or gender targets to support the development and expansion of female entrepreneurship. In addition, entrepreneurship itself has become increasingly recognized for playing an essential role in promoting innovation, creating jobs, and leveraging output through research on and commercialization of innovative products and services. Investments in knowledge-based capital (e.g., R&D) are an important building block of such efforts as are investments in human capital.[3] Both investments leverage the ability of small firms (SMEs) to compete more effectively in global technology-based markets.

In this paper, we rely on an explicit two-period model of the firm's productive process to explore the effect the gender of its founding owners and innovation on the employment growth of young, knowledge-intensive entrepreneurial (KIE) firms. We draw on a large sample of European firms to estimate, across countries and sectors, and by country and sector, the role of gender and innovation for employment growth. Also, adopting an instrumental variable approach, we control for a wide set of knowledge-based capital variables (e.g., importance of R&D and strategic alliances to firms' growth) and human capital variables (e.g., education and experience of firms' founders) that may influence the firms' innovation.

The remainder of the paper is organized as follows. In Section 2, we briefly review the background literature related to gender and firms' economic performance. In Section 3, we describe the data that we use for our analysis; we also offer descriptive information about employment growth, selectively by country, innovation status, gender of founders, and industrial sector of operation. In Section 4, we present our econometric models and findings. Finally, we offer concluding remarks in Section 5 along with a possible agenda for future research in this area.

Background literature on gender and firm growth

Findings in the academic literature related to gender and the economic performance of firms, entrepreneurial firms in particular, are mixed, but they lean in the direction that women-owned firms are disadvantaged in that dimension.[4] There is substantial evidence of no differences between the performance of women-owned and men-owned businesses in the USA (Kalleberg and Leicht 1991; Robb and Watson 2012; Conroy and Weiler 2016) as well as internationally (Chell and Baines 1998; Johnsen and McMahon 2005; Zolin et al. 2013). Coleman (2005) uses data from the Survey of Small Business Finances to find that, despite the smaller size of female-owned firms and controlling for human capital differences, female-owned firms are more profitable and have higher sales growth than male-owned firms. The study by Dautzenberg

[3] "Knowledge-based capital comprises a variety of assets. These assets create future benefits for firms but, unlike machines, equipment, vehicles and structures, they are not physical. This non-tangible form of capital is, increasingly, the largest form of business investment and a key contributor to growth in advanced economies" (OECD 2013, p.12).

[4] See Link and Strong (2016) for a more in-depth review of this body of literature.

(2012) on technology-based firms in Germany concludes that the overall commercial success (e.g., return on investment) of women- and male-owned firms was statistically the same. Other scholars find no gender difference with the inclusion of appropriate control variables, such as for industry (Watson 2003; Du Rietz and Henrekson 2000) and relevant demographic characteristics (Robb and Watson 2012).

However, still other researchers find that women-owned firms underperform relative to male-owned firms, even when controlling for influential determinants, such as start-up capital (Robb 2010). Fairlie and Robb (2009) use US Census data to find that women-owned business performance lags behind male-owned firms due to less similar work experience, less family exposure to similar work, and lower access to financial capital. Further, the authors suggest that women's motivations for entrepreneurship may be different than men's and may impact some business outcomes (Fairlie and Robb 2009). Coleman (2016) finds that performance of male- and female-owned firms may respond differently to human and financial capital; human capital positively impacts the profitability of female-owned firms, while for men, financial capital has a larger impact. Relatedly, Sauer and Wilson (2016) show that women-owned UK firms face higher liquidity constraints than do male-owned firms.

To the extent that sales growth is positively correlated with employment growth, Bates et al. (2013) show that women-owned firms grow relatively slower, but holding constant gender ownership, there were no differences by minority status of the firm. These findings exist for high-technology, financial-capital-intensive, and human-capital-intensive firms. Du Rietz and Henrekson (2000) also examine sales growth and find that growth rates among non-technology-based small women-owned firms in Sweden were lower than comparable male-owned firms.

An examination of the limited literature specifically linking gender ownership and commercialization, one relevant performance measure in this paper, shows that women are less likely to commercialize innovations than men. Using bibliometric and interview data from the USA, Ding et al. (2006) identify a gender gap in commercialization to which they link female scientists' low exposure to commercial sector and the perception that commercialization activities detract from academic pursuits.

Also relevant is the analysis of Link and Ruhm (2009) who examine the probability that National Institutes of Health (NIH) SBIR-funded research project's technology would be commercialized. They found that small women-owned firms were less successful in commercializing their technology.

Data and descriptive statistics

The AEGIS project was funded by the European Commission under Theme 8 "Socio-Economic Sciences and Humanities" of the 7th Framework Programme for Research and Technological Development. The focus of the project was on KIE firms under the assumption that KIE is one potential means through which to obtain economic growth and societal well-being.

We are using the acronym KIE to characterize the nature of firms (e.g., knowledge-intensive entrepreneurial firms) as well as to describe, as AEGIS (2012, p.4) does, abroader spectrum of behavior (e.g., knowledge-intensive entrepreneurship):

> "Knowledge-intensive entrepreneurship is [the] core interface between two interdependent systems: the knowledge generation and diffusion system, on the one hand, and the productive system, on the other. Both systems shape and are shaped by the broader social context—including customs, culture and institutions—thus also pointing at the linkage of entrepreneurship to that context."

Malerba (2010, p.4) defines, arguably more precisely for research purposes, knowledge-intensive entrepreneurship in the following manner:

> Knowledge-intensive entrepreneurship concerns new ventures that introduce innovations in the economic systems and that intensively use knowledge. From this broad definition, it follows that knowledge-intensive entrepreneurship may take place in various ways: through the foundation of new firms or through the display of entrepreneurial spirit with existing firms or through the action of single individuals within non-profit organizations such as universities or public laboratories.

The AEGIS database, arguably the most complete compilation of economic and managerial activities about firms in the EU, is used for our analyses. It contains information on 4,004 KIE firms established between 2001 and 2007 across 10 EU countries and across high-tech, low-tech, and knowledge-intensive business services (KIBS) sectors.

We describe the AEGIS data in the following tables in terms of the theme of this paper.

Table 1 shows the average annual employment growth (%) from 2009–2010, by country and by gender of the founder. Clearly, employment growth during this year varied across country, with Sweden having the highest average annual growth rate and Croatia having the lowest. Also, employment growth not only varied by country, it also varied by the gender of the firm's founder, defined here and in the tables that follow as the gender of the first-listed founder in cases where there is more than one founder.[5] Overall, except for Germany, employment growth was greater among male-founded firms.

Table 2 also segments employment growth by country, by gender of the founder, and by whether firms had previously (2007–2009) commercialized an innovation (0/1). We characterize firms that have previously commercialized an innovation as innovative firms, and the other non-commercializing firms as non-innovative firms. With only a few exceptions, annual employment growth among innovative firms is on average greater than in those that are not so classified. And, that generalization holds on average for male-founded firms compared to female-founded firms.

[5] An alternative specification of the founders' gender could be defined in terms of strict majority in the gender of the founders. Our results are robust to this alternative specification of gender and available upon request.

Table 1. Average annual employment growth (%) from 2009–2010 by country and gender of the founder (n = 3,947)

Country	Overall	By gender of the founder	
		Male (n = 3,338)	Female (n = 609)
Croatia (n = 192)	− 1.0	0.5	− 6.9
Czech Republic (n = 190)	2.2	2.9	− 2.9
Denmark (n = 330)	9.8	10.5	5.5
France (n = 568)	8.0	8.9	3.5
Germany (n = 541)	10.7	10.3	14.0
Greece (n = 323)	1.1	1.4	− 2.2
Italy (n = 572)	5.7	5.8	5.1
Portugal (n = 330)	3.6	4.1	1.7
Sweden (n = 333)	15.0	15.2	14.2
UK (n = 568)	5.7	6.3	1.8

Source: compiled by the authors from the AEGIS database
n number of KIE firms

Table 2. Average annual employment growth (%) from 2009–2010 by country, gender of the founder, and innovativeness

Country	Non-innovative		Innovative	
	Male (n = 1,202)	Female (n = 235)	Male (n = 2,136)	Female (n = 374)
Croatia	−2.8	−11.8	1.9	−4.2
Czech Republic	−0.9	−7.0	4.4	0.9
Denmark	5.9	0.3	13.5	9.3
France	5.6	2.3	11.7	4.4
Germany	6.3	4.9	13.0	19.8
Greece	0.8	−0.6	1.6	−3.1
Italy	2.1	−6.5	7.0	10.1
Portugal	3.1	−2.3	4.6	4.6
Sweden	15.7	20.6	14.9	11.8
UK	2.9	3.2	8.5	0.5

Source: compiled by the authors from the AEGIS database
n number of KIE firms

In Table 3, we introduce the sectoral divisions in the data, and we report average annual employment growth by sector and again by gender. In general, across the three sectors, employment growth in male-founded firms is greater than in female-founded firms. There are of course exceptions: the KIBS sector in Germany, the high-tech and KIBS sectors in Italy, and the low-tech sector in Sweden and Greece.

The descriptive statistics in these three tables anticipate our econometric findings. As well, they underscore the importance of, in addition to gender, both country considerations and sector considerations in the analyses that follows.

Table 3. Average annual employment growth (%) from 2009–2010 by by country, gender of the founder, and industrial sector

Country	KIBS (*n* = 1,948)		High-tech (*n* = 417)		Low-tech (*n* = 1,582)	
	Male	Female	Male	Female	Male	Female
Croatia	7.2	2.0	− 4.6	12.5	− 1.0	− 11.0
Czech Republic	4.2	−5.0	3.9	0.0	1.5	0.0
Denmark	10.1	8.1	21.3	−16.0	5.3	0.8
France	12.8	8.2	3.7	−0.4	4.1	−0.5
Germany	11.1	22.5	6.8	0.0	10.3	6.3
Greece	2.3	−5.9	8.7	0.0	−0.1	0.4
Italy	8.2	10.4	3.5	48.0	4.7	−2.4
Portugal	5.4	3.3	3.1	0.0	3.3	1.1
Sweden	18.0	15.9	21.3	0.0	7.8	13.0
UK	6.0	2.8	12.3	11.0	5.2	−1.1

Source: compiled by the authors from the AEGIS database. High-tech sector includes aerospace; computers and office machinery; radio-television communication equipment; manufacturer of medical, precision, and optional instruments; pharmaceuticals; manufacturer of electrical machinery and apparatus; manufacturer of machinery and equipment; and chemical industry. Low-tech sector includes paper and printing; textile and clothing; food, beverage and tobacco; wood and furniture; basic metals; and fabricated metal products. Knowledge-intensive business services (KIBS) sector includes telecommunications; computer and related activities; research and experimental development; and selected business services activities

n number of KIE firms

Structural econometric model

To investigate the role of innovativeness and gender in the growth of employment, we consider a firm's production process in two periods, t_1 and t_2, introducing one or more new products (or services) in between these two periods. Suppose the firm i introduces new products in t_1, the production of new products is denoted by Y^*_{it1}, while the production of old products is Y_{it1}. Production in period t_2 is simply Y_{it2}. Following Harrison et al. (2014), we assume that the production technology of innovative and non-innovative products in both periods follows a homogenous Cobb-Douglas function with two factors, labour L, and capital K:

$$Y_i = \omega_i F(L_i, K_i)$$
$$Y_i^* = \omega_i^* F(L_i, K_i),$$

where ω is the Hicks-neutral productivity. Minimization of the total cost of production implies that the technical rate of substitution between labour and capital, F_L/F_K, coincides with the ratio of the cost of the factors, namely the unit cost of labour, w, and the unit cost of capital, r. Hence, from the technical rate of substitution $F_L/F_K = w/r$, and from the production technologies described above, we can deduce the conditional labour demands. After several calculations, we have that the labour demands corresponding to the production of non-innovative and innovative products can be written as follows:

$$L_i = c_w(w_i)\frac{Y_i}{\omega_i}$$

$$L_i^* = c_w(w_i)\frac{Y_i^*}{\omega_i^*},$$

where $c_w(\cdot)$ is the derivative of the total cost function with respect to the wage, which we assume does not vary with the type of product produced.

Our estimating strategy rests on the decomposition of the employment growth between the two periods t_1 and t_2. In particular, we break down employment growth at time t_1 into the employment growth due to the non-innovative and innovative products:

$$\Delta L_{i,t2} = \frac{L_{i,t2} - L_{i,t1}}{L_{i,t1}} = \frac{L_{i,t2} - \left(L_{i,t1} + L^*_{i,t1}\right)}{L_{i,t1} + L^*_{i,t1}} \simeq \Delta L_{i,t2} + \frac{L^*_{i,t1}}{L_{i,t1} + L^*_{i,t1}} \simeq \log\frac{L_{i,t2}}{L_{i,t1}} + \frac{L^*_{i,t1}}{L_{i,t1} + L^*_{i,t1}}$$

Substituting the labour demands for non-innovative and innovative products, we obtain the following equation for the employment growth rate in t_2:

$$\Delta L_{i,t2} = \left(\log\omega_{i,t1} - \log\omega_{i,t2}\right) + \Delta Y_{i,t2} + \omega^*_{i,t1}\frac{Y^*_{i,t1}}{\frac{\omega^*_{i,t1}}{\omega_{i,t1}}Y_{i,t1} + Y^*_{i,t1}}$$

To derive an estimating equation from the labour growth decomposition above, we assume that changes in productivity ($\log\omega_{i,t1} - \log\omega_{i,t2}$) are in part explained by the gender of the firm founder (Coleman 2005; Amin 2011; Dautzenberg 2012), and by firm size (VanBiesebroeck 2005; Carter et al. 2015; Coleman 2016). Additionally, the expression $\frac{Y^*_{i,t1}}{\omega^*_{i,t1}/\omega_{i,t1}Y_{i,t1}+Y^*_{i,t1}}$ is approximated by the share of new or significantly improved goods or services to total sales in period t_1 (*inno*). Also, to avoid expressing our dependent variable as the difference between employment and output growth rates ($\Delta L_{i,t2} - \Delta Y_{i,t2}$, as in Harrison et al. 2014), we assume $\Delta Y_{i,t2} = \delta\Delta Y_{i,t1} + u_{i,t2}$, where $\Delta Y_{i,t1}$ is proxied by the share of output growth due to non-innovative products, and $u_{i,t2}$ is a normally distributed error term.

Our estimating equation can thus be written as follows:

$$\Delta L_{i,t2} = \alpha_0 + \alpha_1 wmn_{i,t1} + \alpha_2 size_{i,t1} + \delta\Delta Y_{i,t1} + \omega^* inno_{i,t1} + X'_{i,t1}\beta + \varepsilon_{i,t2} \qquad (1)$$

where t_1 = 2007–2009 and t_2 = 2009–2010. Therefore, $inno_{i,t1}$ is the firm share of turnover from new products/services over the period 2007–2009 (the base time period for the data), and the parameter ω^* captures the technical efficiency from producing new products; $wmn_{i,t1}$ is a binary variable equal to 1 for female-founded firms, and 0 otherwise; *size* is the log number of employees, $\Delta Y_{i,t1}$ is the sales growth rate in 2007–2009 from non-innovative products, computed as the total sales growth times the share from non-innovative goods or services $\left(Y_{i,t1} + Y^*_{i,t1}\right)\left(1 - inno_{i,t1}\right)$. It is well known that innovation affects firm performance, employment growth in particular, so to isolate the effect of gender, this behavior must be held constant (Link 1987; Link and Siegel 2003). In addition to these focal variables, X_i is included to hold

constant a number of country and industrial sector fixed effects, and $\varepsilon_{i,t2} = u_{i,t2} + \epsilon_{i,t2}$ is a composite normally distributed error term.

The identification of the regression coefficients in (1) relies on the lack of correlation between the regressors and the error term. While the gender composition of the founding team and the size at time t_1 are not likely to change as a consequence of a future shock ($\varepsilon_{i,t2}$) to employment growth, the error term may include unobservable industry- and firm-level characteristics (residual productivity not explained by difference in gender and size, managerial skills, market competition, etc.) that are potentially associated to the past commercialization of innovative and non-innovative products. To account for the endogeneity, we adopt an instrumental variable approach (two-stage least squares, 2SLS). We use three sets of instrumental variables relative to the firm's market environment (such as competition, business cycle, etc.), entrepreneurial characteristics (past job experience, personal abilities, etc.), and the firm's knowledge capital.

The variables used in the estimation of Eq. 1 are defined in Table 4. For example, our dependent variable is defined as the change in employment over the period 2009–2010 reported by the firm; $inno_{i,t1}$ is the share of new or significantly improved products or services to total sales in the antecedent period 2007–2009; $wmn_{i,t1}$ is a dummy taking on the value 1 if the first-listed founder is a woman (there are up to four founders for each firm). Summary statistics of our key and control variables are reported in Table 5. Employment and non-innovative sales growth rates are the most dispersed variables, together with the previous job experiences (university/government, unemployed, first job). The size of firms is skewed to the right; in fact, the average firm size is 5.4 (exp(1.69)) employees, while the smallest and largest firms have 2 and 1408 employees, respectively.

In the next section, we report and discuss the results of both (1) and the first-stage regression on innovative sales.

Empirical findings

Tables 6 and 8 report the 2SLS results from the regression model (1), using a set of market environment, entrepreneurial, and knowledge capital instrumental variables. Table 6 presents the results for the complete sample of firms (first column) and by technological sector group (high-tech, low-tech manufacturing, and KIBS). The bottom part of the table reports the number of observation, the root mean squared error, the *p* value associated with the Sargan test of overidentification of the endogenous variables and the *F*-statistic for the overall significance of the regressors. The effect of the gender of the first founder on employment growth seems to be statistically neutral for the overall sample and for the KIBS sectors, while it has a significant positive and negative effect for the high- and low-tech manufacturing sectors, respectively. In high-tech (low-tech) manufacturing sectors, firms with a female first-listed founder have a 13.8% faster (5.7% slower) employment growth rate than male first-listed founded firms. Past firm size is positively associated with future employment growth for the whole sample, for low-tech manufacturing and KIBS sectors.

Table 4. Definition of the variables

Variable	Definition
ΔL_{t2}	Change in employment over 2009–2010
inno	The share of new or significantly improved products or services in the period 2007–2009 to total sales
*wmn**	Equals 1 if the first-listed founder is a female; 0 if a male
Control Variables (*X*)	
size	Logarithm of the number of full time employees
ΔY_{t1}	Change in sales over 2007–2009 multiplied by the share of non-innovative products (1- *Inno*)
Market environment controls	
*demand***	Equals 1 if customers regularly ask for new products and/or services; otherwise 0
*competition***	Equals 1 if the activities of major competitors are unpredictable and competition is very intense; otherwise 0
*price competition***	Equals 1 if price competition is prevalent in the industry; otherwise 0
*quality competition***	Equals 1 if quality competition is prevalent in the industry; 0 otherwise
*business cycle***	Equals 1 if the life of projects in the industry is typically short and the speed of technological change is high; 0 otherwise
sector export intensity	Average of the percent of sales from 2007–2009 to international markets in the sector
sector R&D intensity	Average of the percent of sales allocated to R&D in the sector
Entrepreneurial controls	
*abilities****	Normalized index from 0 to 1 to reflect the extent to which the firm agrees or disagrees (continuous from 1 to 0) with statements regarding the sensing and seizing of opportunities
*risk aversion*****	Equals 1 if technology risk/uncertainty and market risk/uncertainty are obstacles to firm growth; otherwise 0
*funding capability*****	Equals 1 if finding the necessary funding for growth investments is an obstacle to firm growth; otherwise 0
*network capability*****	Equals 1 if finding business partners is an obstacle to firm growth; otherwise 0
owner experience	Equals 1 if the first-listed founder's previous occupation was as the owner of a firm; otherwise 0
employee experience	Equals 1 if the first-listed founder's previous occupation was as another firm's employee; otherwise 0
self-employed	Equals 1 if the first-listed founder's previous occupation was as a self-employed individual; otherwise 0
uni/gov experience	Equals 1 if the first-listed founder's previous occupation was as a university or government employee; otherwise 0
unemployed	Equals 1 if the first-listed founder was previously unemployed; otherwise 0
first job	Equals 1 if this firm represents the first-listed founder's first job; otherwise 0
Knowledge capital controls	
education	Highest level of education of the firs-listed founder
R&D intensity	Percent of firm sales allocated to R&D
*marketing******	Equals 1 if marketing and promotion activities are important for creating and sustaining a competitive advantage; otherwise 0
*cooperation******	Equals 1 if establishing alliances/partnerships are important for creating and sustaining a competitive advantage; otherwise 0
*networks with science******	Equals 1 if networking with scientific research organizations are important for creating and sustaining a competitive advantage; otherwise 0
patents	Equals 1 if the firm used from 2007–2009 patents to protect its intellectual property; otherwise 0
Other fixed effects (fe)	

Variable	Definition
country	Binary country controls
industrial sector	Binary sector controls

Source: constructed by the authors based on AEGIS survey

* The AEGIS data provides information on each of up to four founders of a firm. However, the overall mean number of founders is 1.4 (when a respondent reported 0 founders, that value was changed to 1 founder). Thus, we assumed that the first-listed founder is the primary founder

** The variable is based on the firm's response to the AEGIS survey statement: "In the principal industry in which our firm operates ..."

*** The normalized score is based on the firm's Likert response of 1 to 5 to the AEGIS survey statement: "Please indicate the extent to which you agree or disagree with the following statements regarding the sensing and seizing of opportunities within your firm:

[1] Our firm actively observes and adopts the best practices in our sector

[2] Our firm responds rapidly to competitive moves

[3] We change our practices based on customer feedback

[4] Our firm regularly considers the consequences of changing market demand in terms of new products and services

[5] Our firm is quick to recognize shifts in our market (e.g., competition, regulation, demography)

[6] We quickly understand new opportunities to better serve our customers

[7] There is a formal R&D department in our firm

[8] There is a formal engineering and technical studies department in our firm

[9] Design activity is important in introducing new products/services to the market

[10] We implement systematic internal and external personnel training

[11] Employees share practical experiences on a frequent basis

**** Firms were asked to respond to statements using a Likert scale of 1 = not at all to 5 = to a great extent; a response of 4 or 5 is coded a 1 and a response less than 4 is coded as 0

***** Firms were asked to respond to statements using a Likert scale of 1 = no impact to 5 = to a huge impact; a response of 4 or 5 is coded a 1 and a response less than 4 is coded as 0

Table 5. Summary statistics of the variables

Variable	Mean	SD	Min	Max
ΔL_{t2}	6.8	36	−300	800
inno	16.3	18.4	0	99
wmn	0.15	0.36	0	1
ΔY_{t1}	18.1	60.4	−170	1010
size	1.69	1.17	−0.69	7.25
demand	0.39	0.49	0	1
competition	0.45	0.5	0	1
price competition	0.52	0.5	0	1
quality competition	0.61	0.49	0	1
business cycle	0.74	0.44	0	1
sector export intensity	14	6.4	7.1	80
sector R&D intensity	12	5.4	7.3	41
abilities	0.56	0.12	0.17	0.88
risk aversion	0.47	0.5	0	1
funding capability	0.59	0.49	0	1
network capability	0.77	0.42	0	1
owner experience	0.16	0.37	0	1
employee experience	0.62	0.49	0	1
self-employed	0.1	0.3	0	1
uni/gov experience	0.07	0.25	0	1
unemployed	0.03	0.17	0	1
first job	0.02	0.13	0	1

Variable	Mean	SD	Min	Max
education	3.1	1.1	1	5
R&D intensity	12	19	0	100
marketing	0.45	0.5	0	1
cooperation	0.37	0.48	0	1
network with science	0.19	0.39	0	1
patents	0.10	0.31	0	1

Source: compiled by the authors from the AEGIS database

Table 6. The effects of gender and innovation on employment growth (by technological sector)

Variable	All firms	High-tech	Low-tech	KIBS
wmn	−1.892	13.820**	−5.663***	0.603
	(1.912)	(6.693)	(1.948)	(3.301)
size	2.619***	2.881	2.302***	2.540**
	(0.647)	(1.903)	(0.767)	(1.098)
inno	0.365***	0.354***	0.302***	0.360***
	(0.090)	(0.151)	(0.099)	(0.073)
ΔY	0.270***	0.036	0.153***	0.394***
	(0.070)	(0.167)	(0.056)	(0.091)
constant	−7.472	−15.638	−10.744*	−7.509
	(6.221)	(12.306)	(5.974)	(14.294)
N	3,540	394	1,394	1,752
RMSE	39.13	31.34	28.24	46.38
Sargan test	0.0186	0.189	0.170	0.0875
F-stat	0.000	0.001	0.000	0.000

Standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

The estimated parameter for the *inno* variable is positive and significant for the entire sample of firms. Everything else equal, a 10% increase in the share of sales of innovative products during the period 2007–2009 corresponds to 3.7% increase in employment growth in 2009–2010. Firms in high-tech manufacturing and KIBS sectors have a higher return to innovations than low-tech; however, the differences are not statistically significant. The impact of non-innovative sales growth varies by sector. Past growth of sales of non-innovative products is related to employment growth only for firms in low-tech manufacturing and KIBS sectors in particular.

Finally, in this regression framework, the value of the constant is an estimate of the residual efficiency changes that are not taken into account by the gender of the first-listed founder or by firm size. The negative sign implies that there is a positive average productivity growth ($ln\omega_{t1} - ln\omega_{t2} = -\Delta\omega_{t2}$) from non-innovative product in the period t_2 = 2009 −−2010 and that this is significantly associated with employment growth only for low-tech firms.

In Table 7, we report the regression results of the same model, including an interaction term between gender and size. The coefficient for the interaction term is positive and statistically significant only for firms in high-tech manufacturing sector, where an increase in firm size is related to a faster employment growth rate of female-founded firms. The marginal effects of gender maintain the same significant signs for high-tech (positive) and low-tech (negative) manufacturing sectors.

Table 7. The effects of gender and innovation on employment growth (by technological sector)—size/gender interaction

Variable	All firms	High-tech	Low-tech	KIBS
wmn	−1.971	−12.797	−6.969*	3.849
	(2.932)	(10.631)	(3.592)	(4.552)
size	2.613***	1.528	2.170***	2.827**
	(0.675)	(1.883)	(0.825)	(1.117)
wmn ∗ *size*	0.061	15.070***	0.791	−3.384
	(1.676)	(5.069)	(1.799)	(3.369)
inno	0.366***	0.327**	0.302***	0.359**
	(0.091)	(0.150)	(0.099)	(0.139)
ΔY	0.269***	0.039	0.151***	0.398***
	(0.069)	(0.164)	(0.055)	(0.092)
constant	−7.563	−11.812	−10.460*	−7.868
	(6.224)	(12.169)	(5.993)	(14.305)
wmn_{ME}	−1.872	16.516**	−5.506***	−0.715
	(1.969)	(6.736)	(1.968)	(3.591)
N	3,540	394	1,394	1,752
RMSE	39.13	30.90	28.18	46.42
Sargan test (*p*)	0.000	0.305	0.002	0.012
F-stat	0.000	0.001	0.000	0.000

Standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 8. The effects of gender and innovation on employment growth (by country group)

Variable	East	South	North	West
wmn	− 2.035	− 2.267	− 1.434	-2.772
	(3.119)	(3.628)	(6.705)	(2.460)
size	3.861***	1.864	5.061*	2.560***
	(1.039)	(1.518)	(2.756)	(0.735)
inno	0.137	0.115	0.697**	0.391***
	(0.143)	(0.169)	(0.294)	(0.098)
ΔY	0.067	0.373***	0.078	0.215***
	(0.089)	(0.097)	(0.190)	(0.068)
constant	−7.354*	−5.068	0.115	-6.179**
	(3.991)	(5.768)	(5.996)	(3.048)
N	362	1,143	527	1,508
RMSE	20.21	45.18	54.06	31.38
Sargan test (*p*)	0.886	0.089	0.224	0.000
F-stat	0.002	0.000	0.002	0.000

Standard errors in parentheses. East countries are Czech Republic and Croatia. South countries are Greece, Portugal, and Italy. North European countries are Sweden and Denmark. Western countries are Germany, France, and UK
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 8 presents the results by groups of countries. The gender of the first-listed founder does not affect the employment growth for any group of firms, while size is positively associated with the growth of employment except for the group of firms in Southern European countries. A positive and significant effect of innovative sales is found only for Western and (especially)

North European countries. Past sales growth of non-innovative products/services has a positive effect on employment growth in South and Western countries. Lastly, productivity growth in 2009–2010 is statistically positively related to employment growth in Eastern and Western European countries (7.4 and 6.2% employment growth increase for a 1% change in productivity growth, respectively).

Table 9 shows the results from a specification with the interaction term between gender and size, by group of countries. There is no evidence of an interaction effect between the gender of the first founder and firm size.

Table 9. The effects of innovation and gender on employment growth (by country group)—size/gender interaction

Variable	East	South	North	West
wmn	− 6.020	2.794	− 4.199	− 2.085
	(5.802)	(7.329)	(9.200)	(3.482)
size	3.515***	2.254	4.890	2.628***
	(1.121)	(1.567)	(3.059)	(0.772)
wmn ∗ *size*	2.345	−2.739	3.850	−0.641
	(2.888)	(3.584)	(9.265)	(2.253)
inno	0.138	0.118	0.720**	0.390***
	(0.142)	(0.169)	(0.294)	(0.098)
ΔY	0.058	0.378***	0.056	0.216***
	(0.089)	(0.098)	(0.193)	(0.068)
constant	−6.534	−6.143	0.597	−6.289**
	(4.069)	(5.938)	(5.993)	(3.072)
wmn_{ME}	−1.195	−2.854	0.048	−3.003
	(3.284)	(3.763)	(7.835)	(2.577)
N	362	1,143	527	1,508
RMSE	20.27	45.23	54.49	31.405
Sargan test (*p*)	0.924	0.085	0.179	0.000
F-stat	0.003	0.000	0.001	0.000

Standard errors in parentheses. East countries are Czech Republic and Croatia. South countries are Greece, Portugal, and Italy. North European countries are Sweden and Denmark. Western countries are Germany, France, and UK
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

In summary, our results show that the gender gap is mainly a sectoral issue rather than a country-specific one. As Fig. 1 shows, women not only founded fewer businesses (from 8.3% in Greece to a maximum of 23.3% in Portugal), they also generally tend to concentrate in less profitable sectors such as the low-tech manufacturing.

Finally, Tables 10 and 11 report the results from the first-stage regressions on the determinants of innovative turnover.[6]

[6] The first stage comprises of two regression equations, one for each endogenous variable: the innovative share of turnover and the sales growth from non-innovative products. We report only the first-stage results of the innovative turnover regressions.

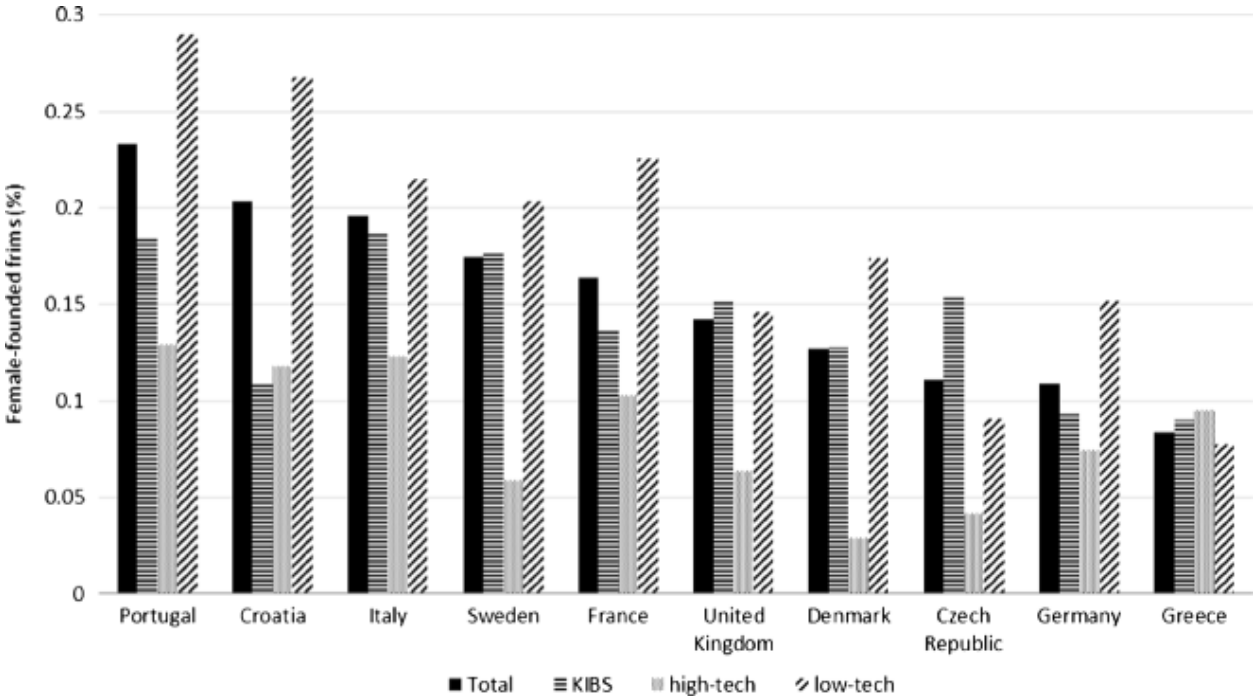

Fig. 1. Women-founded firms as % by sector and country

Table 10. First-stage regression results: determinants of innovation (by technological sector)

Variable	All firms	High-tech	Low-tech	KIBS
wmn	−1.093	−4.533	−0.656	−0.887
	(−1.35)	(−1.50)	(−0.56)	(−0.73)
size	0.504*	−1.279	0.119	0.824**
	(1.80)	(−1.40)	(0.24)	(2.17)
demand	2.083***	4.371**	1.317	1.653*
	(3.36)	(2.40)	(1.34)	(1.84)
competition	−0.290	0.672	0.757	−1.671*
	(−0.47)	(0.34)	(0.75)	(−1.89)
price competition	−3.448***	−7.129**	−4.949***	−1.928**
	(−5.46)	(−2.63)	(−4.74)	(−2.14)
quality competition	0.031	2.343	−0.158	−0.487
	(0.05)	(1.30)	(−0.16)	(−0.54)
business cycle	1.620**	0.245	3.811***	0.563
	(2.29)	(0.12)	(3.27)	(0.57)
sector export int	−0.154**	−0.299	−0.079	−0.561***
	(−2.36)	(−1.24)	(−0.94)	(−4.03)
sector R&D int	0.142**	−0.006	0.803***	0.339***
	(1.97)	(−0.03)	(3.04)	(3.02)
abilities	31.468***	49.518***	28.665***	31.430***
	(10.37)	(5.26)	(5.96)	(7.25)
risk aversion	1.465*	2.684	2.541***	0.702
	(2.31)	(1.47)	(2.64)	(0.81)
funding capability	−1.452**	−3.663	−0.641	−1.704*
	(−2.34)	(−1.43)	(−0.66)	(−1.88)
network capability	−0.138	−0.293	0.506	−0.745

Variable	All firms	High-tech	Low-tech	KIBS
	(−0.20)	(−0.13)	(0.46)	(−0.71)
owner exp	1.799**	2.520	2.829**	−0.364
	(2.14)	(0.98)	(2.26)	(−0.29)
self-employed	0.605	4.027	2.625*	−0.803
	(0.63)	(1.28)	(1.74)	(−0.59)
uni/gov exp	1.606	5.931	−0.254	3.007*
	(1.39)	(1.52)	(−0.14)	(1.87)
first job	3.165*	13.293**	3.635	0.005
	(1.82)	(2.26)	(1.27)	(0.00)
education	0.392	2.783***	−0.510	0.534
	(1.39)	(3.53)	(−1.16)	(1.27)
R&D int	0.185***	0.150***	0.257***	0.133***
	(11.27)	(3.24)	(8.92)	(5.87)
marketing	0.973	−0.912	1.422	1.211
	(1.55)	(−0.33)	(1.41)	(1.36)
coop	0.369	−2.363	−1.191	1.635*
	(0.58)	(−0.86)	(−1.12)	(1.89)
network with science	−0.275	0.045	−1.648	1.888*
	(−0.34)	(0.02)	(−1.22)	(1.66)
patents	8.865***	6.145***	5.871***	13.220***
	(8.90)	(2.752)	(3.55)	(8.70)
constant	−8.759**	−11.546	−15.950***	−4.75 2
	(−2.41)	(−1.09)	(−2.88)	(−0.76)
N	3540	394	1394	1752
Adj. R2	0.21	0.30	0.20	0.22
RMSE	16.89	16.20	16.82	16.83

t statistics in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 11. First-stage regression results: determinants of innovation (by country group)

Variable	East	South	North	West
wmn	3.384	−3.113**	3.450	−0.593
	(1.42)	(−2.31)	(1.58)	(−0.46)
size	−0.243	0.660	1.118	0.131
	(−0.29)	(1.21)	(1.45)	(0.33)
demand	2.202	1.914*	6.075***	1.147
	(1.24)	(1.76)	(3.46)	(1.22)
competition	−2.308	1.674	−3.563*	−1.220
	(−1.28)	(1.51)	(−1.96)	(−1.31)
price competition	0.408	−5.977***	−0.501	−2.708***
	(0.23)	(−5.28)	(−0.3)	(−2.92)
quality competition	0.459	2.149*	0.920	−1.049
	(0.27)	(1.87)	(0.58)	(−1.14)
business cycle	5.253**	1.852	0.174	1.712*
	(2.38)	(1.3)	(0.09)	(1.69)
sector export int	0.077	0.042	−0.367*	−0.417***
	(0.43)	(0.43)	(−1.93)	(−3.66)
sector R&D int	0.456**	−0.236*	0.130	0.397***

Variable	East	South	North	West
	(2.05)	(−1.65)	(0.71)	(3.61)
abilities	38.301***	33.924***	20.343***	33.273***
	(3.84)	(6.77)	(2.34)	(7.45)
risk aversion	−1.713	2.360***	4.688***	0.764
	(−0.98)	(2.2)	(2.75)	(0.85)
funding capability	−2.686	−3.164***	0.023	−0.950
	(−1.49)	(−2.91)	(0.01)	(−1.03)
network capability	0.626	3.090***	−0.524	−2.170**
	(0.35)	(2.59)	(−0.25)	(−1.98)
owner exp	−4.110*	2.976**	1.059	−0.755
	(−1.67)	(2.37)	(0.41)	(−0.52
self-employed	0.479	−1.886	7.932***	1.507
	(0.19)	(−1.2)	(2.67)	(1.02)
uni/gov exp	−4.179	−0.086	3.999	3.193*
	(−1.38)	(−0.04)	(1.08)	(1.84)
first job	−5.611	−1.603	6.875	4.891*
	(−1.24)	(−0.53)	(1.12)	(1.91)
education	1.529	0.335	1.348	0.263
	(1.5)	(0.69)	(1.61)	(0.62)
R&D int	0.181***	0.217***	0.166***	0.151***
	(3.35)	(7.81)	(3.67)	(5.86)
marketing	−1.774	2.613**	3.188*	−0.161
	(−1)	(2.39)	(1.86)	(−0.17)
coop	1.536	−0.783	3.352**	0.433
	(0.82)	(−0.71)	(2.07)	(0.44)
network with science	−4.564**	−1.675	1.140	0.685
	(−2.18)	(−1.32)	(0.53)	(0.5)
patents	6.404**	4.669***	6.701**	11.674***
	(2.13)	(2.77)	(2.3)	(7.61)
constant	−25.177***	−8.169*	0.111	−0.410
	(−3)	(−1.83)	(0.02)	(−0.11)
N	362	1143	527	1508
Adj. R2	0.17	0.20	0.23	0.263
RMSE	15.21	17.00	16.97	16.58

t statistics in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

From the first column of Table 10, we see that facing higher demand and shorter business cycles, having better entrepreneurial abilities at seizing business opportunities, tendency to risk aversion, R&D intensity, and the adoption of patents as intellectual property mechanism is significantly and positively associated with the share of sales from new products. On the other hand, the share of sales due to the commercialization of new products/services is negatively associated with price competition, sectoral export intensity, and the ability to obtain funding.

Country-wise, Table 11 shows that there is a negative association between gender and innovation for Southern European countries (3.1% smaller innovative sales than male-founded firms). Besides differences across country groups, R&D intensity, entrepreneurial abilities, and patenting activity are key determinants of innovation commercialization.

Conclusions

In this paper, we study the relationship between gender, innovation, and employment growth. Under a structural econometric framework, we are able to decompose the employment growth into the growth of productivity, the growth of past sales of non-innovative products, and the sales of innovative products. To take into account the potential endogeneity of the productivity growth, we replace the productivity growth with a proxy function of gender of the first-listed founder and firms size. Lastly, we adopt a 2SLS approach, where in the first stage, both non-innovative sales growth and innovative sales are regressed on a set of control variables that describe the market environment, the entrepreneurial skills, and the knowledge capital available to the firm.

In summary, the results from our analyses of the employment growth decomposition show that there is a positive link between past sales and current employment growth. In particular, this positive relationship is stronger for the past sales of innovative products, rather than for the sales of non-innovative products. The employment growth rate of knowledge-intensive firms is also stringily related to their size. In addition, dividing the sample by technological sectors and country groups, we find that the relationship between the gender of the first-listed founder and firm performance (both in terms of employment growth and innovative sales) is mixed. In high-tech manufacturing sectors, this relationship is positive, while in low-tech and in Southern European countries, results show a negative relation between the female gender of the founder and the performance of these firms. Overall, our results show that the gender gap in employment growth is mainly a sectoral issue rather than a country-specific one. To this extent, understanding the reasons why women-founded firms cluster in low-profitability sectors may help policymakers to delineate the target group of firms for a support program.

A limitation of the present study is that, due to the lack of appropriate information, it does not go as far as understanding the underlying mechanisms for the underperformance or overperfomance of women-led firms in low-tech and high-tech sectors. However, the literature has traditionally offered two sets of potential explanations. On the one hand, there are institutional and cultural barriers, regulatory environment, and social norms. Post and Byron (2015) point to institutional gender differences in human capital and the societal gender discrepancies in cognitive frames such as prior experience, ethical values, and corporate strategy. Also, Rosenthal and Strange (2012) theorize that female entrepreneurs may be less networked than their male counterparts and therefore less exposed to agglomeration. On the other hand, there are internal motivations such as risk aversion, and personal preferences of balancing private life with work. Fairlie and Robb (2009) find evidence that women entrepreneurs in the USA work fewer hours and have different goals for their businesses.

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