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Gender Diversity from a Large Panel of
European Firms**

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All on board? New evidence on board gender diversity from a large panel of European firms¹

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Abstract

Using a unique database of over 20 million firms over two decades, we examine industry sector and national institution drivers of the prevalence of women directors on supervisory and management boards in both public and private firms across 41 advanced and emerging European economies. We demonstrate that gender board diversity has generally increased, yet women remain rare in both boards of firms in Europe: approximately 70% have no women directors on their supervisory boards, and 60% have no women directors on management boards. We leverage institutional and resource dependency theoretical frameworks to demonstrate that few systematic factors are associated with greater gender diversity for both supervisory and management boards among both private and public firms: the same factor may exhibit a positive correlation to a management board, and a negative correlation to a supervisory board, or vice versa. We interpret these findings as evidence that country-level gender equality and cultural institutions exhibit differentiated correlations with the presence of women directors in management and supervisory boards. We also find little evidence that sector-level competition and innovativeness are systematically associated with the presence of women on either board in either group of firms.

Key words: female directors, glass ceiling, gender board diversity, institutional theory, resource dependency theory

JEL codes: J7, P5

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1. Introduction

Among New York Stock Exchange-listed firms' executive managers, there are fewer women altogether than men named John (Wolfers, 2015). This tendency is global, with men comprising the vast majority of corporate upper echelons, including directors of both management (e.g., employee) and supervisory (e.g., corporate entity) boards. Board gender diversity is frequently debated by policy makers, media, society, and corporations. Ten countries implemented quotas and more than twenty countries developed recommendations for board gender diversity in corporate governance codes (Terjesen et al., 2015; Schwartz-Ziv, 2015; de Cabo et al., 2019).

A growing literature explores institutional and cultural drivers of cross-country variation in gender diversity on boards (e.g., Grosvold and Brammer, 2011; Grosvold, 2011; Grosvold et al., 2016), with a focus on the supervisory board, which is elected by shareholders.² Nonexecutive directors do not work in the firm, and are therefore equivalent to other countries' supervisory boards. A country's level of gender equality is believed to drive gender diversity on supervisory boards (Adams & Kirchmaier, 2013, 2016; Brieger et al., 2019a) as the same forces that increase e.g., female labor force participation – culture, preferences, and institutions (e.g., Altonji & Blank, 1999; Fernandez & Fogli, 2009; Alesina et al, 2013; van Staveren, 2014) – are expected to also lead to greater representation of women at higher echelons.

This rich and growing literature faces three important limitations. First, because of data availability of publicly traded firms' directors, and a dearth of private company data, most board research only considers public companies – a small fraction of most countries' enterprises (Finkelstein et al., 2009). The understudied private firms may face cultural preferences and institutions uninhibited by legal frameworks. Moreover, compared to their public counterparts, private firms face less scrutiny (Ingram, Yue & Rao, 2010), and have distinct governance structures (George, 2005). Second, most studies focus on only one board type, supervisory boards or management boards, usually on the former and in a single country study that may not be generalizable to other countries. A third limitation concerns causal identification: management and supervisory board directors are purposefully selected. Hence, individual

² There are country-level differences in corporate governance. In the U.S., executive directors on corporate boards lead their firms through direct decision-making management positions, which we deem equivalent to other countries' "management boards."

characteristics, including gender, are not randomly assigned to firms, biasing estimates for the effect of any individual characteristic on becoming a director (Antonakis et al., 2010). The first two limitations accrue to a frequent logical leap in the literature: culture and norms shape women's participation in the labor market, and the lack of female top managers is further constrained by the limited presence of women on supervisory boards' nominating committees. As summarized by Adams and Kirchmaier (2013): “[f]emale labor force participation has some explanatory power for executive director participation, the magnitude of the effect is roughly one third of the effect for non-executive directors.”³ Thus, associations between societal institutions and women's presence as supervisory and management directors may be similar, but attenuated for management boards by lower representation on supervisory boards.

To explore the veracity of this claim, we develop a comprehensive database covering 20 years of public (e.g., stock-listed) and private (e.g., non-listed) firms from 41 advanced and emerging economies in Europe. Our sample includes over 100 million person-year observations for supervisory and management board directors, and covers a substantial share of output and employment in the analyzed countries. We leverage institutional and resource dependency theories to explore how women's representation in supervisory and management boards is shaped by country and industry factors. This theorizing builds on a rich comparative corporate governance literature of how institutional environments shape outcomes (e.g., Crossland & Chen, 2013; Crossland & Hambrick, 2007; Oehmichen et al., 2017a, b).

Our study offers several theoretical and methodological contributions to the existing literature. First, we extend the institutional theory by examining country-level determinants of gender board diversity, finding positive correlations between gender equality institutions and the share of women on boards of public firms, but negative correlations to women directors' presence in private firms. These findings suggest a nuanced relationship such that supervisory boards of public firms that by definition have greater visibility and tracking are more likely to reflect their more gender equal country environments than are private firms. We augment the knowledge base on the resource dependency theory by examining the specific resources that are required in highly knowledge- and technology-intensive sectors. Our finding that this sector has little impact on women's presence on either board suggests that women may not be a particularly

³ Note that the use of (executive) director and nonexecutive director by Adams and Kirchmaier (2013) is analogous to our terminology of management and supervisory boards, respectively.

demanded resource in these environments. From a methodological standpoint, we offer a country-level gender board diversity study, which is less common than micro-level studies (Brieger et al., 2019a; Grosvold et al., 2016; Kirsch, 2018), and answer calls for replication and extension (Bergh et al., 2017). We measure women's prevalence in management and supervisory boards over a long period and comprehensively across public and private firms. We describe country, sector, and time patterns of gender diversity for both management and supervisory boards, documenting stylized facts, which were previously unknown in the corporate governance literature. In corporate Europe, there are no women on 70% of the management boards and roughly 60% of the supervisory boards. Our third contribution is identifying important similarities and differences between management and supervisory boards even within the same group of public or private firms. For example, we find that women's presence on both management and supervisory boards is associated with more female students in tertiary education. Among the many key differences across the board types, female full-time labor market participation, codetermination, family firms, and tax and social security have statistically significant different associations for management and supervisory boards. Fourth, we answer calls for more comparative corporate governance research with our multicountry study, which moves beyond the single-country studies that dominate the literature.

2. Theoretical development and hypotheses

A rich corporate governance literature explores how women's presence on corporate boards may be driven by factors at individual (e.g., Hillman, Cannella, & Harris, 2002; Nekhili & Gatfaoui, 2013), firm and industry (e.g., de Cabo, Gimeno, & Nieto, 2012; Nekhili & Gatfaoui, 2013; Grosvold, Brammer, & Rayton, 2007; Brammer, Millington, & Pavelin, 2007), and country levels (Grosvold, 2011; Chizema, Kamuriwo, & Shinozawa, 2015) (see Terjesen, Sealy, & Singh, 2009 and Kirsch, 2018 for reviews). We extend this literature by developing an institutional theory and a resource dependency theory rationale to examine country and sector trends, respectively, for management and supervisory boards. These two theories are complementary as institutional perspectives consider the importance of the environment, while resource dependency is concerned with extracting resources from this environment. Taken together, the theories describe how an organization faces constrained choices and competitive pressures from other actors in the environment, and seeks to build legitimacy through external stakeholders.

2.1. Institutional theory and country-level indicators

Institutional theory describes how individuals and organizations develop and refine practices that “fit” their environment. Institutions exist at individual, industrial, organizational, and societal levels, and can be formal – e.g., laws, regulations, and policies around work and family life – or informal in terms of norms and conventions; they interact and are mutually constituted (North, 1990; Scott, 1995, 2001). We focus on two country-level institutions that may play a key role in women’s professional emancipation, including appointment to directorships: gender equality in the labor market and cultures that promote rationality and freedom of self-expression.

Institutional theory concerns the processes through which rules, norms, and routines become authoritative guidelines for social behavior (Scott, 1995), and is widely studied in corporate governance (e.g., Haxhi & Aguilera, 2017), including board gender diversity (Terjesen & Sealy, 2016), especially at the country level (e.g., Grosvold et al., 2016). Institutions are longstanding and shape gender role beliefs that correspond to women’s role in the labor market, including on corporate boards (Grosvold, 2011; Chizema, Kamariwo, & Shinzawa, 2015). We examine a range of institutions that generally and specifically impact women’s ability to reach the highest echelons of a corporation: directorships on management and supervisory boards.

2.1.1. Gender equality

One key formal institution in gender equality is women’s participation in the labor market. Women who enjoy more equal access to the labor market, from entry through to advancing levels, are more likely to reach the highest echelon: the corporate board. That is, women must be able to first attain entry-level positions, and then work their way up to higher administrative roles by acquiring necessary managerial, technical, and financial skills.

There are a variety of other country-level work-related institutional mechanisms that can help women to ascend to supervisory and management boards. Many countries adopt “codetermination” (also referred to as “copartnership” or “worker participation”) policies that enable employees to participate in works councils, for example offering consultation on employment issues and board appointments. We expect that codetermination policies help firms to consider a range of issues, and pursue policies that help all employees, including women, to contribute to firms, with the potential for reaching firms’ higher echelons. Another key institution is a country’s overall employment and output; general economic growth suggests the

creation of more opportunities for all citizens, including women. Within any national economy, the prevalence of family firms can create opportunities for family members, including women, to develop skills that are necessary to move up corporate ladders. Human capital – that is, knowledge and skills – is initially acquired in education, and later through work experience. Countries with greater populations of educated women, at the tertiary high school level or higher, are expected to be able to make more substantial contributions to their firms, and may be rewarded by appointment to directorships. Birth rates constitute another component of country context. We expect that societies with higher birth rates take women out of the long-term labor market, and therefore, limit opportunities for women to move up to management and supervisory board directorships. Moreover, when considering tax and social security contributions, higher expenditures indicate more provisions to residents, including child care support needed to help women return to the workplace, and move up in their careers. Finally, the gender wage gap captures how women typically earn less compensation than their male colleagues, and may be a proxy for barriers to attaining the requisite knowledge, skills, and networks needed for career advancement, including to corporate boards. As women in the workplace become mothers, countries with greater gender equality reduce the “motherhood penalty” of typically lower labor force activity and wages, by providing support through maternity leave and childcare such that women can better balance home and work responsibilities. These institutional supports enable women to better balance family and career, and return to the workplace to attain necessary experience. There is ample empirical evidence that countries with more women female directors in large public firms tend to have more female senior managers and limited gender pay gaps (Terjesen & Singh, 2008), greater full-time female labor participation (Adams & Kirchmaier, 2013), paternity leave, and quality of childcare services (Iannotta et al., 2016). As management and supervisory boards draw from the same population of women, we expect that gender equality structures in the labor market will result in more women on both types of boards:

Hypothesis 1: Increasing gender equality across countries is associated with higher shares of women directors on management and supervisory boards of both public and private firms.

2.1.2. Societal culture

While gender equality structures are formal sets of institutions, another critical institution is informal: societal culture. Societies vary tremendously in their support of certain values, which

may shape and constrain gender role expectations, including women's ascension to management and supervisory boards. Among the many measures of national culture, one of the most highly regarded is Inglehart and Welzel's (2005) scaled dimensions of traditional/secular-rational and survival/self-expression, also used by Adams and Kirchmaier (2013). Traditional societies prioritize family values, religion, absolute standards, and authority, often rejecting divorce and abortion. By contrast, secular-rational societies place less focus on religion and traditional values. The second dimension, survival/self-expression, scales from (a) survival values emphasizing economic and physical security, and generally low levels of trust and tolerance, and (b) self-expression values prioritizing environmental protection, and greater toleration of foreigners, gays and lesbians, and gender equality, and correspond with a greater demand for participation in economic and political life. Inglehart and Welzel's (2005) institutional theorizing suggests that many countries experience an intergenerational shift from focusing on economic and physical security toward the prioritization of self-expression, subjective well-being, and quality of life. A variety of religions reinforce traditional gender patterns, focusing women on domestic rather than professional roles (Grosvold et al., 2015). A transition to more secular and self-expression values opens up more opportunities to women for professional careers. Women who live in societies that are more free to express themselves are likely to be less encumbered by traditional gender roles. As individuals who live in a society begin to see their freedoms, they will value them, and prioritize gender equality over patriarchy and traditional values (Brieger et al., 2019a, b). While men traditionally have more power in traditional and survival-oriented contexts, as a country transitions to secular values and self-expression, men will be more open to professional possibilities for women, and women can and will often aspire to leadership roles. That is, as women recognize the many options available to them in their professional careers, more women will consider roles outside that of a homemaker. In this context of greater freedom, we can expect that the differences will be more pronounced for supervisory boards. That is, supervisory boards, by definition, draw from nonexecutive ranks of women who are able to attain more experience across a range of sectors. We, therefore, expect these cultural values to differentially affect women's presence on supervisory and management boards:

Hypothesis 2: Cultural values changing toward promoting rationality and freedom of self-expression will be conducive to higher shares of women directors on supervisory boards as compared to management boards, of both public and private firms.

2.2. Resource dependency theory and sector-level indicators

In contrast to the institutional theory's focus on how organizations adapt to practices that are considered legitimate in an organizational field, resource dependence theory (Pfeffer & Salancik, 1978) describes how an organization's behavior is shaped by the need to procure external resources from the environment. Resource dependency theory lenses dominate the corporate governance literature (e.g., Payne et al., 2009; Oehmichen et al., 2017), exploring how boards aim to reduce uncertainty by appointing corporate directors who can maximize access to valuable resources required by the firm. For example, based on desired resources and linkages needed for the firm, boards appoint directors who are business experts, support specialists, and community influencers (Hillman, et al., 2000). Compared to their male counterparts, Fortune 1000 female directors are more likely to have advanced degrees and nonbusiness backgrounds, and to join multiple boards faster (Hillman et al., 2002). Among FTSE 100 firms, women directors are more likely than their male counterparts to possess international experience and MBA degrees (Singh, Terjesen, & Vinnicombe, 2008).

Resource dependency is particularly valuable at the meso-level of industry as both management and supervisory directors must be able to access resources in a particular sector. A recent systematic review notes that women will only be appointed as directors when their skills benefit firms (Kirsch, 2018). We explore firms that operate in highly competitive industries that are knowledge-intensive and utilize high levels of technology. Prior research indicates that firms operating in knowledge and technology-intensive competitive industries have greater shares of female directors (Hillman et al., 2007; Grosvold et al., 2016), although samples are generally confined to supervisory boards of public firms. Highly innovative industries require individuals who can think outside the box. Top management team diversity enables a firm's choice to establish innovation fields as these teams may encourage creative and divergent thinking (Talke, Salomo, & Rost, 2010). Moreover, members on a diverse team, such as a corporate board, will possess different social networks, which expand the base of knowledge for making decisions, including around innovation. Greater gender diversity on the board might therefore expose directors to a larger pool of information, which is particularly vital in a competitive industry.

To operate in highly competitive industries, effective strategic decision-making requires diversity (Ancona & Caldwell, 1992), and directors may need to take on considerable risks. Risk propensity is a fairly stable preference. Although some empirical evidence suggests that female

directors may prefer more risk-averse strategies and less competitive approaches to business (e.g., Nakano & Nguyen, 2012; Berger et al., 2014; Levi et al., 2014), Adams and colleagues (2009, 2012) suggest that female directors exhibit greater risk propensity on par with their male colleagues. Moreover, firms in knowledge- and technology-intensive industries require more flexible and less hierarchical approaches, which may be better aligned to female management styles. Taken together, firms in highly competitive and knowledge- and technology-intensive sectors may be keenly aware of the important resources that female directors can acquire and actively seek them out for their boards. We expect that resource dependency will be attenuated based on board type. That is, the more competitive and innovative sectors will particularly seek women to their supervisory boards, rather than their management boards:

Hypothesis 3: Sectors exhibiting higher growth in competitiveness and innovativeness within sectors will be associated with higher shares of women directors on supervisory boards as compared to management boards on both public and private firms.

3. Data

We use six editions of the Bureau van Dijk (commonly known as Amadeus): 2000, 2004, 2006, 2010, 2012, and 2014. Taken together, our data cover 1995-2013, with a median of 16 years for each firm in the sample⁴. As Amadeus data are derived from national registry records and courts, financial and accounting information availability varies across countries. Combining subsequent waves of Amadeus editions enables us to replace missing data from a given year with data for that year as reported in a subsequent edition. In line with Kalemli-Ozcan et al.'s (2015) procedure, we drop firms with missing industry or management and supervisory board information. Overall, we retain 91% of the sample's 24 million firms. By contrast, Christiansen et al. (2016) use one Amadeus edition and require financial data, leaving them with less than 10% of the original sample.

3.1. Data coverage

Earlier studies generally rely on a relatively narrow subsample of firms, particularly public companies (e.g., Dezsö & Ross, 2012; Hillman, Shropshire, & Cannella, 2007; Wolfers, 2006;

⁴ Amadeus' firm sample depends on year and country. Recent editions are far more comprehensive than the 1990s editions. Larger countries tend to have more records. For example, the 2014 edition of Amadeus comprises 18.3 million firms from 44 countries, but the 2004 edition comprises 6.8 million firms from 38 countries.

Matsa & Miller, 2011; Ahern & Dittmar, 2012; Adams & Kirchmaier, 2013, 2016), which constitute a small subsample of all firms (and all boards) in most economies. As argued by Adams and Kirchmaier (2013), narrowing the sample to large public firms (e.g., Fortune 500) is not representative of the full population as public firms typically have more gender board diversity than private firms. Our novel gender identification and board assignment utilize information from the majority of private and public firms with supervisory and management boards for up to 18 years for 44 countries.

Compared with extant research, we use more Amadeus editions, thus yielding wider time coverage for each firm. To analyze data comprehensiveness, we compare our sample's aggregate employment and value added with the employment and value added from the World Input-Output Database (WIOD) (see Appendix Table A3). This comparison reveals that in some countries, sectors, and years, Amadeus' coverage of employment exceeds WIOD aggregates. This may stem from the fact that employees' self-reported employment sector – the basis for WIOD measurement of employment by sectors – is not always consistent with the employer's reported sector in registry records, which by construction follows the main product, not the largest employment. Likewise, the problem is less acute for output measures. Second, coverage varies across years for the same countries and sectors. So long as these changes appear roughly continuous and follow patterns, one may assume that coverage variance stems from sample atrophy (and incomplete replenishing of the sample with the new establishments) or sample broadening. Some cases reflect a structural change in an economy's data coverage, for example 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.

To mitigate the possibility that results are driven by substantial swings in sample composition, we tag cases of substantial change in data coverage in a given country and sector in a given year, as these observations may compromise study representativeness. We tag low employment shares (below 10%) and large changes in employment (above 150% year on year). We also tag substantial changes in coverage, with a threshold of 10%. Eventually, we are left with sample of firms from sectors with relatively stable employment shares across countries and years. This yields a final sample of 16.9 million firms, i.e., 90.9% of the usable sample. We include sector- and country-fixed effects in the estimations.

3.2. Management and supervisory board members

Amadeus provides the exact names of supervisory and management directors; however, there are numerous typing errors and inconsistencies across editions. Given the vast size of our firm and person-level Amadeus dataset, we implement several heuristics. First, we parse personal records to obtain first name and surname. Because of typos by Bureau van Dijk, individual name fields sometimes contain firm names, which can be identified through legal form keywords such as Gesellschaft (Germany), Club, D.D., Aktiebolag (Sweden), Srl (France and Italy), and Z o.o. (Poland). These typos comprise less than 2% of all name records, and we drop them from the sample. This heuristic slightly reduces sample size as not all firms report individual directors.

Second, we trim any salutations or other prefixes and suffixes, which blur the distinction between actual name and surname.⁵ In some languages, salutations identify gender; however, this is not universal and salutations are frequently abbreviated (e.g., Bar. may refer to baron or baroness), limiting their usefulness for gender identification. We identify the name from surname using each country's rules (e.g., surname comes first in Hungary and Bosnia and Herzegovina and names come before surnames in German and French; see WALSH, 2019).⁶ We identify nearly 20 million unique individuals in 18.6 million companies, totaling 146 million person-years.

Some legal company forms are not required to have management or supervisory boards, and are outside the scope of our analysis. The assignment to management and supervisory board roles is only available in the most recent editions of Amadeus data. Prior editions provide the name of the position for each reported person, and we use this information as the basis of the supervisory and management board attribution. Countries have different legal rules on who is reported within registries or courts. For example, most countries require legal proxy in addition to management and supervisory board directors. The legal proxy (e.g., delego/a in Italian, procureur/trice in French, and Prokurist in German) does not make management decisions in

⁵ The list of the salutations identified in Amadeus data and dropped for name identification purposes includes: "Mr. Mr Duke Dr. Dr Sir Count Court Barron Baron Mister Lord Visconte Comte Viscomte Rev Miss Mrs Ms Duchess Countess Baroness Lady Sister Viscontessa Viscomtesse Comtesse Dame Damme Baronesse Baronessa Von De Van Der Zue Fur Die Da Dela I II Rev Ifl Mag. Dipl. Ing. Councillor The Reverend Honourable Hon Reverend Rt Very Right Rt Revd Fourth Marquess Von Prof. PhDr. Dr. Ing."

⁶ We parse surnames and names to identify repeat cases to assure that the same set of names receives the same gender attribution in each edition of Amadeus. A parser algorithm identifies the 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. If the mismatch resulted from an obvious typo, the two records were coded as a match in terms of gender attribution. An example of an obvious typo is a discrepancy between Bernath and Bernaht 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 Mallie and Maile because both exist in French.

the firm and does not supervise managers' work, but has the legal authority to sign contracts on par with the top management, and hence, should not be considered in this study. Also, in the UK, most director positions are reported, including regional and sales directors, management, and public relations. These positions are middle management, and hence are not considered in our study. As another example, Amadeus data frequently report a contact person, such as an assistant to the general manager or CEO or a marketing team member.

To reliably isolate actual board directors and attribute them to the correct board, we identify every country's available positions and design heuristics to drop irrelevant positions and assign relevant positions to management and supervisory boards. We follow two basic heuristics. First, we identify the list of the positions in every country that refer specifically to either board, e.g., CEO and general director (always management board) or shareholder representative (always supervisory board). This common list of categories classifies a large share of reported individuals in some countries, but leaves most individuals unattributed in the other countries. For the unattributed individuals, we ascribe relevant positions to management or supervisory boards on a case-by-case basis, using each country's legal standards. For example, a member of the board of directors refers to supervisory board in some countries, but management board in other countries.⁷ Table A4's comparison of our identification with Amadeus data assignment in the most recent edition as a verification of our heuristics shows a reliable assignment.

3.3. Gender attribution

As pre-2010 Amadeus editions do not include gender identification,⁸ we propose a novel approach to gender attribution. To assign gender, we use board member's names and surnames and linguistic rules. For most languages, individuals' full names and surnames are sufficient to attribute gender. We employ two heuristics. The first heuristic is that some languages directly identify gender from the individual's first name or surname. For example, Slavic languages'

⁷ For each language and each legal system in our sample, we formulate a list of keywords identifying either board. For example if a position name contains a conjunction of "Supervis" and "Board" (parts of "Supervisory Board" title and variations) and does not contain "Secret" (part of "Secretary" title and variations), we code as supervisory board membership. The conjunction of "" ("Presid" ("President") and "" ("Gener" ("General"), which does not contain "Secret" is coded as management board. We develop the keywords list in two steps. First, we code the obvious position names from the languages in our sample. Subsequently, we tabulate the position names without assignment and check them one by one, using online legal dictionaries, World Bank repositories, consulting companies, and colleagues' expertise. The full list of assignments to boards by countries is available from the authors.

⁸ This is why Christiansen et al. (2016) work with a cross-section from 2014 edition of Amadeus data.

female names end with a vowel (Lithuanian, Russian, Slovenian, Polish); in other languages a surname ends with a suffix that directly identifies gender (e.g., Slovak, Czech, Russian). We compile rule lists from the World Atlas of Languages Structures (WALS, 2019).

The second heuristic is attribution of gender based on the names database, referred to as the books of names. In some languages (including exceptional cases from Heuristic 1) names directly identify a gender. For example, there are no women named John in English, just as there are no men named Catherine. Several names databases provide gender attribution.⁹ We utilize these databases and address any conflicts on a case-by-case basis. Some individuals are reported with more than one name, with or without a dash. In such cases, we split the name into separate components, and apply Heuristic 1 or 2 depending on the language. We apply heuristics sequentially, and assign gender only if there is no conflict.

There are three general groups of countries in Amadeus data. The first type of countries has one linguistic rule to assign genders. Our first heuristic assigns gender to all individuals based on a rule or by complementing the rule for one gender. For example, in Poland, certain vowels as last letters in a name identify women, and a lack of vowels detects men; we set all individuals as men, and then replace the men as women based on the last letter of a name. To account for expatriates and minorities, we verify whether the sample contains names that are consistently identified as opposite gender in other languages. In the rare cases of conflict between the original gender assignment from the first and second heuristic, we hand-check each case with language and culture dictionaries.

The second group of countries has no clear rule for languages, so if one language is universal or dominant, gender is assigned based on the language's default rule. Subsequently, we apply a book of names for this language, as in the second heuristic. We then test the unassigned individuals with the book of names for the second most popular language. The third group of countries has more than one spoken language, and hence, we attribute gender based on a combination of the book of names of all applicable languages.

There are some cases in which gender identification is controversial or impossible. For example, the Netherlands data only report initials for names, and Dutch surnames do not denote

⁹ We use <http://babynames.merschat.com/> (general); <http://www.behindthename.com/> (Croatian, Danish, Estonian, Finnish, French, Hungarian, and Italian); <https://de.wiktionary.org/wiki/Verzeichnis:Deutsch> (German).

gender. Hence, no gender identification is possible and we drop the Netherlands. Individuals sometimes have incomplete or more than one name, yielding contradicting gender attribution. For example, in French Jean-Marie is identifiable as a man, Jeanne-Marie as a woman, but J-Marie cannot be unequivocally attributed to either gender. Most countries only have a few cases of conflicting gender attributions for a given individual as well as missing gender attributions after applying the heuristics. Appendix Table A1 reports the details.

We compare our identification rules to the 2014 Amadeus edition, and find a complete concordance across gender assignments. There is negligible misattribution of gender (see Appendix Table A2), while the majority of discrepancy between our gender assignment and recent Amadeus editions comes from cases where heuristics cannot reliably assign gender (e.g., because of a missing name). Indeed, relative to Amadeus salutations, our assignment may marginally understate women's roles, but this comes with the advantage of 20 additional years of data.

3.4. Measures of female presence on boards: Descriptive statistics and stylized facts

There are many measures of women's presence on boards. One frequently applied measure computes each firm's share of women directors on a board (Matsa & Miller, 2011; Ahern & Dittmar, 2012; Adams & Kirchmaier, 2016), such that one woman on a two-person board is equivalent to ten women on a 20-person board. This unweighted measure captures the intensity of female presence, but is insufficient to investigate whether it is easier for women to enter management or supervisory boards. An alternative indicator focuses on the number of women (e.g., Wolfers, 2006; Adams & Ferreira, 2009). Our rich data set enables a focus on the number of women on the boards; however, as Amadeus sample size steadily increases across editions, then the sums may reflect asymmetrically wider economy coverage in Amadeus rather than women's increasing access to managerial and supervisory boards. Hence, we compute a weighted measure, which scales the number of women by the total head count on a given board type. The third indicator focuses on the very presence of women directors and is partially immune to Amadeus' growing sample size.¹⁰ This indicator computes the fraction of firms that do not have women directors. With increasing sample size, if the share of firms with no women

¹⁰ Our indicator follows Daily et al. (1999) who use the percentage of firms with women on boards.

on boards decreases, then management and supervisory positions become more gender diversified.

To analyze *female presence on boards*, we compute and utilize all three indicators with firm level data. The first measure computes each firm's share of women separately for managerial and supervisory boards. Subsequently, we use an unweighted average of these shares in a given sector, country, and year. The second measure adds the number of women in managerial boards and separately women in supervisory boards for a given sector, country, and year, obtaining a weighted average. The third measure identifies the presence of at least one woman in a firm's management or supervisory board. Table 1 reports descriptive statistics.

[Insert Table 1 here]

The data reveal a striking dissimilarity between weighted and unweighted diversity measures at up to 10 percentage points. Approximately 70% of firms have no women in supervisory boards, and roughly 60% of firms have no women in management boards. Clearly, gender board diversity measurement cannot be addressed with a single indicator.

To better understand variation across the three gender diversity measures, we perform an analysis of variance, controlling separately for country effects, sector effects, their combination, and time effects. Table 2 results reveal that time variation explains a negligible fraction of variance in aggregates of gender board diversity for countries, sectors, and years. In fact, the majority of variance comes from between country differences and there is little country-specific heterogeneity across sectors. Furthermore, country specificity explains a larger fraction of variance for a measure of prevalence, such as the fraction of firms with no women on boards.

To elaborate on country specificity, we run a regression with country, sector, and year fixed effects (thus, accounting for the sample's changing composition), and use the coefficients to obtain country-level predictions for the three measures of both boards. Figure 1 reports these conditional predictions, and highlights the paramount importance of using comprehensive data and alternative measures of gender diversity. The ranking of countries based on averages differs substantially from the ranking based on the fraction of firms with no women on management boards. Moreover, this heterogeneity does not follow the "usual suspects" patterns. Ireland is among the most diverse management boards, and the least diverse supervisory boards. Likewise, countries considered relatively equal – e.g., Sweden and Denmark – are among the highest share of firms with no women on management boards, but fare relatively well in terms of averages.

[Insert Figure 1 and Table 2 here]

3.5. Independent variables

Our independent variables are based on published studies, particularly Adams and Kirchmaier (2013, 2016) and Talke, Salomo, and Rost (2010). We test our first hypothesis on country-level *gender equality* using some of Adams and Kirchmaier's (2013, 2016) variables, updated to the most recent observations. We lag all measures by ten years to limit possible simultaneity bias. *Female full-time economic labor force participation* captures the share of women working full time. *Codetermination* is a dummy variable with 1 indicating a country enables workers to participate in works councils, for example, to be consulted on employment issues and 0 otherwise. *Gross national income (GNI) per capita*: captures the value of output of all residents and taxes less subsidies as well as from abroad. *Family firms (fraction)*: captures the share of family firms in an economy. *Female students (fraction)*: refers to the share of students in tertiary education. *Birth rate* is the number of births per 1,000 inhabitants. *Tax and social security*: captures the fraction of tax and social security receipts over gross income. We innovate from Adams and Kirchmaier's (2013, 2016) measure of raw (unadjusted) labor market gender gaps (from the Organization for Economic Cooperation and Development) to use adjusted *gender wage gaps* (van der Velde and Tyrowicz, 2017), which provide a plausibly more sensitive measure by adjusting for differences in characteristics between male and female labor force participants. The adjusted gender wage gaps are higher than raw gaps in countries where women have more valuable labor market characteristics (e.g., higher levels of education) that are not equally rewarded as compared with men.

To test our second hypothesis, we follow Adams and Kirchmaier (2013) in measuring country-level *culture* with Inglehart and Welzel's (2005) traditional/secular and survival/self-expression value scores, which explain over 70 percent of cross-cultural variance in World Values Survey (WVS) scores. The traditional/secular distinction explores society's importance on religion, with the former emphasizing traditional family values. The survival/self-expression value explores a society's transition from industrial to postindustrial, thereby shifting focus from economic and physical security toward subjective well-being, self-expression, and quality of life. We follow Adams and Kirchmaier in using scores rather than individual WVS items.

We test our third hypothesis with industry-level *competition* as measured by the Herfindahl-Hirschman index of market concentration, which we derive directly from Amadeus

data, with 0 for very competitive markets and 1 if only feasible in a monopoly market. We compute the Herfindahl-Hirschman index using 3-digit NACE (Nomenclature des Activités Économiques dans la Communauté Européenne: European industry standard classification system) industry codes in a given country in a given year. Hence, this measure of competitive pressure has time, country, and sector level variation. Our robustness check computes the Herfindahl-Hirschman index using revenue data. We measure *innovativeness* with Eurostat's classification of the knowledge-intensive services and high technology classification of manufacturing industries based on R&D intensity from financial records, with 1 for intensive in innovation and 0 otherwise. This classification is time-invariant and defined at sector level, and hence, varies by country and sector levels.

4. Results

We estimate a linear probability model where the dependent value equals 1 for a female director and 0 otherwise. We have one firm-level indicator: number of board directors. All time-invariant firm characteristics are absorbed by firm fixed effects.¹¹ Table 3 reports country-level tests of the first and second sets of hypotheses. Table 4 provides sector-level tests for our third hypotheses.

We estimate four models with null hypothesis of statistically equivalent estimated coefficients. We then show results for management board directors, separately for public and private firms. The third column tests for statistical differences in the coefficients from these two regressions. We then move to supervisory boards, and run separate regressions for public and private firms. The final two-column tests for statistical differences in coefficients between management and supervisory boards for public and private firms.

Estimates for the country-level measures of gender equality and women's prevalence on management boards reveal substantial contradictions for the majority of measures suggested by Adams and Kirchmaier (2013). Most importantly, the key variable in most academic narratives – full-time female economic participation – has a significant negative correlation for management boards of private firms, but not for public firms, nor for the supervisory boards of both types of firms. These differences are statistically significant, i.e., the negative significant coefficient for management boards of private firms is statistically different from insignificant negative

¹¹ For robustness, we run a variety of specifications with a broader set of firm controls. We include (log of) employment, (log of) assets, and profit/assets ratio. The results are unaffected, but substantially reduce sample size because of missing financial and employment data. These additional estimations are available upon request.

coefficient for management boards of public firms, and the insignificant positive and insignificant negative coefficients for the two boards for public firms are different from one another. Overall, we interpret these results that women's stronger participation in the general labor market is negatively related to women's ascension to management and supervisory boards of private firms (insignificant for the latter, plausibly because of smaller sample size), but not for public firms.

Looking at the other variables, greater codetermination is associated with a significantly lower coefficient for women's presence on supervisory boards of public firms, but no significant correlation was found for management boards of public firms and both types of boards for private firms. Again, this lack of systematic correlation is not just due to low statistical power: tests comparing the estimated coefficients reveal them to be significantly different from one another. We find only one significant coefficient for GNI per capita (and only marginally so): there is a correlation between greater GNI per capita and women's presence on supervisory firms of public firms, but this is not significant across board types. For family firms, again, we find only one significant coefficient: greater presence of family firms is associated with fewer women on supervisory boards in private firms, but public firms have a significant difference between management and supervisory boards ($p < .05$). The share of female students in tertiary education shows a significant coefficient across management and supervisory boards for all public and private firms, and this is a statistically significant difference for public firms ($p < .10$). Higher birth rate has a statistically significant coefficient related to greater presence of women in private firms' management boards and supervisory boards (of similar magnitude), but there is virtually no correlation for the public firms. Tax and social security show significant coefficients for management boards of both public and private firms, as well as private firms' supervisory boards, and the difference is significant for private firms ($p < .001$) as well as public firms ($p < .10$). Finally an increasing gender pay gap is associated with fewer women on management and supervisory boards in private firms, but not in public firms, and this difference is significant ($p < .05$). Taken together, we find highly mixed results for the variables that were universally accepted to be conducive to gender board diversity, and were foundational for hypothesis 1.

Findings for our first hypothesis appear counter-intuitive, but are consistent with the behavioral and psychological literature on differences in women's aspirations for their professional lives. In more equal societies, individuals are more free to pursue their individual

professional objectives and, if those do not happen to comprise uniformly advancing to the top business positions, the representation may be highly imbalanced. This interpretation is corroborated by the results for gender wage inequality: higher gender wage inequality is universally negative, especially for supervisory boards and private firms. This finding is in contrast to prior research indicating that the probability of promotions and wage raises or assignments to different jobs are not directly linked (Booth, Francesconi, and Frank, 2003; Lazear and Rosen, 1990). These differences may be due to significantly different labor markets and time periods; prior studies tended to focus on all labor markets in a historical context.

Our results on country-level cultural institutions provide support for hypothesis 2. Table 3 shows that traditional/secular-rational culture is significantly associated with greater women's presence on management and supervisory boards of private firms, and this difference is significant ($p < .001$). Survival/self-expression culture also reveals a significant association, albeit negative, with women's presence on public management boards and both public and private supervisory boards and this difference is significant ($p < .10$). Taken together this suggests that a country culture that prioritizes family values will result in fewer women directors, especially for supervisory boards. Similarly, as a country's society transitions from focusing on economic value to prioritizing self-expression and well-being, the effect will be stronger.

Looking at Table 4 tests of our third hypothesis, innovativeness and competitiveness of a given sector display neither strong, nor consistent correlations with female presence on management or supervisory boards. Only the greater presence of a knowledge-intensive sector is significantly associated with fewer women on private supervisory boards. The final column of tests reveals that the differences are significant for private firms: competitiveness ($p < .10$) and innovativeness ($p < .001$). Roughly, the magnitude of the effects is often the same as the magnitude of the standard errors, which points to small overall effect sizes and considerable heterogeneity. Taken together, we have mixed support for hypothesis 3.

[Insert Table 3 and Table 4 here]

5. Conclusions

Gender board diversity is a hot policy debate. Women on supervisory boards are believed to serve as role models and mentors for subsequent generations of female professionals, thereby leading to greater representation of women in top management positions. Moreover, women's presence on supervisory boards is expected to increase gender equality as these women will

appoint more female executives who may someday become management board directors. Motivated by these beliefs, ten countries implemented a gender quota for supervisory boards among public firms, and several countries are actively exploring a potential policy.

Our study offers an extensive and relatively comprehensive overview of women's presence on management and supervisory boards in corporate Europe. We utilize two decades of firm level data for a large panel of firms, and develop a novel gender assignment algorithm to identify the gender of supervisory and management directors in private and public firms. This large dataset offers several key findings. First, the glass ceiling appears stronger for any single woman to be appointed director of a supervisory board rather than a management board. In our sample, we more commonly find a firm that has no women on a supervisory board than a firm with no women on a management board. A second key finding is that more gender equality is not at all associated with more women directors on management boards. Adams and Kirchmaier (2016) argue that cracking the glass ceiling takes several steps and first requires improving women's educational attainment and labor force participation. Our results reject this conjecture and offer implications for institutional theory. From a theoretical perspective, the institution of women's full-time labor force participation is not as relevant as others identified in prior literature, e.g., legal and economic systems (Grosvold & Brammer, 2011), type and strength of religious beliefs (Chizema, Kamuriwo, & Shinozawa, 2015), gender-differentiated language structures (Santacreu-Vasut, Shenkar, & Shoham, 2014), and other family, education, economic, and government institutions (Grosvold, Rayton, & Brammer, 2016). In addition to these key results, we provide an array of stylized facts concerning country and sector specificity as well as time trends. Because we compare three different measures of gender board diversity, we also offer contributions by highlighting the risks associated with relying on a single indicator.

Before concluding, we acknowledge several limitations that should be addressed in future research. First, while we control for several country-level factors identified in prior research, additional country-level norms and values may be relevant, for example measures of institutional quality (e.g., Oehmichen, Schrapp, & Wolff, 2017) and underlying political processes (Seierstad, Warner-Søderholm, Torchia, & Huse, 2017). That is, we might expect that countries with greater political freedom will also have higher shares of women on management and supervisory boards. Second, although we incorporate many variables at micro and meso levels, future research should consider other variables previously linked to greater female presence on management

boards, such as institutional and individual owners (Oehmichen, Rapp, & Wolff, 2012). For example, activist institutional investors such as the California Public Employees' Retirement System recently voted 438 directors in 141 companies, which did not respond to efforts to increase board diversity (Jacobius, 2018). Third, future scholars should prioritize more longitudinal research, for example on firm and country histories of gender board diversity through a balanced panel. This line of scholarship could trace histories of firms with no women on boards that eventually appoint a woman director, and patterns across industries within a single country. The correlates of these processes can inform further policy development. Fourth, as our study did not include firm performance, future research could utilize more administrative data as Amadeus financial data would reduce the sample in a nonrandom way. Fifth, we encourage future researchers to explore these and other factors also as potential moderators and mediators. As an example, prior research indicates that analyst coverage can affect director exit (Harrison et al., 2018) and antecedents of legitimacy pressure should be closely examined (Schreck & Raithel, 2018). This line of enquiry is particularly promising to unpack some of our study's identified differences between more visible public firms and their private counterparts.

In addition to future research suggested by study limitations, we encourage scholars to explore potential new theoretical angles, as well as phenomenological and methodological avenues. Recent theorizing describes how firms can express "governance deviance" by adapting practices outside the established national corporate governance framework (Aguilera et al., 2018). Scholars could expand the theory by examining why some firms may deviate from their national template. For example, some firms may have extensive operations in countries that already have quotas, and thus may be exposed to the possibility of these quotas or just the presence of more female leaders, and thus be more likely to proactively appoint women to management and supervisory boards. From a phenomenological perspective, as our data collection concluded in 2014, eight countries' soft and hard board gender quotas are now effective (e.g., German public companies face a quota of 30% of nonexecutive/supervisory directorships by 2016), and there are early indications that these quotas profoundly shape directors (Seierstad & Opsahl, 2011). We recommend future studies to explore quota effectiveness in leading to more women on both management and supervisory boards of public and private firms, as well as how these quotas may shape the supply of women directors, including across countries. This line of research could utilize difference-in-difference

methodology to exploit the quota as a natural experiment, and also offer tremendous insights for policy development. From a methodology standpoint, a growing body of research utilizes perceptions of facial appearance (e.g., beauty, competence) to predict appointments of CEOs and directors, albeit mostly male samples (e.g., Geiler, Renneboog, & Zhao, 2018; Graham, Harvey, & Puri, 2017). Future research could expand this research to female corporate leaders, and explore differences across supervisory and management boards of both public and private firms. Finally, researchers could employ more qualitative methods to explore the contributions of women in management and supervisory board directorships, as well as in public and private firms.

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Table 1. Sample descriptive statistics

	Full data		With country-level institutional measures available	
	People	Firms	People	Firms
Total #	112,351,222	69,327,072	28,946,738	17,666,148
Total unique	20,873,827	11,924,905	6,917,093	3,657,692
# Men	87,064,480	-	22,674,348	-
# Women	25,286,742	-	6,272,390	-
In firms that should have a supervisory board (*)				
Total #	59,907,648	37,680,656	-- --	-- --
Total unique	10,825,012	6,324,058	-- --	-- --
# Men	45,988,164	-	-- --	-
# Women	13,919,484	-	-- --	-
In firms with data on supervisory board members (**)				
Total #	1,960,606	463,872	625,192	134,399
Total unique	317,812	67,914	194,567	32,327
# Men	1,532,492	-	521,825	-
# Women	428,114	-	103,367	-
# in Agriculture	1,122,686	687,640	392,841	252,015
# in Construction	5,595,518	4,106,126	2,810,547	2,064,417
# in Manufacturing	8,465,073	5,157,065	3,752,291	2,261,830
# in Market services	37,219,860	24,379,932	17,766,112	11,339,031
# in Non-mark. serv.	7,504,511	3,138,262	4,224,947	1,641,350
# in 1995	888,335	519,812	-	-
# in 1996	1,120,168	664,217	-	-
# in 1997	1,446,838	832,395	-	-
# in 1998	1,860,346	1,033,641	-	-
# in 1999	2,281,265	1,291,203	-	-
# in 2000	2,604,263	1,488,125	-	-
# in 2001	2,845,465	1,657,157	1,715,834	904,795
# in 2002	2,953,884	1,829,892	1,663,319	976,131
# in 2003	2,786,590	1,968,131	2,108,746	1,411,410
# in 2004	4,048,358	2,450,555	2,521,224	1,451,823
# in 2005	4,791,507	2,879,635	3,410,759	1,929,840
# in 2006	5,141,796	3,059,848	3,420,982	1,937,610
# in 2007	4,086,539	2,535,491	3,491,923	2,123,077
# in 2008	3,973,082	2,614,763	3,294,790	2,130,000
# in 2009	4,451,559	2,974,276	3,565,217	2,331,381
# in 2010	4,778,223	3,217,556	3,753,944	2,470,080
# in 2011	5,095,033	3,457,821	-	-
# in 2012	4,754,397	3,206,138	-	-
Unweighted average				
Management boards (*)	-	22.55%	-	20.62%
Management boards (**)	-	16.80%	-	13.45%
Supervisory boards	-	23.30%	-	16.72%
Weighted average				
Management boards (*)	-	14.13%	-	14.49%
Management boards (**)	-	16.99%	-	14.45%
Supervisory boards	-	32.48%	-	21.54%
% of firms with no women on board				
Management boards (*)	-	70.86%	-	72.28%
Management boards (**)	-	77.80%	-	78.96%
Supervisory boards	-	59.11%	-	68.35%

Notes: Weighted, unweighted average and the fraction of firms with no women are averaged over every year-country-sector unit in corresponding data set; # denotes the number of observations for a given criterion. (*) denotes the sample of all management board members, whereas (**) denotes the sample of management board members for firms, where supervisory board members have been identified as well. Data availability for institutional measures is constrained by access as well as by 10 year lags (see Adams and Kirchmaier, 2013, 2016).

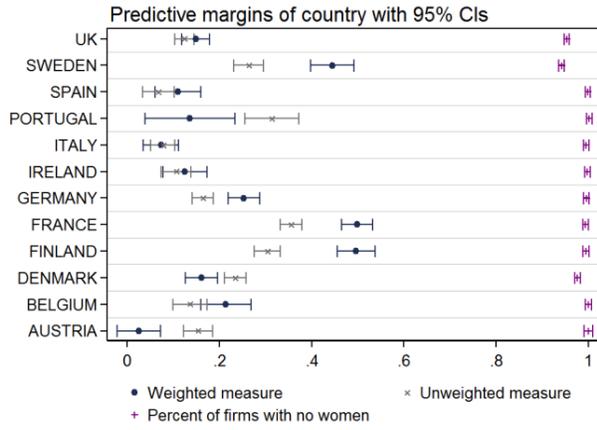
Table 2. Gender diversity on boards: Decomposition of variance

	Full data		With country-level institutional measures available	
	Management	Supervisory	Management	Supervisory
	Unweighted average			
Country	23.11%	18.96%	38.51%	24.60%
Sector (broad)	12.79%	1.31%	17.84%	0.63%
Sector (2 digits)	25.29%	7.23%	29.22%	8.38%
Country and sector	39.77%	32.46%	60.59%	38.56%
Year	2.22%	0.09%	0.36%	1.31%
All	54.04%	37.37%	72.00%	44.69%
	Weighted average			
Country	42.99%	22.40%	56.05%	31.94%
Sector (broad)	2.59%	0.44%	6.20%	0.40%
Sector (2 digits)	7.35%	5.36%	10.15%	4.88%
Country and sector	54.66%	30.51%	75.26%	38.45%
Year	1.17%	2.15%	0.91%	4.98%
All	60.71%	35.04%	80.07%	44.06%
	% of firms with no women			
Country	32.96%	26.98%	54.47%	12.81%
Sector (broad)	9.37%	0.74%	11.05%	1.70%
Sector (2 digits)	18.54%	3.76%	17.55%	5.72%
Country and sector	46.58%	33.48%	70.53%	19.28%
Year	2.11%	0.51%	1.01%	2.20%
All	57.14%	36.89%	77.69%	25.86%
# of observations	12,119		2,756	

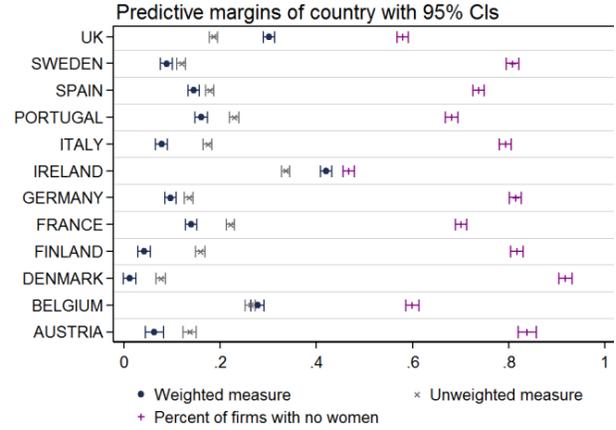
Notes: Analysis of variance decompositions, with alternative controls in each row. The number of observations denotes the number of country-year-sector cells available in the data. The reduction in the number of cells is due to limitations of institutional level measures at country and year level. Note that availability is lower as 10 year lags are used (see Adams and Kirchmaier, 2013, 2016). Unweighted 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. Weighted measure is obtained by dividing the total number of women on boards in firms from a given 2-digit sector in a given country in a given year by the total headcount of management boards from that sector. The fraction of firms with no women in management boards is obtained by dividing the number of firms with no women in management boards by the total number of firms in a given sector, country, and year.

Figure 1. Heterogeneity of gender board diversity across countries

(a) Supervisory boards



(b) Management boards



Notes: Marginal predictions from a regression where a female board member is a predicted variable, accounting for country, year, and sector fixed effects as conditioning variables.

Table 3. Country level characteristics and gender board diversity

	Management boards (MB)			Supervisory boards (SB)			Tests between MB and SB for	
	Public	Private	Test	Public	Private	Test	Public firms	Private firms
	1	2	1=2	3	4	3=4	1=3	2=4
# people on a board (log)	0.017 (0.018)	-0.015** (0.007)	406.47*** (0.000)	0.059*** (0.015)	-0.047 (0.033)	1210.81*** (0.000)	8.39*** (0.004)	0.80 (0.371)
Hypothesis 1								
Female full-time economic participation	-0.385 (0.556)	-1.440*** (0.519)	69.64*** (0.000)	0.532 (0.424)	-1.418 (1.027)	29.22*** (0.000)	4.89** (0.027)	0.00 (0.981)
Codetermination	0.019 (0.025)	-0.011 (0.019)	17.50*** (0.000)	-0.038* (0.020)	0.025 (0.040)	13.93*** (0.010)	7.66*** (0.006)	0.58 (0.446)
GNI per capita	1.281 (1.941)	-0.256 (2.232)	30.77*** (0.000)	1.610* (0.861)	-3.622 (2.604)	30.76*** (0.000)	0.04 (0.848)	0.73 (0.391)
Family firms (fraction)	-0.085 (0.113)	-0.041 (0.069)	3.24* (0.072)	0.111 (0.093)	-0.128* (0.071)	16.49*** (0.000)	3.83** (0.050)	1.93 (0.164)
Female students (fraction)	1.247*** (0.456)	0.901* (0.513)	17.11*** (0.002)	0.734** (0.339)	1.523*** (0.426)	31.73*** (0.000)	3.57* (0.059)	0.91 (0.339)
Birth rate	0.001 (0.006)	0.023** (0.010)	225.80*** (0.000)	0.005 (0.005)	0.028*** (0.008)	29.59*** (0.000)	0.16 (0.692)	0.13 (0.718)
Tax and social security	0.004** (0.002)	0.004** (0.002)	1.35 (0.245)	0.001 (0.002)	0.009*** (0.003)	27.64*** (0.000)	3.00* (0.083)	6.93*** (0.009)
Gender pay gap	-0.169 (0.213)	-0.322** (0.141)	31.10*** (0.000)	-0.080 (0.080)	-0.751** (0.227)	70.04*** (0.000)	0.22 (0.636)	5.43** (0.020)
Hypothesis 2								
Traditional/secular-rational	0.014 (0.028)	0.041** (0.019)	137.70*** (0.000)	0.021 (0.014)	0.064*** (0.025)	5.78** (0.016)	0.03 (0.857)	29.45*** (0.000)
Survival/self-expression	-0.092** (0.040)	-0.098 (0.063)	0.79 (0.375)	-0.056** (0.028)	-0.234*** (0.074)	53.68*** (0.000)	1.58 (0.209)	3.44* (0.064)
Joint test:			905.99*** (0.000)			135.81*** (0.000)	190.85*** (0.000)	16800.53*** (0.000)
Year and sector FE	Yes			Yes			-	-
Country-clustered SE	Yes			Yes				
Observations	209,548	28,400,160		76,981	260,049			
R-squared	0.037			0.038				

Notes: Following Adams and Kirchmaier (2013), we lag all country level measures by 10 years to exclude endogeneity bias stemming from contemporaneous correlation in the error terms for country-level measures and board diversity. Standard errors clustered at country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Parentheses within test columns reflect probability > test statistic. Full-time female economic participation formula from Adams and Kirchmaier (2013). Tertiary education (percent of women in the labor force, as percentage points) and female percent of parliament seats occupied indices from World Bank database. Women economic rights ratio, women social rights ratio, and women administrators' ratio come from the Indices of Social Development database; higher index values signify greater equality. Gender Equality Index developed by European Institute for Gender Equality. Gender wage gap from van der Velde and Tyrowicz (2017).

Table 4. Sector level characteristics and gender board diversity

Panel A: Employment-based HHI	Management boards (MB)			Supervisory boards (SB)			Tests between MB and SB	
	Public	Private	Test	Public	Private	Test	Public firms	Private firms
	1	2	1=2	3	4	3=4	1=3	2=4
# people on both boards (log)	0.002 (0.009)	0.018 (0.012)	276.83*** (0.000)	0.052*** (0.019)	-0.010 (0.041)	624.25*** (0.000)	7.20*** (0.007)	0.54 (0.461)
Hypothesis 3								
Competitiveness (sector)	-0.052 (0.056)	0.067 (0.064)	219.45*** (0.000)	0.021 (0.057)	-0.084 (0.073)	36.44*** (0.000)	0.82 (0.365)	2.79* (0.094)
Innovativeness (sector)	0.000 (0.011)	0.001 (0.014)	1.25 (0.262)	0.002 (0.008)	-0.040*** (0.013)	269.30*** (0.000)	0.03 (0.865)	10.59*** (0.001)
Joint test:			176.10*** (0.000)			328.50*** (0.000)	28.56*** (0.000)	22.49*** (0.000)
Year and country FE	Yes			Yes			-	-
Sector-clustered SE	Yes			Yes				
Observations	438,909	58,310,933		125,216	1,032,561			
R-squared	0.002			0.012				

Panel B: Revenue-based HHI	Management boards (MB)			Supervisory boards (SB)			Tests between MB and SB	
	Public	Private	Test	Public	Private	Test	Public firms	Private firms
	1	2	1=2	3	4	3=4	1=3	2=4
# people on both boards (log)	0.002 (0.009)	0.019 (0.106)	291.86*** (0.000)	0.054*** (.019)	-0.011 (0.042)	655.31*** (0.000)	7.72*** (0.005)	0.58 (0.447)
Hypothesis 3								
Competitiveness (sector)	-0.067 (0.061)	-0.016 (0.810)	43.25*** (0.000)	-0.066 (0.069)	-0.102 (0.091)	4.64** (0.031)	0.00 (0.995)	0.60 (0.439)
Innovativeness (sector)	-0.001 (0.011)	0.001 (0.014)	2.30 (0.129)	0.000 (0.009)	-0.040*** (0.013)	232.96*** (0.000)	0.00 (0.968)	10.28*** (0.001)
Joint test:			114.27*** (0.000)			314.55*** (0.000)	15.11*** (0.001)	14.88*** (0.001)
Year and country FE	Yes			Yes			-	-
Sector-clustered SE	Yes			Yes				
Observations	438,909	58,310,933		125,216	1,032,561			
R-squared	0.002			0.012				

Notes: Sample size in Table 4 differs from Table 3 due to differences in the availability of sectoral indicators for knowledge intensity. HHI measures obtained from Amadeus data. Standard errors clustered at sector level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Parentheses within test columns reflect probability > test statistic.

Appendices

Table A1. Heuristics on gender attribution

Country	Total sample				
	% 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	0.670	0.078	0.328	0.282	0.001
Cyprus	0.908	0	0.047	0.013	0.045
Czech Rep.	0.640	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	0.340	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	0.050	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	0.830	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
Russia	0.741	0.007	0.258	0.236	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	0.100	0.058	0.011
Turkey	0.927	0	0.057	0.011	0.016
Ukraine	0.186	0.103	0.814	0.609	0
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 expatriates: 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	.810	.185
2006	.824	.003	.005	.806	.188
2007	.835	.003	.005	.815	.179
2008	.898	.001	.002	.890	.107
2009	.990	0	0	.985	.015
2010	.990	0	0	.980	.020
2011	.989	0	0	.981	.019
2012	.980	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	.990	0	.001	.990	.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
Russia	.903	0	0	.959	.041
Serbia	.970	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
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.

A3. Assignment of supervisory and management board functions

As of the 2014 edition, Amadeus data identify management and supervisory board members. We verify our assignment to boards with the Amadeus 2014 identification. Table A3 reports high overlap. There are only a few important cases where the assignments depart from each other, namely:

- Among the cases where we provide no assignment and Amadeus provides assignment to supervisory boards, i.e., 229,861 cases, 229,109 cases come from functions named “Advisor” in Italy. The remaining 752 cases are discordant between our assignment and Amadeus assignment and are related to single-occurrence typos in the raw Amadeus data;
- Among cases where we provide no assignment and Amadeus provides assignment to management boards (1,359,167 cases), 1,096,447 come from functions named as “Business manager” and 8,816 come from a function named “Liquidator” in France (out of 1,181,442 discordant for that country). In addition, Amadeus classifies individuals with a function “President” as management, whereas in many firms the president could be a nonexecutive function on a supervisory board. We assign functions described as “President” without additional explanation to position on board. This concerns 63,003 cases for France. In addition, there are 26,384 cases of “Representative” in Greece (out of 33,247 discordant for that country) and 23,115 cases of “Representative” in Hungary (out of 37,332 discordant in this country). An additional 23,692 cases come from functions named “Partner” or “Agent” in Belgium (out of 27,246 discordant for that country). Finally, Amadeus classifies all senior management positions: 81,852 persons with the manager function “Company Secretary” and 197,452 persons with manager function “Regional Director” in Ireland (out of 292,087 discordant in this country).
- Among cases where Amadeus assigns no board function and we assign a supervisory board function (in total 17,535 cases), 2,096 come from employee representatives in Denmark. An additional 13,623 cases come from a manager function “Member of the Council” and “Chairman of the Council” in Estonia;
- Among cases where Amadeus assigns management board and assigns supervisory board function (in total 3,796 cases), all originate from Austria and refer to manager functions “General Partner Representative” and “Shareholder (Ultimate Owner)” in the case of incorporated firms, hence, unequivocally Amadeus provides inappropriate assignment; and
- Among cases where Amadeus assigns no board function and we assign management board function (998,736 cases in total), 223,630 cases refer to “Chairman of the Board of Directors” or “Vice Chairman of the Board of Directors” in Italy, 200,939 cases refer to top management positions in Spain (e.g., “Sales Director,” “Human Resources Director,” and “Purchases Director” concern 184,324 cases), and 229,574 cases refer to positions in French firms with “Chief” and “Officer” or “Chairman” and “Executive” in manager function description. There are 156,793 analogous cases in French-speaking Belgium. In addition, there are 131,438 cases of “Member of the Board” in Estonia, where supervisory boards have a different name, and hence, the position of the member of the board is universally attributable to top management.

Table A3. Board assignment: Amadeus data versus our heuristics (2014 data)

		Our heuristics				
		No board function	Supervisory Board	Management Board	# Total	Percent
Amadeus data	No board function	2,488,540	17,535	998,736	3,504,811	34.8%
	Supervisory Board	229,861	106,848	14	336,723	3.4%
	Management Board	1,359,167	3,796	4,861,980	6,224,943	61.8%
	# Total	4,077,568	128,179	5,860,730	10,066,477	100%
	Percent	40,5%	1,3%	58,2%	100%	

Data: Amadeus 2014, person-level variable "type of position." Amadeus' Supervisory Board assumed if variable contents were "SupB," "AdvB," "AudC," "CoGoC," "NomC," "RemC," or "ChmC." Amadeus' Management Board assumed if variable contents were "SenMan," "ExeB," or "BrOff."

Table A4. Employment coverage: Amadeus aggregated employment versus WIOD

Country	Year																	
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	0.09	0.09	0.13	0.32	0.41	0.45	0.56	0.54	0.56	0.60	0.61	0.61	0.54	0.33	0.32	0.34	0.36	0.35
Belgium	0.98	0.96	1.12	1.17	1.20	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
Bulgaria	0.36	0.42	0.45	0.50	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
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
Czech Rep.	0.25	0.28	0.32	0.36	0.45	0.52	0.56	0.57	0.52	0.63	0.61	0.60	0.59	0.63	0.64	0.89	0.93	0.90
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
Estonia			0.37	0.52	0.69	0.77	0.77	0.80	0.79	0.87	0.88	0.82	0.63	0.63	0.67	0.65	0.68	0.68
Finland	0.34	0.36	0.40	0.44	0.50	0.53	0.56	0.71	0.60	0.66	0.71	0.75	0.73	0.77	0.79	0.82	0.88	0.87
France	0.41	0.44	0.47	0.52	0.54	0.55	0.55	0.60	0.57	0.60	0.60	0.55	0.47	0.48	0.49	0.51	0.52	0.49
Germany	0.21	0.40	0.45	0.52	0.60	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
Greece	0.23	0.25	0.27	0.30	0.30	0.31	0.31	0.30	0.27	0.48	0.50	0.49	0.32	0.27	0.32	0.34	0.32	0.26
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
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	0.80	0.84
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
Latvia	0.21	0.23	0.30	0.33	0.36	0.38	0.40	0.40	0.40	0.64	0.68	0.70	0.66	0.65	0.69	0.73	0.75	0.79
Lithuania	0.07	0.15	0.32	0.32	0.31	0.33	0.34	0.40	0.39	0.37	0.31	0.32	0.53	0.51	0.51	0.53	0.48	0.40
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	0.50	0.74	0.81	0.61
Malta			0.03	0.06	0.21	0.29	0.29	0.21	0.16	0.38	0.41	0.40	0.40	0.38	0.32	0.33	0.42	0.36
Poland	0.42	0.66	0.69	0.76	0.82	0.79	0.51	0.37	0.36	0.40	0.41	0.43	0.43	0.44	0.57	0.54	0.53	0.43
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
Romania	0.56	0.63	1.10	1.19	1.00	1.06	1.15	1.07	0.54	0.58	0.64	0.55	0.57	0.60	0.57	0.56	0.60	0.62
Russia			0.01	0.13	0.3	0.39	0.53	0.42	0.29	0.30	0.31	0.32	0.13	0.14	0.16	0.17	0.18	0.19
Slovakia	0.13	0.16	0.19	0.21	0.26	0.35	0.40	0.35	0.33	0.44	0.46	0.49	0.52	0.52	0.49	0.64	0.63	0.57
Slovenia	0.02	0.08	0.49	0.51	0.53	0.53	0.55	0.53	0.46	0.50	0.49	0.50	0.45	0.44	0.44	0.58	0.59	0.59
Spain	0.35	0.39	0.43	0.47	0.51	0.52	0.56	0.60	0.58	0.63	0.63	0.62	0.52	0.57	0.60	0.61	0.60	0.52
Sweden													1.07	0.71	1.03	1.07	1.12	1.17
UK	0.60	0.65	0.70	0.81	0.89	0.96	1	0.98	0.86	0.89	0.92	0.94	0.78	0.80	0.85	0.88	0.90	0.92

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 at sector level. The Netherlands is included in the Amadeus but not included in estimation because of missing names (gender could not be assigned). Amadeus data for Sweden 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, and Ukraine. Hence, data coverage could not be verified for these countries. Data for 2013 not used because of poor coverage in Amadeus 2014 edition. Detailed sectoral coverage for each country and year is available upon request.

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