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All on board? New evidence on board gender diversity from a large panel of firms

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Abstract
We provide an overview of gender board diversity in Europe, using an exceptional database of over 100 million firms over the period of two decades and a novel gender assignment. We show that women on supervisory boards reduce the likelihood that a woman is on a management board. In fact, as much as 90% of European corporations have no women on supervisory boards, whereas roughly 80% of them has no women on management boards. We also show that more gender equality at a country level is not conducive to greater gender board diversity.

Keywords:
glass ceiling, gender board diversity

JEL Classification
J7, P5

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1. **Introduction**

According a widely known fun fact, there are more men by the name of John among executive managers in firms listed on the New York Stock Exchange than all women taken together. The low presence of women on management and supervisory boards has long been a hotly debated issue, with some countries – such as Israel or Norway – implementing dedicated policies to raise participation of women in top management (Dale-Olsen et al. 2013; Wang and Kelan, 2013; Terjesen et al., 2015; Schwartz-Ziv, 2015). The literature has so far identified two stylized facts. First, women are unicorns among top managers and supervisory board members – in the US, Europe and elsewhere. Second, there is little to no evidence that female management is systematically associated with weaker firm performance (e.g. Wolfers 2006; for an overview see Terjesen et al., 2009).

This literature has faced two important hurdles. First, in most cases the analysis is limited to a small and non-representative fraction of all management positions: stock-listed companies. Admittedly, management and supervisory board composition for listed companies is publically available and so are the firm performance indicators, which makes empirical studies feasible. However, majority of firms in most countries are not listed in stock exchanges. Access by women to the executive management and supervisory positions of this majority has been off the radar of a large share of the studies. A rare exception from this rule is a recent IMF study by Christiansen et al. (2016). However, in this study the sample was cut to less than 2 million firms from 34.4 million of total data coverage, thus again keeping of the radar a vast majority of firms.

The second hurdle concerns causal identification. Members of both management and supervisory boards are selected purposefully, which implies that their characteristics, including gender, are not randomly assigned to firms. Hence, estimating the *effect* of any individual characteristic on being on a board as well as any individual executive on firm performance would be biased – both due to omitted variable problem and due to simultaneity.

Against the literature, our paper offers two contributions. First, we develop a comprehensive database covering 20 years of listed and non-listed firms from a wide selection of 44 advanced and emerging economies. Our analysis covers a substantial share of output and employment in the analyzed countries. We analyze the prevalence of women's presence in management (and supervisory) boards, country and sector-level specificity as well as the time trends. As a side product, we also offer a methodological contribution: we compare alternative measures of women's presence in management and supervisory boards. Although these alternative measures are correlated, they do not offer the same conclusions, which hints to areas of possible policy intervention.

Second, we exploit the benefits of a long firm-level panel. Following Matsa and Miller (2011), we ask if the presence of women on the supervisory boards is conducive to subsequent presence of women in top management positions. We utilize time dependence a la Granger to analyze the sequencing of women entry into

supervisory and executive positions. In contrast to the earlier evidence from stock-listed firms in the US, paraphrasing, Matsa and Miller, we find that "women do not help women in corporate Europe". We also seek to corroborate the findings of Adams and Kirchmaier (2013, 2016), who argue that generally more gender equal countries are characterized by greater gender board diversity. In this case too, data deny the results from the earlier literature: measures of gender equality are negatively correlated with the gender (management) board diversity, and so is the (management) board size.

The remainder of the paper is structured as follows. First, we relate our study to earlier literature in the field, showing similarities as well as dissimilarities between our approach and the evidence provided before. Second, we provide a novel way to identify women's presence on boards. Thanks to this method, our sample is substantially more comprehensive than earlier studies. We discuss the gender assignment and data in detail in section 3. This section concludes by descriptive evidence and stylized facts. We subsequently move to analyzing the results of our study, focusing on the stylized facts behind the heterogeneity of women presence in management and supervisory boards. Our paper is concluded by the policy implications.

2. **Insights from earlier literature**

The literature about women on corporate boards is diverse. In fact, in a recent overview, Gabaldon et al (2016) argue that the research in the field is fragmented into too many silos lacking also comprehensive theoretical foundations. The relevant empirical studies can be broadly organized in three strands.

The first strand of the literature analyzes the determinants of boards diversity. Typically, studies rely on listed companies and focus on identifying firm-level correlates of women share on management boards. This strand is possibly the most numerous in terms of studies and covers a wide selection of countries. A rich body of literature analyzes the US (Adams and Ferreira, 2009; Carter et al, 2010), UK (Brammer et al. 2007), France (Sabatier, 2015), Finland (Virtanen, 2012) Japan (Morikawa, 2016), Italy (Ferrari et al, 2016) and BRICS (Saed et al., 2016) to name a few. There are also numerous sector-level studies, e.g. de Cabo et al. (2012) who analyze the European banking sector. All of the above studies utilize data for the stock exchange (or otherwise) listed companies. A notable exception is offered by Martín-Ugedo and Minguez-Vera (2014) who focus on small and medium sized firms in Spain and find that the odds for at least one woman on board increase with firm performance and size.

The second strand of the literature attempts to relate gender diversity of management boards to the firm performance. Here too, studies utilizing data on listed firms dominate, beginning with Wolfers (2006) and several follow up studies (e.g. Adams and Ferreira, 2009; de Cabo et al, 2011; Dezsö and Ross, 2012; Chapple and Humphrey, 2014; Gregory-Smith et al., 2014; Sabatier, 2015). These studies typically find modest or no negative effect on performance per se. However,

a sub-strand of the literature focuses on firm risk-taking (e.g. Nakano and Nguyen, 2012; Berger et al, 2014; Facio et al, 2016), engagement in CSR (e.g. Bear et al, 2010; Rao and Tilt, 2015), mergers and acquisitions (e.g. Levi et al, 2014), innovativeness (e.g. Talke et al, 2010), etc. Here apparently female CEO or gender board diversity contribute to differentiated corporate policies. A relatively weaker side of this literature concerns causal identification. Authors attempt numerous empirical strategies, such as instrumental variables (e.g. Sabatier, 2015). However, the key concern in this literature is that if consumer tastes are biased against women, female presence on board may be much more a signal about a firm and much less an actual causal effect of a particular board member or members, management or communication.[1]

Hence, interest in exploiting natural or quasi-natural experiments, such as legislative changes. For example, exploiting the Norwegian boards of directors' quota reform Dale-Olsen et al. (2013) find that increased women's presence had negligible effect on firm performance. In spite of comparable performance, Ahern and Ditmar (2012) show that the quota reform was followed by a significant drop in the stock price at the announcement and a large decline in Tobin's Q over the subsequent years. Here too, the concerns of endogeneity arise, however. Namely, legislating quotas for women on supervisory boards is not entirely exogenous to corporate culture, firm performance, etc, as conceptualized recently by Tjersen et al. (2015). To address this concern, a number of laboratory experiments has focused on gender diversity in teams and subsequent team performance (e.g. Hoogendoorn et al. 2013; Bohnet et al., 2015; Amini et al. 2016). These studies argue that gender diversity is conducive to improved performance of the teams.

In the third strand of the literature, the core of the interest lies at identifying factors limiting the presence of women on management boards (an extensive overview was given by Doldor et al., 2012). For example, Tienari et al. (2013) show, that already the search for executives is exclusive in a sense that firms seeking candidates to top management positions often preclude women at screening stage. Moreover, once already on boards, women need not make a difference. For example Schwartz-Ziv (2015) analyzes the minutes of board meetings over a long time horizon in Israel and argues in favor of the critical mass hypothesis: it is not just women's presence, but also the number of women and positions they hold (see also earlier insights by Torchia et al., 2012). This strand of literature also analyzes factors conducive to increasing women's participation in boards. Smith et al. (2007) argue that women work more frequently in fields which are less likely to deliver a top executive position. Van Staveren (2014) argues that this is an outcome of gender stereotypes, which hinder women's careers in some fields. A similar approach is taken by Adams and Kirchmaier (2013, 2016) who find that the same institutional factors explain cross-country variation in gender board diversity and female labor force participation. Namely, it appears that ability to participate in the labor market full time correlates strongly with women's presence on boards even when controlling for

[1] Some more light on this issue is shed by studies which analyze actual behavior of women on boards (e.g. Adams and Ferreira, 2009; Schwartz-Ziv, 2015).

a large number of confounding factors, such as legislation, cultural norms, gender wage gap, etc. One of the ways to interpret these results is that the ability to self-fulfill and aspire are key determinants of women corporate success. Matsa and Miller (2011) argue that a woman's hand may be of help as well: women in the supervisory boards facilitate the subsequent increase in the presence of women among the management boards.

Of the above strands of the literature, our study is most similar to the last strand. Unlike earlier studies, we utilize a large and comprehensive firm-level panel dataset. Since in our data management and supervisory boards are clearly separated, we also provide a verification of the hypothesis that women's presence on supervisory boards facilitates women's presence among the executives. In contrast to Matsa and Miller (2011), our analysis goes beyond stock-listed companies, as we analyze a large set of small, medium and large enterprises across all sectors and from more than 40 countries. This is relevant, because one can extend the taste based discrimination argument, following Wolfers (2006), only to the companies whose management and supervisory boards are widely known and whose composition may be verified by each stock holder and customer at virtually zero cost. For non-listed companies it is not evident that the taste discrimination argument should work at all, let alone that the prior presence on supervisory boards is needed, nor effective, to open the doors to executive positions for women.

We also provide an extension to the work of Adams and Kirchmaier (2013, 2016). They too narrowed their sample to stock-listed companies. As a consequence, the list of confounding factors they analyzed abstracted from sector specificity. However, earlier literature seems to suggest that there may indeed be differences in how decisions are taken by the management boards with and without women's presence. This may be particularly relevant in industries with higher risk associated with doing business, more fierce competition, etc. Exploiting the richness of our data we compute proxies and test if controlling for these confounding factors still affects the main conclusion of Adams and Kirchmaier (2013, 2016).

3. **Data**

Data in this study come from Bureau van Dijk a.k.a Amadeus. These data are distributed in editions, with each edition covering up to 10 years of firms' history. Clearly, not each firm in a given edition of Amadeus data has existed for up to 10 years. Effectively, the median duration of a panel for most countries in Amadeus is about 4 to 6 years, but when combined, subsequent editions of Amadeus yield longer firm-level panels. In this study we combine editions from 2002, 2003, 2004, 2008, 2010 and 2014, thus obtaining nominal data coverage from 1995 to 2013.

The number of firms in each edition of Amadeus depends on a year and country. Recent editions are far more comprehensive than the editions from the past, while larger countries are characterized by a larger number of records. For example, in total, a 2014 edition of Amadeus comprises data on 18.3 million firms from 44 countries, but a 2004 edition comprises data on 6.8 million firms and from 38 countries.

Data in Amadeus usually come from national information providers and are based on registry administrative records or courts (depending on the country legislation). Hence, data coverage by size differs between countries and so does the availability of financial and accounting information. Due to this reason, Kalemli-Ozcan et al (2015) propose a procedure to step-wise clean the Amadeus data. However, given that most of the management and supervisory boards records come from the registries, this type of information is particularly widely available in Amadeus. Hence, we are less constrained than Kalemli-Ozcan et al (2015), who require full financial records. We drop a firm from the sample only if its industry is never reported in the sample or if the information on management and supervisory board members is missing. Both exclusions concern a negligible fraction of the sample, hence, unlike Christiansen et al. (2016), who are left with roughly 10% of the original sample, we work effectively with a full Amadeus database.[2]

The Amadeus design for collecting management and supervisory board data is both fortunate and unfortunate from the perspective of this study. On one hand, having exact names of boards members, we may control for individuals participating in multiple boards and thus obtain effective number of boards members. On the other hand, given the large sample sizes at firm-level and the quality of this data, the individual records are prone to numerous typing errors and inconsistencies between editions. Due to these constraints, we implemented a number of heuristics to make this large bulk of data useful for the analysis. We discuss them below.

3.1. Names

We parse individual records for boards members to obtain name and surname. Due to typos, fields for individual names sometimes contained firm name or owner name. These cases were identified based on the presence of key words (such as Geselschaft, Club, D.D., United, Venture, Z o.o., etc.).[3] In total this was 2% of all analyzed names records and we drop them from the sample.

Before individuals could be identified, the records had to be trimmed for salutations or other prefixes and suffixes which blur the distinction between the actual name and surname and e.g. social functions. These comprise cases such as baron/baroness or reverend.[4] In some languages, some of the salutations permit gender identification, but this is not universal and frequently salutations are abbreviated, which limits their usefulness for gender identification. To identify name from surname we follow country rules to identify cases where surname comes first (e.g. Hungary, Bosnia and Herzegovina). Based on the list of individuals, we construct an individual level panel of all members of management and supervisory boards observed at any point in time in all analyzed editions of Amadeus.[5]

[2] We do follow Kalemli-Ozcan et al (2015) in obtaining consistent industry identifiers across the subsequent editions of Amadeus.
[3] Full list of these exceptions is available upon request.
[4] Full list of these exceptions available upon request.
[5] We parse surnames and names to identify repeat cases in order to assure that the same set of names receives the same gender attribution in each edition of Amadeus. A parser algorithm identifies the

3.2. Gender attribution

We propose a novel approach to gender attribution. Instead of utilizing the attribution provided by Amadeus, we use names and surnames of each individual board member. In fact, editions of Amadeus prior to 2010 do not comprise gender identification for the members of management and supervisory boards.[6] However, for most of the countries, full names and surnames of individuals are sufficient to attribute a gender. We utilize an array of heuristics to identify gender from the names.

- Heuristic 1. In the case of some languages, gender is directly identifiable from the form of the first name or the surname. In some Slavic languages, for example, female names end with a vowel (Lithuanian, Russian, Slovenian, Polish), in other languages a surname ends with a suffix with direct identification of gender (Slovak, Czech, Russian). The complete list of such rules has been compiled based on the Wikipedia entries for each of the respective languages.
- Heuristic 2. If Heuristic 1 is not sufficient, we attribute gender based on the names database. In some languages (including exceptional cases from Heuristic 1 as well) there exist names which directly identify a gender. For example, there are no women named John in English, just as there are no men named Catherine. There are a number of names databases with gender attribution[7]. On a language by language basis these databases were combined, with conflicting cases sorted one by one.

Some individuals are reported with more than one name, with or without a dash. In such cases, the name was split to each component separately and Heuristic 1 or 2 were applied, depending on the language at hand. Heuristics were applied sequentially and gender was assigned only if there was no conflict between them.

In general there are three types of countries in the Amadeus data. For the first type of countries, there is one linguistic rule to assign genders. For example, H1 assigns gender to all individuals based on a rule (or by complementing the rule for one gender, e.g. in the case of Bosnia and Herzegovina, there is a comprehensive rule that certain vowels as last letters in a name identify women, hence lack thereof identifies men; we set all individuals to be men and then replace all individuals with specified vowels as last letter of name to be women). We then verify if the sample contains names which are consistently identified as opposite gender in other

longest sequence of characters in a name field and surname field and reports cases where individuals could not be matched between the editions of Amadeus. These cases were analyzed manually. If the mismatch resulted from an obvious typo, the two records were coded as a match. In other cases these two records were treated as separate individuals. An example of an obvious typo is a discrepancy between Bernáth and Bernáht in Hungarian, because the latter is not likely to exist in Hungarian, whereas "th" is a frequent morpheme in Hungarian. An example of separate individuals are Maille and Maile because both may likely exist in French.

[6] This is why in a recent study Christiansen et al. (2016) work with a cross-section.

[7] We gratefully acknowledge the use of the following sources: http://babynames.merschat.com/ (general) http://www.behindthename.com/ (for Croatian, Danish, Estonian, Finnish, French, Hungarian and Italian), as well as https://de.wiktionary.org/wiki/Verzeichnis:Deutsch (for German names).)

languages, to account for expats and minorities. In the rare cases of the conflict between original gender assignment from the first and second heuristic, we identify on a case by case basis, using language and culture dictionaries.

However, in some languages there is no clear rule or there is more than one language spoken in a given country; hence, the second and third type of countries. For the second type of countries, in the presence of default rules, if one language is universal or dominating, gender is assigned based on the default rule for this language. Subsequently we apply a book of names for this language, as in the second heuristic. Once this assignment is complete, the unassigned individuals are tested with the book of names for the second most popular language, etc. For the third type of countries, if there is no default rule and there is more than one frequent language, gender is attributed based on the combination of the book of names of all the applicable languages.

Clearly, there are some cases in which gender identification is controversial or not possible at all. For example, data for the Netherlands in Amadeus report only initials for names, whereas surnames are insufficiently informative about gender in Dutch. Hence, no gender identification is possible. In some cases individuals report incomplete or more than one name, which yields contradicting gender attribution (e.g. Jean-Marie is identifiable to a man, Jeanne-Marie to a woman, but J-Marie cannot be unequivocally attributed to any of the genders). In the case of most countries, however, there were only few cases of conflicting gender attributions for a given individual as well as missing gender attributions after applying all three heuristics. Table A1 in the Appendix reports details.

In addition to being fairly comprehensive and allowing wider time coverage, the proposed procedure for gender attribution is also rather effective. In the 2010 and 2014 edition of Amadeus we may utilize gender attribution by Bureau van Dijk. We apply our identification rules to the names in these two editions of the data and compare gender assignment from the our heuristics to the salutation / title in Amadeus. This verification yields effectively a complete concordance between Amadeus gender assignment and our gender assignment. The actual misattribution of gender is negligible, see Table A2 in the Appendix, while the majority of discrepancy between our gender assignment and salutation in recent editions of Amadeus comes from the cases where heuristics cannot reliably assign gender (e.g. due to a missing name). Indeed, relative to the Amadeus salutations, our assignment may marginally understate the role of women, but it comes at the advantage of being able to use the data for 20 additional years.

3.3. Economy coverage

Earlier studies have typically relied on a relatively narrow subsample of firms in the analyzed economies (e.g. Wolfers, 2006; Matsa and Miller, 2011; Ahern and Dittmar, 2012). Due to our novel gender identification, we are able to utilize information on effectively majority of firms as many as 20 years of data for 44 countries. However, data coverage in Amadeus is not equivalent to administrative data. After removing missing observation and correcting for consistency, a number

of records in some countries are dropped. For example, the cleaning procedure described by Kalemli-Ozcan et al (2015) yields 45% out of 4.4 million companies with financial records, i.e. roughly 20% of the total sample.

In this study we need to identify only the sector and size, hence our procedure for cleaning the data is less restrictive than Kalemli-Ozcan et al (2015). Moreover, we use a larger number of Amadeus editions, thus yielding wider time coverage for each firm. Consequently, we are able to keep as much as 91% of the 24 million companies available in the sample. For these firms we identify the individuals in supervisory and management boards. In some cases, as discussed earlier, there are no names of persons in supervisory and management boards. These firms have to be dropped. In total we identify individuals in 18.6 million companies, i.e. 77.5% of the total sample. We call this the full data set, henceforth.

The data we utilize represent a fair share of the total economy. We compare the aggregate employment and value added in the sample to the available analogues from World Input-Output Database (WIOD), see Table A3 in the Appendix.[8] While the coverage is indeed comprehensive, for some years, countries and sectors, comparison to WIOD reveals other problems. First, self-reported sector of employment reported by workers in labor force surveys – which is the base for WIOD measurement of employment by sectors – need not overlap with the NACE reported by the employer. Hence, in some sectors, countries and years comparison of WIOD employment and aggregated sector employment in the Amadeus data reveals cases of more than 100% coverage. This need not be incorrect *per se*, but if the discrepancy is large, it may hint mistakes in the Amadeus data. The problem is less acute in the case of output measures, but still exists, if NACE reported in Amadeus is different than NACE reported for the national statistical purposes, used in WIOD. Overall, it appears that Amadeus data in general has heterogeneous quality. Second, coverage of the economy tends to vary across years for the same countries and sectors. So long as these changes appear roughly continuous and follow patterns, one may assume this stems from sample atrophy and incomplete replenishing of the sample with the new establishments. However, in some cases it appears to be a structural change in data coverage in the economy (e.g. a jump from under 60% to nearly 90% between 2001 and 2002 in Finland and France or two years of substantially smaller coverage in Denmark in 2007 and 2008). These structural breaks are large at aggregate level, but reflect sometimes even more profound changes at sectoral level.

To mitigate the possibility of the results being driven by such substantial swings in sample composition we employ the following procedure. First, we include sector and country fixed effects, in the estimations. Second, we tag cases of substantial change in data coverage in a given country and sector in a given year, as these observations may compromise the representativeness of the study. We develop tagging for large

[8] For some countries from the Amadeus data, data are unavailable in WIOD. This concerns Albania, Belarus, Croatia, Iceland, Liechtenstein, Macedonia, Montenegro, Norway, Serbia, Switzerland and Ukraine. For these countries the reliability of Amadeus data cannot be verified. Hence, they are included in the full sample estimation, but omitted from the trusted sample estimations.

changes in employment share and for low employment share.[9] Eventually, we are left with observation for firms from sectors with trustworthy representation within countries and years. This yields 16.9 million companies, i.e. 90.9% of the usable sample. We call this the trusted data set, henceforth.

3.4. Management and supervisory board membership identification

More recent editions of Amadeus – from 2008 onwards – comprise confirmation dates. Since data about boards members may concern as many as 10 years of a company's history, changes in both supervisory and management boards are a common phenomenon. Moreover, it occurs that an individual moves between management board and supervisory board. To correctly classify participation in either of the boards, confirmation dates are of vital importance. However, Amadeus editions prior to 2008 do not comprise confirmation dates. If a person held more than one position in boards of a given firm, these positions are all listed with no time boundaries. Moreover, even post-2008 Amadeus editions frequently have this information missing. In fact, confirmation dates are only available for roughly 37% of individuals in the sample post-2008.

Given this methodological constraint we implement the following two approaches. First, we develop a sample where full identification of confirmation dates was possible. This sample covers two of the most recent editions of Amadeus and slightly under 40% of individuals identified in those two editions of the data. In the second approach, we assign the person to be in management or the supervisory board, respectively, for each year of the data covered by a given edition of Amadeus. If in the same year, a person is listed in both management and supervisory board, we randomly assign belonging to either management board or supervisory board, because the exact daily confirmation dates are unavailable. Random assignment should be neutral from the perspective of our research question. However, it is likely to introduce additional noise to the data.

Since our random assignment may be applied also the individuals for whom confirmation dates are available (as if confirmation dates were unknown), we may analyze the consequences of such imputation in-the-sample. Figures A1, A2 and A3 in the Appendix report the correlations between the actual measures and measures based on random assignment. Most of the disparities fall within 5pp each way. Hence, random assignment of confirmation dates multiples the data coverage with little risk of large mistake. Any discrepancy between measures for the actual board membership and the ones we obtain from randomly assigning confirmation dates stems from individuals holding more than one position in a given year for a given firm. Hence, one should not expect the actual bias of our final estimates to be large.

3.5. Measures of female presence on boards

[9] Coverage tags are set for below 10% of the employment coverage and above 150% of the employment coverage. In addition, we tag substantial changes in coverage, with the threshold set at 10% of employment coverage.

It is not immediate how the presence of women on boards should be measured. One possible indicator – used by e.g. Matsa and Miller (2011); Ahern and Dittmar (2012) as well as Adams and Kirchmaier (2016) – computes a firm level share of female presence on a board. For this measure one woman in a 2-persons board is equivalent to ten women in 20-persons board. This may be useful if one is interested in intensity of female presence, but may be insufficient if one wants to evaluate if – for example – it becomes easier for women to enter the management or supervisory boards.

Hence, an alternative indicator would focus on the number of women-headed firms rather than a fraction. Such a measure was used by e.g. Wolfers (2006) as well as Adams and Ferreira (2009). Given that our data set is richer, we may extend this approach to focus on the number of women *per se* on the boards (relative to total management and/or supervisory board headcount). However, this measure becomes susceptible to the sample size. In particular, since Amadeus sample size is steadily increasing between the editions, the sums may reflect asymmetrically wider economy coverage in Amadeus rather than increasing access to managerial and supervisory boards for women.

An alternative, at least partially immune to the growing sample size in Amadeus, focuses on the very presence of women on boards. This indicator computes the fraction of firms that do (not) have women on boards. With increasing sample size, if the share of firms with no women on boards was decreasing, then that would be indicative of top positions becoming more available to women. Admittedly, stable and increasing shares are not necessarily informative of the changing position of women, especially if composition effects are large with sample size expansion.

Since each of the indicators has its vices, we compute and utilize all three. We utilize firm level data and we apply the following aggregation rules. For the first measure, we compute a share of women on managerial board and supervisory board for every firm. Subsequently we compute an average of these shares in a given sector, country and year. For the second measure, we add the number of women in managerial boards and separately women in supervisory boards for a given sector, country and year. For the third measure we identify at firm level that at least one woman is present in management board or supervisory board. Subsequently, we compute the share of these firms for each given sector, country and year.

3.6. Descriptive statistics

Combined Amadeus editions yield more than 24 million unique firms observed between 1995 and 2012. Admittedly, these data are of heterogeneous quality. However, we provide a number of ways to address its weaknesses, which serve as sensitivity and robustness checks. In Table 1 we report descriptive statistics, demonstrating how subsequent narrowing of the sample translates to the effective sample size, in terms of individuals, in terms of firms and in terms of years covered.

The first observation concerns the coverage over time: it is increasing for the subsequent years, but the increase is not monotonous, with a drop between 2001

and 2003, subsequent hike in 2004-2006, and another decline in 2007. These changes replicate from full set to trusted set as well as reduced set. Year on year changes in the number of observations reach even 40-60%. While larger data set need not comprise different time trends in measures of gender board diversity, one needs to be cautious about deriving conclusions from one cross-section or even one edition of Amadeus data.

We utilize four definitions of the data. The full set signifies all available information, for which we could identify names of boards members, employment and industry. The trusted set implements selection based on employment coverage in Amadeus relative to WIOD for each country and each year for two-digit NACE sectors. We drop firms from sectors with unusually low (below 10%), unusually high (above 150%) or unusually time-varying (above 10 pp yoy) coverage. The trusted sample comprises roughly 91% of individuals and firms.

Table 1. Descriptive statistics

	Full set		Trusted set		Reduced set		Conf. dates set	
	People	Firms	People	Firms	People	Firms	People	Firms
Total #	241036736	111910296	194996320	92495280	43679648	9096418	6305613	3467427
Total unique	46988701	18610968	38533902	16890260	7609661	1414534	5734709	2564411
	Measure based on shares							
Management boards	-	19.12%	-	19.51%	-	16.60%	-	21.94%
Supervisory boards	-	18.99%	-	18.92%	-	14.85%	-	25.28%
	Measure based on sums							
Management boards	-	17.18%	-	16.78%	-	26.57%	-	15.51%
Supervisory boards	-	18.64%	-	18.06%	-	19.97%	-	36.87%
	Measure based on a % of firms with no women in boards							
Management boards	-	80.44%	-	80.56%	-	68.21%	-	80.61%
Supervisory boards	-	95.04%	-	95.29%	-	87.09%	-	94.73%
# Men	135294144	-	110311264	-	27530066	-	4428730	-
# Women	45870672	-	37099824	-	7388920	-	1876883	-
# in agriculture	5003640	2335412	4603686	2098444	921771	176012	53343	35140
# in construction	22945476	12279008	21913096	11808950	4407621	1144580	277125	119738
# in manufacturing	35794616	14223746	28769054	11492980	13059598	2638408	393882	200729
# in market services	150997968	72149848	116580152	57653488	21029368	4497729	2041548	1058889
# in non-mark. serv.	26295032	10922279	23130340	9441420	4261287	639689	459123	222220
# in 1995	4542979	1579203	3734333	1270437	1332260	256486	-	-
# in 1996	6049391	2119150	5194448	1789894	1806163	363926	-	-
# in 1997	8337528	2833917	6413699	2064274	2360726	435441	-	-
# in 1998	10745087	3621587	8291935	2636962	2741315	500843	-	-
# in 1999	13128664	4542079	10011616	3323265	2898712	531686	-	-
# in 2000	14731537	5120372	11736608	4043599	3091005	575844	-	-
# in 2001	15466813	5532247	11662129	4086087	3084624	585157	490040	282867
# in 2002	14579158	5676959	11785316	4534063	2718785	559048	697590	389951
# in 2003	11120048	5525843	9893769	4991394	1825156	445786	879458	475655
# in 2004	15792903	6844216	11775110	5322492	3002811	616732	895488	488791
# in 2005	17596982	7682396	13513087	6142230	3248940	688545	969292	524376
# in 2006	18152012	7690998	14070620	6235310	3417890	734857	856522	475293
# in 2007	13079864	6812916	12140424	6384179	2225984	507802	584148	359620
# in 2008	12978143	7353589	12049641	6879835	2010786	456951	192965	119185
# in 2009	14923134	8871238	12221242	7498496	1936906	451339	113844	58291
# in 2010	16156254	9763006	13185648	8255125	1986334	462991	144379	74547
# in 2011	16883952	10203124	13674417	8551913	2009491	468206	186776	94327
# in 2012	16772291	10137456	13642284	8485725	1981758	454778	295111	124524

Notes: share measure, sum measure and fraction zeros are means of those across every year-country-sector unit in corresponding data set; # is number of observations for given criteria within the corresponding data set

The reduced set comprises firms with at least 10 employees and at least two members on a management board reported in Amadeus. In terms of economic

identification, this would be the highest accuracy data, but it comprises only 13% of firms and 12% of individuals.[10] Holding more than one position in one year may be clarified between management and supervisory board using information on confirmation dates from Amadeus. However, this information is available only in the latest editions of Amadeus. Hence the fourth and final sample from the data, reporting only those observations for which confirmation dates are unquestionable. This sample contains roughly 14% of all firms and 12% of individuals.

An immediate observation from Table 1 concerns the measures of gender board diversity for the management and supervisory boards: they are strikingly similar for the measures based on shares, but depart by up to 10 percentage points for the measure based on sums and on a fraction with no women on boards. For all the measures, diversity is larger for the supervisory boards than for the management boards. This finding is not a statistical artefact of having in the sample the few countries with supervisory board gender quotas – it occurs in every country in the sample. Hence, it appears that supervisory boards have a higher number of women than management boards. However, in excess of 87-95% of firms have no women in supervisory boards and roughly 80% of firms have no women in management boards. This is an important insight: a larger number of women in supervisory boards coupled with a lower share of firms with any women on supervisory boards, relative to management boards, implies that measurement of gender board diversity cannot be addressed with a single indicator.

Our interest in this paper lies in management boards. In order to build some intuition about the variation of the three measures of gender diversity on management boards we perform an analysis of variance, controlling separately for country effects, sector effects, their combination and time effects. The results reported in Table 2 reveal several important observations. First, it appears that despite as much as two decades of the data, time variation explains a negligible fraction of variance – majority of variance comes from between countries dispersion. In fact, it seems that countries are characterized, with nonexistent role of the sectoral composition effects, because a combination of country and sector controls explains a roughly the same fraction of variance as simply summing the two would suggest. Second, country specificity explains a larger fraction of variance for a measure of prevalence, such as the fraction of firms with no women on boards. For the measure averaging the fraction of women on boards within the sector, there appears to be less of country specificity. Third, controlling for the employment coverage in Amadeus makes a difference. The total fraction of variance explained is much higher for the sample without exceptionally low, high or unstable employment coverage. In addition, the between country variation becomes more relevant. Nevertheless, the general conclusions about the relative importance of the sector, country and time are preserved across samples.

[10] Note that in less than 1% of cases, the reduced set randomly assigns year of board membership in some cases, when one person is reported to participate in management and supervisory board in the same year.

Although time effects do not seem to contribute much to the variation of the gender diversity measures, they are highly relevant. To account for changing country and sector composition we run a series of regressions with measures of gender diversity as explained variable and country, sector and year fixed effects as covariates. We subsequently report marginal prediction for each available year in the data in Figure 1.

Table 2. Decomposition of variance – gender diversity on management boards

	Total data			Confirmation dates sample		
	Full	Trusted	Reduced	Full	Trusted	Reduced
			Share measure			
country	37.5%	55.7%	47.2%	28.3%	27.9%	25.9%
sector (broad)	0.5%	1.0%	2.5%	0.7%	0.9%	2.1%
sector (2 digits)	2.9%	4.8%	8.2%	2.3%	2.7%	4.3%
country and sector	41.5%	59.8%	51.6%	34.1%	33.6%	34.1%
year	0.7%	0.5%	5.0%	0.9%	1.6%	0.9%
all	41.3%	60.6%	58.7%	31.3%	31.0%	30.0%
			Sum measure			
country	20.7%	24.2%	34.0%	15.0%	15.6%	18.6%
sector (broad)	8.0%	13.6%	7.6%	4.0%	3.8%	6.6%
sector (2 digits)	16.3%	28.8%	18.2%	10.2%	10.6%	11.6%
country and sector	34.1%	41.0%	44.5%	25.8%	26.1%	31.8%
year	5.5%	7.1%	7.7%	0.8%	0.5%	0.1%
all	42.0%	57.6%	57.6%	24.3%	25.8%	29.1%
			Fraction of firms with no women			
country	45.9%	64.8%	67.2%	22.6%	23.9%	28.5%
sector (broad)	1.1%	1.2%	1.1%	0.9%	1.0%	1.7%
sector (2 digits)	3.4%	4.5%	4.0%	3.0%	2.9%	3.7%
country and sector	49.9%	68.3%	69.9%	28.6%	29.3%	34.7%
year	0.4%	0.3%	2.0%	2.5%	3.6%	6.5%
all	49.8%	69.4%	72.4%	28.1%	29.5%	34.2%

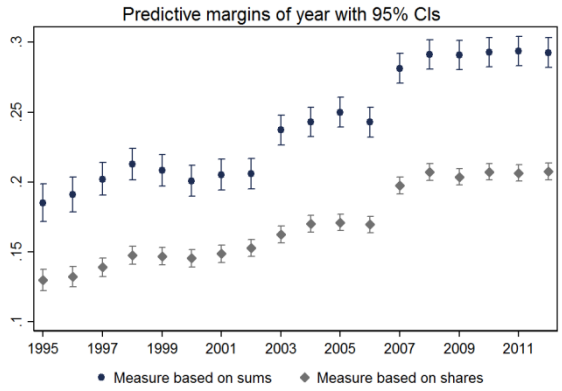
Notes: analysis of variance decompositions, with alternative controls in each row. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points.

The results reveal that although there is a clear time pattern in measures based on shares, it is not fully reflected in measures based on sums, nor measures of women absence from the management boards. Moreover, the positive trend is not robust to eliminating the sectors with exceptionally low, high or time-varying employment coverage. Second, the change in the Amadeus data gathering process as of 2006 reveals that sudden increases in data coverage are associated with structural breaks in estimated time effects. Outside the single year when Amadeus substantially increased the sample, there appear to be no significant time trends in the measure of women exclusion from the boards. Third, the sample limited by information on confirmation dates does not reveal any time trends, mostly because firms present in Amadeus in 2008, that were operational already in 2001 tend to be different than the total sample of firms collected in Amadeus in 2001. This comparison emphasizes the need to combine subsequent waves of Amadeus in coherent data sets. It also suggests that results from a cross-section of data may be particular, relative to the whole available sample.

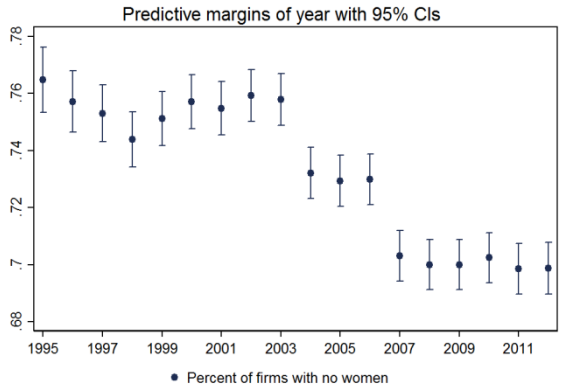
We complement the analysis of the stylized facts with an overview of the country heterogeneity. In parallel to time effects, we estimate the country effects, which are shown in Figure 2. This comparison too exemplifies the paramount importance of using comprehensive data and alternative measures of gender board diversity. Even the very narrow sample of the most recent data with the confirmation dates hints that some countries are different, whereas the ranking of countries based on sum measure and share measure would differ. Moreover, this ranking surely will not replicate in the measure based on the fraction of firms with no women on management boards. Moreover, this heterogeneity does not follow the "usual suspects" patterns. Lithuania and Latvia – countries with many commonalities – rank among the lowest and the highest, respectively, in terms of management boards with no women. Countries considered as relatively equal – e.g. Sweden and Denmark – have among the highest share of firms with no women on management boards, although they fare relatively well in sum measure and share measure. By contrast, in Ireland and Lithuania, more than half of the individuals identified on management boards are women (notably, share measure is substantially smaller).

Figure 1. Time trends in measures of gender diversity on management boards

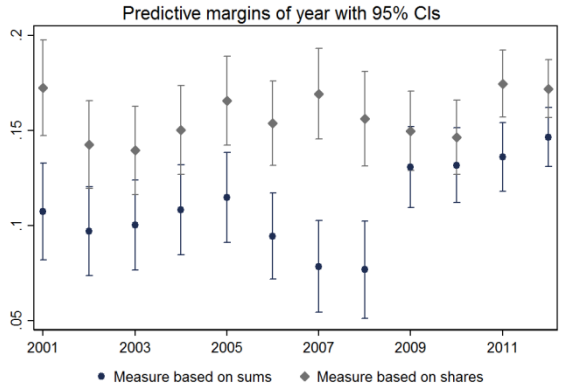
Sum measure and share measure
Reduced



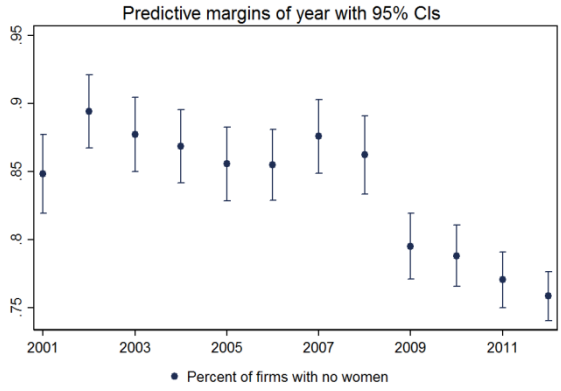
Fraction of firms with no women
Reduced



Confirmation dates full sample



Confirmation dates full sample

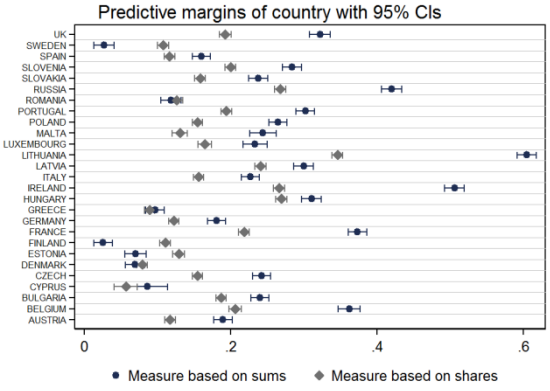


Notes: marginal prediction of year effects. Analogous estimates for the alternative samples available in Table A4 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available.

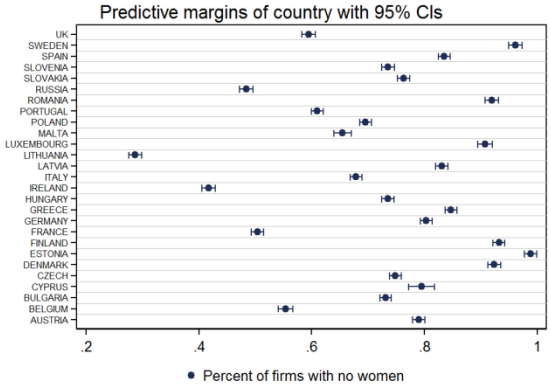
The final set of stylized facts concerns the sector specificity of gender diversity in management boards. Following the intuition, women are more frequently on management boards in services (particularly non-market services) and less frequently in construction. However, although the differences are statistically significant, unlike previous inquiries, economically these differences do not seem large. With the exception of non-market services, most sectors seem relatively close in terms of gender diversity of management boards.

Figure 2. Country trends in measures of gender diversity on management boards

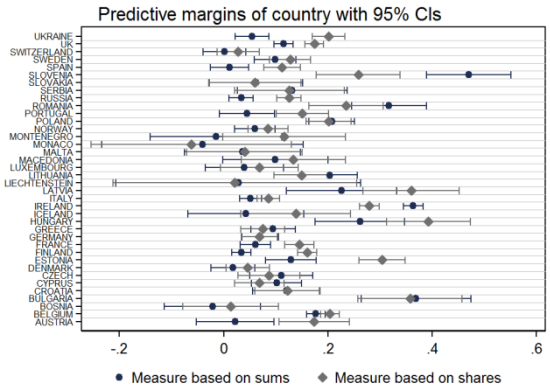
Sum measure and share measure
Reduced



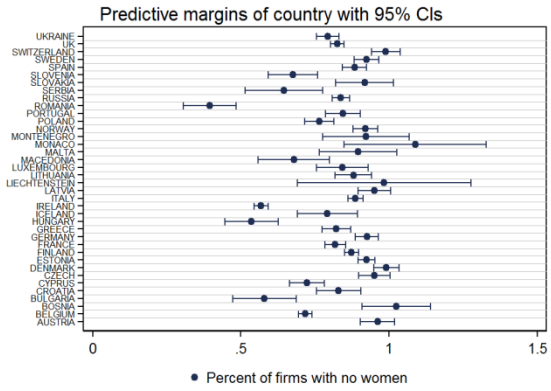
Fraction of firms with no women
Reduced



Confirmation dates full sample



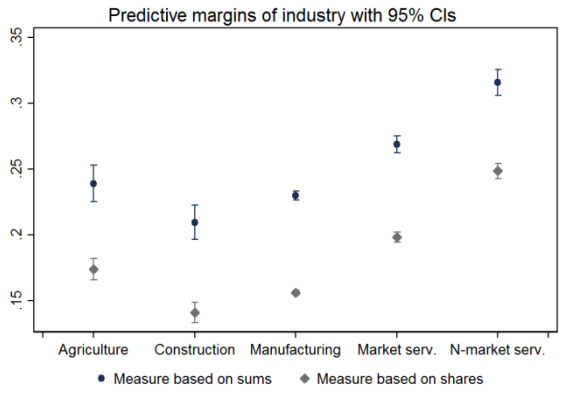
Confirmation dates full sample



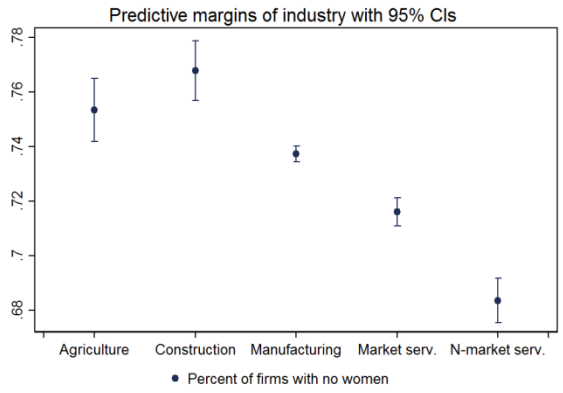
Notes: marginal prediction of country effects. Analogous estimates for the alternative samples available in Table A5 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available.

Figure 3. Industry trends in measures of gender diversity on management boards

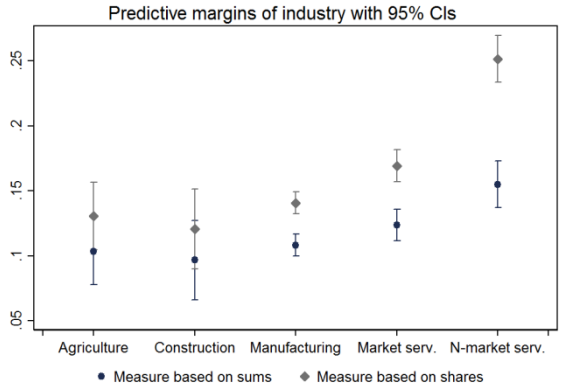
Sum measure and share measure
Reduced



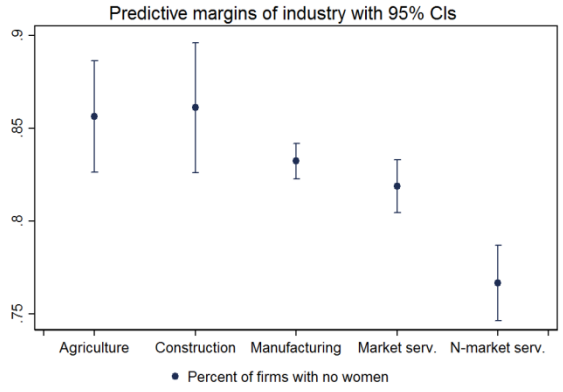
Fraction of firms with no women
Reduced



Confirmation dates full sample



Confirmation dates full sample



Notes: marginal prediction of industry effects. Analogous estimates for the alternative samples available in Table A5 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available..

4. **Results**

We estimate a model of women's presence on management boards, using a panel of firm level data. This approach builds on the approach of Matsa and Miller (2011). The model comprises lagged information on women's presence in supervisory boards as well as additional controls. In order to obtain estimates with firm-level fixed effects, we run a linear probability model for the binary outcome variable that at least one woman is present on the management board of a given firm. The control variables include sector, country and year dummies as well as firm size and board size.

Some earlier empirical evidence suggests that women on boards of firms may prefer more risk averse strategies and less competitive approach to business (e.g. Nakano and Nguyen, 2012; Berger et al., 2014; Facio et al., 2016, Levi et al., 2014). However, reverse causality may also be possible, i.e. supervisory boards of firms operating in more competitive and risky markets may prefer to select men for

executive positions. To address this point, we include a measure of market concentration – the Herfindahl-Hirschman index – as a control factor to test, if controlling for intensity of a competitive pressure affects our estimates. The Herfindahl-Hirschman index is computed based on data on employment in a given two-digit sector in a given country in a given year.

Finally, following Talke et al. (2010) we test also if controlling for the scope of innovativeness in a given two-digit sector changes the estimated relationship between women on supervisory boards and women on management boards. The measure of innovativeness comes from the Eurostat glossaries: Knowledge-intensive services (KIS) and High-tech classification of manufacturing industries.

Results reveal that in principle, more women on supervisory board in the past tend need not be associated with a higher probability of women in the management boards. In parsimonious specifications, we obtain a statistically significant and positive coefficient for the one year lag, but a relatively large and negative coefficient for a two year lag. Once we control for the size of the management board, presence of women in the supervisory board tends to be of negligible correlation or actually negatively associated with the presence of women in the management board. This result is robust across specifications and samples. It is particularly strong in the preferred strata of the data, i.e. for firms that have more than one position in management and supervisory boards (columns denoted by 4) and for firms which are neither fully masculinized nor fully feminized (columns denoted by 5). Indeed, what matters for the probability of having a woman on a management board is whether there was a woman in an executive position in the past and the size of the board.

Unlike suggested by some earlier studies, the size of the firm, the fierceness of the competition in the sector and how innovative the sectors is do not seem to have a particularly strong nor a particularly robust relationship with the probability that a firm has at least one woman on management board. The estimated elasticity on firm size changes from positive from negative, depending on a specification and remains low. The estimated coefficient on HHI is somewhat more robust in a sense that it remains of positive and statistically significant for specifications denoted by (4) and (5), i.e. our preferred specifications. Also its economic significance seems to be non-negligible: an increase of HHI by 1 percentage point (which is equivalent to changing a market from 10 equal sized firms to 9 equal sized firms) is associated with roughly a 0.1- percentage point change in the probability of having a woman in management, that is a 5% increase. Markets with less fierce competition appear to have more women among top executives.

Table 3. Probability of a woman on management board

	Full data set					Trusted data set		Reduced data set		Confirmation dates	
	(1)	(2)	(3)	(4)	**(5)**	(4a)	**(5a)**	(4b)	**(5b)**	(4c)	**(5c)**
woman in management in t-1	0.372***	0.396***	0.372***	**0.328*** **	**0.069*** **	0.326***	0.070***	0.408***	0.111***	-0.218***	-0.010***
	(0.000)	(0.000)	(0.000)	**(0.000)**	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)
woman in supervisory board											
in t-1	0.046***	0.052***	0.046***	**0.007*** **	**-0.052*** **	0.011***	-0.051***	0.016***	-0.083***	0.058***	-0.007*
	(0.000)	(0.000)	(0.000)	**(0.000)**	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.004)
in t-2	-0.030***	-0.029***	-0.030***	**-0.022*** **	**-0.010*** **	-0.025***	-0.012***	-0.036***	-0.021***	0.004	0.027
	(0.000)	(0.000)	(0.000)	**(0.000)**	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.019)	(0.019)
employment (in logs)		0.001***		**0.001*** **	**0.004*** **	0.000***	0.004***	0.005***	0.003***	0.014***	0.009*
		(0.000)		**(0.000)**	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.005)
# of people in boards (in logs)				**0.138*** **	**0.034*** **	0.142***	0.038***	0.156***	0.044***	0.189***	0.013***
				(0.000)	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.005)
innovative sector			-0.004***								
			(0.000)								
HHI	-0.015***	-0.001*	-0.015***	**0.009*** **	**0.018*** **	0.032***	0.017***	0.061***	0.014***	0.029	0.159***
	(0.000)	(0.001)	(0.000)	**(0.001)**	**(0.002)**	(0.001)	(0.003)	(0.002)	(0.004)	(0.029)	(0.028)
Sector fixed effects	Yes	Yes	Yes	**Yes**	**Yes**	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.132***	0.105***	0.132***	**0.083*** **	**0.606*** **	0.088***	0.605***	-0.005**	0.592***	0.086***	0.504***
	(0.001)	(0.001)	(0.001)	**(0.001)**	**(0.002)**	(0.001)	(0.003)	(0.002)	(0.004)	(0.006)	(0.011)
Observations	111,910,296	68,143,716	111,910,296	**53,929,198**	**10,281,973**	45,102,173	8,486,459	9,096,418	3,841,044	349,762	69,150
No of firms	18,610,968	10,031,643	18,610,968	**7,936,691**	**1,549,339**	7,347,962	1,393,994	1,414,535	596,697	253,207	63,651
R-squared	0.227	0.235	0.227	**0.248**	**0.025**	0.247	0.025	0.309	0.064	0.099	0.012
R2 between	0.791	0.833	0.791	**0.573**	**0.664**	0.561	0.623	0.736	0.712	0.000219	0.00929
R2 within	0.227	0.235	0.227	**0.248**	**0.0253**	0.247	0.0248	0.309	0.0644	0.0988	0.0118

Notes: firm fixed effects estimator, standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. In columns (4) we report estimates for all firms that have more than one member of supervisory and management board. In columns (5) we report estimates for all firms that are not fully masculinized, nor fully feminized. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Reduced sample additionally excludes companies with less than 10 people employed and 2 identified members of boards within reported year. Confirmation dates sample comprises only firms for which for all individuals confirmation dates were available. For the definitions of full sample, trusted sample, reduced sample and confirmation dates sample, see Figure Innovative sector identification comes from Eurostat glossaries: Knowledge-intensive services (KIS) and High-tech classification of manufacturing industries. HHI index computed based on employment (use of sales revenues or assets would reduce the number of firms included in the computation). The number of firms in column (1) is the total usable sample in Amadeus, accounting for firm size reduces the sample to a lower number of usable observations.

Table 4. Probability of a woman on management board

	Full data	Full data	25% of full data	
	OLS	OLS	MULTI-LEVEL LOGIT	
	Marginal eff.	Marginal eff.	Coefficient	Marginal eff.
	(1)	(2)	(3)	(4)
# people on management board	-0.014***	-0.014	**-0.126*** **	**-0.010*** **
	(0.000)	(0.445)	**(0.000)**	**(0.000)**
Innovative sector	0.001***	0.001	**-0.116*** **	**-0.020*** **
	(0.000)	(0.592)	**(0.000)**	**(0.000)**
HHI	-0.001***	-0.001	**0.001*** **	**0.002*** **
	(0.000)	(0.932)	**(0.000)**	**(0.000)**
Labor force participation rate of women	0.031***	0.031	**-0.004* **	**-0.001**
	(0.000)	(0.515)	**(0.036)**	**(0.036)**
Tertiary education (% LF, women)	-0.001***	-0.001	**-0.059*** **	**-0.011*** **
	(0.000)	(0.116)	**(0.000)**	**(0.000)**
% parliament seats occupied by women	0.013***	0.013	**-0.067*** **	**-0.011*** **
	(0.000)	(0.599)	**(0.000)**	**(0.000)**
Women economic rights ratio	**-0.010*** **	**-0.010*** **	**-0.070*** **	**-0.012*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
Women social rights ratio	**0.003*** **	**0.003* **	**-0.014*** **	**-0.002*** **
	(0.000)	**(0.022)**	**(0.000)**	**(0.000)**
Women administrators ratio	0.006***	0.006	**0.022*** **	**0.004*** **
	(0.001)	(0.583)	**(0.000)**	**(0.000)**
Gender Equality Index	**0.336*** **	**0.336* **	**0.070*** **	**0.012*** **
	(0.000)	**(0.020)**	**(0.000)**	**(0.000)**
Gender wage gap	**-0.055*** **	**-0.055*** **	**-1.446*** **	**-0.27*** **
	(0.000)	**(0.006)**	**(0.000)**	**(0.000)**
Standard errors	Robust	Clustered	Robust	Robust
Multi-level	No	No	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Sample as % of trusted sample	100%	100%	25%	25%
Observations	124,056,246	124,056,246	24,814,735	24,814,735
R-squared	0.433	0.433	-	-

Notes: standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The results for the total of 120 million observations could not be obtained with the multi-level logit model. Firm fixed effects estimator with robust standard errors in column (1), firm fixed effects estimator with standard errors clustered for country and industry in column (2). Columns (3) and (4) report estimation of multi-level regression estimated for 25% of the sample; marginal effects and coefficients, respectively. Estimations include year fixed effects and sector fixed effects. The number of people on a management board reported in `100. Innovative sector identification comes from Eurostat glossaries: Knowledge-intensive services (KIS) and High-tech classification of manufacturing industries. HHI index computed based on employment (use of sales revenues or assets would reduce the number of firms included in the estimation). Women labor force participation ratio from OECD database (expressed in percentage points). Tertiary education (percent of women labor force, expressed in percentage points) and percent of parliament seats occupied indices from World Bank database. Women economic rights ratio, women social rights ratio and women administrators ratio from Indices of Social Development database, higher values of these indices signify more equality. Gender Equality Index developed by European Institute for Gender Equality. Gender wage Gap from van der Tyrowicz & Smyk (2017).

To corroborate our findings, we take an alternative modeling approach. We ask if certain features of a sector, country (and period) are associated with a higher likelihood of finding a woman in a management board. Hence, we move from firm-level to individual-level and estimate a multi-level regression with firm, sector and country characteristics as explanatory variables. The explained variable is a dummy taking a value of one if an identified person in a management position is a woman. Hence, instead of estimating the chance that a firm has a woman in management board, we estimate a chance that an identified board member is a woman, conditional on firm, sector and country characteristics. This specification builds on the approach of Adams and Kirchmaier (2013, 2016). The results are reported in Table 4.

The large sample size poses a technical difficulty. The model contains information from personal, sector and country level over years, which calls for the use of the multi-level regression. However, obtaining non-linear estimates for such large data is impossible with this estimator. We provide several alternative specifications to shed some light on the true underlying patterns. First, we estimate a linear model

with firm fixed effects. This model understates the standard errors for sector and country-specific variables. Second, we estimate analogous model with standard errors clustered at country and sector level. This model, however, overstates the standard errors for variables which have variation at firm or personal level. The two estimators are reported in columns (1) and (2) respectively. The actual multi-level regression is reported in column (3) for coefficients and (4) for marginal effects comparable to the point estimates from columns (1) and (2). However, the multi-level estimation is performed on a random 25% subsample from the total dataset, because the estimation with the full data is technically impossible. The 25% of the sample concerns roughly 25 million individual management board members identified in the full set.

We find that greater gender equality in a given country or sector need not be conducive to higher presence of women on management boards. For example, higher labor force participation of women and their better educational attainment yield negative coefficients, undermining the findings of Adams and Kirchmaier (2016). In fact, other indicators of gender inequality – such as gender wage gap, gender inequality index, women in parliament, indices of social and economic rights – they all exhibit negative correlation with the probability that a given management board member is a woman. Some of these coefficients are positive or insignificant in linear probability models on a full sample, but the linear probability model confounds effects from multiple levels, whereas the multi-level regressions identify the correlation at a respective level of the sector, the country or the firm. In addition to yielding the opposite sign, our regressions reveal as well that the correlation between gender equality and women's presence in management boards is relatively low in terms of economic significance.

Conclusions

Gender board diversity is a topic of multiple hot policy debates – women on boards of important enterprises are considered a proof that glass ceiling is not as thick as feared. They are also considered role models for the next generations of young female professionals. For these and other reasons, in many countries policies forcing gender quota on supervisory and / or management boards are either considered or already implemented. One of the long standing underpinning of necessitating gender quotas on supervisory boards has been that women there will promote more gender equality when selecting executives for management board positions, thus further cracking the glass ceiling. These policy considerations have not been without merit, as some earlier studies argue in favor of sequential gender diversity.

In this paper we provide an extensive and relatively comprehensive overview of the presence of women on management and supervisory boards in corporate Europe. We utilize two decades of firm level data for roughly 20 million unique firms. In these firms we identify gender of the supervisory and management board members utilizing a novel gender assignment algorithm. With this exceptional database we set on to verify if the findings obtained for the stock-listed companies can be confirmed for the rest of the enterprise sector.

We provide three key findings. First, there is more firms with no women on supervisory boards than firms with no women on management boards. While there is more women in terms of number and in terms of share in management boards, the glass ceiling seems to be stronger for any single women to be a part of the supervisory board. If the policy objective is to crack the glass ceiling, gender quotas on supervisory boards may be an objective in itself.

Second, women on supervisory boards are not likely to increase gender diversity of the management boards, because presence of women on the supervisory boards correlates *negatively* with the presence of women among top executives. In this respect, our results are in contrast to the finding of Matsa and Miller (2011). Their argument was based on the premise that "women help women in corporate America" (p. 2). Hence the policy implication that a presence of women on supervisory boards is likely to open the executive management positions to women in stock-listed companies in the US. Our results are obtained for – as good as it gets – a universe of firms in Europe. Not only do we find that a larger share of firms have no women on supervisory boards than on management boards, but we also confirm that women on supervisory boards are actually associated with a lower chance for a woman in top management.

The third key finding is that more gender equality is not at all associated with more women on management boards. This finding has been put forth, as a justification that cracking the glass ceiling takes several steps and first requires improving the educational attainment and labor force participation of women. Our results strongly reject this conjecture. In addition to these key results, we provide also an array of stylized facts concerning country and sector specificity as well as time trends. Since we compare three different measures of gender board diversity, we contribute also by hinting the risks associated with relying on a single indicator.

As is frequent in the case of empirical studies, our findings suffer from several limitations. First, the set of country-level controls could encompass social norms and values. However, these measures are typically available at a relatively low frequency and for selected countries. With increasing country and time coverage of these indicators, one could possibly go deeper into the processes, which are now bundled as country specificity. Second, one may want to view the history of gender board diversity in Europe via the lenses of balanced panel, i.e. trace histories of firms with no women on board who eventually comprise a woman among top executives. The correlates of this process are likely to inform further effective policies for cracking the glass ceiling. Third, beyond the scope of interest in this paper lies the firm performance conditional on gender board diversity. With the Amadeus data, utilizing financial data reduces the sample by roughly 90%, possibly in a non-random way. However, with more administrative data becoming available, this direction of future research is also worth pursuing.

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Appendices

Table A1. Heuristics on gender attribution

	Total sample				
Country	% attributed	% expats	% unattrib.	% unatt. & missing	% conflicts
Albania	0.588	0.267	0.404	0.116	0.008
Austria	0.702	0	0.298	0.204	0.001
Belarus	0.964	0	0.034	0.033	0.002
Belgium	0.574	0	0.424	0.247	0.002
Bosnia	0.481	0	0.507	0.507	0.012
Bulgaria	0.754	0.017	0.242	0.225	0.005
Croatia	0.67	0.078	0.328	0.282	0.001
Cyprus	0.908	0	0.047	0.013	0.045
Czech Rep.	0.64	0.311	0.353	0.263	0.007
Denmark	0.783	0.167	0.214	0.176	0.002
Ireland	0.869	0.709	0.128	0.032	0.003
Estonia	0.657	0.372	0.34	0.218	0.003
Finland	0.866	0.108	0.133	0.088	0.001
France	0.586	0.083	0.414	0.262	0.001
Germany	0.746	0.098	0.253	0.214	0
Greece	0.707	0.087	0.292	0.082	0
Hungary	0.587	0.05	0.387	0.309	0.026
Iceland	0.696	0	0.301	0.241	0.003
Italy	0.385	0.042	0.615	0.453	0
Latvia	0.779	0	0.149	0.145	0.071
Liechtenstein	0.807	0	0.188	0.096	0.005
Lithuania	0.894	0.07	0.101	0.089	0.005
Luxembourg	0.808	0	0.188	0.062	0.004
Macedonia	0.861	0	0.094	0.049	0.045
Malta	0.855	0	0.138	0.057	0.008
Monaco	0.859	0	0.139	0.073	0.003
Montenegro	0.83	0	0.153	0.021	0.017
Norway	0.664	0.092	0.33	0.236	0.006
Poland	0.675	0.024	0.319	0.319	0.007
Portugal	0.748	0.502	0.24	0.146	0.012
Romania	0.063	0.042	0.936	0.827	0.001
Serbia	0.647	0	0.342	0.147	0.011
Slovakia	0.666	0	0.326	0.19	0.008
Slovenia	0.606	0	0.385	0.385	0.01
Spain	0.535	0.105	0.463	0.181	0.002
Sweden	0.415	0.288	0.585	0.546	0.001
Switzerland	0.889	0.726	0.1	0.058	0.011
Ukraine	0.186	0.103	0.814	0.609	0
Russia	0.741	0.007	0.258	0.236	0.001
Turkey	0.927	0	0.057	0.011	0.016
UK	0.839	0.182	0.159	0.084	0.002

Notes: total name-type-observations across all Amadeus sources: 109,669,372; total attributed: 63,023,592; total expats: 13,692,080; total unattributed: 46,332,543 (of which: total due to missing name variable: 35,139,279); total conflicted: 313,237

Table A2. Heuristics on gender attribution vs. gender identification in Amadeus

Year	% men in Amadeus		% women in Amadeus		
	attrib. as men	attrib. as women	attrib. as men	attrib. as women	unassigned
2000	.826	.002	.004	.815	.18
2001	.824	.002	.005	.808	.187
2002	.824	.002	.004	.812	.184
2003	.823	.002	.004	.809	.187
2004	.825	.003	.005	.809	.186
2005	.825	.002	.005	.81	.185
2006	.824	.003	.005	.806	.188
2007	.835	.003	.005	.815	.179
2008	.898	.001	.002	.89	.107
2009	.99	0	0	.985	.015
2010	.99	0	0	.98	.02
2011	.989	0	0	.981	.019
2012	.98	0	0	.979	.021
Country	% men in Amadeus		% women in Amadeus		
	attrib. as men	attrib. as women	attrib. as men	attrib. as women	unassigned
Austria	.939	.001	.001	.963	.036
Belgium	.876	.005	.006	.913	.081
Bosnia	.952	0	0	1	0
Bulgaria	1	0	0	1	0
Croatia	.969	0	0	.943	.057
Czech Rep.	.736	.001	0	.712	.288
Denmark	.982	0	0	.983	.017
Ireland	.918	.001	.003	.918	.079
Estonia	.745	.005	.021	.759	.22
Finland	.998	0	0	.996	.003
France	.99	0	.001	.99	.008
Germany	.941	0	0	.974	.026
Greece	.991	0	0	1	0
Hungary	.956	0	.005	.671	.325
Iceland	.976	0	0	1	0
Italy	.982	0	0	.991	.009
Latvia	.936	0	0	.995	.005
Liechtenstein	1	0	0	0	0
Lithuania	.992	0	0	.988	.013
Luxembourg	.958	0	0	.975	.025
Macedonia	.949	0	0	.916	.084
Malta	.926	0	0	.941	.059
Monaco	1	0	0	1	0
Montenegro	.946	0	0	1	0
Norway	.934	0	.003	.939	.058
Poland	.996	0	0	.982	.018
Portugal	.964	0	0	.962	.038
Romania	.975	0	0	1	0
Serbia	.97	0	0	.998	.002
Slovakia	.726	0	0	.862	.138
Slovenia	.925	0	0	1	0
Spain	.937	.001	0	.924	.076
Sweden	.994	0	.001	.994	.005
Switzerland	.966	0	0	.987	.013
Ukraine	1	0	0	1	0
Russia	.903	0	0	.959	.041
UK	.913	.001	.002	.897	.1

Notes: total name-type-observations assigned with year-month-accurate company position across Amadeus 2008 and 2014 sources: 16,254,928; total with Amadeus' confirmed gender: 15,371,479; total men attributed as men: 10,074,034; total women assigned as women: 4,048,932; total men assigned as women: 10,963; total women assigned as men: 10,626

Table A3. Employment coverage – Amadeus aggregated employment versus WIOD

	YEAR																		
COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.09	0.09	0.13	0.32	0.41	0.45	0.56	0.54	0.56	0.6	0.61	0.61	0.54	0.33	0.32	0.34	0.36	0.35	0.04
Belgium	0.98	0.96	1.12	1.17	1.2	1.27	1.24	0.74	0.71	0.72	0.73	0.78	0.64	0.65	0.65	0.66	0.68	0.67	0.04
Bulgaria	0.36	0.42	0.45	0.5	0.59	0.69	0.79	0.83	0.82	1.04	0.89	0.75	0.45	0.47	0.48	0.47	0.46	0.52	0.01
Cyprus							0.11	0.12	0.04	0.03	0.06	0.06	0.09	0.09	0.09	0.09	0.07	0.03	0
Czech	0.25	0.28	0.32	0.36	0.45	0.52	0.56	0.57	0.52	0.63	0.61	0.6	0.59	0.63	0.64	0.89	0.93	0.9	0.02
Denmark	0.32	0.39	0.41	0.47	0.52	0.55	0.55	0.72	0.72	0.68	0.72	0.76	0.28	0.29	0.74	0.75	0.81	0.84	0.51
Estonia			0.37	0.52	0.69	0.77	0.77	0.8	0.79	0.87	0.88	0.82	0.63	0.63	0.67	0.65	0.68	0.68	0.06
Finland	0.34	0.36	0.40	0.44	0.5	0.53	0.56	0.71	0.6	0.66	0.71	0.75	0.73	0.77	0.79	0.82	0.88	0.87	0.3
France	0.41	0.44	0.47	0.52	0.54	0.55	0.55	0.60	0.57	0.6	0.6	0.55	0.47	0.48	0.49	0.51	0.52	0.49	0.11
Germany	0.21	0.4	0.45	0.52	0.6	0.66	0.68	0.73	0.71	0.61	0.66	0.66	0.59	0.50	0.50	0.51	0.54	0.49	0.15
Greece	0.23	0.25	0.27	0.3	0.3	0.31	0.31	0.3	0.27	0.48	0.5	0.49	0.32	0.27	0.32	0.34	0.32	0.26	0.06
Hungary	0	0.13	0.25	0.34	0.37	0.39	0.40	0.39	0.38	0.86	0.88	0.78	0.76	0.53	0.64	0.65	0.65	0.65	0.04
Ireland	0.23	0.28	0.44	0.47	0.53	0.57	0.58	0.52	0.51	0.65	0.61	0.55	0.43	0.54	0.53	0.72	0.8	0.84	0.31
Italy	0.16	0.22	0.28	0.32	0.32	0.36	0.38	0.45	0.43	0.52	0.57	0.57	0.43	0.46	0.49	0.53	0.53	0.51	0.02
Latvia	0.21	0.23	0.3	0.33	0.36	0.38	0.4	0.4	0.4	0.64	0.68	0.7	0.66	0.65	0.69	0.73	0.75	0.79	0.36
Lithuania	0.07	0.15	0.32	0.32	0.31	0.33	0.34	0.4	0.39	0.37	0.31	0.32	0.53	0.51	0.51	0.53	0.48	0.4	0.07
Luxembourg	0.79	0.79	1.04	1.07	1.02	1.18	0.84	1.11	0.26	0.47	0.46	0.35	0.45	0.45	0.5	0.74	0.81	0.61	0.04
Malta			0.03	0.06	0.21	0.29	0.29	0.21	0.16	0.38	0.41	0.4	0.4	0.38	0.32	0.33	0.42	0.36	0.03
Poland	0.42	0.66	0.69	0.76	0.82	0.79	0.51	0.37	0.36	0.4	0.41	0.43	0.43	0.44	0.57	0.54	0.53	0.43	0
Portugal	0.18	0.21	0.22	0.25	0.27	0.29	0.32	0.36	0.42	0.49	0.65	0.64	0.58	0.62	0.63	0.63	0.61	0.55	0
Romania	0.56	0.63	1.1	1.19	1	1.06	1.15	1.07	0.54	0.58	0.64	0.55	0.57	0.6	0.57	0.56	0.6	0.62	0
Russia			0.01	0.13	0.3	0.39	0.53	0.42	0.29	0.3	0.31	0.32	0.13	0.14	0.16	0.17	0.18	0.19	0
Slovakia	0.13	0.16	0.19	0.21	0.26	0.35	0.4	0.35	0.33	0.44	0.46	0.49	0.52	0.52	0.49	0.64	0.63	0.57	0.02
Slovenia	0.02	0.08	0.49	0.51	0.53	0.53	0.55	0.53	0.46	0.5	0.49	0.5	0.45	0.44	0.44	0.58	0.59	0.59	0
Spain	0.35	0.39	0.43	0.47	0.51	0.52	0.56	0.6	0.58	0.63	0.63	0.62	0.52	0.57	0.6	0.61	0.6	0.52	0.04
Sweden													1.07	0.71	1.03	1.07	1.12	1.17	0.55
UK	0.6	0.65	0.7	0.81	0.89	0.96	1	0.98	0.86	0.89	0.92	0.94	0.78	0.8	0.85	0.88	0.9	0.92	0.3

Data: Amadeus and World Input-Output Database. Notes: Yearly total employment. National aggregates reported, but selection of unusually high, low or time-varying employment coverage performer at sector level. The Netherlands included in the Amadeus but not included in estimation due to missing names (gender could not be assigned). Data for Sweden in Amadeus reports employment coverage in excess of 300% until 2007 and thus was dropped. WIOD data miss employment information for Albania, Belarus, Croatia, Iceland, Liechtenstein, Macedonia, Montenegro, Norway, Serbia, Switzerland, Ukraine. Hence, data coverage could not be verified for those countries. Data for 2013 not used due to poor coverage in Amadeus 2014 edition. Detailed sectoral coverage for each country and year available upon request.

Table A4. Employment coverage – Amadeus aggregated employment versus WIOD, "trusted" sectors only

	YEAR																		
COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.05	0.07	0.12	0.32	0.41	0.44	0.55	0.53	0.56	0.59	0.61	0.6	0.53	0.32	0.3	0.32	0.33	0.33	0.01
Belgium	0.3	0.34	0.2	0.09	0.1	0.11	0.11	0.69	0.7	0.49	0.65	0.51	0.61	0.62	0.61	0.63	0.64	0.64	0
Bulgaria	0.36	0.4	0.43	0.5	0.57	0.69	0.79	0.83	0.82	0.92	0.79	0.74	0.45	0.46	0.48	0.46	0.45	0.51	0
Cyprus	0	0	0	0	0	0	0.09	0.1	0.02	0.02	0.05	0.01	0.06	0.07	0.08	0.06	0.05	0	0
Czech Rep.	0.24	0.27	0.31	0.36	0.44	0.52	0.56	0.57	0.52	0.59	0.57	0.56	0.52	0.56	0.58	0.83	0.87	0.84	0
Denmark	0.32	0.39	0.4	0.41	0.44	0.46	0.46	0.43	0.47	0.43	0.44	0.46	0.27	0.28	0.28	0.28	0.3	0.31	0.16
Estonia	0	0	0.36	0.52	0.68	0.76	0.76	0.78	0.75	0.71	0.72	0.66	0.5	0.47	0.52	0.51	0.53	0.54	0.02
Finland	0.33	0.35	0.39	0.43	0.49	0.51	0.54	0.53	0.58	0.46	0.47	0.5	0.46	0.47	0.49	0.5	0.51	0.5	0.25
France	0.39	0.43	0.45	0.5	0.52	0.53	0.53	0.56	0.53	0.55	0.55	0.5	0.43	0.43	0.45	0.47	0.47	0.45	0.08
Germany	0.2	0.4	0.45	0.51	0.44	0.44	0.49	0.45	0.45	0.59	0.64	0.63	0.56	0.48	0.48	0.49	0.51	0.46	0.12
Greece	0.22	0.24	0.26	0.28	0.28	0.3	0.3	0.29	0.26	0.44	0.46	0.45	0.29	0.26	0.31	0.33	0.31	0.25	0.03
Hungary	0	0.11	0.24	0.33	0.36	0.38	0.39	0.38	0.37	0.69	0.69	0.73	0.7	0.48	0.6	0.6	0.6	0.6	0.01
Ireland	0.19	0.24	0.3	0.42	0.49	0.52	0.53	0.51	0.48	0.4	0.52	0.45	0.33	0.36	0.38	0.34	0.34	0.35	0.05
Italy	0.15	0.22	0.27	0.31	0.31	0.35	0.38	0.45	0.43	0.51	0.56	0.57	0.41	0.44	0.47	0.5	0.5	0.48	0
Latvia	0.19	0.22	0.29	0.32	0.35	0.37	0.39	0.4	0.4	0.64	0.68	0.69	0.65	0.62	0.66	0.71	0.72	0.76	0.35
Lithuania	0.05	0.12	0.3	0.29	0.3	0.28	0.34	0.39	0.38	0.37	0.31	0.32	0.52	0.51	0.51	0.53	0.48	0.39	0.04
Luxembourg	0.31	0.32	0.43	0.42	0.41	0.45	0.4	0.47	0.26	0.45	0.45	0.33	0.42	0.43	0.21	0.2	0.22	0.21	0
Malta	0	0	0	0.04	0.2	0.26	0.27	0.2	0.15	0.38	0.41	0.4	0.39	0.38	0.32	0.32	0.18	0.15	0.02
Poland	0.41	0.65	0.64	0.68	0.66	0.67	0.51	0.37	0.36	0.4	0.41	0.43	0.42	0.44	0.52	0.5	0.49	0.42	0
Portugal	0.17	0.19	0.21	0.24	0.26	0.29	0.31	0.35	0.42	0.48	0.51	0.63	0.55	0.59	0.6	0.6	0.58	0.52	0
Romania	0.54	0.61	0.42	0.34	0.31	0.6	0.26	0.39	0.53	0.57	0.63	0.54	0.53	0.56	0.56	0.56	0.59	0.5	0
Russia	0	0	0	0.11	0.25	0.31	0.48	0.41	0.29	0.28	0.29	0.3	0.12	0.13	0.15	0.15	0.16	0.17	0
Slovakia	0.11	0.13	0.18	0.2	0.25	0.34	0.39	0.34	0.32	0.43	0.44	0.46	0.48	0.47	0.45	0.59	0.57	0.51	0
Slovenia	0	0.04	0.48	0.51	0.52	0.51	0.53	0.47	0.46	0.5	0.49	0.49	0.41	0.4	0.4	0.53	0.54	0.54	0
Spain	0.34	0.38	0.42	0.46	0.5	0.52	0.56	0.59	0.57	0.49	0.48	0.47	0.49	0.55	0.43	0.43	0.41	0.5	0.02
Sweden	0	0	0.28	0.29	0.31	0.34	0.35	0.39	0.28	0.32	0.33	0.34	0.37	0.39	0.7	0.72	0.74	0.77	0.54
UK	0.52	0.56	0.57	0.61	0.65	0.69	0.66	0.67	0.71	0.55	0.55	0.56	0.69	0.71	0.49	0.51	0.54	0.55	0.26

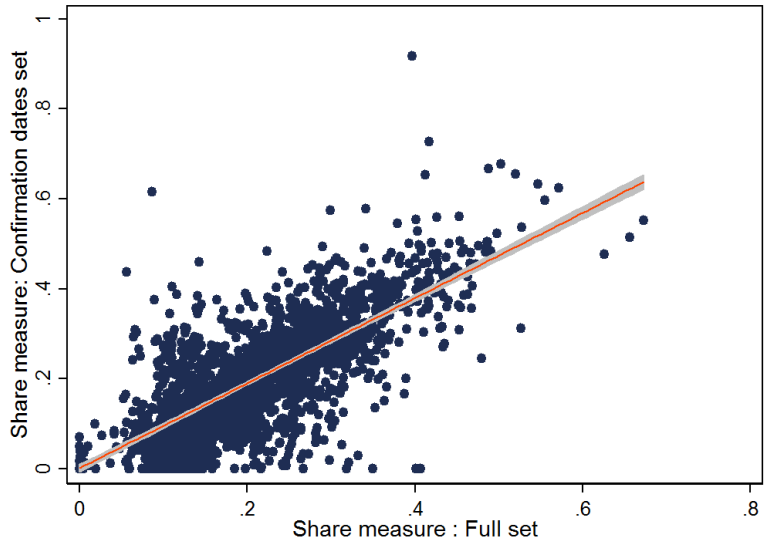
Data: Amadeus and World Input-Output Database. Notes: Yearly aggregates of employment from sectors which fulfil the employment coverage criteria. The exclusion criteria include employment coverage below 10%, above 150% and yoy changes in excess of 10 percentage points. Detailed sectoral coverage for each country and year available upon request.

Table A5. Employment coverage – Amadeus aggregated employment versus WIOD, "trusted" sectors, firms above 10 workers with at least two management board members.

	YEAR																		
COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.05	0.05	0.11	0.25	0.31	0.35	0.43	0.39	0.34	0.38	0.39	0.41	0.36	0.17	0.17	0.18	0.2	0.2	0.01
Belgium	0.67	0.62	0.6	0.61	0.6	0.24	0.47	0.53	0.29	0.48	0.47	0.53	0.48	0.48	0.48	0.5	0.51	0.51	0
Bulgaria	0.27	0.29	0.38	0.41	0.45	0.47	0.51	0.29	0.22	0.44	0.41	0.39	0.16	0.15	0.14	0.14	0.14	0.16	0
Cyprus	0	0	0	0	0	0	0.08	0.09	0	0	0.01	0.01	0.05	0.05	0.06	0.05	0.04	0	0
Czech Rep.	0.2	0.23	0.28	0.32	0.39	0.46	0.49	0.49	0.4	0.5	0.48	0.45	0.35	0.36	0.37	0.39	0.4	0.38	0
Denmark	0.27	0.32	0.33	0.39	0.37	0.39	0.39	0.5	0.41	0.37	0.38	0.4	0.22	0.24	0.26	0.26	0.27	0.29	0.16
Estonia	0	0	0.32	0.44	0.53	0.58	0.57	0.59	0.58	0.51	0.62	0.55	0.4	0.39	0.41	0.39	0.41	0.41	0.01
Finland	0.31	0.32	0.33	0.35	0.4	0.42	0.44	0.59	0.49	0.54	0.55	0.43	0.37	0.38	0.38	0.41	0.41	0.41	0.21
France	0.27	0.29	0.3	0.34	0.36	0.38	0.38	0.4	0.31	0.4	0.4	0.36	0.31	0.31	0.31	0.32	0.32	0.31	0.05
Germany	0.17	0.3	0.36	0.41	0.46	0.5	0.52	0.53	0.48	0.41	0.46	0.47	0.42	0.36	0.36	0.37	0.4	0.37	0.11
Greece	0.21	0.23	0.24	0.26	0.26	0.27	0.27	0.26	0.24	0.4	0.42	0.41	0.26	0.23	0.28	0.29	0.27	0.22	0.03
Hungary	0	0.1	0.19	0.29	0.31	0.31	0.31	0.29	0.25	0.47	0.47	0.47	0.45	0.26	0.28	0.28	0.28	0.28	0.01
Ireland	0.19	0.23	0.38	0.4	0.46	0.48	0.49	0.46	0.45	0.48	0.46	0.41	0.3	0.33	0.35	0.32	0.33	0.34	0.05
Italy	0.14	0.18	0.23	0.25	0.26	0.29	0.3	0.29	0.25	0.37	0.38	0.39	0.31	0.32	0.34	0.36	0.36	0.36	0
Latvia	0.19	0.19	0.26	0.27	0.29	0.3	0.32	0.31	0.28	0.4	0.39	0.39	0.29	0.28	0.31	0.32	0.34	0.36	0.12
Lithuania	0.05	0.12	0.3	0.33	0.27	0.27	0.34	0.38	0.38	0.31	0.25	0.23	0.18	0.17	0.17	0.18	0.19	0.18	0.01
Luxembourg	0.09	0.11	0.13	0.12	0.14	0.14	0.11	0.06	0.02	0.31	0.31	0.24	0.37	0.37	0.42	0.16	0.16	0.16	0
Malta	0	0	0	0.02	0.17	0.22	0.24	0.18	0.11	0.31	0.36	0.35	0.33	0.34	0.3	0.3	0.17	0.13	0.02
Poland	0	0	0.09	0.12	0.17	0.18	0.16	0.09	0	0.25	0.25	0.27	0.17	0.17	0.18	0.18	0.18	0.14	0
Portugal	0.16	0.18	0.2	0.22	0.24	0.26	0.28	0.29	0.32	0.38	0.44	0.45	0.37	0.39	0.4	0.41	0.39	0.36	0
Romania	0.36	0.39	0.5	0.53	0.47	0.52	0.53	0.52	0.23	0.24	0.25	0.22	0.03	0.03	0.02	0.02	0.02	0.03	0
Russia	0	0	0	0.04	0.12	0.17	0.13	0.1	0.01	0.08	0.09	0.1	0.01	0.01	0.01	0.01	0.01	0.01	0
Slovakia	0.03	0.07	0.14	0.17	0.21	0.28	0.32	0.35	0.26	0.34	0.35	0.35	0.28	0.28	0.28	0.3	0.28	0.25	0
Slovenia	0	0.01	0.17	0.17	0.17	0.17	0.17	0.16	0.2	0.36	0.37	0.37	0.28	0.28	0.28	0.28	0.27	0.27	0
Spain	0.19	0.2	0.23	0.25	0.26	0.28	0.31	0.32	0.26	0.4	0.4	0.41	0.32	0.35	0.37	0.39	0.38	0.34	0.01
Sweden	0	0	0.21	0.26	0.27	0.25	0.29	0.34	0.3	0.31	0.32	0.34	0.26	0.29	0.3	0.31	0.32	0.34	0.11
UK	0.5	0.53	0.54	0.58	0.64	0.65	0.65	0.63	0.65	0.51	0.5	0.51	0.65	0.66	0.72	0.49	0.52	0.53	0.26

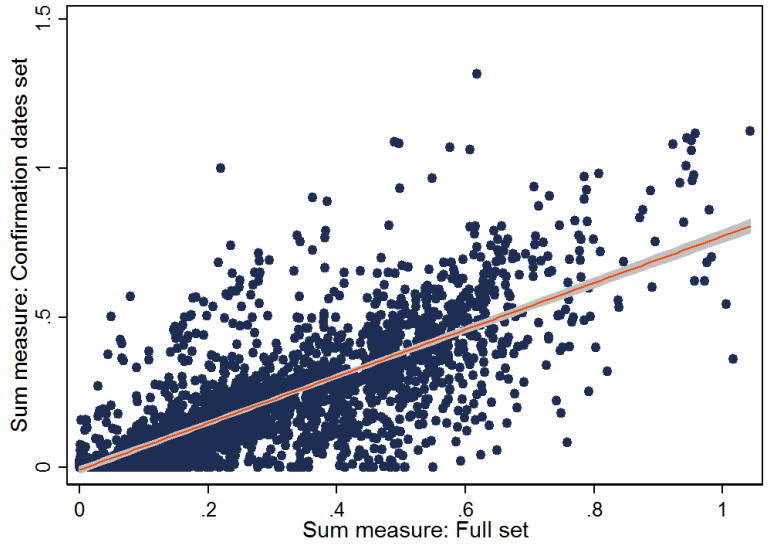
Data: Amadeus and World Input-Output Database. Notes: Yearly aggregates of employment from sectors which fulfil the employment coverage criteria (see Table A4), firm size criterion and management board size criterion. Detailed sectoral coverage for each country and year available upon request.

Figure A1. Comparing imputed confirmation dates with random assignment for a measure based on shares



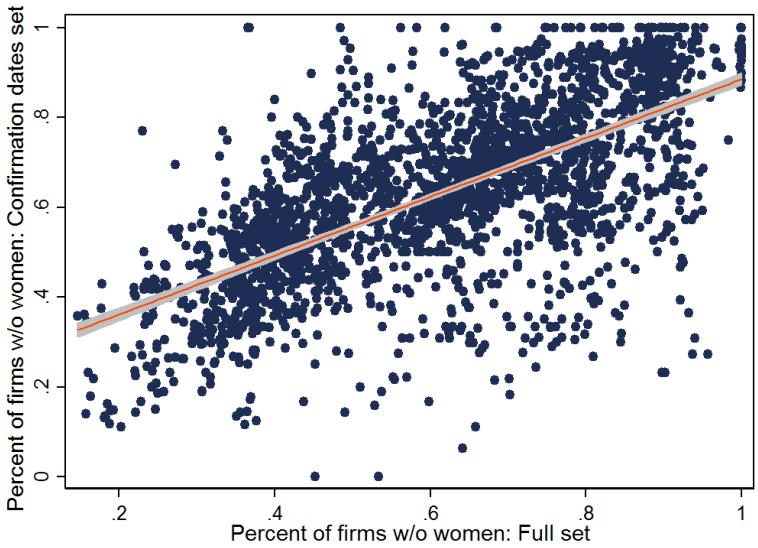
Note: correlation between the actual and counterfactual measure equals 0. 745.

Figure A2. Comparing imputed confirmation dates with random assignment for a measure based on sums



Note: correlation between the actual and counterfactual measure equals 0. 746.

Figure A3. Comparing imputed confirmation dates with random assignment for a measure percentage of firms without women on either of the boards

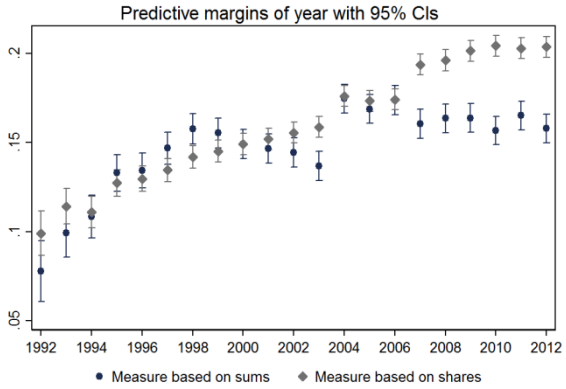


Note: correlation between the actual and counterfactual measure equals 0.662.

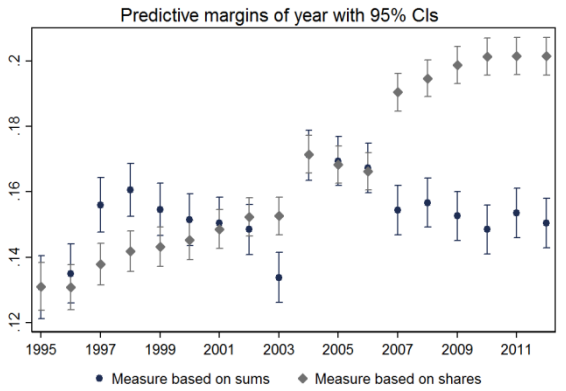
Figure A4. Time trends in measures of gender diversity on management boards

Sum measure and share measure

Full sample

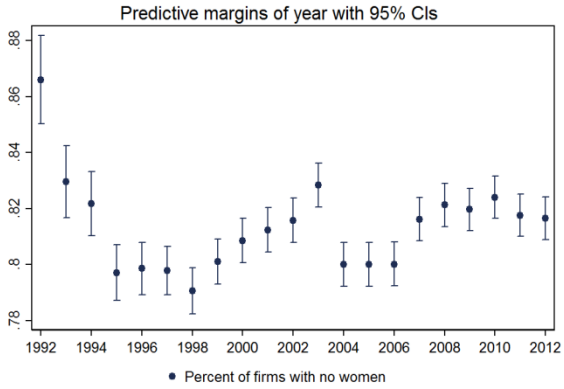


Trusted



Fraction of firms with no women

Full sample



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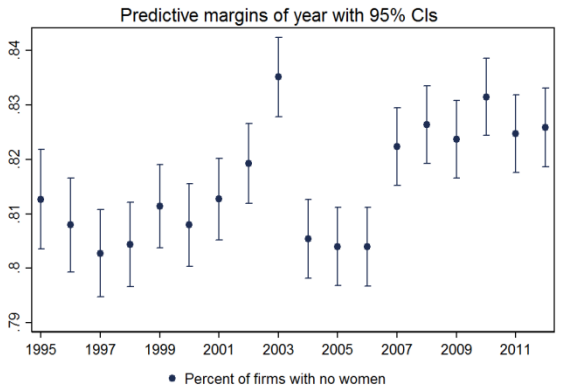
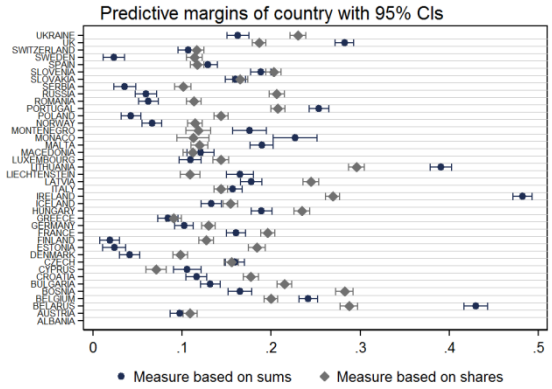


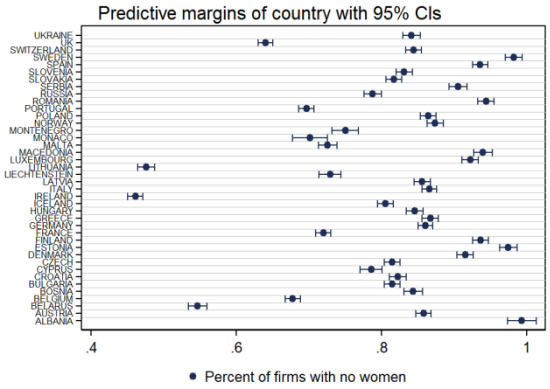
Notes: marginal prediction of year effects. Analogous estimates for the alternative samples available in Table A4 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available.

Figure A5. Country-specific effects in measures of gender diversity on management boards

Sum measure and share measure — Full sample



Fraction of firms with no women — Full sample



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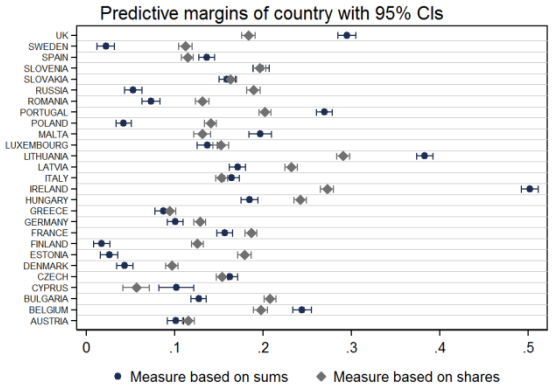

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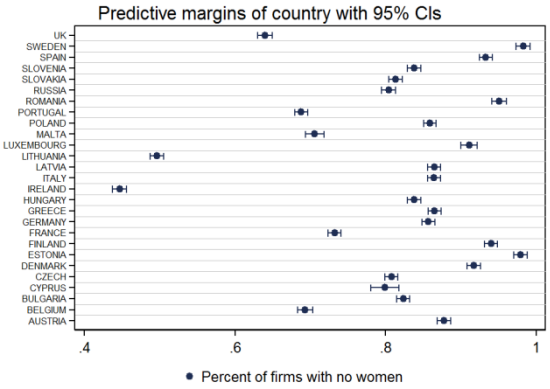
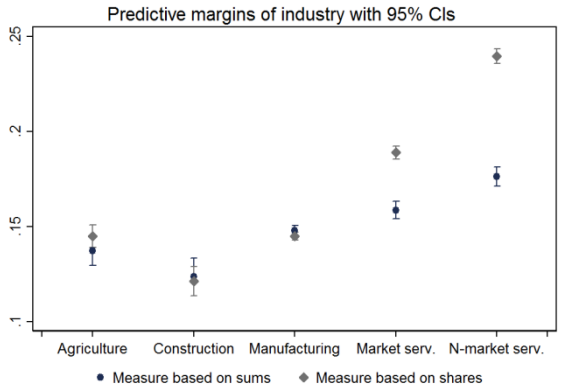


Notes: marginal prediction of country effects. Analogous estimates for the alternative samples available in Table A4 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available.

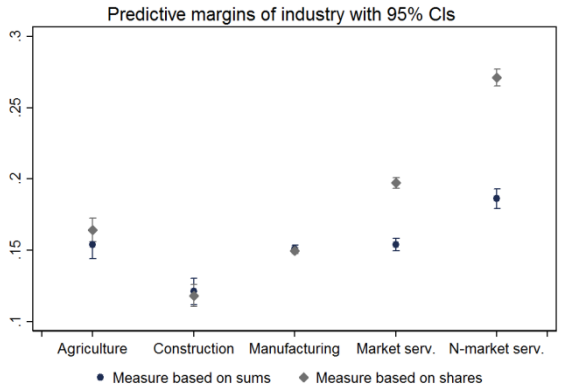
Figure A6. Industry-specific effects in measures of gender diversity on management boards

Sum measure and share measure

Full sample

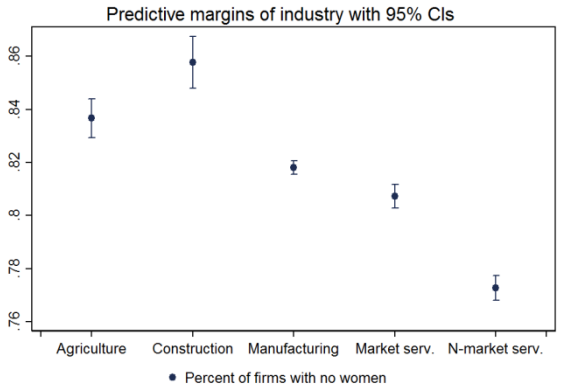


Trusted

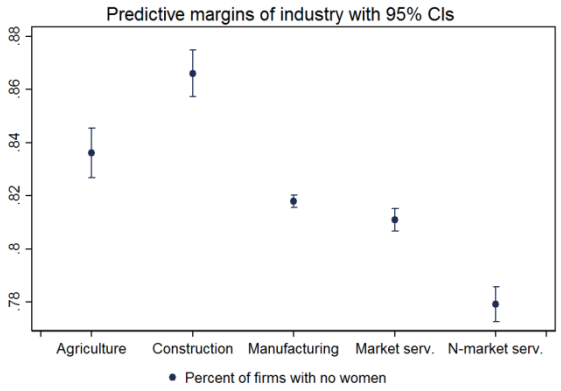


Fraction of firms with no women

Full sample



Trusted



Notes: marginal prediction of sector effects. Analogous estimates for the alternative samples available in Table A4 in the Appendix. Share measure obtains a firm-level fraction of women in management boards and subsequently aggregates for a 2 digit sector in a given country in a given year. Sum measure is obtained by dividing a total number of women on boards in firms from a given 2-digit sector in a given country in a given year divided by the total headcount of the management boards from that sector. Fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by a total number of firms in a given sector, country and year. Reduced sample is a trusted sample, additionally excluding companies with less than 10 people employed and 2 identified members of boards within reported year. Trusted sample excludes sectors in a given country and year with employment coverage below 10%, above 150% or with yoy changes exceeding 10 percentage points. Confirmation dates sample comprises firms for which for all the listed individuals confirmation dates were available.