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The Gender Diversity Effect on R&D Investments and Innovation Performance

Master's Thesis

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We have written this master's thesis independently. All viewpoints of other authors, literary sources,and data from elsewhere used for writing this paper have been referenced.

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Abstract

In recent years, research on gender diversity and innovation in companies has become the subject of heated debate and controversy. While some researchers note the importance of women's influence on innovation, others, on the contrary, do not agree with them. In this study, the authors aim to find a connection between female employees and their influence on innovation in the areas of products, organizations, and marketing. Since various authors have not previously used the BEEPS dataset and CDM model with female variables, the authors of this study decided to diversify this topic using them. To work with the BEEPS dataset, the authors decided to use the Stata and 3 stages CDM framework. Based on the aforementioned dataset and research methodology, the authors found that gender diversity has a connection with R&D, as well as with innovation.

Keywords: *Innovation, female workforce, gender diversity, CDM framework, R&D*

JEL classification: S180

1. Introduction

The prospective link between the gender of employees and a company's level of innovation has been a field of notable research interest for scholars all around the world, especially from times when women's rights to equality were restored in most countries. For instance, Quintana-García et al. (2022) using a large panel database of 1,345 publicly US-traded firms found that gender and ethnic diversity at all levels of management showed a strong positive association with innovation within companies. Additionally, Quintana-García et al. (2022) found that in contrast, women and ethnic minorities at the CEO level had no critical impact.

The balance between the two genders, also called gender diversity, has become an increasingly important issue in recent times. Even more important is the impact of gender diversity on innovation within companies. According to Lynch (2022) since 2000, there have been 6.6 million studies published in 15,000 medical journals on the importance of different genders at work. According to Lynch (2022), during the analysis of various scientific studies by employees of three American universities, it turned out that, in general, teams in which there are 50% men and 50% women, are more effective in terms of innovation than teams in which either 100% are men or 100% are women. Furthermore, a study by Hoogendoorn et al. (2013) found that groups with lower rates of women have lower deals and lower benefits than groups with gender diversity. Also, the study showed that clashes, fellowships, decision-making, environment, learning, and teamwork had nothing to do with the sexual orientation of the members of the tested group.

The thesis of the authors **aims** to find out the link between the female workforce and the innovation performance of companies. In addition, the topic of the relationship between the gender of company employees and innovation has been studied quite often by various researchers and the authors sighted frequent disagreements on the results of the particular study theme. Moreover, the authors of this study did not find previous research work created by studying BEEPS data with a focus on gender (female) variables. Even though there is a decent number of studies with both the BEEPS dataset and CDM Model. For fulfilling the aim of the study, the authors use the BEEPS dataset and CDM framework. Crépon et al. (1998) developed a 3 stages model to connect innovation input, innovation output, and productivity. The CDM approach not only observes the relationship between innovation input and innovation output but also considers innovation output as a driver of productivity.

As it was already mentioned whether or not there is a link between gender diversity and innovation in companies has also been highly ambiguous. For the most part, the authors of the studies come to the opposite conclusion, namely that the connection still exists. For example, a study by Teruel & Segarra-Blasco (2017) showed that in Spain from 2007-2012, after analyzing 5383 companies, there is a positive link between gender diversity in the workplace and innovative approaches. Moreover, Janjuha-Jivraj (2020) in her recent study writes that after the pandemic, companies are restructuring their activities and, in her evidence, gender diversity should be one of the key points to pay attention to. Thus, Janjuha-Jivraj (2020) draws the reader's attention to the fact that teams that have gender diversity are more effective and show better performance in innovation when it comes to solving working problems. Furthermore, Ritter-Hayashi et al. (2019), in their cross-country study, also revealed the advantages of gender diversity concerning innovation. They state that after studying 15 countries and 18,547 companies, diversity among company managers and the presence of a woman in the general manager role help in the growth in innovation output in developing countries.

In the theoretical part, the authors write about the definitions of the term “innovation”, discuss the mechanisms of why and how gender diversity and investments in R&D affect firm innovation performance and the relationship between gender and innovation in the company, and an analysis of various empirical studies on this topic. Subsequently, in the empirical part of the authors, the authors use the BEEPS data and CDM model to conduct their analysis. Employing the CDM framework allows the authors to generate reliable results that can shed light on the potential influence of females in the workforce on innovation performance. The CDM model is well suited to address our hypothesis, which is, that women’s participation contributes to a firm’s propensity to innovate and that gender diversity directly contributes to productivity.

In small summary, this study seeks to contribute to the existing knowledge on the relationship between such criteria as the gender of the workforce and its impact on innovation by utilizing robust theoretical and empirical frameworks and methodologies. In the end, both authors of the thesis aim to produce insightful, relevant, and impactful findings which can be valuable for business leaders, policymakers, and academics.

2. Literature review

First, the authors would like to describe the term "innovation" from the point of view of various authors/organizations. In general, in terms of the paper, it is very important to understand what innovation is.

In the theoretical literature, there are many definitions of what is innovation. Thus, according to OECD/Eurostat (2005), innovation is the execution of a modern or altogether progressed item (good/service) or process (method/practice/relationship). A similar definition in their study was also given by Mulgary and Albury (2003), who described innovation as the creation and execution of unused forms, items, administrations, and strategies of conveyance that result in noteworthy changes in results, proficiency, adequacy, or quality. In turn, CBI/QUINETIQ (2008) considered that the innovation process is ongoing. Thus, they described innovation as a continuous and dynamic process in which ideas are transformed into value. Damanpour and Schneider (2009) also write that innovation is the improvement (generation) and/or utilization (adaption) of modern thoughts or behaviors. According to a newer definition given by De Vires et al. (2015), innovation is the introduction of modern components into a service—new information, unused organization, and modern management/skills. And according to Nesta (2012), innovation is the method by which modern thoughts turn into modern products or services. Moreover, Fagerberg (2013) in his paper compares the term invention and innovation and gives his definition of the term. Fagerberg (2013) states that innovation is the first practical approach to carrying out new technology. For that, according to Fagerberg (2013), one needs skills, knowledge, and information about a product.

The authors have made a summary table for the term "innovation" which the reader can find in the Appendix section at the end of the work. The table is named as follows "Table 1. Definitions of innovation".

After discussing the concept of "innovation" and its theoretical background, it is also important to analyze the mechanisms between gender and innovation. More specifically, next we will look at what are the mechanisms of why board structure affects firm innovation. As Budworth and Mann (2010) state men and women have various gender socialization and life experiences, and the differences between them cannot be ignored when discussing leadership characteristics. For instance, Evans (2010) writes that is a more democratic leadership style, and men, in contrast, are more autocratic (do not pay attention to other people's opinions). Also,

Sheaffer et al. (2011) indicated that when it comes to stereotypes men are considered to be emotionally stable, self-confident, and competitive.

Adams & Ferreira (2007) write the function of a company's board of directors is to monitor and control the mechanisms within the company and to be a source of help in the company's decision-making. Furthermore, according to Sierra-Morán et al. (2021), several mechanics of the board may matter for company performance. These are the size of the board, the composition of the board, equity of directors, duality of the board, and characteristics of the meetings of the board (e.g., frequency of meetings, teamwork during meetings when the board of directors becomes a source of consultation), board demographic diversity, and social capital of the board (Sierra-Morán, 2021).

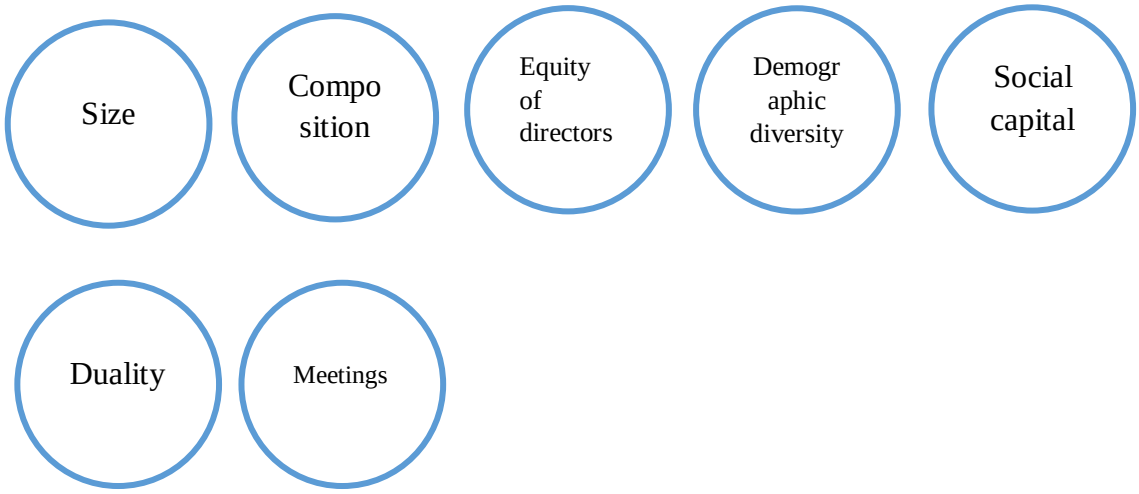
At the end of the last century, when studying the relationship between the board of directors and innovation, authors usually considered the board with firm innovation centered on board equity and the extent of inside and outside executives (Baysinger et al., 1991). Unlike past studies, current studies also take into account such parameters as gender, knowledge, professional diversity, or connections outside the firm (Hernández-Lara & Gonzales-Bustos, 2019). In modern times, the study of the board of directors has become an important part of the research. Thus, Wang (2011) wrote that a good example of how the decision-making process can lead to innovation is gender diversity on the board. In turn, Torchia et al. (2011) analyzing "Critical mass theory" by Kanter (1977), write that thanks to a small group of women on the board of directors, there is a qualitative change in the behavior of the group (interaction within it) and the organization that subsequently leads to innovation. Del Brío & Del Brío (2009) and Mukarram et al. (2018) in their studies confirmed that the relationship between gender diversity and company innovation exists and the relationship between them is positive.

However, not all authors agree with the thoughts listed in the previous paragraph. Galia and Zenou (2012) in their study found that a large number of women in a company lead to marketing innovation, but not to product innovation. Moreover, Whitler et al. (2018) did not find any relationship between women as the heads of the company and innovativeness in the company, as well as Rossi & Cebula (2015) even found a negative relationship in their study. Furthermore, Eckel and Grossman (2008) point out that in different psychological studies results show that men are more risky, confident, and competitive than women. At the same time Eckel and Grossman (2008) state that this difference in behavior between men and women was poorly studied in terms of a boardroom of companies.

Treichler (1995) in his paper mentioned that gender diversity in the top management of a firm can have a bad effect, namely on intra-group conflicts. Additionally, the study of Barsky et al. (1997) proposed that women in companies are more careful and cautious when it comes to decision-making. In their understanding carefulness of women in this regard can affect the allocation of resources of the company to very risky investments, especially when one is talking about investments in R&D or innovation.

Thus, one can see several mechanics of how board structure affects firm innovation. The instruments are different and very different from each other. Having considered gender diversity, the authors concluded that the opinions of researchers differ regarding the strategies of this topic and the degree of their influence on the innovativeness of the company.

Figure 1. Mechanisms between board and innovation



Source: created by the authors based on the previous section

To date, there is more and more research on the relationship between gender and innovation in companies. Ostergaard et al. (2011) in their study concluded that the balance between gender diversity (balance between two genders) in developed countries has a positive impact on innovation. According to Ostergaard et al. (2011), gender diversification aids innovation through a more diversified knowledge pool and improvements in decision-making. On the other hand, according to researchers from the OECD (2012) in Africa, the Middle East, and South Asia, the relationship between gender and development is not as strong as in already developed countries. Moreover, diversity in knowledge provides new combinations and helps companies to create new ideas and products, and external knowledge increases the level of innovation within the company (Van Der Vegt & Janssen (2003)).

There are many reasons why studying the relationship between gender and innovation is undoubtedly an important area of research. For instance, Terjesen & Singh (2008) argue that

men and women in the workplace are very different due to the contrasts in experience, career paths, cognitive schemas, and systems of meaning. At the same time, gender diversification, according to Milliken & Martins (1996), enables companies to gain access to different external networks and through this more diverse field of knowledge from outside the company.

It is also worth noting that gender diversity can help in problem-solving and decision-making. As De Dreu & West (2001) write, successful innovations always require deliberate decisions to implement innovative ideas and bring them to life. Furthermore, Priem et al. (1995) also take into account in their research that cognitive differences in the behavior of men and women, as well as their views, expressions, and experiences, can eventually lead to an agreement between them and a common conclusion that will lead to a better decision and therefore to a better innovative solution.

Innovation is mainly initiated by the employees of companies. According to Leonard & Sensiper (1998), in the process of innovation, employees use their knowledge and experience and use them in various activities in the innovation process. Moreover, Ipe (2003) in his study concluded that both individual knowledge and knowledge derived from groups are critical to innovation.

The relationship between several characteristics of the board of directors and firm performance has been extensively studied both theoretically and empirically (Coles et al., 2008). For most variables, the results are heterogeneous. As an example, with board size, Jensen (1993) argued that a smaller board is more effective in carrying out monitoring activities In contrast, Coles et al. (2008) studied a sample of 8,165 firms and found that there is no “one size fit all”.

Gender composition of boards is also a recurrent topic in the economic/management literature in recent years. Several papers have tried to synthesize the theory and the previous evidence. One of the most important literature surveys was published ten years ago (Terjesen et al., 2009). This paper included more than 400 studies on this topic, from different areas of research, with different theoretical perspectives, as well as with different levels of study – individual, board, firm, and industry/environment. As a consequence, most previous studies do not consider just one theory or approach. In another more recent survey, Kirsch (2018), has analyzed 310 articles from the period 1981–2016. Kirsch (2018) points to four different streams, examining: whether women directors are different from men on boards; what factors shape board gender diversity; how board composition affects organizational outcomes, and regulation of board gender composition. This manuscript focuses mainly on the third stream,

how composition affects organizational outcomes, but it also benefits from arguments derived from the other streams.

As pointed out in the introduction, female presence on the board has not only economic/managerial implications, but also an ethical component, due to (possible) discrimination against women. For instance, Gabaldon et al. (2016) point out that the low female presence on Spanish boards may be due to a demand-led problem. This situation has provoked many countries to legislate to get gender quotas on boards. Terjesen et al. (2015) distinguish two different kinds of countries/regulations: countries that establish compulsory board quotas for female representation in publicly traded or state-owned firms, and countries introducing non-binding gender quotas, enforcing a "comply or explain" principle. Given that most countries' legislation about the presence of women on boards passed recently, it is difficult to conclude if compulsory or non-binding gender quotas are better. Klettner et al. (2016) argue that in some situations monitored targets may be more effective at promoting cultural and strategic change at the heart of the firm. Furthermore, Klettner et al. (2016) state that in summary, mandatory quotas (set through hard law usually with sanctions for noncompliance) may achieve early and significant results in terms of female board representation. However, voluntary targets for women's participation on boards and in executive ranks (proposed in soft regulation such as corporate governance codes and set as part of the corporate strategy) may promote more effective cultural and practical change in support of greater representation of women in leadership" (Klettner et al., 2016).

The establishment of such quotas, mainly in the case of compulsory quotas, is an attempt to solve an ethical problem, the under-representation of women despite their equal competence. However, it may raise another ethical problem, if women are appointed as board members when they are not the best candidates. A detailed study examining board gender quotas from an ethical point of view can be found in Terjesen and Sealy (2016).

There is little evidence about how quotas work, and that is mainly from Norway, the first country to establish gender quotas. Wang and Kelan (2013) find that gender quotas, and the increased representation of women on boards that it has caused, have created fruitful space for women to take top leadership positions and it is also positively related to female directors' independent status and qualifications.

As previously argued, Terjesen et al. (2009), and some other studies, such as Kirsch (2018), adopt many different theories that have considered factors influencing the presence of women on boards, as well as the influence of women on the board on firm outcomes. Most empirical studies simultaneously consider arguments of several theories to present their

hypotheses and results. Next, the authors will very briefly summarize the theories that the authors consider best for this manuscript: agency, social psychology, resource dependence, and institutional theory.

Focusing on the agency theory, according to Jensen and Meckling (1996), an agency relationship is a contract under which one or more persons (the principal/s) engage another person (the agent) to perform some service on their behalf which involves delegating some decision-making authority to the agent. Furthermore, Fama (1980) argues that a board is efficient when it provides high-quality, impartial advice, and this depends on the independence of its members. This is why a large proportion of outside and independent directors are recommended. Following this reasoning, a more diverse board may increase board independence and thus improve the monitoring and control of management (Carter et al., 2003).

Theories related to social groups such as social identification and social categorization theories, based on social psychology, examine how individuals try to surround themselves with people with similar characteristics (demographic profiles, values, etc.) that help them reinforce intra-group communication. According to these theories, individuals divide the group members into in-groups (individuals similar to themselves) and out-groups (individuals dissimilar to themselves) and have a tendency to perceive the former positively and the latter negatively (Nielsen and Huse, 2010). Thus, a more diverse group may be less integrated and the likelihood of dissatisfaction is higher (Milliken and Martins, 1996). Consequently, these theories predict a negative effect of diversity on group outcomes. In addition, in most corporate boards, if there are women present, there is only one woman or a small minority of women. Thus, women on the boards are considered tokens and are easily marginalized (Kanter, 1977).

Following resource dependence theory, firms are viewed as operating in an open system, with a need to exchange resources, creating a dependency between the firm and external units. Thus, boards serve to link the firm to other external organizations to address environment dependencies (Pfeffer and Salancik, 1978). Resource dependence theory usually points to a positive influence of diversity on group outcomes. For example, greater diversity in working groups may imply a better knowledge of the market and a better identification with customers and employees, increasing the ability of a firm to penetrate markets (Robinson and Dechant, 1997). However, women may have fewer relationships with boards of other firms.

In the next sections, the authors observe different empirical studies on the connection between the gender of workers in companies and innovation. In total, there are five empirical studies which at the end of it are combined into one table. The authors of the paper decided to

include these empirical studies in a table as they are the most important in the course of the work.

The first study was conducted by Teruel and Segarra-Blasco (2017) in Spain between 2007 and 2012 and examined 5,383 companies. Their results point out that, gender diversity in R&D teams does not have a sufficient impact on the capacity of the firm to register patents, and the diversity according to the professional role in R&D teams has a positive influence. Additionally, they noticed that nontechnological advancements benefit from work situations when there is an equal number of men and women, affirming their theory that this sort of advancement is more "people-oriented", which needs work situations with more extensive viewpoints to be created. Moreover, they saw that indeed controlling for gender-differing qualities, firm estimate applies a positive influence towards innovation. In other words, bigger firms have more capacity to create innovation. Another work in Spain was done by Sastre (2015). Sastre (2015) analyzes the impact of R&D teams' gender-differing qualities on diverse advancement yields: items, administrations, processes, and hierarchical innovations. Results of their study show that companies that have R&D teams with diverse functional skills have more working potential (products, services, processes, and organizational innovations) than those having a gender-diverse workforce. The only exception is service innovation and for which, gender diversity is as essential as functional diversity. Furthermore, an interesting study was done in Africa in 2020 by Steyn and De Bruin. Their sample represents 52 South African associations, with 60 representatives from each, producing 3143 respondents, of which 56.4% were men and 43.6% were ladies. The results uncover that the connections between innovation and employees don't vary for all purposes over gender, nor does gender direct the relationship between these factors. Although gender differences are frequently related to innovation, the study uncovers that gender does not modify the way the employees are related to impacting innovation at a personal level.

Chen et al. (2015) in their study tried to answer the question: how important is the presence of women on the board of directors for corporate innovation? Chen et al. (2015) found that firms with a higher proportion of female directors tend to invest more in innovation and achieve greater success in generating innovation outputs, such as patents and citations, compared to firms with fewer female boards of directors, even when accounting for differences in R&D expenditures. This relationship between board gender diversity and innovation remains consistent across various measures of board gender composition, statistical models, and subsets of the data. In essence, having more women on the board appears to increase the efficiency of R&D spending in generating innovative outcomes (Chen et al., 2015). Furthermore, Accenture

(2019) also examined the relationship between women at work and their impact on innovation. However, Accenture (2019) has focused on innovation in companies where men and women are equally rewarded. Accenture (2019) overviewed over 18,000 laborers in 27 countries, counting more than 150 C-suite-level administrators, and found that at organizations that treat ladies and men more similarly, innovation was essentially higher than at those that do not. In reality, innovation is six times higher at organizations with the foremost equal working environment societies compared to those organizations with the slightest break even with ones, concurring to the report. This claim was backed up by worker reactions. Almost 40 percent of those from the most equal organizations said "Nothing stops me from innovating," compared to a fair 7 percent from those with elevated levels of imbalance.

Zhang's (2020) study looks at information from 35 nations and 24 businesses to get the relationship between sexual orientation differences and firm execution. Using a special longitudinal test of 1,069 driving open firms worldwide, Zhang (2020) found that the relationship between sex-differing qualities and firm performance shifts altogether over nations and businesses due to contrasts in an organization setting. The more gender-differing qualities have been normatively acknowledged in a nation or industry, the more gender-diverse firms create innovation and make more income. These discoveries emphasize the significance of the broader social setting when considering the relationship between gender qualities and firm execution.

The authors of the study made a summary table on the term "Different empirical studies on gender diversity in work" which the reader can find in the Appendix at the end of the work. The table is titled "Table 2. Different empirical studies on Gender Diversity in Work".

After analyzing the theoretical part and its subparagraphs, the authors would like to emphasize the most important thing they learned. Definitions of the term innovation include different opinions about what innovation is. The authors believe that all definitions of innovation include that innovation is the execution of modern thoughts into a new product or service. Concerning the main mechanisms between board structure and firm innovation, the authors realized that there are differences between men and women and their approaches to work. Also, in this part, the authors again encountered different points of view regarding gender and innovation. Previous empirical studies included different points of view. For instance, some studies say that women do not influence product innovation, but influence marketing innovation.

In the preceding section, the authors commence an in-depth review of the theoretical foundation of their study. This included a comprehensive investigation of the existing literature

on innovation, and gender diversity, as well as an exploration of the different mechanisms through which those factors can impact a company's innovation performance.

3. Study design

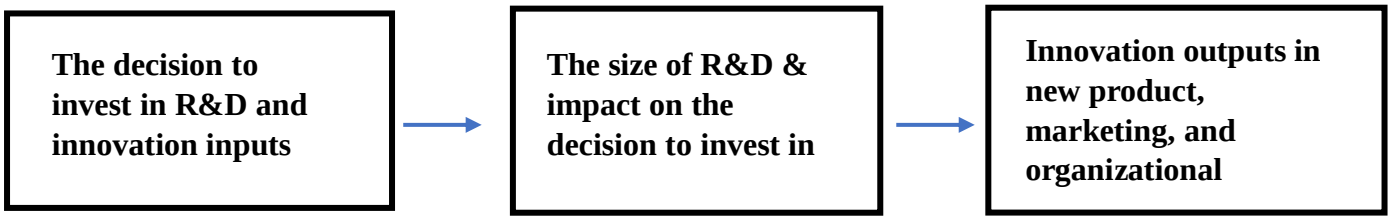
3.1 Data, Method, and List of Countries

The Business Environment and Enterprise Performance Study (BEEPS) is a joint activity of the European Bank for Reconstruction and Advancement and the World Bank, presently in its 4th iteration, it implies collecting firm-level information on a wide extent of issues around the business environment and execution of firms, including business-government relations, firm financing, labor, infrastructure, informal payments and debasement, and other points such as training and development.

As the basis of methodology, the authors collected their data from the BEEPS database. It contains 23,132 completed interviews in 41 countries or territories in Eastern Europe and Central Asia and the Middle East and North Africa. For the method of the study, the authors decided to use the CDM model. To find the relationship between innovation, productivity, and research, Crépon, Duguet, and Mairesse (1998) created a three-stage model. The model of Crépon et al. (1998) also clarifies efficiency in a three-stage method driven by at first by R&D and then leads to licenses and after that to efficiency improvements. As stated by Lööf et al. (2016) CDM has received hundreds of citations and has been frequently used by researchers around the world in its 20 years of existence. Furthermore, Notten et al. (2016) stated that the CDM is not only frequently cited by authors but also that it compares very well with the most cited comparable articles in indexed journals in its field of study. Just like the creators of the model, the authors of the thesis are using 3 stages in their model.

Additionally, the authors decided to split Non – European and European into 2 different groups, because of cultural and geographical differences. In return this allowed the authors to see the difference between gender diversity in different countries or even continents. Next, the reader can find the figure of the CDM model of the authors. A more detailed analysis of all three stages is written in subchapter 3.3.

Figure 2. CDM model description



Source: compiled by the authors

A common problem that can appear when working with survey data is the potential perception bias of respondents (Wei & Kaufmann, 1999). For instance, a respondent can feel ill during an interview, answer wrongly and thus give a false answer. The authors assume that in their paper the bias is not correlated over groups of respondents. In the case of the authors, the bias can only be when talking about countries where firms are located. For example, political freedom, the rights of women, and different cultural traditions and norms may be a bias at the country level that can affect negatively the critical review of the chosen topic. Nevertheless, when dealing with such concern the authors examined a paper by Fries et al. (2003), who in the course of their work examined BEEPS 2002 data by statistically measuring survey responses to related objects. In the end, they found zero perception biases between countries in their sample. The wave of beeps that the authors are using in their thesis has a similar methodology as Fries et al. (2003) had. Therefore, the authors are confident that bias will not influence their results.

Next, the authors created two tables of countries with several observations per each that were analyzed in the study. They are divided into two types: European Union countries and non-European Union countries. A reader can find both tables in Appendix.

3.2 Definitions of all variables and descriptive analysis of the sample

The present study used a total of 15 variables, which were selected for their suitability, accuracy, and availability in the Business Environment and Enterprise Performance Survey (BEEPS dataset). To facilitate a thorough understanding of the methodology of the authors and the progression of the research, a table has been constructed and provided below.

Table 5. Definitions of variables

Variable name	**Description**
Firm age	Is calculated as 2023 minus the year of establishment
Firm size	Number of employees in the firm
Foreign ownership	Percentage owned by domestic individuals
Female power (board)	Dummy that takes the value 1 if at least one of the decision makers is female and the share of female ownership is greater than 30%
Female share	Number of females in the total amount of employees, both permanent and temporary hired
Access to finance	Categorical variable: to what degree is access to finance an obstacle to the current operations of this establishment
Skilled workers	Percentage of full-time employees who completed a university degree
Direct exports	Direct exports as a percentage of total annual sales
Technology from foreign companies	Categorical variable: the company was using technology from a foreign-owned company
Average years of education	Percentage of people with a university degree
Product innovation	Dummy that takes the value 1 if the company introduced new or significantly upgraded goods or services, and equals 0 if otherwise
Marketing innovation	Dummy that takes the value 1 if new marketing method/methods were/were introduced over the last 3 years and 0 if otherwise
Organizational innovation	Dummy that takes the value 1 if new organizational/management practices or structures were introduced over the last 3 years and 0 if it is otherwise

Source: compiled by the authors based on BEEPS dataset description

The descriptive statistics of the variables used in all three stages can be found in Appendix.

The authors have chosen 2 variables as dependent variables for estimating the R&D expenditures. In the 1st stage as the dependent variable the dummy variable is chosen to analyze what variables have an impact on the decision to invest in R&D. In the 2nd stage the authors have taken into account the natural logarithm of expenditures in R&D per employee during the last 3 years.

A significant part of our analysis is devoted to the estimation of what impact different variables presenting gender diversity have on the company's innovation performance and the

expenditures in R&D. The authors have included the following explanatory variables for gender diversity:

- The share of females is calculated as the number of females in the total amount of employees, both permanent and temporary hired;
- Female power is a dummy that takes the value 1 if at least one of the decision makers is female and the share of female ownership is greater than 30%. For this dummy variable, the authors have included the share of female ownership as one of the indicators of female power. The ownership composition can intend to risk aversion and the lack of willingness to be involved in strategic change ad the decision to invest in R&D and use innovative products. The same approach was used by (Brunninge O., Nordqvist M., and Wiklund J, (2007).) Also, as one of the factors the authors have included the decision makers among females in the company.

Table 6. Descriptive statistics

Variable	**Observations**	**Mean**	**Std. dev.**	**Min**	**Max**
Organizational innovation	23,004	.200226	.4001781	0	1
Marketing innovation	22,969	.2279594	.4195254	0	1
New product	22,987	.2013312	.4010037	0	1
Female share	23,132	.5843109	.4401831	0	1
Female power	23,132	.2388466	.4263881	0	1
Firm Size (ln of number of employees)	21,732	3.168212	1.294248	0	9.952278
Share of direct exports	22,698	7.311437	21.39598	0	100
Access to finance	22,747	1.257001	1.335874	0	4
Firm Age (ln)	22,901	3.186393	.4100832	2.079442	5.293305
Foreign ownership	22,865	5.210409	20.4241	0	100
Technology from foreign companies	23,132	.2056891	.6790316	0	3
Skilled workers	21,132	3.864387	5.63328	0	60
The decision to invest in R&D	22,839	.0888393	.2845178	0	1
R&D expenditures per employee (ln)	1,152	8.361793	3.050631	-4.941642	18.42068

Source: compiled by the authors

For analyzing the company's performance and their innovations processes the following variables have been chosen:

- **Product innovation** is a dummy variable that was taken from the BEEPS dataset. The dummy shows if the company had developed a product that was brand new for the market. Considering the definition in the BEEPS dataset the authors decided that product innovation equals 1 if the company introduces new or significantly upgraded goods or services, and equals 0 if otherwise
- **Organizational innovation** stands for a company that improved management or organizational processes (e.g., management of quality or knowledge), modified work organization (e.g., training, boosting teamwork activities), or introduced new methods for cooperation with partners (e.g., partnerships, subcontracting). It is a dummy variable that takes the value of 1 if at the minimum one of the previous steps was implemented by a company
- **Marketing innovation** is a dummy variable that equals 1 if the company implemented any adjustments in marketing concepts or strategies (e.g., design packaging, new methods for promotion, pricing)

The authors also attach **Marginal effects** tables which are in the Appendix of the work. Table 11 for the first stage, table 12 for the second stage, and table 13 for the third stage.

3.3 Description of stages

Description of 1st stage:

The first model estimates the decision to invest in R&D which was carried out using Probit regression depending on the variables that are listed below. In the second stage gender diversity variables have been added to the regression. The dependent variable (the decision to invest in R&D) is a dummy variable that takes the value of 1 for such companies that have invested in R&D during the last 3 years and 0 otherwise. The regressors include variables such as the natural logarithm of firm age, the natural logarithm of firm size, a dummy variable for foreign ownership, direct exports, and access to finance.

- **Equation 1.1.**

$$d_{dexpintra} = K + \beta_1(Firm\ age) + \beta_2\ (Firm\ size) + \beta_3(d\_\ foreign\ ownership) + \beta_4(access\ to\ finance) + \beta_5\ (direct\ exports) + \mu$$

- **Equation 1.2.**

$$d_{dexpintra} = K + \beta_1(Firm\ age) + \beta_2\ (Firm\ size) + \beta_3(d\_\ foreign\ ownership) + \beta_4(access\ to\ finance) + \beta_5\ (direct\ exports) + \beta_6\ (share\ of\ female) + \beta_7\ (female\ power) + \mu$$

Description of 2nd stage:

In the second stage, the predicted results from the first stage are incorporated to estimate whether the size of R&D investments per employee could be dependent on the decision to invest in R&D and gender diversity variables. Skilled workers and companies that use technology from a foreign-owned company are the only variables that differ from the previous model. This is similar to the study of Ramadani et al. (2018).

- **Equation 2.1.**

$$lnrdexpintr\_empl = K + \alpha(predictions) + \beta_1\ (firm\ size) + \beta_2(share\ of\ direct\ exports) + \beta_3(access\ to\ finance) + \beta_4(firm\ age) + \beta_5(\%\ of\ foreign\ owners) + \beta_6(technology\ from\ foreign\ competitors) + \mu$$

- **Equation 2.2.**

$$lnrdexpintr\_empl = K + \alpha(predictions) + \beta_1\ (firm\ size) + \beta_2(share\ of\ direct\ exports) + \beta_3(access\ to\ finance) + \beta_4(firm\ age) + \beta_5(\%\ of\ foreign\ owners) + \beta_6(technology\ from\ foreign\ competitors) + \beta_7(average\ years\ of\ education) + \beta_8\ (share\ of\ female) + \beta_9\ (female\ power) + \mu$$

Description of 3rd stage:

The dependent variables for 3rd stage are the usage of new product innovation, marketing innovations, and organizational innovations. Explanatory variables include the following: the share of female, female power, the natural logarithm of firm size, the share of direct exports, access to finance, the natural logarithm of firm age, the percentage of foreign owners, and technology from foreign companies.

- **Equation 3.1.**

$$newproduct = K + \alpha(predictions) + \beta_1(share\ of\ female) + \beta_2(female\ power) + \beta_3(\log firm\ size) + \beta_4(share\ of\ direct\ export) + \beta_5(access\ to\ finance) + \beta_6(\log firm\ age) + \beta_7(\%\ of\ foreign\ owners) + \beta_8(technology\ from\ foreign\ competitors) + \beta_9(average\ years\ of\ education) + \mu$$

- **Equation 3.2.**

$$marketinginnovation = K + \alpha(predictions) + \beta_1(share\ of\ female) + \beta_2(female\ power) + \beta_3(\log firm\ size) + \beta_4(share\ of\ direct\ export) + \beta_5(access\ to\ finance) + \beta_6(\log firm\ age) + \beta_7(\%\ of\ foreign\ owners) + \beta_8(technology\ from\ foreign\ competitors) + \beta_9(average\ years\ of\ education) + \mu$$

- **Equation 3.3.**

$$orginnovation = K + \alpha(predictions) + \beta_1(share\ of\ female) + \beta_2(female\ power) + \beta_3(\log firm\ size) + \beta_4(share\ of\ direct\ export) + \beta_5(access\ to\ finance) + \beta_6(\log firm\ age) + \beta_7(\%\ of\ foreign\ owners) + \beta_8(technology\ from\ foreign\ competitors) + \beta_9(average\ years\ of\ education) + \mu$$

The mathematical equation is the same for product innovation, marketing innovation, and organizational innovation.

4. Results

4.1 Stage I

In the first stage, the authors made a Probit Model in which the dependent variable was a dummy variable that shows the decision to invest in R&D. For explanatory variables, the authors identified the natural logarithm of firm size, the share of direct export, access to finance, firm age, and percentage of foreign owners.

In the first model in stage 1 (Table 7), the findings show that firm size per employee has a both positive and statistically significant effect on the decision to invest money in research and development across all countries. What surprised the authors is the fact that the influence of firm size on research and development is noticed to be higher in European Union countries when compared with non-European ones. This fact tells us that the larger the company is the more it is willing to allocate its resources in the direction of R&D activities. The findings of the authors are similar to previous research findings of Hall et al. (2013), who in their study also found a positive link between R&D investment and the size of firms.

Additionally, Petruzzelli et al. (2018) pointed out that larger companies present a greater capability for innovation by utilizing both emerging and highly mature knowledge. However, smaller companies are keen to create innovative solutions that are more valuable when they build upon more mature knowledge. The study of Petruzzelli et al. (2018) supports the present conclusion that bigger companies are tending to invest money in research and development. The authors believe that possibly due to more enhanced innovative capabilities of bigger companies. It is consistent with the Schumpeterian thesis that larger firms innovate more.

Changing the focus to gender diversity, it is seen that the presence of women in a company has a negative influence on the decision to invest in research and development, especially in European Union countries. Nevertheless, this negative influence is less seen in non-EU countries. At the same time, variable female power (taken into account female decision-makers and female ownership) has a positive relationship with the company's decision to invest in R&D. The authors observe a stronger relationship between these variables in the countries of the European Union than in non-European countries.

Table 7. First stage Probit model for estimating the decision to invest in R&D

	All countries	EU countries	Non-EU countries	All countries (w/o gender diversity)	EU countries (w/o gender diversity)	Non-EU countries (w/o gender diversity)
Intramural R&D expenditure (dummy)						
Firm size(log)	0.170***	0.188***	0.180***	0.182***	0.202***	0.192***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of female	-0.277***	-0.362***	-0.264***			
	(0.000)	(0.000)	(0.000)			
Female power	0.120***	0.101	0.0830*			
	(0.000)	(0.070)	(0.019)			
Share of direct export	0.00547**	0.00562***	0.00495**	0.00561**	0.00617**	0.00493***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Access to finance	0.0393***	0.0571**	0.0377***	0.0447***	0.0623**	0.0433***
	(0.000)	(0.004)	(0.000)	(0.000)	(0.001)	(0.000)
Firm Age(log)	0.0346	0.0638	0.00180	0.0563	0.0856	0.0188
	(0.278)	(0.384)	(0.960)	(0.075)	(0.238)	(0.599)
% of foreign owners	0.00130*	0.000878	0.000902	0.00101	0.000425	0.000692
	(0.021)	(0.373)	(0.200)	(0.073)	(0.661)	(0.325)
Constant	-2.031***	-1.982***	-1.998***	-2.256***	-2.269***	-2.211***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	20407	4074	16333	20407	4074	16333

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

Furthermore, variables "access to finance" and "share of direct exports" are found to be significant factors that positively affect the decision to invest in research and development in combined EU and non-EU countries. This shows that companies which have better situations with financial resources and a bigger proportion of direct exports are more willing and are more focused on allocating funds towards R&D activities, thereby boosting their innovation capabilities.

Lastly, the variable "foreign ownership" demonstrates its statistical significance. Nevertheless, its influence on R&D investment is found to be small and only significant when one talks about the entire sample of countries.

4.2 Stage II

In the second model, the researchers absorb the predicted values that were gained from the first stage as explanatory variables. Predictions from the first stage are significant and harm it. At the same time, the female power variable has a significant positive effect. Noticeably, firm size continues demonstrating its significance and exerts a positive influence on research and development expenditures in the list of all countries. This also reaffirms the finding that bigger companies are more eager to allocate their resources in the direction of R&D, showing their greater scope for innovation.

Focusing on gender diversity, the share of women is found to be significant only in the dataset regarding all countries. What is interesting is that only the female power variable is significant with a positive effect. The finding of the authors echoes the work of Adams and Ferreira (2007), who also pointed out the decision-making function of the board to be an essential aspect of companies.

In the second stage of the study, two additional variables were used. The authors talk about such variables as "skilled workers" and "usage of foreign technology". The authors observe the significance of the usage of new technology. It highlights that companies that use foreign technology are more eager to spend more on R&D, as they want to strengthen their technological abilities and maintain their competence.

Table 8. Second stage Tobit model

	All countries	EU countries	Non-EU countries	All countries (w/o gender diversity)	EU countries (w/o gender diversity)	Non-EU countries (w/o gender diversity)
R&D expenditures per employee(log)						
Pr(d_rdexpintra)	-0.985	1.942	-1.390	0.690	3.224*	-0.165
	(0.313)	(0.375)	(0.204)	(0.286)	(0.023)	(0.821)
Firm size(log)	0.124***	0.104	0.133***	0.0740**	0.0672	0.0976***
	(0.000)	(0.135)	(0.000)	(0.002)	(0.196)	(0.000)
Share of female	-0.0878	-0.0709	-0.0738			
	(0.095)	(0.552)	(0.210)			

Female power	0.100**	0.0630	0.0610			
	(0.009)	(0.422)	(0.179)			
Share of direct export	0.00743***	0.00423	0.00728***	0.00537***	0.00268	0.00572***
	(0.000)	(0.156)	(0.000)	(0.000)	(0.229)	(0.000)
Access to finance	0.0595***	0.0749**	0.0569***	0.0496***	0.0681**	0.0500***
	(0.000)	(0.006)	(0.000)	(0.000)	(0.009)	(0.000)
Firm Age(log)	0.0341	0.106	-0.00438	0.0312	0.0990	-0.00823
	(0.358)	(0.256)	(0.914)	(0.397)	(0.284)	(0.838)
% of foreign owners	0.00202**	0.000452	0.00193*	0.00150*	0.0000157	0.00156
	(0.009)	(0.756)	(0.037)	(0.042)	(0.991)	(0.081)
Average years of education	0.00166	-0.00745	0.00590	0.00250	-0.00706	0.00703*
	(0.583)	(0.257)	(0.085)	(0.379)	(0.268)	(0.028)
Technology from foreign company	0.602***	0.831***	0.561***	0.602***	0.832***	0.562***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.167	-0.419	-0.0822	-0.151	-0.395	-0.0791
	(0.167)	(0.174)	(0.534)	(0.209)	(0.193)	(0.547)
/ var(e.lnrdexpintra_empl)	4.008***	4.158***	3.953***	4.010***	4.159***	3.954***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	19662	3917	15745	19662	3917	15745

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

To sum up, the second stage allowed the authors to enhance their understanding of the factors that influence R&D expenditures. It points out the significance of such variables as firm size, gender diversity, and the usage of foreign technology. The findings that the authors found in this stage contribute to the existing literature on the decision to invest in R&D.

Upon comparing the marginal effects of the models from the first and second stages, the researchers observe consistent influences for all the significant regressors. However, a noticeable difference arises regarding the variable "Number of females between decision-makers". While this variable influences the size of R&D expenditures, it does not attain statistical significance for the decision to innovate in R&D. Conversely, the percentage of the company owned by women does impact the decision to innovate, but it lacks significance for expenditures in R&D. An increase in the women share within the firm is found to decrease the

likelihood of positive decisions to invest in R&D and, to a less extent, reduce expenditures per employee in R&D. These findings suggest that the presence and ownership of females within a company may have nuanced effects on R&D investment decisions and expenditure levels.

In the second stage of the analysis, the authors introduce the variable “technology from foreign countries”, and they observe its substantial impact on the decision to invest in R&D. Importantly, the authors confirm that the utilization of external knowledge significantly increases R&D costs. This finding aligns with the work of Van Der Vegt and Janssen (2003), who also emphasized the importance of external information in driving R&D investment decisions.

The incorporation of foreign technology as an additional variable underscores the growing recognition among researchers of the pivotal role played by external knowledge sources in fostering innovation and technological advancement. By leveraging technological insights and advancements from foreign countries, firms can enhance their R&D capabilities and remain competitive in the global marketplace. However, it is important to note that the utilization of such external knowledge comes at a cost, as it requires significant investment in R&D activities.

The findings from the second stage of the analysis shed light on the complex interplay between gender diversity, foreign technology utilization, and R&D investment decisions. They provide valuable insights into the factors that influence firms' choices to invest in research and development and the subsequent impact on expenditures.

4.3 Stage III

In the third and final model, the authors identify several important variables that affect firms' performance in terms of product innovation, marketing innovation, and organizational innovation. These variables include the identification of R&D expenditure per employee, firm size per employee, female power, direct exports, access to finance, and the usage of new technology.

The predicted variables from the second part of the analysis appear significant effect on product innovation. This implies an increase in R&D expenditure per worker, as predicted by the model, is associated with the adoption of innovations there may be other factors in the decision-making process. The variable female power is significant in this model, although female share is not significant in this regression. The authors highlight that female power has a higher impact in non-EU countries than in European Union.

Table 9. Probit Model for the Third Stage

	New Product	New Product w/o Gender Diversity	Organizational Innovations	Organizational Innovations w/o Gender Diversity	Marketing Innovations	Marketing Innovations w/o Gender Diversity
main						
Predictions (with gender variables) from the 2nd stage	1.685***	1.251***	1.620***	1.331***	1.145***	1.060***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of female	0.00838		0.102***		0.121***	
	(0.796)		(0.001)		(0.000)	
Female power	-0.0861*		-0.0125		0.0415	
	(0.017)		(0.691)		(0.173)	
Firm size(log)	-0.0712*	-0.0301	0.00563	0.0279	0.0128	0.0152
	(0.013)	(0.156)	(0.814)	(0.125)	(0.589)	(0.395)
Share of direct export	-0.00965***	-0.00701***	-0.00968***	-0.00783***	-0.00817***	-0.00750***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Access to finance	-0.0141	0.00948	-0.0151	-0.00198	0.0285	0.0301*
	(0.424)	(0.491)	(0.317)	(0.870)	(0.054)	(0.011)
Firm Age(log)	-0.00504	0.000955	-0.0695*	-0.0614*	-0.0417	-0.0355
	(0.868)	(0.975)	(0.010)	(0.023)	(0.111)	(0.171)
% of foreign owners	-0.000841	-0.0000354	-0.000185	0.000340	0.00100	0.00116*
	(0.262)	(0.956)	(0.773)	(0.543)	(0.113)	(0.035)
Technology from a foreign company	0.257	0.517***	-0.540***	-0.369***	-0.297*	-0.250*
	(0.150)	(0.000)	(0.000)	(0.001)	(0.044)	(0.018)
Average years of education	-0.0338***	-0.0326***	-0.0244***	-0.0266***	-0.0187***	-0.0223***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.296***	-1.360***	-1.233***	-1.193***	-1.163***	-1.074***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	20508	20508	20527	20527	20502	20502

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

Estimating marketing innovation, the authors observe the positive relation between marketing innovations and female share, although female power does not affect marketing innovations. In European Union countries the female power is stronger than in non-EU countries. Such variables as the usage of new technology and direct exports are connected with marketing innovations. Lee et al. (2018) confirmed that the relationship between a new product and firm performance is increased with the introduction of marketing innovation. Also, it is found additionally that "non-R&D technological innovators may embrace marketing and organizational innovations to increase technological innovation and counteract their lack of R&D resources. In the regression with organizational innovation, the authors found the same relations as for marketing innovations.

Table 10. Product and Process Innovations (Third stage)

	New Product	Organizational Innovations	Marketing Innovations	New Product (EU countries)	Organizational Innovations (EU countries)	Marketing Innovations (EU countries)	New Product (non-EU countries)	Organizational Innovations (non-EU countries)	Marketing Innovations (non-EU countries)
main Predictions (with gender variables) from the 2nd stage	1.685***	1.620***	1.145**	1.504*	1.682**	0.515	1.676**	1.493***	1.363***
	(0.000)	(0.000)	(0.000)	(0.022)	(0.003)	(0.348)	(0.000)	(0.000)	(0.000)
Share of female	0.00838	0.102***	0.121**	0.0812	0.0950	0.100	-0.0230	0.0857*	0.111***
	(0.796)	(0.001)	(0.000)	(0.235)	(0.126)	(0.096)	(0.537)	(0.011)	(0.001)
Female power	-0.0861*	-0.0125	0.0415	-0.0566	-0.121	0.0248	-0.143**	0.00365	0.0115
	(0.017)	(0.691)	(0.173)	(0.436)	(0.061)	(0.692)	(0.001)	(0.922)	(0.749)
Firm size(log)	-0.0712*	0.00563	0.0128	-0.0170	0.0299	0.0965	-0.0623	0.0214	-0.00404
	(0.013)	(0.814)	(0.589)	(0.796)	(0.589)	(0.081)	(0.056)	(0.429)	(0.879)
Share of direct export	-0.00965***	-0.00968***	-0.00817***	-0.00864	-0.0105**	-0.00709	-0.0101***	-0.00941***	-0.00878***
	(0.000)	(0.000)	(0.000)	(0.051)	(0.005)	(0.050)	(0.000)	(0.000)	(0.000)

Access to finance	-0.0141	-0.0151	0.0285	-0.00332	0.0168	0.0896**	-0.0104	-0.0149	0.0117
	(0.424)	(0.317)	(0.054)	(0.933)	(0.621)	(0.008)	(0.605)	(0.382)	(0.482)
Firm Age(log)	-0.00504	-0.0695*	-0.0417	-0.112	-0.0883	-0.0419	-0.00921	-0.0846**	-0.0651*
	(0.868)	(0.010)	(0.111)	(0.118)	(0.169)	(0.499)	(0.787)	(0.005)	(0.026)
% of foreign owners	-0.000841	-0.000185	0.00100	-0.00134	-0.000386	0.00204	-0.00105	-0.000452	0.000400
	(0.262)	(0.773)	(0.113)	(0.385)	(0.770)	(0.117)	(0.237)	(0.549)	(0.588)
Technology from a foreign company	0.257	-0.540***	-0.297*	0	-0.634	-0.0626	0.232	-0.445**	-0.395*
	(0.150)	(0.000)	(0.044)	(.)	(0.062)	(0.850)	(0.254)	(0.009)	(0.018)
Average years of education	-0.0338***	-0.0244***	-0.0187***	-0.0243***	-0.00694	0.000407	-0.0368***	-0.0287***	-0.0238***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.116)	(0.924)	(0.000)	(0.000)	(0.000)
Constant	-1.296***	-1.233***	-1.163**	-0.987**	-1.151**	-1.157**	-1.318**	-1.209***	-1.093***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	20508	20527	20502	3773	4077	4079	16431	16450	16423

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

The third stage confirms the assumption that the higher expenditures on R&D will increase companies marketing and organizational performance, and product innovation as well. It's interesting to mention that female power and female share have opposite influences depending on what parameter is taken into account.

For organizational innovation the share of females is significant and the authors observe the opposite results for female power.

The discoveries of the study point out a positive relationship between the number of women that are taking part in the decision-making process and the level of their ownership of

the product innovation. The same results have been found by Shrader et al., 1997; Welbourne et al., 2007; Adams and Ferreira 2009 in the USA; Campbell and Mínguez-Vera, 2008; Martín-Ugedo and Mínguez-Vera, 2014 in Spain; Rossi et al., 2017 in Italy.

Worth mentioning that the number of women in decision-making roles had a huge impact on the adoption of new products or technologies, with a positive influence.

In the end, the authors can suggest that the presence of females in the roles of decision-makers has a positive impact on overall innovation. Nevertheless, the link between the female workforce and product innovation is stronger than that of marketing innovation. The variable that stands for "female power" appears to be a major and important factor in driving organizational innovation.

Comparing the effects of various explanatory variables, the authors found that it is evident that in general, they have a greater impact on accepting new products than on marketing and organizational innovations. Moreover, higher levels of female power indicate a raise in product innovation, thereby clearing the way to adopt new products. On the other side, the number of females among employees is tightly positively correlated with marketing and organizational innovations. These findings are similar to the results of Rossi and Cebula (2015) and Ritter-Hayashi et al. (2019) which in their studies also pointed out the link between these indicators.

5. Conclusion

This paper aims to investigate the innovation performance and gender diversity relationship. The examination involves a comprehensive review of existing and recent literature on the determinants of firms to invest in R&D, first of all, gender diversity determinants and other parameters describing the activity to invest in R&D and improve the innovation activity.

To access this link, the BEEPS firm-level dataset of 2012–2016 is used in this paper. This research contributes to the research on estimating gender) on the decision to invest in R&D, expenditures of R&D, and innovation process through multistage equation modeling to measure this impact. The results also indicate the effects of different determinants.

In addition, in this research, the country determinants have been taken into account to check if there is any difference between European Union and non-European Union countries.

During all stages the authors confirm that the firm size (calculated as the number of employees per company) has a significant impact on the process of investing in R&D, so the

larger the company the higher the probability that this firm invests in R&D. Furthermore, the firm size is an important determinator of product and process innovations.

The main result from the first two stages that are worth the attention – is that the number of females in the company has the opposite influence on the decision to invest in R&D, but females between decision-makers are likely to be inclined to have positive decisions on the decision to innovate. One of the explanations for this could be the firm's industry, if the larger part of workers is female probably such industries do not invest a lot in new technologies. It makes send to point out that the influence of foreign ownership and direct exports are important for companies' decisions to invest in R&D.

In terms of the level of expenditures in R&D, the more significant meaning is found for female power, so the following conclusion could be made that the level of expenditures is tightly connected with the board composition who are the decision-makers in this process. All variables chosen for the 2nd stage have a positive relationship with the level of expenditures in R&D per employee including the usage of new technologies and products.

The authors confirm that investments in R&D access to finance, the usage of foreign technology, and the percentage of foreign owners have a higher impact than gender diversity variables. Although for product and process innovation both gender diversity and innovation process indicators are significant. Moreover, we see the consistency between the share of women and the female power (joint variable including female decision-makers and female ownership). Product innovation is correlated with female power, although the female share has more impact on organizational and marketing innovations.

In summary, the work of the authors provides a reader with insights into the link between innovation performance and gender diversity. The main findings point out the significance of firm size, the share of females in the company, female power, and different determinants that are related to access to finance and foreign ownership.

Overall, the study of the authors and their findings contribute to the existing knowledge on gender diversity and its impact on R&D investment and innovation processes.

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Appendices

Table 1. Definitions of the term innovation

Authors and Years	Definition
Mulgary, G. and Albury, D. (2003)	Innovation is the creation and execution of unused forms, items, administrations, and strategies of conveyance which result in noteworthy changes in results, proficiency, adequacy, or quality.
OECD/Eurostat (2005)	Innovation is the execution of a modern or altogether progressed item (good/service) or process (method/practice/relationship).
CBI/QUINETIQ (2008)	Innovation is a continuous and dynamic process in which ideas are transformed into value.
Damanpour and Schneider (2009)	Innovation is the improvement (generation) and/or utilization (adaption) of modern thoughts or behaviors.
Nesta (2012)	Innovation is the method by which modern thoughts turn into viable esteem within the world.
Fagerberg (2013)	Innovation is the first practical approach to carry out new technology and for doing it one needs skills, knowledge, and information about a product.
De Vires et al. (2015)	Innovation is the presentation of modern components into a service—new information, unused organization, and modern management/skills.

Source: created by the authors

Table 2. Different empirical studies on gender diversity in work

Authors and Years	**Method, Data, Sample**	**Results**
Teruel and Segarra-Blasco (2017)	Spanish Community Innovation Survey between 2004 and 2014. Application of a two-step procedure to control for endogeneity.	Gender diversity in R&D teams does not have a decent impact on the capacity of the firm to register patents and diversity according to the professional role in R&D teams has a positive influence.
Sastre (2015)	BSC-based models, data from World Bank	Companies that have R&D teams with diverse functional skills have more working potential than those having a gender-diverse workforce. The only exception is service innovation and for which, gender diversity is as essential as functional diversity.
Chen, Leung, Evans (2015)	Econometrical methods with own model. Data from RiskMetrics, ExecuComp, Compustat, and CRSP. Sample: 6644 companies	Firms with a higher proportion of female directors tend to invest more in innovation and achieve greater success in generating innovative outputs.
Steyn and De Bruin (2020)	Four instruments (no information)	The connections between innovation and employees don't vary for all purposes over gender, nor does gender direct the relationship between these factors. The study uncovers that gender does not modify the way the employees are related to impacting innovation at a personal level.
Accenture (organization) (2019)	Overviewed over 18,000 laborers in 27 countries	At organizations that treat ladies and men more similarly, innovation was essentially higher than at those that do not treat employees of different genders in the same way.
Zhang (2020)	A special longitudinal test of 1,069 driving open firms	The more gender-differing qualities have been normatively acknowledged in a nation or industry, the more gender-diverse firms create innovation and make more income.

Source: created by the authors

Table 3. List of European Union countries and number of observations

Country	Number of observations
Bulgaria	293
Croatia	360
Cyprus	360
Czech-Republic	254
Estonia	273
Greece	323
Hungary	310
Latvia	336
Lithuania	270
Poland	542
Romania	540
Slovak-Republic	268
Slovenia	270

Source: compiled by the authors

Table 4. List of non-European countries and number of observations

Country	Number of observations
Albania	360
Armenia	360
Azerbaijan	390
Belarus	360
Bosnia-Herzegovina	360
Djibouti	266
Egypt	2,897
FYR Macedonia	360
Georgia	360
Israel	483
Jordan	573
Kazakhstan	600
Kosovo	202
Kyrgyzstan	270
Lebanon	561
Moldova	360
Mongolia	360
Montenegro	150
Morocco	407
Russia	4,220
Serbia	360
Tajikistan	359
Tunisia	592
Turkey	1,344
Ukraine	1,002
Uzbekistan	390
West Bank and Gaza	434
Yemen	353

Source: compiled by the authors

Table 11. Marginal Effects for 1st Stage Models

	With gender diversity variables	Without gender diversity variables
Intramural R&D expenditure (dummy)		
Firm size(log)	0.170***	0.182***
	(0.000)	(0.000)
Share of female	-0.277***	
	(0.000)	
Female power	0.120***	
	(0.000)	
Share of direct export	0.00547***	0.00561***
	(0.000)	(0.000)
Access to finance	0.0393***	0.0447***
	(0.000)	(0.000)
Firm Age(log)	0.0346	0.0563
	(0.278)	(0.075)
% of foreign owners	0.00130*	0.00101
	(0.021)	(0.073)
Constant	-2.031***	-2.256***
	(0.000)	(0.000)
Observations	20407	20407

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

Table 12. Marginal Effects for 2nd Stage Models

	With gender diversity variables	Without gender diversity variables
R&D expenditures per employee(log)		
Pr (d_rdexpintra)	-0.985	0.690
	(0.313)	(0.286)
Firm size(log)	0.124***	0.0740**
	(0.000)	(0.002)
Share of female	-0.0878	
	(0.095)	
Female power	0.100**	
	(0.009)	
Share of direct export	0.00743***	0.00537***
	(0.000)	(0.000)
Access to finance	0.0595***	0.0496***
	(0.000)	(0.000)
Firm Age(log)	0.0341	0.0312
	(0.358)	(0.397)
% of foreign owners	0.00202**	0.00150*
	(0.009)	(0.042)
Average years of education	0.00166	0.00250
	(0.583)	(0.379)
Technology from a foreign company	0.602***	0.602***
	(0.000)	(0.000)
Constant	-0.167	-0.151
	(0.167)	(0.209)
/		
var(e.lnrdexpintra_empl)	4.008***	4.010***
	(0.000)	(0.000)
Observations	19662	19662

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

Table 13. Marginal Effects for the 3rd Stage

	New Product	New Product w/o Gender Diversity	Organizational Innovations	Organizational Innovations w/o Gender Diversity	Marketing Innovations	Marketing Innovations w/o Gender Diversity
main						
Predictions (with gender variables) from the 2nd stage	1.685***	1.251***	1.620***	1.331***	1.145***	1.060***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of female	0.00838		0.102***		0.121***	
	(0.796)		(0.001)		(0.000)	
Female power	-0.0861*		-0.0125		0.0415	
	(0.017)		(0.691)		(0.173)	
Firm size(log)	-0.0712*	-0.0301	0.00563	0.0279	0.0128	0.0152
	(0.013)	(0.156)	(0.814)	(0.125)	(0.589)	(0.395)
Share of direct export	-0.00965**	-0.00701***	-0.00968***	-0.00783***	-0.00817***	-0.00750***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Access to finance	-0.0141	0.00948	-0.0151	-0.00198	0.0285	0.0301*
	(0.424)	(0.491)	(0.317)	(0.870)	(0.054)	(0.011)
Firm Age(log)	-0.00504	0.000955	-0.0695*	-0.0614*	-0.0417	-0.0355
	(0.868)	(0.975)	(0.010)	(0.023)	(0.111)	(0.171)
% of foreign owners	-0.000841	-0.0000354	-0.000185	0.000340	0.00100	0.00116*
	(0.262)	(0.956)	(0.773)	(0.543)	(0.113)	(0.035)
Technology from a foreign company	0.257	0.517***	-0.540***	-0.369***	-0.297*	-0.250*
	(0.150)	(0.000)	(0.000)	(0.001)	(0.044)	(0.018)
Average years of education	-0.0338**	-0.0326***	-0.0244***	-0.0266***	-0.0187***	-0.0223***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.296***	-1.360***	-1.233***	-1.193***	-1.163***	-1.074***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	20508	20508	20527	20527	20502	20502

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: compiled by the authors

Soolise mitmekesisuse mõju teadus- ja arendustegevuse investeeringutele ning innovatsiooni tulemuslikkusele

Kokkuvõte

Autorite magistritöö on suunatud ettevõttesiseste uuenduste ja töötajate soo vaheliste seoste uurimisele. See teema on teadlastele väga oluline ja siiani tekitab palju küsimusi. Mõned teadlased märgivad naiste olulisust ettevõtete uuenduslikkuse küsimuses, teised aga vastupidi väidavad, et seos puudub.

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Antud teema teoreetilist aluse jaoks analüüsiti erinevaid "innovatsiooni" mõiste definitsioone, miks ja kuidas mõjutab juhatuse struktuur ettevõtte innovatsiooni, soolist mitmekesisust, soo ja innovatsiooni seost ettevõttes ning analüüsiti ka erinevaid seda teemat puudutavaid empiirilisi uuringuid.

Lisaks kasutati uuringus BEEPS-i andmeid ja CDM-mudelit. BEEPS-i andmed sisaldavad 23 132 intervjuud 41 riigist või Ida-Euroopa, Kesk-Aasia, Lähis-Ida ja Põhja-Aafrika maadelt. Uurimismeetodina otsustati kasutada CDM-mudelit. CDM mudeli töötasid välja Crepon et al. (1998) ja see täpsustab kolmeastmelise meetodi tõhusust, mis põhineb esmalt uurimis- ja arendustegevusel ning viib seejärel litsentsimiseni ja seejärel tõhususe suurenemiseni.

Uuringu tulemusena leiti, et ka soomuutujatel on oluline mõju. Alustades naiste osakaalust ettevõttes, naistele kuuluvate ettevõtete osakaalust, naiste koolituse kestusest ja peamise omaniku soost, näitavad kõik need muutujad statistilist olulisust innovatsiooni seisukohalt seoses uute toodete kasutamisega. See näitab, et sooline mitmekesisus ettevõtetes võib mängida rolli uute toodete kasutuselevõtu otsuse tegemisel. Üldiselt on selle uuringu autorite sõnul naistel positiivne mõju toote- ja turundusalase teadus- ja arendustegevuse ning innovatsiooni suurendamisele.

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