



R A M I N T A B E N E T Y T Ė

**INTENSITY AND
RISK OF CORPORATE
INNOVATION
INVESTMENTS
IN THE CONTEXT
OF COUNTRY
SUSTAINABILITY**

D O C T O R A L D I S S E R T A T I O N

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KAUNAS UNIVERSITY OF TECHNOLOGY

RAMINTA BENETYTĖ

INTENSITY AND RISK OF CORPORATE
INNOVATION INVESTMENTS IN THE
CONTEXT OF COUNTRY SUSTAINABILITY

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Social Sciences, Economics (S 004)

Kaunas, 2020

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MAIN CONCEPTS

Intensity of corporate innovation investments - an increase in business investments in research and experimental development to create innovation that increase operational efficiency.

Risk of corporate innovation investments - the uncertainty of the funds allocated by corporate to research and experimental development in order to create innovations, the loss of which would reduce assets.

Corporate innovation investments - funds allocated by corporate for research and experimental development in order to create innovations that would increase the assets and operational efficiency.

R&D expenditure - business spending on fundamental, applied and experimental research to innovate through new knowledge.

Corporate governance - 5 pillars (board's: functions, policy of compensation, structure, strategy and rights of shareholder) which describes corporate's framework- how board members and head condition shareholders' interests in the long-term perspective.

Innovation value chain – the process of directing initial funding to research and experimental development will ultimately create high added value for companies and countries through innovation.

Corporate size – financial indicator that shows the corporate's ability to invest in innovation and acts as a risk factor for the intensity and risk of corporate innovation investments.

Debt ratio – a financial indicator that shows the corporate's ability to invest in innovation from external sources and acts as a risk factor for the intensity and risk of corporate innovation investments.

ROA – financial indicator showing the opportunities to invest in innovation from internal sources and acts as a risk factor for the intensity and risk of corporate innovation investments.

Cash ratio – financial indicator showing opportunities to invest corporate's own money in innovation and acts as a risk factor for the intensity and risk of corporate innovation investments.

Tobin Q ratio – financial indicator showing whether the value of a corporate's assets exceeds the book value of assets and acts as a risk factor for the intensity and risk of corporate innovation investments.

National Innovation System - comprehensive framework showing the environment created (both favorable and unfavorable to innovation) for the development of innovation in both the private and public sectors.

Country sustainability - long-term economic growth based on a clean environment and social responsibility, as well as sustainable innovation, consisting of economic sustainability, environmental sustainability, social sustainability based on innovation sustainability.

Innovation sustainability - technological breakthrough in the country with high value-added innovations that do not pollute nature.

Economic sustainability - long-term economic growth in the country, which is based on fostering a clean environment and social responsibility, as well as sustainable innovation.

Environmental sustainability - global environmental protection and reduction of pollution through the use of renewable, clean energy, and reducing carbon emissions.

Social sustainability – the pursuit of social equality, social responsibility in the country in the long run through social security.

OLS – ordinary least squares regression, a method used to test the applicability of a developed estimation methodology.

Fixed effects - second regression method used to test the applicability of a developed estimation methodology.

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INTRODUCTION

Formulation of the problem. Technological, economic, climatic, and social changes in countries, as well as regulation, change of laws, rapidly changing needs of market players, shortening product life cycles all have a major impact on the business of companies and their environment. In order to stay competitive, companies must develop and innovate. This requires funds that are invested in a consistent, cohesive and long-term innovation development. Research and development (R&D) is a particularly important component in the development of innovation. Adverse internal and external risk factors of innovation investments hinder the rapid development of innovation. Alongside companies' ambition to remain competitive in the marketplace, countries are competing against each other to lead in the global world. Each year, countries in the world are ranked according to a number of indicators, including changes in the economy, as well as in protecting of the environment, social responsibility and innovation. According to 2020 data, the United Nations set 17 key sustainability goals (UN, 2020) that countries must achieve these goals by 2030. These are the key sustainability goals of the United Nations that each country must pursue. The large differentiation between the intensity of corporate investment in innovation and the risk and sustainability of country is a signal that companies and countries are moving slowly or in the wrong direction.

Today, companies need to offer new or improved products, services, processes, marketing, management and organizational innovation with long-term added value in order to remain competitive in the marketplace and meet ever-growing consumer demands. Today, innovation based on research and development is needed because there is too little to change the look of a product or a description of a service. This requires not only more efficient management of financial resources, but also more transparent and fairer corporate governance. Businesses must not only be financially accountable to employees, board, clients, creditors, suppliers, the public and government, but also have a social and legal, specific and clear definition of management policies and all related aspects. This would not only enable businesses to remain competitive, but also make the country more responsible and more committed to the goals of sustainability: country's innovation progress, economic growth, environmental sustainability and social responsibility. Research done by scientists proves problem of innovation investments evaluation by country sustainability groups is very sensitive in all different world regions. One way to achieve more sustainable corporate investment in innovation in the context of country sustainability is to assess the intensity and risk of corporate innovation investment in different groups across different sustainability dimensions. Nowadays, problems often arise when the corporate innovation investments intensity and risk in the future by the corporate activities, the factors affecting it, as well as the concept of sustainability in practice, should be assessed. Evaluating the intensity and risk of corporate investment in innovation is not a systematic and exhaustive process, and the methods of evaluation are quite limited, covering a specific area.

Due to the fact that measuring the intensity and risk level of corporate innovation investment in the context of country sustainability is still a limited

scientific area and requires specific definitions and evaluation methodologies, there is no suitable analysis tool. It is highly important to identify the determinants and assessment methodologies for assessing the intensity and risk of innovation investment by companies in the context of country sustainability. Therefore this research addresses the scientific problem: what are the key factors influencing the intensity and risk of corporate innovation investments and what impact they have on different countries' groups measured by sustainability dimension ratios.

Relevance of the research. In a rapidly changing technology world, companies need to conform the exigence of their participants if would like to remain competitive in the marketplace. New products, services, processes, marketing, management, and organizational innovation can all be tools to keep companies competitive. The innovation process is a long and complex path that covers the initial, development and implementation periods, which consist of many details such as idea planning, division of labor, attracting investors, building infrastructure, setting criteria, adapting. Increasingly, researchers, government representatives, as well entrepreneurs see innovation as a critical and important development of new or improved products, services and processes with a clear economic impact (Krušinskas and Benetyte, 2016; Frishammar et al., 2019; Oeij et al., 2019; Bradonjic et al., 2019). According to scientists (Weng and Soderbom, 2018; Hausmann et al., 2007; Cameron, 2000; Cafouros, 2005), R&D development is particularly significant in the innovation stage, which significantly influences the outcome of new services and new products (new things) for the market. The innovation value chain, based on the link between R&D expenditures, innovation investments and added value for corporate and countries (by Guan and Chen, 2010; Dedrick et al., 2015; Chen et al., 2018; Benitez et al., 2020) includes all innovation path from idea generation to added value for corporate and country. However, many authors emphasize that corporate innovation investments is a risky activity and every corporate should assess its capabilities (Craig et al., 2019; Oeij et al., 2019; Žemaitis, 2019). Risk factors include internal and external risks that can influence a company's innovation process such as company culture, resources, capabilities, management attitudes and goals, employee motivation, economic, environmental, social and innovation climate in the country. Authors (Dziall and Blind, 2019; Becheikh et al., 2006) distinguish management system to help achieve better result, because corporate can manage internal and external factors. According to the scientific literature, corporate governance and financial ratios can be very important variables that can have a significant impact on the innovation process. Acting transparently and honestly with all stakeholders (employees, suppliers, customers, creditors, government, community), companies can contribute to ensuring and enhancing the sustainability of the whole country through efficient management of financial resources and channeling them towards high value-added innovation. Additionally, authors (Weng and Soderbom, 2018; Yigitcanlar et al., 2020) distinguish that R&D and innovation is the driving force behind an endogenous economy that affects overall economic growth. Already in 2012, The World Bank stated that 'green growth', which encompasses innovation sustainability and economic sustainability, as well as environmental sustainability and included social sustainability, must be among the priorities in each country (World Bank, 2012;

Alekna and Kazlauskienė, 2019). In scientific works, how to reconcile technological development, economic growth, the reduction of environmental pollution and social responsibility, if at all possible, is also a growing scientific issue. This problem has been studied by a great deal of scholars (Drewis et al., 2018; Kubiszewski et al., 2013; Posner and Costanza, 2011; Van den Bergh, 2011; Martínez-Alier et al., 2010; Van den Bergh, 2017; Schneider et al., 2010; Linlin, 2019; Nogueira, 2019; Pham and Kim, 2019; Alfredsson and Malmaeus, 2019; Heikkurinen et al., 2019). Key dimensions of sustainability include economic growth, environmental protection and social responsibility based on sustainable innovation. Therefore sustainable innovation is particularly relevant with regard to country sustainability, if the country wishes to achieve more development level through economic growth, cleaner environment and better social protection. Of course, it is very difficult to find all the high-level dimensions of sustainability in one country, because if a country leads in terms of economy, it does not necessarily lead in the environment. To sum up, investments in innovation are essential for a company to grow and be able to compete in the national and international market. As well as, investments in innovation (innovation investments) are especially significant for the economic that it could to grow steadily, develop and make comprehensive progress in both environmental and social sustainability terms (Proksch et al., 2019). Therefore this research proposes a methodology for integrated assessment of corporate investment intensity and risk in the context of country sustainability, aimed at companies and countries for more efficient investment in innovation and sustainability development outcomes.

The object of the research is the corporate innovation investments intensity and risk as the driver for country innovation sustainability and economic sustainability, as well as environmental, and included social sustainability.

The main aim of the research is to develop an evaluation methodology of integrated assessment of corporate innovation investments intensity and risk in the context of country sustainability (innovation, economic and environmental, as well as social sustainability), as an instrument for the stimulation of business innovation and strategic development of the country's economy.

Main tasks are set in this research:

1. To investigate the importance of corporate innovation investments in the context of corporate competitiveness, as well as country sustainability.
2. To examine potential factors that may influence the corporate innovation investments intensity and risk.
3. To analyze the sustainability measurement as the dimensions integration with corporate performance of country sustainability and present key dimensions of sustainability.
4. To create and to investigate the practical applicability of the developed evaluation methodology of corporate innovation investments intensity and risk.

Research methodology. The methodology of analytical research (systematization, comparison, generalization, analysis and synthesis of scientific literature) is applied in the first chapter in order to find significance of the corporate innovation

investments, the possible risk factors and their evaluation methodologies. Theorizing the model of corporate innovation investments intensity and risk integrated assessment methodology, the results are systematized, analyzed, compared, generalized and graphically represented in the second chapter. Theoretical background is based on generalization of the scientific literature, synthesis and practical modelling. In addition, there were created regression models (OLS (Ordinary least squares) and Fixed effects). The third section sought to empirically test evaluation methodology of integrated assessment of corporate innovation investments intensity and risk using data analysis, systematization, regression and generalization. Essentially, research methodology of the thesis is based on an evaluation methodology development process for corporate innovation investments intensity and risk assessment. This evaluation methodology development process (based on theoretical background of the analyzed foreign scientific literature) involves these methods in the main research steps: (1) data collection; (2) calculation of ratios; (3) formation of OLS regression models; (4) selection and development of country sustainability methodologies; (5) grouping countries according to sustainability dimensions; (6) formation of fixed-effects regression models. Finally, testing the practical applicability of the study is applied.

Scientific novelty & practical significance of research results. Despite the fact that the thematic of corporate innovation investments is greatly popular among researchers and is intensively analyzed in the past and now, the authors analyzed the a variety of things: benefits and advantages for business of innovation, risk factors, innovation performance and innovation results, as well as innovation investments for country sustainable growth. Research results scientific novelty and practical significance can be summarized as following. It was proposed to include the corporate governance alongside financial indicators that demonstrated how companies behave in a transparent and fair manner towards all stakeholders (employees, board, owners, clients, creditors, government and society) in developing evaluation methodology for measuring the innovation investments intensity and risk in companies. Four key dimensions have been offered to evaluate the country sustainability: innovation, economic and environmental, as well as social sustainability. The system of grouping countries according to sustainability dimensions is characterized by the effectiveness of the evaluation criteria. Evaluation methodology enables the assessment of the significant factors influencing innovation investments intensity and risk according to different sustainability groups. This methodology of integrated assessment of corporate investments intensity and risk in the context of sustainability of countries is innovative, new and applied for the first time to obtain practical results. It enables better assessment of potential risks, more efficient management of available resources, and more informed sustainable decisions of innovation, environmental and economic, as well as social sustainability. Results enable to provide guidance to all public companies and countries, because the purpose was achieved - developing a evaluation methodology for integrated assessment of corporate innovation investments intensity and risk in the context of country sustainability. This guidance includes important question on how to more effectively assess the innovation investments intensity and risk in different sustainability dimensions (innovation,

economic, environmental and social), along with offering a tool - a created comprehensive evaluation methodology. Such created evaluation methodology as tool for companies and countries would enable to better assess the significant drivers of innovation investments intensity and risk across countries of different sustainability, to identify potential risks that would enable companies to manage their innovation investments more effectively, and to achieve sustainability objectives more consistently. The evaluation methodology of integrated assessment of corporate innovation investments intensity and risk is complex, allowing to evaluate different companies and countries. This evaluation methodology can be applied in countries with low, medium and high sustainability dimensions: innovation, economic, environmental and social. This dissertation can be used as a methodology for assessing the results of innovative activities of corporate in order to achieve strategic economic growth in the country in the long-term perspective.

Structure of dissertation: introduction, 4 chapters, conclusions and general conclusions, references. Volume of research without annexes is 106 pages. The research contains numbered formulas, illustrations, tables. Literature sources are used in the preparation of the thesis. The first section analyzes the importance of corporate innovation investments, the importance of R&D expenditure, as well its meaning in the innovation process, financial factors, the corporate governance (level of transparency and fairness), their impact on innovation investments, and the concept of country sustainability. The chapter concludes with a theoretical framework for a complex assessment of corporate innovation investments intensity and risk and presents the main conclusions. The second section deals with the theoretical modelling of corporate innovation investments intensity and risk. The third chapter forms the final evaluation methodology for the complex assessments of innovation investments intensity and risk by companies. In the fourth chapter the modelling is provided on real data of corporate and countries. The paper concludes with general overall conclusions.

Approval of research results: there were 13 scientific articles published in the topic scientific journals cited in other databases. Dissertation results were presented and published at 12 scientific conferences in Lithuania and abroad.

1. IMPORTANCE OF ASSESSING CORPORATE INNOVATION INVESTMENTS INTENSITY AND RISK IN THE CONTEXT OF COUNTRY SUSTAINABILITY

This Chapter of dissertation analyzes the importance of corporate innovation investments and their intensity and risk in the context of business competitiveness, operational efficiency and country sustainability. It also analyzes the impact of R&D expenditure on the corporate innovation investments intensity and risk as one of the most important and significant part of the innovation growth development. In addition, this Chapter looks at the key factors that can have an important effect on the corporate innovation investments intensity and risk. These are financial ratios and corporate governance; therefore, their importance on the corporate innovation investments intensity and risk are analyzed here too. This chapter also looks at the link between corporate innovation investments intensity and risk and the sustainability of the country, highlighting the most important dimensions of sustainability by economic growth, cleaner environment, better social protection, as well as technological breakthrough. The chapter concludes with a summary of the importance of corporate innovation intensity and risk in the context of business competitiveness and country sustainability.

1.1. Significance of innovation for business competitiveness and operational efficiency

Innovation has become increasingly important for business survival and competitiveness due to rapidly changing technologies. Increasingly, entrepreneurs, researchers and government representatives see innovation as a critical and important development of new or improved products, services and processes with a clear economic impact (Frishammar et al., 2019; Oeij et al., 2019; Bradonjic et al., 2019; Krušinskas and Benetyte, 2016). It is, therefore, necessary to promote the development of innovation in enterprises, municipalities and countries (Atkočiūnienė et al., 2019; Dace and Sloka, 2020). Moreover technological potential (technological innovation) is a key factor in business competitiveness (Venckuviene et al., 2014). Descriptions of the concept of innovation, explanations, methodologies, factors, impact on various different economic fields in scientific literature are the most debated. Researchers are talking not only about the need to create and develop innovation, but also about the risks of innovation. In any case, corporates need to invest in innovation if they wish to stay in the market. Many authors emphasize innovation investments as a risky activity, which capabilities should be carefully assessed corporates (Oeij et al., 2019; Craig et al., 2019; Žemaitis, 2019). The researchers highlight different risks for innovation investments, but they also stress the need to analyze these risks in an integrated way, defining the importance of innovation for business performance (Lee et al., 2019; Craig et al., 2019). Therefore every corporate must have a good understanding of what these innovations are, why they are important and why corporates need to invest in them (Jiang and Yuanb, 2018; Dubra, 2013). In a general sense, innovation itself can be described as the improvement of novel products and services (Craig et al., 2019). In a broad sense, the

concept of innovation found in scientific literature is not only products, services, but also processes, organizational and marketing innovations (Craig et al., 2019). Other researchers distinguish between four major types of innovation: product, process, marketing, and organizational (Lee et al., 2019). However, Craig et al. (2019) also add management innovation and broadens the understanding of innovation. Product innovation can be associated with any improved product that adds more value to the consumer than the product previously on the market. These can range from food innovation to satellite rockets, lasers, oncology drugs, or non-invasive human head pressure gauges. Product innovation is strongly influenced by branding as consumers pay attention (Flikkema et al., 2019). Product innovation is particularly relevant in manufacturing, construction, wholesale and retail. Process innovation is crucial when developing new products to maximize added value for the future consumer. Therefore, process innovation can be attributed to the use of new technologies in product innovation (Aliasghar et al., 2019). These innovations are important in every field, but service, education, human health care, artistic, recreational, and recreational activities are particularly distinctive. Marketing innovations go hand in hand with delivery services, rebate systems, online advertising, online booking, outdoor advertising, smartphone app launches and partnerships with outside businesses (Craig et al., 2019). These innovations are highly important in the wholesale, retail, accommodation, catering, entertainment, art, and leisure activities. Organizational and managerial innovation are largely correlated. These innovations are significant in the process of improving the company's business strategy, employee incentive and motivation system. The management of each company seeks to focus its business strategy on the overall efficiency of the company through the responsible and sustainable use of the resources at its disposal (Lee et al., 2019). Effective activities are possible when the employees of the company are motivated, ready to work responsibly, learn, propose ideas and implement them. Therefore, innovations that can contribute to the improvement of human resources performance in each company are extremely significant.

All types of innovation can affect the performance of corporate (*see figure 1*). Through different research and discovery of new information, adapting it can lead to improved or new process innovation. By using research results and process innovations in experimental activities, it is possible to develop improved or new products. Both, process together with product innovation, contribute to the efficiency of the company. Along with process and product innovation, adding organizational and marketing innovations can provide an improved integrated enterprise performance system. Companies operating both, nationally and internationally, must continually offer consumers newer, higher quality, and nicer packaged products. Possible market failures, rapid reaction from competitors, changing and growing consumer demands oblige companies to improve their production, sales and marketing processes. The research shows that companies that are complex in their ability to develop new products and adapt processes have higher operational efficiencies (Lee et al., 2019). The interconnectedness between company innovation and operational productivity allows greater profits (Li, 2020). For enterprises, by appreciating the synergies between innovation and their performance, would be better

placed to analyze and manage the innovation development process for commercial gain.

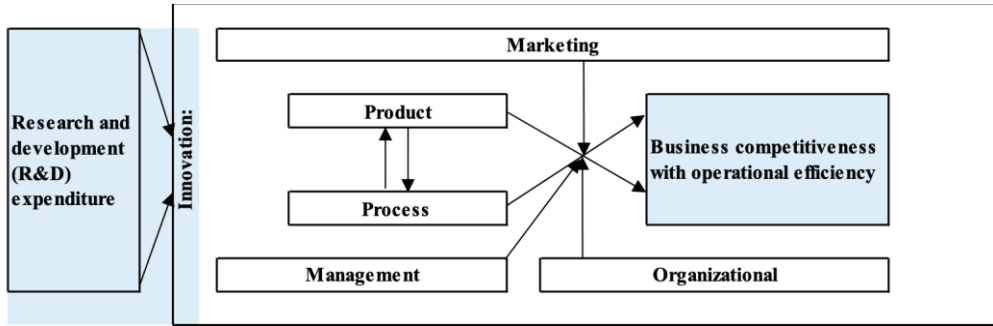


Figure 1. Link between corporate innovation investments intensity by R&D expenditure and business competitiveness and operational efficiency (according to Lee et al., 2019; and Craig et al., 2019)

The development of innovations, generation of new ideas, introduction of improved products and services into the market is influenced by the comprehensive enterprise environment. Frishammar et al. (2019) highlight several key aspects (*see figure 2*) that correlate with one another in carrying out innovative activities. Culture is the significant facet of the corporate, which consists of the values cherished by the employees, defined standards and their observance. Companies that consider innovation as one of their values, their constant desire to change, improve, seek new, advanced working methods and tools, understand that innovation is the key to competitive advantage and prove it to their customers through products, services or radical technologies (Shaikh and O'Connor, 2020), and adapt a complex innovation process. Regardless of the age, corporate size, financial status, status, market of the company, each company has its own culture, which is best reflected in its employees and activities. Frishammar et al. (2019) thus distinguish between resources and capacity, the management of the innovation process, the generation of ideas and their implementation prior to the making of a product or service, the business model as important aspects in carrying out innovation activities. Both material and human resources are needed to start generating new ideas from which research and experimental activities can generate commercial benefits for the company. The company needs to recruit additional staff or reallocate jobs to existing employees to remain motivated, creative but also able to work with sufficient knowledge in the field. Launching R&D can cause problems that the company has not yet encountered. With the resources and capabilities at their disposal, the management of the company can achieve first results by properly managing the innovation process and encouraging them to continue brainstorming and developing. Creating the first prototypes, developing the manufacturing process, improving the products, services and planning to launch them, requires an updated business model that clearly defines the characteristics of the improved or new product or service, the production, sales and marketing process, added value, potential new or existing customers. Successful

adaptation of innovation activities to the existing business area can be expected to provide a competitive advantage in the market.

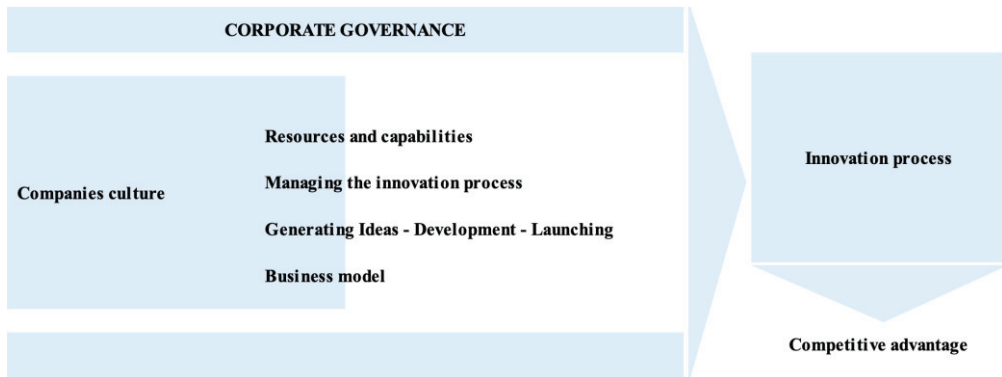


Figure 2. Common factors determining competitive advantage in corporate innovation activities (according to Frishammar et al. (2019))

Innovation activities in the expectation of competitive advantage in the market, Oeij et al. (2019) are divided into three main phases (*see figure 3*): initial, development and implementation periods, which usually exhibit certain characteristics common to many corporate engaged in innovative activities. Oeij et al. (2019) note that periods of innovation activity are influenced by the age, size, ownership, R&D activity and size of the corporate. Idea generation, maturation and development can characterize the initial period of innovation activity. During this period, it is possible to distinguish between company investors (existing and / or new shareholders) who are committed to investing in the development of a new idea in the hope of commercial success, and company management who take responsibility for turning an idea into a product or service. O'Brien (2020) emphasizes that companies lack strategies to generate new ideas more effectively. In the first phase, the company faces a certain kind of shock when the management of the company develops a plan and distributes work to those responsible who introduce the remaining employees to the engagement. At this stage, employees who do not show any initiative, are reluctant to change, are afraid of innovation, may not be motivated by the salary they receive, may become dissatisfied or less able to work (Becheikh et al., 2006). In companies where innovativeness is a value and a phenomenon of encouragement, employees experience significantly less shock and take the initiative faster. Psychological help at this stage is very important (Andersson et al., 2020). With the involvement of top management and organizational staff who can help solve the problems of the first phase, setting clear criteria for what is needed to achieve the goal moves to the second phase, when serious research and experimental development begins (*see figure 3*). There are also difficulties at this stage that are more specific, focused on specific problems, which are solved with the help of experts and professionals (Dziallas ir Blind, 2019). Once the technical barriers have been resolved, the pilot phase continues with the third phase of implementation or termination. During this period, the idea is to create a prototype from an idea through research and experimentation, adapt it to the company, expand the infrastructure, prepare for production and sales, or vice versa, without creating a

prototype and stopping experimental development. At this stage, when a mature idea is transformed into a prototype through research, experimental testing, and adapting to the business, one can already expect commercial benefits, planning production and sales costs. Symmetry of information is very important in the development of innovation (Župerkienė et al., 2016), i.e. no errors when information flows from one stage to another can occur. As well, time management is very important at all stages, and very risky (Siren et al., 2020). Therefore, the interface is simply necessary in all processes. Trischler et al. (2020) recommend involving as many stakeholders as possible in complex innovation development.

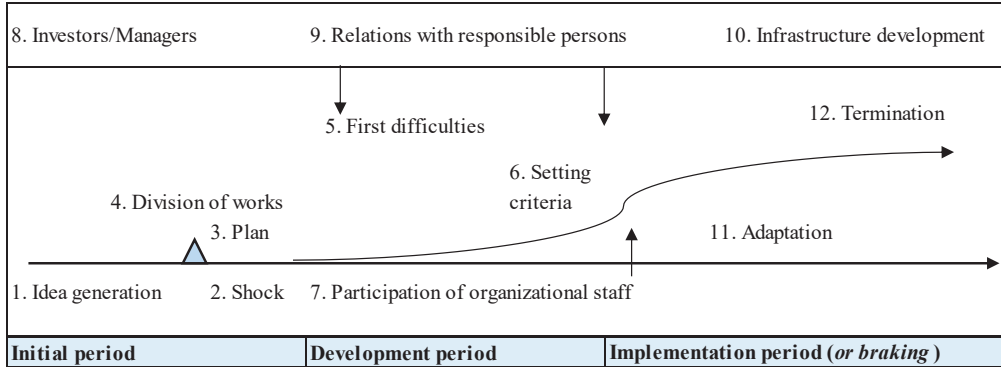


Figure 3. Key stages of corporate innovation activities expecting competitive advantage in the market (according to Oeij et al., 2019))

As a result of innovative activities in a company, it is expected to create a new or improved product, service, process. To help achieve this result Dziall and Blind (2019), Becheikh et al. (2006) distinguish between internal and external factors (*see figure 4*) that exist in companies when developing innovative activities. Internal risk factors are directly related to the company itself and its environment. Research and development is a particularly important variable that can influence the final outcome of an innovation activity. Innovation enables an opportunity to develop innovative activities and to create an improved or new prototype that can be applied to commercialization. Research and development cannot be achieved without a well-educated, motivated and competent workforce. As emphasized by Oeij et al. (2019) and Sunder et al. (2017), top managers (CEOs) (Li et al., 2019), organizational staff, and staff specifically involved in research, experimentation express a special role in developing innovation. Except the necessary capital of a human, the corporate will not be capable to launch any innovative activities. The financial performance of the company is also of great importance as research, experimentation and staff retention require financial resources. Lower financial constraints allow for a smoother investment in innovation (He et al., 2020). Having a relatively small equity stake will limit the start-up of an innovative business without sufficient cash. The level of risk will increase if the company decides to borrow from external sources in order to set up a research and development department, buy the necessary equipment, materials and pay salaries. The culture of the company in terms of innovation, organizational structure, long-term strategy, attitude are just as emphasized by Frishammar et al.

(2019) have important implications for innovation performance. Without a company with the required culture of innovation, it can be harder to stay competitive in the market. When the values, vision and mission are not focused towards more innovative, modern, higher value-added workplaces, employee motivation systems, technologies, innovation will not be a priority for the company. External factors (*see Figure 4*) that correlate with the internal factors of the company may also determine the results of innovative activities. The market and its size can be distinguished as contributing factors to innovation performance. An innovation-oriented company with the necessary resources and capacity to develop it, operating in a large market with a significant number of innovation-driven buyers, will facilitate commercial gain. A network of business partners can also contribute to the success of innovation activities. Partners operating in both, national and international markets, can facilitate the integration of newly created or improved products and services into the market. Consumers must also be interested in sustainability at this stage (Nielsen, 2020). Partners may also be financiers of a new idea or experts who can help solve specific problems while developing new products and services. Competitors are often seen as an additional risk factor in innovation development activities, which may misappropriate information and use it in their activities. However, competitors can also act as incentives for a company to change, innovate, move towards more intensive use or development of technology. Easy-to-understand legislation, laws allowing new products, services and processes to be patented smoothly and without major interruptions can also contribute to faster innovation performance. Integrated evaluation of internal and external factors in the company's activities can help to achieve faster and higher quality results of innovative activities.

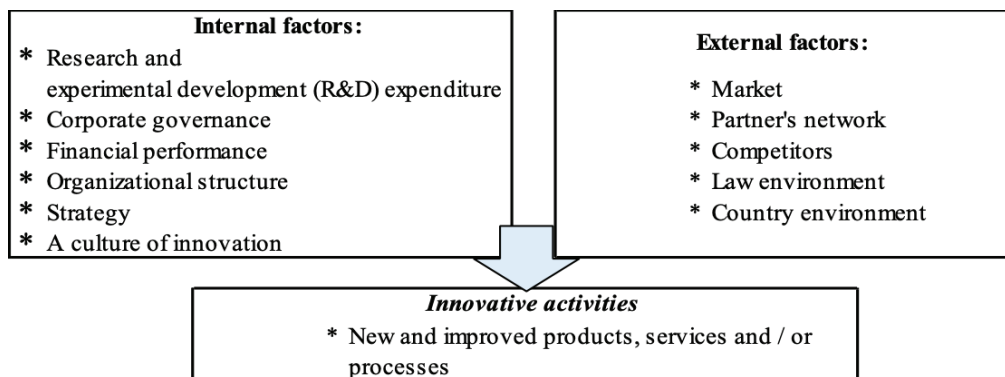


Figure 4. Corporate specific external and internal factors influencing innovation performance (according to Dziallas and Blind, 2019); Becheikh et al., 2006); Zhang (2015); Krušinskas and Benetytė, 2015)

Although it is very difficult for companies to define innovation (Cirera and Muzi, 2020), creating, developing and implementing innovation is one of the most important tasks for a company in becoming more efficient. The concept of innovation can be interpreted as innovation in products, processes, marketing, organization and / or management. These innovations are very closely linked when it comes to integrated company efficiency. Research and experimental development (R&D) expenditure,

which enable ideas to be transformed into knowledge, experimentation, prototyping and ultimately into products or services, performs a relevant part in the innovation process. However, the human and financial resources of a company are also very important when investing in R&D. Organizational and technical staff is assigned to the human resources required for innovation activities. Workplaces for creating and maintaining these employees and various materials for experimentation require financial resources. Without sufficient equity, the company may borrow funds from external sources, but this presents additional risks alongside risky innovation activities. Culture, organizational structure, strategy, business model influence the development of innovation. For a company that is not interested in innovation may be difficult to achieve successful performance, so it is important to take a holistic outlook to the potential risks that the company may face in its innovation activities.

1.2. R&D expenditure and innovation investments intensity and risk

Research and development expenditure (R&D expenditure) is interpreted as business spending on fundamental, applied and experimental research to innovate through new knowledge. R&D expenditure is relevant dimension of innovation activity, influencing the company's innovation capacity. R&D is a “critical input to innovation” (Fan and Wang, 2019). The innovation capacity of a company can be defined as the potential to develop or improve products, services, processes by assessing the resources available to the company. According to Weng and Soderbom (2018), R&D and innovation is the driving force behind an endogenous economy that affects overall economic growth (Yigitcanlar et al., 2020). The increasing complexity of technological production of products, the expansion of production, changes in the structure of products and production itself require high productivity, which can be achieved through research and development (Hausmann et al. 2007; Yuan and Zhang, 2020). High productivity contributes to long-term economic growth. Research and development intensity (R&D intensity) can be used to evaluate the effectiveness of the results of the innovation process.

Corporate R&D expenditure can reflect the current situation of enterprise innovation and a strategic plan for innovation. The R&D of larger and longer-lasting companies is more internationally distributed (Gruning, 2018) however, all companies that plan ahead of time for research investments, assess the financial position of the company, identify possible risks, and have greater potential for innovation and market adaptation. Similarly, the direct impact on innovation performance can be achieved by measuring the costs of R&D. Various scientific studies are available to support this claim. Authors (Cameron, 2000; Cafouros, 2005; Audretsch and Belitski, 2020) examined an unquestionable relation between R&D and corporate productivity growth. Researchers also agree that companies directors must invest in innovation, if they want to remain competitive, even though this is a risky activity. Investments in R&D can be defined as a dynamic process, a series of sequential creative, scientific tasks, the completeness of which enables an improved product, service, process or technology. The dynamic process has no specific timeframe; however, the sooner a company is able to complete its sequence and create a market-driven innovation, the faster it becomes more competitive. Changing environments and sophisticated

strategy management can be the key challenges for a company. Properly adapting, integrating, reconfiguring enterprise skills, resources, and changing environments can be the key to innovation success.

Research and experimental development (R&D) expenditure may be developed by highlighting the main stages of the activity. The work of Salguero et al. (2015) distinguishes a scheme for conducting R&D expenditure (*see figure 5*), which includes systems for planning, management, process execution, risk assessment, action improvement, and interpretation of results. The planning and management system is based on the planning of research and experimental activities, including the preparation of the strategy, the overall financial budget, and the assessment of risks and opportunities. The planning and management system is maintained by senior management of the research and experimental activities. The system of the R&D process is directly related to those in charge who develop targeted project plans, implement technology transformation and adaptation, and manage and control project progress. This stage also addresses additional risks that may have arisen in the course of the work that may have been unforeseen at the outset. The action improvement system is based on solving the problems encountered in consultation with experts. Continuing and improving research, as well as development activities, can provide results from the first tests, which are further tested and analyzed.

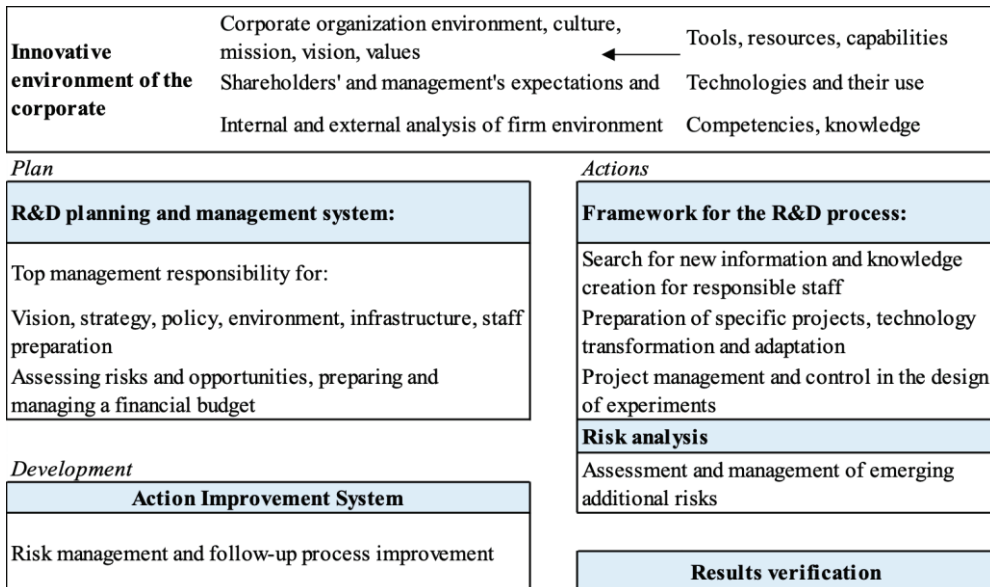


Figure 5. Scheme of R&D growth (according to Salguero et al., 2015)

Lee et al. (2017) consider the system of the total R&D growth process as one of the most important stages of research on which the final results depend. These scholars distinguish the process system (3P) model (*see figure 6*) to explain the process system, which includes the organizational and design levels. At the organizational level, there is one fundamental organizational process that defines the idea of where and for what purpose the research will be undertaken, the planned financial budget, the works and

their timeframes. For this purpose, the necessary infrastructure is created and the necessary team is established with knowledge and competencies in the field. The main result of this process, moving to the next stage, is the creation of intellectual property, whereby the company is granted exclusive rights to the intangible assets: patents, trademarks, trade secrets, industrial design, and commercial appearance. The project level includes support and implementation processes. The experimental activity is continued, in order to move on with the experimental activity with intellectual property. The development of these activities requires defining work, assessing capacity, planning financial costs and the resources needed to finance them. Collaboration with experts and research staff is also required to achieve results. Therefore, business and science cooperation is just essential (Juknevičienė and Bersėnaitė, 2016). Also, risk planning and peer review is a very important part of the support process. When properly managed, the problems go into a runtime where you get expert test results: a prototype, improved product or service specifications. Innovation results provide opportunities for further business development within the company, with the expectation of commercial gain, analysis of renewed business opportunities, changing business model, research and expansion of the market.

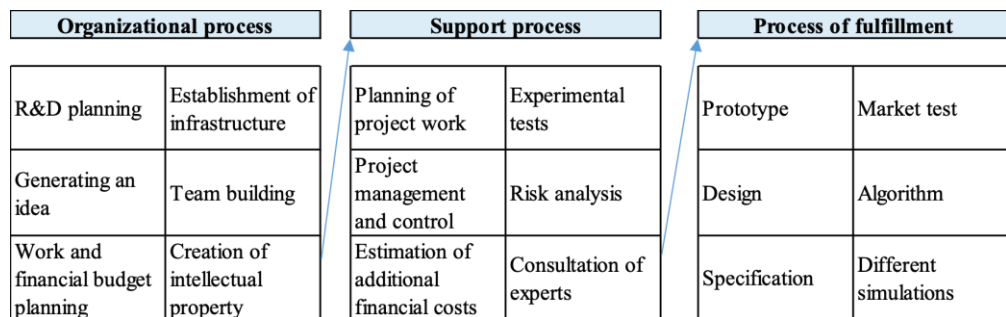


Figure 6. Model 3P for R&D growth (according to Lee et al., 2017; Fan et al., 2013)

Companies do not always enable adaptation to a changing environment: lack of financial resources, changing financial situation, shrinking market, cases of plagiarism, outgoing employees, lack of knowledge, patenting restrictions or legal restrictions (*see table 1*). Research and development enables the creation of novel knowledge that can quickly be brought to competitors in other companies or even in other countries. Rather, products developed by competitors based on adaptive knowledge, entering the market, can be one of the biggest risks leading to bankruptcy (Benetyte and Krusinskas, 2019). Businesses need to be prepared to protect the new information generated by various research and development activities. Agreements with employees on complete non-disclosure may also prevent you from losing proprietary information. Potential suspicious investors may also be one of the risk factors to ensure information security. There are fraudulent investors who want to get the most out of their target company. After investing their equity, such investors apply for all sorts of information, which they then apply to other businesses.

Investing in innovation (intangible assets) is significantly more risky than investing in fixed assets (Wang et al., 2016). Companies investing in the creation of new knowledge and information in the hope of creating a product are more ignorant

than those who buy new buildings, equipment or vehicles. It is serious to assess the quality of R&D investments in the long term compared to short term and low risk projects. Highly qualified scientists, engineers and other professionals must work on projects involving research and development. Attracting and retaining such employees requires high salaries as well as fringe benefits and bonuses as incentives for performance and motivation to continue research. It is relatively expensive for companies to retain these professionals for a short period, as temporary employment requires job creation, training, and preparation for real work. With the temporary cessation of research and development activities in a company, the jobs created remain empty, without added value, but the cost of maintaining them remains. During intermittent investments activities, a company may face ‘transition shocks’ that it needs to prepare in advance.

Table 1. Potential risk factors for innovation investments (according to Craig Lee et al., 2019; Jevsejev, 2020; Turčinavičius, 2019; Xu, 2019; Gorodnichenko et al., 2020; Thum-Thysen et al., 2019; Weiyu and Xixiong, 2019; Parast, 2020)

	Internal risk factors	External risk factors
Risk Factors of Innovation Investments	Employee reluctance to change, innovate, non-motivating salary	Low awareness of users, clients about innovations implemented, implemented in the company
	High innovation costs	Low market interest in innovation
	Lack of ideas, innovation partnership	A small market and low FDI (foreign investments), ‘GEPU: government economic policy uncertainty’
	High staff turnover, IT risk, lack of knowledge	The expected results of potential innovations are unclear, corruption
	Low investments in R&D, Financial performance, Corporate governance	Unfavorable environment for investments in innovation within the country, disrupted supply chain
	Fear of not implementing the idea of innovation	Unfavorable, ambiguous legal environment, unfriendly regulations

The company may find it more difficult to obtain external financing from credit institutions (banks, credit unions) or the cost of borrowed capital may be higher than the cost of equity (Machokoto and Areneke, 2020; Savaneviciene et al., 2015). When designing an investments project to finance long-term R&D, it is much more difficult to measure efficiency and risk sensitivity parameters. The real return on these investments can be very difficult and uncertain. Creditors may reject the first project or increase their borrowing margins when evaluating an investments project that is more abstract than a standard investments project on fixed assets that could

immediately generate sales revenue. Once research and development is under way, support investments may be required due to unforeseen circumstances: failed experiment, damaged materials, increased prices, retired employees. There are fewer unforeseen risk factors when buying a fixed asset. Expanding the market, finding new customers, and attracting new customers will incur additional costs for the company. For a small company, this can be a barrier to start-up an innovation activity, so early assessment of risk levels, identification and analysis of risk factors, and forecasting are important processes in R&D. Valinejad and Rahmani (2018) distinguish between the model of risk assessment of research and experimental activities (*see figure 7*) applicable to enterprise processes. This model performs risk level identification, which includes risk assessment and analysis, identifying each of the potential risk factors: internal and external. The identified risk factors shall be assigned a risk priority number (RNN), calculate the proportion of risk in the overall risk level and present a possible solutions by nature. The research by Kocnd Ceylan (2007) and Guan et al. (2006) proposes to include different numbers of qualitative and quantitative variables in the risk assessment process. Quantitative variables in the research and development evaluation process are considered reliable as they measure specific company or market datum and produce an analysis based on that data. The use of qualitative variables may pose additional risks as these data are derived from peer review, which may include factors of subjectivity. Despite the possible occurrence of subjectivity in the risk assessment, it is suggested to include 3 to 7 different variables. According to Deptula (2017), it is very difficult to define how much risk variables should be included in the evaluation process and how specific they should be, but a combination of internal and external, quantitative and qualitative risk factors would allow better identification of the overall level of risk in the enterprise. In addition to carrying out an overall risk assessment, this stage also presents the final decision approach and preventive measures to be applied in subsequent iterative R&D processes.

Despite the risk factors, R&D investments enable corporate to better recognize, manage new information, commercialize it and transform it into innovation. The R&D results enable the further development of production processes that reduce environmental impact, reduce downtime and damage due to disruptive processes, maintain a consistent level of company competitiveness in the market, extend product life cycles by using more durable materials, do not create long-term added value, and improve systems through technology transformation and adaptation (Deptula, 2017). Also, despite the risky conduct of R&D, its results in having a certain effect on the company's financial results. Oliveira et al. (2018) highlight that a strong positive relationship between R&D and financial results of a company occurs when the development of complex innovative activities that results in commercial benefits is consistent, focused and effective. The results of various econometric analysis (Babkin et al., 2015) show that increasing costs of corporate R&D have an impact on increasing corporate income and profits. Analyzing R&D performance and overall innovation performance, sales share of new products and services, financial and human resources, risk and potential solutions can help to improve the efficiency of the company and predict future trends. Approaches based on artificial intelligence

could be a tool for managing an easier investment process for innovation (Kakatkar et al., 2020).

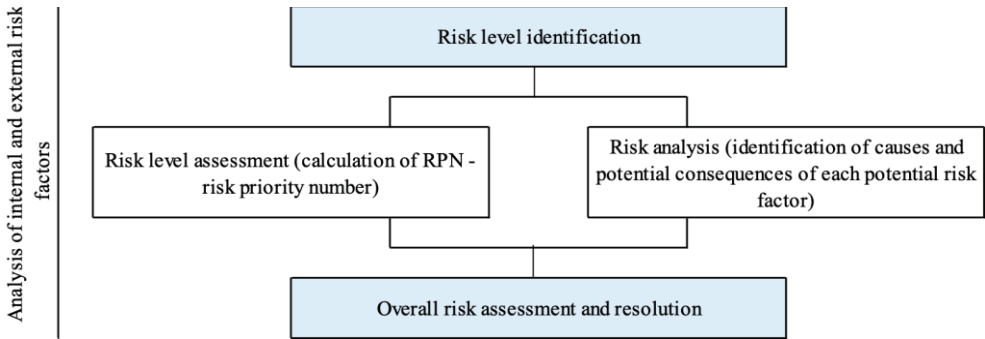


Figure 7. R&D Risk Level Identification Model (according to Valinejad ir Rahmani, 2018)

Thus, R&D expenditure growth is a relevant component of an innovation activity (Tan et al., 2019; Wu and Chung, 2019), and its effective results enable the company to operate efficiently through upgraded processes, improved services or new products. The process of research and experimental development can be long and complex, seeking important upfront financial and human resources. The planning and control, risk analysis, as well as action development phases must be staffed with highly qualified, responsible and motivated staff. They need infrastructure to develop and experiment and a favorable environment for innovation, which requires upfront and supportive investments. The development of R&D results up to product development and commercialization also requires a favorable legal environment that allows for the smooth registration and legalization of new patents, a large market with a sufficient number of interested buyers. High levels of uncertainty and unpredictability in research, experimentation, commercialization activities present a high degree of risk, for which the additional methods used to manage them also cost the company but are inevitable. Disaggregating all potential risk factors by assigning a priority number and weight to the overall risk level of the company, expert analysis, and assigning possible solutions by their nature could be methods that the company uses to manage risk. Effective risk management would lead to better results in the field of innovation, which would enable these activities to be more effective due to the direct link to the company performance.

Moreover despite the fact that investing in innovation is a very risky activity in a company due to high uncertainty, a successful outcome can create significant added value for both sides, the company and the country. The innovation investments value chain (IVC) (Chen et al., 2018) (*see figure 8*) involves 6 important steps. As the first step (step 1), companies are channeling their money into R&D activities. During the second step (step 2), more R&D expenditure can increase the intensity of innovation investments. During the third step (step 3), the intensity of innovation investments (accompanied by innovation risk) creates added value for companies. During a fourth step (step 4), the intensity of innovation investments (accompanied by innovation risk) adds value to the countries. During the fifth step (step 5), the value added of the all

companies in the country contributes to the creation of the added value of the country development. Finally, during the last step (step 6), the added value created at a national level can contribute to the performance improvement of the company through the promotion of R&D spending. This creates a strong link not only between innovation investments and company growth, but also between innovation investments and country development (Dedrick et al., 2015). In addition, it creates a strong link between the growing of the corporates themselves and the evolution of the country.

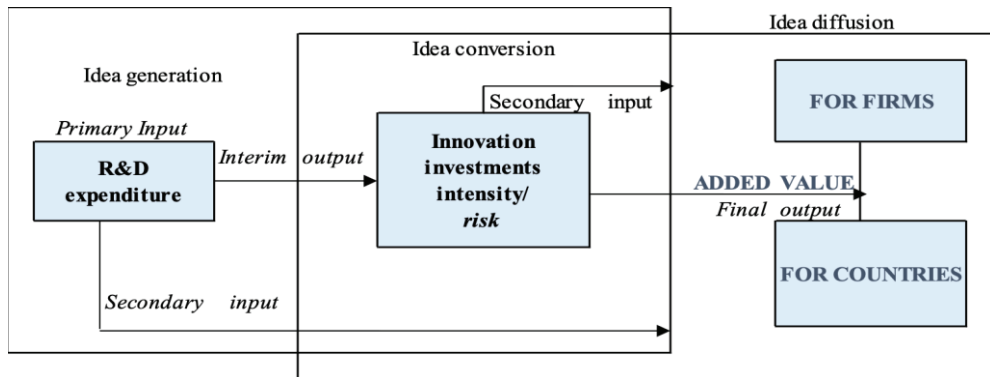


Figure 8. The innovation value chain (IVC) based on innovation investments and added value for corporate and countries (according to Guan and Chen, 2010; Dedrick et al., 2015; Chen et al., 2018; Benitez et al., 2020).

It should be emphasized that the primary added value is for businesses, if they direct their funds towards R&D activities. There are 3 main things (*see figure 9*) that can be distinguished, which show whether the company has added value based on R&D, innovation intensity (with more committed risk) (Guan and Chen, 2010).

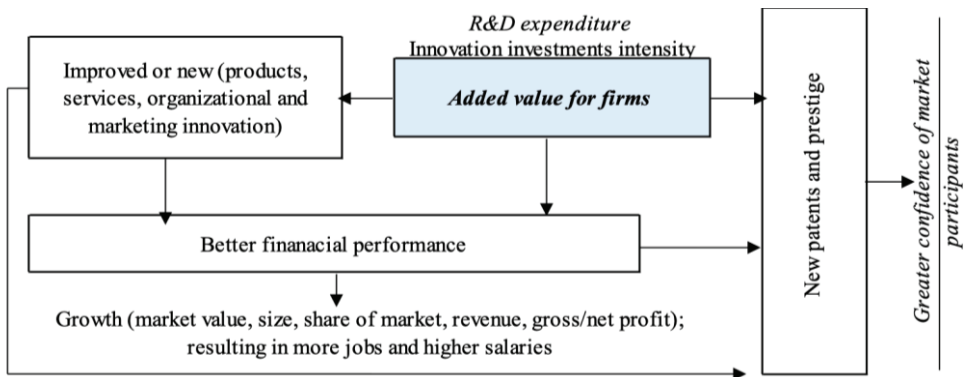


Figure 9. Components that add value to the business by investing in innovation (according to Guan and Chen, 2010; Dedrick et al., 2015; Chen et al., 2018; Benitez et al., 2020).

In such way by the added value for firms (*see Figure 9*) innovations are created, new patents are registered, financial performance are improved as well as a new breakthrough in the market may appear. Innovation includes improved or new products, services, organizational or marketing innovations. This gives for companies

the opportunity to patent all innovation and offer it to market participants. With consumer demand, the company has the potential to grow as sales, gross margin, and market share increase. Better financial performance of company enables to create new jobs and pay higher salaries in the market. Households will also have an incentive to innovate if wages and jobs improve (Chen et al., 2020). All of this leads to the company's increased breakthrough and confidence in the global market. This raises the price of the stock, which attracts more investors. New investors can offer new sources of financing through continued R&D (innovation) activities. The country's added value based on innovation investments is significant in two important ways (Benitez et al., 2020) (see figure 10). One of them is that increased added value of companies from the creation and application of successful innovation in the market increases the well-being of the whole country. The second is that public innovation investment directly adds value to the country.

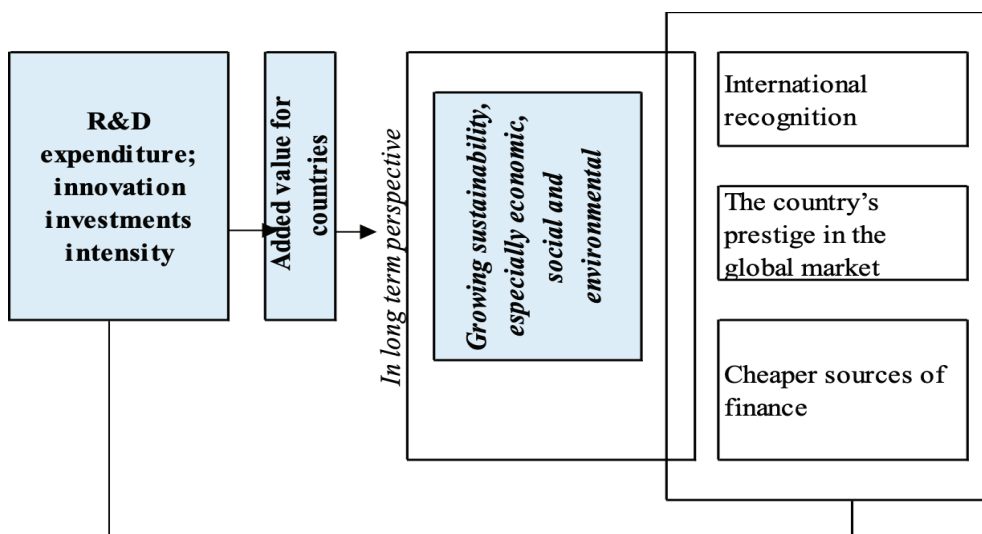


Figure 10. Added value to the countries by investing in innovation through corporate performance (according to Guan and Chen, 2010; Dedrick et al., 2015; Chen et al., 2018; Benitez et al., 2020).

Innovation is needed to make the public sector more efficient (Chlivickas, 2014). In particular, public innovation must be open, accessible, effective and sustainable (Pedersen, 2020). A strong effect comes when the added value created by companies and countries is combined (Dedrick et al., 2015). In any case, the country's added value, based on R&D and innovation, primarily involves increasing the country sustainability. The country sustainability is increasing through innovation, economic, environmental and social prism. All of this allows for greater recognition and prestige of the country in the market, as well as cheaper sources of borrowing due to the country's greater global credibility.

Summing up the importance of R&D activity and innovation investments, two important aspects need to be highlighted. Foremost, R&D expenditure is subject to a high degree of uncertainty. The analysis of the scientific works has identified the

internal and external risk variables, which can influence uncertainty. However financial performance, human resources, including the corporate governance, are of particular importance. Meanwhile the innovation investments intensity based on risk enables the add value to companies and countries. The added value for companies comes through new patents, better financial performance, greater confidence and attractiveness. The added value of the countries includes increasing sustainability, international recognition and cheaper financial resources.

1.3. Connection between innovation and country sustainability

Already in 2012 The World Bank has stated that 'green growth', which encompasses economic growth, cleaner environment and better social protection, as well sustainable innovation, must be one of the priorities in each country (World Bank, 2012; Alekna and Kazlauskienė, 2019), however, this phenomenon is a particularly complex and lengthy process (Xiong et al., 2020), requiring time, resources and strategy. The problem in scientific sources includes how to reconcile technological development, economic growth and reduction of environmental pollution, as well as social responsibility. This problem (coherence between technological development, economic growth, reduction of environmental pollution and social responsibility) has been large studied (Drewis et al., 2018; Kubiszewski et al., 2013; Posner and Costanza, 2011; Van den Bergh, 2011; Martínez-Alier et al., 2010; Van den Bergh, 2017; Schneider et al., 2010; Linlin, 2019; Nogueira, 2019; Pham and Kim, 2019; Alfredsson and Malmaeus, 2019; Heikkurinen et al., 2019). According to the authors, the relationship between the sustainability of innovation (technological breakthrough), long-term economic growth (as economic sustainability) (Pilipavičius, 2017) and environmental (cleaner environment), as well as social sustainability (better social protection) (Tumelero et al., 2019; Hoepner et al., 2016) is a very pressing public problem, which is becoming more and more evident. Social inequality and high levels of exclusion, societal dissatisfaction, the consequences of the global economic crisis, lower economic growth rates due to the application of global precautionary measures to prevent potential crises create preconditions for raising questions in academic, political and social spheres. With the help of the media, among scientists, politicians, economists, the disagreement between continuous economic expansion and opportunities is becoming more acute and relevant (Drews et al, 2018). According to the results of a public survey in 2016, including 1001 respondents and using LCA analysis (latent class analysis), showed that 41.1% interviewees strongly advocated technology deployment and long-term economic growth. Also, 36.3 percent did not have a single assured opinion on economic growth through modern innovation. To sum up, 22.6 percent respondents expressed environmental concerns about increasing technology and uncertain economic growth (Tomaselli et al., 2019). According to a report from the International Organization of Economic Cooperation and Development (OECD), past economic growth has been achieved through the unsustainable use of natural resources, which cannot be allowed now in the 21st century due to rapid technological change and changing world and human perceptions (OECD, 2012). OECD and some scholars believe that the countries of the world should seek sustainable economic growth,

greening and wisdom (OECD, 2020; Alfredsson and Malmaeus, 2019; Heikkurinen et al., 2019). They clearly state that countries must strive for economic sustainability in the context of environmental and social sustainability, based on sustainable green business innovation. Although many authors (Klevas et al., 2007; Hasheminasa et al., 2018; Daunorienė et al., 2015) emphasize the three key dimensions of a country sustainability (economic, social, and environmental sustainability) and their indicators, sustainable growth is difficult to achieve without sustainable innovation that creates high added value (Sinevičienė and Deltuvaitė, 2014). Not only in the future, but already in the design phase, new products and services must be created from durable materials, using renewable natural resources, with the possibility of sorting and recycling. Intensive and comprehensive business-to-country cooperation, by effectively leveraging natural, human and capital resources through high value-added innovation, can contribute to economic growth included cleaner environment and more social protection, finally by ensuring the country's global competitiveness. Thus, the comprehensive development of a country encompasses four main dimensions of sustainability: economic, environmental and social, as well as innovation. These four dimensions are closely interrelated and interact with each other. The following describes each of the dimensions of sustainability in the country, their interrelationships and their relationship to the intensity and risk of corporate innovation investments. For the country innovation sustainability, R&D is a crucial milestone, the results of which enable prototyping to become new products and services on the market. R&D is particularly important to hold a competitive advantage in the country (Pilinkienė, 2015). Increased investments by corporate in innovation activities and the emergence of new products as a result of these activities, leading to higher consumption, increases the country's gross domestic product, which includes the sum of investments, consumption, public expenditure and the difference between exports and imports. Moreover businesses themselves must look towards a sustainable future when developing sustainable products for consumers (Maletic et al., 2016). In this way, gross domestic product (GDP) can show the economic development of a country. Innovative business activities and the results of a wealth of research, experimentation, risk management, prototyping and, ultimately, the market integration of new products and services create new jobs. It also leads to the growth of business, the use of more sustainable and higher quality materials, the growth of production, marketing and the service sector. Such results can contribute to the improvement of the regions and the long-term growing of country's economy (Wu, 2019; Maletic et al., 2016; Law and Gunasekaran, 2012).

Collaboration between the private and public sectors is an inevitable process of creating a sustainable future (Hermans et al., 2019; Petružis and Tamošiūnas, 2019; Žemaitis, 2014), because corporate's "innovation is the key driving factor for economic development and social progress" (Wu et al., 2019). Economic sustainability development is a growing and pressing issue in the scientific literature. Some scholars define the concept of economic sustainability as long-term sustainable economic growth (Hribar et al., 2015; Drews et al., 2018), which can be measured using the variation of the a measure of the economy - Gross Domestic Product (GDP) over a period of time. However, some authors (Zhu et al., 2015; Giampietro, 2019)

tend to expand the concept of economic sustainability, adding that long-term sustainable economic growth can only be achieved through the use of modern technology and advanced infrastructure, more efficient use of land resources, and energy resources. Similarly, economic sustainability as a long-term sustainable economic growth according to the use of new technology, smart infrastructure and renewable energy sources is integral to the development of business innovation, including research and development (Alfredsson and Malmaeus, 2019). Private-public partnerships (*see figure 11*) are vital for innovation development in the country.

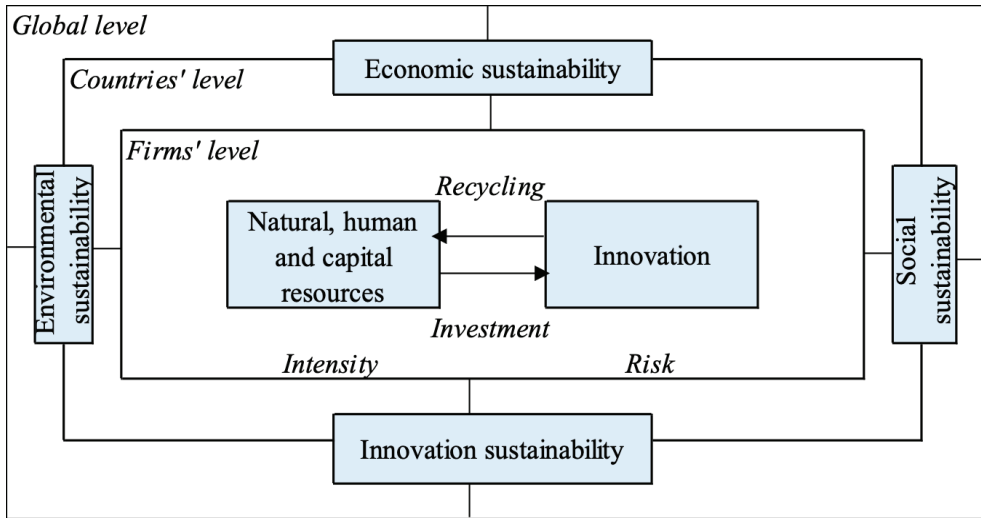


Figure 11. Linkage between corporate innovation investments intensity and risk and country sustainability (according to OECD, 2020; Alfredsson ir Malmaeus, 2019; Heikkurinen et al., 2019)

Sustainable and balanced economic growth of the country would increase the revenue of the country's budget. Higher net profits earned by companies, combined with the creation, market integration and sale of new products or services, would generate higher taxable profits, which would increase the tax revenue, which is especially relevant item of government's revenue. Making new jobs in businesses to develop innovation, research and experimentation, prototyping, and generating higher country budget revenue through Personal Income Tax (PIT), which is also one of the key items in generating country budget revenue. At the same time, new jobs would reduce unemployment, as companies need a full process of innovation from top management, scientists, researchers, engineers, designers, manufacturing, and sales to service staff. Zhu et al. (2020) demonstrated in their study that innovation has a significant impact on employment by reducing it. Increased supply of new jobs would also be a mean of motivating people returning to work abroad. Among other things, newly integrated innovative products and services that reach the consumers would also increase government revenue through value added tax (VAT), the largest revenue's source for country budget. Higher country budget revenues would unequivocally increase allocations for various areas (general government services, public safety, defense, economics, environment, communal services, health,

education, social security), while improving the quality of these activities through the implementation of innovative and modern processes and applications. At the same time, this will create a more business-friendly environment that encourages innovation, research, experimentation, fear of potential risks and innovation.

Analyzing different scientific articles suggests that economic sustainability is nevertheless closely linked to stable long-term economic growth, which can be strongly influenced by companies investing in more environmentally friendly innovations and shifting business towards socially responsible activities (Ruiz, 2018). Among other things, the authors emphasize that in the world, economic growth, which is usually evaluated by one of the most popular indicator - Gross Domestic Product (GDP) - remains one of the main goals of governments. The decline in GDP in the country shows that investments in R&D, cleaner technology, renewable energy is either under-implemented or under-implemented. Even in the short term or in times of economic crisis, a decline in GDP may mean that manufacturing companies use cheaper, dirty production methods, which can be very costly in the future to preserve the environment (Van den Bergh, 2011). In this way, looking at the GDP indicator and its components, it can be seen that the country has low level of overall sustainability.

Examining the concept, characteristics and interrelationships of a country sustainability, it can be concluded that a country economic growth is based on sustainable, high-value-added business innovation using renewable energy sources for public welfare and social responsibility (Yuen et al., 2019). To sum up, the country sustainability is closely linked to growing economy, sustainable innovation, cleaner environment and better social protection. Environmental and social sustainability can be defined as not increasing environmental pollution and increasing social welfare in order to achieve economic growth through innovation. Enterprise-driven innovation, which results in innovation through products and services, requires human, capital and energy resources. Efficient use of resources without polluting the environment and conducting business can contribute not only to economic sustainability but also to the competitiveness and progress of the country in the global sphere. In order to evaluate and interpret this, it is recommended to use a complex methodology that includes different indicators.

Findings and insights

R&D is an especially significant tool of all innovative activity, and its effective results enable the development of new products and services. This process is long and complex, requiring significant upfront financial and human resources. Highly qualified employees must work. They need the infrastructure to develop and experiment and a favorable environment for innovation. This also requires a favorable legal environment for the smooth registration of new patents, a large market with a sufficient number of interested buyers. High levels of uncertainty and unpredictability in research, experimentation, commercialization activities pose significant risks, and the additional methods used to manage them also cost the company. The concept of innovation covers the complete innovation or improvement of products, processes, marketing, organization and management. Creating and marketing innovation is vital

for businesses, as it helps them stay competitive in a constantly changing environment. In all innovation activities, but particularly in the initial periods of R&D, the company needs the financial resources of its own or to lend. Funding for innovation includes creation, retention, purchase of materials for experimentation and prototyping, and market research for the necessary staff. A company may not borrow money from a variety of external sources (banks, credit unions, parent companies) or capital market; however, this creates additional risks for risky innovation activities. Therefore, pre-analysis and forecasting of a financial ratios could be one of the factors that can contribute to a more successful research and experimental results and innovation investments performance. The competence, motivation of employees and board in corporate are particularly important when embarking on research and development. Their qualitative and quantitative characteristics, such as their personal qualities, ambitions, gender, age, experience, remuneration, including bonuses and bonuses, board composition and term of office, may influence research and development, the financial position of the company and any innovation. The ability of board to analyze and effectively address risk factors can be a key to the success of an innovation activity. Therefore, corporate governance can also be one of the factors that can contribute to more successful innovation investments results. The country sustainability could be integrated to the sustainable economic growing in long term in country, based on sustainable, high value-added innovation by companies that use renewable energy sources in their design for the benefit of society. As a result, the country sustainability is closely linked not only to economic growth, innovation but also to environmental and social sustainability (can be defined as not increasing environmental pollution and increasing social welfare in order to achieve economic growth through innovation). Innovative performance can contribute not only to economic sustainability but also to the competitiveness and progress of a country in a global context. To evaluate and interpret this, it is recommended to use a complex methodology that includes different indicators. More corporate innovation investments can have a relevant effect on the growth of a country economic. To further harmonize such phenomena and enable the country to achieve higher levels of sustainability growth and innovation, there should be business-driven investments in innovation through capital and energy resources, intensive R&D, and ultimately the growth of new or improved products, services, marketing and organizational innovation.

2. THEORETICAL BACKGROUND FOR CORPORATE INNOVATION INVESTMENTS INTENSITY/RISK AND COUNTRY SUSTAINABILITY EVALUATION

Corporate innovation investments intensity and risk, valuation methodologies are analyzed in this chapter. The main factors that can influence the corporate innovation investments intensity and risk are analyzed together. On purpose to empirically assess the impact of the analyzed variables on the corporate innovation investments intensity and risk, the risk factor assessment methodologies are analyzed below. The main dimensions of sustainability (innovation, economic, environmental and social sustainability) and methodologies for their evaluation are discussed in this chapter. The conclusions are presented at the end of the chapter.

2.1. Theoretical modelling for assessment methodologies of corporate innovation investments intensity and risk

Investing in product, service, marketing and / or organizational innovation using human, capital and energy resources is the goal of every company to stay competitive in the market. This also applies to countries. There is a lot of research in the scientific literature on innovation, its types, characteristics and impact on different aspects that have been changing over the years as new scientists evolve, expanded based on the experience of other companies and countries, but one crucial factor remains (Viederyte, 2016). Investments in innovation is essential for a company to grow and be able to compete in the national and international market, and for the country's economy to grow steadily, develop and make comprehensive progress in both economic, environmental and social terms (Proksch et al., 2019). Innovation must be applied not only in companies but also in the public sector; moreover, it must be sustainable, value-added and socially responsible (Gasparin et al., 2020). Likewise, not only workers, but society as a whole must be willing and ready to change, embrace innovation and contribute to their development not only through consumption but also through creativity.

Each country has its own innovation system, which can be called the National Innovation System (NIS), based on the different historical, cultural, social and economic experiences (Liu, 2018). According to Liu (2018), the NIS can be described as a set of institutions and companies that work together for the common goal of creating a cohesive innovation environment in the country, developing new technologies and communicating their benefits and added value to the public (*see figure 12*). Datta et al. (2019) also emphasize that the NIS can be described as a combination of companies, heads of country and scientists who, with a certain innovation capacity, power and willingness, create an innovation and innovation-friendly environment. Thus, the public and private sectors, their partnerships and their common goal in the national innovation system are one of the key success factors for increasing a country's level of innovation, as it will determine whether innovation will be initiated, created, imported, modified and disseminated. Acs et al. (2016) note that the level of innovativeness of a country can show how harmoniously and institutions, businesses and scientists, work to achieve a technological, economic, social and

environmental breakthrough in a country. International Organization of Economic Cooperation and Development (OECD) also emphasized that the efficiency of the National Innovation System (NIS) is determined by the interaction, intensity and efficiency of the key players in the system, innovating and disseminating their benefits and inevitability to remain competitive in the market (Liu, 2018).

Thus, businesses, government and researchers are the cornerstones of the National Innovation System, which design and develop it, which determine the overall level of innovation in a country (*see figure 12*). Their main functions can be identified, which need to be monitored, analyzed and enhanced to expand the level of innovation in the country (Liu, 2018). The key role of researchers in the National Innovation System is to conduct research, educate and train students, and generate new ideas and knowledge. Scientists conduct research, generate new ideas, as well as, knowledge to create new products, services, patent them and commercialize them. Through education and training, researchers can not only train potential employees for the right competences, but also provide new knowledge to those already in the labor market but with little or no skills to contribute to innovation and development.

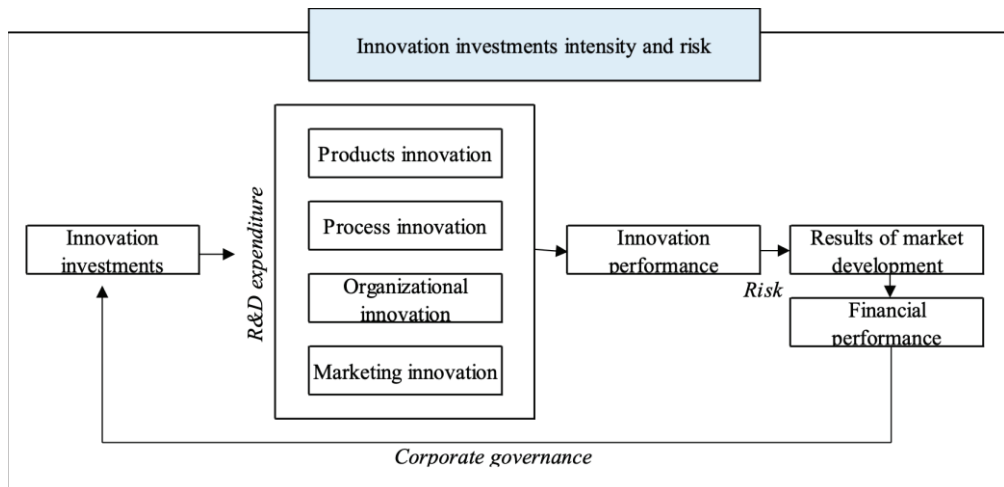


Figure 12. Scheme of operation of the National Innovation System (according to Datta et al., 2019; Liu, 2018)

The central role of the Government in the National Innovation System is to appropriately allocate the available financial resources, highlighting priority areas in the development of the country innovation, especially to finance research, to create innovation infrastructure favorable to companies, researchers, to prepare science and technology policy to improve the strategy for higher education. In this way, the government, when it works properly, can create an incentive for researchers and businesses to successfully innovate. The role of businesses in the National Innovation System is to implement ideas generated by scientists, to contribute to the creation of new knowledge by investing in R&D themselves, to improve products and processes so that they bring greater added value to the society through consumption, to encourage employees through training and development. The national innovation system can be divided into regional and sectoral sub-systems. A regional innovation

system is characterized by the fact that local businesses, government and researchers can contribute directly to the national level of innovation by effectively developing new products, services, marketing and / or organizational innovations, developing an innovation-friendly environment in their region. Meanwhile, a sector-based innovation system is being created in the country, where significant state efforts are made to encourage companies to develop and implement innovations according to their priority economic activities, channeling the necessary highly qualified scientists and other specialists, as well as financial and energy resources. Some researchers (Acs et al., 2016) point out that the harmonization and effectiveness of regional and sectoral innovation systems in each country should be a priority issue at the policy level.

However, the national innovation system can have a strong impact on the economic evaluation of the country (Bartels et al., 2012), because it is the interaction between companies, the country and scientists, innovative solutions and results that can create an environment conducive to innovation and development. As well as, international innovators contribute to raising the level of innovation across the country. Economic growth based on innovation and development creates the conditions for higher consumption, which directly contributes to higher production volumes of enterprises. Likewise, opportunities for countries to encourage companies to innovate and create a more innovation-friendly environment are always in periods of greater economic upturn rather than stagnation or decline. Samara et al. (2012) suggest that the National Innovation System can be an effective tool for measuring and predicting competitive advantage in a country. Changes in institutions and businesses are inevitable for innovation and a supportive environment for innovation. Moreover, not only national innovation actors can influence the level of innovation of a country, but also the level of innovation of a country can contribute to the development of innovation activity of enterprises.

Businesses are not isolated from the National Innovation System, since they are within the system. Business activity has a hugely effect on the results of the National Innovation System (Flammer, 2013), and innovation is considered not only as one of the key success variable for increasing the country's level of innovation, but also as a basis for maintaining the competitiveness of companies and developing their activities. There is research in the scientific literature which shows that there is a strong direct link between innovation and national innovation and the performance of a company (*see figure 13*). Newer research may also find a new approach between corporate human resources and innovation as research exploring the correlation between human resources and innovation, using different input and output results, is emerging. Human resources, which include internal and external (consultants, advisory bodies, external experts) company team members who work for a common purpose, are considered as one of the main innovation hubs capable of implementing ideas. Ye et al. (2019) argues that business environments are increasingly dynamic, competitive, but at the same time challenging due to accelerating technology and accelerating processes, making it more important than ever for companies to strive to maintain creative teams that generate new ideas and knowledge that can be transformed into new products and services. In modern business enterprises, human capital is a very important element of innovation in order to achieve better

performance. If there is a strong correlation between innovation and the country's level of innovation and the performance of corporate, it can be assumed that there is a correlation between innovation and the company's human resources, and there may be a link between human resources and the country's level of innovation. In this case, the promotion of innovation and human resources in corporate activities should be one of the priority areas of the country (Ye et al., 2019) due to increase the not only country's innovation but also international competitiveness.

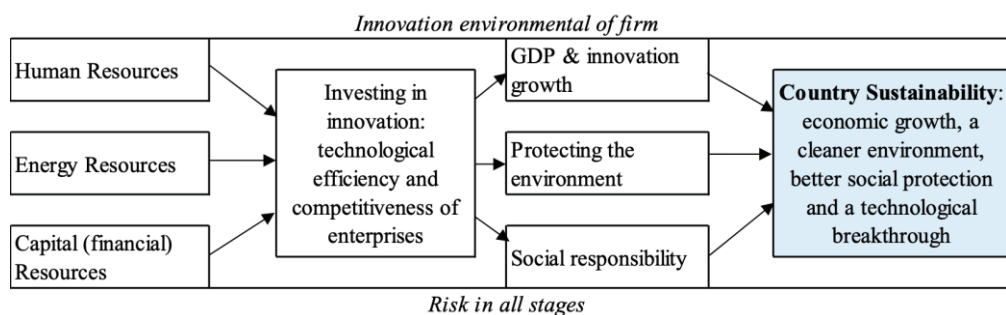


Figure 13. Risk factors of corporate innovation investments intensity and risk, and country sustainability (according to Mavi et al., 2019)

Cirera and Maloney (2017); Fernández-Sastre and Montalvo-Quizhpi (2019) emphasize that companies themselves must invest more in R&D in order to stimulate their innovation performance (*see table 2*). According to them, in order to contribute to the stimulation of the innovation activity of enterprises, the country must develop an effective innovation policy, which could directly or indirectly contribute to the financing of innovation.

Table 2. Evaluation methodologies of corporate innovation investments intensity and risk (according to Fernández-Sastre and Montalvo-Quizhpi, 2019; Cirera and Maloney, 2017)

Name	Description
R&D expenditure	R&D spending shows how intensively companies invest in innovation
Assets	Changes in company assets entail some risk if assets begin to decline. Investment in research and development (expenditure) must create new patents (new assets), however, unprofitable investments can rapidly reduce this assets (Cirera and Maloney, 2017).
R&D expenditure / assets	For corporate innovation investments intensity and risk evaluation - the ratio between R&D expenditures and Assets shows

The country should also seek to facilitate innovation through infrastructure, taxation and legal issues (Monux and Ospina, 2017). Regardless of the country's National Innovation System (NIS) and its characteristics, the intensity of business

innovation investments in each country can be determined by R&D spending. The more company invests in R&D, the greater intensity of innovation investments by such corporate and the country is. However, there is a rising risk of more funding for R&D. As risks increase, the company risks all of its assets. Therefore, R&D expenditure and assets can be key factors in determining the innovation investments intensity and risk of corporate (*see Table 2*). According to Fernandez-Sastre and Montalvo-Quizhpi (2019) and Cirera and Maloney (2017), the R&D expenditure-to-asset ratio can be one of the main methods of assessing the innovation investments intensity and risk in companies.vv

Corporate innovation investments intensity and risk and its assessment methodologies in context of countries sustainability could be the most important output ratio as independent variable.

2.2 Financial ratios assessment methodologies

Financial resources for innovation activities are also very important, along with human resources for R&D, and for the whole process of innovation activity in the company (Benetyte et al., 2019; Benelienė, 2019). The quality of the R&D results, which directly determines the final market output of an innovation activity, may depend on how much assets the company has. The structure of an enterprise's assets, how much current assets and non-current assets the company has, can also influence the performance of its innovation activities. Higher accumulated cash invested in the development of innovative activities in a company can give the company a significant advantage over its competitors in the long run. Asset coverage sources can also make a difference. Equity-financed company assets make the company more reliable for investors and creditors (Choi et al., 2012; Chi et al., 2019). In such case, the company becomes less risky and more likely to obtain a long-term loan at a competitive interest rate in order to carry out an investments project related to the development of innovative activities in the company and to borrow from credit institutions to cover the required amount of investments.

Financial ratios show the financial position of a company and its financial capacity to innovate (Pradhan et al., 2018). As well, financial reporting (FR) policies can also affect the results of innovation investments and the effectiveness of corporate governance (Laux and Ray, 2020). Financial ratios include profitability, leverage, liquidity, asset efficiency and market value. Profitability ratios that indicate how profitable or unprofitable a company works to start a risk analysis (Huang and Hou, 2019). The lower the gross, operating, and net profit margins compared to the industry in which the company operates, the stronger the signal that the company is visibly less competitive than other companies in the same business. This can be a strong signal that a company needs to innovate, improve existing activities or develop new ones. Conversely, if the company's profitability ratios are competitive in the business sector, this indicates efficient operations and, moreover, a greater capacity to develop innovative activities in the long-term period. Leverage and liquidity ratios are also important indicators of a company's financial strength. High levels of leverage, reflecting a high proportion of liabilities compared to assets and equity, may signal the threshold that any more risky business with uncertainty may lead to bankruptcy in

the event of failure. Moreover, high levels of indebtedness make it very difficult to obtain external financing for the improvement of existing activities or the development of new activities, especially for green investments (D’Orazio and Valente, 2019) due the high risk. Meanwhile, a low level of commitment, reflecting a lower level of risk in the company's operations, opens up opportunities for additional borrowing and innovation activities that will generate new profits, if it is successful. Low liquidity ratios, reflecting the low level of current assets compared to current liabilities, may prevent the launch of new innovative activities altogether. Equally important are asset efficiency indicators, which can highlight specific areas of the enterprise that need to be addressed through innovation. The long turnaround time of inventory and trade debtors and the shortage of trade debtors to suppliers can signal the need for innovation in the management of trade debt and stock management. Meanwhile, longer settlement with suppliers, compared to the period of trade receivables, allows for a certain period of free cash flow, which, when invested, could contribute to the development of innovative activities in the company. Market value indicators are crucial in attracting new potential investors who can finance the realization of new ideas and turn them into innovation. The higher the Net Earnings per Share and the Dividend, the more valuable the Equity seems to the investor. Conversely, if the market price of a share is high while the dividend yield is low, it is difficult to attract new potential investors who believe in the long-term success of the company. Again, the intensity of dividend payouts can influence corporate innovation investments (Lahiri and Chakraborty, 2014). If big dividends are paid, companies have nothing left to invest. According to Rajapathirana (2018), innovation performance as an improved product and service, as well as process and organizational or marketing innovation developed from the R&D capacity of the enterprise can clearly improve financial performance if the innovation has been commercialized in the market and added more value to the consumer than before (*see figure 14*). Improved financial performance through innovation activities enables a company with more financial resources to increase its innovation capacity and further develop its innovation activities. Corporate size, age and economic activity are also attributed to financial performance characteristics that may not only determine innovation capacity, but would also influence innovation performance. In addition, a socially responsible company may have fewer problems with financial performance, especially credit (Stellner et al., 2015). Large, long-established companies with market shares not only in the national but also in the international market in manufacturing, retail and wholesale, construction, information technology, financial technology development, usually have established R&D departments professional top managers and experts in their field – technicians (Han, 2019). Such companies are constantly innovating continuously in order to remain dominant in the market and are constantly providing their customers with improved versions of their products. They are the leading companies in terms of investments in R&D and high financial performance. At the European level, the following companies can be named (Tou et al., 2019): Volkswagen Aktiengesellschaft (Germany, automotive), Roche Holding AG (Switzerland, pharmaceutical, biotechnology), Novartis AG (Switzerland, pharmaceutical), Daimler (Germany, automotive) industry), Sanofi (France,

Pharmaceuticals), Siemens Aktiengesellschaft (Germany, Technology Solutions for Industry, Energy), GlaxoSmithKline plc (UK, Pharmaceuticals, Biotechnology), Bayerische Motoren Werke (Germany, Automotive), Nokia Corporation (Finland, Information Technology)), Exor NV (Netherlands, Financial Technology). Well-established in the international arena, these companies are in the top ten of Europe in terms of R&D investments.

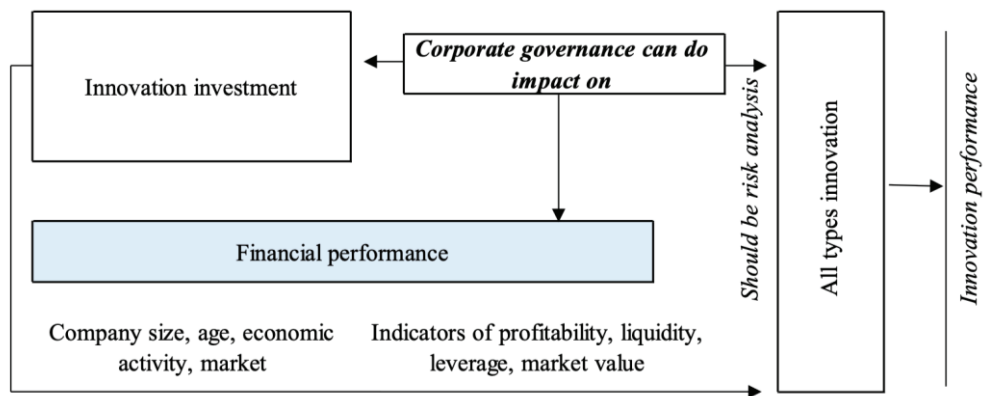


Figure 14. Impact of financial performance on corporate innovation investments (according to Rajapathirana, 2018)

The significance of financial performance in research and development and in the development of new or improved products or processes in companies (*see figure 15*) is highlighted by authors such as Chen (2019), Custodio and Metzger (2014), Lin et al. (2011) and Makri and Scandura (2010). In their view, there are many financial factors that can influence a corporate innovation performance at all stages, from starting a long-term innovation development strategy to conducting research, experimenting and prototyping products or services in the marketplace.

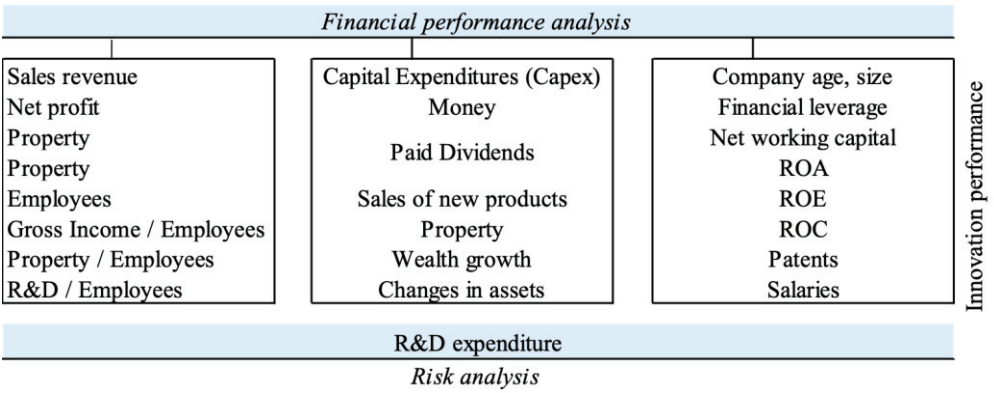


Figure 15. Financial analysis characteristic (according to Makri ir Scandura, 2010; Custodio ir Metzger, 2014; Chen 2019; Lin et al., 2011)

Custodio and Metzger (2014) and Lin et al. (2011) believe that financial resources (Ullah, 2019) and good financial performance of a company are particularly

important at the very beginning when it comes to attracting new investors or additional new borrowed capital for start-ups. Potential investors and credit institutions are not interested in lending to a company with higher leverage and liquidity ratios and lower market values and profitability ratios compared to the financial position of competitors in the same industry. Makri and Scandura (2010) also argue that good financial performance (the most significant variables by Custodio ir Metzger (2014), Chen (2019), Lin et al. (2011) could be size, return on assets, cash ratio, Tobinq ratio, cash ratio (*see figure 16*) indicates a more favorable position for a company to launch R&D, which results in new prototypes. Therefore, these variables could be essential risk factors on corporate innovation investments intensity and risk. The Tobin q indicator is particularly important in assessing the intensity and risk of firms' innovation investments, as it reflects the essential point of one of the theories that a firm can increase innovation investments when the market value of assets exceeds the book value of assets. An enterprise that has accumulated retained earnings after paying out dividends to its shareholders and has sufficient cash and cash equivalents can more easily plan and innovate by hiring highly qualified employees, creating a work environment and infrastructure that is conducive to their purchase, and the necessary means for carrying out the experiments. However, Chen (2019) emphasizes the importance of a corporate good financial performance at the start-up of an innovative activity, as well as their importance in the process of transforming a prototype into a product or service and in their market launch. This period of time to create and market a real new product or service requires high direct and indirect costs, which include the cost of materials, salaries paid to manufacturing and service personnel to maintain the product or service, advertising and distribution costs. (2019). A company that is financially capable of research and experimentation but is financially incapable of fully developing new or improved products and services may face financial problems because no new revenue will be generated unless the company commercializes the results of research and development. However such a move by a corporate to sell significant R&D results to another corporate without completing the innovation process itself may subsequently lead to more serious competitiveness problems if a competitor in the same field commercializes the purchased idea. On the contrary, when research and development activities are carried out only by corporate or research centers engaged in this field, they are specialists in the field of product development for other businesses. This way new knowledge created by one and passed on to others can be successfully transformed into prototypes and then into products and services.

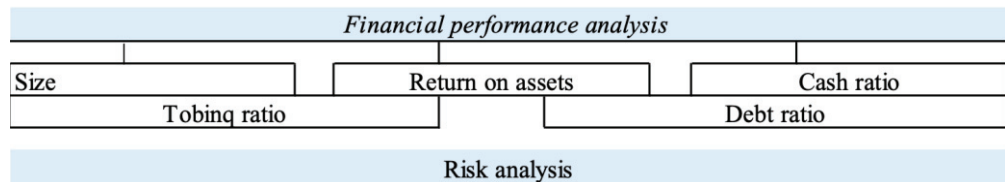


Figure 16. Key financial indicators as risk factors of innovation investments intensity and risk (according to Custodio ir Metzger, 2014; Chen 2019; Lin et al. 2011)

In summary, a company's financial performance, as measured by a variety of financial ratios such as profitability, liquidity, asset efficiency (turnaround), leverage, market value, or individual items such as capital expenditure, cash, company age, size, patents, can perform an important part in all stages of innovation. The company can see the importance of financial performance when launching an innovation implementation plan for the long term, attracting new investors, seeking long-term credit from financial institutions for an investments-related innovation project, or taking first steps in innovation and facing risks costs. Among other things, the company also costs the maintenance of top management, scientists, researchers, designers, engineers, managers and service personnel and their jobs and infrastructure, materials, reagents, market research and promotions to launch new products. Good financial performance can be an additional incentive for a company to innovate or, on the contrary, hesitate to take any action towards innovation.

2.3. Corporate governance assessment methodologies

Corporate governance, characterized by clarity, robustness and efficiency, can have a significant meaning on investments in innovation investment (Liu et al., 2020). The corporate governance framework includes pre-defined requirements that clarify the responsibilities, rights and expectations of the board members and shareholders of the company (*see figure 17*) (Bebchuk et al., 2009). Board members may not infringe on each other's rights and obligations and may not seek sole benefit for themselves.

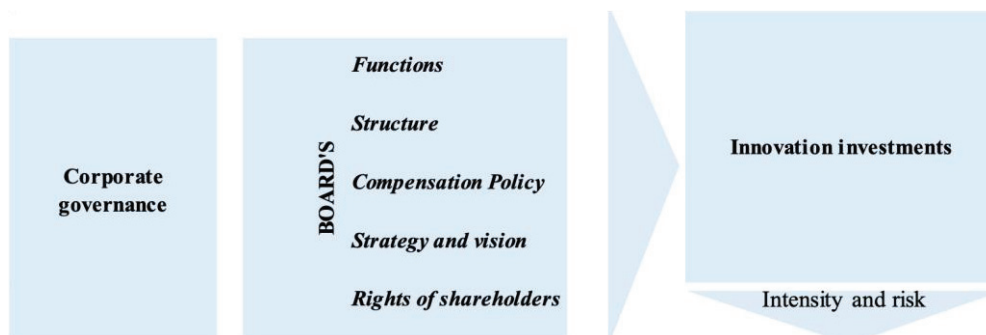


Figure 17. Corporate Governance and Corporate Investments in Innovation (according to Bernile et al., 2018; Choi et al., 2012; O'Connor and Rafferty, 2012; Bolton and Zhao, 2018)

Each member of the board must be a leader that encourages the company to grow, change, adapt to market innovation. As a leader, board members can provide a significant help to growing the intensity of innovation investment (Chen et al., 2019; Sheikh, 2018). Board members are not the same as the CEO, but the CEO can be a board member. Board members aim at the company's development. CEOs (Lee et al., 2020) together with corporate analysts (Guo et al., 2019) especially can stimulate the process of innovation. However, the CEO may ignore the board's ambitions, fearing to take on additional risks of innovation failure (Cho and Kim, 2017; Sariol and Abebe, 2017). The survey results (1036 correspondents - CEOs) reflected assuming that connection is between CEO traits and propensities influenced by the board and innovation development (Zhang et al., 2017). Thus, ambitious, empowered,

determined and fearless CEOs can develop the innovation and fulfil the goal of board members to keep the company competitive in the global marketplace. The corporate governance framework is multifaceted, formed throughout the year in order to get the results - the highest value of the company in the long run, taking into account all possible effective circumstances of the company's management application (Bernile et al., 2018). The following table (*see table 3*) was compiled to allow the exhaustive analysis of corporate governance framework measurement methodology. The corporate governance methodology is based on 5 variables.

Table 3. Evaluation methods of 5 dimensions of corporate governance (according to Lu ir Wang, 2018; Becker-Blease, 2011; Balsmeier et al., 2017; Aghion et al., 2013)

Measurement methodology of corporate governance	
Variables of Board's:	Evaluation's description
Functions	The clarity, validity and consistency of the company's management functions must be specifically defined and recorded in order to avoid unnecessary ambiguities.
Structure	The company's management structure must be efficient, logical, able to jointly generate new ideas and implement those ideas by consensus on the company's growth.
Compensation Policy	The company's management compensation policy must be consistent and not contradict between the management's ambitions and the company's growth aspirations.
Strategy and Vision	The strategy and vision of the company's management must be based on innovations that create high added value, which would not contradict the general goal of the scountry - environmental protection and social responsibility.
Rights of Shareholders	Company shareholders should be given equal rights based on the desire to increase the value of their invested assets.

Balsmeier et al's (2017) measurement variables methodology of corporate governance is described in more detail below. The corporate governance framework is characterized by five important criteria (board's: functions, compensation policy, structure, vision and strategy and rights of shareholders), which are evaluated individually, summarizing how effective the corporate governance system is and how much it needs to be further improved in order to achieve better corporate governance results. Clearly described functions for each managerial position, detailing what goals are set and how they are measured, contribute to a more effective corporate governance framework. A logically based structure defined by specific instructions, on the basis of which the company's management is made as transparent and efficient as possible, also has a significant positive impact on the company's management system. Legally, transparently and clearly defined executive compensation policies, including the calculation of salaries, bonuses and bonuses, can contribute to more

effective management practices. Meanwhile, the company's strategy and vision play a particularly significant role, which should be geared towards more sustainable innovation, a cleaner environment and greater social protection in order to shape good governance practices. Finally, shareholders' rights should be the same for all shareholders. The aim should be to increase the assets invested by all shareholders at the same rate, without granting illegal benefits to some shareholders.

In summary, the corporate governance system (practice) can be a very important factor in determining the intensity and risk of corporate investment in innovation. A more efficient corporate governance system can contribute to the intensity and improvement of a company's activities through innovation. Meanwhile, only a theoretically, but not practically implemented company management system can create only additional risks in the company's activities without results.

2.4. Dimensions of country sustainability and their assessment methodologies

First of all, for the development of country sustainability human, capital and natural resources are among the most important factors. Human capital, which encompasses all workers in the labor market, can make a significant contribution to the process of achieving sustainability. Educated, motivated, possessing and seeking to improve their knowledge and skills is a very expensive economic asset. Employee skills and knowledge can depend on productivity and creativity, as well attitude of the employee towards the company's policies and market competitiveness. The greater number of companies operating domestically, investing in international markets, investing in sustainable innovation and upgrading the skills of their workforce, the easier it is to achieve an overall level of sustainability (Gonzalez et al., 2020). Capital and its resources, or assets in addition to human, are also crucial to sustainability. First, any activity in the country requires capital to develop. Second, resources are also needed to invest in innovative activities that will ensure market competitiveness and enable the growth of the company. Thirdly, both capital and non-capital (workers) should be active and bring economic prosperity.

Secondly, the national innovation system also has an impact on the country sustainability development. The authors (Bartels et al., 2012; Samara et al., 2012) highlight the National Innovation System as relevant aspects in the process of improving economic, environmental and social growth, which includes the interaction of scientists and companies. A national innovation system in which each country can enhance sustainability requires the evaluation of all influencing indicators. A sophisticated analysis of indicators, the identification of interrelationships can show not only the level of innovation in a country, but also a possible direction in which a country should turn in order to achieve higher sustainability. Increasing levels of innovation and intensifying use of advanced technologies are aspirations of each country for sustainability growth. The country's innovativeness encompasses many aspects, from research, experimental development, patenting inventions, bringing new products, services to the market and exporting, to creating new businesses and jobs, creating an investments-friendly environment and economic growth. Still not all countries are able to develop innovation as fast as they would like. Eastern European countries such as Bulgaria and Romania are in the lowest position in terms of the level

of innovation (European Commission, 2019), while the Scandinavian countries Sweden, Finland, Denmark and the Netherlands are in the lead. The problem of innovativeness in the scientific literature is very topical and debated. A country develops a seamless process of innovation development, when it seeks to create an effective innovation policy through the financing of innovation activities (from credit institutions, especially from capital markets (Shen et al., 2020)), infrastructure development, public procurement, as well when scientists generate ideas and carry out research to improve innovation activities, and companies implement those ideas. Without at least one function, the process cannot run smoothly. In developing, weaker economies, this is clearly evident. In these countries, the process of innovation is not as smooth as in developed and stronger economies. Lack of knowledge and skills, slow uptake of modern technology (Rutkauskas et al., 2014), ambiguous approach to innovation, corruption, historical experience, culture and low financial capacity may all be factors that hinder innovation performance in the country. All this together hampers the country sustainability growth (*see figure 18*). Third, countries with lower companies innovation capacity cannot direct large flows of investments into research and development that enable prerequisites for innovation to emerge. In order to balance this phenomenon and enable the country to achieve innovation-based economic growth together with protection of environment and social responsibility, researchers (Flammer, 2013; Ye et al., 2019) highlight the significance of companies in the development of innovative activities in the country. Low investment flows are hampering greater sustainability in the country. Then companies are not capable of developing product, service, marketing and organizational innovation through human, capital and energy resources through research and experimental testing.

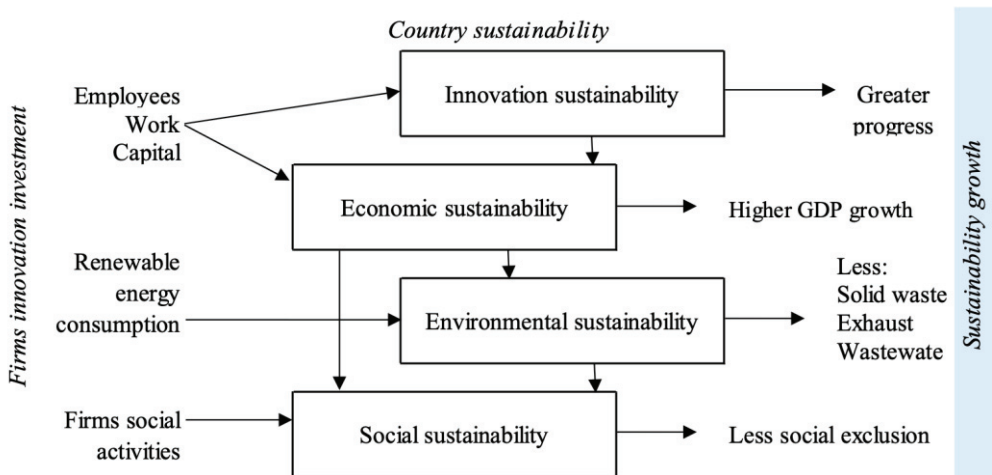


Figure 18. Country sustainability and relationship between its dimensions and corporate investments intensity and risk (according to Linlin et al., 2019)

Innovation development, economic growth, environment protection and social responsibility are very closely linked dimensions of country sustainability. Country sustainability will not be possible to increase without economic growth and it will not be possible to increase economic growth without increasing innovation. Each of these

components (human, capital and natural resources, environment protection, social responsibility, national innovation system, companies innovation capacity) for country sustainability development are critical. Human resources, including board members, managers, engineers, designers, service personnel and other, can join teams to generate new ideas, create new knowledge and transform it into prototypes and ultimately products. Ideas should be realized with capital, financial and natural resources (water, solar energy, air, forests, soil, minerals such as peat, metal ore, oil). With greater human, capital and financial resources, a company can more easily direct the flow of investments towards innovation, thus not only being able to save competitive in the market, but also contributing to the country sustainability growth. However, by directing investment flows towards the development of innovation activities on purpose to save competitive in the market and country sustainability growth, there are certainly risks throughout the entire process. Thus, having concluded that country sustainability encompasses 4 key dimensions (innovation sustainability, economic sustainability, environmental sustainability and social sustainability), it is essential to analyze evaluation methodologies. The following are given below.

Innovation sustainability or national innovation system and its development could be the one key dimension of the overall context in order to achieve country sustainability. Innovation has an essential effect on the sustainability of countries (Kuzma et al., 2020). Sustainable innovation across industries must enable solutions to address major economic, environmental and social challenges such as climate changing, depletion of resource and food insecurity (Wydra, 2020). High added value innovation and its growth in the long-term perspective can have an important effect on the economic, environmental and social sustainability (Posner and Costanza, 2011). It (*see table 4*) shows the results of literature analysis of methodologies for measuring innovation sustainability. One important result of the pursuit of innovation sustainability may be the ratio - R&D expenditure divided to GDP (*see table 4*). Country innovation sustainability based on R&D intensity is very risky. This risk arises from corporate innovation investments intensity. The main risk factors could be as follows: reluctance of employees, non-motivating salary, high cost of innovation, lack of ideas, high turnover of employees, lack of knowledge, fear of not implementing innovation ideas, and uncertain expected results of potential innovations, as well low investments. Also, low market interest in innovation, small market, low public R&D funding, and country innovation investments climate or unfavorable legal environment could be risk factors too. As well in many countries, the main investment goes to the capitals, abandoning other regions (Min et al., 2020). However, a much cleaner environment is observed in these regions (Chen et al., 2020). To analyze the country innovation sustainability, risk analysis, management and forecasting of private and public innovation investments is the most relevant tool. The money spent on innovation can generate even greater cash flows across the country in the future. It can contribute to business growth, economic growth, more sustainable products, services using renewable energy, and more sustainable materials. All of this can pave the way for sustainable growth in the country.

Table 4. Methodologies for measuring innovation sustainability (according to Hao et al., 2018; Long ir Ji, 2019; Posner ir Costanza, 2011; Heikkurin et al., 2019; Salman 2019; Sekulovic et al., 2018; SII 2019)

Methods	Description
R&D expenditure divided to GDP	Shows the level of R&D in the country (private and public) relative to gross domestic product
Real Progress Indicator (GPI)	Measures economic growth by including environmental and social factors that are not measured by GDP. The indicator is used to assess economic sustainability, environmental protection and social factors.
Number of scientific works per 1 million population	To estimate how many new inventions a country has for a given population compared to other countries
Economic added value of innovative enterprises as a percentage of GDP	To estimate how much more innovative companies create economic added value compared to non-innovative ones
Export and import of innovative companies	To measure how much more innovative corporate export and import compared to non-innovative corporate
Country and business R&D expenditure	Public ir private investments in research and development
Human Development Index (HDI)	To estimate the average life expectancy, standard of living, education and literacy of the country's population. Reflects the socio-economic situation of the population.
Aggregate Innovation Index	Indicator of the country's level of innovation

Economic sustainability is the key dimension in the overall context of achieving country sustainability. Economic growing in the long-term perspective can have an important effect on environmental and social sustainability, as well innovation development (Linlin et al., 2019; Posner and Costanza, 2011; Chelan et al., 2018). It (*see table 5*) presents the results of literature analysis of methodologies for measuring economic sustainability. One result of the pursuit of economic sustainability may be the sustained by ratio of growth of Gross Domestic Product (GDP), which reflects economic growth over time and, at the same time, synergies between efficient use of labor, capital and energy (Linlin et al., 2019). Economic growth in terms of GDP is measured by all the EU Member countries (28 EU Members), which are compared annually. A growing economy can be one of the factors for increasing public budgets. Measuring and interpreting the ratio of Gross Domestic Product (GDP) indicator and its components can measure the level and prospects of economic sustainability in countries (Posner and Costanza, 2011). Also, the researchers highlight other important indicators: True Progress, Sustainable Economic Well-Being, Economic Sustainability, Global Competitiveness, which could be measured and interpreted

alongside GDP, measuring a country economic sustainability and comparing countries. Integrated measurement and evaluation of indicators could show the true progress of a country in terms of economic sustainability. Drews et al (2018) identifies Real Progress (GPI) and Sustainable Economic Well-Being (ISEW) as key metrics for measuring economic sustainability, which can measure the impact of economic growth on a country's sustainable well-being, including qualitative and non-market factors on changes in economic activity. In addition to this, the methodology for measuring indicators includes the methodology for measuring social capital, resources, environment, and income distribution.

Table 5. Methodologies for measuring economic sustainability (according to Marques et al., 2018; Menegaki and Tugcu, 2018; Long ir Ji, 2019; Posner ir Costanza, 2011; Heikkurin et al., 2019; Gaigalis and Skema, 2014)

Methods	Description
Annual change in Gross Domestic Product (GDP) or absolute	It shows the economic growing of a country (how GDP in the country changes every year) or country's ending market value of services, as well as goods produced.
Sustainable Economic Well-being Index (ISEW)	A macroeconomic indicator that can complement GDP but at the same time includes expenditure on pollution and other unsustainable costs
Economic Sustainability Index (ESI)	An index developed by the European Commission to measure simultaneously the short-term and long-term economic prospects of all European countries
Global Competitiveness Index (GCI)	An indicator developed by the World Economic Forum, which measures a country's business, economic, social environment and its climate in terms of competitiveness and production
Dow Jones Sustainability Index	A stock index that measures the sustainability performance of thousands of publicly traded companies

It (*see table 6*) presents the methodologies for measuring environmental sustainability, because its dimension could have the important impact on environment protection. It must be argued that links certainly can be among environmental sustainability, economic sustainability, and innovation sustainability, as well as social sustainability. Human and capital resources require natural resources (for example, renewable energy) such as water, solar energy, air, forests, soil, minerals such as peat, metal ore, and oil. The European Commission has developed a separate indicator, the Economic Sustainability Index, to measure the sustainability of national economies, and the World Economic Forum proposes to measure and interpret the Global Competitiveness Index. A complex methodology involving a variety of criteria is needed to assess the country economic sustainability. Environmental sustainability is the third major dimension of the country sustainability. Environmental sustainability is one important subsystem of global development (Staniskis and Staniskiene, 2006).

Regulatory Framework (RF) includes appropriate rules of competitive market can be a key tool to achieve environmental sustainability in country (Streimikiene et al., 2007). The combination of human, capital and natural resources, their preservation and, at the same time, their efficiency, can bring great business results, which in turn will contribute to sustainability across the country. Therefore, Asadi et al. (2020) aim for ‘green’ innovation. Kesidou and Wu (2020) propose even stricter environmental regulations. Various public financial instruments aimed at increasing the use of renewable energy sources and improving the quality of life of different groups in the society. It can ensure balanced growth of economic and the reduction of solid waste, and exhaust gas, as well wastewater.

Table 6. Methodologies for measuring environmental sustainability (according to Banerjee and Gupta, 2017; Long ir Ji, 2019; Posner ir Costanza, 2011; Heikkurin et al., 2019)

Methods	Description
Part of Renewable energy in total energy	Shows how much renewable energy from the sun and wind use in the country relative to the total energy consumed.
Environmental Sustainability Index (ESI)	The Environmental Sustainability Index (ESI) is an indicator of overall progress towards environmental sustainability. The index presents a complex profile of national environmental surveillance based on a set of indicators derived from the underlying datasets.
Long-term environmental damage (CO ₂ , CH ₄)	Pollution of carbon dioxide and methane chemical elements and costs for mitigation.
Depletion of non-renewable energy sources	Extent of use of fossil fuels, coal, oil, gas.
The cost of water pollution	The extent of harmful substances discharged into the water and the cost of decontamination.
Air pollution costs (SO ₂)	Amount of sulfur dioxide (colorless gas with pungent odor) emissions to air and costs for prevention.

According to the authors (Linlin et al., 2019; Posner and Costanza, 2011), social sustainability could be the last key dimension in the overall context of achieving country sustainability. It (*see table 7*) presents the results of literature analysis of methodologies for measuring social sustainability. Social sustainability ant its dimension can have a significant impact on social country’s life (Melnikas, 2019). It should be emphasized that connections between social and other sustainability dimensions such as innovation, economic and environmental are really strong. This explains that increased revenues to the country budget provide opportunities to increase government allocations for social sustainability through socially responsible

action. The involvement of the country, businesses and citizens in the process of achieving sustainability is the most important factor that can enable this (Irandoost, 2018). Therefore real progress in the country can be expected. Business leaders, their employees and citizens need to understand that there is a very close link between economic growth and social responsibility.

Table 7. Methodologies for measuring social sustainability (according to Albert, 2019; Long ir Ji, 2019; Posner ir Costanza, 2011; Heikkurin et al., 2019)

Methods	Description
Social score	Average of all countries companies' social score ratio, which shows social activities by company
Public spending on health and education	A percentage of the total country budget revenue is allocated to health and education.
The cost of car accidents	Costs to eliminate the consequences of car accidents are required.
Travel expenses to and from work	The cost of costs incurred by employees during their return and return to work.
The value of volunteering	Evaluation of volunteering, socially responsible work
Private spending on health and education	Percentage of households allocated to health and education.

The country's sustainability assessment methodologies are different and varied, but their purpose is the same - to assess the country's progress through change in innovation, the economy, the environment and social protection.

Findings and insights

Research and development expenditure can be part of the total innovation investments process, and, therefore, it is also significant for assessing the intensity and risk of innovation investments. The more companies invest in research and development, the greater the intensity of their investments is in innovation. However, at the same time, if the desired results are not achieved, the company assumes greater risk. In this case, the company risks all of its assets. Therefore, the intensity and risk of an enterprise's innovation investments can be described as the ratio of research and development costs to assets. Moreover, by the information (*see table 8*) financial performance and corporate governance can be key risk factors that can have a relevant effect on the intensity and risk of innovation investments. Financial ratios include debt ratio, cash ratio, return on assets, corporate size, and Tobin's q ratio. Management of all ratio shows how a company treats its shareholders, employees, customers, creditors, government and the community.

Country sustainability includes innovation, economic, environmental and social sustainability. There are different definitions of sustainability in scientific articles, but overall, sustainability is still about economic growth, sustainable innovation,

protecting the environment and reducing social exclusion. Therefore, it is possible to divide a country sustainability into four main dimensions of sustainability: innovation, economic, environmental and social, where each has its own proposed assessment methods.

Table 8. Key variables for innovation investments (according to Huang and Hou, 2019; Lahiri and Chakraborty, 2014; Rajapathirana, 2018; Stellner et al., 2015; Chen, 2019; Custodio and Metzger, 2014; Lin et al., 2011; Makri and Scandura, 2010).

Significant variables	Reason of significant impact on corporate innovation investments intensity and risk
Corporate governance	Board members (of which various company directors) can make important effect on the whole value chain of innovation investments
Corporate size	Significant impact on the volume of innovation investments
Debt ratio	Important influence on external sources of financing for investments
Return on assets	Significant effect on corporate development and market prestige
Cash ratio	Significant impact on internal sources of financing for investments
Tobin's q ratio	Important influence on corporate value. Corporate could increase the intensity of innovation investments, if asset's market value is bigger than asset's book value.

An evaluation methodology is provided for each sustainability dimension (*see table 9*). Innovation sustainability or technological progress in the country in the long term, can be evaluated as the intersection of R&D expenditure and gross domestic product. Economic sustainability or long-term economic growth, can be measured as the annual change in gross domestic product and unemployment rate. Environmental sustainability or long-term preservation of the country's environment, can be measured as the share of renewable energy in the country's total energy consumption, amount of carbon dioxide and clean energy. Social sustainability or reduction of a country's social exclusion in the long term, can be measured as an average of the corporate social indicator and social protection. According to the authors, methodologies for assessing a country's sustainability are different, especially when the dimensions of a country's sustainability are assessed separately, such as only economic sustainability or only environmental sustainability. However, when the three dimensions of sustainability are considered together with the sustainability of innovation, the assessment of country's sustainable growth based on economic growth, environmental cleanliness and social responsibility must be particularly complex.

Table 9. Country sustainability dimensions based on scientific literature analysis (according to Hao et al., 2018; Marques et al., 2018; Banerjee and Gupta, 2017; Albert, 2019)

Key dimensions	Reason of significant impact on country sustainability
Innovation sustainability	Sustainable high value-added innovations
Economic sustainability	Economic growth in the long term without major shocks
Environmental sustainability	Clean environment and clean energy
Social sustainability	Social responsibility and protection

After assessing the risk factors and analyzing the valuation methodologies, the third chapter will develop an evaluation methodology for assessing the corporate innovation investments intensity and risk (*see figure 19*).

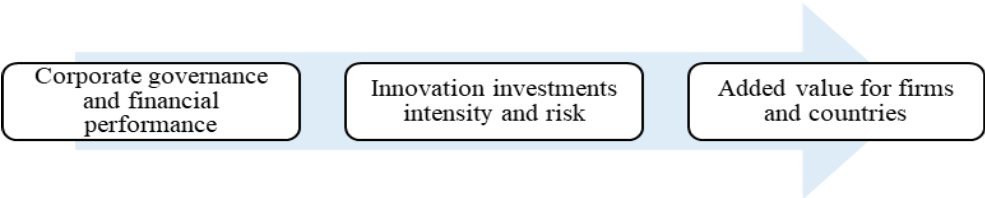


Figure 19. The relationship between corporate governance, financial performance, innovation investments intensity/risk and added value for corporate and countries

Finally, exploring the significance of innovation investments, key factors and valuation methodologies of corporate innovation investments intensity and risk across different sustainability groups in countries will be developed a research model.

3. DEVELOPMENT OF EVALUATION METHODOLOGY OF CORPORATE INNOVATION INVESTMENTS INTENSITY AND RISK

An evaluation methodology of corporate innovation investments intensity and risk assessment and the main research stages are described in the third part of the thesis. In total there are 6 significant steps: (1) *data collection*; (2) *calculation of ratios*; (3) *formation of OLS regression models*; (4) *select methodologies for country sustainability measurement*; (5) *grouping countries according to sustainability dimensions*; (6) *formation of fixed-effects regression models*. This part of the thesis is based on the analyzed foreign scientific literature from the second part, which revealed the significance of the corporate innovation investments, the possible risk factors and their evaluation methodologies (*see table 2 and figures 15-17 from Chapter 2*). Findings and insights are provided at the end of the third chapter, which will help test the evaluation methodology in fourth chapter of the dissertation.

The evaluation methodology aims to analyze the impact of financial ratios (return on assets, debt ratio, corporate size, cash ratio, Tobin's q ratio) and corporate governance on corporate innovation investments intensity and risk in the context of country sustainability. The evaluation methodology includes data from corporate and countries that will enable the assessment of key factors influencing the corporate innovation investments intensity and risk in the fourth part of the thesis across different sustainability groups in countries: innovation, economic, environmental and social.

The evaluation methodology was time limited because not all historical required data was found for the investigation for more than 17 full years since 2002 to 2018. In the compiled dataset was included data from 50 countries in the different 7 regions of the world, which provided data on their financial performance, level of corporate governance, R&D expenditure, since 2002 to 2018. Evaluation methodology includes the microeconomic and macroeconomic data of the corporate and countries based on scientific literature. Total of 15 variables were included in the investigation (7 ratios are direct linked to the operations of the corporate; 8 ratios are direct linked to the performance of the countries).

The following are described in **6 STEPS** for developing an **EVALUATION METHODOLOGY** of corporate innovation investments intensity and risk in the context of country sustainability.

Step 1. Data collection. First of all, using Datastream 50 countries from around the world were included, which all relevant data was available. These countries are from 7 different regions of the world (*see table 10*): Western Europe (17 countries; 34 percent), Eastern Europe (4 countries; 8 percent), North America (2 countries; 4 percent) and Latin America (5 countries; 10 percent), Asia (18 countries; 36 percent), Africa (2 countries; 4 percent) and Oceania (2 countries; 4 percent). Altogether data on corporates' activity from 50 countries was collected from 2002 to 2018, using Data Stream, Wharton, Bloomberg and World Bank databases, according data availability and time line.

Table 10. Information of the countries that were included in the evaluation methodology

Region	Countries
Western Europe (17 countries) 34 %	Austria (AUT), Belgium (BEL), Switzerland (CHE), Germany (DEU), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), United Kingdom (GBR), Greece (GRC) , Ireland (IRL), Italy (ITA), Luxembourg (LUX), Netherlands (NLD), Norway (NOR), Portugal (PRT) and Sweden (SWE)
Eastern Europe (4 countries) 8 %	Czech Republic (CZE), Hungary (HUN), Poland (POL) and Russia (RUS)
North America (2 countries) 4 %	United States of America (USA) and Canada (CAN)
Latin America (5 countries) 10 %	Brazil (BRA), Chile (CHL), Colombia (COL), Mexico (MEX) and PER (Peru)
Asia (18 countries) 36 %	United Arab Emirates (ARE), China (CHN), Hong Kong (HKG), Indonesia (IDN), India (IND), Israel (ISR), Japan (JPN), North Korea (KOR), Kuwait (KWT), Malaysia (MYS), Philippines (PHL), Qatar (QAT), Saudi Arabia (SAU), Jordan (JOR) Singapore (SGP), Thailand (THA), Taiwan (TWN) and Turkey (TUR)
Africa (2 countries) 4 %	Egypt (EGY) and South Africa (ZAF)
Oceania (2 countries) 4 %	Australia (AUS) and New Zealand (NZL)

Panel Data dataset was compiled, with each company being matched with its country ratios, sequentially adding data to each column (*see table 11*). All the data collected from databases was as follows.

Table 11. Description of data from databases

Name	Description	Position in evaluation methodology
R&D_expenditure_USD	Expenditure on Research and development (R&D expenditure) in millions USD	Used in formula 7
CORP_GOVERNANCE	Corporate governance (score from 1 to 100) (by DataStream)	Formula 6; independent variable
MCAP_USD	Market capitalization in millions USD	Used in formula 5
NET_INCOME_USD	Net income in millions USD	Used in formula 3
CASH_USD	Cash in millions USD	Used in formula 4

ASSETS_USD	Assets in millions USD	Used in formulas 1-5
TOTAL_DEBT_USD	Total debt in millions USD	Used in formula 2
COMMON_EQUITY_USD	Common equity in millions USD	Used in formula 5
SOCSCORE_SCORE	Social score (score from 1 to 100)	Used in formula 38
REGION	Region of world	Total 7 regions name
GDPGROWTH	GDP growth	Formula 33
RENEWENERG	Renewable energy consumption	Used in formula 35
RDPROC GDP	R&D expenditure of GDP proc.	Formula 32
UNEMPLOYR	Unemployment rate	Formula 34
DIOXIDE	Carbon dioxide emissions per unit of GDP	Formula 36
ELECTRICITY	Proportion of population with access to electricity	Formula 37
SOCROTECTION	Share of wages and social protection in GDP	Formula 39

Summarized information about the data. “Panel Data” dataset was compiled from corporates’ performance results from 50 countries from 2002 to 2018, in total of more than 600 thousand observations, using 4 databases.

Step 2. Calculation of ratios. Secondly, the following financial ratios were calculated (Becker-Blease, 2011; Bernile, Bhagwat & Yonker, 2018; Choi, Park & Hong, 2012; O'Connor & Rafferty, 2012; Aghion, Reenen, & Zingales, 2013) (return on assets (ROA), debt ratio (DEBT_RATIO), corporate size (CORPORATE_SIZE), cash ratio (CASH_RATIO) and Tobin’s q Ratio (TOBINQ_RATIO).

Next there are methodologies for calculating each financial indicator included in the evaluation methodology.

Financial ratios:

$$CORPORATESIZE = \ln(ASSETS) \quad (1)$$

Corporate size, evaluated as the natural logarithm of total corporate assets (*see formula (1)*), is included in the evaluation methodology as one of the key financial indicators that can influence the innovation investments intensity and risk (Choi, Park and Hong, 2012). It is more difficult for small businesses to invest in innovation due to the smaller financial resources available. However small businesses must invest in innovation if they are to remain competitive. Although small companies have fewer shareholders, executives, employees, clients, creditors and their corporate governance can be clearer. Big companies have more opportunities to invest in innovation through

R&D expenditure, but with more shareholders, managers, employees, clients, creditors, their corporate governance needs to be very clear.

$$DEBT_RATIO = \frac{TOTALDEBT}{ASSETS} \quad (2)$$

Debt ratio is classified as leverage indicator and shows how much liabilities a company has. This ratio is the division between total liabilities of the company and total assets (*see formula (2)*) (Bernile, Bhagwat & Yonker, 2018). The debt ratio is included in the evaluation methodology as a key leverage indicator that can influence the innovation investments intensity and risk. Corporate with higher debt levels are riskier and may find it more difficult to attract investments. However effective debt management can be a great tool for managing the innovation investments intensity and risk, which is why debt ratio is an important tool in debt level management in the evaluation methodology.

$$ROA = \frac{NETINCOME}{ASSETS} \quad (3)$$

Return on assets is measured as the ratio of the net profit of the corporate to the total assets (*see formula (3)*) (Becker-Blease, 2011). This indicator is included in the evaluation methodology as a measure of profitability that can influence the innovation investments intensity and risk. Increasing return on assets indicates greater opportunities for a corporate to invest in innovation.

$$CASH_RATIO = \frac{CASH}{ASSETS} \quad (4)$$

The cash ratio is the fourth financial indicator included in the evaluation methodology. This ratio is evaluated by dividing total cash and cash equivalents by total assets (*see formula (4)*) (O'Connor & Rafferty, 2012). A small amount of cash in a company can create additional risk for operational activity. It is also a major obstacle towards investing innovation. Too much free money may indicate inefficiency.

$$TOBINQ_RATIO = (ASSETS + MCAP * 1000 - COMMONEQUITY)/ASSETS \quad (5)$$

Tobin q ratio is the fifth financial indicator included in the evaluation methodology. The formula for calculating this ratio is shown in *formula (5)* (Aghion, Reenen, & Zingales, 2013; Andrei et al., 2019). A higher Tobin q score can provide opportunities for increased innovation investments intensity and risk.

Corporate governance:

$$CORP_GOVERNANCE = (BoardFunctions + BoardStructure + Compensation + VisionandStrategy + ShareholderRights) \quad (6)$$

Corporate governance was included in the evaluation methodology as an independent variable that shows how fair and transparent a company is to shareholders, employees, clients, creditors, the community, and the government. The formula for calculating this ratio is shown in *formula (6)* and it is measured on a scale of 1 to 100 each year (Bolton & Zhao, 2018). A higher score indicates fairer and more

transparent corporate governance. This indicator has 5 sub-dimensions in assessing boards (directors) of corporate governance: 1) functions; 2) structure; 3) compensation policy; 4) vision and strategy; 5) shareholder rights.

Director functions demonstrate the board's ability to have an effective team with clear responsibilities and tasks. The company's structure of directors shows the diversity of a board and how independently the external forces can make decisions. The Company's Compensation Policy demonstrates the ability to retain and attract high-level executives and board members, reflecting the company's long-term financial goals. The vision and strategy of the company show whether the company pursues social goals, not just financial ones, in order to achieve sustainable growth of the company while contributing to the long-term development process of the entire country. Shareholder rights of a company indicate whether all shareholders have the same privileges and rights, regardless of the number of shares held and the level of control.

Corporate innovation investments intensity and risk:

$$INNOV_INTENSITYRISK = \frac{RDexpenditure}{ASSETS} \quad (7)$$

The corporate innovation investments intensity and risk is a key dependent variable included in the evaluation methodology (*see formula (7)*). According to the research (Bernile, Bhagwat & Yonker, 2018; Balsmeier, Fleming, & Manso, 2017), the intensity and risk of companies investments in innovation can be demonstrated by the ratio of R&D expenditure to total assets. Research and development are the key part of the innovation process, creating and patenting new products, services, processes, organizational and marketing innovations (Salguero et al., 2015). Asset is at the heart of the company's operations (Salguero et al., 2015). The more a company invests in research and development, the more likely it is that the company will innovate. As a result, a higher proportion of R&D expenditure per unit of value of assets may reflect greater corporate innovation investments intensity and risk. Also, a winsorized process was performed (similar to mean and median, only further strengthened), retrieving new variables (*see table 12*).

Summarized information about variables: independent variables- corporate size, debt ratio, return on assets, cash ratio, Tobin q indicator; dependent variable- corporate innovation investments intensity and risk.

Step 3. Formation of OLS regression models. Testing of scientific hypotheses 1-4 (Corporate governance and financial ratios do not have the same impact on the corporate innovation investments intensity and risk in the different groups of countries innovation (H₁) (*see formulas (8-13)*/ economic (H₂) (*see formulas (14-19)*/ environmental (H₃) (*see formulas (20-25)*/ social (H₄) (*see formulas (26-31)* sustainability) by constructing OLS regression models. OLS regression equations for the first dimension of countries sustainability - the level of innovation - grouped countries into 3 groups: low innovation sustainability, medium innovation sustainability, and high innovation sustainability.

Table 12. Description of the ratios included in the evaluation methodology and calculation methodology

Ratio	Name	Methodology	A winsorized process	New ratios
INNOV INTENSITY & RISK	Intensity and risk of corporate investments in innovation	R&D expenditure/ASSETS		w_INNOV INTENSITY & RISK
CORP GOVERNANCE	Corporate governance	AVERAGE OF 5 SUB-DIMENSIONS of BOARD'S (functions; structure; compensation policy; vision and strategy; shareholder rights) (SCORE FROM 1 TILL 100) Board		w_CORP GOVERNANCE
ROA	Return on assets	NET INCOME/ASSETS		w_ROA
DEBT RATIO	Debt ratio	DEBT/ASSETS		w_DEBT RATIO
CORPORATE SIZE	Size	LN(ASSETS)		w_SIZE
CASH RATIO	Cash ratio	CASH/ASSETS		w_CASH RATIO
TOBINQ RATIO	Tobin's q ratio	(ASSETS+MCAP*1000-COMMON EQUITY)/ASSETS		w_TOBINQ RATIO

$$INNOV_INTENSITYRISK_{it|Slow(Model1)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (8)$$

$$INNOV_INTENSITYRISK_{it|Slow(Model2)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (9)$$

Countries are characterized by **low innovation sustainability** if public and private investment combined represent a very small percentage or do not account for a share of GDP. Investments in infrastructure (high technology, communication technology, information technology, transport) in these countries are almost non-existent.

$$INNOV_INTENSITYRISK_{it|Smedium(Model3)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (10)$$

$$INNOV_INTENSITYRISK_{it|Smedium(Model4)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (11)$$

When public and private investment, taken together, account for a certain percentage of GDP and generate innovation in various industries (energy, transport, production) but are not large enough to ensure technological progress for countries, these countries have a **medium innovation sustainability**.

$$INNOV_INTENSITYRISK_{it|Shigh(Model5)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (12)$$

$$INNOV_INTENSITYRISK_{it|Shigh(Model6)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (13)$$

Undoubtedly, countries that create sustainable innovations in all industries, especially manufacturing, services, and provide a high percentage of GDP for this, have a **high innovation sustainability**. OLS regression equations for the second dimension of countries sustainability – economic growth - grouped countries into 3 groups: low economic sustainability, medium economic sustainability, and high economic sustainability.

$$INNOV_INTENSITYRISK_{it|ESlow(Model1)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (14)$$

$$INNOV_INTENSITYRISK_{it|ESlow(Model2)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (15)$$

Slow GDP growth, poverty, high unemployment as well as inaccessibility of financial services in countries are accompanied by **low economic sustainability**.

$$INNOV_INTENSITYRISK_{it|ESmedium(Model3)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (16)$$

$$INNOV_INTENSITYRISK_{it|ESmedium(Model4)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (17)$$

Countries balancing between slow and fast economic growth, low and high unemployment have **medium economic sustainability**.

$$INNOV_INTENSITYRISK_{it|EShigh(Model5)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (18)$$

$$INNOV_INTENSITYRISK_{it|EShigh(Model6)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (19)$$

Economic growth without major economic shocks, low unemployment, income equality is in countries with **high economic sustainability**. OLS regression equations for the second dimension of countries sustainability – environmental - grouped countries into 3 groups: low environmental sustainability, medium environmental sustainability, and high environmental sustainability.

$$INNOV_INTENSITYRISK_{it|ENSlow(Model1)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (20)$$

$$INNOV_INTENSITYRISK_{itENS\text{low}(Model2)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (21)$$

Low environmental sustainability exists in countries where people have no access to energy or use dirty, inefficient energy.

$$INNOV_INTENSITYRISK_{itENS\text{medium}(Model3)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (22)$$

$$INNOV_INTENSITYRISK_{itENS\text{medium}(Model4)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (23)$$

Countries which populations have access to energy and encourage the use of as much renewable energy as possible have **medium environmental sustainability**.

$$INNOV_INTENSITYRISK_{itENS\text{high}(Model5)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (24)$$

$$INNOV_INTENSITYRISK_{itENS\text{high}(Model6)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (25)$$

Excellent access to energy, high production and consumption of renewable energy exists only in countries with **high environmental sustainability**. OLS regression equations for the second dimension of countries sustainability – social - grouped countries into 3 groups: low social sustainability, medium social sustainability, and high social sustainability.

$$INNOV_INTENSITYRISK_{itSS\text{low}(Model1)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (26)$$

$$INNOV_INTENSITYRISK_{itSS\text{low}(Model2)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (27)$$

High levels of social exclusion, poverty and inequality accompany countries with **low levels of social sustainability**.

$$INNOV_INTENSITYRISK_{itSS\text{medium}(Model3)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (28)$$

$$INNOV_INTENSITYRISK_{itSS\text{medium}(Model4)} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_{it} \quad (29)$$

Countries with low levels of social exclusion and inequality have a **medium level of social sustainability**.

$$INNOV_INTENSITYRISK_{itSS\text{high}(Model5)} = a + \beta1ROA_{it} + \beta2DEBT_RATIO_{it} + \beta3SIZE_{it} + \beta4CASH_RATIO_{it} + \beta5TOBINQ_RATIO_{it} + u_{it} \quad (30)$$

$$INNOV_INTENSITYRISK_{itSShigh(Model6)} = a + \beta 1CORP_GOVERNANCE_{it} + \beta 2ROA_{it} + \beta 3DEBT_RATIO_{it} + \beta 4SIZE_{it} + \beta 5CASH_RATIO_{it} + \beta 6TOBINQ_RATIO_{it} + u_{it} \quad (31)$$

Undoubtedly, low social exclusion, low poverty and inequality ensure **high social sustainability**.

In summary, total 48 OLS regression equations were created for the each dimension of countries sustainability – innovation, economic, environmental and social. In each group countries were grouped into 3 groups: low, medium and high innovation sustainability (6 OLS); low, medium and high economic sustainability (12 OLS); low, medium and high environmental sustainability (18 OLS); low, medium and high social sustainability (12 OLS).

Step 4. Selection and development of country sustainability methodologies. Fourth, selection and development of country sustainability methodologies. Data to assess the country sustainability were further developed. All of this can be combined into 4 main dimensions: innovation, economic, environmental and social. Therefore, sustainability has been divided into 4 dimensions: innovation sustainability, economic sustainability, environmental sustainability and social sustainability. To analyze how corporate governance and financial performance interact with the corporate innovation investments intensity and risk across different groups of countries sustainability dimensions, a methodology has been developed to measure sustainability dimensions. The following is a methodology for assessing each sustainability dimension:

Innovation sustainability

$$INNOV_SUSTAIN = \frac{RD}{GDP} \quad (32)$$

The share of R&D expenditure from gross domestic product is a key indicator that measures changes in the country innovation sustainability (*see formula (32)*) (Hu et al., 2019). According to the Frascati Handbook (Research Methodology for Innovation Policy), this indicator is very important in assessing the sustainability of a country, because only innovation, scientific, applied and experimental research is conducted to increase knowledge of stocks, society, people, culture, new programs and methodologies for the long-term prosperity of the country (OECD, 2020). The higher the share of R&D expenditure from the gross domestic product, the greater the potential for innovation sustainability development.

Economic sustainability

$$ECON_SUSTAIN_1 = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \quad (33)$$

The annual growth rate of gross domestic product (market value of government-produced final services and goods) is the second macroeconomic indicator included in the evaluation methodology as a key indicator of a country economic sustainability and its development (*see formula (33)*) (Hashmi & Alam, 2019). Long-term economic growth, without major fluctuations (economic shocks) based on innovation,

environmental sustainability and social responsibility, shows a greater potential for the country sustainability development.

$$ECON_SUSTAIN_2 = \frac{All\ unemployed}{Total\ labor\ force} \quad (34)$$

Unemployment rate is the third macroeconomic indicator included in the evaluation methodology as a key indicator of a country economic sustainability and its development (*see formula 34*) (Hashmi & Alam, 2019). Declining unemployment in the long-term perspective, without force major based on innovation, environmental sustainability and social responsibility, shows a greater potential for the country economic sustainability development.

Environmental sustainability

$$ENVIRON_SUSTAIN_1 = \frac{Renewable\ energy}{Total\ energy} \quad (35)$$

Renewable energy (*see formula (35)*) and carbon dioxide emissions per unit of GDP are the other macroeconomic indicators included in the evaluation methodology as an important measure of environmental sustainability and development trends (Akadiri et al., 2019). It shows how much carbon dioxide emissions per unit of GDP are consumed in the country. The indicator is calculated by dividing total carbon dioxide emissions by GDP (*see formula (36)*). Declining carbon dioxide emissions per unit of GDP shows that the country is interested in an environment protection: cleaner environment and better health of the population.

$$ENVIRON_SUSTAIN_2 = \frac{Carbon\ dioxide\ emissions}{GDP} \quad (36)$$

Proportion of population with access to electricity is the sixth macroeconomic indicator included in the evaluation methodology as an important measure of environmental sustainability and development trends (Akadiri et al., 2019). It shows how many people in the country have access to electricity. The indicator is calculated by dividing population with access to electricity by total population in country (*see formula (37)*). The increasing indicator shows that the country is interested to ensure services of reliable, modern and affordable energy.

$$ENVIRON_SUSTAIN_3 = \frac{Population\ with\ access\ to\ electricity}{Total\ population\ in\ country} \quad (37)$$

Social sustainability

$$SOCIAL_SUSTAIN_1 = \overline{Social\ Score} \quad (38)$$

Social score (*see formula (38)*) and share of wages and social protection in GDP are the other macroeconomic indicators included in the evaluation methodology and shows the social sustainability level in country (*see formula (39)*) (Silvestre & Tirca, 2019). First, it shows inequality within countries; second, it shows inequality among countries. Results of this indicator require policies of social protection and wage; greater equality; especially fiscal; as well as adoption of policies.

$$SOCIAL_SUSTAIN_2 = \frac{Wages\ and\ social\ protection\ transfers}{GDP} \quad (39)$$

The summarized 8 macroeconomic indicators included in the evaluation methodology are linked to the key dimensions of the country sustainability-innovation, economic, environmental and social, to clarify the effect of financial ratios and corporate governance on the innovation corporate investments intensity and risk across different groups of countries in terms of sustainability

Table 13. Description of the sustainability indicators included in the evaluation methodology and calculation methodology

Indicator	Name	Methodology
INNOV SUSTAIN	Innovation sustainability	R&D expenditure/GDP
ECON SUSTAIN	Economic sustainability	$(GDP_t - GDP_{t-1})/GDP_{t-1}$
		All unemployed/Total labor force
ENVIR SUSTAIN	Environmental sustainability	Renewable energy/Total energy
		Carbon dioxide emissions/GDP
		Population with access to electricity/Total population in country
SOCIAL SUSTAIN	Social sustainability	Social Score
		Wages and social protection transfers/GDP

Step 5. Grouping countries according to sustainability dimensions. In this step, countries were first grouped into 2 groups:

- 1) 25th percentile and
- 2) 75th percentile, based on countries indicators of innovation sustainability, economic sustainability, environmental sustainability and social sustainability (see table 14).

The countries were then divided into 3 groups (low, medium, high) for each sustainability dimension (innovation sustainability, economic sustainability, environmental sustainability, social sustainability).

When the country indicator (R&D expenditure of GDP proc.) was below the 25th percentile, the country fell into the first group (low innovation sustainability). The country with indicator between the 25th and 75th percentiles fell into the second group (medium innovation sustainability); in cases when the indicator was above the 75th percentile, the country came in third group (high innovation sustainability).

Table 14. Grouping countries according to innovation sustainability dimension

Innovgroup25		Innovgroup75	
Percentile 25 of R&D expenditure of GDP proc.		Percentile 75 of R&D expenditure of GDP proc.	
Low	Medium		High
R&D expenditure of GDP proc. < innovgroup25 & R&D expenditure of GDP proc.	R&D expenditure of GDP proc. > innovgroup25 & R&D of GDP expenditure proc.< innovgroup75		R&D expenditure of GDP proc. > innovgroup75 & R&D expenditure of GDP proc.

The country with indicator (GDP growth; unemployment rate), which was below the 25th percentile, fell into the first group (low economic sustainability) (*see table 15*). When the country's indicator was between the 25th and 75th percentiles, country fell into the second group (medium economic sustainability); in cases when the indicator was above the 75th percentile, the country was in third group (high economic sustainability).

Table 15. Grouping countries according to economic sustainability dimension

Econgroup25		Econgroup75	
Percentile 25: 1) GDP growth; 2) unemployment rate		Percentile 75: 1) GDP growth; 2) unemployment rate	
Low	Medium		High
GDP growth < econgroup25 & GDP growth	GDP growth > econgroup25 & GDP growth < econgroup75		GDP growth > econgroup75 & GDP growth
Unemployment rate < econgroup25 & Unemployment rate	Unemployment rate > econgroup25 & Unemployment rate < econgroup75		Unemployment rate > econgroup75 & Unemployment rate

While the country indicator (Renewable energy; Carbon dioxide emissions; Access to reliable electricity) was below the 25th percentile, the country fell into the first group (low environmental sustainability) (*see table 16*); in cases when the indicator was between 25th and 75th percentiles, the country came in second group (medium environmental sustainability). When the indicator was above the 75th percentile, the country was in third group (high environmental sustainability). The country with indicator (mean of social score; Social protection), which was below the 25th percentile, fell into the first group (low social sustainability) (*see table 17*). When the country's indicator was between the 25th and 75th percentiles, country fell into the second group (medium social sustainability). In case when the indicator was above the 75th percentile, the country was in third group (high social sustainability).

Table 16. Grouping countries according to environmental sustainability dimension

Envirgroup25		Envirgroup75	
Percentile 25: 1) Renewable energy; 2) Carbon dioxide emissions; 3) Access to reliable electricity		Percentile 75: 1) Renewable energy; 2) Carbon dioxide emissions; 3) Access to reliable electricity	
Low	Medium	High	
Renewable energy < envirgroup25 & Renewable energy	Renewable energy > envirgroup25 & Renewable energy < envirgroup75	Renewable energy > envirgroup75 & Renewable energy	
Carbon dioxide < envirgroup25 & Carbon dioxide	Carbon dioxide > envirgroup25 & Carbon dioxide < envirgroup75	Carbon dioxide > envirgroup75 & Carbon dioxide	
Access to reliable electricity < envirgroup25 & Access to reliable electricity	Access to reliable electricity > envirgroup25 & Access to reliable electricity < envirgroup75	Access to reliable electricity > envirgroup75 & Access to reliable electricity	

Table 17. Grouping countries according to social sustainability dimension

Socialgroup25		Socialgroup75	
Percentile 25: 1) mean of Social Score; 2) Social protection		Percentile 75: 1) mean of Social Score; 2) Social protection	
Low	Medium	High	
Mean of Social Score < envirgroup25 & mean of Social Score	Mean of Social Score > envirgroup25 & mean of Social Score < envirgroup75	Mean of Social Score > envirgroup75 & mean of Social Score	
Social protection < envirgroup25 & Social protection	Social protection > envirgroup25 & Social protection	Social protection > envirgroup75 & Social protection	

Step 6. Formation of fixed-effects regression models. Third, fixed effects regression models were developed to test scientific hypotheses 5-6. A fixed-effects regression model (*see formula (40)*) was constructed to test Hypothesis 5 (*H5: Financial ratios influence the corporate innovation investments intensity and risk*), as such a model allows the control of factors that are overlooked or unmeasured over time. Data is likely to have units of heterogeneity that can often be overlooked. Factors that are different but unobservable or unmeasurable over time should be controlled.

$$INNOV_INTENSITYRISK1_{it} = \alpha + \beta_1 ROA_{it} + \beta_2 DEBT_RATIO_{it} + \beta_3 SIZE_{it} + \beta_4 CASH_RATIO_{it} + \beta_5 TOBINQ_RATIO_{it} + u_i + v_{it} \quad (40)$$

A second fixed-effects regression model (*see formula (41)*) was constructed to test Hypothesis 6 (*H6: Corporate governance and financial ratios influence the corporate innovation investments intensity and risk*).

$$INNOV_INTENSITYRISK2_{it} = a + \beta1CORP_GOVERNANCE_{it} + \beta2ROA_{it} + \beta3DEBT_RATIO_{it} + \beta4SIZE_{it} + \beta5CASH_RATIO_{it} + \beta6TOBINQ_RATIO_{it} + u_i + v_{it} \quad (41)$$

Scales of correlation and determination values are very important in formulating and interpreting regression models.

Summarized information about 2 fixed-effects regression models. Model 1 included the following variables: corporate size, debt ratio, return on assets, cash ratio, Tobin's q ratio, intensity and risk of corporate investments in innovation (tested Hypothesis *H5: Financial ratios influence the corporate innovation investments intensity and risk*). Meanwhile, model 2 included these variables: corporate size, debt ratio, return on assets, cash ratio, Tobin's q ratio, corporate governance and corporate innovation investments intensity and risk (tested Hypothesis *H6: Corporate governance and financial ratios influence the corporate innovation investments intensity and risk*).

Findings and insights

An evaluation methodology was developed to analyze the impact of corporate governance and financial performance on corporate innovation investments intensity and risk in the context of country sustainability. In the end, the scheme of the evaluation methodology of corporate innovation investments intensity and risk is shown in figure 20.

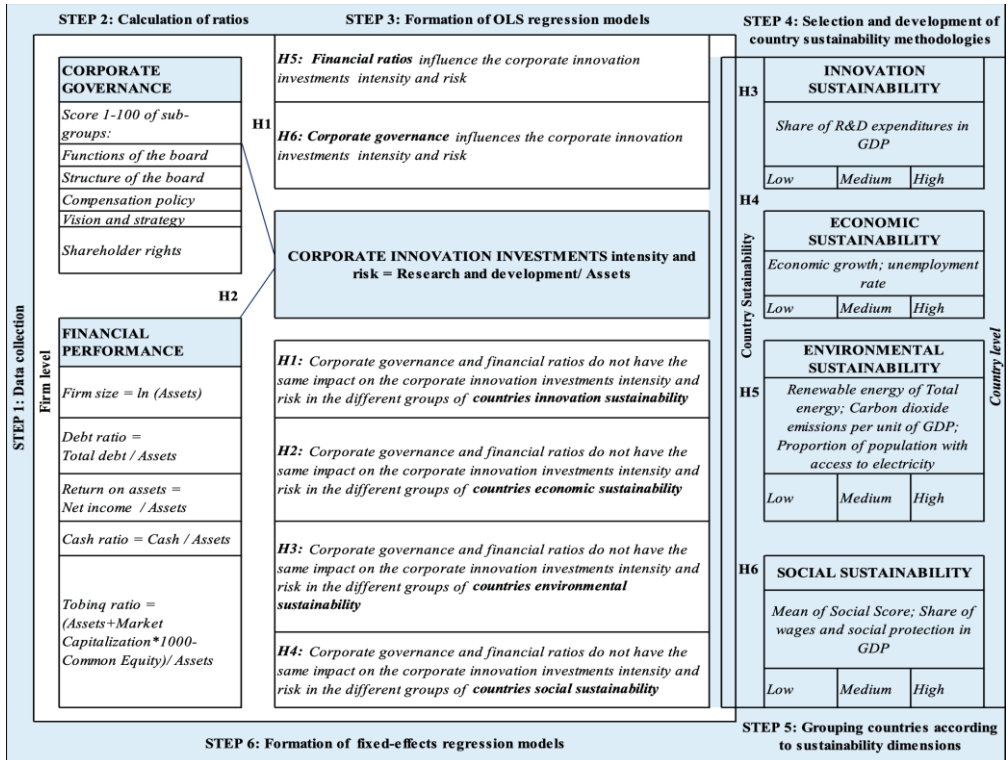


Figure 20. Evaluation methodology of corporate innovation investments intensity and risk assessment

The model includes 6 significant steps: (1) data collection; (2) calculation of ratios; (3) formation of OLS regression models; (4) select methodologies for country sustainability measurement; (5) grouping countries according to sustainability dimensions; (6) formation of fixed-effects regression models. In the first step a panel data set was compiled that included data from corporates results from 50 countries 7 world regions between 2002 and 2018 in total of more than 600 thousand observations. In the second step in total 7 indicators, directly related to corporate performance, were calculated based on foreign scientific sources: corporate governance, return on assets, debt ratio, corporate size, cash ratio, Tobin's q ratio and intensity and risk of corporate investments of innovation. In the third step, OLS regression model equations were constructed to test the remaining scientific hypotheses 1-4 (*H1-H4: Corporate governance and financial ratios do not have the same impact on the corporate innovation investments intensity and risk in the different groups of countries innovation, economic and environmental, as well as social sustainability*). In the fourth step, the indicators identifying the sustainability dimensions of the countries were calculated. In the fifth step was to group the four dimensions of sustainability. Each country was grouped according to innovation, economic, environmental, as well social sustainability into 3 sub-groups: low, medium, high. Finally, in step six, fixed-effects regression equations were constructed to test the 5-6 hypotheses (*H5-H6: Financial ratios influence the corporate innovation investments intensity and risk corporate governance*). The fourth chapter of the thesis will present and describe the results obtained based on this developed evaluation methodology.

4. ASSESSMENT OF APPLICABILITY OF THE EVALUATION METHODOLOGY OF CORPORATE INNOVATION INVESTMENTS INTENSITY AND RISK

The fourth chapter of dissertation is devoted to present the main empirical findings from the performed calculations, together with the discussion about the results while testing the applicability of the model designed in the third chapter. Additionally, there are the key variables of corporate governance and financial factors (return on assets, debt ratio, size, cash ratio, Tobin's q) of corporate innovation investments intensity and risk (*see table 12 from chapter 3*) in the context of different levels of sustainability across countries, incorporating the dimensions of innovation, economic, environmental and social (*see table 13 chapter from 3*). To achieve the main goal of the investigation, a statistical description of the variables is provided, and the results obtained are based on a detailed analysis of the developed and tested regression models: OLS (*see formulas 8-31*) and fixed effects (*see formulas 40-41*) in different dimensions of sustainability of the countries (*see tables 18-29*). Finally, the chapter concludes with the overall conclusions of the analysis.

4.1. Statistical description of data

The aim is to find the connection between corporate governance, financial performance and corporate innovation investments intensity and risk across different sustainability groups prior to all regression models (OLS and fixed effect); therefore, *table 18* provides a statistical description of all variables: total number of observations (N), mean (MEAN), minimum (MIN), maximum (MAX), and percentiles (p50, p1, p25 and p99) (*see Annexes 5-7*). A detailed statistical description of the data is the basis for analyzing interconnections and constructing regression models. Therefore the purpose of discovery of the statistically significant relationships among financial ratios (return on assets, debt ratio, size, cash ratio, Tobin's q), corporate governance and corporate innovation investments intensity and risk. The regression models, both OLS and fixed effect (*see formulas (8-31)* and *formulas (40-41)*), will be based on the strength of the interconnections. All variables are winsorized (transformation of statistics to minimize the potential impact of errors on results), so each variable is marked with a 'w' sign in the table 18. There are (*see table 18*) in total 42,160 variables included into the model. Financial performance includes 6 significant variables (return on assets, debt ratio, size, cash ratio, Tobin's q). Other important variable is corporate governance that demonstrates transparency in corporate governance. Financial performance and corporate governance in regression analysis were independent variables. Moreover corporate innovation investments intensity and risk in regression analysis were dependent variable. In each country, sustainability group (innovation sustainability, economic sustainability, environmental sustainability and social sustainability), regression analysis looks for relations between independent and dependent variables to answer the key question of the dissertation, whether corporate governance and financial performance influence innovation investment intensity and risk across different sustainability groups of countries.

Table 18. Statistical description of variables included in all regression models without countries' groups by sustainability dimensions

Variable	N	MEAN	p50	MIN	p1	p25	p99	MAX
INTENSITY&RISK	42160	.0179	0	0	0	0	.212	.378
w_CORPORATE_SIZE	42160	15.266	15.265	9.429	11.37	14.32	18.84	18.91
w_DEBT_RATIO	42160	.252	.239	0	0	.112	.800	.862
w_ROA	42160	.042	.045	-.594	-.439	.017	.298	.314
w_CASH_RATIO	42160	.141	.096	.0006	.0012	.043	.709	.830
w_TOBINQ	42160	1.882	1.438	.574	.574	1.091	8.468	9.740
w_CORP_GOVERN	42160	.521	.580	.0176	.0176	.228	.959	.959

Before creating the regression models (OLS and fixed effect), a correlation matrix of all variables was constructed to assess the relationship between corporate governance, financial performance (return on assets, debt ratio, size, cash ratio, Tobin's q) and corporate innovation investments intensity and risk across different sustainability groups (*see table 19*).

Table 19. Overall correlation between variables included in OLS and fixed effects regression models

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
INTENSITY&RISK (1)	1.000						
w_CORPORATE_SIZE (2)	-.0,1397*	1.000					
w_DEBT_RATIO (3)	-.0,1689*	0,2493*	1.000				
w_ROA (4)	-.0,1606*	0,0982*	-0,168*	1.000			
w_CASH_RATIO (5)	0,4323*	-0,276*	-0,333*	-.0,02*	1.000		
w_TOBINQ (6)	0,2764*	-0,329*	-0,171*	0,27*	0,3695*	1.000	
w_CORP_GOVERN (7)	0,0071	0,079*	0,0444*	0,008	-0,114*	0,0272*	1.000

(*Correlation is significant at the 0.01 level)

The correlation matrix shows that the largest statistical relationship between the dependent variable in the model (corporate innovation investments intensity and risk) and other independent variables is with financial indicators such as the cash ratio and

the Tobin's q ratio. It also appears that correlation coefficients between independent variables do not exceed 0.5 (e.i. autocorrelation between variables is not here).

Table 19 shows that the statistical relationship is between all independent variables with the dependent variable, regardless of strength. This displays that all identified financial ratios and corporate governance can have a significant effect on the corporate innovation investments intensity and risk. Also table 19 evinces that corporate size, debt ratio and return on assets have a relationship with the corporate innovation investments intensity and risk, because it can reduce the risk of investors for the sake of better financial results. It means, if an investor wished to reduce his risk of investment, he should first analyze financial ratios such as corporate size, debt ratio and return on assets. In contrast, cash ratio, Tobin's q and corporate governance increase not only the risk of innovation investments, but also the intensity.

In summary, a general statistical description of all variables, included in the different regression models, was provided.

The following is each regression model developed in all sustainability groups of countries.

4.2. Results of impact of key risk financial factors on corporate innovation investments intensity and risk by OLS regression models

Innovation sustainability means the country's long-term progress, based on product, process, management, organization and marketing innovation. The sustainability of innovation is measured by the share of total R&D expenditure in GDP in the country (*see Chapter 3 table 13 and formula (32)*). OLS regression models based on *formulas 8-13* were created to analyze, whether financial performance and corporate governance could influence corporate innovation investments intensity and risk in different groups of countries innovation sustainability. Regression models were compiled for each countries innovation sustainability group: low, medium and high (the dynamics of countries innovation sustainability groups in 2002-2018 are presented in *Annex 1*).

First, OLS regression model includes only the financial ratios of corporate from low innovation sustainability countries (in total 5,741 observations). The results of the first OLS regression model (*see table 20, Column Model1*) show that return on assets (negative impact on innovation investments risk), cash ratio and the Tobin's q ratio are the most significant variables for corporate innovation investments intensity and risk, because estimated probability p is less than 0.01 significance level. It means that management of cash and assets in the market can help to control risk of innovation investments. The results of the second OLS regression model (*see table 20, Column Model2*), which included the financial indicators of corporate from low innovation sustainability countries (in total 5,741 observations) and corporate governance, show that the variable representing transparent and fair board functions, compensation practices, vision, strategy, shareholder rights practices, is not a significant variable. It means that financial performance in low innovation sustainability countries are most important. Model 3 includes only the financial ratios of corporate from the medium innovation sustainability countries (in total 6,234 observations) (*see table 20, column Mode3*). The results of this OLS regression model, unlike before, show that return on

assets (negative impact on innovation investments risk), cash ratio, Tobin's q ratio together with debt ratio (as well negative impact on innovation investments risk) are significant variables. Probability p of these variables (debt ratio, cash ratio, and Tobin's q ratio) is less than a significance level 0.01 (1 %) and probability p of this variable (return on assets) is less than a significance level 0.05 (5 %). It demonstrates that own and borrowed funds can manage not only risk but also intensity of innovation investments. The results of the fourth OLS regression model (*see table 20, column Model4*), which included the financial performance and corporate governance of corporate from medium innovation sustainability countries (in total 6,234), show that corporate governance is not the same as in low innovation sustainability countries. In this case, corporate governance is not significant, but it is positive, meaning that it can increase rather than reduce the intensity of innovation. It evinces that financial performance in medium innovation sustainability countries as well in low innovation sustainability are most important. The results of the fifth OLS regression model (*see table 20, column Model5*), which included only the financial ratios of corporate from high innovation sustainability countries (in total 18,307 observations), display that financial indicators without corporate size can influence corporate innovation investments intensity and risk (the estimated probability p is less than a significance level of 0.01 (1 %)). It means that management of financial performance can help to control innovation investments intensity and risk in countries with high innovation sustainability. Model 6 includes financial indicators and corporate governance of corporate from high innovation sustainability countries (as well in total 18,307 observations). The results of this OLS regression model (*see table 20, column Model6*) show that not only financial performance but also the corporate governance can impact innovation investments intensity and risk. Cash ratio, Tobin's q ratio and corporate governance make positive impact on innovation investments intensity. Return on assets and debt ratio have a negative impact on innovation investments intensity. It means that all these ratios are significant variables and its control can help to manage innovation investments. Also results show that corporate governance has the important effect on the corporate innovation investments intensity and risk only in high innovation sustainability countries. It is a signal for countries with low and medium innovation sustainability level and for companies that want to increase their innovation investments intensity and risk contribute to the innovation sustainability of the country. Consequently, not only financial results, but also corporate governance (showing how transparently the company is managed by its board of directors) can contribute to the development of innovation both at company and national level.

Results on corporate innovation investments intensity and risk in low, medium and high countries innovation sustainability groups, financial ratios such as return on assets, cash ratio and Tobin's q are significant variables that influence the corporate innovation investments intensity and risk, regardless of whether corporate are operating in low, medium or high innovation countries. Financial ratios (cash ratio and Tobin's q ratio) can have a significant impact on the innovation investments intensity and risk, as these ratios increase, the amount of money and the market value increases too. This makes it possible to boost the intensity of innovation investment. Debt ratio is a significant variable that affects the corporate innovation investments

intensity and risk only in countries with medium and high innovation sustainability. Debt ratio and can make a relevant effect on the intensity and risk of corporate innovation investments, as this ratio increases, borrowed capital decreases; therefore, the risk of innovation investments decrease as well. Relationship between corporate governance and corporate innovation investments intensity and risk were found only in countries with high innovation sustainability. It proves that corporate with more transparent and fair level corporate governance are more efficient in high innovation sustainability countries. A significant indicator of corporate governance, as well as can increase corporate innovation investments intensity; therefore, it could be a meaningful signal to other companies operating in low and medium innovation sustainability countries and seeking to increase their country innovation level in long-term perspectives.

Table 20. OLS regression models' results by countries innovation sustainability groups (measured by the share of total R&D expenditure in GDP) (*see formula (8-13)*)

Innovation Sustainability	Low		Medium		High	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE_SIZE, w	-0.000 [0.001]	-0.000 [0.001]	0.000 [0.001]	0.000 [0.001]	0.000 [0.001]	-0.000 [0.001]
DEBT_RATIO, w	-0.001 [0.005]	-0.001 [0.005]	-0.02*** [0.005]	-0.020*** [0.005]	-0.025*** [0.004]	-0.024*** [0.004]
ROA, w	-0.027*** [0.010]	-0.027*** [0.010]	-0.037** [0.017]	-0.037** [0.017]	-0.168*** [0.011]	-0.169*** [0.011]
CASH_RATIO, w	0.028*** [0.008]	0.028*** [0.008]	0.066*** [0.015]	0.066*** [0.015]	0.101*** [0.007]	0.101*** [0.007]
TOBINQ_RATIO, w	0.003*** [0.001]	0.003*** [0.001]	0.006*** [0.002]	0.006*** [0.002]	0.009*** [0.001]	0.008*** [0.001]
CORP GOVERNANC, w		-0.003 [0.003]		0.001 [0.004]		0.009*** [0.003]
Constant	0.002 [0.008]	0.001 [0.008]	0.011 [0.015]	0.012 [0.015]	-0.032*** [0.012]	-0.024** [0.012]
R-squared	0.288	0.288	0.315	0.315	0.524	0.525
Observations	5741	5741	6234	6234	18307	18307

Economic sustainability is country's economic growth in the long-term perspective based on innovation development, environmental protection and social responsibility. Moreover economic sustainability of country was measured by two key indicators: changes in economic growth (GDP) and unemployment rate (*see Chapter*

3 table 21 and formulas (14-18). Economic growth reflects the sustained change in the final market value of services and goods produced in a given state over time.

First of all, calculation results are presented, when economic sustainability was measured by ratio of changes in economic growth (GDP), to analyze, whether corporate governance and financial results may affect the corporate innovation investments intensity and risk across different groups of countries economic sustainability. In total 6 OLS regression models based on formulas 20-25 were developed. Regression models were developed for each of the countries economic sustainability groups: low, medium, and high (the dynamics of the countries economic sustainability groups are presented in *Annex 2*).

The results of the first OLS regression model (*see table 21, Column Model1*), which included only the financial ratios of companies in countries with low economic sustainability (in total 14,227 observations), show that debt ratio (negative impact), return on assets (negative impact), cash ratio and Tobin's q ratio are the most significant. It proves the estimated probability p , which is less than 0.01 (1 %) significance level). The results mean that these financial ratios can have influence on the corporate innovation investments intensity and risk. The results of the second OLS regression model (*see table 21, Column Model2*), which included the financial ratios of companies with low economic sustainability (as well in total 14,227 observations) and the corporate governance, show that the same financial ratios are significant but corporate governance is not as significant. Corporate governance shows the transparent and fair practice of the board's functions, structure, compensation policy, vision, strategy, and shareholder rights. It means that corporate governance does not affect the corporate innovation investments intensity and risk in the low economic sustainability countries. The results of the third OLS regression model (*see table 21, column Model3*), which included only the financial ratios of the companies from the medium economic sustainability countries (in total 14,552 observations), show that the same financial indicators as in the models 1-2 are significant. The results of the fourth OLS regression model (*see table 21, column Model4*), which included the financial ratios and the corporate governance of corporate from the medium economic sustainability countries (in total 14,552 observations), show that corporate governance is a significant variable, because estimated probability p is smaller than a significance level of 0.05 (5 %). Results substantiate that corporate governance together with financial performance (debt ratio, return on assets, size and Tobin's q) can have influence on the corporate innovation investments intensity and risk in low economic sustainability countries. Model 5 included only the financial ratios of corporate from high economic sustainability countries (in total 7,704 observations). The results of this OLS regression model (*see table 21, column Model5*) show that the same financial ratios are significant as in Models 1-4, but the level is less significant because the debt ratio's estimated probability p is less than the significance level 0.05 (5 %). The results of the sixth OLS regression model (*see table 21, column Model6*), which included financial indicators and corporate governance in high economic sustainability countries (in total 7,704 observations), show that besides financial indicators, the corporate governance is a particularly strong and significant variable. This variable is affecting the corporate innovation investments intensity and risk, because the

estimated probability p is less than a significance level of 0.01 (1 %). Thus, financial performance and corporate governance are important variables that can influence the corporate innovation investments intensity and risk. It means that financial performance and corporate governance can be a signal for other corporate operating in lower economic sustainability countries and seeking to improve economic sustainability.

Table 21. OLS regression models' results by countries economic sustainability groups, where economic sustainability was measured by changes in economic growth (GDP) (see formulas (14-19))

Economic Sustainability	Low		Medium		High	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE_SIZE, w	0.000 [0.000]	0.000 [0.001]	0.001 [0.000]	0.000 [0.000]	0.000 [0.000]	-0.000 [0.000]
DEBT_RATIO, w	- 0.022*** [0.003]	- 0.022*** [0.003]	- 0.015*** [0.004]	- 0.015*** [0.004]	-0.006** [0.003]	-0.006** [0.003]
ROA, w	- 0.144*** [0.010]	- 0.144*** [0.010]	- 0.074*** [0.009]	- 0.074*** [0.009]	- 0.038*** [0.010]	- 0.038*** [0.010]
CASH_RATIO, w	0.098*** [0.007]	0.098*** [0.007]	0.074*** [0.007]	0.075*** [0.007]	0.037*** [0.006]	0.038*** [0.006]
TOBINQ_RATIO, w	0.008*** [0.001]	0.008*** [0.001]	0.006*** [0.001]	0.006*** [0.001]	0.002*** [0.001]	0.002*** [0.001]
CORP GOVERNANC, w		0.004 [0.003]		0.006** [0.002]		0.008*** [0.002]
Constant	-0.008 [0.010]	-0.004 [0.011]	- 0.018*** [0.007]	-0.017** [0.007]	-0.005 [0.008]	0.000 [0.008]
R-squared	0.497	0.497	0.422	0.423	0.309	0.312
Observations	14227	14227	14552	14552	7704	7704

Second, economic sustainability was measured by unemployment rate, to seek to find, whether corporate governance and financial results may affect the corporate innovation investments intensity and risk across different groups of countries economic sustainability. Unemployment (unemployment rate) is a significant economic indicator, which represents the number of unemployed persons. It is measured as a percentage of the labour force. It should be noted that unemployed include those without a job and those who can work and are actively seeking work. Likewise, when unemployed people lose expectations and do not look for work, they are excluded from the statistics, so the labor market can change whether or not real employment changes. Economic sustainability refers to the long-term reduction of unemployment. In total 6 OLS regression models, based on formulas 14-18, were developed. Regression models were developed for each of the countries economic

sustainability groups: low, medium, and high (the dynamics of the countries economic sustainability groups are presented in *Annex 2*).

Firstly, OLS regression model (*see table 22, Column Model1*) included the financial ratios of corporate from low economic sustainability countries (the highest unemployment rate) (in total 8,936 observations). Results show that debt ratio, return on assets, cash ratio and Tobin's q ratio are the most significant, because the estimated probability p is less than 0.01 (1 %) significance level. It means that these financial ratios can influence the corporate innovation investments intensity and risk. Secondly, OLS regression model (*see table 22, Column Model2*) included the financial ratios and corporate governance (it is showing the transparent and fair practice of the corporate board) from companies operating in low economic sustainability countries (in total 8,936 observations). Results prove that the same financial ratios are significant but corporate governance (CG) is not significant. CG does not have an important impact on corporate innovation investment in low economic countries. Thirdly, OLS regression model (*see table 22, column Model3*) included the financial ratios of the companies from the medium economic sustainability countries (the medium unemployment rate) (in total 16,151 observations). Results show that the same financial indicators as in the models 1-2 are significant, however, impact of debt ratio for innovation investment is stronger due the estimated probability p , which is better. Fourthly, OLS regression model (*see table 22, column Model4*) included the financial ratios and corporate governance from corporate operating in the medium economic sustainability countries (in total 16,151 observations). Results prove that corporate governance is a significant variable, because estimated probability p is less than a significance level of 0.01 (1 %). It means that financial ratios and corporate governance can have a significant impact on corporate innovation investments in medium economic countries. Fifth of all, OLS regression model included financial ratios of corporate from high economic sustainability countries (the lowest unemployment rate) (in total 12,164 observations). The results of this OLS regression model (*see table 22, column Model5*) show that the same financial ratios are significant as in Models 3-4 and the estimated probability p is less than the significance level 0.01 (1 %). Sixth, OLS regression model (*see table 22, column Model6*) included financial ratios and corporate governance from high economic sustainability countries (in total 12,164 observations). Results prove that corporate governance is not a significant variable by Model 6, because the estimated probability p is not important. In this scenario, corporate governance is not affecting the corporate innovation investments intensity and risk in high economic sustainability. Control of financial performance can be a meaningful signal for corporate and countries seeking to improve sustainability level.

Results on corporate innovation investments intensity and risk in low, medium and high countries economic sustainability groups by changes in economic growth (GDP) and unemployment rate, financial ratios (debt ratio, return on assets, cash ratio and the Tobin's q ratio) are significant variables. Financial performance can have an important impact on corporate innovation investments intensity and risk. However corporate governance is not a significant variable in low economic sustainability countries. It proves that companies with better financial performance and more

transparent, and fair level corporate governance are more efficient in activities of innovation investments in medium and high economic sustainability countries. Thus, these results could be strong signal to other companies operating in low economic sustainability countries. Moreover cash ratio and Tobin's q ratio can have important impact on the corporate innovation investments intensity and risk, because when these ratios increase, the money and the market value increase. This makes it possible to increase the intensity of innovation investment. Return on assets can have a significant impact on the intensity and risk of firms innovation investments, since this indicator increases, profits increase as well, so the risk of innovation investments decreases.

Table 22. OLS regression models' results by economic sustainability (ES) groups, where ES was measured by unemployment rate (*see formulas (14-19)*)

Economic sustainability	Low economic sustainability		Medium economic sustainability		High economic sustainability	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE_SIZE, w	-0.000 [0.001]	-0.000 [0.001]	0.001 [0.001]	0.000 [0.001]	0.000 [0.001]	-0.000 [0.001]
DEBT_RATIO, w	-0.009* [0.005]	-0.009* [0.005]	- 0.018*** [0.004]	- 0.017*** [0.004]	- 0.021*** [0.004]	- 0.021*** [0.004]
ROA, w	- 0.028*** [0.009]	- 0.028*** [0.009]	- 0.074*** [0.011]	- 0.074*** [0.011]	- 0.190*** [0.012]	- 0.190*** [0.012]
CASH_RATIO, w	0.031*** [0.008]	0.031*** [0.008]	0.080*** [0.008]	0.081*** [0.008]	0.094*** [0.007]	0.095*** [0.007]
TOBINQ_RATIO, w	0.003*** [0.001]	0.003*** [0.001]	0.007*** [0.001]	0.006*** [0.001]	0.007*** [0.001]	0.007*** [0.001]
CORP GOVERNANC, w		0.002 [0.003]		0.010*** [0.003]		0.004 [0.003]
Constant	0.011 [0.010]	0.012 [0.009]	-0.013* [0.008]	-0.006 [0.008]	-0.015 [0.012]	-0.012 [0.012]
R-squared	0.307	0.307	0.444	0.445	0.497	0.497
Observations	8936	8936	16151	16151	12164	12164

Environmental sustainability defines the pursuit of long-term preservation of the country environment (such as the use of renewable energy, the reduction of harmful gas emissions, and the availability of (clean) energy). Environmental sustainability was measured by three important indicators: 1) the share of renewable energy in total energy; 2) carbon dioxide emissions per unit of GDP; 3) proportion of population with access to electricity. Thus, 18 OLS regression models developed, using formulas 26-31, in order to find, whether corporate governance and financial performance can

influence the corporate innovation investments intensity and risk across different levels of countries environmental sustainability. In addition, regression models were created for each countries environmental sustainability group: low, medium and high (the dynamics of the countries environmental sustainability groups are presented in Annex 3). First of all, the results are presented, when environmental sustainability is measured according to the indicator of the share of renewable energy in total energy. The results of the first OLS regression model (*see table 23, Column Model1*) included only financial ratios of companies in low environmental sustainability countries (the lowest share of renewable energy in total energy) (in total 12,238 observations). Results show that debt ratio, return on assets, cash ratio and Tobin's q ratio are significant variables for the corporate innovation investments intensity and risk, because estimated probability p is less than a significance level 0.01 (1 %). Model 2 included the financial performance and corporate governance from companies operating in low environmental sustainability countries (in total 12,238 observations). The results of this OLS regression model (*see table 23, column Model2*) show that corporate governance representing the transparent and fair practice of board functions, structure, compensation policy, vision, strategy, shareholder rights is a particularly significant variable (the estimated probability p of corporate governance is less than 0.01 (1 %)). Summarized results prove that financial performance and corporate governance have an important impact on corporate innovation investments intensity and risk in low environmental sustainability countries, where low environmental sustainability is the lowest share of renewable energy in total energy. The results of the third OLS regression model (*see table 23, column Model3*), which included the financial ratios of companies from countries with medium environmental sustainability (medium share of renewable energy in total energy) (in total 16,428 observations), show that the same financial ratios, as in the models 1-2, are significant. The results of the fourth OLS regression model (*see table 23, column Model4*), which included the financial ratios and corporate governance from companies operating in the medium environmental sustainability countries (16,428 observations in total), show that corporate governance is a significant variable, because estimated probability p of corporate governance is less than 0.05 (5 %)). Summarized results prove that financial performance and corporate governance are significant variables and these ratios have an important impact on corporate innovation investments intensity and risk in medium environmental sustainability countries, where medium environmental sustainability is the medium share of renewable energy in total energy. The results of the fifth OLS regression model (*see table 23, column Model5*), which included only the financial ratios of companies from high environmental sustainability countries (highest share of renewable energy in total energy) (in total 8,585 observations), show that the same financial ratios are significant, as in Models 1-4. Model 6 included financial ratios and corporate governance from high environmental sustainability countries (in total 8,585 observations). The results of this OLS regression model (*see table 23 column Model6*) show that corporate governance is not significant variable, which is not affecting the corporate innovation investments intensity and risk. Consequently, corporate governance has a greater influence on corporate innovation investments intensity and risk in countries with medium

environmental sustainability. In addition, it could be a signal to companies operating in countries with lower environmental sustainability in order to increase their higher innovation investments intensity and contribute to seek environmental sustainability level.

Table 23. OLS regression models' results by countries environmental sustainability groups, where environmental sustainability was measured by the share of renewable energy in total energy (*see formulas (20-25)*)

Environmental Sustainability	Low		Medium		High	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE_SIZE, w	0.001 [0.001]	0.001 [0.001]	0.000 [0.001]	-0.000 [0.001]	-0.000 [0.001]	-0.001 [0.001]
DEBT_RATIO, w	-0.019*** [0.004]	-0.019*** [0.004]	-0.020*** [0.004]	-0.020*** [0.004]	-0.002*** [0.006]	-0.002*** [0.006]
ROA, w	-0.042*** [0.013]	-0.042*** [0.013]	-0.113*** [0.010]	-0.113*** [0.010]	-0.045*** [0.014]	-0.045*** [0.014]
CASH_RATIO, w	0.023*** [0.008]	0.024*** [0.008]	0.100*** [0.007]	0.100*** [0.007]	0.064*** [0.011]	0.064*** [0.011]
TOBINQ_RATIO, w	0.004*** [0.001]	0.004*** [0.001]	0.007*** [0.001]	0.007*** [0.001]	0.004*** [0.001]	0.004*** [0.001]
CORP GOVERNANC, w		0.009*** [0.004]		0.007** [0.003]		0.001 0.003
Constant	-0.015 [0.010]	-0.010 [0.009]	-0.028** [0.014]	-0.024* [0.015]	0.003 [0.011]	0.003 [0.011]
R-squared	0.334	0.336	0.506	0.507	0.390	0.390
Observations	12238	12238	16428	16428	8585	8585

Second, results are presented, when environmental sustainability is measured according to indicator of carbon dioxide emissions per unit of GDP. The results of the first OLS regression model (*see table 24, Column Model1*) included financial ratios of companies from low environmental sustainability countries (most carbon dioxide emissions per unit of GDP) (10,643 observations in total). Results show that debt ratio, return on assets, cash ratio and Tobin's q ratio are important variables for the corporate innovation investments intensity and risk, because estimated probability p is less than a significance level 0.01 (1 %). Model 2 included the financial performance and corporate governance from companies operating in countries with low environmental sustainability (in total 10,643 observations). The results of this OLS regression model (*see table 24, column Model2*) show that corporate governance, which represents the

transparent and fair practice of board members, is not a significant variable. Summarized results prove that only financial performance influences the corporate innovation investments intensity and risk in low environmental sustainability countries, where low environmental sustainability is measured by the highest indicator of carbon dioxide emissions per unit of GDP.

Table 24. OLS regression models' results by countries environmental sustainability groups, where environmental sustainability was measured by the indicator of carbon dioxide emissions per unit of GDP (*see formulas (20-25)*)

Environmental sustainability	Low environmental sustainability		Medium environmental sustainability		High environmental sustainability	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE_SIZE, w	-0.000 [0.001]	-0.001 [0.001]	0.002** [0.001]	0.001 [0.001]	0.000 [0.000]	-0.000 [0.001]
DEBT_RATIO, w	-0.012** [0.006]	-0.012** [0.006]	-0.021*** [0.004]	-0.020*** [0.004]	-0.018*** [0.004]	-0.018*** [0.004]
ROA, w	-0.062*** [0.016]	-0.062*** [0.016]	-0.039*** [0.013]	-0.038*** [0.013]	-0.101*** [0.009]	-0.101*** [0.009]
CASH_RATIO, w	0.063*** [0.012]	0.064*** [0.012]	0.021** [0.009]	0.021*** [0.008]	0.098*** [0.006]	0.098*** [0.006]
TOBINQ_RATIO, w	0.005*** [0.001]	0.005*** [0.001]	0.001 [0.001]	0.001 [0.001]	0.007*** [0.001]	0.007*** [0.001]
CORPGOVERNANC, w		0.003 [0.003]		0.020*** [0.005]		0.006** [0.003]
Constant	-0.006 [0.012]	-0.004 [0.011]	-0.023 [0.014]	-0.003 [0.014]	-0.013 [0.009]	-0.008 [0.010]
R-squared	0.320	0.320	0.420	0.430	0.495	0.495
Observations	10643	10643	8160	8160	18448	18448

The results of the third OLS regression model (*see table 24, column Model3*), which included the financial ratios of companies from countries with medium environmental sustainability (medium carbon dioxide emissions per unit of GDP) (in total 8,160 observations), show that all included financial ratios are significant and make an impact on corporate innovation investments intensity and risk. The results of the fourth OLS regression model (*see table 24, column Model4*), which included the financial ratios and corporate governance from companies operating in medium environmental sustainability countries (in total 8,160 observations), show that corporate governance is important variable too. Thus, summarized results demonstrate that financial performance and corporate governance can make a meaningful impact on corporate innovation investments intensity and risk in medium environmental

sustainability countries, where medium environmental sustainability is measured by the medium indicator of carbon dioxide emissions per unit of GDP. The results of the fifth OLS regression model (*see table 24, column Model5*), which included the financial ratios of companies from high environmental sustainability countries (minimum carbon dioxide emissions per unit of GDP) (in total 18,448 observations), show that the same financial ratios are as significant as in models 1-2. Model 6 included financial ratios and corporate governance from high environmental sustainability countries (in total 18,448 observations). The results of this OLS regression model (*see table 24, column Model6*) show that corporate governance is a significant variable too. It means that corporate governance is affecting the corporate innovation investments intensity and risk, because estimated probability p is less than a significance level of 0.01 (5 %). Summarized results prove that financial performance and corporate governance have an important impact on corporate innovation investments intensity and risk in high environmental sustainability countries, where high environmental sustainability is the lowest indicator of carbon dioxide emissions per unit of GDP.

Third, the results, when environmental sustainability is measured according to indicator of proportion of population with access to electricity, are presented. The results of the first OLS regression model (*see table 25, Column Model1*) included financial ratios of corporate from low environmental sustainability countries (the lowest proportion of population with access to electricity) (in total 12,218 observations). Results prove that debt ratio, return on assets, cash ratio and Tobin's q ratio are significant variables for the corporate innovation investments intensity and risk, because estimated probability p is less than a significance level 0.01 (1 %). Model 2 included the financial performance and corporate governance from companies operating in low environmental sustainability countries (in total 12,218 observations). Results of this OLS regression model (*see table 25, column Model2*) show that corporate governance is a significant variable. However the estimated probability p of corporate governance is smaller than a significance level of 0.1 (10 %). Results demonstrates that financial performance and corporate governance can make an impact on corporate innovation investments intensity and risk in low environmental sustainability countries, where low environmental sustainability is the lowest indicator of proportion of population with access to electricity. The results of the third OLS regression model (*see table 25, column Model3*), which included the financial ratios of companies from countries with medium environmental sustainability (medium indicator of proportion of population with access to electricity) (in total 6,834 observations), show that the same financial ratios as in the models 1-2 are significant. The results of the fourth OLS regression model (*see table 25, column Model4*), which included the financial ratios and corporate governance from companies operating in the medium environmental sustainability countries (6,834 observations in total), show that corporate governance is a significant variable. Additionally, estimated probability p of corporate governance is less than a significance level of 0.1 (10 %). Summarized results prove that financial performance and corporate governance can have an impact on corporate innovation investments intensity and risk in medium environmental sustainability countries, where medium

environmental sustainability is the medium indicator of proportion of population with access to electricity.

Table 25. OLS regression models' results by countries environmental sustainability groups, where environmental sustainability was measured by the proportion of population with access to electricity (*see formulas (20-25)*)

Environmental sustainability	Low environmental sustainability		Medium environmental sustainability		High environmental sustainability	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATE SIZE, w	0.000	-0.000	-0.000	-0.001	-0.000	-0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
DEBT_RATIO, w	-0.013**	-0.012**	-0.014***	-0.014***	-0.023***	-0.023***
	[0.005]	[0.005]	[0.004]	[0.004]	[0.004]	[0.004]
ROA, w	-0.073***	-0.073***	-0.036***	-0.036***	-0.130***	-0.131***
	[0.017]	[0.017]	[0.012]	[0.012]	[0.010]	[0.010]
CASH_RATIO, w	0.046***	0.047***	0.036***	0.036***	0.108***	0.108***
	[0.010]	[0.010]	[0.012]	[0.012]	[0.006]	[0.006]
TOBINQ_RATIO, w	0.005***	0.005***	0.002***	0.002***	0.007***	0.007***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
CORP_GOVERNANC, w		0.008*		0.005*		0.004
		[0.004]		[0.003]		[0.003]
Constant	-0.024*	-0.017	0.009	0.015	-0.035*	-0.035
	[0.013]	[0.013]	[0.012]	[0.012]	[0.021]	[0.021]
R-squared	0.341	0.342	0.266	0.268	0.533	0.533
Observations	12218	12218	6834	6834	18199	18199

The results of the fifth OLS regression model (*see table 25, column Model5*), which included only the financial ratios of companies from high environmental sustainability countries (highest indicator of proportion of population with access to electricity) (in total 18,199 observations), show that the same financial ratios are as significant as in Models 1-4. Model 6 included financial ratios and corporate governance from high environmental sustainability countries (in total 18,199 observations). The results of this OLS regression model (*see table 25, column Model 6*) show that corporate governance is not a significant variable. It means that corporate governance does not affect the corporate innovation investments intensity and risk. In summary, by this case only control of financial performance can be a meaningful signal for corporate and countries seeking to improve environmental sustainability level, where higher environmental sustainability would be measured by the highest indicator of proportion of population with access to electricity. All results from this

chapter, financial ratios (debt ratio, return on assets, cash ratio and Tobin's q ratio) have an important effect on the corporate innovation investments intensity and risk in all (low, medium, and high) environmental sustainability countries, where countries were divided into groups by three different indicators. Return on assets, size and debt ratio can have a significant impact on the intensity and risk of corporate innovation investments, as this indicator increases, profits, possibilities and own equity increase as well, so the risk of innovation investments decreases. Ratios (cash ratio and Tobin's q ratio) can have important effect on the corporate innovation investments intensity and risk, because the money and the market value increase, when these ratios increase too. However corporate governance influences the corporate innovation investments intensity and risk in medium and high countries environmental sustainability groups. It proves that corporate with higher financial performance and level of corporate governance are more efficient in activities of innovation investments in medium and high environmental sustainability countries. Thus, these results could be a meaningful signal to other companies operating in low economic sustainability countries. It could be a signal to other countries seeking higher environmental sustainability.

Social sustainability is country's social activity and social responsibility in the long-term perspective. Moreover social sustainability of a country was measured by 2 key indicators: social score and share of wages and social protection in GDP (*see Chapter 3 table 26 and formula 26-31*). To investigate whether corporate governance and financial performance may influence the corporate innovation investments intensity and risk across countries at different levels in terms of social sustainability, six OLS regression models based on *formulas 26-31* were developed. These regression models are for each countries social sustainability groups: low, medium and high (the dynamics of the each country social sustainability groups presented in *Annex 4*). First of all, the calculations results, when social sustainability was measured by ratio of social score, are presented. OLS regression model number 1 includes only the financial ratios of companies in low social sustainability countries (9,289 observations in total). The results of this OLS regression model show that debt ratio, return on assets, cash ratio size and Tobin's q ratio are the most significant and these ratios influence the corporate innovation investments intensity and risk, because estimated probability p is less than 0.01 significance level (*see table 26, column Model1*). Regression Model 2 includes the financial ratios and corporate governance in companies of low social sustainability (9,289 observations in total). The results of this OLS regression model (*see table 26, column Model 2*) show that financial ratios both with corporate governance are significant. Corporate governance, which is representing the transparent and fair practice of the board's functions, structure, compensation policy, vision, strategy, shareholder rights, is also a significant variable, because an estimated probability p is less than a significance level of 0.05. The results of the third OLS regression model (*see table 26, column Model3*), which included only the financial ratios of companies of medium social sustainability (18,626 observations in total), show that all financial ratios (debt ratio, ROA, cash ratio and Tobin's q ratio) are significant (estimated probability p is less than a significance level of 0.01). The results of the fourth OLS regression model (*see table 26, column Model4*), which included the financial ratios and corporate governance of enterprises

in the medium social sustainability countries (18,626 observations in total), show that financial ratios without corporate governance is significant variable, because probability p is less than a significance level of 0.01. Model 5 includes only the financial ratios of companies in high social sustainability countries (9,336 observations in total). The results of this OLS regression model (*see table 26, column Model 5*) show that the same financial ratios are significant as in Models 1, 2, and 4; however, the debt ratio and size is not significant. The results of the sixth OLS regression model (*see table 26, column Model 6*), which included financial ratios and corporate governance from high social sustainability countries (9,336 observations in total), show that financial ratios (ROA, cash ratio, Tobin's q ratio) are more significant than corporate governance. It means only financial ratios are affecting the corporate innovation investments intensity and risk in high social sustainability countries.

Table 26. OLS regression models results' by countries social sustainability groups, where social sustainability was measured by the social score (*formulas (26-31)*)

Social Sustainability	Low social Sustainability		Medium social Sustainability		High social Sustainability	
	Model1	Model2	Model3	Model4	Model5	Model6
CORPORATESIZE, w	-0.003*** [0.001]	-0.003*** [0.001]	-0.000 [0.001]	-0.001 [0.001]	0.001 [0.001]	0.001 [0.001]
DEBT_RATIO, w	-0.014*** [0.004]	-0.014*** [0.004]	-0.016*** [0.003]	-0.015*** [0.003]	-0.008 [0.006]	-0.008 [0.006]
ROA, w	-0.122*** [0.009]	-0.122*** [0.009]	-0.068*** [0.011]	-0.068*** [0.011]	-0.045*** [0.016]	-0.045*** [0.016]
CASH_RATIO, w	0.079*** [0.007]	0.079*** [0.007]	0.070*** [0.007]	0.070*** [0.007]	0.085*** [0.010]	0.085*** [0.010]
TOBINQ_RATIO, w	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]	0.005*** [0.001]
CORP GOVERNAN, w		0.009*** [0.003]		0.003 [0.002]		0.005 [0.004]
Constant	0.026* [0.014]	0.028** [0.014]	-0.002 [0.010]	-0.001 [0.010]	-0.014 [0.012]	-0.017 [0.012]
R-squared	0.513	0.514	0.386	0.386	0.484	0.485
Observations	9289	9289	18626	18626	9336	9336

Second, calculations results, when economic sustainability was measured by ratio of Share of wages and social protection in GDP, are presented. Firstly, OLS regression model includes only the financial ratios of companies in low social sustainability countries (the lowest Share of wages and social protection in GDP) (in total 8,430 observations). The results of this OLS regression model show that debt

ratio, return on assets, cash ratio and Tobin's q ratio are the most significant and these ratios influence the corporate innovation investments intensity and risk, because estimated probability p is less than 0.01 significance level (see table 27, column Model1). Regression Model 2 includes the financial ratios and corporate governance from companies operating in low social sustainability countries (in total 8,430 observations). The results of this OLS regression model (see table 27, column Model2) show that corporate governance is not significant. It proves that only financial ratios are affecting the corporate innovation investments intensity and risk in low social sustainability countries, where social responsibility was measured by the lowest share of wages and social protection in GDP. The results of the third OLS regression model (see table 27, column Model3), which included only the financial ratios of companies of medium social sustainability (the medium Share of wages and social protection in GDP) (15,16 observations in total), show that all financial ratios (corporate size, debt ratio, ROA, cash ratio and Tobin's q ratio) are significant. The estimated probability p is less than a significance level of 0.01. The results of the fourth OLS regression model (see table 27, column Model4), which included the financial ratios and corporate governance of enterprises in the medium social sustainability countries (15,167 observations in total), show that financial ratios both with corporate governance are significant variables, because probability p is less than a significance level of 0.01. It means that financial ratios and corporate governance are affecting the corporate innovation investments intensity and risk in medium social sustainability countries, where social responsibility was measured by the medium share of wages and social protection in GDP. Model 5 includes only the financial ratios of companies from high social sustainability countries (the highest ratio - share of wages and social protection in GDP) (in total 12,746 observations). The results of this OLS regression model (see table 27, column Model5) show that the same financial ratios are significant as in Models 1-4, because the debt ratios estimated probability p is less than the significance level 0.01. The results of the sixth OLS regression model (see table 27, column Model6), which included financial ratios and corporate governance from high social sustainability countries (in total 12,746 observations), show that financial ratios (debt ratio, ROA, cash ratio, Tobin's q ratio) are more significant than corporate governance. It means that only financial ratios are affecting the corporate innovation investments intensity and risk in high social sustainability countries, where social responsibility was measured by the highest ratio - share of wages and social protection in GDP. Corporate size is a significant variable that influences the corporate innovation investments intensity and risk in countries of medium social sustainability. Corporate governance only affects the corporate innovation investments intensity and risk in countries with low and medium social sustainability. This shows that in countries with high social sustainability, corporate governance is less relevant to the corporate innovation investments intensity and risk. Return on assets and debt ratio can have a significant impact on the intensity and risk of corporate innovation investments, as as this indicator increases, the risk of innovation investments decreases, because profits and own equity increase as well. Cash ratio and Tobin's q ratio can have important impact on the corporate innovation investments intensity and risk, when the money and the market value increase too.

Table 27. OLS regression models' results by countries social sustainability groups, where social sustainability was measured by the share of wages and social protection in GDP (*see formulas (26-31)*)

Social sustainability	Low social sustainability		Medium social sustainability		High social sustainability	
	Model1	Model2	Model3	Model4	model5	model6
CORPORATE_SIZE, w	-0.000 [0.001]	-0.001 [0.001]	0.000 [0.001]	0.000 [0.001]	0.000 [0.001]	0.000 [0.001]
DEBT_RATIO, w	⁻ 0.008*** [0.003]	⁻ 0.007*** [0.003]	⁻ 0.017*** [0.005]	⁻ 0.017*** [0.005]	⁻ 0.024*** [0.004]	⁻ 0.024*** [0.004]
ROA, w	⁻ 0.029*** [0.011]	⁻ 0.030*** [0.011]	⁻ 0.088*** [0.012]	⁻ 0.088*** [0.012]	⁻ 0.183*** [0.011]	⁻ 0.183*** [0.011]
CASH_RATIO, w	0.022** [0.009]	0.023** [0.009]	0.093*** [0.008]	0.093*** [0.008]	0.091*** [0.008]	0.091*** [0.008]
TOBINQ_RATIO, w	0.002*** [0.001]	0.002*** [0.001]	0.007*** [0.001]	0.007*** [0.001]	0.010*** [0.001]	0.010*** [0.001]
CORPGOVERNAN, w		0.004 [0.003]		0.005* [0.003]		0.006 [0.004]
Constant	0.003 [0.009]	0.007 [0.008]	-0.011 [0.014]	-0.009 [0.014]	-0.008 [0.011]	-0.003 [0.011]
R-squared	0.209	0.211	0.491	0.491	0.484	0.484
Observations	8430	8430	15167	15167	12746	12746

In summary, debt ratio, return on assets, cash ratio and the Tobin's q ratio are significant variables that influence the corporate innovation investments intensity and risk in all low, medium, and high social sustainability countries included in the investigation. In addition, it could be a signal to countries with lower environmental sustainability too.

4.3. Results of impact of key risk financial factors on corporate innovation investments intensity and risk by Fixed-effects regression models

To analyze whether the corporate governance and financial performance of corporate can influence their innovation investments intensity and risk, fixed-effects regression models were first developed, involving all countries. The first fixed-effects regression model included only corporate financial ratios (corporate size, debt ratio, return on assets, cash and Tobin's q ratios).

The results show (*see table 28*) that all 5 financial variables included in the model are significant (the estimated probability p of all variables is less than the significance level 0.05). Consequently, financial variables of companies such as corporate size, debt ratio, return on assets, cash and Tobin's q ratios have a significant influence on the level these companies investments intensity and risk. 4 financial ratios out of the 5 included in the model can reduce the corporate innovation investments intensity and risk (negative *Coef.*). These are corporate size, debt ratio, return on assets, and cash ratio. The decline in the level of innovation risk depending on the corporate size, expressed as a natural logarithm of the assets, indicates that companies with larger assets are less risky to invest in innovation, but at the same time the intensity of innovation is slower. Growth of the company by increasing the volume of assets may be a signal for smaller companies, which seek to reduce risk by investing in innovation. The potential reduction in innovation risk depending on the level of debt, reflecting the level of liabilities per unit of assets, means that companies with higher levels of debt are less likely to invest in innovation. For companies with significantly higher levels of equity than debt, this may also be a signal for higher investments intensity. The decline in the risk level of innovation, influenced by the return on assets, which is expressed as the ratio of net profits to assets, shows that companies with higher return on assets are less risky to invest in innovation, but at the same time innovation intensity may be slower. Management of net profit and wealth can be a signal for companies with lower return on assets that want to reduce risk by investing in innovation. The potential reduction in innovation risk depending on the level of cash ratio, which reflects the amount of cash and cash equivalents per asset unit, means that companies with a higher cash level have a lower level of investments risk in innovation. For companies with consistently low cash balances, this can be a signal for reducing investments risk. Contrary to corporate size, debt level, return on assets, and cash ratio, the Tobin's q coefficient in this regression model is positive. Consequently, depending on the Tobin's q ratio, which is expressed as the ratio of assets to market capitalization excluding equity and total assets, there is a potential increase in the intensity of innovation and, at the same time, an increase in risk. Increasing market capitalization per unit of assets may be a signal for companies seeking to increase the intensity of innovation. The coefficient of determination (*R-squared*) of this first fixed-effects regression model, showing the dispersion about the mean of the random values acquired, is 0.9128 (*see table 28*). This ratio shows that 91.28% of the financial performance (corporate size, debt ratio, return on assets, cash ratio and Tobin's q ratio) determines corporate innovation investments intensity and risk. Only 8.72 percent of the proportion of variation in the dependent variable is determined by other unmeasured variables.

Table 28. Fixed-effects regression model results excluding corporate governance (CORP_GOVERNANCE) (*see formula (40)*)

Number of obs = 42,160				Prob > F = 0.0000		
No. of categories = 6,033				R-squared = 0.9128		
F(21, 6032) = 5.23				Adj R-squared = 0.8981		
				Root MSE = 0.0136		
w_INTE&RISK	Coef.	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
w_CORP_SIZE	.0040083	.0008018	-5.00	0.000	-.0055802	-.0024364
w_DEBT_RAT	.0069972	.0024296	-2.88	0.004	-.01176	-.0022343
w_ROA	.0160227	.0033633	-4.76	0.000	-.022616	-.0094295
w_CASH_RAT	.0096931	.0033123	-2.93	0.003	-.0161865	-.0031997
w_TOBINQ	.0012406	.0004795	2.59	0.010	.0003006	.0021806
2003	.0001045	.0004124	-0.25	0.800	-.000913	.000704
2004	.0011022	.0007342	-1.50	0.133	-.0025415	.0003371
2005	.0012909	.0008681	-1.49	0.137	-.0029927	.000411
2006	.0004248	.0009834	-0.43	0.666	-.0023526	.0015031
2007	.0005347	.0010614	0.50	0.614	-.0015461	.0026154
2008	.0020361	.001091	1.87	0.062	-.0001026	.0041748
2009	.0010794	.0011594	0.93	0.352	-.0011934	.0033522
2010	.0003969	.0012315	0.32	0.747	-.0020173	.0028111
2011	.0010641	.0012792	0.83	0.406	-.0014436	.0035719
2012	.00153	.0013164	1.16	0.245	-.0010505	.0041105
2013	.0012522	.0012792	0.98	0.328	-.0012554	.0037599
2014	.001372	.0012724	1.08	0.281	-.0011224	.0038665
2015	.0004368	.001256	0.35	0.728	-.0020254	.0028991
2016	.0014684	.0012788	1.15	0.251	-.0010385	.0039753
2017	.0013055	.0012969	1.01	0.314	-.0012368	.0038478
2018	.0012531	.0014233	0.88	0.379	-.001537	.0040432
_cons	.0797208	.0115003	6.93	0.000	.057176	.1022656

Fixed-effects regression model (*see table 29*) included corporate financial ratios (corporate size, debt ratio, return on assets, cash ratio and Tobin's q ratio) and corporate governance (total of 6 independent variables).

Table 29. Results of a fixed effects regression model incorporating the Corporate Governance (CORP_GOVERNANCE) (*see formula (41)*)

Number of obs = 42,16				Prob > F = 0.0000		
No. of categories = 6,033				R-squared = 0.9128		
F(22, 6032) = 5.26				Adj R-squared = 0.8982		
				Root MSE = 0.0136		
w_INTE&RISK	Coef.	Robust Std. Err.	t	P>t	[95% Conf. Interval]	
w_CORP_SIZE	-.0040943	.0008023	-5.10	0.000	-.005667	-.0025215
w_DEBT_RAT	-.0069896	.0024302	-2.88	0.004	-.0117537	-.0022254
w_ROA	-.0159845	.0033622	-4.75	0.000	-.0225756	-.0093934
w_CASH_RAT	-.0096373	.0033123	-2.91	0.004	-.0161306	-.0031441
w_TOBINQ	.0012453	.0004796	2.60	0.009	.0003051	.0021855
w_CORPGOV	.0024392	.0009152	2.67	0.008	.0006451	.0042333
2003	-.0000851	.0004129	-0.21	0.837	-.0008946	.0007244
2004	-.0013007	.0007408	-1.76	0.079	-.002753	.0001515
2005	-.0015658	.0008758	-1.79	0.074	-.0032826	.000151
2006	-.0006992	.0009892	-0.71	0.480	-.0026384	.0012399
2007	.0002449	.0010625	0.23	0.818	-.0018379	.0023277
2008	.0017313	.0010939	1.58	0.114	-.0004131	.0038757
2009	.0007517	.0011629	0.65	0.518	-.001528	.0030315
2010	-8.82e-06	.0012342	-0.01	0.994	-.0024282	.0024106
2011	.0006506	.0012842	0.51	0.612	-.001867	.0031681
2012	.0011022	.0013242	0.83	0.405	-.0014937	.003698
2013	.0008217	.0012909	0.64	0.524	-.0017089	.0033523
2014	.0009118	.0012842	0.71	0.478	-.0016056	.0034293
2015	-.0000871	.0012748	-0.07	0.946	-.0025862	.0024119
2016	.0008755	.0013011	0.67	0.501	-.0016752	.0034261
2017	.0006521	.0013251	0.49	0.623	-.0019455	.0032498
2018	.0009113	.0014239	0.64	0.522	-.00188	.0037026
_cons	.0801549	.0114946	6.97	0.000	.0576214	.1026884

The results of the second regression model show (*see table 29*) that all variables included in the model are significant (the estimated probability p is less than a significance level of 0.05). In this case, not only the corporate size, debt ratio, return on assets, cash ratio and Tobin's q ratio have a significant influence on corporate innovation investments intensity and risk, but also their corporate governance. According to this second regression model, the same 4 financial ratios (corporate size, debt ratio, return on assets, and cash ratio) may reduce the corporate innovation investments intensity and risk (negative *Coef.*). Declining innovation risk levels depending on corporate size, debt level, return on assets and cash ratio indicate that companies with higher asset volumes, return on assets, total equity and cash levels are less risky to invest in innovation, but at the same time it may be investing slower. Just as the results of the first and second regression models show that, depending on the Tobin's q ratio, there is a potential for an increase in innovation intensity and a corresponding increase in risk. Moreover the most important component of this regression model, an indicator of corporate governance that shows transparency, clarity, fairness and efficiency of board functions, structure, compensation policy is that companies with greater transparency invest in innovation. In this case, the investment intensity of innovation is higher, but it also involves higher risks. A more transparent practice in the shareholder rights can be a signal to companies seeking to increase the intensity of innovation. According to table 29, the coefficient of determination (*R-squared*) of this second fixed-effects regression model shows that 91.28% of the financial performance (corporate size, debt ratio, return on assets, cash ratio and Tobin's q ratio) and the corporate governance determine the corporate innovation investments intensity and risk. Results show that only 8.72% of variation in the dependent variable is determined by other unmeasured variables. In this case, the coefficient of determination correcting (Adj *R-squared*) for the increase in the standard deviation due to the addition of the variables of 0.8982 or 89.82% was corrected. It is also quite high and significant.

Findings and insights

The results as a matrix of economic interconnection are presented in the following *table 30*. In order to answer the main research question, whether corporate governance and financial performance influence the corporate innovation investments intensity and risk in different country sustainability groups (low, medium and high) across countries, 26 regression models were developed, incorporating 42,160 observations, 15 indicators (7 indicators micro level and 4 indicators at macro level). The results of the fixed regression model, where countries were not grouped by sustainability dimensions, showed that corporate governance and financial performance (corporate size, debt ratio, return on assets, cash ratio, Tobin's q ratio) significantly influence corporate innovation investments intensity and risk. The results of the OLS regression models in the Innovation Sustainability Group showed that return on assets, cash ratio and Tobin's q ratio are the main variables affecting corporate innovation investments intensity and risk across all (low, medium, and high) innovation sustainability groups.

Table 30. Economic interconnection matrix

	Corporate innovation investments intensity and risk		
	Low sustainability	Medium sustainability	High sustainability
	Innovation sustainability of countries group		
Return on assets	SNI	SNI	SNI
Debt ratio	-	SNI	SNI
Corporate Size	-	-	-
Cash ratio	SPI	SPI	SPI
Tobin's q ratio	SPI	SPI	SPI
Corporate governance	-	-	SPI
	Economic sustainability of countries group		
Return on assets	SNI	SNI	SNI
Debt ratio	SNI	SNI	SNI
Corporate Size	-	-	-
Cash ratio	SPI	SPI	SPI
Tobin's q ratio	SPI	SPI	SPI
Corporate governance	-	SPI	SPI
	Environmental sustainability of countries group		
Return on assets	SNI	SNI	SNI
Debt ratio	SNI	SNI	SNI
Corporate Size	-	-	-
Cash ratio	SPI	SPI	SPI
Tobin's q ratio	SPI	SPI	SPI
Corporate governance	SPI	SPI	SPI
	Social sustainability of countries group		
Return on assets	SNI	SNI	SNI
Debt ratio	SNI	SNI	SNI
Corporate Size	SNI	SNI	
Cash ratio	SPI	SPI	SPI
Tobin's q ratio	SPI	SPI	SPI
Corporate governance	SPI	SPI	-

SNI – significant negative impact; *SPI* - significant positive impact; - no impact.

Meanwhile corporate governance only affects this intensity and risk in high-innovation countries. Corporate governance can be a signal for low and medium innovation sustainability countries to improve their innovation performance. Results

from OLS regression models across economic sustainability groups showed that not only return on assets, cash ratio, Tobin's q ratio, but also debt ratio, influence corporate innovation investments intensity and risk across all (low, medium, and high) economic sustainability groups. Meanwhile corporate governance influences the intensity and risk of corporate investments in innovation in middle and high economic sustainability countries. Corporate governance can also be a signal for countries with low economic sustainability. Results from OLS regression models across countries environmental sustainability groups showed that debt ratio, return on assets, cash ratio, Tobin's q ratio, and corporate governance are key variables affecting the corporate innovation investments intensity and risk in all (low, medium, and high) environmental sustainability groups. Results from OLS regression models of country social sustainability groups showed that debt ratio, return on assets, cash ratio, Tobin's q ratio are also key variables affecting corporate innovation investments intensity and risk across all (low, medium, and high) social sustainability groups. In this case, corporate governance influences this intensity and risk in low and medium social sustainability countries. In conclusion, corporate governance is of a particular focus because, when corporate clearly define and practice the functions and structure of the board, compensation policies, vision and strategy, as well as shareholder rights, corporate not only have the opportunity to increase their innovation investments intensity, but also contribute to country sustainability improvement.

CONCLUSIONS

1. The analysis of the significance of corporate innovation investments intensity and risk in the context of the countries sustainability based on scientific sources, revealed three important findings.
 - 1.1. Corporate innovation investments are crucial for maintaining the competitiveness and efficiency of operations. Researchers unequivocally agree that the development of new and/or improved products, services, management, marketing and organizational innovation enables corporate to compete in the market, apply advanced technologies, develop infrastructure, expand and streamline operations. Despite the benefits of innovation explored by researchers, there are risks throughout the innovation value chain that need to be assessed. Risk (internal and external risk variables) leads in all stages of innovation activities.
 - 1.2. Research and experimental development expenditure (R&D expenditure) is a relevant criterion for assessing the corporate innovation investments intensity and risk due to higher added value in products and other innovation. According to research, R&D expenditure must be allocated to three important activities, which are very closely related, for fundamental (theoretical knowledge), applied (practical knowledge), and experimental research (experiments), the results of which create clear added value for companies. Nevertheless, it must also be emphasized that the added value also accrues to the countries. Therefore there is a link between R&D expenditure, innovation investments, business and countries added value. If companies do not innovate, there will be no higher added value for both side corporate and country.
 - 1.3. The intensity and risk of corporate innovation investments and country sustainability are closely interlinked. According to researchers, the innovation investments intensity is development of something new, accompanied by risk. According to them, the country sustainability basically involves the economic growth, cleaner environment and social protection based on sustainable innovation (technological breakthrough). Therefore the innovation investments intensity and risk, innovation itself, economic growth, as well environmental and social protection are highly interlinked, which each country should aspire.
2. The analysis of methodologies for assessing the corporate innovation investment intensity and risk, as well as the key variables influencing it, based on the scientific literature, revealed four essential findings.

- 2.1. According to the research, there is no single specific and rigorous methodology for assessing the innovation investments intensity and/or risk. There are many of them and each corporate must choose the most suitable one according to the specifics and capabilities of its activities. However R&D expenditure is vital for any corporate to stay in the national and international markets. Also, asset is a key criterion for corporate operations, because it is significant indicator of a corporate expanding. Still, asset is the first thing everyone pays attention to if corporate encounters problems with all stakeholders (employees, creditors, suppliers, owners, consumers, government). Therefore the ratio of R&D expenditure to assets was chosen as the main valuation methodology for assessing the corporate innovation investments intensity and risk.
- 2.2. The financial performance (financial results) of corporate according to researchers, who examine the risk factors of innovation investments, is particularly important. Different financial indicators that can have a strong impact are analyzed in scientific sources. However five financial indicators can be distinguished as the main ones: corporate size, debt ratio, return on assets, cash ratio and Tobin's q ratio. Size can affect innovation investment capacity. Debt and cash may influence the sources of financing innovation investments. Return on assets and Tobin q are important for all investors expectations in the market.
- 2.3. In addition to financial indicators, corporate governance can have a significant impact on the innovation investments intensity and risk for several reasons. Usually, the members of the board are directors of different departments of the same company, who receive not only salaries, but also bonuses and premiums for an excellent performance of a company. Innovation investments require additional risks that can affect company's performance, especially during the period when applied, fundamental and experimental research is conducted. As a result, board members may avoid increasing innovation investments.
- 2.4. Country sustainability is understood as long-term economic growth based on environmental protection and social responsibility (three main pillars), but it is crucial that this goal would be based on sustainable innovation. Therefore the country sustainability, based on economic growth, environmental and social protection, is inseparable from the development of innovation (sustainable innovation). So, innovation must be sustainable, contributing to the country sustainability goals such as economic and innovation growth, as well as reducing unemployment and poverty, and of course, ensuring social protection and providing clean energy.

3. A 6-step evaluation methodology was developed to test the scientific hypotheses: (1) data collection; (2) calculation of ratios; (3) formation of OLS regression models; (4) selection and development of country sustainability methodologies; (5) grouping countries according to sustainability dimensions; (6) formation of fixed-effects regression models.
4. The main results based on the tested evaluation methodology (included corporates from 50 countries, 15 indicators from 2002 to 2018, a total of 94 311 750 data points) after testing the scientific hypotheses are formulated in the third part of the dissertation revealed 3 essentially significant findings:
 - 4.1. The results of both OLS and fixed-effects regression models have shown that in assessing the corporate innovation investments intensity and risk, it is important to analyze the factors that significantly affect them, e.i., financial performance and corporate governance (scientific hypotheses H1-H6 were tested). The innovation investments intensity can be stimulated and thus increased if the financial results and the attitude of the board members towards innovation investments improve; however increasing innovation investments increases the risk as well. Therefore planning and risk management are particularly important.
 - 4.2. The financial performance of different groups of countries in terms of innovation, economic and environmental, as well as social sustainability (low, medium and high sustainability) essentially has the same significant impact on the innovation investments intensity and risk. Debt ratio and return on assets reduce innovation investments intensity and risk, while cash ratio and Tobin's q increase this intensity and risk.
 - 4.3. Corporate governance generally has different levels of significant effect on the innovation investments intensity and risk. In low sustainability countries, corporate governance has little significant effect on the innovation investment intensity and risk. This is based on the assumptions that in these countries, board members are less inclined to take risks when allocating funds for applied, fundamental and experimental research. In medium sustainability countries, corporate governance has an important impact on the innovation investments intensity and risk, but this impact is not very strong. This can be explained by the arguments that in these countries, board members tend to take risks, carry out research and experimental development, but it is not sufficient. In high sustainability countries, corporate governance has a particularly strong impact on the innovation investment intensity and risk. The reason is that board members in these countries tend to take on more risk, invest heavily

in applied, fundamental and experimental research, and innovate and patent them quite intensively.

5. Finally, the evidence of the formulated hypothesis and conclusions based on empirical calculations show that financial ratios (financial performance) and corporate governance influence the corporate innovation investments intensity and risk. In addition, corporate governance and financial ratios do not have the same impact on the corporate innovation investments intensity and risk in the different groups of countries *innovation/ economic/ environmental/ and social sustainability*. Corporate governance has stronger impact on corporate innovation investments in higher country sustainability groups. It means that in order to achieve more sustainable growth in the country, it must monitor not only the financial performance of companies, but also the management of corporate governance. Seeking to keep a competitive company in the market by investing in innovation, company owners must not only manage the financial results, but also monitor the management of the corporate governance – total corporate governance framework.

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MOKSLO STRAIPSNIAI DISERTACIJOS TEMA

Humanitariniai, socialiniai mokslai ir menas (HSM)

STRAIPSNIAI RECENZUOJAMUOSE MOKSLO LEIDINIUOSE

Web of Science ar Scopus duomenų bazėse indeksuotuose leidiniuose be cituojamumo rodiklio

Tarptautinėse leidyklose

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(Periodiniuose leidiniuose, tęstiniuose ir vienkartinuose straipsnių rinkiniuose)

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Annex 1. Dynamics of countries' innovation sustainability

Dynamic of innovation sustainability by the share of total R&D expenditure in GDP																	
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Australia	3					3		3	3					3	3		3
Austria	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Belgium	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Brazil			3	3	3	3	3	3			3	3		3	3		3
Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chile			3			3	3			3			3	3	3		3
China	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Colombia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Czech Republic	2	3	2	2	3	2	2	2	3	2	2	2	2	2	2	2	1
Denmark	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Egypt, Arab Rep.	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
Finland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
France	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Germany	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hong Kong SAR, China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hungary	2	1	1	2	1	3	1	2	2	2	2	2	2	1	2	1	1
India	3		3	3		3		3			3	3					3
Indonesia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Israel	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Japan	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Jordan																	
Korea, Rep.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Kuwait		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Luxembourg	2	2	2	2	2	2	2	2	1	1	1	2	1	1	1	2	2
Malaysia						3		3				3	3		3	3	3
Mexico	3		3		3	3	3		3		3	3	3		3		3
Netherlands	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
New Zealand			3			3			3			3					3
Norway	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Peru	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Philippines		1	1			1			1					1		1	
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Portugal	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1
Qatar						3											3
Russian Federation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Saudi Arabia		3	3			1	1		1	3	1			1	3		1
Singapore		3	3		3			3	3			3	3	3		3	3
South Africa		3	3			3		3	3	3		3	3		3		3
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sweden	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Switzerland	3					3								3		3	
Taiwan																	
Thailand	2	3	2		2	3		2	3			3	2	2			3
Turkey	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Arab Emirates						3								3	3		
United Kingdom	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
United States	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1- low innovation sustainability

2- medium innovation sustainability

3- high innovation sustainability

Annex 2. Dynamics of countries' economic sustainability

Dynamic of economic sustainability by changes in economic growth															
Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Australia	3	3	3	2	2	2	3	3	1	2	3	2	2	2	3
Austria	1	1	1	1	2	2	2	2	1	2	1	1	1	1	1
Belgium	2	1	2	1	1	2	2	2	2	2	1	1	1	2	1
Brazil	3	1	3	2	2	3	3	3	3	3	2	3	1	1	1
Canada	3	2	2	2	2	2	2	2	2	3	2	2	2	1	1
Chile	3	3	3	3	3	3	3	3	3	3	3	3	1	2	2
China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Colombia	2	3	3	3	3	3	3	3	2	3	3	3	3	3	2
Czech Republic	1	3	3	3	3	3	3	1	1	2	1	1	3	3	3
Denmark	1	1	1	1	2	1	1	1	1	1	1	1	1	2	2
Egypt, Arab Rep.	2	3	2	3	3	3	3	3	3	2	2	2	3	3	3
Finland	2	2	2	1	3	3	2	1	2	2	1	1	1	1	2
France	1	1	1	1	1	2	2	2	1	2	1	1	1	1	1
Germany	1	1	1	1	2	2	2	1	2	3	1	1	2	2	2
Greece	3	3	3	1	3	2	1	1	1	1	1	1	1	1	1
Hong Kong SAR, China	1	2	3	3	3	3	2	2	3	3	2	3	3	2	3
Hungary	3	3	3	3	2	1	2	1	1	2	1	2	3	3	3
India	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Indonesia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Ireland	3	3	3	3	3	3	1	1	1	2	1	1	3	3	3
Israel	1	1	3	3	3	3	3	3	3	3	2	3	3	3	3
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Japan	1	1	1	1	1	1	1	1	3	1	2	2	1	1	1
Jordan															
Korea, Rep.	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3
Kuwait		3	3	3	3	3	3	1	1	3	3	1	1	1	3
Luxembourg	3	1	2	2	3	3	1	1	3	2	1	3	3	3	3
Malaysia	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
Mexico	1	1	3	1	3	2	2	1	3	3	3	1	2	2	3
Netherlands	1	1	1	1	2	2	2	2	1	2	1	1	1	2	3
New Zealand	3	3	2	2	2	2	1	3	1	2	3	2	3	3	3
Norway	1	1	2	1	1	2	2	3	1	1	3	1	2	2	1
Peru	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
Philippines	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Poland	2	3	3	3	3	3	3	3	2	3	2	1	3	3	3
Portugal	1	1	1	1	1	2	2	2	1	1	1	1	1	2	2
Qatar		3	3	3	3	3	3	3	3	3	3	3	3	3	3
Russian Federation	3	3	3	3	3	3	3	1	3	3	3	2	1	1	1
Saudi Arabia	1	3	3	3	2	2	3	2	3	3	3	3	3	3	2
Singapore	3	3	3	3	3	3	2	3	3	3	3	3	3	2	2
South Africa	3	2	3	3	3	3	3	3	2	3	2	2	1	2	1
Spain	2	3	2	3	3	2	2	2	1	1	1	1	1	3	3
Sweden	2	2	3	1	3	2	1	1	3	2	1	1	2	3	3
Switzerland	1	1	1	2	3	3	2	2	2	2	1	2	2	1	1
Taiwan															
Thailand	3	3	3	3	3	3	2	3	3	1	3	3	1	3	3
Turkey	3	3	3	3	3	3	2	1	3	3	3	3	3	3	3
United Arab Emirates		3	3	3	3	2	3	1	1	3	3	3	3	3	3
United Kingdom	2	3	1	2	1	2	1	1	1	1	1	2	3	2	2
United States	2	2	2	3	2	1	1	2	1	2	2	1	2	2	1

1- low economic sustainability

2- medium economic sustainability

3- high economic sustainability

Dynamic of economic sustainability by unemployment rate																		
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Australia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Austria	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Belgium	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Brazil	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Canada	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Chile	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Colombia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Czech Republic	3	1	1	2	2	1	1	1	2	1	2	1	1	2	2	2	1	
Denmark	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	
Egypt, Arab Rep,	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Finland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
France	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Germany	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	
Greece	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Hong Kong SAR, China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Hungary	2	2	3	2	2	2	2	3	2	2	2	2	2	3	2	2	2	
India	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Indonesia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Ireland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Israel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	
Italy	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Jordan																3	3	
Korea, Rep,	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Kuwait		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Luxembourg	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	
Malaysia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Mexico	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Netherlands	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Peru	3	2	2	3	2	3	2	2	2	3	2	3	3	3	3	3	3	
Philippines	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Poland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Portugal	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Qatar		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Russian Federation	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Saudi Arabia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Singapore	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
South Africa	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Spain	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Sweden	3	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	
Switzerland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Taiwan	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	
Thailand	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Turkey	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
United Arab Emirates		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
United States	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	

1- high economic sustainability

2- medium economic sustainability

3- low economic sustainability

Annex 3. Dynamics of countries' environmental sustainability

Dynamic of environmental sustainability by the share of renewable energy in total energy																	
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Australia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Austria	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Belgium	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Brazil	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Canada	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Chile	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
China	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3
Colombia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Czech Republic	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Denmark	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Egypt, Arab Rep,	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Finland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
France	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Greece	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Hong Kong SAR, China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hungary	3	2	3	2	3	3	3	2	3	2	3	3	2	3	2	3	3
India	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Indonesia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Italy	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Jordan																1	1
Korea, Rep,	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kuwait		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Luxembourg	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Malaysia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mexico	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
New Zealand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Norway	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peru	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Philippines	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Poland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Portugal	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Qatar		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Russian Federation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Saudi Arabia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Singapore	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
South Africa	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Spain	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sweden	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Switzerland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Taiwan	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Thailand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Turkey	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	2	3
United Arab Emirates		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United States	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

1- low environmental sustainability

2- medium environmental sustainability

3- high environmental sustainability

Dynamic of environmental sustainability by the indicator of carbon dioxide emissions per unit of GDP																		
Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Australia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Belgium	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	1	
Brazil	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Canada	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Chile	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Colombia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Czech Republic	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Egypt, Arab Rep.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Finland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
France	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Germany	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Greece	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Hong Kong SAR, China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Hungary	1	1	2	2	1	1	1	2	2	1	1	1	1	1	1	1	1	
India	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Indonesia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Israel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Japan	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Jordan																3	3	
Korea, Rep.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Kuwait		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Luxembourg	1	1	2	1	2	1	2	1	1	1	1	1	1	2	1	1	1	
Malaysia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mexico	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Netherlands	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	1	
New Zealand	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	1	
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Peru	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Philippines	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Poland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Portugal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Qatar		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Russian Federation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Saudi Arabia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Singapore	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
South Africa	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Taiwan	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Thailand	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Turkey	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	
United Arab Emirates		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
United States	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

1- high environmental sustainability

2- medium environmental sustainability

3- low environmental sustainability

Dynamic of environmental sustainability by the proportion of population with access to sustainable and modern energy																		
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Australia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Belgium	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Brazil	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Canada	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Chile	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	
China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Colombia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Czech Republic	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Egypt, Arab Rep.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Finland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
France	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Hong Kong SAR, China	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Hungary	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
India	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Indonesia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Jordan																2	2	
Korea, Rep.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Kuwait		2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Malaysia	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mexico	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Netherlands	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	
New Zealand	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Peru	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Philippines	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Poland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Portugal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Qatar		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Russian Federation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Saudi Arabia	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Singapore	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
South Africa	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Sweden	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Taiwan	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Thailand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Turkey	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
United Arab Emirates		2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
United States	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

1- low environmental sustainability

2- medium environmental sustainability

3- high environmental sustainability

Annex 4. Dynamics of countries' social sustainability

Dynamic of social sustainability by the social score																		
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Australia	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Austria	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	
Belgium	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	
Brazil	3	3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	
Canada	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Chile						3	2	2	2	2	2	2	2	2	2	2	1	
China	1	2	2	2	3	2	2	2	2	2	2	1	2	2	2	2		
Colombia							3	3	2	3	3	2	2	3	2	2		
Czech Republic						2	2	2	2	2	2	2	2	2	2	2		
Denmark	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	2	2	
Egypt, Arab Rep,							1	1	2	2	1	1	1	1	2	2		
Finland	2	2	2	2	2	2	2	2	3	3	3	2	3	3	3	3	3	
France	2	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	
Germany	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	3	
Greece	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Hong Kong SAR, China	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Hungary							3	3	3	3	3	3	3	3	3	3		
India						3	2	2	2	2	2	2	2	2	2	2	2	
Indonesia							2	2	2	2	2	2	2	2	2	2		
Ireland	2	1	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	
Israel	1	1	1	2	2	1	1	2	2	2	2	2	2	2	2	2	2	
Italy	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	2	
Japan	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Jordan																2		
Korea, Rep,	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2		
Kuwait							2	2	2	3	3	3	3	1	2	2	1	
Luxembourg			2	2	1	2	2	2	2	2	2	2	2	2	2	2	1	
Malaysia							2	2	2	2	2	2	2	2	2	2	2	
Mexico	3	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2		
Netherlands	3	2	3	3	2	3	2	3	3	3	3	2	2	3	3	3	2	
New Zealand			2	2	2	2	2	2	2	2	2	2	2	1	2	1	2	
Norway	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Peru							2	2	2	2	2	2	2		2			
Philippines							1	2	2	2	2	2	2	2	2	2		
Poland						2	2	2	2	2	2	2	2	2	2	2	2	
Portugal	2	2	2	2	2	3	3	3	3	3	3	3	3	2	2	3	2	
Qatar							1	1	1	1	1	1	1	2	2	1	1	
Russian Federation	2	1	2	2	3	3	2	2	2	2	2	2	2	2	2	2		
Saudi Arabia						2	1	1	1	1	2	1	2	2	2	2		
Singapore			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
South Africa							2	2	3	3	2	2	2	3	3	2	2	
Spain	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	
Sweden	2	2	2	2	2	2	2	2	3	2	3	2	3	2	2	2	3	
Switzerland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Taiwan	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2		
Thailand						2	2	2	2	2	2	2	2	2	2	2	3	
Turkey							2	2	2	2	2	2	2	2	2	3		
United Arab Emirates							1	1	2	2	2	2	2	2	2	2		
United Kingdom	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
United States	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

1- low social sustainability

2- medium social sustainability

3- high social sustainability

Dynamic of social sustainability by the share of wages and social protection in GDP																	
CountryName	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Australia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Austria	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Belgium	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Brazil																	
Canada	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Colombia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Czech Republic	1	2	2	2	2	2	2	2	2	2	1	2	2	2	1	2	1
Denmark	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3
Egypt, Arab Rep,																	
Finland	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
France	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Germany	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hong Kong SAR, China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hungary	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
India	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Indonesia																	
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Italy	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Japan	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Jordan																	
Korea, Rep,	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Kuwait		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Luxembourg	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Malaysia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mexico	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Netherlands	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
New Zealand	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Peru	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Philippines	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Portugal	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Qatar		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Russian Federation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Saudi Arabia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Singapore	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
South Africa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Spain	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Switzerland	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Taiwan	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Thailand																	
Turkey	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Arab Emirates		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Kingdom	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
United States	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3

1- low social sustainability

2- medium social sustainability

3- high social sustainability

Annex 5. Count of variables data

Country	INTENSITY&RISK	w_CORPORATE SIZE	INNOV_SUSTAIN	ECON_SUSTAIN1	ECON_SUSTAIN2	ENVIRON_SUSTAIN1	ENVIRON_SUSTAIN2	ENVIRON_SUSTAIN3	SOCIAL_SUSTAIN1	SOCIAL_SUSTAIN2
Australia	5457	3060	8	4723	5457	5457	5457	5457	3060	5457
Austria	205	167	205	173	205	205	205	205	167	205
Belgium	337	264	337	283	337	337	337	337	264	337
Brazil	1258	559	15	1085	1258	1258	1258	1258	559	0
Canada	4653	2685	4653	4059	4653	4653	4653	4653	2685	4653
Chile	343	167	10	290	343	343	343	343	167	343
China	1341	617	1341	1081	1341	1341	1341	1341	617	1341
Colombia	124	59	124	96	123	124	124	124	59	124
Czech Republic	54	30	54	45	54	54	54	54	30	54
Denmark	370	299	370	313	370	370	370	370	299	370
Egypt, Arab Rep.	127	62	125	110	127	127	127	127	62	0
Finland	431	361	431	377	431	431	431	431	361	431
France	1538	1169	1538	1340	1538	1538	1538	1538	1169	1538
Germany	1399	1016	1399	1201	1399	1399	1399	1399	1016	1399
Greece	256	197	255	226	256	256	256	256	197	256
Hong Kong SAR,	2522	1412	2522	2155	2522	2522	2522	2522	1412	2522
Hungary	53	26	53	45	53	53	53	53	26	53
India	1364	685	11	1158	1364	1364	1364	1364	685	1364
Indonesia	522	216	510	447	522	522	522	522	216	0
Ireland	221	155	221	195	221	221	221	221	155	221
Israel	213	107	213	180	213	213	213	213	107	213
Italy	578	459	578	491	578	578	578	578	459	578
Japan	6294	5016	6294	5444	6294	6294	6294	6294	5016	6294
Jordan	19	1	0	0	19	19	19	19	1	0
Korea, Rep.	1596	608	1596	1359	1596	1596	1596	1596	608	1596
Kuwait	90	31	90	67	90	90	90	90	31	90
Luxembourg	68	49	67	58	68	68	68	68	49	68
Malaysia	670	346	11	560	670	670	670	670	346	670
Mexico	529	233	15	454	529	529	529	529	233	529
Netherlands	558	417	558	485	558	558	558	558	417	558
New Zealand	576	267	7	475	576	576	576	576	267	576
Norway	398	311	398	348	398	398	398	398	311	398
Peru	80	35	74	53	80	80	80	80	35	80
Philippines	256	125	7	227	256	256	256	256	125	256
Poland	315	153	315	258	315	315	315	315	153	315
Portugal	155	116	155	136	155	155	155	155	116	155
Qatar	86	35	2	59	85	86	86	86	35	86
Russian Federati	518	289	518	454	518	518	518	518	289	518
Saudi Arabia	119	60	11	92	118	119	119	119	60	119
Singapore	664	479	15	573	664	664	664	664	479	664
South Africa	1715	786	14	1468	1715	1715	1715	1715	786	1715
Spain	664	510	664	570	664	664	664	664	510	664
Sweden	918	606	917	782	918	918	918	918	606	918
Switzerland	896	688	4	758	896	896	896	896	688	896
Taiwan	1997	851	0	0	1997	1997	1997	1997	851	1997
Thailand	478	197	13	404	478	478	478	478	197	0
Turkey	319	147	319	267	319	319	319	319	147	319
United Arab Emir	80	38	4	54	80	80	80	80	38	80
United Kingdom	5323	4004	5323	4550	5323	5323	5323	5323	4004	5323
United States	22273	12813	22273	18301	22273	22273	22273	22273	12813	22273
Total	71020	42983	54637	58329	71017	71020	71020	71020	42983	68616

Country	w_CORP ORATE_ SIZE	w_DEBT_ RATIO	w_CASH_ RATIO	w_TOBINQ	w_ROA	INTENSIT Y&RISK	w_CORP_ GOVERN
Australia	5455	5433	5425	5257	5406	5457	3060
Austria	205	203	196	193	205	205	167
Belgium	337	332	332	317	337	337	264
Brazil	1258	1257	1242	1148	1257	1258	559
Canada	4650	4648	4597	4509	4649	4653	2685
Chile	343	343	339	339	343	343	167
China	1341	1340	1304	1198	1340	1341	617
Colombia	124	124	117	119	124	124	59
Czech Rep	54	54	51	54	54	54	30
Denmark	370	370	360	346	370	370	299
Egypt, Arab	127	127	121	122	127	127	62
Finland	431	431	428	415	430	431	361
France	1538	1537	1522	1472	1538	1538	1169
Germany	1399	1399	1385	1326	1398	1399	1016
Greece	256	256	244	256	256	256	197
Hong Kong	2522	2516	2509	2305	2522	2522	1412
Hungary	53	53	51	53	53	53	26
India	1364	1364	1342	1323	1361	1364	685
Indonesia	522	522	511	503	522	522	216
Ireland	221	221	215	214	221	221	155
Israel	213	212	205	203	213	213	107
Italy	578	578	547	560	577	578	459
Japan	6294	6292	6229	6236	6294	6294	5016
Jordan	19	19	0	19	19	19	1
Korea, Rep	1596	1595	1572	1543	1594	1596	608
Kuwait	90	90	82	86	90	90	31
Luxembourg	68	68	68	58	68	68	49
Malaysia	670	670	654	642	669	670	346
Mexico	528	528	520	493	528	529	233
Netherlands	558	558	549	532	557	558	417
New Zealand	576	576	569	536	576	576	267
Norway	398	398	392	387	398	398	311
Peru	80	78	78	80	80	80	35
Philippines	256	256	251	240	256	256	125
Poland	315	315	296	283	315	315	153
Portugal	155	155	152	151	155	155	116
Qatar	86	86	74	83	86	86	35
Russian Fed	518	518	512	439	518	518	289
Saudi Arabia	119	119	108	117	119	119	60
Singapore	664	664	656	650	664	664	479
South Africa	1715	1715	1688	1646	1715	1715	786
Spain	664	664	648	621	663	664	510
Sweden	918	917	912	901	917	918	606
Switzerland	896	896	877	873	896	896	688
Taiwan	1997	1997	1965	1945	1997	1997	851
Thailand	478	478	464	455	478	478	197
Turkey	319	319	311	299	318	319	147
United Arab	80	80	72	76	80	80	38
United Kingdom	5323	5318	5269	5051	5322	5323	4004
United States	22270	22203	21740	21062	22254	22273	12813
Total	71011	70892	69751	67736	70929	71020	42983

Annex 6. Mean of variables data

Country	INTENSITY& RISK	w_CORP_GO VERN	INNOV_SUS TAIN	ECON_SUST AIN1	ECON_SUST AIN2	ENVIRON_S USTAIN1	ENVIRON_S USTAIN2	ENVIRON_S USTAIN3	SOCIAL_SUS TAIN1	SOCIAL_SUS TAIN2
Australia	.0101563	.5922539	2.116122	2.948535	4.299249	8.737624	.3501723	5.041964	40.16793	48.41594
Austria	.0034769	.3614054	.49825	1.409685	4.130244	35.06479	.1718537	3.60722	66.04323	54.2961
Belgium	.0227147	.5077216	.3482797	1.452225	6.218398	8.922207	.2015727	4.979941	54.95845	59.14955
Brazil	.0018282	.2540553	1.117355	2.580899	9.354213	47.25608	.1498649	4.078164	67.00394	.
Canada	.0079963	.7444598	.1642954	1.923286	5.601161	22.02789	.3300989	7.482276	41.37181	54.90185
Chile	.0000548	.0991719	.358638	3.907757	5.923324	26.88743	.2199125	3.919475	47.87281	44.13105
China	.0061911	.2983301	.2298917	9.507084	9.854892	13.68194	.4717673	6.284713	36.55989	29.7607
Colombia	.0004956	.3714729	.0482346	4.124205	6.362602	29.32657	.1390323	2.646371	69.22322	33.57742
Czech Rep	.0000605	.3526833	.5627663	2.694454	3.518519	8.261124	.3364815	5.611111	56.07633	49.72222
Denmark	.0470284	.4273268	.4173528	.9502624	4.896216	21.48209	.1324054	2.669703	62.26595	56.07676
Egypt, Arab	0	.088121	.1058985	4.234389	6.759055	7.381894	.2115748	3.66937	28.24532	.
Finland	.0201764	.5900327	.3884993	1.120774	7.179814	41.09101	.2122738	6.565058	73.68562	52.96172
France	.0168181	.5520182	.2390899	1.096168	8.193563	11.84438	.1202471	4.045098	80.22062	58.28791
Germany	.0277915	.3280247	.3307199	1.202544	3.538456	4.489499	.2103145	3.555933	69.15493	56.79207
Greece	.0006521	.1895579	.1500464	.0884583	19.91875	11.17989	.2517578	3.648281	48.29635	49.52812
Hong Kong	.0046104	.4152465	.0841504	3.807512	10.18723	1.063568	.1101784	6.452205	38.52169	50.10807
Hungary	.0159519	.4462923	.43402	1.927749	4.639623	14.26435	.1920755	4.420566	78.88423	48.27925
India	.006316	.3353412	.7900245	7.500929	1.795894	38.98604	.2603959	4.501298	63.13731	33.89413
Indonesia	.0013	.2408046	.0248859	5.440335	2.081226	39.02403	.1706897	3.47318	62.97259	.
Ireland	.0042647	.668289	.1924548	4.561169	5.922172	4.296765	.1252489	2.019819	41.70555	34.55294
Israel	.0344986	.3726645	.7362152	3.499774	3.966667	3.864749	.235446	3.48892	45.01402	45.48873
Italy	.0066473	.4756039	.1656296	-.0351249	8.084256	6.87443	.1608131	3.018218	71.03174	52.50813
Japan	.022258	.1133806	.3278002	.8083467	2.802765	6.293824	.2400334	3.691678	51.99049	57.40281
Jordan	0	.5812	.	.	25.91579	2.905487	.3210526	4.817895	82.18	.
Korea, Rep	.0102244	.1306757	.4850336	3.778382	3.395865	1.351447	.2522243	6.613246	56.904	58.73647
Kuwait	0	.1350226	.0311436	3.93275	1.595556	0	.3281111	3.343111	39.8671	39.54444
Luxembou	.0012494	.3666327	.4255145	2.83203	4.645588	4.365748	.1775	2.470882	53.8951	53.66029
Malaysia	.0002348	.5179329	.9841191	5.036425	1.117224	4.736657	.280806	4.664955	55.42795	34.09857
Mexico	.0000789	.154333	.4591587	2.338754	2.810397	10.29355	.2109452	3.56518	54.75288	34.82079
Netherlands	.0170603	.6444902	.2472649	1.162815	4.098208	2.306873	.2006093	3.914642	77.94597	57.21971
New Zealand	.009349	.4708861	1.184801	2.538074	3.307986	31.31965	.1911806	5.246267	37.31045	50.80486
Norway	.0038998	.4917344	.270574	1.593426	3.371106	57.81102	.1106281	3.416985	58.2001	49.61281
Peru	.0003087	.1440829	.0246967	4.827175	5.7875	28.50892	.1395	2.64875	24.55	30.92925
Philippines	.0000545	.3623896	.1225129	5.445438	1.626563	31.68307	.1599609	3.114727	51.03472	36.16367
Poland	.0001439	.2296889	.1358413	3.737552	4.472381	11.33623	.3141587	4.275143	42.7281	48.82857
Portugal	.000019	.5244448	.2406409	.1997041	7.895484	25.55171	.1714839	3.353226	75.19095	52.29548
Qatar	0	.0668286	.494145	10.27281	.1235294	0	.2754651	5.953837	18.20514	18.63605
Russian Fed	.0003317	.282037	.1416817	3.329208	4.528185	3.486157	.4527027	8.596313	54.26128	48.17239
Saudi Arabi	.0013454	.0957217	.3492436	4.481581	4.273729	.0072822	.3278151	6.182101	31.703	28.99496
Singapore	.0028996	.4749543	2.161242	5.573298	3.803464	.8507833	.100738	5.20762	42.65752	41.85617
South Africa	.0011029	.6328266	.8044029	2.845027	23.68496	16.59606	.6205364	8.567213	73.44943	23.39943
Spain	.0083785	.4820204	.1468694	1.412185	15.77395	19.50386	.1608434	3.250663	78.69986	53.75964
Sweden	.0206589	.5061896	.3804478	2.269996	5.298475	64.12002	.0805991	4.492756	68.52203	48.89826
Switzerland	.036661	.4716148	2.986985	1.798171	4.387612	22.98547	.0803571	2.107567	62.10765	65.66719
Taiwan	.0227572	.1360187	.	.	5.115228	15.35325	.767992	6.21679	44.35086	53.67191
Thailand	.0012935	.501264	.3449754	3.967289	.4987448	22.66742	.2307741	5.381402	67.13386	.
Turkey	.0027167	.2542735	.1280201	5.677469	8.100313	14.33338	.1811285	3.040251	58.12088	48.15768
United Arab	0	.2466605	.75963	3.991118	1.344375	.1042274	.307625	3.879625	36.49368	33.2325
United Kin	.0135636	.7269949	.1717717	1.670893	3.303062	6.011708	.1501691	2.114456	65.15257	58.39889
United States	.0329497	.7000098	.2818824	1.833565	3.701082	8.480834	.2900458	5.270579	45.21	56.10136
Total	.0186479	.5213564	.2592697	2.385365	5.053701	12.52284	.2741143	4.925768	52.28051	52.51603

Country	w_CORPORATE SIZE	w_DEBT_RATIO	w_CASH_RATIO	w_TOBINQ	w_ROA	INTENSIFY&RISK	w_CORP_GOVERN
Australia	12.66191	.1908607	.1870518	2.28751	-.0190741	.0101563	.5922539
Austria	15.43363	.2362649	.1341277	1.380578	.0330555	.0034769	.3614054
Belgium	15.24419	.2665693	.1244034	1.592223	.042237	.0227147	.5077216
Brazil	14.91246	.3255489	.1600285	1.641636	.0456148	.0018282	.2540553
Canada	13.95533	.2259198	.1204212	1.80378	.0023227	.0079963	.7444598
Chile	15.21744	.2986585	.0724886	1.402885	.051059	.0000548	.0991719
China	15.80845	.2670769	.1703989	1.315483	.0518996	.0061911	.2983301
Colombia	15.61953	.2302412	.0716378	1.700091	.0333816	.0004956	.3714729
Czech Repub	15.48216	.266811	.0898851	1.459128	.0306985	.0000605	.3526833
Denmark	14.89385	.2183435	.1399574	2.568651	.0683311	.0470284	.4273268
Egypt, Arab	14.89302	.3209431	.1227053	1.331067	.0490058	0	.088121
Finland	15.08709	.2318412	.1023929	1.603227	.0529749	.0201764	.5900327
France	16.21575	.2769408	.1235166	1.560379	.0349508	.0168181	.5520182
Germany	15.76319	.2345345	.1288937	1.615038	.0368032	.0277915	.3280247
Greece	14.74735	.3041657	.1240593	1.549651	.0487881	.0006521	.1895579
Hong Kong S	14.901	.2394001	.1988401	1.837666	.0564445	.0046104	.4152465
Hungary	15.55454	.1847984	.0973325	1.349199	.0656454	.0159519	.4462923
India	14.73601	.25031	.1230825	3.087561	.0904558	.006316	.3535412
Indonesia	14.26191	.2431426	.1589881	2.578632	.105587	.0013	.2408046
Ireland	14.46943	.2854115	.1625106	1.814386	.0586086	.0042647	.668289
Israel	15.08318	.3154578	.155136	1.476202	.0589215	.0344986	.3726645
Italy	16.05751	.3201289	.0937559	1.392532	.0250228	.0066473	.4756039
Japan	15.67865	.2270689	.1614661	1.485831	.0342348	.022258	.1133806
Jordan	17.7076	.0950422	.	.9441012	.0164266	0	.5812
Korea, Rep.	15.49141	.2551101	.1398483	1.465496	.047756	.0102244	.1306757
Kuwait	14.95439	.2419432	.1201564	1.436693	.0692266	0	.1350226
Luxembourg	15.89635	.2017731	.0929066	1.566356	.0418144	.0012494	.3666327
Malaysia	14.82144	.2662474	.1478	2.028369	.0724273	.0002348	.5179329
Mexico	15.35124	.2566064	.113616	1.565228	.0583655	.0000789	.154333
Netherlands	15.88192	.2646095	.1128181	1.540048	.0375714	.0170603	.6444902
New Zealand	13.42843	.2634022	.0550136	1.991314	.0533874	.009349	.4708861
Norway	15.03	.3061847	.1104589	2.059863	.0255691	.0038998	.4917344
Peru	14.24214	.2117604	.0854604	1.500011	.0633283	.0003087	.1440829
Philippines	14.82417	.3358646	.145008	1.608554	.0628061	.0000545	.3623896
Poland	14.64992	.2105701	.1033438	1.602609	.056226	.0001439	.2296889
Portugal	15.64116	.401725	.0792637	1.44087	.0175858	.000019	.5244448
Qatar	15.63086	.3040198	.1587294	1.663107	.0698767	0	.0668286
Russian Fede	16.01993	.2597616	.1023533	1.450405	.0801659	.0003317	.282037
Saudi Arabia	16.46379	.2422579	.1032724	2.006345	.0753685	.0013454	.0957217
Singapore	15.14886	.2416851	.1589106	1.465667	.0645847	.0028996	.4749543
South Africa	13.76992	.1890062	.1166677	1.926821	.0741631	.0011029	.6328266
Spain	15.7843	.330825	.1110358	1.912928	.0452792	.0083785	.4820204
Sweden	14.57992	.2373769	.1110284	1.91901	.0562301	.0206589	.5061896
Switzerland	14.98011	.1993392	.2065402	2.253093	.050237	.036661	.4716148
Taiwan	14.54445	.230765	.2003751	1.677464	.0617753	.0227572	.1360187
Thailand	14.66829	.3244915	.1224139	2.072554	.0745506	.0012935	.501264
Turkey	15.1295	.2689809	.1685913	1.587092	.0768366	.0027167	.2542735
United Arab	16.00627	.1907616	.1710612	1.568332	.0481613	0	.2466605
United Kingd	14.5509	.2363209	.1175603	1.88158	.0528093	.0135636	.7269949
United States	14.94063	.2677125	.167949	2.171521	.0311602	.0329497	.7000098
Total	14.7892	.2487101	.1520419	1.928181	.0368468	.0186479	.5213564

Annex 7. Statistics of variables data

stats	INTENSITY&RISK	w_CORP_GOVERN	INNOV_SUSTAIN	ECON_SUSTAIN1	ECON_SUSTAIN2
N	71020	42983	54637	58329	71017
mean	.0186479	.5213564	.2592697	2.385365	5.053701
p50	0	.5797	.280161	2.364455	3.7
sd	.0484857	.3032569	.2015918	2.560664	3.840604

stats	ENVIRON_SUSTAIN1	ENVIRON_SUSTAIN2	ENVIRON_SUSTAIN3	SOCIAL_SUSTAIN1	SOCIAL_SUSTAIN2
N	71020	71020	71020	42983	68616
mean	12.52284	.2741143	4.925768	52.28051	52.51603
p50	8.48145	.29	5.27	53.38	56.1
sd	11.62374	.1300893	1.513157	30.73753	8.269479

stats	w_ROA	w_TOBINQ	w_CASH_RATIO	w_CORPORATE_SIZE	w_DEBT_RATIO
N	70929	67736	69751	71011	70892
mean	.0368468	1.928181	.1520419	14.7892	.2487101
p50	.0443082	1.438413	.0985235	14.86657	.233389
sd	.11691	1.484851	.1627213	1.78939	.1909607

