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Female firm leadership. Extent and performance in 14 EU member states

March 1, 2016

Evidence on female firm leadership is scarce and often confined to a small number of firms included in share price indices. Our large firm level data set from 2011 contains 441287 firms from 14 EU states. Based on management information, we provide evidence for the extent and the performance of female-led firms. We find strong differences in the extent of female firm leaders between the 14 states but for most countries no evidence for significant performance differences between male- and female-led firms, neither for the whole country samples nor within six broadly defined sectors. This result is confirmed when applying a matching approach to account for potential selection problems.

Keywords: female leadership, firm performance, self-selection, matching, gender

1 Introduction

In many European countries, the proportion of women in top management positions is very low. E.g. in Germany, the proportion of women in executive boards of the 200 largest (in terms of revenue, excluding the financial sector) firms was 5.4% in 2014. Moreover, only 2.2% of all chief executives are women and none of the top-100 German enterprises has a female chief executive (Holst & Kirsch, 2015).

Women are to a large extent underrepresented in higher managerial positions in EU member states and it is often referred to a glass ceiling keeping women out of leading positions regardless of their qualifications and experiences. The considerable gender pay gap - which is e.g. about 22-23% in Germany¹ - is assumed to be partly driven by this glass ceiling. Moreover, there is a gender pay gap also in leading positions (Holst, Busch, & Kröger, 2012).

In the EU, women were represented by about 19% in decision-making committees of the highest listed enterprises in April 2014, with an increasing share over the last years. Countries with the highest fraction of women were e.g. Iceland (46%), Norway (40%), Latvia (31%), France (30%), Finland (29%), Sweden (27%), and the Netherlands (25%). Very low fractions were reported by Cyprus (7%), Estonia (7%), Czech Republic (7%), and Malta (3%) (Holst & Kirsch, 2015).

Some European countries, e.g. Norway or France, already introduced a female quota (see table 10) for boards to improve gender equality in leading management positions as voluntary quotas for firms often do not lead to the desired increase of female representation in top management positions. In 2013, the European Parliament passed a law which states a legal female quota of 40% - with obligations to implement until 2020 - in executives boards of listed business enterprises, but the bill still needs approval of the EU council of ministers.

We provide evidence on the extent of female firm leadership in the EU and firm performance. Our empirical analysis is based on international balance sheet data. We consider 441287 firms from 14 EU member states for which all required information are available. The data set contains not only large incorporated companies but also a great number of smaller unincorporated companies allowing comprehensive information on the extent of female firm leadership for 14 countries disaggregated for six broadly defined sectors. Including information on the management, i.e. sex and academic degree, we also provide detailed evidence on the performance of male- and female-led firms based on the return on assets.

We observe substantially differences in the extent of female-led firms in the 14 countries, with a strong overrepresentation in Portugal and Romania, and a strong underrepresentation in the United Kingdom, Austria and Greece. Moreover, while we find the sectoral differences for female leadership, the sectoral structure which varies strongly across countries seems not to be responsible for the differences in the proportions of female leaders.

Regarding the characteristics of female firm leaders, women seem to be more risk averse

¹See Statistisches Bundesamt (2015).

and female led firms are smaller on average. For all countries, we find no evidence for significant performance differences between female- and male-led firms, neither for the entire country nor within six different sectors within each country.

This paper is organized as follows: the second section provides a brief overview of the relevant literature on the impact of female leadership on firm performance. In section 3, we discuss the data base and the variables used in the analysis, followed by a first descriptive analysis in section 4. Section 5 contains the estimation methodology based on the matching approach and empirical results for all countries. Section 6 concludes.

2 Review of the literature

As female quotas in management positions have become a relevant political topic, a growing body of literature analyzes the effects of executives' gender on firm performances for different countries. There are opposing views on the effects of the introduction of female quotas. One may assume a negative impact of higher female representation in managerial positions on firm performance because under the pressure of meeting quotas probably less competent and experienced women attend the board. It could be the fact that there are not enough women qualified to sit on boards, and that putting more of them on boards probably will decrease decision quality and firm performance.

On the other hand, women-led firms may be assumed to perform better because of profitable female leadership styles. Some research shows that women tend to be more risk averse (e.g. Parrotta & Smith, 2013; Watson & Robinson, 2003) and to have a higher endowment of soft skills. Moreover, women seem to better interpret productivity signals probably leading to better job matches and therefore to better firm performances (Flabbi, Macis, Moro, & Schivardi, 2014). Proponents of female quotas claim that without female quotas it is more likely that a number of qualified women will be disregarded. Moreover, higher board diversity - with respect to gender as well as to nationality, age, etc. - is assumed to improve firm performance, because of the availability of a broader talent pool and more diverse skills, knowledge and experiences.

A third point of view expects no effects of a higher female representation in top management on firm performance. Both, female and male managers underlie the same profit-maximizing conditions and therefore pursue the same strategies and goals.

For the US, Adams and Funk (2012) reveal important differences between male and female directors. Female directors seem to be more benevolent and tend to be less power and security oriented than their male counterparts. Surprisingly, they find female directors to be slightly more risk loving. Adams and Ferreira (2009) find female directors to be more likely to attend meetings and to join monitoring committees. Using a firm fixed effects model and an instrumental variables approach, they detect a negative diversity effect on performance. An interesting finding is that diversity has a positive impact on performance in firms with weak governance, measured by their abilities to resist takeovers.

Similarly to Adams and Ferreira (2009), Dezsö and Ross (2012) find the effect of female representation in top management on firm performance also to be context-specific. They estimate interaction effects between gender and firm strategies and reveal a positive effect

of female representation in top management on Tobin's q , return on assets (roa) and return on equity (roe) for innovative firms.

Considering risk attitudes, Robb and Watson (2012) analyze performance differences of female- and male-owned firms in the US. The data allows to construct firm performance measures as firm closure rates and roa as well as risk-adjusted measures as the Sharpe ratio which is a reward-to-variability ratio. The impact of female firm owner is estimated by a Cox-proportional hazard model and standard linear regression techniques. No significant effect of owners' gender on firm performance is found, neither for unadjusted nor for risk adjusted performance. This is in contrast to Watson and Robinson (2003) who conclude that gender has explanatory power for non-adjusted performance measures, but not for risk-adjusted measures. Similarly, Wolfers (2006) does not detect any performance differences between female- and male-headed firms for the US.

Negative effects of female ownership for small businesses in the U.S. are found by Fairlie and Robb (2009). A decomposition technique reveals that female-owned businesses are less successful than male-owned businesses because they use less start-up capital and have less prior work experience.

Some studies also exist on female firm leadership in the European context. Evidence for Denmark is provided by Smith, Smith, and Verner (2006). The results are quite mixed and depend on the definition of female leadership and firm performance. They find that a positive impact of female representation is mainly related to women with an academic background. Female CEOs with a lower educational background seem to have a smaller or insignificant effect on firm performance. When controlling for firm fixed effects, the majority of effects become insignificant.

A recent study by Flabbi et al. (2014) investigates the effect of female leadership on wage-distribution and firm performance in the manufacturing sector in Italy. Based on an employer-employee panel data set, they apply a fixed effects regression. No direct effect of leadership gender on firm performance is detected, but a positive effect of the interaction between female leadership and the fraction of female workers. The authors explain this effect by assuming that female leaders may better interpret productivity signals from female workers resulting in better productivity allocations.

No significant effect at all is found by Rose (2007), who analyzes the association between female representation in the board on firms' performance for Denmark. This is partly consistent with Smith et al. (2006).

A further study for Denmark, conducted by Parrotta and Smith (2013), uses an employer-employee panel sample of Danish firms to investigate the effect of female leadership on absolute firm performance measures as well as on their variability. Applying OLS and fixed effects regression, they find a negative relationship between female CEOs and performance variability, but no significant effect of female leadership on absolute performance measures. This is in line with previous findings on male and female directors' risk behavior and management practices (see e.g Adams & Ferreira, 2009).

For Germany, Gagliarducci and Paserman (2015) analyze the effect of the gender composition of management's top layer on establishment and worker outcomes. Using a linked employer-employee data on German establishments and estimating pooled OLS regressions, they find a strongly negative effect of the share of women in top management

on establishment outcomes. A positive effect is detected on hiring and termination rates. Including fixed effects and time trends, all significant effects vanish. Therefore, they regard their previously estimated negative effects as spurious, being the result of the sorting of female managers into smaller and less productive firms.

For Norway, there exists some evidence on the introduced mandatory female quota in 2006. Matsa and Miller (2013) investigate the impact of gender quotas on firm value measured as the ratio of operating profits to assets. Using a difference-in-difference approach as well as matching strategies, a negative impact of quota on firm performance is found. A decomposition of these profit changes reveals that this effect is mainly driven by increased labor costs due to fewer layoffs and higher relative employment. Similar results were reported by Ahern and Dittmar (2012). Moreover, they find the gender quota to change board characteristics (e.g. younger, less experienced) and firm policy (e.g. increased financial risk and acquisition).

Evidence for Spain is provided by Minguez-Vera and Martin (2011). Using panel data for Spanish SMEs and fixed effects regression, they reveal a negative and significant effect of women's presence on the board on firm performance (roe). Moreover, a negative effect of women's presence on firm risk is detected. The author concludes that female presence on boardrooms generates less risky firm policies and that women's risk aversion is an important factor causing a negative impact on firms' performance.

For small business entrepreneurs in Sweden, Rietz and Henrekson (2000) find that female entrepreneurs tend to underperform relative to their male counterparts. In a multivariate regression with a large number of controls, female underperformance disappears for the most performance measures.

In summary, previous research on female leadership and firm performance shows ambiguous results for the US as well as for some European countries. Context-specific positive effects are found for Denmark and Italy. For Germany and again for Denmark, no effect of female representation in higher management is reported. Negative relationships are observed for Norway, Spain and Sweden. A concise overview of the relevant literature is given in the appendix (table 12). The estimation of the effect of female leadership on firm performance may be hampered by potentially existing selection mechanism of women towards specific firms. Some researchers (e.g. Flabbi et al., 2014; Gagliarducci & Paserman, 2015; Robb & Watson, 2012; Watson & Robinson, 2003) state that women tend to sort themselves into smaller firms than men. On the contrary, some studies (e.g. Adams & Ferreira, 2009; Ahern & Dittmar, 2012; Smith et al., 2006) conclude that women are more likely to lead larger firms. Smith et al. (2006) reveal that mainly older firms tend to have female managers, Watson and Robinson (2003) find the opposite.

Moreover, there is some evidence for sectoral selection effects. According to Robb and Watson (2012), female managers work more likely in retail, and less likely in construction. Following Watson and Robinson (2003), women tend to be underrepresented in manufacturing, and to be overrepresented e.g. in accommodation, cafes/restaurants, personal and other services. Similarly, Smith et al. (2006) reveals that women are overrepresented in more family friendly sectors as private service, retail, hotel and restaurants. Wolfers (2006) detects no substantial sector differences between female- and male-led firms. In summary, previous studies find ambiguous results for the self-selection

issue.

3 Data and variables

Our empirical analysis is based on international balance sheet data for the year 2011 obtained from the Amadeus database provided by “Bureau van Dijk Electronic Publishing GmbH” (BvD). We consider 441287 firms from 14 countries for which all required information are available. To prevent outliers biasing the results of the performance comparison, we ensure variable values to lie within sensible intervals (see table 11 in the appendix).

To identify a women-led firm, we use the person data set which contains the information on firm’s employees in leading positions, e.g. members of the executive board. As the executive board decides on activities and strategies of a firm, we construct a dummy variable Z which indicates if women have the majority, i.e. at least 50% of seats in the board of capital companies or if the firm is led by a women (private firms).

The comparison of the male- ($Z = 0$) and female-led ($Z = 1$) firms is carried out in two ways. The first comparison is based on all male- and all female-led firms. The second comparison is based on a control group of male-led firms of size equal to the group of female-led firms. In this approach, the indicator variable Z can be seen as the treatment indicator. The construction of the control group is based on estimated propensity scores for female firm leadership within two-digit sectors. We observe that the male-led control groups differ considerably less from the female-led firms in terms of firm size and capital structure, thereby hopefully reducing selection effects.

Throughout, we use the return on assets (roa) as the performance measure:

- *return on assets* : $roa = \frac{\text{net profit} + \text{interests on borrowed capital}}{\text{total capital}}$

The return on assets quantifies how profitable a firm uses its total capital. roa is a rather broadly defined performance measure and less affected by firm specificities compared to other measure as e.g. the return on equity.

Female led firms are indicated by the variable sex

- gender of board majority (capital company) / owner (private company): sex

This variable serves as the treatment indicator Z in the analysis.

Previous research finds some systematic differences between firms choosing male or female top managers which may have an impact on firm performance thereby biasing results. To ensure comparability of male- and female-led firms, we consider the following control variables:

- firm age: age

A firm's age is widely accepted in the literature on balance sheet analyses (e.g. Anders & Szczesny, 1996; The Dun & Bradstreet Corporation, 1998). *age* is calculated based on the foundation date given in the data base. Its relation to the gender of the board majority is unclear.

- firm size: $size = \log(balance\ sheet\ total)$

Firm size is also an often used control variable in balance sheet analyses (e.g. Wu, Gaunt, & Gray, 2010). Bigger firms with a larger balance sheet total are believed to be more able to solve temporary difficulties, to grow slower and to be less risky than younger firms. Previous studies find ambiguous results on the relation between women in management and size.

- number employees: *emp*

Instead of total asset, some studies use the number of employees as a measure of firm size.

- debt ratio: $dr = \frac{total\ debt}{total\ capital}$

The debt ratio indicates to which degree credit capital is used for funding purposes (Penner, 2004). A small *dr* may enable the firm to borrow more money to react to sudden financial problems. A high debt ratio makes a firm more vulnerable to rising interest rates and potentially increases its financial distress (e.g. Bieg & Kußmaul, 2006). Its relation to the board majority is unclear. Due to the leverage effect, a high ratio may induce higher profits and higher risk.

- liquidity ratio: $liq = \frac{short-term\ assets}{short-term\ debts}$

Availability of short-term capital ensures the capability to repay its short-term debts. A large liquidity ratio may indicate a risk-averse management (Mensch, 2008).

- fixed assets ratio: $far = \frac{fixed\ assets}{total\ capital}$

The fixed assets ratio shows the degree of capital commitment. A high *far* reduces the flexibility of a firm and puts pressure on it to constantly achieve a high degree of capacity utilization since fixed assets generate continuous expenses which need to be covered (Heesen & Gruber, 2009).

- debt structure: $ds = \frac{short-term\ debts}{total\ debt}$

The debt structure ratio indicates the part of total debt that must be repaid within one year, i.e. a firm's reliance on short-term financing. The higher the ratio, the more risk of being unable to repay current debt obligations on time. Therefore, a low debt structure may indicate a risk-averse management (Mensch, 2008).

- sector: *sec*

The fraction of women-led firms as well as the impact of female management on firm performance may differ between sectors. Therefore, we analyze six sectors separately. The regarded sectors and their NACE codes are given in table 1.

Table 1: Sector classification and the corresponding NACE regions.

Range of first two NACE digits	Sector designation	Acronym
01-33	Manufacturing	s_{ma}
35-43	Energy	s_{en}
45-56	Trade	s_{tr}
58-68	Finance	s_{fi}
69-82	Services	s_{se}
84-99	Social	s_{so}

As we try to separate the effect of female firm leadership from selection effects, we use several firm characteristics to estimate the propensity to treatment, i.e. the firm is led by women, and to build pairs of very “similar” firms according to their propensities allowing a sensible comparison. As our data set allows for a detailed analysis of the financial structure of these firms, it is possible to control for these characteristics in our analysis.

4 Descriptive statistics

4.1 Share of female leaders by country and sector.

Table 2 provides information on the extent of female-led firms for 14 EU member states² as well as the six sector specific shares in each country. Moreover, the extent of female-led firms and the sector specific shares over all countries (last row) are presented. Note that “female-led” firm means that women have the majority, i.e. at least 50% of seats, in the board ($Z = 1$). Over all countries and sectors, we observe that 17.7% of firms are led by women. The country specific shares of female-led firms vary substantially. Noticeable is the very high share of female-led firms in Portugal (32.6%) and Romania (25.8%). A very low fraction is observed for United Kingdom (7.4%), Austria (9.2%), and Greece (10.4%).

These differences could not be explained by female quotas as such laws were introduced in the EU at the earliest in 2007 (Spain) with obligations to implement until the earliest in 2012 (Belgium, see table 10). In some countries, there are no legal quotas at all. As most of the existing statistics provide figures only on female representation in executive boards (and not female leadership as defined in this article) and, moreover, only for listed companies, our figures being based on a much broader data base are not directly comparable to those statistics. E.g. according to the European Commission, in 2012, Sweden (25%), Finland (27%), and France (22%) report the highest fractions of women in

²Abbreviations: DE: Germany, GB: United Kingdom, SE: Sweden, ES: Spain, RO: Romania, PT: Portugal, PL: Poland, IT: Italy, GR: Greece, FR: France, FI: Finland, CZ: Czech Republic, BE: Belgium, AT: Austria.

decision-making committees of top listed companies (regarding the 14 considered countries). In Italy and Portugal (6%), this fraction was very low (Europäische Kommission, 2012).

A closer look at the six different sectors reveals the highest fraction of female-led firms (over all 14 countries) to be in sector social (26.4%) and the lowest fraction to be in sector energy (14%). This is also observed for the sector specific shares within each country. In addition, in United Kingdom, Sweden, Spain and Belgium, the share of female-led firms is very low in manufacturing. Despite that, some countries as e.g. Germany record relatively homogenous sector specific proportions of female-led firms. In e.g. Sweden, this proportion varies remarkably across sectors.

Table 2: Share of female-led firms by country and sector.

	all	s_{ma}	s_{en}	s_{tr}	s_{fi}	s_{se}	s_{so}
DE	0.171	0.176	0.178	0.171	0.165	0.146	0.185
GB	0.074	0.046	0.047	0.095	0.079	0.081	0.099
SE	0.128	0.088	0.076	0.119	0.137	0.149	0.350
ES	0.180	0.154	0.158	0.178	0.269	0.191	0.228
RO	0.258	0.251	0.211	0.275	0.217	0.300	0.343
PT	0.326	0.314	0.284	0.346	0.292	0.301	0.443
PL	0.169	0.164	0.118	0.167	0.214	0.202	0.292
IT	0.163	0.160	0.117	0.174	0.149	0.179	0.262
GR	0.104	0.093	0.072	0.108	0.117	0.123	0.158
FR	0.176	0.141	0.113	0.203	0.171	0.169	0.285
FI	0.151	0.118	0.098	0.164	0.160	0.161	0.346
CZ	0.176	0.143	0.120	0.202	0.195	0.216	0.344
BE	0.146	0.108	0.138	0.130	0.157	0.185	0.268
AT	0.092	0.074	0.078	0.110	0.080	0.072	0.185
all	0.177	0.162	0.140	0.191	0.180	0.177	0.264

4.2 Sectoral shares of firms by country

To reveal possible causes of the strong variation of the country specific shares of female-led firms, table 3 presents the sectoral structure in terms of firm numbers for each country separately as well as the overall sectoral composition. Regarding all 14 countries, the sectors trade (36.6%) and manufacturing (26.5%) dominate the sectoral structure. The sector social represents only 4.3%. For Sweden, we observe a great divergence of their sectoral structure from the structural composition over all countries, especially reflected in the shares for manufacturing and finance. In United Kingdom, the shares for service and trade differ strongly from the overall shares. In Greece, mainly the sector trade is overrepresented. The sectoral structure of Spain, Austria and Portugal is very similar to the sectoral composition over all countries.

These first descriptive statistics provide no obvious hint for the strong overrepresentation of female-led firms in Portugal and Romania and the underrepresentation in United Kingdom, Austria and Greece compared to the European mean. Therefore, in the next section, we decompose the country specific differences towards the overall share into a gender, a sector and a mixed effect.

Table 3: Share of sectors of all firms by country.

	s_{ma}	s_{en}	s_{tr}	s_{fi}	s_{se}	s_{so}
DE	0.312	0.113	0.282	0.083	0.111	0.098
GB	0.257	0.070	0.267	0.147	0.209	0.051
SE	0.162	0.103	0.300	0.235	0.158	0.042
ES	0.242	0.148	0.392	0.089	0.086	0.045
RO	0.314	0.157	0.382	0.050	0.075	0.022
PT	0.269	0.146	0.420	0.064	0.064	0.036
PL	0.339	0.148	0.351	0.068	0.047	0.047
IT	0.357	0.139	0.335	0.061	0.073	0.034
GR	0.267	0.075	0.514	0.050	0.071	0.023
FR	0.166	0.140	0.411	0.116	0.125	0.043
FI	0.246	0.157	0.298	0.125	0.122	0.053
CZ	0.343	0.135	0.337	0.068	0.090	0.028
BE	0.217	0.097	0.383	0.112	0.109	0.082
AT	0.312	0.086	0.370	0.083	0.111	0.038
all	0.265	0.134	0.366	0.094	0.099	0.043

4.3 Sectoral effect of differences in share of female firm leaders

For countries, we use index k ($k = 1, \dots, K$) and for sectors index j ($j = 1, \dots, J$). n is the number of all firms in the data set. n_k is the number of firms in country k and n_{kj} is the number of firms in country k in sector j . The share of sector j in all firms in country k , we denote as $g_{kj} = n_{kj}/n_k$. We use f for the fraction of female-led firms. Hence, f_{kj} denotes the fraction of female-led firms in sector j in country k . Using index i ($i = 1, \dots, n_{kj}$) for individual firms, we define f_{kj} as

$$f_{kj} = \frac{\sum_{i=1}^{n_{kj}} z_{k,j,i}}{n_{kj}}.$$

The fraction of female-led firms f_k in country k (see first column in table 2) is the weighted average of sectoral shares f_{kj} :

$$f_k = \sum_{j=1}^J f_{kj} \cdot g_{kj} = \sum_{j=1}^J \frac{\sum_{i=1}^{n_{kj}} z_{k,j,i}}{n_{kj}} \cdot n_{kj}/n_k.$$

The overall fraction of female-led firms in the complete data set (dropping country index k) can analogously be expressed as

$$f = \sum_{j=1}^J f_j \cdot g_j = \sum_{j=1}^J \frac{\sum_{k=1}^K \sum_{i=1}^{n_{kj}} z_{k,j,i}}{n_j} \cdot \frac{n_j}{n} = \sum_{j=1}^J \frac{\sum_{k=1}^K \sum_{i=1}^{n_{kj}} z_{k,j,i}}{\sum_{k=1}^K n_{kj}} \cdot \frac{\sum_{k=1}^K n_{kj}}{n}.$$

Differences between country specific fractions f_k and the overall fraction f can be disaggregated into (weighted) isolated differences of gender fractions ($f_j - f$), isolated (weighted) differences in sectoral shares ($g_j - g$) and a combined (or mixed) effect including both, differences in ($f_j - f$) and in ($g_j - g$):

Table 4: Decomposition of country specific differences.

	total diff.	gender eff.	sector eff.	mixed eff.
DE	-0.006	-0.006	0.004	-0.003
GB	-0.103	-0.104	0.002	-0.001
SE	-0.049	-0.058	0.002	0.007
ES	0.003	0.003	0.000	-0.001
RO	0.080	0.083	-0.003	0.001
PT	0.148	0.147	-0.000	0.002
PL	-0.008	-0.005	-0.001	-0.002
IT	-0.014	-0.013	-0.003	0.001
GR	-0.073	-0.074	0.002	-0.002
FR	-0.002	-0.006	0.002	0.002
FI	-0.026	-0.027	-0.001	0.002
CZ	-0.002	0.005	-0.003	-0.004
BE	-0.031	-0.038	0.006	0.001
AT	-0.085	-0.085	0.001	-0.001

$$\begin{aligned}
f_k - f &= \sum_{j=1}^J f_{kj} \cdot g_{kj} - \sum_{j=1}^J f_j \cdot g_j \\
&= \underbrace{\sum_{j=1}^J (f_{kj} - f_j) \cdot g_j}_{\text{gender effect}} + \underbrace{\sum_{j=1}^J (g_{kj} - g_j) \cdot f_j}_{\text{sector effect}} + \underbrace{\sum_{j=1}^J (f_{kj} - f_j)(g_{kj} - g_j)}_{\text{mixed effect}}.
\end{aligned}$$

Table 4 presents the decomposition results of country specific differences of the fraction of female-led firms into a gender, sector and mixed effect. We observe for all countries that the total difference is mainly driven by the gender effect. In particular, this finding is noticeable in countries with a very high difference between the country specific share and the overall share, i.e. in United Kingdom, Romania, Portugal, Greece and Austria. The sector as well as the mixed effect are almost negligible.

4.4 Covariates by country and leadership gender

Table 5 presents mean values of covariates by gender of management majority and country. In almost all countries, we find that on average women-led firms are smaller according to total assets and employment. This is in line with studies by Flabbi et al. (2014) for Italy and Gagliarducci and Paserman (2015) for Germany. Moreover, in the majority of countries women-led firms tend to be younger (in line with Watson and Robinson (2003)), have slightly smaller debt ratios and debt structures and slightly higher liquidity and fixed assets ratios. Hence, less risky firms seem to be more likely to be led by women. This is also found by Parrotta and Smith (2013) for Denmark.

Table 5: Means of covariates by country and leadership gender.

country	sex	age	size	emp	dr	liq	far	ds
DE	m	33.753	9.630	272.433	0.628	3.175	0.363	0.560
	w	33.282	9.534	206.012	0.620	3.212	0.381	0.541
GB	m	24.893	9.901	315.874	0.607	2.313	0.321	0.787
	w	21.616	9.468	210.757	0.583	2.236	0.360	0.784
SE	m	21.048	8.148	48.558	0.643	2.285	0.385	0.704
	w	20.970	8.064	55.536	0.654	2.316	0.403	0.695
ES	m	19.547	8.154	57.102	0.572	2.632	0.401	0.697
	w	18.984	7.986	40.221	0.527	3.262	0.446	0.668
RO	m	11.512	7.108	83.263	0.615	2.008	0.421	0.737
	w	11.675	6.809	52.556	0.616	2.051	0.425	0.734
PT	m	19.529	7.701	51.253	0.650	2.254	0.330	0.714
	w	19.297	7.551	40.206	0.637	2.403	0.344	0.701
PL	m	21.124	8.512	194.788	0.517	1.934	0.421	0.806
	w	23.556	8.534	245.629	0.491	2.040	0.459	0.795
IT	m	20.077	8.299	44.012	0.744	1.599	0.277	0.754
	w	19.981	8.032	29.010	0.738	1.643	0.288	0.744
GR	m	20.040	8.232	38.002	0.600	2.092	0.320	0.826
	w	19.948	8.010	26.578	0.594	2.094	0.325	0.836
FR	m	20.582	7.762	57.425	0.620	1.864	0.279	0.833
	w	20.463	7.610	42.861	0.607	1.912	0.332	0.809
FI	m	19.385	8.149	81.999	0.618	2.153	0.407	0.663
	w	19.774	7.888	56.519	0.632	2.071	0.438	0.634
CZ	m	12.955	7.503	90.870	0.563	2.186	0.351	0.791
	w	12.460	7.185	68.526	0.562	2.278	0.363	0.781
BE	m	28.073	9.392	123.707	0.605	2.128	0.331	0.786
	w	26.820	9.048	91.266	0.591	2.273	0.369	0.747
AT	m	29.029	9.919	234.761	0.629	2.041	0.376	0.767
	w	31.564	9.575	179.218	0.632	1.770	0.390	0.787

4.5 Return on assets (*roa*) by country, sector and leadership gender

Table 6 presents mean values of *roa* by gender of management majority, country and sector. Comparing the means of *roa* for men (m)- and women (w)-led firms, we most often find only slight differences across sectors. Regarding the 14 differences in countries when aggregating over all sectors, we find 4 countries with larger average *roa* for male-led firms. In 8 countries women-led firms have on average higher *roa*.³ Regarding the 84 comparisons for 6 sectors in the 14 countries, we find that in 40 cases women-led firms have on average higher *roa*, whereas in 38 cases male-led firms outperform women-led firms. In particular, higher *roa* for women-led firms are found in the trade and service sector.

³When regarding *roa*-values rounded towards three digits.

Table 6: Roa by country, sector and leadership gender.

country	sex	all	s_{ma}	s_{en}	s_{tr}	s_{fi}	s_{se}	s_{so}
DE	m	0.097	0.112	0.092	0.101	0.087	0.106	0.042
	w	0.096	0.108	0.086	0.103	0.088	0.114	0.042
GB	m	0.081	0.095	0.054	0.069	0.084	0.086	0.087
	w	0.085	0.092	0.072	0.079	0.081	0.092	0.086
SE	m	0.091	0.092	0.105	0.099	0.066	0.101	0.102
	w	0.091	0.088	0.093	0.097	0.064	0.111	0.109
ES	m	0.034	0.031	0.023	0.037	0.033	0.046	0.050
	w	0.034	0.032	0.022	0.036	0.023	0.044	0.060
RO	m	0.091	0.086	0.084	0.084	0.103	0.147	0.129
	w	0.095	0.091	0.084	0.085	0.114	0.148	0.126
PT	m	0.045	0.040	0.039	0.048	0.038	0.067	0.065
	w	0.047	0.036	0.038	0.052	0.034	0.071	0.065
PL	m	0.074	0.081	0.058	0.080	0.078	0.088	0.019
	w	0.065	0.072	0.070	0.074	0.056	0.081	-0.014
IT	m	0.049	0.048	0.051	0.047	0.052	0.060	0.068
	w	0.051	0.049	0.054	0.047	0.056	0.070	0.058
GR	m	0.041	0.024	0.062	0.039	0.041	0.080	0.093
	w	0.049	0.021	0.060	0.048	0.016	0.117	0.121
FR	m	0.084	0.072	0.086	0.086	0.080	0.088	0.105
	w	0.085	0.076	0.077	0.087	0.073	0.093	0.111
FI	m	0.098	0.084	0.107	0.103	0.074	0.125	0.095
	w	0.094	0.083	0.099	0.106	0.057	0.109	0.100
CZ	m	0.075	0.075	0.062	0.074	0.077	0.090	0.083
	w	0.078	0.070	0.066	0.076	0.058	0.110	0.112
BE	m	0.064	0.057	0.064	0.070	0.072	0.066	0.033
	w	0.060	0.064	0.065	0.062	0.066	0.074	0.033
AT	m	0.073	0.080	0.063	0.068	0.055	0.095	0.047
	w	0.080	0.080	0.084	0.085	0.118	0.072	0.023
all	m	0.064	0.060	0.061	0.064	0.065	0.080	0.071
	w	0.064	0.059	0.056	0.065	0.055	0.086	0.076

5 Estimating the effect of female leadership on firm performance

5.1 The aim of the analysis

We analyze the subsample of $n = 24007$ German firms in detail and apply the analogous analysis to the remaining 13 countries. As we are interested in the potential effect of female leadership on the return on assets (roa), we regard the group of female-led firms as the treatment (t) group.

We will calculate three different estimates of the country specific effects of female leadership on firm performance. First, we estimate the simple prima facie effect resulting from the simple comparison of average roa of female- and male-led firms. This comparison is prone to potential selection bias, as firms led by women may differ systematically from

firms led by men already at the time of leadership appointment.⁴ E.g. the descriptive analysis revealed differences in firm size and sectoral composition between female- and male-led firms.

As the decision of assigning male or female top managers is endogenous, in the second step of our analysis, we take this endogeneity of the assignment into account and try to mimic a random assignment as close as possible. Therefore, we use available covariates to account for the (overt) bias on observables. This analysis is based on the estimation of assignment probabilities used to construct a control group via a matching strategy based on propensity scores within NACE two-digit subsectors. In the logit model to estimate propensity scores, we include seven firm characteristics. Our second estimate of the effect of female leadership is based on pairs of firms, each pair including a female-led firm and a most similar male-led firm. These male-led firms will be regarded as the control group and the estimated effect is denoted treatment effect on the treated.

This matching routine includes the potential pitfall of controlling to some extent for differences in firm performance as some of the regarded covariates may to some extent 'explain' the firm performance measured as *roa*. This conjecture is supported by the results of regressing the *roa* on seven firm characteristics, which combined explain about seven percent of the variance of *roa*. Therefore, we provide a third estimate of the effect of female leadership based on a less comprehensive matching routine. The matching is carried out within NACE two-digit sectors based solely on firm size measured as (logarithmic) total assets. This approach assures the comparison of female- and male-led firms producing in the same subsector and being of comparable size.

Throughout, male-led firms serve as the non-treatment (*nt*) group. As is explained in detail below, a sub-sample of this non-treatment group will be selected to serve as the control group (*c*) including the same number of firms as the treatment group, hence $n^t = n^c$. In our data for Germany, we observe $n^t = 4117$ female-led firms (treatment group) and $n^{nt} = 19890$ male-led firms (non-treatment group).

We proceed in our analysis in three steps. First, we counterfactually regard the assignment of a majority of women or men to a firm's executive board as purely random. Applying the concept of randomization tests, we estimate the effect of a majority of women in the board (female-led firm) on *roa* and its significance under the hypothesis of random assignment. To assess the significance, we will apply randomization tests using an approximation of the true randomization distribution based on 100,000 random draws of the assignment vector. Due to the large country specific data sets, the approximate randomization distribution resembles the normal distribution very closely. We will demonstrate this for the German sub-sample and proceed with tests based on the normality assumption for all countries.

To take into account potential selection effects, we proceed with two matching procedures. One taking into account many firm characteristics in the estimation of the propensity to be female-led, the other regarding only size when matching within two-digit subsectors.

⁴We have only information on firm leadership for the latest period (2012) and therefore we cannot analyze dynamic effects, e.g. analyze differences in firm development.

5.2 The estimation methodology under random assignment

We regard Z as a random variate which indicates whether the firm receives treatment ($Z = 1$, i.e. female-led) or not ($Z = 0$, i.e. male-led). n is the number of firms with observed Y , Y as an abbreviation for return on assets (*roa*). m denotes the number of female-led firms (treatment group, t). For the moment, we do not differentiate between the non-treatment and the (smaller) control group of male-led firms because of the assumption of random assignment. Hence, $n - m$ is the number of male-led firms (control group, c). One has:

$$0 \leq m = \sum_{i=1}^n Z_i = 4117 \leq n = 24007.$$

The effect we are interested in is the difference in Y (*roa*), i.e. $y_{iT} - y_{iC}$. Note that the effect at the individual level is never observed as we either observe y_{iT} or y_{iC} , but never both.

We apply the idea of randomization and obtain in the following the approximate distribution of the difference in means under the null hypothesis of no effect that is identical average *roa* in both groups:

$$H_0 : \bar{Y}_1 - \bar{Y}_0 = 0.$$

where \bar{Y}_1 denotes the mean *roa* in the treatment and \bar{Y}_0 in the non-treatment group. The assignment vector \mathbf{Z} is random and indicates which individual belongs to the treatment group

$$\mathbf{Z} = [Z_1 \ Z_2 \ \cdots \ Z_n]'$$

We observe y_{iT} for individuals in the treatment group and y_{iC} for individuals in the control group. The vector of all observed outcomes is (here ordered according to the assignment vector)

$$\mathbf{y} = [y_T \ y_T \ \cdots \ y_T \ y_C \ y_C \ \cdots \ y_C]'$$

To make the idea of randomization evident, we express both means making use of the assignment indicator:

$$\bar{Y}_1 = \frac{\mathbf{Z}'\mathbf{y}}{\mathbf{Z}'\mathbf{1}} \quad \bar{Y}_0 = \frac{(1 - \mathbf{Z})'\mathbf{y}}{(1 - \mathbf{Z})'\mathbf{1}}.$$

In random experiments, the treatment vector Z is randomly assigned with $P(Z_i = 1)$. Ω is the set of possible treatment assignment vectors \mathbf{Z} . The number of possible treatment assignments is

$$K = \binom{n}{m} = \binom{24007}{4117}.$$

and the probability for each assignment is $P(\mathbf{Z} = \mathbf{z}) = 1/K$ for all $\mathbf{z} \in \Omega$.

We test the null hypothesis of no treatment effect, which states that the response is identical in the treatment and in the control state and the effect τ measured as the difference is 0:

$$\tau = y_{iT} - y_{iC} = 0.$$

Using observed \mathbf{Z} and observed \mathbf{y} , the treated-minus-control difference, denoted as statistic $t(\mathbf{Z}, \mathbf{y})$, is obtained as

$$t(\mathbf{Z}, \mathbf{y}) = \frac{\mathbf{Z}'\mathbf{y}}{\mathbf{Z}'\mathbf{1}} - \frac{(1 - \mathbf{Z})'\mathbf{y}}{(1 - \mathbf{Z})'\mathbf{1}},$$

$$T = 0.0958 - 0.0973 = -0.0015.$$

The average *roa* in the treatment group exceeds the average in the control group by -0.0015 which is about -1.5%.

Now we turn to the inference for $t(\mathbf{Z}, \mathbf{y})$. Under the null hypothesis of no effect, \mathbf{y} is regarded as fixed. Assignment vector \mathbf{Z} is randomly chosen from Ω . T is the empirical value of the test statistic $t(\mathbf{Z}, \mathbf{y})$. The p -value is the probability to observe T or an even higher statistic given the null hypothesis of no effect holds. In this case, the one-sided p -value can be obtained by the probabilities for $\mathbf{z} \in \Omega$ which result in T or an even higher statistic $t(\mathbf{Z}, \mathbf{y})$:

$$P \{t(\mathbf{Z}, \mathbf{y}) \geq T\} = \sum_{\mathbf{z} \in \Omega} [t(\mathbf{z}, \mathbf{y}) \geq T] \cdot P(\mathbf{Z} = \mathbf{z})$$

where $[\text{event}] = \begin{cases} 1 & \text{if event occurs} \\ 0 & \text{otherwise.} \end{cases}$

Note that Ω is a very large set and the probability therefore is difficult to obtain. In the uniform randomized experiment, one has:

$$P(\mathbf{Z} = \mathbf{z}) = \frac{1}{|\Omega|} = \frac{1}{K}$$

$$P \{t(\mathbf{Z}, \mathbf{y}) \geq T\} = \frac{|\{\mathbf{z} \in \Omega : t(\mathbf{z}, \mathbf{y}) \geq T\}|}{K}.$$

We approximate the distribution of the test statistic $t(\mathbf{Z}, \mathbf{y})$ by drawing 100,000 assignment vectors randomly and calculating the test statistic for each draw. The approximate two-sided p -value obtained from the simulated distribution is 0.434. Hence, we would not reject the hypothesis of no effect at conventional levels. The normal approximation leads to the same conclusion. Note that in a conventional t -test the outcomes (here: *roa*) are treated as random variables having a hypothetical distribution. Applying a conventional t -test leads to similar results as due to the large groups the averages in the randomization experiments are quite normally distributed. The two-sided p -value for the hypothesis of equal expected values for women- and men-led firms is 0.503. Hence, we obtain the same conclusion of maintaining the hypothesis of no effect.

A confidence interval could be obtained by inverting the hypothesis test. We now ask at what empirical difference the hypothesis would be rejected at a two-sided significance level of $\alpha = 0.05$. Based on the approximated distribution, we obtain

$$P(-0.0058 \leq \bar{Y}_1 - \bar{Y}_0 \leq 0.0028) = 1 - \alpha = 0.95.$$

Summing up, we find that for Germany the hypothesis of no effect of female firm leadership has to be maintained when testing the hypothesis of equal average returns on assets under the assumption of random assignment.

5.3 Treatment assignment with unknown probabilities

So far, we maintained the assumption that men and women have been randomly assigned to firm leadership. This assumption is unreasonable because executives are selected by advisory boards (capital companies) or by self-selection (ownership led firms). This fact may bias the analysis based on the random assignment assumption. The assumption of simple random assignment can be also expressed as constant treatment probabilities π for all individuals.

Because of the endogeneity of the treatment probability, we, in fact, will have individual probabilities denoted as $\pi_{[j]} = P(Z_{[j]} = 1)$. The corresponding control-probability therefore is $1 - \pi_{[j]} = P(Z_{[j]} = 0)$. For all varying treatment probabilities π , it holds that $0 < \pi_{[j]} < 1$.

Given individual treatment probabilities the probability for assignment vector \mathbf{Z} is given as

$$P(Z_{[1]} = z_1, \dots, Z_{[n]} = z_n) = \prod_{j=1}^n \pi_{[j]}^{z_j} \{1 - \pi_{[j]}\}^{1-z_j}.$$

The problem we now face is that $\pi_{[j]}$ is unknown. We assume that the individual probabilities $\pi_{[j]}$ depend on observed covariates $\mathbf{x}_{[j]}$

$$\pi_{[j]} = \lambda(\mathbf{x}_{[j]}) \quad \text{for } j = 1, \dots, n,$$

where $\lambda(\mathbf{x}_{[j]})$ is the propensity score. Using the propensity scores, we obtain the probability for assignment vector \mathbf{Z} as

$$P(Z_{[1]} = z_1, \dots, Z_{[n]} = z_n) = \prod_{j=1}^n \lambda(\mathbf{x}_{[j]})^{z_j} \{1 - \lambda(\mathbf{x}_{[j]})\}^{1-z_j}.$$

5.3.1 Stratifying on two-digit NACE sectors

The NACE two-digit sector information in our data set comprises 87 different two-digit subsectors. Because we want to apply a matching strategy within two-digit sectors, we ensure that the minimum number of firms contained in a two digit sector is at least five. In the cases with less than 5 firms in two-digits sectors (in any of the considered 14 countries), we merged sectors with neighboring two-digits sectors to allow for enough potential controls. This aggregation procedure resulted in 51 sectors considered for each country. The aggregation scheme of 87 original NACE two-digit sectors towards 51 broader defined sectors is shown in table 7.

Table 7: Recoding (aggregation) of NACE2 sector codes.

old	new	old	new	old	new	old	new
2	1	19	18	60	58	90	86
3	1	30	29	63	62	91	86
5	1	36	35	66	64	92	86
6	1	37	35	72	71	93	86
7	1	39	38	74	73	94	86
9	8	50	49	80	79	95	86
12	11	51	49	84	82	97	96
14	13	53	52	87	86	98	96
15	13	59	58	88	86	99	96

To base the individual comparisons on firms operating in the same two digit sector, we built S strata and match within these strata. Z_{si} is the treatment indicator for individual i in stratum s . \mathbf{x}_{si} denotes the vector of covariates of individual i in stratum s . In all S strata, we have n assignment indicators and the assignment vector with stratification is $\mathbf{Z} = (Z_{11}, \dots, Z_{S,n_s})'$ of length n . m denotes the number of treated, $m_s = \sum_i Z_{si}$ is the number of treated in stratum s and $\mathbf{m} = (m_1, \dots, m_s, \dots, m_S)'$ is a vector containing the information of the number of treated in each stratum.

Assume that we would accomplish exact stratification, i.e. firms would only be heterogeneous across strata but homogeneous within strata: $\mathbf{x}_{is} = \mathbf{x}_{js}$ for s, i, j . In this case, stratifying on two-digit subsectors would result in identical propensity scores within a specific stratum s : $\lambda(\mathbf{x}_{is}) = \lambda_s$. Because all subjects in s now have identical treatment probabilities, the probability for the assignment vector is

$$\begin{aligned} P(\mathbf{Z} = \mathbf{z}) &= \prod_{s=1}^S \prod_{i=1}^{n_s} \lambda_s^{z_{si}} (1 - \lambda_s)^{1-z_{si}} \\ &= \prod_{s=1}^S \lambda_s^{m_s} (1 - \lambda_s)^{n_s - m_s}. \end{aligned}$$

This results in constant probabilities given the number of treated in the strata for all possible assignment vectors.

$$\begin{aligned} |\Omega| = K &= \prod_{s=1}^S \binom{n_s}{m_s} \\ P(\mathbf{Z} = \mathbf{z} | \mathbf{m}) &= \frac{1}{K}. \end{aligned}$$

Note that in this case, we were allowed to use randomization methods identical to the case of truly “randomized” data. This holds even if we do not know the probability to be chosen for the different strata.

5.3.2 Matching on firm characteristics

We use several firm characteristics to estimate the propensity to treatment. As covariates, we use firm’s age and size (in terms of total assets), the number of employees, and some

covariates identifying a firm’s financial structure, i.e. the debt ratio, liquidity ratio, fixed asset ratio and the debt structure as described in the data section. As we wish to estimate propensities, we use a logit model as a natural choice because estimates are bounded towards the interval $[0; 1]$.

Table 8 presents the results of the country specific logit regression. We observe the covariate size to have a highly significant negative effect on the probability to belong to the treatment group (female-led firms) in 13 out of 14 countries. The only exception being Poland. The debt structure affects leadership gender in five countries highly significantly negative. The fixed asset ratio has a significant positive impact on the probability to be led by a women for 12 EU member states. Exceptions being Greece and Austria. The coefficient of the liquidity ratio is only significant and positive in three countries. The coefficients of the number of employees and of the debt ratio are in the most significant cases (four and five, respectively) negative. The results for firm’s age are quite mixed. Hence, it seems that small and less risky firms are more likely to be led by women. This is in line with our descriptive findings and previous research for European countries (e.g. Flabbi et al., 2014; Gagliarducci & Paserman, 2015; Parrotta & Smith, 2013).

Table 8: Results of country specific logit regressions.

country	int.	age	size	emp	dr	liq	far	ds
DE	-0.763 (0.000)	-0.000 (0.668)	-0.060 (0.000)	-0.000 (0.050)	-0.149 (0.066)	-0.007 (0.165)	0.175 (0.028)	-0.304 (0.001)
GB	-0.477 (0.110)	-0.006 (0.000)	-0.199 (0.000)	0.000 (0.770)	-0.427 (0.006)	0.000 (0.971)	0.651 (0.000)	0.061 (0.664)
SE	-1.862 (0.000)	0.002 (0.128)	-0.069 (0.000)	0.000 (0.011)	0.267 (0.002)	0.013 (0.010)	0.387 (0.000)	0.157 (0.051)
ES	-0.152 (0.085)	-0.003 (0.001)	-0.151 (0.000)	0.000 (0.650)	-0.555 (0.000)	0.019 (0.000)	0.591 (0.000)	-0.133 (0.002)
RO	-0.329 (0.014)	0.008 (0.003)	-0.129 (0.000)	-0.000 (0.001)	0.088 (0.213)	0.008 (0.188)	0.138 (0.046)	-0.038 (0.577)
PT	0.183 (0.121)	0.000 (0.933)	-0.095 (0.000)	-0.000 (0.485)	-0.285 (0.000)	0.007 (0.124)	0.260 (0.000)	-0.153 (0.013)
PL	-1.549 (0.000)	0.004 (0.002)	-0.037 (0.103)	0.000 (0.268)	-0.213 (0.155)	0.019 (0.140)	0.534 (0.000)	0.020 (0.900)
IT	0.051 (0.590)	0.002 (0.000)	-0.199 (0.000)	-0.000 (0.043)	-0.157 (0.001)	0.010 (0.051)	0.353 (0.000)	-0.144 (0.005)
GR	-0.971 (0.014)	0.003 (0.227)	-0.174 (0.000)	-0.001 (0.073)	0.043 (0.792)	0.003 (0.797)	0.294 (0.057)	0.108 (0.536)
FR	-0.862 (0.000)	0.003 (0.000)	-0.129 (0.000)	0.000 (0.653)	-0.086 (0.055)	0.016 (0.000)	0.906 (0.000)	-0.000 (0.982)
FI	-0.834 (0.008)	0.004 (0.061)	-0.129 (0.000)	-0.000 (0.948)	0.140 (0.410)	0.001 (0.933)	0.393 (0.013)	-0.283 (0.097)
CZ	-0.191 (0.264)	-0.008 (0.025)	-0.161 (0.000)	0.000 (0.611)	-0.137 (0.129)	0.002 (0.674)	0.351 (0.000)	-0.168 (0.060)
BE	0.476 (0.104)	-0.002 (0.196)	-0.200 (0.000)	0.000 (0.635)	-0.238 (0.102)	0.017 (0.139)	0.491 (0.000)	-0.532 (0.000)
AT	-0.087 (0.909)	0.003 (0.108)	-0.274 (0.000)	0.000 (0.653)	-0.259 (0.503)	-0.020 (0.621)	0.339 (0.255)	0.558 (0.236)

Table 9: Effect of female firm leadership on *roa*.

country	n_1	\bar{y}_1	\bar{y}_0	\bar{y}_{0C}	\bar{y}_{0M}	Δ_{PF}	p_{PF}	Δ_{TC}	p_{TC}	Δ_M	p_M
DE	4117	0.096	0.097	0.096	0.097	-0.001	0.503	-0.000	0.923	-0.001	0.721
GB	993	0.085	0.081	0.076	0.079	0.003	0.448	0.009	0.148	0.006	0.332
SE	3423	0.091	0.091	0.087	0.091	0.000	0.952	0.004	0.333	-0.000	0.998
ES	14286	0.034	0.034	0.034	0.034	-0.001	0.381	0.000	0.982	-0.000	0.865
RO	6226	0.095	0.091	0.093	0.096	0.004	0.105	0.001	0.606	-0.001	0.648
PT	8406	0.047	0.045	0.046	0.045	0.001	0.293	0.001	0.477	0.002	0.251
PL	1521	0.065	0.074	0.067	0.072	-0.009	0.010	-0.002	0.680	-0.007	0.133
IT	17097	0.051	0.049	0.051	0.050	0.002	0.007	0.001	0.479	0.001	0.261
GR	1050	0.049	0.041	0.043	0.045	0.008	0.030	0.006	0.159	0.004	0.390
FR	15723	0.085	0.084	0.085	0.084	0.002	0.098	0.000	0.908	0.001	0.280
FI	1072	0.094	0.098	0.096	0.107	-0.003	0.479	-0.002	0.731	-0.013	0.042
CZ	2764	0.078	0.075	0.074	0.073	0.003	0.247	0.004	0.315	0.004	0.200
BE	1348	0.060	0.064	0.061	0.067	-0.003	0.293	-0.000	0.955	-0.006	0.112
AT	220	0.080	0.073	0.071	0.093	0.007	0.474	0.009	0.446	-0.013	0.352

We apply a matching algorithm without replacement that searches for each of the $n_1 = 4117$ female-led firms a male-led firm with identical or almost identical propensity for treatment, thereby restricting the search for firms within the respective two-digit subsectors, i.e. we match exact on two-digit subsectors.⁵

Looking again at the German example, we compare 4117 pairs of firms which have either exact or at least very similar probabilities to be treated and therefore the assignment on estimated propensities will be closer to random assignment. To judge the effect of female leadership, we now compare the *roa* for each of the matched pairs making use of a paired t -test. The average return on assets (*roa*) for female-led firms is denoted by \bar{y}_1 . The average *roa* for all male-led firms is denoted by \bar{y}_0 . The difference in return on assets $\Delta_{PF} = \bar{y}_1 - \bar{y}_0$ obtained from the simple prima facie comparison may be prone to selection bias. The p -value obtained for the null hypothesis assuming random assignment and no effect of female leadership is denoted by p_{PF} . The average *roa* of the control male-led firms obtained from the matching procedure based on estimated propensity scores is denoted by \bar{y}_{0C} . The difference in return on assets for female-led (treatment) and control male-led firms is denoted by Δ_{TC} and the corresponding p -value of the paired t -test by p_{TC} . As this matching procedure based on estimated propensity scores may also “control” for strategic differences between female- and male-led firms which may cause differences in *roa*, we conduct a third comparison. We disregard firm characteristics beside the size of the firm and match only within two-digit subsectors according to *size*. The average *roa* of male-led control firms obtained from this simpler matching on covariates (subsectors and size) is denoted by \bar{y}_{0M} . The difference $\bar{y}_1 - \bar{y}_{0M}$ is denoted by Δ_M and the p -value obtained from the paired t -test correspondingly by p_M . The results of these three comparisons for all countries are given in table 9. The first column shows

⁵In Portugal the number of female-led firms in some two-digit subsectors exceeded the number of male-led firms. Therefore, 22 of the 8428 female-led firms were disregarded in the comparison based on the comparison of propensity scores.

the number of firms led by women (n_1) in each country.

A simple analysis of mean *roa* between firms led by women and men reveals in five countries (Germany, Spain, Portugal, Finland, and Belgium) a small negative difference Δ_{PF} , i.e. male managers perform better than their female counterparts. But only for Poland this difference is significant (at the 5%-level). For Italy and Greece, we find a highly significant but also small positive difference between *roa* of female- and male-led firms, i.e. female managers outperform their male counterparts. For France, this positive difference is significant at the 10%-level.

As the discussion of the descriptive statistics made evident, firms led by women and men differ strongly with respect to size in most countries. To take into account the non-random assignment to treatment and control group due to the self-selection process, we carry out the matching strategy explained in detail above, i.e. matching without replacement exact on two-digit sectors based on the estimated propensity scores. Accounting for the overt bias on observables in the matching routine, the difference in *roa* between female-led firms and their matched male-led firms (Δ_{TC}) is still negative in Poland and positive in Italy, Greece, and France, but the absolute values of the performance difference decrease and the p -values increase in most cases. All of the observed differences Δ_{TC} become insignificant at conventional levels.

A third comparison (Δ_M), disregarding firm characteristics beside the size of the firm, changes some absolute values and also signs of the differences between male and female return on assets, but 13 out of 14 differences remain insignificant, with Finland being the only exception.

Previous research on female leadership and firm performance led to ambiguous results for some European countries. Context-specific positive effects were found for Denmark and Italy. For Germany and again for Denmark, no effects of female representation in higher management were reported. Negative relationships were observed in Norway and Spain. Hence, our results for Germany are consistent with Gagliarducci and Paserman (2015), and for Italy partly consistent with Flabbi et al. (2014). But in contrast to Minguez-Vera and Martin (2011), we find no negative effect of female managers on firm performance for Spain.

In summary, all three estimates of the effect of female leadership on firm performance ($\Delta_{PF}, \Delta_{TC}, \Delta_M$) are almost always negligible and statistically insignificant different from 0. Given these results, we conclude that female managers do as good as their male counterparts in 14 EU member states.

6 Conclusion

Most of EU member states are characterized by a very low fraction of women in top management positions. As some European countries, e.g. Norway or France, already introduced a female quota for boards to improve gender equality in leading management positions, it is an important issue to analyze the effect of female representation in management positions on firm's performances.

Our empirical analysis is based on firm level balance sheet data. We consider 441287

firms from 14 EU member states, including large incorporated companies as well as a great number of smaller unincorporated companies. We provide detailed evidence on the extent of female firm leadership and performance of male- and female-led firms.

We calculate three different estimates of the country specific effects of female leadership on firm performance. First, we estimate the simple *prima facie* effect resulting from the simple comparison of average *roa* of female- and male-led firms. Secondly, we apply a matching approach based on an extensive set of firm characteristics and match exact within NACE two-digit sector. This matching routine may include the potential pitfall of controlling to some extent for differences in firm performance as some of the regarded covariates may to some extent 'explain' the firm performance measured as *roa*. Therefore, we provide a third estimate of the effect of female leadership based on a matching routine which is carried out within NACE two-digit sectors based solely on firm size.

A first descriptive analysis reveals noticeable differences in the extent of female-led firms in the 14 countries, with above average fractions in Portugal and Romania, and low fractions in United Kingdom, Austria and Greece. The sectoral structure varies considerably across countries, but according to our decomposition analysis this sector effect is not responsible for the differences in countries' proportions of female leaders. Mainly we observe only minor differences between female- and male-led firm characteristics, but women-led firms seem to be smaller and less risky than male-led firms. For most countries, we find no manifest differences in return on assets between female- and male-led firms for the whole country as well as for different sectors.

A simple comparison (*prima facie* effect) of performances of women- and men-led firms reveals a significantly negative effect of female leadership for Poland, and significantly positive effects for Italy, Greece, and France. By applying a matching routine based on a comprehensive set of covariates, we find unequivocally no effect for each of the 14 member states. In the third comparison, controlling only for firm size and sector affiliation, 13 out of 14 differences remain insignificant, with Finland being the only exception.

In summary, all three estimates of the effect of female leadership on firm performance are almost always negligible and statistically insignificant. Therefore, we conclude that female managers do as good as their male counterparts in the 14 EU member states considered.

Our study adds further evidence to international research on female representation in top management positions and firm performance for the EU. Our results suggest that female-led firms do not underperform male-led firms in almost all considered countries. The finding that the extent of female-led firms varies substantially across EU member states suggesting further country specific investigations.

While it is not confirmed by our study that higher female representation on boards lead to higher firm performances, there are nevertheless reasons for promoting a higher proportion of women in leading management positions in the EU, e.g. for gender equality reasons or to provide motivation for younger women to break the glass ceiling. Moreover, our results indicate that female quotas should not be hampered by fears of a decline in firm performance.

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Table 10: Overview: legal gender quotas in Europe

country	year introduction (implementation)	quota
Norway	public firms: 2003 (2004) private firms: 2006 (2008)	40%
Spain	2007 (2015)	40%
Iceland	2010 (2013)	40%
France	2011 (2014-2017)	20%-40%
Netherlands	2011 (2016)	30%
Belgium	public firms: 2011 (2012) private firms: 2011 (2017-2019)	one third
Italy	2011 (2015)	one third
Germany	2015 (2016)	30%
Denmark, Finland, Greece, Austria, Slovenia	only for public firms	

Note: based on Bauernschuster and Fichtl (2013)

Table 11: Conditions which every analyzed firm has to fulfill.

Predictor	Minimum value	Maximum value
<i>roa</i>	-1.0	1.0
<i>age</i>	0.0	500.0
<i>dr</i>		1.0
<i>liq</i>		50.0

Table 12: Literature overview

<i>Paper</i>	<i>Data</i>	<i>Variables</i>	<i>Methods</i>	<i>Results</i>
Adams, R.B. & Ferreira, D. (2009): Women in the boardroom and their impact on governance and performance, <i>Journal of Financial Economics</i> 94	US, director-level data for S&P 500, S&P MidCaps, S&P SmallCap firms, ExecuComp, CRSP, 1996-2003, n1=1939 firms and n2=8,253 firm-year obs.	firm outcomes: Tobin's q, roa, female leadership: fraction of women on the board, determinants: board size, board independence, log(sales), number of business segments	fixed effects model with firm fixed effects, year and industry dummies, IV approach	diversity effect on performance negative after inclusion of firm fixed effects, IV estimation: also significantly negative effect on performance, but positive impact in firms with weak governance
Dezsö, C.L. & Gaddis Ross, D. (2012): Does Female Representation in Top Management Improve Firm Performance? A Panel Data Investigation, <i>Strategic Management Journal</i> 33	US, S&P 1500 firms, S&P's ExecuComp and Compustat database, CRSP, 1992-2006, n1>2,500 firms and n2=21,790 firm-year obs.	firm outcomes: log of Tobin's q, (return on assets/equity), female leadership: dummy variable: 1 (0) if any (none) of the firm's managers is female, (percentage of women in top management), determinants: innovation, CapEx and marketing intensity, size, firm age, leverage, age of capital stock, numbers of managers, (lagged Tobin's q)	fixed effects regression with firm and year fixed effects	positive effect of female representation in top management on firm performance, especially for innovative firms
Robb, A.M. & Watson, J. (2012): Gender differences in firm performance: Evidence from new ventures in the United States, <i>Journal of Business Venturing</i> 27	US, Kauffman Firm Survey, 2004-2008, n1=4016 firms	firm outcomes: firm closure rates, roa, Sharpe ratio, female leadership: female firm owner, determinants: firm age and size, industry, incorporation, owner's hours worked in the business, education and experience	Cox-proportional hazard model, linear regression	no effect of owner gender on firm closure, roa and Sharpe ratio
Watson, J. & Robinson, S. (2003): Adjusting for risk in comparing the performances of male- and female-controlled SMEs, <i>Journal of Business Venturing</i> 18	Australia, Business Growth and Performance Surveys of Australian SMEs, 1994-1998, n1=2367 firms	firm outcomes: average annual profit, Sharpe ratio, female leadership: female controlled firms, determinants: age and size of business, industry	ANOVA	sex has explanatory power for profits (male-controlled firms have higher profits), but not for risk-adjusted performance
Wolfers, J. (2006): Diagnosing Discrimination: Stock Returns and CEO Gender, <i>Journal of the European Economic Association</i> 4(2-3)	US, S&P 1500, ExecuComp data, CRSP, 1992-2004	firm outcomes: monthly stock return, female leadership: proportion of month in which firm was run by a woman, determinants: CEO tenure, dummy for Nasdaq and S&P 500 firm, book-to-market ratio, dividend, stock price, market capitalization, trading volume, returns over the previous months	Fama-Macbeth regression, matching approach	regression: no effect of female CEO on performance, matching: no significant difference between female- and male-headed firms

<i>Paper</i>	<i>Data</i>	<i>Variables</i>	<i>Methods</i>	<i>Results</i>
Smith, N. et al. (2006): Do women in top management affect firm performance? A panel study of 2,500 Danish firms, <i>International Journal of Productivity and Performance Management</i> 55(7)	Denmark, Statistics Denmark, KOB, 2500 largest Danish firms, 1993-2001, n=2300-2500 firms each year	firm outcomes: gross profit/net sales, contribution margin/net sales, operating income/net sales, net income after tax/net assets, female leadership: proportion of women among the top CEOs (+ vice-directors), proportion of women on the director's board, determinants: size and age of firm, export orientation, minimum efficient scale (MES)	pooled and fixed effects regression with firm fixed effects, industry and year dummies, IV approach	mixed; pooled: positive or insignificant effects of female CEOs on performance measures, fixed effects: mostly insignificant effects, IV: similar results; positive effects mainly driven by women with university degree
Flabbi, L. et al. (2014): Do Female Executives Make a Difference? The Impact of Female Leadership on Gender Gaps and Firm Performance, <i>CEPR Discussion Paper No. DP10228</i>	Italy, Bank of Italy's annual survey of manufacturing firms, Italian Social Security Institute, Company Accounts Data, manufacturing sector, 1987-1997, n1=795 firms (234 firms in balanced panel) and n2=5,029 firm-year obs.	firm outcomes: workers' wage distribution, sales/value added per worker, Total Factor Productivity, female leadership: fraction of female executives, female CEO dummy, determinants: firm size, industry, region, worker's age, tenure, occupation, gender distribution, firm leader's age, tenure	fixed effects regression with firm, worker, and executive fixed effects, year dummies, industry-specific time trends	no effect of female leadership on firm performance, positive effect of interaction between female leadership and fraction of female workers on firm performance
Rose, C. (2007): Does female board representation influence firm performance? The Danish evidence, <i>Corporate Governance: An International Review</i> 15(2)	Denmark, Danish firms listed on the Copenhagen Stock Exchange, firms' annual accounts, 1998-2001, n2=443 firm-time obs.	firm outcomes: Tobin's q, female leadership: proportion of women on the supervisory board, dummy variable: 1 (0) if any (none) of the firm's managers is female, determinants: foreigner, lawyers, economists, engineers on the supervisory board, average worker's payment, growth, cumulated ownership of shareholders, size (turnover) and standard deviation of turnover (firm's risk), options, industry dummies	OLS	no effect of female managers on performance
Parrotta, P. & Smith, N. (2013): Female-Led Firms: Performance and Risk Attitudes, <i>IZA Discussion Paper No. 7613</i>	Denmark, Danish register data, Experian, 1997-2007	firm outcomes: firm net investment, gross profits, roe, total sales, variability of these measures, female leadership: female CEO, female chairman, proportion of women on board, determinants: education, occupation, and nationality of workers (women), share of women, firm size, industry, export/import rate, new establishment indicator, year dummy	OLS regression, fixed effects regression with firm fixed effects	no robust effect of female leadership on absolute performance, but systematic negative effect on performance variability

<i>Paper</i>	<i>Data</i>	<i>Variables</i>	<i>Methods</i>	<i>Results</i>
Gagliarducci, S. & Paserman, M.D. (2014): The Effect of Female Leadership on Establishment and Employee Outcomes: Evidence from Linked Employer-Employee Data, <i>Research in Labor Economics</i> 41	Germany, IAB establishment panel, employee social security history → linked employer-employee data on German establishments (LIAB), 1993-2012, n1=7,554 firms and n2=106,143 firm-year obs.	firm outcomes: business volume, investment, and wage bill per worker, total employment, hiring rate, and termination rate, female leadership: fraction of women among top managers, and among working proprietors, determinants: year, region, sector, size, and type of establishment, legal form dummies, age, education, tenure, and foreign nationality status of management	pooled OLS regression, fixed effects regression with establishment fixed effects, establishment-specific time trends	pooled reg: negative effect of women in top management on all establishment outcomes and total employment, positive effect on hiring and termination rate, fixed effects: no effects
Matsa, D.A. & Miller, A.R. (2013): A Female Style in Corporate Leadership? Evidence from Quotas, <i>American Economic Journal: Applied Economics</i> 5(3)	Norway, panel of Nordic companies, Bureau Van Dyjk's Orbis database, Norwegian Register of Business Enterprises, Thomson ONE Banker, 2003-2009, n1=104 (396) listed (unlisted) firms	firm outcomes: operating profits/assets, female leadership: female directors, determinants: board size, average number of other board seats, firm and year fixed effects, time trends by industry	difference-in-difference approach (before and after the gender quota)	negative impact of quota on performance, mainly driven by increased labor costs
Ahern, K.R. & Dittmar, A.K. (2012): The Changing of the Boards: The Impact on Firm Valuation of Mandated Female Board Representation, <i>The Quarterly Journal of Economics</i> 127	Norway, public limited firms that traded on the Oslo Stock Exchange, firms' annual report, Compustat Global and CRSP, 2001-2009, n1=248 firms and n2=1,230 firm-year obs.	firm outcomes: Tobin's q, (leverage, asset turnover), female leadership: percentage of female board members, (count of women), determinants: -	fixed effects regression with firm and year fixed effects, IV approach	negative effect of gender quota on performance, persistent over time
Minguez-Vera, A. & Martin, A. (2011): Gender and management on Spanish SMEs: an empirical analysis, <i>The International Journal of Human Resource Management</i> 22	Spain, nonfinancial SMEs included on SABI, 1998-2003	firm outcomes: return on equity, female leadership: dummy variable: 1(0) when at least one (none) woman is present on the board, percentage of women on the board determinants: risk, type of major shareholder, leverage, firm's age, number of employees, total asset, number of directors	fixed effects regression	negative effect of women's presence on the board on performance