UNIVERSITY OF LJUBLJANA
FACULTY OF PUBLIC ADMINISTRATION

UNIVERSITY OF RIJEKA
FACULTY OF ECONOMICS AND BUSINESS

Doctoral Dissertation

THE HOLISTIC MODEL OF COMPLIANCE COSTS OF ENVIRONMENTAL REGULATION AND COMPANIES' PRODUCTIVITY

Lenart Milan Lah

Ljubljana, September 2026

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DECLARATION OF AUTHORSHIP OF THE DOCTORAL DISSERTATION

I, the undersigned Lenart Milan Lah, a doctoral candidate of the joint doctoral study program Governance and Economics in the Public Sector, with enrolment number 0421350, I am the author of a doctoral dissertation entitled The Holistic Model Of Compliance Costs Of Environmental Regulation And Companies' Productivity.

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ABSTRACT

This dissertation investigates the compliance costs of environmental regulation and their implications for companies in Slovenia and Croatia. The study builds on previous research by applying a comprehensive methodological framework to assess and interpret both the compliance costs of environmental regulations faced by firms and managerial perceptions of these costs. It further evaluates the potential effects of these costs on firm productivity, in line with the Porter Hypothesis, which examines the possible positive impacts of stricter environmental regulation on business performance.

Compliance costs were estimated using the Standard Cost Model (SCM), which offers a robust basis for measuring the financial and administrative burden of environmental regulation. In addition, managers' perceptions of these costs were assessed, and the factors influencing these perceptions were analyzed. This approach contributes to the literature on institutional theory, the resource-based view, and managerial cognition theory by highlighting the role of managerial attitudes toward environmental issues.

Structural Equation Modelling (SEM) was employed to examine the determinants of compliance costs of environmental regulation and their impact on productivity in Slovenia and Croatia. Empirical results revealed that firm size increases compliance costs of environmental regulation in both countries, although larger firms in Slovenia perceive them as less burdensome. Regulatory complexity consistently drives both compliance costs and their perception, while environmental obligations and non-financial measures are significant only in Slovenia. In contrast, institutional quality raises perceived costs only in Croatia. While compliance costs of environmental regulation strongly shape its cost perceptions across both countries, the influence of regulatory complexity is more pronounced in Slovenia, whereas in Croatia, perceptions reflect a more balanced effect among compliance costs, regulatory complexity, and institutional quality.

Furthermore, the inclusion of productivity enabled testing of the strong Porter Hypothesis, providing limited evidence that, despite being perceived as burdensome, compliance costs of environmental regulation as proxy of environmental stringency may enhance firm productivity in both countries. However, the explanatory power of the model remains robust, albeit with some minor limitations that should be acknowledged.

This dissertation develops the holistic theoretical model that integrates key internal and external factors shaping compliance costs of environmental regulation and their perception, while also establishing a framework for assessing how these costs influence productivity. It contributes both theoretically and empirically by advancing methods for estimating compliance costs, incorporating managerial cognition into the analysis of environmental regulation, and examining the relationship between regulation and productivity. Although the study is limited by sample size, particularly in Croatia, it nevertheless provides a solid foundation for future research, especially in areas related to innovation effects, subjective managerial traits, and broader international comparisons.

Keywords: environmental regulation, compliance costs, firm productivity, Standard Cost Model (SCM), Structural Equation Modeling (SEM), Porter Hypothesis

POVZETEK

HOLISTIČNI MODEL STROŠKOV PREVERJANJA SKLADNOSTI OKOLJSKE REGULATIVE IN PRODUKTIVNOST PODJETIJ

Doktorska disertacija proučuje stroške skladnosti z okoljsko regulativo ter njihove učinke na poslovanje podjetij v Sloveniji in na Hrvaškem. Raziskava nadgrajuje preučevanje področja z uporabo celovitejšega metodološkega okvirja za ocenjevanje in razlago stroškov skladnosti z okoljsko regulativo, s katerimi se podjetja soočajo, kot tudi percepcije podjetij glede obsega teh stroškov. Hkrati vključuje tudi oceno morebitnih učinkov stroškov skladnosti na produktivnost podjetij, kar je skladno s Porterjevo hipotezo, ki izpostavlja možne pozitivne učinke strožje okoljske regulative na poslovanje podjetij.

Stroški skladnosti so bili ocenjeni z uporabo metode Standard Cost Model (SCM), ki predstavlja ustrezno osnovo za merjenje administrativnih in finančnih bremen, ki jih okoljska regulativa nalaga podjetjem. Poleg tega, so bile ocenjene zaznave menedžerjev o teh stroških kot tudi dejavniki, ki vplivajo na te zaznave. Na ta način, disertacija prispeva k literaturi s področja institucionalne teorije, teorije na temelju virov in teorije menedžerske kognicije, saj poudarja vlogo menedžerskih stališč in interpretacij stroškov, ki izhajajo iz okoljske regulative.

Za preučevanje dejavnikov, ki vplivajo na stroške skladnosti z okoljsko regulativo, ter njihovega vpliva na produktivnost podjetij v Sloveniji in na Hrvaškem je bila uporabljena metoda modeliranja strukturnih enačb (SEM). Rezultati empirične analize so pokazali, da se z naraščanjem velikosti podjetij povečujejo tudi stroški skladnosti v obeh državah, pri čemer večja podjetja v Sloveniji te stroške zaznavajo kot manj obremenjujoča. Dejavnik kompleksnosti regulativ dosledno vpliva na stroške skladnosti in njihovo percepcijo v obeh preučevanih državah, medtem ko imata dejavnika okoljske obveznosti in nefinančni ukrepi vpliv le v Sloveniji. Po drugi strani, dejavnik kakovosti institucij povečuje percepcijo stroškov le na Hrvaškem. Nadalje, sama velikost stroškov skladnosti močno vpliva na percepcijo teh stroškov v obeh državah, vendar pa se je v Sloveniji vpliv kompleksnosti regulativ izkazal celo za izrazitejši dejavnik kot pa sami stroški. Na Hrvaškem je vpliv treh dejavnikov, ki vplivajo na percepcijo, med katere spadajo stroški skladnosti, kompleksnost regulativ in kakovost institucij, bolj enakomeren.

Vključitev produktivnosti podjetij v raziskavo je omogočilo testiranje močne Porterjeve hipoteze. Rezultati v obeh državah le v omejenem obsegu potrjujejo hipotezo, da lahko stroški skladnosti z okoljsko regulativo, ki so uporabljeni kot indikator strogosti okoljske regulative, prispevajo k večji produktivnosti podjetij,

čeprav jih podjetja zaznavajo kot breme. Kljub temu, pojasnjevalna moč modela ostaja robustna, čeprav z nekaterimi manjšimi omejitvami.

Teoretični in empirični prispevki disertacije se kažejo v nadgrajenih metodah merjenja stroškov skladnosti z okoljsko regulativo, vključevanju teorije menedžerske kognicije v analizo učinkov teh stroškov ter proučevanju vpliva okoljske regulative na produktivnost. Čeprav je raziskava v določenih vidikih omejena, zlasti zaradi velikosti vzorca na Hrvaškem, predstavlja izhodišče za prihodnje raziskave, predvsem na področju odzivov podjetij na spremembe okoljske regulative, bodisi glede njene strukture bodisi glede njenega obsega. Raziskave na tem področju so v državah srednje in vzhodne Evrope še vedno razmeroma omejene, kar predstavlja priložnosti za nadaljnji znanstveni razvoj.

Ključne besede: okoljska regulativa, stroški skladnosti, produktivnost podjetja, standardni stroškovni model (SCM), modeliranje strukturnih enačb (SEM), porterjeva hipoteza

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Lah, L. M., & Kotnik, Ž. (2026). Is the Porter Hypothesis more relevant today than 30 years ago? Bibliometric and content analysis. *Journal of Environmental Management, 402*, 129113. https://doi.org/10.1016/j.jenvman.2026.129113

Lah, L. M., & Kotnik, Ž. (2025). Drivers of environmental regulation costs and their perception by firms: Evidence from Slovenia. *Journal of Cleaner Production*, 501, 145274. https://doi.org/10.1016/j.jclepro.2025.145274

Lah, L. M., & Kotnik, Ž. (2022). A literature review of the factors affecting the compliance costs of environmental regulation and companies' productivity. *Central European Public Administration Review, 20*(2), 57–80. https://doi.org/10.17573/cepar.2022.2.03

1 INTRODUCTION

"Reducing the business burden is not simply about pandering to the special pleas of an enclave within society: it is about significantly increasing the prosperity and welfare of society in general. Similarly, the move to better regulations is not simply about reducing the business burden: it is also about getting better, more effective regulation which achieves the intended purpose at a minimum cost." (Nijsen, 2008)

Can deregulation and regulation be balanced in a way that neither compromises public objectives nor hinders economic growth? Can environmental regulations encourage firms to pursue green objectives without adversely affecting their productivity? Do managers perceive the compliance costs of environmental regulations as fair and not detrimental to business decision-making? Can government, by implementing high-quality regulations promote entrepreneurship and stimulate economic growth? These are just some of the questions underscoring the crucial role of policymakers and legislators in designing environmental regulations that foster a sustainable society while minimizing unnecessary compliance burdens for businesses. Achieving this balance requires a deep understanding of the various characteristics of businesses across different sectors, sizes, classifications, and development stages.

According to Nijsen (2008) key challenge in studying compliance costs lies in the blurred distinction of compliance costs from the two perspectives: the business side, which dominates in the literature, and the public policy standpoint. It might sound paradoxical that although compliance costs are the costs of businesses, only a minor part of these costs can be influenced by businesses, and it is to be expected that businesses will do their utmost to keep the cost of compliance as low as possible by complying in an efficient way (Nijsen, 2008). Therefore, to determine the economic impact on businesses of complying with legal requirements, a comprehensive examination of various contextual factors specific to regulated firms is necessary. This also entails understanding of the significance of legal information obligations as internal management tools for businesses. Furthermore, to calculate firms' costs of complying with their obligations, it is necessary to reckon all the different specific conditions of the regulated businesses. Finally, to find out whether compliance costs of environmental regulation are hindering economic activity of businesses, it is important to estimate the effect of compliance costs on firms' productivity.

Environmental regulations represent the intersection between environmental policy and business operations. On the one hand, such regulations bring societal benefits and contribute to reducing environmental damage. On the other hand, particularly in times of rapid change and increasingly complex environmental legislation, such

regulations can impose constraints on businesses through higher compliance costs. One of the main challenges, therefore, is to encourage firms to adopt environmentally friendly measures (Arnold & Whitford, 2006), which often require substantial initial investments and entail additional ongoing costs. Therefore, to understand the compliance costs of environmental regulation and their implications for businesses, it is essential to first establish a comprehensive theoretical foundation on compliance costs. Furthermore, examining case studies and analyzing real-world examples can provide valuable insights into the practical effects of environmental regulation costs on firms across different sectors and regions.

This thesis examines the compliance costs of environmental regulation faced by firms in Slovenia and Croatia. It first explores similarities and differences in the burden of these costs across the two countries. The empirical model then identifies key factors that determine the magnitude of compliance costs. A further aim is to assess whether these costs, used as a proxy for environmental regulatory stringency, affect firms' productivity. The latter adds to the long-standing debate over whether environmental regulations merely impose costs that hinder investment or, conversely, stimulate innovation that can yield benefits exceeding the costs, thereby raising productivity. This perspective challenges the neoclassical notion of a fixed trade-off between ecology and the economy (Porter & Van der Linde, 1995).

The link between compliance costs, innovation, and productivity is commonly studied in the context of the Porter Hypothesis (e.g., Ambec et al., 2013; Porter & Van der Linde, 1995; Rubashkina et al., 2015; Sun et al., 2024), particularly its "strong" version, which posits that well-designed regulation can produce a win-win outcome i.e. environmental improvements alongside gains in competitiveness, often measured via productivity. Scholarly interest in Porter Hypothesis has grown, as seen in the rising number of publications indexed in Scopus, with an annual growth rate of 37.2% since 2018 and a more than twofold increase in articles only between 2021 and 2022 (Lah & Kotnik, 2026). However, the Porter Hypothesis has been only marginally addressed in the context of Slovenia or Croatia. Among the few exceptions is the work of Hojnik (e.g. Hojnik et al., 2022; Hojnik & Ruzzier, 2016, 2017), which primarily investigates the effects of eco-innovations on firm performance while also considering the role of environmental regulation and ISO standards, thereby indirectly or directly testing elements of the Porter Hypothesis. Besides, Klun and Erker (2012) examined the compliance costs of employment and environmental regulation in Slovenia and assessed their effects on business productivity. More broadly, research that explicitly tests the Porter Hypothesis in Central and Eastern Europe remains scarce, with only a few notable contributions such as Arouri et al. (2012), Horváthová (2012), Radulescu et al. (2018), and Prokop et al. (2022).

1.1 DEFINITION OF PROBLEM

In times of global environmental degradation and pollution-related problems, countries' attention to sustainable development has been on the rise. With commitments under the Paris Agreement, the European Green Deal stimulates EU countries to pay special attention to achieving the goal of becoming the first climate-neutral continent by 2050. The measures agreed upon for economic recovery from the COVID-19 crisis have brought the need for a green future even further to the forefront, with environmental regulations being one the main governmental instruments to follow this goal. EU currently leads global efforts in environmental protection, implementing some of the world's most stringent environmental policies (Olasehinde-Williams & Folorunsho, 2025). Furthermore, to achieve greater environmental respect, firms should be encouraged to adopt eco-innovations, particularly in high-impact sectors like agriculture, by advancing eco-friendly production methods, product improvements, and enhancing organizational and marketing practices (García-Granero et al., 2018).

Firms' motivation for ecological responsiveness was primarily driven by concerns for legitimacy, with other factors such as stakeholder pressure, economic opportunities, and ethical motives being less substantial (Bansal & Roth, 2000). Consequently, environmental regulation, whether through traditional “command and control” regulation or incentives programs i.e. “market-based instruments”, emerged as a critical tool for achieving sustainable economic and social development (Baylis et al., 1998; Driesen, 2006). However, other factors, particularly normative and mimetic pressures, have gained importance in recent years. Therefore, to meet ambitious milestones of the central agreements, the environmental regulatory framework needs to constantly adapt in a way to ensure the sustainable development of economies while maintaining economic competitiveness in the global market. This represents a challenge as compliance with environmental regulations often entails significant costs for firms which include payments of green levies, acquiring pollution permits, investments in new technologies, adjustments to production processes, management and administrative expenses, and potential penalties for non-compliance. For many firms, especially small and medium-sized ones, these costs can be burdensome, impacting their competitiveness and financial stability (Jaffe & Palmer, 1997). Therefore, understanding and quantifying these costs is essential for designing effective policies that balance environmental protection with economic interests (Ambec et al., 2013).

According to the neoclassical economic theory, strict environmental regulation impairs competitiveness and productivity due to the constraints imposed by regulation (Gollop & Roberts, 1983). Elaborating on this traditional view, different hypotheses were formed, such as the “pollution heaven hypothesis” and the “race-to-the-bottom

hypothesis". In general, these hypotheses argue that environmental regulations are detrimental to businesses as they represent an additional cost burden. Based on the neoclassical assumption that economic agents act rationally, firms affected by environmental regulations will consequently shift their production to countries with less stringent environmental regulations to lower their compliance costs, thereby reducing the potential negative impact of stringent environmental regulation on their productivity (Cole & Fredriksson, 2009; Dechezleprêtre & Sato, 2017; Iraldo et al., 2011). On the contrary, Porter (Porter, 1991; Porter & Van der Linde, 1995) proposed that tighter environmental regulation, if properly designed, could trigger innovations that offset the compliance costs of environmental regulation and even increase productivity. This "win-win" scenario has become known as the Porter Hypothesis. Over the past two decades, the Porter Hypothesis has been further developed and tested by numerous researchers using a variety of indicators (Lah & Kotnik, 2026). This has led to the emergence of different versions of hypothesis and the exploration of various combinations of innovation effects and forms of environmental regulation. In this context, three distinct versions of the hypothesis have emerged (Jaffe & Palmer, 1997). The weak version suggests that environmental regulation can stimulate innovation, although it does not necessarily lead to improved firm performance. The strong version goes further, arguing that regulation enhances economic performance by encouraging firms to reorganize and improve efficiency, resulting in productivity gains that outweigh compliance costs. The narrow version emphasizes that only certain types of regulation, particularly flexible and market-based instruments, effectively promote innovation and productivity growth, while traditional command-and-control approaches tend to be less effective (Franco & Marin, 2017; Xie et al., 2017). Empirical evidence testing the different versions of the hypothesis varies substantially (e.g., Costantini & Mazzanti, 2012; Huiban et al., 2018; Ramanathan et al., 2017; Prokop et al., 2022), and contemporary research has shown that the effects largely depend on the industry and production methods involved (e.g., Zhao et al., 2018). Nevertheless, much of the research on the Porter Hypothesis (e.g., Gray & Shadbegian, 2003; Rubashkina et al., 2015; Zhao & Sun, 2016) uses compliance costs of environmental regulation as a proxy for environmental stringency. These studies find that when such costs are excessive, indicating stricter regulation, they can stimulate firms to innovate more, thereby enhancing both environmental and technological performance. Such innovations have the potential to offset total compliance costs, ultimately leading to increased productivity.

Hence, from the business perspective, which dominates in the literature on regulatory costs compared to the public policy standpoint (Nijsen, 2008), compliance costs of environmental regulation represent a significant concern for firms striving to meet regulatory requirements while managing financial constraints. According to the results of the EIB Survey (European Investment Bank, 2021) conducted among 13,500 firms,

primarily in EU countries, about 43% of firms consider uncertainty over environmental regulations and taxation and perceive high upfront costs as significant barriers to green investment. Building on the implications of the Porter Hypothesis, that well-designed environmental regulation may result in a win-win outcome of positive environmental effects and increased productivity, green investments accompanied by eco-innovation are of great importance for firms as they provide customer and business value, while contributing to sustainable development and reducing environmental costs and impacts (Cai & Li, 2017). Besides, Ramanathan et al. (2017) suggest that factors such as managerial attitude and the capacity of a firm to innovate are also important in determining the nature of the relationship between environmental regulations and business performance.

Therefore, the perceived problems in the field of research include potentially excessive compliance costs of environmental regulation, firms' incomplete awareness of the magnitude and types of costs associated with such regulation, and a growing recognition of the need to systematically address these issues, internalize environmental costs, and maintain competitiveness.

1.2 OBJECTIVES OF THE THESIS

Industrial pollution exerts significant pressure on the environment, impacting nearly all areas of environmental protection, such as air, water, waste, noise, and chemicals. This issue is addressed by the most extensive environmental legislation in Slovenia (Environmental Protection Act - Zakon o varstvu okolja (ZVO-2), Uradni list RS, št. 44/22, 18/23) and Croatia (Environmental Protection Act - Zakon o Zaštiti Okoliša – NN 80/13, 153/13, 78/15, 12/18, 118/18). For instance, both acts outline the basic principles of environmental protection, measures for environmental protection, environmental monitoring and information, economic and financial instruments, and public environmental protection services. They also integrate EU directives into the national legal framework.

In the case of Slovenia, the European Commission identifies the primary challenge in implementing environmental policy as the rationalization of the legal framework for planning and environmental assessments, by aligning it with EU environmental legislation and reducing administrative burdens and investment barriers (European Commission, 2019). According to a report by the European Commission, the administrative burden of environmental regulations was estimated at 1.2 billion euros, with 30% of the additional burdens stemming from the regulatory requirements of individual member states (Kotnik et al., 2020).

Furthermore, since the launch of the European Emissions Trading System (ETS) in 2005, an increasing number of firms have become aware of environmental challenges and have actively addressed them by internalizing environmental costs while simultaneously striving to maintain their competitiveness (Letmathe & Balakrishnan, 2005). Consequently, firms have increasingly adopted Environmental Management Systems (EMS), which provide a framework for managing environmental responsibilities in a systematic and effective manner. The most widely recognized EMS is the ISO 14001 standard, offering a structured approach for setting environmental objectives, implementing policies, and monitoring performance to ensure continuous improvement (Hojnik & Ruzzier, 2017). By implementing EMS, firms can reduce environmental impacts, enhance operational efficiency, and improve their reputation among stakeholders and customers. In the EU, the number of firms certified with ISO 14001 grew from 7,400 in 2000 to 84,316 in 2017. In Slovenia, the number increased from 88 to 494 during this period, while the number of firms rose even more substantially, from 8 to 1,138 in Croatia, indicating a significant rise in environmental awareness among businesses.

Nevertheless, the implementation of the recent EU Corporate Sustainability Reporting Directive (CSRD)[1] comes with notable cost implications for firms. While the Directive aims to reduce unnecessary reporting burdens for firms, it is estimated that preparers will still face significant one-off expenses, as well as recurring annual costs, to ensure compliance. At the same time, as highlighted in the Directive itself, growing stakeholder demand for sustainability information has already led many firms to incur rising costs in disclosing such data, even prior to the CSRD's entry into force.

Building on the identified challenges and developments in environmental regulation at both the national and European levels, the main objective of the empirical part of this thesis is threefold: (i) to adequately assess firms' compliance costs of environmental regulation in Slovenia and Croatia, (ii) to measure the impact of different factors that affect the relative size of compliance costs of environmental regulation as well as firms' perception of the size of the costs, and (iii) to examine the impact of these costs on firms' productivity, i.e., to test the "strong version" of the Porter Hypothesis, which posits that higher costs of environmental regulation can drive firms to become more productive.

[1] The aim of the Directive is to transform how firms approach sustainability by placing non-financial reporting on equal footing with financial disclosures. Its goal is to ensure that key decision-makers within organizations adopt a mindset where environmental, social, and governance (ESG) factors are treated as integral to business strategy (European Commission, n.d.).

To address the first objective of the thesis, the survey questionnaire included detailed questions on the various types of cost firms incur to comply with environmental regulation. Specifically, according to SCM's classification of regulatory costs (SCM Network, 2006) firms were asked to assess financial costs, substantive compliance costs, information compliance costs, and total costs related to environmental regulation. The results concerning cost data and the comparison between the two countries included in the study are presented at the beginning of the empirical section using descriptive statistics.

To address the second objective, i.e., to identify and measure the impact of various factors influencing the size of compliance costs of environmental regulation, a preliminary literature review highlights several relevant determinants, including normative, institutional, economic-financial, organizational, and procedural factors. These factors can be broadly classified into internal and external categories. The theoretical framework for formulating hypotheses and incorporating individual variables into the model is based on factors influencing firms' environmental attitudes, examined from three interrelated perspectives: institutional theory, resource-based view, and managerial cognition theory. According to the literature review, several identified factors are classified as internal (firm-specific) and are grounded in the resource-based view, which posits that firms' strategies and decisions are shaped by their internal resources and capabilities (Cai & Li, 2017). Other factors are classified as external and are based on institutional theory, which identifies coercive pressure as a primary driver of a firm's environmental performance. Still, the research focuses solely on objective factors influencing the independent variables, excluding subjective factors, such as managers' personal characteristics for example, which may also have an effect. These limitations and related research opportunities are discussed in Section 9.3.

Using these internal and external factors as independent variables, a conceptual holistic model has been formulated to assess factors' impact on compliance costs of environmental regulation and their perception (dependent variables) and, subsequently, on productivity. This addresses the final research objective, i.e., measuring the impact of compliance costs of environmental regulation on firms' productivity. The research objectives are addressed through a quantitative cross-country empirical analysis of firms in Slovenia and Croatia, which is explained in more detail in the methodological chapter.

1.3 RESEARCH QUESTIONS AND HYPOTHESES

Based on the literature review and previous research in the field of compliance costs of environmental regulation, the main goal of the thesis is to perform empirical research in Slovenia and Croatia to provide answers to the following research questions:

- RQ1: What is the estimated size of compliance costs of environmental regulation for firms? To answer this question, a descriptive statistical analysis is conducted to quantify and summarize the main components of compliance costs.
- RQ2: Are there statistically significant differences in compliance costs of environmental regulation between the countries studied? This research question is examined using comparative statistical techniques, testing whether the results on a macro level substantially differentiate between both countries.
- RQ3: What are the reasons for the cross-country differences? This question is addressed through a descriptive and interpretative analysis, linking observed cost patterns to institutional, regulatory, and structural characteristics of each country.
- RQ4: What is the effect of selected internal and external factors on the compliance costs of environmental regulation and perception of these costs? Structural equation modelling (SEM) is employed to estimate the relationships between firm-level characteristics, external pressures, compliance costs and their perception by firms.
- RQ5: What is the impact of compliance costs of environmental regulation on the overall productivity of firms? Structural equation modelling (SEM) is employed to estimate the impact of the size of compliance costs on productivity.

The following hypotheses are derived from the main research questions and the statistical methods used to test them:

- H1: There are significant differences in compliance costs of environmental regulation between Slovenia and Croatia.
  Research method: This hypothesis is tested using descriptive statistics and Mann–Whitney U test.
- H2a: Internal factors affect the compliance costs of environmental regulation and their perception in Slovenia.
- H2b: External factors affect the compliance costs of environmental regulation and their perception in Slovenia.
- H3a: Internal factors significantly affect the compliance costs of environmental regulation and their perception in Croatia.
- H3b: External factors significantly affect the compliance costs of environmental regulation and their perception in Croatia.

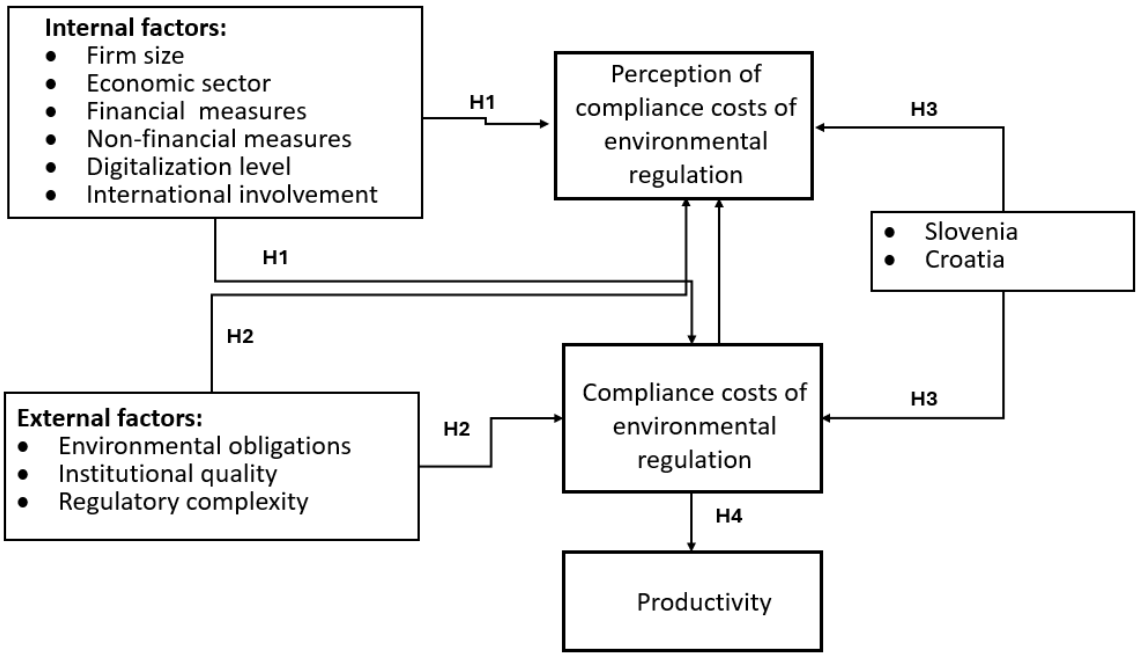
Research method: Hypotheses H2a, H2b, H3a, and H3b are tested using structural equation modelling (SEM), operationalized through a set of sub-hypotheses in which each internal or external factor is linked to the outcomes (CER – Compliance Costs of Environmental Regulation and CER_P – Compliance Costs of Environmental Regulation Perception).

- H4: The level of compliance costs of environmental regulation affects firms' productivity.
  Research method: H4 is tested using SEM by estimating the effect of compliance costs of environmental regulation (CER) on firm productivity within a joint model combining data from both countries.

The empirical analysis is based on the conceptual model presented in Figure 1, that specifies the hypothesised relationships between internal and external factors, compliance costs of environmental regulation, perceptions, and productivity.

Research questions and hypotheses are aimed at providing a structured approach to understanding the factors affecting compliance costs and their implications for firm productivity across different contexts.

Figure 1: Schematic representation of the examination of the main hypotheses



Source: own elaboration

1.4 STRUCTURE OF THE THESIS

The remainder of the thesis is organized as follows:

- Chapter 2 provides a theoretical exploration of compliance costs, presenting various definitions, studies, concepts, and measurement techniques.
- Chapter 3 examines the potential factors influencing the size and perception of compliance costs of environmental regulation. These factors are analysed from three interrelated perspectives: institutional theory, the resource-based view, and managerial cognition theory. The latter emphasizes that not only the absolute size of compliance costs but also their perception is crucial for firms' environmental and financial performance.
- Chapter 4 investigates into environmental regulation, outlining theoretical concepts and describing the environmental regulatory frameworks in Slovenia and Croatia, along with their alignment with European directives.
- Chapter 5 integrates the content from the previous chapters, addressing the interrelated areas of compliance costs, environmental regulation, and the impact of environmental regulation on companies' productivity, often referred to as the Porter Hypothesis.
- Chapter 6 outlines the methodological framework and details the data collection process.
- Chapter 7 synthesizes the empirical results and develops the empirical model, which serves as the basis for answering the research questions and confirming or rejecting the research hypotheses.
- Chapter 8 presents a discussion of empirical findings and their connections to the theoretical background, framed through research questions and hypotheses.
- The final Chapter 9 discusses key findings, policy implications and explores potential for further research on the topic as well as limitations of the research.

2 THEORETICAL APPROACH TO COMPLIANCE COSTS

"One difficulty in estimating the private expenses incident to ascertaining and discharging tax liability is that no one has ever undertake to define the concept of "compliance costs." Aside from lack of a clear-cut concept, no agreement has been reached as to how such costs are to be segregated from other uncompensated expenditures publicly required of private individuals and corporations and form the cost of producing ordinary commodities or services the business is organized to turn out." (Martin, 1944)

"Compliance costs are generally inevitable and irreducible (Tran-Nam et al, 2000). Moreover, they are difficult to calculate in detail, which causes the costs to remain hidden between other administrative costs." (Schoonjans et al., 2011)

It should be noted that each regulation is understood to impose certain kinds of costs on the subjects required to comply with it. These costs do not necessarily take the form of monetary transfers to public institutions. They could instead involve time spent by individuals or firms understanding the regulation, investment expenditure required for products or process adaptation to meet environmental standards, or other forms of financial or non-financial costs. However, compliance costs arise from the implementation of rules and laws, making them inherent to regulations from their inception. All regulations, even the most effective ones, entail costs that may outweigh their benefits. Therefore, the quality of regulation should not be assessed solely by its effectiveness, but also by its cost-effectiveness (Marneffe & Vereeck, 2011).

2.1 THE CONCEPT

The word "compliance" originates from the Latin root "complere", which means "to fill up" or "to complete". The word evolved through the Old French "complir", which retained a similar meaning of fulfilling or accomplishing something. Similarly, the verb "to comply" comes from the late Latin "complīre," meaning "to fulfil, to accomplish or to carry out". It originally carried the sense of fulfilling or carrying out a command, wish, or request, which aligns with its current meaning of acting in accordance with rules, standards, or commands ("Compliance," n.d.). In modern usage, "compliance" generally refers to adherence to laws, regulations, or standards, while "to comply" means to act in accordance with these requirements or to yield to a request or command. As taxes and regulations impose costs on different economic entities, they are obliged to make payments to meet required legal obligations e.g. to comply with the regulation. It would be easy to understand compliance costs if these costs only included money transfers to tax collectors, i.e., the government. Unfortunately, taxes

and regulations also spur other costs that may have intentional or unintentional economic effects (Saxton, 2005).

From an economic standpoint, the complexity of regulatory costs can be estimated through the operational expenses associated with a regulatory system. These expenses include costs incurred by regulatory authorities and the expenditures borne by private households and businesses in complying with regulations (Marneffe & Vereeck, 2011, Eichfelder & Schorn, 2012, Pavel & Vítek, 2014). According to Nijsen (2008) key challenge in studying compliance costs lies in the blurred distinction of compliance costs from the two perspectives: the business side, which dominates in the literature, and the public policy standpoint.

Researchers primarily focus on the effects of direct tax costs (e.g. Slemrod, 2004) and other costs associated with compliance with specific legislation (e.g. Fauziati & Kassim, 2018; Klun & Blazic, 2005; Kneller & Manderson, 2010; Kramer et al., 2020, Nemec et al., 2017; Pavel & Vítek, 2014; etc.). Consequently, existing research tends to concentrate on the business perspective of compliance costs (Nijsen, 2008). However, to gain a comprehensive understanding of the total costs of regulation, it is also necessary to consider expenditures incurred by public institutions for tax collection and for monitoring compliance by businesses and individuals. Therefore, a comprehensive, "broad" definition of all the costs spurred by the regulation should include all types of costs, considering both business and government side. This is in accordance with OECD's definition of the compliance costs which is formed as: "*Compliance costs are the costs that are incurred by businesses or other parties at whom regulation may be targeted in undertaking actions necessary to comply with the regulatory requirements, as well as the costs to government of regulatory administration and enforcement. Compliance costs can be further divided into administrative burdens, substantive compliance costs and administration and enforcement costs"* (OECD, 2014). In this manner, researchers (e.g. Evans, 2008; Nemec et al., 2017; Pavel & Vítek, 2014) divide total costs of taxation into three elements: taxes themselves, efficiency costs that involve tax-induced market distortions, and operating costs of the tax system, often referred to as administrative costs. The latter refer to costs of the government for administering and collecting the taxes, and compliance costs, which are the costs of taxpayers in complying (or sometimes not complying) with their tax obligations (Evans, 2008).

Research on compliance costs often does not explore definitions of these costs in detail (e.g., Eichfelder & Vaillancourt, 2014; Harju et al., 2019; Joshi et al., 2001; Schoonjans et al., 2011). Some authors (e.g., Joshi et al., 2001; Nijsen, 2008; Schaltegger & Müller, 1998) address certain compliance costs as hidden costs, implying that firms are often not fully aware of all the costs associated with

environmental regulations as accounting systems do not perceive them as costs at all. As they are “hidden”, they are also more difficult to measure, so the results of previous research on these costs are very inconsistent. However, compliance costs are generally categorized in two ways: as the total costs of regulation, representing a “broad definition” (e.g. Joshi et al., 2001; Tran-Nam et al., 2000) or as a “narrow definition” that distinguishes between the direct costs of taxes and regulation and the indirect compliance costs, but focuses solely on the costs borne by firms. Indirect compliance costs are typically understood as the additional expenses firms incur to comply with legislation. Despite extensive research in this area, literature still lacks a universally accepted definition of compliance costs. Two of the most comprehensive classifications of regulatory costs[2] come from the Standard Cost Model Network (SCM Network, 2006) and the OECD (2014), which differ in several key aspects of compliance cost categorization. Figure 2 illustrates a model of compliance costs that combines characteristics from other research studies, which are elaborated upon in the subsequent paragraphs.

The concept of Okun’s leaky bucket can be perceived as the beginning of the broad definition of compliance costs. Arthur Okun used the metaphor of a leaky bucket to illustrate income redistribution, a concept well-established in economic literature (Tresch, 2022). In his work, Okun (1975) described a scenario in which the wealthy pay taxes, which are collected in a bucket by a government official and then redistributed to the less affluent. However, if the bucket leaks, the poor receive less than what the wealthy originally contributed. These "leaks" represent three specific issues:

- Compliance costs incurred by taxpayers, including costs related to record-keeping, filing tax forms (whether by the taxpayer or a third-party preparer), and efforts to reduce tax liabilities, whether legally or illegally.
- Administrative costs associated with revenue collection, including monitoring taxpayers and enforcing tax laws.
- Deadweight losses in labor and capital markets caused by the distorting effects of taxes and other regulatory costs on prices.

Interest in studying compliance costs has grown significantly since the 1980s in the EU and OECD countries and has expanded to developing and transition countries since the 2000s. According to Eichfelder and Schorn (2012), compliance costs represent a significant economic issue for at least three reasons:

[2] Terms regulatory costs, compliance costs or costs of environmental regulation are used interchangeably across research.

- Compliance costs of regulation reduce the resources of private businesses without contributing to the government's financial budget, making them an economic inefficiency or "waste."
- Empirical studies indicate that the economic burden of tax compliance tends to decrease as business size increases, making these costs regressive in nature, as smaller firms bear relatively higher compliance costs compared to larger ones (Schoonjans et al., 2011, Fauziati & Kassim, 2018, Pang et al., 2022). Conversely, compliance costs increase with the international scope of a business' activities. These trends may adversely affect the competitiveness of small and medium-sized enterprises (SMEs) and limit their ability to access international markets.
- Tax compliance costs appear to be correlated with compliance levels. High costs may discourage compliance and potentially lead to tax evasion.

2.1.1 Business perspective

For the business side, which is the focus of empirical part later in the study, the compliance costs are measured based on the classification of Nijsen (2008) that each regulation imposes three types of obligations on firms, namely: financial obligations, content obligations, and information obligations (see Figure 2). The costs arising from these different types of obligations can be classified according to SCM's classification of regulatory costs into financial costs, substantive compliance costs, and information compliance costs (SCM Network, 2006):

- Financial compliance costs are the result of a concrete and direct obligation to transfer a sum of money to the government or the competent authority. Examples of these costs include environmental levies, administrative charges, dues, etc.
- Substantive compliance costs are the costs that businesses make to comply with the content obligation that legislation and regulation require of a production process or a product. Examples of these costs include filters in accordance with environmental requirements, physical facilities in compliance with working conditions regulation, obtaining the specific professional knowledge necessary for a particular diploma.
- Information compliance costs refer to the costs that businesses incur to fulfil the information obligations required by regulation. Examples include preparing reports on emission measurements, drafting reports on working conditions, or demonstrating the possession of a specific diploma.

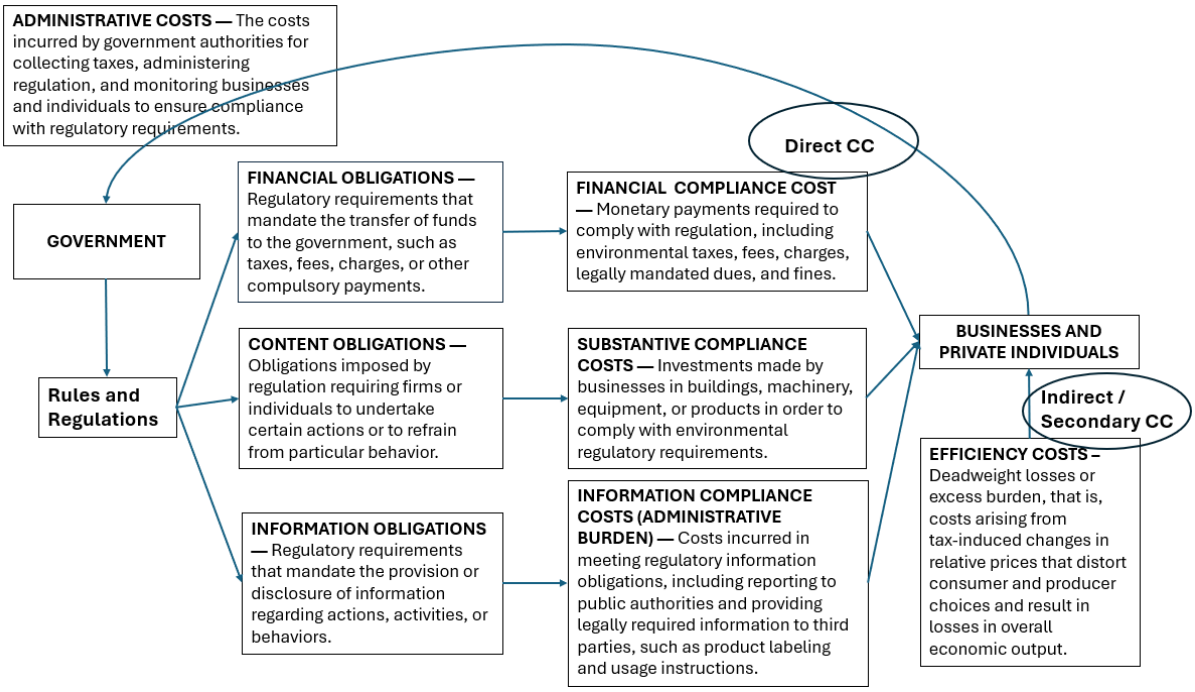
Following SCM's classification, business operations complying with Slovenian and Croatian legislation, aligned with EU directives, incur various costs. These costs can be categorized as direct (financial) costs (levies, contributions, fees, fines), indirect

costs (i.e. product or process adaptation to meet regulatory requirements) and administrative costs (e.g. time spent to fill in reports). While the former arise from monetary obligations, the latter relate to obtaining goods or services for direct public interest realization and transmitting information to government authorities. Further on, information compliance costs can be categorized as those stemming from normal operations and those arising specifically from regulatory requirements, the latter commonly referred to as administrative burden.

Still, a fourth type of cost could be added to the classification of business costs that is not included in the SCM definition - efficiency costs. Although these costs would be even more difficult to measure than information compliance costs, they do exist. According to economic theory on taxation, any imposition of tax results in a deadweight loss for suppliers and consumers, depending primarily on the market structure and elasticity of demand. Regulation triggers costs by inducing changes in relative prices, distorting consumer and producer choices, and leading to losses in overall output (Tran-Nam et al, 2000). These costs can also be referred to as secondary compliance costs or second-round effects of regulation (i.e. indirect costs and macroeconomic costs), which are subject to significant uncertainty and pose major analytical challenges (OECD, 2014).

Following the OECD's classification, a fifth category of business costs may also be considered which are opportunity costs. These costs arise when expenditures must be diverted to regulatory compliance rather than to preferred, more productive uses. Measuring and quantifying these costs in real life is even more challenging than measuring other types of costs. In general, besides direct financial costs other costs are many times perceived as hidden costs. According to (Joshi et al., 2001) field studies mainly conclude that most firm' costing systems fail to identify the full effect of regulation cost.

Figure 2: Compliance costs classification



Source: own elaboration

Figure 2 represents a graphical depiction of various costs incurred by private and public sector.

In relation to the debate on cost specification, it is worth noting the term administrative burden, which is often used in scholarly research to describe the costs businesses face when complying with information obligations imposed by regulation (e.g., OECD, 2014). This term tends to carry a negative connotation, as research frequently links administrative burdens to their adverse impact on efficiency (Feeney, 2012; Madsen et al., 2022). However, it is important to distinguish between the terms “administrative burden” and “administrative barrier”, the latter being a concept also explored in the empirical part of this study. According to the Standard Cost Model (SCM Network, 2006), administrative burdens refer specifically to the costs’ businesses incur when fulfilling the information obligations required by law. Still, as per the classification used by the Slovenian government’s EMMS[3] system (Vlada Republike Slovenije, 2013), not all costs related to information compliance are considered administrative burdens. Kotnik et al. (2020) describe administrative burdens as unnecessary obligations dictated by law, which could be mitigated or eliminated through improved regulatory quality. In this sense, administrative burdens differ from the broader category of

[3] EMMS – A unified methodology for measuring the costs that legislation imposes on entities (in Slovenian: *Enotna metodologija za merjenje stroškov, ki jih zakonodaja povzroča subjektom*).

information compliance costs, as they represent only those tasks that entities would not perform in the absence of such regulation.

This distinction is critical in economic and taxation analysis, as reducing administrative burdens can foster a more business-friendly environment and lower operational costs for both businesses and citizens. In this context, administrative burdens are typically considered a subset of administrative costs resulting from regulatory requirements. By contrast, the term “administrative barrier” refers to a narrower concept. It specifically denotes those administrative burdens that are not essential for achieving public policy objectives. For example, many authors (e.g. Kalaš & Bačlija, 2015; Kovač, 2010; Milavec & Klun, 2011) identify administrative barriers as regulatory obstacles that could potentially hinder efficiency without contributing to the public interest (Government of the Republic of Slovenia, 2013). While both terms belong to the same conceptual category, the distinction between them is often blurred. Determining when a regulation constitutes an unnecessary burden and when eliminating such requirements might harm the public interest remains a challenging task (Kalaš & Bačlija, 2015).

From the perspective of citizens’ interaction with public administration, Moynihan et al. (2015) define administrative burdens as a combination of learning costs, psychological costs, and administrative costs. Learning costs involve the effort required to obtain information about public services, psychological costs arise from stigma or stress associated with navigating administrative procedures, and administrative costs refer to completing forms and providing necessary documentation. Similarly, Peeters & Widlak (2018) emphasize that administrative burdens extend beyond the economic costs imposed by regulation to include broader societal impacts. These include barriers to accessing social and political rights, highlighting the broader implications of public bureaucracy.

2.1.2 Public policy perspective

Since the Standard Cost Model (SCM) focuses solely on the business perspective, it does not consider administrative costs, which are the governmental costs associated with collecting taxes and administering and enforcing regulatory requirements. The OECD defines these as administration and enforcement costs and categorizes them as compliance costs, as they are directly related to achieving the underlying regulatory objectives and represent an unavoidable part of the cost of regulation (OECD, 2014). According to the OECD (2014), these costs include publicizing new regulations, developing and implementing licensing or registration systems, assessing and approving applications, processing renewals, and implementing inspection and sanction systems for non-compliance. Evans, (2008) also labels these costs of public sector as “administrative costs” but expands the definition to include the costs of

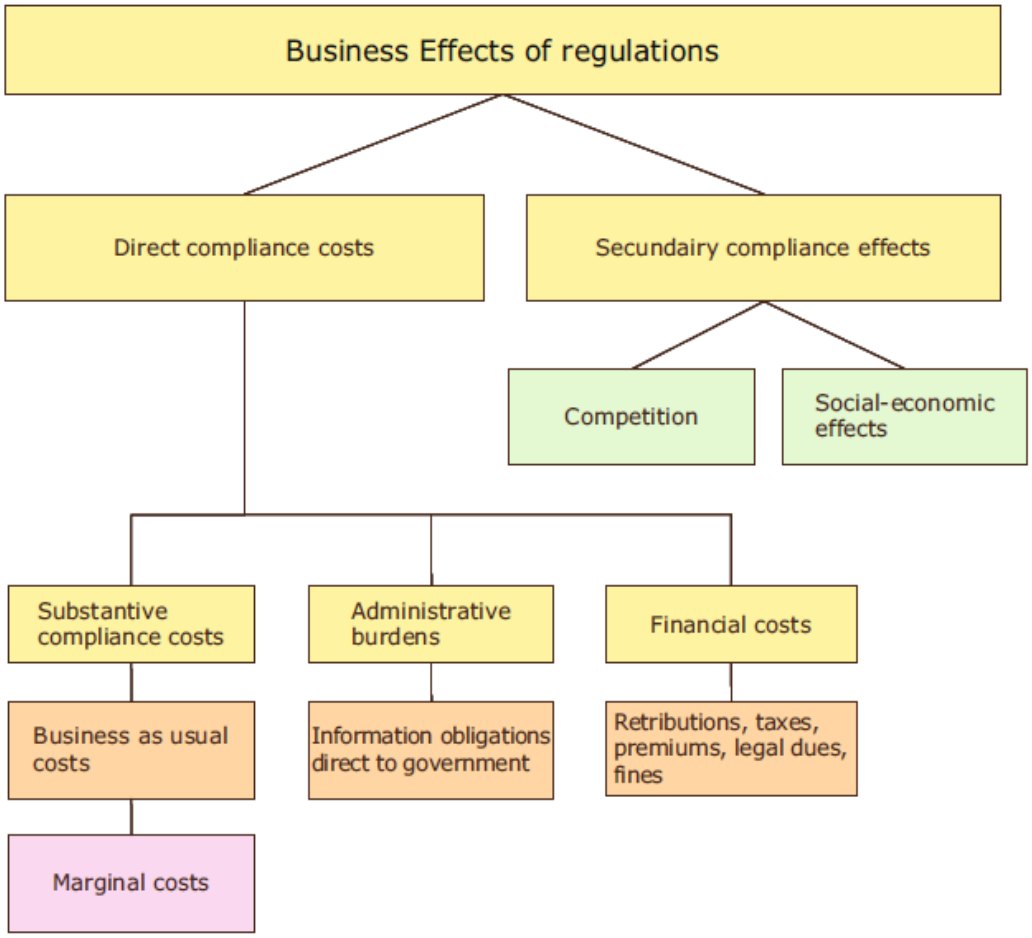
running and maintaining revenue agencies, salaries of staff, pensions relating to those staff, together with accommodation and office expenses for revenue department staff. Furthermore, they can also include the costs of legislative enactment relating to the tax system, from initial policy formulation to statutory or other rule enactment (Evans, 2008).

The intersection between the public policy perspective and the business perspective concerns the costs referred to as the operating costs of regulation. According to the classification by Tran-Nam et al. (2000), these costs represent the sum of companies' (information) compliance costs and the administrative costs incurred by the public sector. In the context of taxation, Pavel and Vítek (2014) define these costs as the aggregate of compliance costs and benefits in the private sector, administrative costs and benefits in the public sector, and other expenses associated with tax payment.

2.1.3 Types of compliance costs

Although the classification from OECD is more comprehensive, as it includes the costs to the government of collecting taxes (i.e., administrative costs) as well as other "secondary" compliance costs of regulation (e.g., indirect costs, opportunity costs, and macroeconomic costs), these are not covered in the Standard Cost Model (SCM) classification. Nevertheless, the SCM is generally more suitable for measuring the costs of regulation from a business perspective, which is the focus of this thesis. According to the SCM definition, each regulation imposes three types of costs on firms: financial costs, substantive compliance costs, and information compliance costs. As Nijsen (2008) notes, these are direct compliance costs, which are easier to measure than secondary compliance costs (see Figure 3).

Figure 3: Categorization of compliance costs from business perspective



Source: Nijsen (2008)

The empirical part of the thesis follows the SCM definition of direct compliance costs, measuring separately each of the three cost categories in relation to environmental regulation. By not focusing solely on information compliance costs or the administrative burden, the study is able to estimate the total costs of environmental regulation in greater detail. These totals are much higher in absolute terms, which increases the relevance of the analysis and, importantly, allows testing of the Porter Hypothesis, one of the thesis's core objectives. In this respect, the approach differs from previous studies in Slovenia and Croatia, as well as from several CEE studies, that focus primarily on information compliance costs/administrative burdens.

Much of the prior literature took this narrower approach because the size of information or administrative compliance costs can serve as an instrument for measuring tax system complexity (Pavel & Vitek, 2014). For example, in Slovenia and Croatia, Klun and Blažič (e.g., Blažić, 2004; Klun, 2004, 2009; Klun & Blažić, 2005) estimated such costs for personal or corporate income taxes, VAT, and social security contributions.

Notably, Klun and Blažić (2005) found that companies' tax compliance costs reached up to 1.0% of GDP in Slovenia and 1.2% in Croatia in 2002. Similar results were reported by Nemec et al. (2017) for Slovakia, who assessed the private sector's compliance costs for paying income tax and employee social contributions at 1.03% of GDP, not even accounting for VAT compliance costs, as in Klun and Blažić (2005). More recently, for the specific context of this thesis, Kotnik et al. (2020) is particularly relevant because it focuses directly on factors affecting the administrative burden of environmental regulation.

In other CEE countries, studies on tax compliance costs have been even more limited than in Western Europe (Nemec et al., 2017). Besides the previously mentioned case of Slovakia, a notable contribution is from Pavel & Vitek (2014), who estimated Czech tax compliance costs in 2004 and 2008 for VAT, corporate income tax, and personal income tax (employees and self-employed). They also conducted a cross-country comparison (Czech Republic, Slovakia, Slovenia, and Croatia), showing that compliance costs are relatively high for personal income taxation and are strongly regressive in these set of countries.

2.2 MEASURING COMPLIANCE COSTS

It has been almost 90 years since Haig's first tentative modern study in the United States which was the first attempt to measure compliance costs (Evans, 2008; Martin, 1944). A decade later Martin (1944) already highlighted the difficulty of separating taxation requirements from other business expenses. He argued that, due to different forms of business organization and various methods of meeting tax requirements, compliance costs could sometimes be clearly delineated and measured. In other cases, where tax compliance is integrated into production processes and spread across different departments, estimating these costs is challenging and often requires approximation or even guessing. Recognizing that personnel expenditure represents a significant portion of tax compliance costs, he suggested that firms maintain daily time reports for each employee to allocate time spent on tax compliance versus other activities.

Until the 1990s, the compliance costs of taxation were generally considered insignificant until the seminal work of Sandford et al. (1989), who identified several reasons for the growing importance of compliance costs. These included technological changes, the introduction of VAT in many countries, the rise of enterprise cultures, and increasing tax system complexity. As the importance of compliance costs grew, more attention was given to their measurement. Tran-Nam et al. (2000) argued that three different data sources are needed to measure tax compliance:

- Macro statistics on the cross-distribution of taxpayers (e.g., personal taxpayers by gross and taxable income, or business taxpayers by legal form and annual turnover) and tax revenue distributions by various characteristics.
- Information about taxpayers' tax compliance costs, such as time spent on personal tax affairs, unpaid helper time, wages (actual or perceived), time spent by different levels of personnel on tax activities or types, fees paid to tax advisers, etc.
- Other information, such as market wages for different occupations and interest rates.

While the first and the third data types could be obtained through various register analyses, the collection of the second type of data represents the main challenge. Several strategies have been proposed to gather this data, including large-scale mail surveys, log-book case studies, face-to-face or telephone interviews, and document analyses. Although surveys have some drawbacks, such as low response rates, small samples, subjectivity, and the incompetence of respondents, large-scale mail structured surveys remain the most popular method for compliance cost research (Bruce-Twum & Schutte, 2021; Eichfelder & Vaillancourt, 2014; Tran-Nam et al., 2000). Diary or log-book studies help address potential underestimations or overestimations of survey costs but are typically limited to small-scale research and are debated in terms of whether using stopwatches is appropriate for measuring the "true" burden of all cost elements. In contrast, there is a scarcity of research that relies on qualitative interview data (Eichfelder & Vaillancourt, 2014).

In general, studies on the compliance costs of environmental regulation fall into two main categories. The first category focuses on costs associated with abatement activities that impose additional financial burdens on businesses, such as modifying products or production processes to meet regulatory standards. These studies typically rely on accounting data analyses and survey-based methods. The second category examines compliance costs arising from increased obligations for firms to monitor their pollution-related activities (Bruce-Twum & Schutte, 2021; Eichfelder & Vaillancourt, 2014; Kotnik et al., 2020). The most common data collection methods for these costs include surveys, in-depth interviews, and time logs. Table 1 presents some of the most important studies on compliance costs, describing their data collection methods and the variables used to measure compliance costs.

Table 1: An overview of studies of compliance costs of environmental regulation by data collection/ methodology and variables used

Author (s)	Type of compliance costs	Data collection/ Methodology	Variables used to measure compliance costs or environmental stringency
Klun & Slabe Erker (2012)	Administration	Internet-based business survey across 323 companies	The paperwork and administrative activities firms undertake to comply with employment and environmental regulations.
Do Céu Colaço Santos & Bilhim (2018)	Administration	SCM methodology	Time spent to fulfil obligations
Fauziati & Kassim, (2018)	Administration	Survey across SMEs; Self-Assessment System (SAS)	Tax compliance costs
Schoonjans et al., (2011)	Administration	Electronic Internet-based anonymous survey	Compliance cost per category; costs and time
Joshi et al., (2001)	Administration & production	PACE data	Environmental costs
Kramer et al., (2020)	Administration	In-depth interviews with a small number of industry representatives; follow up interviews	Quantifying environmental permitting and compliance costs
Kneller & Manderson, (2010)	Administration & Production	Pollution abatement expenditure data as a proxy from UK Environmental Protection Expenditure survey.	Costs of achieving compliance with environmental regulation
Lignier & Evans, (2012)	Administration	Internet-based business survey across 277 companies	Time spent on various taxes

Source: own elaboration

As discussed earlier, the most widely used methodological tool for measuring the costs of environmental regulation is the Standard Cost Model (SCM). SCM has become the regulatory reform tool of choice in EU and OECD countries for identifying and reducing regulatory compliance costs. It is an activity-based measurement model that breaks down regulation into manageable components, called information obligations. Thus, it

is an effective and low-cost method for estimating the administrative burdens businesses face in complying with information obligations from regulation. While SCM does not capture all compliance costs, it is a useful proxy, particularly in environments with limited data or resources, for estimating broader compliance costs, i.e. substantive compliance costs that include investment costs due to regulation requirements. Although SCM is suitable for identifying all types of compliance costs for various actors, including businesses, civilians, and civil servants, it is primarily used to measure the administrative burdens associated with businesses' compliance with information obligations (Nijsen et al., 2008). According to the World Bank, the SCM is one of the tools available to benchmark and monitor compliance costs; however, it is not intended to replace other instruments, such as the Doing Business Indicators or Enterprise Surveys. Nevertheless, SCM is considered the most useful tool for measuring compliance costs related to environmental regulation (Dong, 2021). The final step of the SCM involves aggregating the compliance costs of individual information obligations to the macro level.

2.3 COMPLIANCE COSTS OF ENVIRONMENTAL REGULATION

In the past, several studies have been focusing on the compliance costs of environmental regulations (e.g., Do Céu Colaço Santos & Bilhim, 2018; Kayser et al., 2004; Kotnik et al., 2020; Liu et al., 2021; Priyadarshini & Gupta, 2003). Firms are often not fully aware of all the costs associated with environmental regulation as accounting systems do not perceive them as environmental costs (Joshi et al., 2001). Joshi et al., (2001) analyzed U.S. steel industry environmental costs, reported by firms' accounting systems. They found out that 1$ increase in visible operating expenditure is accompanied by an increase of 9.23$ of total costs, arguing that 8.23$ of costs is not tracked as environmental costs as it should be, which indicated that compliance costs of regulation are highly underestimated when using accounting data. When asking managers to validate assumption of high degree of "hidden" environmental cost, they were aware of these underestimations. Although in many cases compliance costs of environmental regulation represent only a small share of the total costs of the companies, they are nevertheless not negligible (Gray & Shadbegian, 2003). As they are generally inevitable and irreducible (Tran-Nam et al., 2000), its optimization could spur positive effects as total costs would reduce, which could, through increased investments, lead to higher productivity of firms, while the positive environmental effects of regulation would remain unchanged. Compliance costs of environmental regulation are often used as a proxy for the stringency of such regulation. In this context, Albrizio et al. (2017) highlight another potential negative effect of overly stringent environmental policies, namely, high compliance costs can reduce industry productivity by making it less attractive to new entrants. This, in turn, may lead to decreased competition and fewer incentives to innovate and enhance productivity.

However, regulatory simplification alone or greater environmental regulatory flexibility does not necessarily have a positive impact on productivity.

In general, there are two approaches to analyzing the impact of environmental regulation. The first approach involves comparing regulated and non-regulated sectors (e.g., Weiss et al. 2018) and focuses primarily on the effectiveness of regulation in enhancing firms' innovation and productivity. The second approach directly measures the stringency of environmental regulation using different proxies, which Brunel & Levison (2016) classify into five categories: (1) private sector abatement costs, (2) direct assessments of the regulations themselves, (3) composite indexes, (4) measures based on pollution levels and changes or energy use, and (5) measures based on public sector expenditures or enforcement. They argue that while data collection is often cited as the main challenge in measuring regulatory stringency, other deeper conceptual problems exist, such as multidimensionality, simultaneity, industrial composition, and capital vintage. Furthermore, researchers use different indicators to measure these categories of proxies. In the case of private abatement costs, various methods exist for their evaluation. The earliest and most comprehensive data on private-sector pollution abatement costs in the United States come from the U.S. Pollution Abatement Costs and Expenditures (PACE), which appears ideal for measuring stringency because the survey directly asks managers at industrial facilities how much their establishments spend on pollution abatement. In this way, it is like the SCM method, except that the PACE survey was directly targeted at measuring compliance costs of environmental regulation, while the SCM method can be used to measure the costs of various types of regulation. Although these surveys have some drawbacks, such as asking managers to answer complex conceptual questions they may not fully understand, it is important to note that, in aggregate terms, reported abatement costs vary over time and across industries and jurisdictions in ways consistent with intuition (Brunel & Levinson, 2016).

Another widely used composite index in environmental policy research is the environmental policy stringency (EPS) index developed by the OECD, which consists of two components, a market-based and non-market-based[4] instruments (Albrizio et al., 2017). The indicator ranges from 0 to 6, with higher values indicating more stringent environmental policies, and its advantage lies in simplifying a complex set of multi-dimensional policies into a comparable country-specific proxy. In practice, the credibility of the EPS[5] as a proxy for a country's overall environmental policy stringency

[4] The difference between market-based and non-market-based instruments is explained in more detail in Chapters 3.1 and 3.2, respectively.

[5] Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour (OECD, 2014).

is validated by comparing it with other available measures of environmental policy stringency (Albrizio et al., 2017). EPS index has been particularly relevant also for its use in the Porter Hypothesis testing as it directly measures the stringency of environmental policy. Studies (e.g. Martínez-Zarzoso et al., 2019; Rubashkina et al., 2015) have used it in cross country research among OECD countries to test different versions of the Porter Hypothesis on the macro level. However, Cecere & Corrocher (2016) argue that environmental stringency indexes, though promising, require extensive data and may misclassify countries as stringent simply for joining international treaties without ensuring compliance.

2.3.1 Real case examples – the case of Salonit Anhovo

To illustrate the types of costs firms, incur when complying with environmental regulation, the case of the Slovenian company Salonit Anhovo is presented. The firm plays a significant role in the construction industry in Slovenia and the wider region, supplying high-quality cement for infrastructure projects, residential construction, and other applications. For decades, however, the company's asbestos-cement production left a lasting mark on the Soča Valley, causing an epidemic of asbestos-related diseases. These illnesses, with a latency period of 20–40 years, continue to affect and claim lives today, even though asbestos use ended in 1996. Local residents, associations, and civic initiatives persist in their courageous fight for truth and justice. The significance of this case is so profound that amendments to Slovenia's environmental law have been introduced, indirectly targeting the company's activities. Although Salonit Anhovo was renamed Alpacem Cement in 2024, with a new visual identity adopted and alignment achieved with the international Alpacem brand that has been part of the company's corporate identity for over five years, the original name will be used in this study as it remains more widely recognized by the general public.

The selected case study has been deliberately chosen due to its recent public exposure following a dispute between the company's management and workers on one side, and the municipality and environmental non-governmental organizations on the other. Civil society argues that large amounts of hazardous substances from the cement plant and waste co-incineration in the Soča Valley worsen the health of an already vulnerable population. In contrast, the cement plant claims that advanced technologies and strict responsibility make it a minor contributor to air pollution, with air quality in Kanal ob Soči among the best in Slovenia and no data suggesting health risks (Vončina, 2024). For the purposes of this thesis, it is relevant that Salonit Anhovo must comply with environmental regulation, which have recently become even stricter to limit the company's negative externalities, while the dispute itself, despite its importance, will be only briefly presented.

Although Salonit Anhovo claims to be committed to sustainability and environmental responsibility by implementing measures to minimize its ecological footprint and promote environmentally friendly practices, it has consistently faced accusations of causing negative environmental externalities and negatively affecting the health and living conditions of the local population. The firm, which produced asbestos-cement products until 1996, has operated as a cement plant for the past 22 years with a permit for waste incineration and co-incineration, including hazardous waste, predominantly imported from Italy and Austria. for co-incineration could lead to the closure of the factory. The case is particularly interesting as it represents a contemporary change in the strictness of environmental regulation which might result in increasing substantial compliance costs for firms leading even to the point of closing this important Slovenian construction company. In 2024 an amendment to the Environmental Protection Act (ZVO-2) introduced stricter requirements for emissions from co-incineration plants, which targets mainly the activities of Salonit Anhovo. Operators must now conduct air-emission monitoring at all discharge points and report results more frequently to both the competent ministry and the local community (Zakon o spremembah in dopolnitvah Zakona o varstvu okolja (ZVO-2A), Uradni list RS, št. 23/24). Amendment requires stricter emission limits for co-incineration plants, aligned with Best Available Techniques (BAT) for waste incineration, or stricter if BAT so dictates. Operators of co-incineration plants must align operations with environmental permits regarding stricter emission limits within four years of their validity.

Company representatives claimed that stricter conditions for co-incineration could lead to the closure of the factory or at least job losses. Some employees of Salonit Anhovo and representatives of local associations have also confirmed that adoption of the amendment would threaten employment at the cement plant. According to company reports, it has been striving for environmentally sustainable business practices and adopted ISO 14001[6] as early as 2004. Besides, the company reports investments of over €150 million in the past 15 years and announced a new €40 million investment cycle by 2025 to advance towards carbon-neutral cement production. The first phase aims to reduce the carbon footprint by 15% and cut other emissions, including more than halving current nitrogen oxide (NOx) levels, which have been a frequent source of criticism due to higher legal limits for cement plants compared to waste incinerators. Salonit Anhovo argues that further lowering emission limits for cement plants is feasible only within unified EU legislation and realistic timelines. The proposed law, they claim, sets incompatible deadlines and places Slovenia's cement industry at a disadvantage compared to other EU countries. Another important aspect highlighted by the company concerns the timeline for implementing the first modernization step,

[6] More about ISO-14001 in Chapter 4.3.

which depends primarily on the speed of obtaining the necessary permits. If the permits were available today, the initial set of upgrades could be completed within two years.

For the purposes of this thesis, the case is examined primarily from a business perspective; therefore, the issue of negative externalities affecting the health of people living near the facility is omitted, although it remains highly significant. From a business standpoint, the case highlights the challenges posed by heightened regulation, which may reduce productivity and undermine competitiveness compared to firms in other EU countries. Such developments could trigger a domino effect on productivity, leading to significant job losses and potential social challenges within the local community.

2.3.1.1 Financial compliance costs

All payments or transfers of retributions, taxes, premiums, legal dues and fines to government or related authorities. Financial compliance costs are the result of a concrete and direct obligation to transfer a sum of money to the Government or the competent authority. Salonit Anhovo is obliged to pay three different environmental taxes according to publicly available data from FURS[7], namely, the pollution of air with carbon dioxide emissions (CO2 tax), Packaging tax and waste disposal tax.

2.3.1.2 Substantive compliance costs

The costs that businesses incur to comply with the content obligations that legislation and regulation require of a production process or a product (SCM Network, 2006). These are the incremental costs for the target group complying with a regulation other than administrative costs. They include only the direct costs borne by those upon whom the regulation imposes compliance obligations. Substantive compliance costs include the following broad categories: implementation costs, direct labor costs, overheads, equipment costs, materials costs and the costs of external services (OECD, 2014).
In the case of Salonit Anhovo, the firm has faced challenges related to environmental regulation and standards, particularly regarding emissions from its cement production processes. For example, the co-incineration of waste used as a secondary fuel requires that the cement kiln operates in accordance with “best available technology, BAT” and that it must not exceed the permitted emission values (Vončina, 2024). Furthermore, substantive costs also arise because operators must conduct their own emission monitoring, usually through external contractors, and ensure compliance with limits set by environmental permits; this process is known as “self-monitoring” and is never performed by the state.

[7] Financial Administration of the Republic of Slovenia.

2.3.1.3 Information compliance costs

Keeping records according to the moment of obligation for calculation. Many times, also labelled as administrative burdens which OECD (2014) defines as the costs of complying with information obligations stemming from government regulation. Information obligations can be defined as regulatory obligations to provide information and data to the public sector or third parties. An information obligation does not necessarily require that information be transferred to the public authority but may entail a duty to have information available for inspection or supply on request (Torriti & Ikpe, 2015). According to the EU program on reducing administrative burdens, which aims to improve the business environment within the EU, measures are in place to achieve a 25% reduction in existing administrative burdens stemming from EU legislation. This reduction is expected to result in annual savings of €30.8 billion for businesses across EU countries (European Commission, 2012).

In the case of Salonit Anhovo the new amendment of ZVO-2 introduces new monitoring obligations for the company, requiring measurements at all discharge points within six months. Polluters are required to publish half-hourly and daily average emission values online and submit monthly reports to the relevant ministry and municipality, which will also share this information with the public on their website. In addition to monitoring emissions from sources such as cement plants or incinerators, robust monitoring of ambient air emissions should be in place, as this reflects overall ambient air quality (Vončina, 2024).

2.4 MANAGERS' PERCEPTION OF COMPLIANCE COSTS

Finally, the aim of this thesis is to go beyond merely examining and measuring the actual costs of environmental regulation. A critical factor influencing firm strategies, policy design, and ultimately attitudes toward green investments or productivity is not only the absolute level of these costs, but also how they are perceived by the managers responsible for strategic decision-making (Hu et al., 2023). According to the contingency theory and resource-based view (both discussed in the next chapter), as well as other organizational-natural environment literature have all shown that managerial perceptions of the general business environment influence firms' strategy.

Managers may perceive environmental issues as either threats or opportunities (Sharma, 2000), just as they may view the costs associated with environmental regulation as either normal, low or high, which can influence their attitudes toward green investments. This is in line with the proposition by Jong & Kloeze, (2013) that effective policy measures need to account for firms' perspectives on regulation costs and their institutional determinants. Research often undervalues or fails to explicitly

mention the crucial role of managers' opinions and strategies. According to an analysis by Matta et al., (2019) factors impacting firms' environmental disclosure, management and reputation have been the most significant drivers for firms to become more transparent and responsible regarding their social and environmental performance. Initially driven by regulatory requirements, firms have increasingly adopted a proactive stance towards environmental protection, treating environmental awareness and protection as strategic inputs that influence corporate actions and governance routines to achieve environmental goals (Matta et al. 2019). Still, managers are frequently hesitant to implement pro-environmental strategies because the effects of such investments typically take time to manifest, and the outcomes are uncertain. As a result, they tend to allocate resources to more conservative investments (Berrone & Gomez-Mejia, 2009). In their research, Berrone & Gomez-Mejia (2009) demonstrate that when managers perceive environmental regulation as a competitive opportunity, they are more likely to adopt a proactive approach towards environmental commitment.

3 FACTORS AFFECTING COMPLIANCE COSTS AND THEIR PERCEPTION

"Finally, theory and research on external sources of competitive advantage should look beyond the resource and market characteristics of firms to government, society, and interfirm relations as important influences on firm variation." (Oliver, 1997)

This chapter presents the theoretical framework for formulating hypotheses and incorporating individual dependent and independent variables into the model. A comprehensive literature review highlights various types of factors, such as normative, institutional, economic-financial, organizational, and procedural aspects, related to firms' compliance with environmental regulation. Factors influencing compliance costs of environmental regulation as well as firms' perception of these costs are examined through two interconnected perspectives: the resource-based view (including its Natural Resource-Based View theory and the Contingent Natural Resource Based View extensions) and institutional theory. According to Hart (1995), researchers in the field of strategic management have long recognized that firms' performance depends on the match between distinctive internal (organizational) capabilities and changing external (environmental) circumstances. In this context, it can be proposed that compliance costs of environmental regulation are influenced by firm-specific (internal) factors as well as external (institutional) factors, with the latter primarily arising from coercive pressures, such as regulatory obligations. Additionally, managerial cognition theory is used to emphasize the importance of the perception of costs for firms' green performance. To establish a theoretical basis for selecting various potential factors that influence compliance costs, each perspective is briefly presented. Subsequently, each factor is discussed with reference to previous research that supports its inclusion in the analysis.

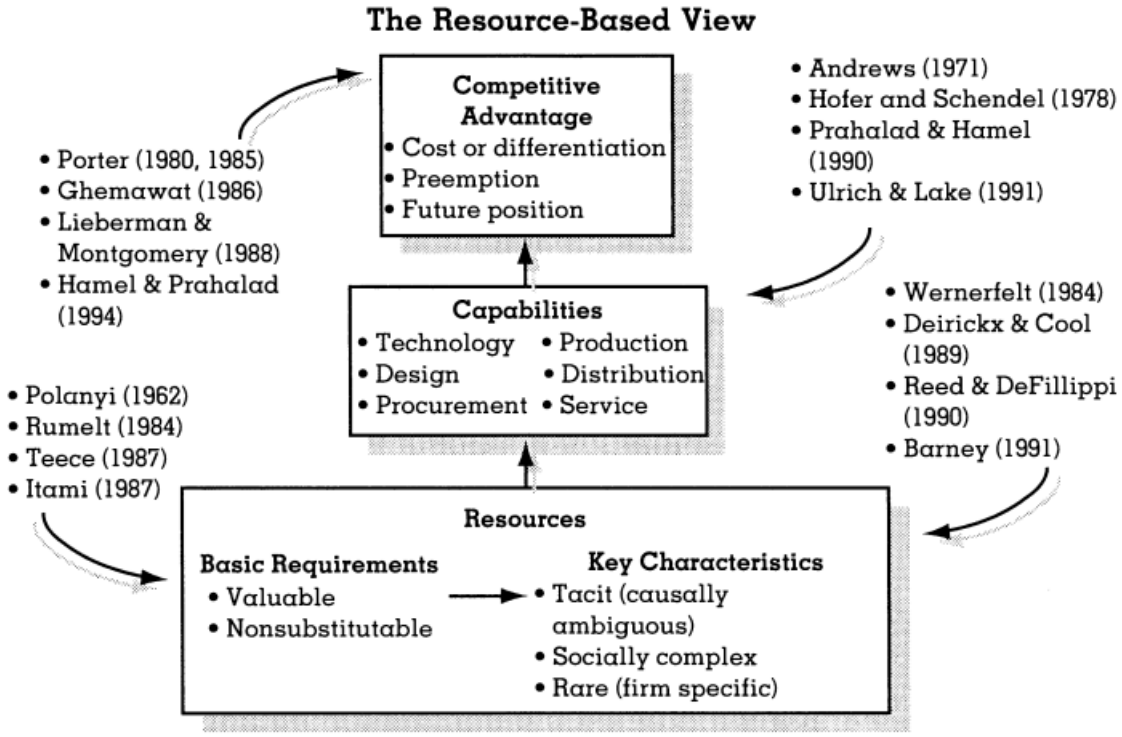
3.1 THEORETICAL FRAMEWORK OF FACTORS AFFECTING COMPLIANCE COSTS AND PERCEPTIONS

3.1.1 Resource-based view (RBV)

The resource-based view (RBV) of the firm builds on the relationships among firm's resources, capabilities, and competitive advantages. Corporate strategies and responses are shaped by internal strategic capabilities, which provide the foundation for sustained competitive advantage. This focus on internal factors is the central element of the RBV (Mishra & Yadav, 2021). RBV posits that competitive advantage of the firm can be sustained only if the capabilities driving the advantage are supported

by resources that are not easily duplicated by competitors. Valuable and costly-to-copy firm resources and capabilities are the key drivers of sustainable competitive advantage. Resources, the fundamental units of analysis in RBV, include physical and financial assets as well as employees' skills and organizational (social) processes. Therefore, firm's capabilities arise from the effective combination of these resources in executing specific value-added tasks. Importantly, these resources must be difficult to replicate because they are either tacit (causally ambiguous) or socially complex (Barney, 1991). Tacit resources are skill-based and people-intensive, making them inherently harder to codify and copy, while socially complex resources rely on the coordinated efforts of numerous individuals or teams, where no single person possesses enough comprehensive knowledge to fully understand the entire process or phenomenon.

Figure 4: Schematic representation of the Resource-Based View



Source: Hart (1995)

3.1.1.1 Natural-Resource-Based View (NRBV)

In 1989, Schneider already discussed the potential impacts of climate change, including rising sea levels and increased desertification, which he warned could threaten the very fabric of human civilization (Schneider, 1989). This coincided with the release of the Brundtland Report on environmental sustainability, which defined sustainable development as "development that meets the needs of the present without

compromising the ability of future generations to meet their own needs" and emphasized the interconnectedness of economic growth, environmental protection, and social equity. In his paper, Schneider (1989) observed that the potential negative environmental consequences had already been recognized by Roger Revelle and Hans E. Suess back in 1957. They described humanity's actions as a "great geophysical experiment" conducted not in a laboratory or on a computer, but on our own planet. This experiment referred to the increasing levels of carbon dioxide in the atmosphere. While the full outcomes would only become apparent decades later, the origins of this phenomenon can be traced back to the beginning of the Industrial Revolution.

At the time of growing interest in sustainability, Hart (1995) found the existing resource-based view (RBV) theory insufficient for identifying key emerging sources of competitive advantage, which spurred development of the natural-resource-based theory which incorporated ecology into the original RBV (Chu et al., 2018; You et al., 2019). While the RBV theory focused primarily on internal factors, it became limited due to its failure to account for the constraints posed by the biophysical (natural) environment. Hart (1995) identified this gap and proposed the natural-resource-based view (NRBV) to explain how organizational capabilities influence a firm's environmental strategy. Aware of the growing importance of sustainable economic activity, he stated: *"It is likely that strategy and competitive advantage in the coming years will be rooted in capabilities that facilitate environmentally sustainable economic activity – a natural-resource-based view of the firm"* (Hart, 1995). According to Kauppi (2013), sustaining competitive advantage over time requires not only economic considerations but also equal attention to social and environmental criteria.

The NRBV identifies three key strategic capabilities: pollution prevention, product stewardship, and sustainable development, each driven by different environmental factors, built upon distinct resources, and providing unique sources of competitive advantage. Pollution prevention focuses on avoiding waste and emissions rather than addressing them after they occur, thereby reducing costs through lower input use, streamlined processes, and decreased compliance and liability expenses. Product stewardship extends pollution prevention to the entire product life cycle, involving stakeholder engagement to incorporate environmental concerns into product design. It offers competitive advantage through strategic pre-emption, such as securing access to green materials or establishing advantageous standards. Finally, sustainable development aims not just to reduce environmental harm but to ensure that production is sustainable in the long term and considers not only environmental but also economic and social issues (Hart & Dowell, 2011). Following the NRBV theory, firms with well-developed organizational capabilities are more likely to adopt a proactive environmental strategy (Mishra & Yadav, 2021). According to the theory the focus

should be on a long-term accumulation of resources and capabilities rather than a short-term focus on profits at the expense of the environment, to envision sustainable technologies and products that can lead to a firm's competitive advantage in the market (You et al., 2019).

In the context of the Porter Hypothesis, discussed later in this thesis, research on organizations and the natural environment from the resource-based view suggests that proactive corporate environmental strategies, those that go beyond regulatory compliance, can positively impact financial performance (Aragón-Correa et al., 2008). Furthermore, studies have also found that firm size has a significant effect on the degree of proactiveness, with larger organizations being more likely to adopt proactive environmental practices. This might lead to an assumption that SMEs' lack of resources prevents them from implementing proactive environmental strategies, consequently reducing their profitability options. While Hart (1995) expressed doubts about the applicability of the NRBV to SMEs, Aragón-Correa et al. (2008) argue that small and medium enterprises (hereafter, SMEs) possess distinctive characteristics that enable more proactive environmental practices, which in turn can lead to superior financial performance. These characteristics include reliance on internally generated funds, a simple capital structure, entrepreneurial orientation among managers, flexibility to adapt to changes in the broader business environment, innovativeness to respond swiftly to competitors' actions, and closer interaction among employees.

3.1.1.2 Contingent natural-resource-based view

According to the natural-resource-based view (NRBV) the positive relationship between proactive environmental strategies and organizational performance results when firms develop complex capabilities, including tacit capabilities of total quality management, the socially complex capabilities of management, and the rare capabilities of shared vision (Aragón-Correa & Sharma, 2003) as these capabilities lower costs, improve reputation, and offer strategic changes in the general business environment (Hart, 1995). Consequently, a proactive strategy to manage the interface between a business and its natural environment has the characteristics of a dynamic capability that enables an organization to align itself with changes in its general business environment. Further, the extent to which the dynamic capability of proactive environmental strategy will lead to a positive impact on an organization's competitiveness will depend on exogenous factors that affect each firm differently via managerial perception. Thus, contingency theory posits that superior organizational performance depends on aligning internal design with external environmental factors, and that varying levels of environmental uncertainty require corresponding degrees of strategic formality to effectively match resources with opportunities and threats (Aragón-Correa & Sharma, 2003). A contingent RBV of the natural environment

explains how characteristics of the general business environment influence the development of a proactive environmental strategy as a dynamic capability (Gupta et al., 2018).

3.1.2 Institutional theory

Institutional theory examines the role of social influence and pressures for social conformity in shaping firms' actions, as the institutional environment not only formulates and reinforces a firm's business philosophy, but also forces it to comply with external rules, norms, and values. According to the institutional theory, firms are not only profit-seeking entities but also recognize the importance of achieving social legitimacy (Chu et al., 2018). Following the institutional theory firms are committed to pursue legitimacy, meaning they seek acceptance and approval from their institutional environment (Suchman, 1995), which exerts significant influence and pressure on their organizational behavior. The institutional environment may comprise national and regional regulations, industrial forums, formal and informal policies, and shared norms among key actors (North, 1990). Institutional theory suggests that business decisions are shaped not only by rational economic considerations but also by external norms, values, and traditions (Chu et al., 2018). Organizations face three types of institutional pressure—coercive, normative, and mimetic—which drive them to strengthen their social and environmental sustainability efforts (Kotnik et al., 2020, Gupta & Gupta, 2021). These responses enable firms to achieve greater legitimacy and enhance brand value.

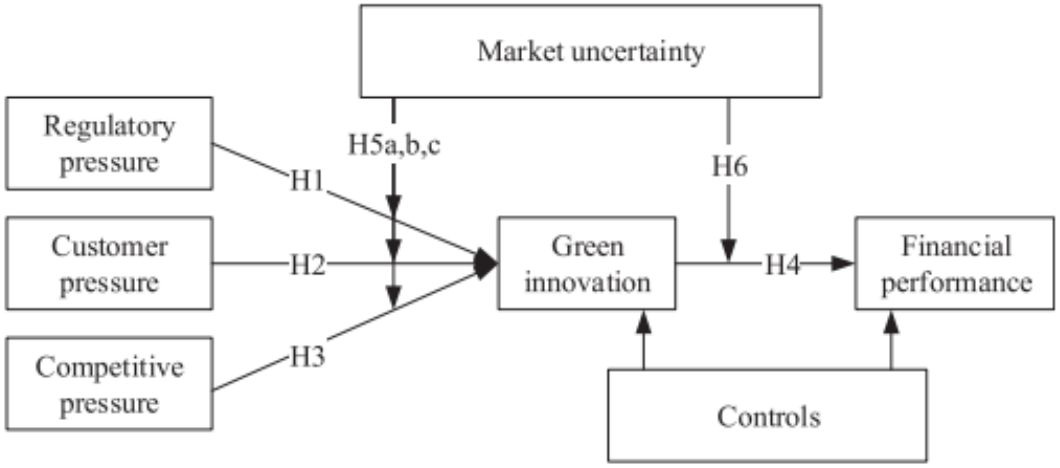
Coercive pressure stems from government regulation, compelling firms to comply with laws to gain legitimacy (Prajogo et al., 2012, Gupta & Gupta, 2021). The institutional context at the interfirm level includes regulatory pressures and industry-wide norms, which are in literature often analyzed as a form of coercive pressure. To address the (negative) externalities of firms' environmental impacts, governments implement regulations (e.g., emission standards, product bans) that set performance targets and impose penalties such as taxes, fines, or license suspensions for non-compliance. Consequently, firms are compelled to adopt environmentally friendly practices to comply with regulations, gain legitimacy, and avoid penalties (Chu et al, 2018). Institutional factors surrounding resource decisions thus influence the potential for firms' economic performance.

Normative pressure, driven by customers and non-governmental organizations, focuses on values and norms related to meeting societal and ethical standards (Berrone et al., 2013). It mainly comes from external stakeholders such as customers, investors, communities, industry associations and the social public. Customers for example, expect firms to adhere to environmental standards, enhance product

sustainability, and implement green supply chains. As a result, customer pressure is recognized among key drivers of green innovation, essential for maintaining competitive advantage (Chen et al., 2018). This growing environmental awareness compels firms to proactively address societal and environmental expectations. In contrast, mimetic pressure arises when firms imitate the strategies and actions of successful competitors to gain their legitimacy. In situations where efficient or effective practices are uncertain, organizations tend to replicate the behavior of others they perceive as successful, thus reinforcing institutional conformity within industries (Chu et al. 2018).

The three types of institutional pressures often operate concurrently, their influence varies, while research indicates that coercive forces, such as government agencies, and normative influences, like non-governmental organizations, significantly impact corporate environmental behavior, highlighting the importance of focusing on coercive pressures in future studies (Chen et al., 2018). Figure 5 represents a conceptual model of how three types of institutional pressures can affect the level of green innovation which further affects financial performance.

Figure 5: Conceptual model of institutional pressures on green innovation and further on financial performance



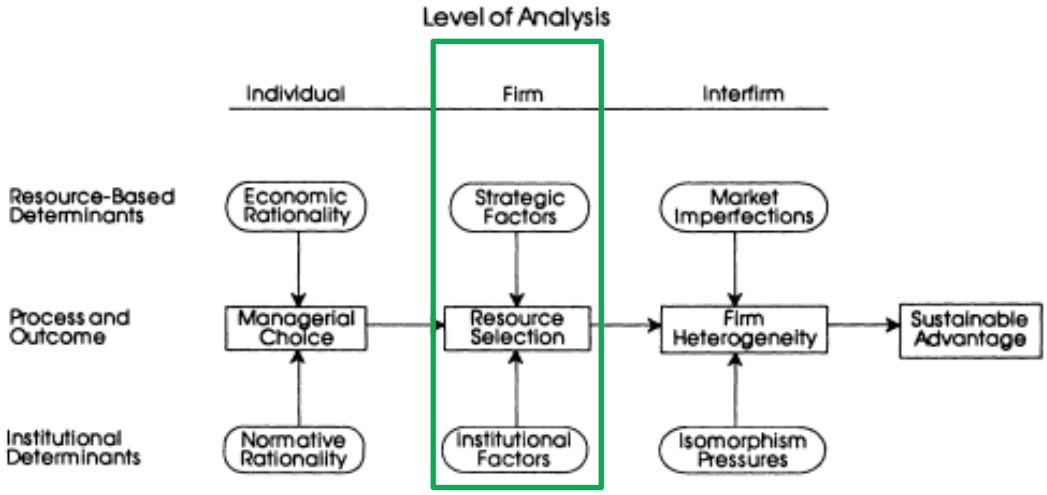
Source: Chu et al. (2018)

3.1.2.1 Resource-based view (RBV) and Institutional theory

Institutional perspectives emphasize the influence of external forces such as social and regulatory pressures in shaping corporate environmental strategies, while the resource-based view (RBV) focuses on internal resources and economically rational decision-making. Institutional theory argues that firms act according to socially

constructed norms of rationality, whereas the RBV assumes decisions are driven by resource availability. Critics contend that the RBV overlooks contextual factors beyond resource characteristics when explaining persistent firm heterogeneity[8] (Oliver, 1997). Particularly, it has not examined the social context in which resource selection decisions occur, such as organizational traditions, network relationships, and regulatory influences. Therefore, Oliver (1997) proposed a theoretical framework integrating the RBV and institutional theory, as both resource capital and institutional capital are indispensable for achieving a sustainable competitive advantage. In this framework, institutional theory highlights normative rationality, while the RBV focuses on economic rationality, differing in the motivations behind choices. She argued that economic choices are constrained not only by the technological, informational, and income limits that neoclassical models emphasize, but by socially constructed limits that are distinctly human in origin, like norms, habits[9], and customs. Therefore, by integrating both theories, firms pursue environmental performance to improve efficiency by ensuring resource availability and legitimacy by achieving resource acceptability.

Figure 6: Sustainable advantage - determinants of the process



Source: Oliver (1997)

[8] Firm heterogeneity is defined here as relatively durable differences in strategy and structure across firms in the same industry that tend to produce economic rents and a sustainable competitive advantage (Oliver, 1997).

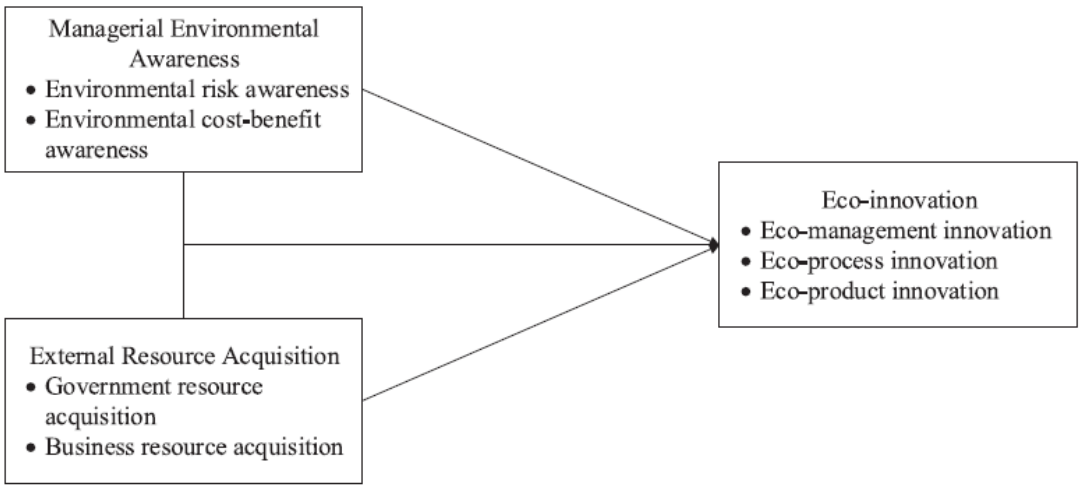
[9] A firm, for example, that retains the same unreliable supplier over a period of years may be perpetuating this institutionalized activity simply out of habit, even though the firm believes such allegiance to be rational (Oliver, 1997). When managers, for example, justify actions with the claim that 'we've always done it this way,' 'everybody does it this way' or 'that's just the way things are around here,' they are referring to institutionalized activities.

Figure 6 outlines Oliver's model of sustainable advantage a process model of sustainable competitive advantage. For the purpose of the later analysis in the thesis, the focus is on firm level, which incorporates the impact of strategic and institutional factors on resource selection. Resources are input factors controlled and used by firms to develop and implement their strategies. At the interorganizational level, pressures emerging from government, industry alliances, and societal expectations (rules, norms, and standards about product quality, occupational safety, or environmental management, for example) define socially acceptable firm conduct, and those social pressures common to all firms in the same sector cause firms to exhibit similar structures and activities (DiMaggio & Powell, 1983).

3.1.3 Managerial cognition theory

The managerial cognition theory highlights that a firm's response to environmental challenges is not purely exogenous but largely depends on how decision-makers perceive and interpret uncertainties. According to the findings of Jiao et al. (2020) managerial perceptions of sustainable operations, which are described as "the set of skills and concepts that allow a company to structure and manage its business processes to obtain competitive returns on its capital assets without sacrificing the legitimate needs of internal and external stakeholders and with due regard for the impact of its operations on people and environment", significantly influence the adoption of sustainable operations. However, previous research has primarily focused on consumer environmental awareness, while studies on managers have been limited and primarily concerned with cultivating awareness. Little attention has been given to how managerial awareness translates into environmental performance through business strategy, despite its importance for sustainable development and reducing resource and energy use (Zameer et al., 2021). Managers' cognitive models shape their focus, environmental interpretation, and reactions to change, making them key predictors of innovation, organizational behavior, and firm performance (Peng & Liu, 2016). In line with the theory as well as particularly relevant for the later study, Berrone & Gomez-Mejia (2009) argue that managerial perceptions of environmental regulation costs as a competitive opportunity are associated with a more proactive stance on environmental commitment. Danihelka (2004) argues that subjective factors such as managerial risk perception can influence the decision-making process of cleaner production. Furthermore, the study of Peng & Liu (2016) recognizes managerial environmental awareness, a specific manifestation of managerial cognition, as one of the main drivers of corporate eco-innovation activities. The authors distinguish between environmental risk awareness (ERA), reflecting managers' ethical concern about the firm's environmental impact, and environmental cost-benefit awareness (ECA), reflecting their recognition of financial gains from improved environmental practices.

Figure 7: Schematic representation of the Resource-Based View and Eco-Innovation



Source: Peng & Liu (2016)

Building on the resource-based view (RBV) of the firm and institutional theory, following proposed theoretical framework by Oliver (1997), the empirical part of this thesis proposes and tests the holistic model of various factors influencing compliance costs of environmental regulation and their perception. The model examines the direct impact of institutional factors on the magnitude of compliance costs, suggesting that part of these costs is driven by external forces. Simultaneously, incorporating RBV principles, the model evaluates the influence of internal factors on both the actual size of compliance costs of environmental regulation as well as how these costs are perceived by firms. To account for firms' heterogeneous interpretations of identical regulatory pressures, the proposed model is further grounded in managerial cognition theory. This perspective emphasizes that compliance costs of environmental regulation are not only objective economic burdens but are also subjectively constructed through managers' cognitive frames, risk assessments, and cost–benefit evaluations. Consistent with prior research, managerial perceptions of environmental regulation, particularly whether such costs are viewed as threats or opportunities, shape strategic responses, environmental commitment, and eco-innovation outcomes. Accordingly, incorporating the perception of compliance costs of environmental regulation into the empirical model allows for capturing the cognitive mechanisms through which institutional and firm-level factors translate into observable environmental and strategic behavior.

3.2 FACTORS AFFECTING COMPLIANCE COSTS OF ENVIRONMENTAL REGULATION, THEIR PERCEPTION AND PRODUCTIVITY

3.2.1 Internal factors

The first six factors (i.e. firm size, economic sector, financial and non-financial measures, use of ICT (digitalization level), and international involvement) discussed in greater detail below, are internal and based on the resource-based view, which posits that firms' strategies and decisions are shaped by their internal resources and capabilities (Cai & Li, 2018). As noted previously, this perspective suggests that firms make economically rational choices shaped by their economic context. The remaining factors (i.e. environmental obligations, quality of institutions, and regulatory complexity) discussed after the internal factors, are external and grounded in institutional theory, which identifies coercive pressure as a primary driver of a firm's environmental performance. It should also be noted that the empirical research in this thesis focuses solely on objective factors influencing both independent variables (absolute costs and their perception), excluding subjective factors such as managers' personal characteristics, which may significantly affect cost perception.

3.2.1.1 Firm size

Firm size is a key factor affecting compliance costs, primarily due to economies of scale. Numerous studies confirm that larger firms face lower compliance costs than smaller ones (e.g. Fauziati & Kassim, 2018; Grediani, 2019; Lewis et al., 2015; Schoonjans et al., 2011; Tran-Nam et al., 2000), as they have more resources for compliance, thereby reducing overall costs (Lanoie et al., 2011). The majority of studies confirm that relative compliance costs are lower for large firms compared to small ones (Crain & Crain, 2010; Fauziati & Kassim, 2018; Grediani, 2019; Klun & Blazic, 2005; Kotnik et al., 2020; Lama & Anderson, 2015; Lewis et al., 2014; Schoonjans et al., 2011; Tran-Nam et al., 2000), suggesting that smaller firms are more likely to experience higher relative compliance costs. Small firms may be disadvantaged due to fixed costs associated with interpreting laws, interacting with regulatory bodies, and managing paperwork, which they cannot distribute across large production volumes. Additionally, they may face unequal enforcement of regulations compared to larger firms (Zhou et al., 2017). On the other hand, larger firms, particularly those with well-known brands, have become key targets for both governmental actions and activist campaigns aimed at improving environmental conditions, not because their practices are the worst, but because their market visibility and the need to protect their brand reputation make them more susceptible to such

pressures (Zhou et al., 2017). Empirical studies, however, produce mixed evidence. The European Commission's survey (European Commission, 2004) confirmed a clear inverse relationship between firm size and compliance costs. For small firms, such costs can constitute a considerable share of turnover (in several studies more than 10%), implying a significant reduction in profitability (Eichfelder & Vaillancourt, 2014). Consequently, managers in larger firms may perceive regulatory costs as less burdensome due to better resource allocation and greater capacity to absorb them (Hart & Ahuja, 1996). According to Baylis et al. (1998), large firms are more likely than SMEs to recognize the benefits of environmental improvements in terms of increased profits and reduced costs. It can therefore be assumed that larger firms incur higher absolute costs of environmental regulation but perceive these costs as lower.

There are various arguments about the impact of firm size on productivity. On one hand, it is argued that large firms could be more efficient in production because they could use more specialized inputs, better coordinate their resources, etc. On the other hand, it is emphasized that small firms could be more efficient because they have flexible, non-hierarchical structures, and do not usually suffer from the so-called agency problem. In general, it is expected that an increase in firm size, initially, will have a positive effect on productivity levels, due to economies of scale and scope. However, when a firm grows beyond a certain size, diseconomies of scale may have a dominating effect, thereby negatively influencing productivity levels (Halkos & Tzeremes, 2007), which is why lower productivity can be predicted at least for micro and small firms versus larger ones.

3.2.1.2 Economic sector

Literature suggests that economic sectors are subject to differences in compliance costs (Baldwin, 1990; Fauziati & Kassim, 2018; Le Roux et al., 2008; Schoonjans et al., 2011; Wu, 2009). Higher compliance costs were estimated in public sector compared to private sector (Bozeman, 1993; Lan & Rainey, 1992). On the contrary, a recent study of Kotnik et al. (2020) found no differences in compliance costs of environmental regulation between economic sectors. As these findings yield mixed results, we may conclude that sectors of activity may conditionally play an important role in estimating compliance costs of environmental regulation. Similarly, as productivity varies substantially across sectors, there is a need to consider both technological and economic factors in the explanation of productivity differences (Castellacci, 2007), which makes anticipations of relation between sectors of economic activity and productivity very unfavorable.

3.2.1.3 Financial and non-financial measures

Literature suggests compliance costs depend also on financial and non-financial measures (Blumenthal & Slemrod, 1992; Hoque, 2003; Ittner & Larcker, 1998; Kotnik et al., 2020; Pope & Fayle, 1990; Prause & Olaniyi, 2019; Sandford et al., 1989; Vaillancourt, 1986; J. Wang et al., 2012). In order for a firm to gain a competitive advantage, it must employ various financial and non-financial instruments (Ittner & Larcker, 1998), with non-financial instruments typically serving as a complement to selected financial instruments (Hoque, 2003). Although results are mixed, Kotnik et al., (2020) found that financial measures increase total compliance cost, while they found the effect of non-financial measures to be insignificant.

Financial measures incorporate reimbursement of paid environmental tax, exemption from excise duty for biofuels, exemption from environmental tax for energy efficiency, and grants for implementation of environmental legislation. Non-financial measures include fostering voluntary agreements and certification systems (e.g. EMAS, ISO 14001 standard), information and awareness-raising programs, promotion actions, training and demonstration projects, and assistance to managers in the implementation of environmental standards and legislation. Non-financial measurements could be linked to environmental awareness of firms which indicate firm's responsible behavior towards the environment. Literature (e.g. José Vinagre Díaz et al., 2013; Steger et al., 2002) suggests that firms with higher environmental awareness, also feel less pressed by changes of environmental regulation. Therefore, it is anticipated that firms with more responsible environmental behavior record lower levels of environmental regulation costs. The effect of environmental awareness on productivity is less straightforward. According to neoclassical theory corporate environmental responsibility increases costs of the firms, through which it negatively affects profits. On the contrary, there are mechanisms related to positive effects of environmental awareness: customers are more willing to buy the firm's product if the firm is known to have a good environmental profile; environmentally responsible firms save labor cost as they can hire at lower wages and get more productive employees; and firms choose responsible behavior independent of the concern for customers or employees to gain investor trust (Brekke & Pekovic, 2018).

3.2.1.4 Use of ICT – Digitalization level

Digitalization level refers to the extent use of ICT (Information Communication Technology), including electronic data management systems, communication infrastructure, and internet-based tools, to automate services, streamline compliance processes, and enhance administrative efficiency (Charoensukmongkol & Moqbel, 2014). With the increasing use of ICT studies (Klun, 2011; Kochanova et al., 2020;

Zuurmond & Robben, 2009) argue that greater utilization likely reduces compliance costs by decreasing the time and resources spent on gathering information, minimizing data duplication, and shortening the time required for submitting environmental consents (Kochanova et al., 2020). A recent study by (Bellon et al., 2022) found that e-invoicing in Peru substantially reduced administrative costs and increased compliance with VAT liabilities, particularly among small firms. Fanea-Ivanovici et al. (2019) reached similar conclusions, finding that digital public services reduce costs for entrepreneurs while increasing compliance due to a higher level of trust in state institutions. Literature suggests that the use of ICT may have a stimulating effect on reducing compliance costs of environmental regulation. These arguments suggest a positive relationship between use of ICT and compliance costs of environmental regulation. It is also to expect a positive effect of the use of ICT on productivity, as the use of ICT is among the most common factors that explain improvements in productivity levels (Dong, 2021). Therefore, it can be expected that advanced and frequent use of ICT reduce firms' compliance costs of environmental regulation and, consequently, their perception of these costs.

3.2.1.5 International involvement

Compliance costs can also depend on firms' international activity. According to Eichfelder & Schorn, (2012) compliance costs rise with the international orientation of business, which could reduce the competitiveness of small and medium-sized enterprises by reducing their access to international markets. Strong international collaboration and internationalization of the firm are typically reflected through higher number of branches offices abroad, share of profit from sales abroad, franchising and acquisition (Ariff, 2001; Crain & Crain, 2010; Klun & Blazic, 2005; Ropret et al., 2018; Tran-Nam et al., 2000). Doing business abroad also means more formalities for firms, which leads to higher compliance costs. Based on the findings of previous research, it can be anticipated that higher compliance costs of environmental regulation due to the existence of international business operations of the firm. Further, there are two explanations for a positive relationship between productivity and participation of a firm in exporting activities; firstly, higher productivity and higher efficiency may be required if firms are to enter export markets, and secondly, by exporting, firm may learn of superior technologies and management techniques and increase their productivity (Baldwin & Gu, 2003; Halkos & Tzeremes, 2007).

3.2.2 External factors

3.2.2.1 Environmental obligations

Firms operating in environmentally polluting industries are typically required to obtain environmental consents, pay environmental taxes or duties, and report compliance with environmental standards. Environmental obligations are organizations' legal responsibilities to protect the environment through compliance with regulation, sustainability, and pollution prevention. Despite the adoption of various cost-cutting measures in the EU countries (European Commission, 2022) obtaining multiple environmental consents and reporting remains costly and time-consuming. Similar findings have been reported in the case of the U.S. clean energy strategy, which found the costs of acquiring environmental permits to be excessively high (Kramer et al., 2020). Thus, more specific regulatory requirements increase costs for firms. Jong & Kloeze (2013) argue that the more rules a manager must follow, the more likely they are to consider the process frustrating, resulting in a higher perception of compliance costs. These arguments indicate that greater environmental obligations result in higher compliance costs and an increased perception of these costs.

Whereby the additional requirements of individual countries in obtaining these consents lead to additional costs. These arguments would suggest that more environmental consents result in higher compliance costs of environmental regulation. Furthermore, as more obligations represent additional costs to firms it is to expect a negative relationship between this variable and productivity.

3.2.2.2 Quality of institutions

Following the institutional view, economic growth and wealth ultimately depend on a country's institutional framework, while increased regulatory quality reduces compliance costs and benefits society (Jong & Kloeze, 2013). Quality of institutions ensures clear regulations, timely information, and fair enforcement, reducing firms' time and resource costs (Djankov et al., 2002). It includes the customer-orientation of tax authorities encompassing the understandability of tax forms, the availability of official staff members, the reliability of administrative statements and suggestions, the appropriateness of compliance obligations, and the proportionality of audit processes. The research results of Eichfelder & Vaillancourt (2014) and Slabe-Erker & Klun (2012) indicate that low institutional quality can be a major obstacle to business development, which can be reflected in higher total compliance costs. Agostino et al. (2020) found strong evidence that better local institutions help especially small and medium-sized firms to become more productive. They mention channels through which productivity could be increased: stimulating firms to innovate and adopt new technologies and to

invest more in research and development; shorten the technology distance and accelerate the process of convergence to the productivity levels of the leader in the domestic market. Conversely, poor institutional quality leads to higher regulatory costs due to complex, opaque, and inconsistent regulatory environments that can lead to delays, increased administrative burdens, and corruption-related expenses (World Bank, 2017). Improving institutional quality therefore reduces the economic burden on firms while maintaining high standards of environmental protection and regulatory compliance (Rodrik et al., 2004). However, an interesting counterhypothesis suggests that increased transparency and accountability of institutions promote regulatory compliance and less non-compliance (Ntangeki et al., 2023), which leads to higher costs for firms and their perception. Therefore, the impact of institutional quality on costs and their perception remains unclear.

3.2.2.3 Regulatory complexity

Regulatory complexity refers to the number, difficulty, and fluidity of regulatory distinctions, with frequent legal changes adding to the challenge (Kaplow, 1995). While complexity can make regulations more precise and encompassing, it can also lead to reduced compliance because it generates compliance costs and difficulties to understand and apply the law (Stafford, 2006). Complex regulations can exacerbate perceptions of distributional unfairness when firms face unequal compliance costs or difficulties in understanding regulations. Large firms may absorb the costs of overly complex regulations more easily (Mendoza et al., 2016), while SMEs tend to have less knowledge of environmental legislation or its trajectory (Baylis et al., 1998). Therefore, regulatory complexity is expected to increase both the actual and perceived compliance costs, as well as have negative impact on productivity.

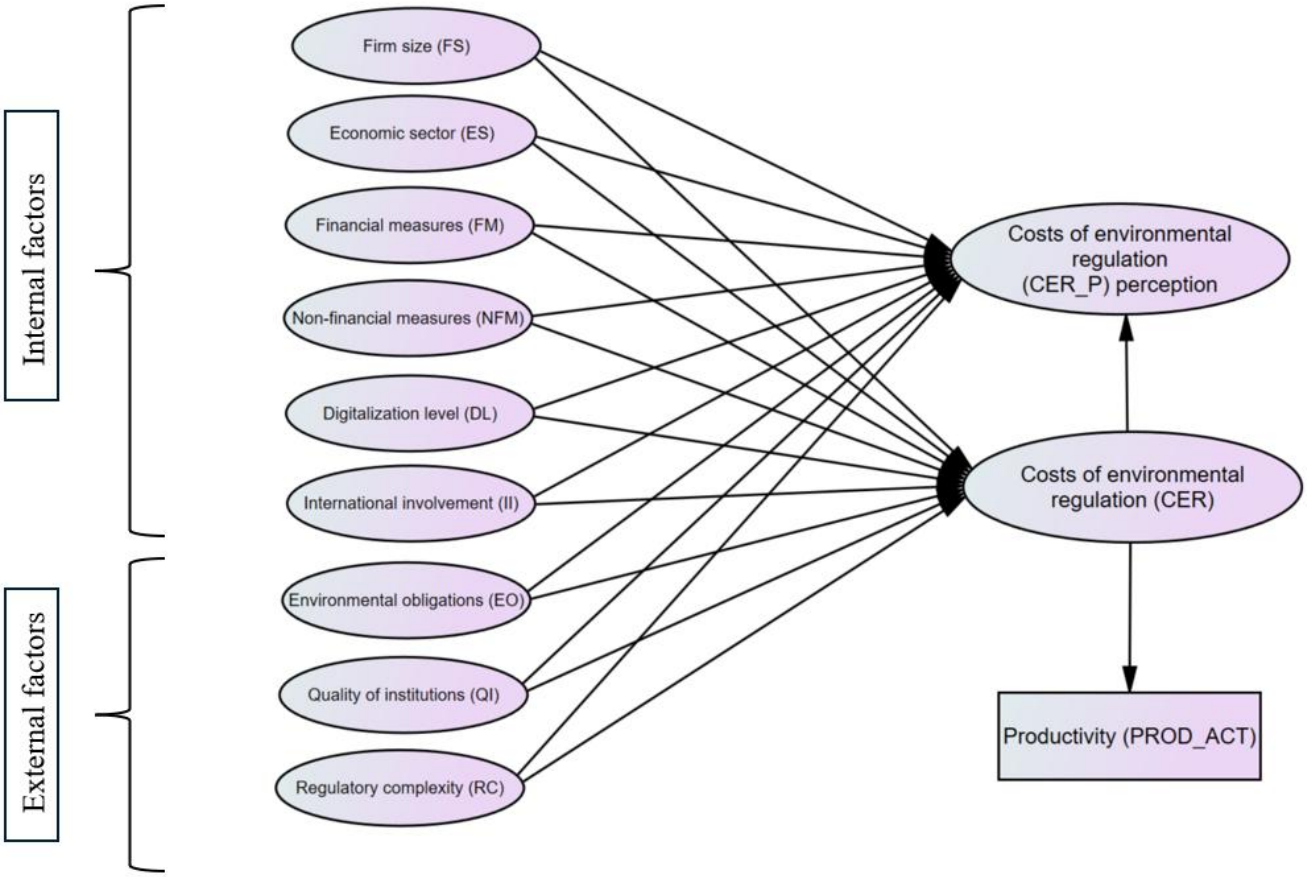
3.2.3 Compliance costs of environmental regulation

Compliance costs of environmental regulation are the costs incurred by firms at whom regulation may be targeted in undertaking actions necessary to comply with the regulatory requirements (OECD, 2001). Firms face costs from current and future environmental compliance, as well as liabilities from past actions, which can drive firms out of business due to high clean-up costs of environmental hazards (Matta et al., 2019). Following the structuralist approach, compliance costs of environmental regulation are considered undesirable as they decrease investment opportunities (Iraldo et al., 2009). Therefore, managers who do not recognize the importance of environmental performance, or do not see it as a competitive opportunity, may perceive compliance costs of environmental regulation as higher than managers who view these costs as necessary and socially desirable. Additionally, managers may not be fully aware of the total costs of regulation. Joshi et al. (2001) label these costs as hidden

costs as they are not always correctly classified in firms' accounting systems. Nevertheless, firms facing higher compliance costs of environmental regulation are expected to perceive them as higher.

Therefore, based on the theoretical framework outlining the internal and external factors that may influence compliance costs of environmental regulation, their perception, and their effects on productivity, Figure 8 presents the proposed conceptual model.

Figure 8: Proposed model illustrating the relationships among determinants of compliance costs of environmental regulation (CER), their perception (CER_P), and firm productivity (PROD_ACT), based on the literature review



Source: own elaboration

4 ENVIRONMENTAL REGULATION

"We destroy the beauty of the countryside because of the unappropriated splendours of nature have no economic value. We are capable of shutting off the sun and the stars because they do no pay a dividend …. Or again, we have until recently conceived it a moral duty to ruin the tillers of the soil and destroy the age-long human traditions attendant on husbandry if we could get a loaf of bread thereby a tenth of a penny cheaper", John Maynard Keynes (Keynes, J. M. (1933) implicitly on potential environmental issues.

It can be argued that the origin of environmental regulation lies in market failure, particularly in the form of negative externalities (Pigou, 1924). Due to negative externalities, natural resources are overused, and environmental problems increase, causing the costs to polluters to be much lower than the costs imposed on society. As Keynes famously cautioned, when policy and business decisions are judged primarily through the lens of financial returns, society risks undervaluing "the unappropriated splendours of nature" precisely because they do not "pay a dividend" (Ghisellini et al., 2021). This insight directly motivates the economic rationale for environmental regulation, namely, to correct market failures by internalising external costs and ensuring that private decision-making reflects broader social and ecological values. Thus, governments must limit the negative externalities and promote environmental equity through the implementation of environmental regulations (Stavropoulos et al., 2018). Among the basic instruments to limit pollution and environmental degradation has been historically environmental taxes, also known as Pigouvian taxes (Bădîrcea et al., 2023). The Pigouvian prescription for correcting an externality is to levy a tax on it equal to its marginal social damage (Gahvari, 2014). Economists have traditionally considered Pigouvian taxes to be a feasible instrument for controlling externality-generating activities and restoring social efficiency (Goel & Hsieh, 1997). While environmental taxes offer numerous benefits, such as improved environmental quality and enhanced social welfare, they also have limitations, the most significant being their potentially disproportionate burden on low-income entities, which may face relatively higher costs. Therefore, alternative forms of regulation also take place, and governments have at their disposal a broad array of instruments, including the setting of production and product standards, environmental permitting requirements, and reporting obligations.

An alternative perspective on addressing negative externalities is provided by the Coase theorem (Coase, 1960). According to this theorem, if property rights are well-defined and transaction costs are negligible, private parties can negotiate solutions to externality problems efficiently without government intervention (Deryugina et al.,

2021). This approach emphasizes the role of bargaining and voluntary agreements in allocating environmental responsibilities, offering a complementary mechanism to traditional regulatory instruments such as Pigouvian taxes. However, assessments of the Coase theorem's applicability to real-world environmental problems vary widely, with textbooks ranging from optimistic interpretations of its efficiency potential to critical views that highlight its unrealistic assumptions (Deryugina et al., 2021). Coase's idealized, transaction-cost-free framework serves primarily to illustrate how ignoring transaction costs can lead to significant distortions and inefficiencies in environmental policy design. Consequently, Coasian bargaining and Pigouvian taxation should be viewed as complementary rather than competing approaches (Schneider, 2022), as both seek to empower actors to make autonomous decisions and, through economic incentives, promote pollution reduction in the most efficient way, thereby minimizing external costs (Ji et al., 2022).

Building on Pigou's theory of environmental taxation and Coase's theorem, which underpins the effectiveness of emission trading systems as a key regulatory instrument, another concept worth mentioning at this point emerged: the Double Dividend Hypothesis. This hypothesis proposes that in order to avoid negative consequences of increasing environmental taxation, other taxes should be simultaneously decreased, specifically income or labor taxes, to generate a double benefit, by reducing negative environmental impacts and improving the economy, shifting from high distorting taxes to less distorting ones (Freire-González, 2018; Köppl & Schratzenstaller, 2021). Such an approach is often considered more effective than subsidies. However, in practice, environmental taxes are rarely linked to reductions in labor taxation, which makes the actual benefits of this policy questionable. Fullerton & Metcalf (1997) critically examined the double dividend hypothesis, concluding that its validity cannot be generally confirmed, as environmental taxes do not necessarily lead to simultaneous improvements in environmental quality and economic efficiency. The study of Silva et al. (2021) conditionally supports the Double Dividend Hypothesis but highlights that the realization of a double dividend under environmental tax reforms depends on the choice of indicators, with alternative measures revealing a double dividend even when traditional ones do not.

In general, regulation provides clear direction to organizations by establishing rules, implementing controls, providing incentives, and enforcing penalties (Berrone et al., 2013). Although there is no unified definition of environmental regulation, it generally aims to prevent and control environmental pollution by transforming production and consumption patterns to minimize the negative externalities of economic activity (Zhong & Peng, 2022). Amid global challenges like energy depletion, environmental degradation, and climate change, countries have tightened environmental regulations, increasing pressure on firms and highlighting their critical role in addressing these

threats. The influence of the natural environment is also gaining importance from a macroeconomic perspective, thereby elevating the relevance of environmental economics. Environmental economics is a branch of economics that examines the economic impacts of environmental policies and the management of natural resources.[10] Environmental regulation, which has become among the key topics in environmental economics, serves as a critical link between macroeconomics and sustainability, addressing the balance between economic growth and environmental protection (Shao et al., 2020). Especially in European countries, that have been historically a leader in the design and adoption of stringent environmental policies (Costantini & Mazzanti, 2012), the importance of the link between environmental regulation and competitiveness has been of a great importance (Rubashkina et al., 2015). Interestingly, with the development of the Chinese economy and growing awareness of environmental pollution in the last decade, this link has also become a major focus of research in China as well (Dong et al., 2021).

Environmental regulation has traditionally been regarded not only as a tool for addressing environmental problems (Wang et al., 2019), but also as a significant driver of ecological innovation (Rubashkina et al., 2015), and a necessary response to environmental influence (Jaffe & Palmer, 1997). Countries possess a diverse array of instruments to regulate emissions and mitigate environmental degradation, among which the polluter-pays principle occupies a central role. This principle mandates that those responsible for pollution bear the financial costs associated with the resulting damage (Luppi et al. 2012). Because environmental harm often constitutes an externality, liability compels the responsible party to internalize the full social cost of their activity, thereby reducing the harm to an economically optimal level. This principle can also be applied at the state level to compensate victims of environmental harm when polluters cannot be identified or are insolvent. Luppi et al. (2012) refer to this system as the “government-pay” regime.

Equally important as the polluter-pays principle is the promotion of sustainable practices, which, from an environmental standpoint, emphasize production and consumption patterns that conserve natural resources, minimize waste, and reduce the ecological footprint of human activity. In general, corporate sustainability encompasses three dimensions: environmental, social, and economic. The environmental aspect requires companies to positively impact ecosystems and protect natural resources, whereas long-term sustainability demands an integrated approach, as success in only one dimension is insufficient (Yadav et al., 2018). The authors found

[10] Nonetheless, in 2018, William Nordhaus was awarded the Nobel Prize in Economic Sciences for his pioneering work integrating climate change into long-term macroeconomic analysis, which has significantly contributed to the field of environmental economics.

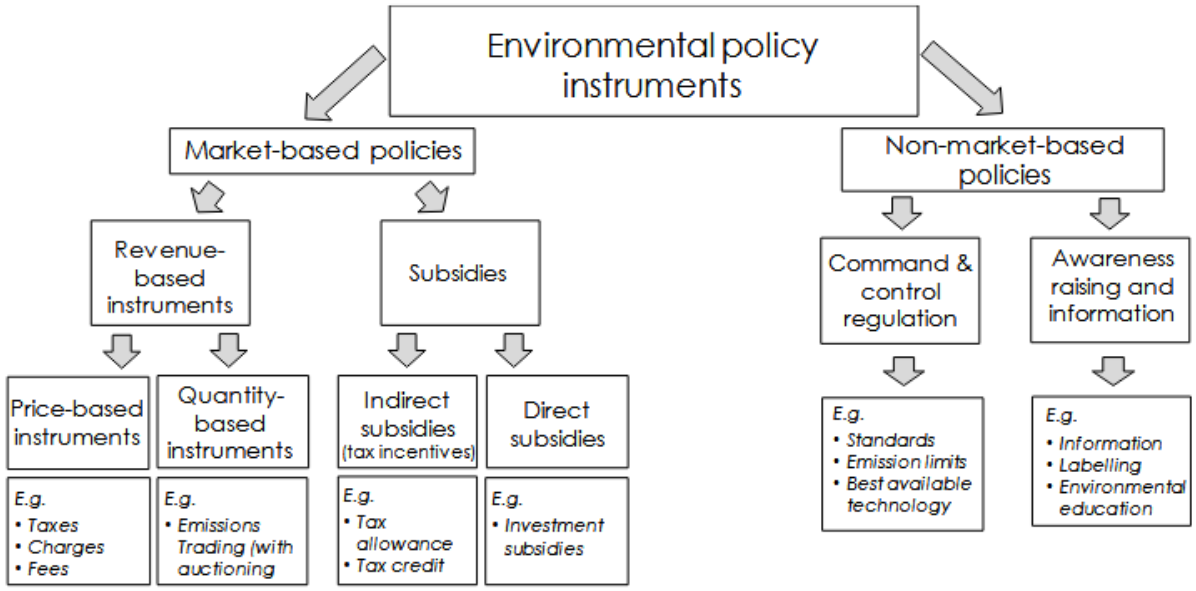
that government is among critical drivers in promoting environmentally sustainable practices, particularly among SMEs, for which high fines and penalties for noncompliance with regulations compel them to adopt such practices. Similarly, Gandhi et al., 2018 identified current and future legislation as key drivers in the adoption of green manufacturing practices. They further observed that incentives such as loans, grants, tax concessions, and other economic benefits facilitate the adoption of sustainable practices among SMEs and encourage behavioural change.

Together, these principles form an integrated framework, linking normative ideals, practical policy measures, and fiscal incentives in the pursuit of a resilient and sustainable environmental governance system.

4.1 TYPES OF ENVIRONMENTAL REGULATION

Figure 9 represents the generally accepted division by the literature between two types of environmental policy instruments: market-based instruments, which include taxes, environmental subsidies and systems for emissions trading, and non-market-based instruments that include command-and-control regulations, i.e. government standards, emission limits, technology prescription, reporting requirements and labelling (Albrizio et al., 2017; Ambec et al., 2013; Driesen, 2006; Niemeier et al., 2008). Economists broadly agree that pricing mechanisms form the cornerstone of effective environmental policy, yet this consensus exists within a broader debate over price-based instruments (taxes) versus quantity-based instruments (emissions trading). Taxes fix the price of emissions while leaving total emissions uncertain, whereas cap-and-trade systems set an emissions cap but make the resulting price uncertain (Köppl & Schratzenstaller, 2021). A systematic review by Ji et al. (2022) shows that environmental policy instruments have evolved from command-and-control approaches to market-based mechanisms, moving from trade-offs between quantity-based and price-based tools within market-based frameworks to integrated combinations of both, and ultimately toward a balanced allocation of command-based and market-based instruments. The main reason for the growing prevalence of market-based policies lies in their foundation on economic incentives, which encourage polluters to make optimal environmental decisions based on their specific circumstances (Ji et al., 2022).

Figure 9: Overview of environmental policy instruments



Source: Köppl & Schratzenstaller (2021)

Similar classification of policy instruments was introduced by Iraldo et al. (2011) who classify them into three main categories: direct regulation (e.g. standards and prohibitions), economic instruments (e.g. taxes, tradable permits), and soft instruments (e.g. voluntary agreements, certifications, and green public procurement). Although economic theory, particularly the strand supporting free market ideology and deregulation, tends to favour economic incentive programs for their cost efficiency over more traditional command and control regulation, these programs do not necessarily represent the superior mechanism for achieving the broader goals of sustainable development (Driesen, 2006). Nevertheless, either market-based, or non-market based, the quality of these regulations and their broader legal and economic context are essential for the success of a country's environmental policy (Esty & Porter, 2001). According to Iraldo et al. (2011), there is an ongoing debate about which regulatory mechanisms most effectively improve industrial environmental performance without compromising global competitiveness. Direct regulation is often viewed as effective but is criticized for inefficiency, while economic instruments, such as tradable permits, are theoretically appealing but lack robust empirical validation. Economic and institutional models offer contrasting perspectives: the former regards regulation as cost-increasing and focused on efficiency, while the latter, which is aligned with the Porter Hypothesis discussed in Chapter 5, suggests that regulation can stimulate innovation and enhance competitiveness.

4.1.1 Market-based policies or economic incentives

Market-based instruments rely on market mechanisms to reduce pollution and internalize externalities, typically through price-based tools such as Pigouvian (emission) taxes and quantity-based tools like tradable emission permits (Stavropoulos et al., 2018). Market-based regulation, also referred to as economic incentives or market-based instruments (MBIs), represents an approach to environmental policy that leverages economic incentives to influence corporate behavior and promote improved environmental performance (Albrizio et al., 2017). Unlike traditional CAC regulations, MBIs offer flexibility, allowing firms to choose their own paths to compliance. These instruments change the economic incentive structure for firms, encouraging innovation and efficiency (Lanoie et al., 2011; Rubashkina et al., 2015).
According to Botta & Kozluk (2014) market-based instruments include four key mechanisms to achieve environmental outcomes.

- Emissions Trading Systems (ETS) represent a widely used market-based mechanism, which sets a cap on overall emissions and allows firms to trade emission allowances. This approach is considered efficient because it encourages firms to reduce emissions at the lowest possible cost. Studies have shown that the adoption of ETS in regions such as the European Union, New Zealand, the US, and China has successfully reduced emissions while minimizing economic disruption. Firms can choose whether to invest in cleaner technology or purchase additional allowances, making it a flexible tool for achieving carbon neutrality targets (S. Zhang et al., 2021)
- Environmental taxes, where firms are taxed based on the pollution they produce. This creates a direct financial cost for pollution, encouraging firms to seek ways to reduce emissions. This is in line with the polluter-pays principle, as seen EU or in China's pollutant discharge fees (Xie et al, 2017). By placing a cost on pollution, firms are incentivized to invest in cleaner technologies and reduce their environmental impact.
- Feed-in tariffs guarantee a fixed price for energy producers who generate power from renewable sources, creating a stable economic incentive for investment in cleaner energy. These tariffs have been instrumental in promoting renewable energy adoption in several regions.
- Deposit-Refund Systems (DRS) encourage recycling and proper waste disposal by offering a refund for returning items such as bottles and cans. This system aligns economic incentives with environmental goals by encouraging consumers and firms to recycle.

Market based or flexible regulation is considered a crucial driver of a positive outcome for all stakeholders (Ramanathan et al., 2017) as they give firms the freedom to determine the most cost-effective ways to comply with environmental targets, which

can drive innovation. Studies have shown that flexible instruments like emissions trading and environmental taxes promote technological advancements as firms explore new methods to reduce pollution efficiently (e.g. Wei et al., 2022; Wu, 2009; Wu et al., 2019) and lower compliance costs compared to more rigid CAC regulations. For example, the shift to an emissions trading program for SO2 in the U.S. led to significantly lower costs (40%-140% below initial projections) for reducing emissions (Burtraw, 2000). This cost-saving aspect makes MBIs attractive to both businesses and policymakers. Another positive characteristic of ETS and other market-based systems is that they can link regional and national climate policies, thereby creating a global framework for emission reductions (Chen et al., 2021). This interconnectedness helps to ensure that carbon reduction targets are met across different jurisdictions, allowing for coordinated efforts to mitigate climate change on a global scale. In general, literature favors flexible regulation over command-and-control approaches (e.g. Jaffe & Palmer, 1997; Ramanathan et al., 2018; Yuan & Zhang, 2020). Prescriptive policies give firms little incentive to find efficient ways to meet environmental objectives (Ramanathan et al., 2018), while instruments like emissions trading, environmental taxes, and deposit-refund systems provide encourage to innovation while reducing the overall costs of achieving environmental targets (Lanoie et al., 2011; Ambec et al., 2013; Jaffe et al., 1995) as firms can focus more on outcomes rather than on processes (Ramanathan et al., 2018).

Despite their advantages, market-based regulations are not without challenges. One limitation is the uneven regional adoption of MBIs, which may lead to discrepancies in environmental performance across countries. Moreover, some industries may resist MBIs due to concerns over initial costs, and the effectiveness of these instruments can depend heavily on how they are implemented and monitored. They can also be regressive towards smaller firms if not implemented properly. Beiser-McGrath et al., (2023) found that MBIs are politically challenging unless policymakers offset visible costs through additional measures. Using the example of increasing fuel taxes (an MBI), they showed that such measures reduce policy support, whereas allocating the additional revenue to subsidize electric vehicles or public transport eliminates this negative effect.

4.1.2 Non-market-based policies: Command and Control regulation

Command-and-control regulation refers to a non-market-based system in which governments impose specific obligations or implement non-monetary incentives to influence the behavior of economic agents (Görlach, 2013). Regulators establish a set of standards that polluters or industries must follow, often mandating the adoption of specific technologies in accordance with established rules, while administrative agencies are empowered to impose sanctions on violators and reward those who

comply (Stavropoulos et al., 2018). Therefore, this type of regulation typically relies on coercive pressures, including rules and mandates issued by governmental agencies, to force firms to comply with standards or face penalties (Prajogo et al., 2012), focusing mainly on limiting the emission of pollutants by industrial enterprises (Feng et al., 2019). As per Singhal (2018) policy makers have long favored Command-and-control (CAC) instruments which historically dominated environmental regulation, comprising over 50% of EU air-pollution policies between 1970 and 2011, with similar top-down approaches prevalent in China and India, where governments enforced strict measures like forced closures of polluting. These CAC measures, including emission limits and technical standards, have been central to environmental legislation in both industrialized and emerging economies since the mid-20th century (Singhal, 2018).

The main advantage of CAC regulation is its ability to ensure compliance through stringent standards, which can push firms to become more efficient and invest in pollution control technologies. It clearly defines expected behaviour, often through explicit standards, making violations easier to identify and enforce (Gunningham et al., 1998). Stringent environmental standards can push firms to realize their inefficiency and to search for pollution abatement measures, such as discovering new end-of-pipe techniques, increasing resource efficiency, and switching to clean energy (Xie et al., 2017). On the other hand, the limitations of CAC regulation include a lack of ongoing innovation incentives once firms have met the regulatory standards. Once compliance is achieved, firms may have little motivation to invest in further research and development (R&D) or to seek out more efficient, sustainable production methods. Additionally, conventional CAC regulation poses a risk known as the "old-plant" effect, where stricter emission standards for new plants encourage the continued operation of older, more polluting facilities (Singhal, 2018). Another limitation can be in the form of information asymmetry which can lead firms to hide or misreport emissions to avoid penalties and reduce environmental costs, undermining the effectiveness of regulation (Xie et al., 2017). In general, Gunningham et al. (1998) argue that it is less effective in addressing mobile or hard-to-monitor firms, diffuse pollution sources, cross-media pollution transfer, and rapidly evolving technologies and economic conditions.

Command-and-control instruments are widely used for their simplicity and directness, though their stringency varies across countries, with developed nations typically enforcing stricter standards than developing ones (Stavropoulos et al., 2018). In rapidly developing economies such as China, the introduction of the 2015 New Environmental Protection Law marked a shift toward stricter enforcement and penalties aimed at promoting compliance and stimulating innovation. However, while such regulation can achieve quick environmental gains, it may also stifle long-term innovation, suggesting the need for complementary market-based reforms to promote sustainable corporate behavior.

Notwithstanding the modern preference for market-based instruments, the literature also agrees that environmental policy should ultimately aim for a balanced allocation of command-based and market-based instruments (Ji et al., 2022). While MBIs have strong economic logic, command-and-control instruments often garner greater public support (Beiser-McGrath et al., 2023). In this regard, results of the study among Slovenian firms (Hojnik & Ruzzier, 2016) indicate a positive and significant influence of both the command-and-control instrument and the economic incentive instrument on process eco-innovation. Furthermore, Guo et al. (2021) argue that both approaches should be promoted, as each is an effective means of reducing GHG emissions and carries distinct advantages and disadvantages. However, they conclude that existing research remains insufficient regarding the impacts and specific mechanisms of environmental regulations on GHG emissions, particularly in terms of the differentiated effects of command-and-control versus market-based instruments.

4.1.3 Voluntary and informal regulation

The third type of environmental regulation is informal regulation. It emerged at a time when formal environmental regulation in developing countries was weak or absent, prompting various groups to reach agreements with local polluting enterprises to reduce emissions in pursuit of their own interests (Song et al., 2019). Unlike formal regulation, it is not imposed by the government but relies on public environmental awareness (Xie et al., 2017) and is therefore grounded in normative and mimetic rather than coercive pressure. More recently, voluntary environmental regulation has gained global attention due to its flexibility and suitability in contexts with weaker institutional frameworks (Bu et al., 2020). There is growing interest in the potential of such informal mechanisms to achieve environmental goals, particularly in developing countries with weak formal regulations.

Regulations vary in their level of flexibility, and this variation has been shown to lead to different impacts on innovation. Furthermore, as Prakash & Potoski (2006) noted, voluntary environmental regulations can take various forms, such as information disclosure, management certification, eco-labelling, and environmental agreements. Given their differing characteristics, these types of regulations may have distinct effects on innovation. Therefore, when assessing drivers of environmental innovation, both external pressures (e.g., regulation, stakeholders) and internal factors (e.g., firm characteristics, voluntary initiatives) must be considered (Inoue et al., 2013). Recently, studies focused on the link between ISO 14001[11] certification and improved

[11] Introduced in 1996, ISO 14001 is a set of voluntary international standards aimed at helping firms establish consistent environmental management systems to achieve their environmental objectives.

environmental performance, such as lower emissions, better compliance, and enhanced recycling, and to higher profitability and market share (Bu et al., 2020). For example, the study of Inoue et al. (2013) focuses on the impact of firms' implementation of ISO 14001, suggesting that improved measurement of environmental impacts can stimulate innovation and increase environmental R&D investment. This proposition aligns with the weak version of the Porter Hypothesis, which emphasizes the impact of (voluntary) regulation on innovation (see Chapter 5). The research of Jiang et al. (2020) also found a positive effect of voluntary regulation, which was measured by environmental information disclosure and environmental management system certification, on corporate technological innovation, particularly in heavily polluting industries, where the effect was stronger than in less polluting ones.

For Slovenian and Croatian firms, the reliance on command-and-control environmental regulation means they face strict compliance requirements enforced by governmental agencies. Both countries' regulations, shaped largely by EU directives, impose detailed limits on emissions, waste management, and industrial activities, with significant penalties for non-compliance. This regulatory environment requires businesses to invest in environmentally friendly technologies and practices to meet government-imposed standards.

In Slovenia, while there is some use of market-based instruments like emissions trading and environmental taxes, the overall framework still demands close adherence to government-set limits. Similarly, in Croatia, firms operate under stringent command-and-control policies but are also subject to emerging market-based mechanisms such as the EU Emissions Trading System (EU ETS). Voluntary regulation is gaining importance in both countries as well. According to data of ARSO (ARSO, 2025), the uptake of ISO 14001 and EU Ecolabel schemes in Slovenia is steadily growing, with notable increases in 2021 (ISO 14001: +63) and 2022 (EU Ecolabel: +15). Per million inhabitants, Slovenia exceeds the EU-27 average in ISO 14001 and EU Ecolabel certifications but lags slightly behind in EMAS registrations. For businesses in both countries, these trends manifest that compliance is not only a legal necessity but also increasingly a competitive advantage, as aligning with environmental standards can enhance legitimacy, reduce long-term costs, and support sustainable growth.

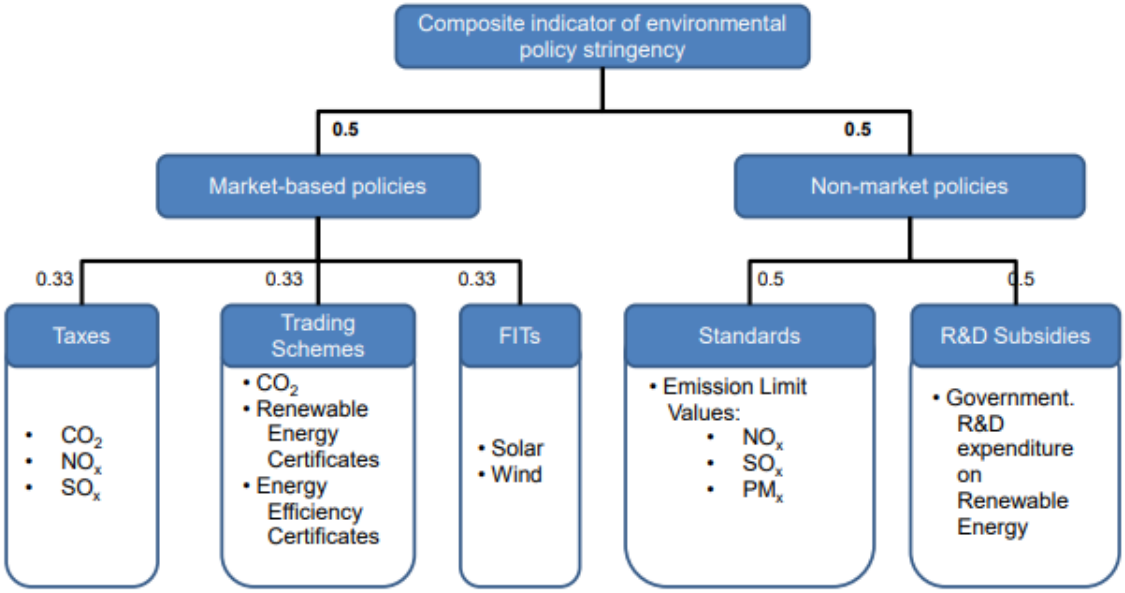
4.2 MEASURING STRINGENCY OF ENVIRONMENTAL REGULATION

Environmental regulation intensity can be assessed from three perspectives: industry, firms, and government. However, according to Zhao & Sun (2016), each approach has limitations. Industry-level standards based on laws and regulations remain relatively stable over time and fail to capture dynamic changes, especially since polluting firms span multiple sectors. Firm-level measures, such as environmental costs relative to

sales, are problematic because costs include penalties and few firms disclose such data, making this approach impractical. Government-level measures may overlook regional differences in development, resources, and pollution. Consequently, accurately assessing the stringency of environmental regulation presents a considerable methodological challenge. The existing literature typically classifies proxies for environmental regulation stringency into three main categories: single indicators, multiple indicators, and composite indicators (Wang et al., 2019). A common single indicator is PACE (Pollution Abatement and Control Expenditures), based on the U.S. Census Bureau's PACE survey. This survey, conducted until 2005, is the most comprehensive national source on pollution abatement costs in the U.S. manufacturing sector, collecting facility-level data on capital and operating expenditures related to regulatory compliance and voluntary pollution abatement. These data are often used as a proxy for environmental regulation. While the PACE survey appears suitable for measuring stringency by reporting pollution abatement costs, its reliance on increasingly difficult questions directed at industrial managers limits its practical usefulness (Brunel & Levison, 2016). Multi-indicator approaches capture the varying effects of different regulatory types by distinguishing market-based instruments, which influence behavior via price signals, from non-market (command-and-control) measures that impose direct compliance standards (Wang et al., 2019).

Finally, compared to single or multiple indicators, a composite indicator of environmental regulation offers clear advantages by integrating various policy instruments into a single measure. An example of composite indicators is the Environmental Policy Stringency (EPS) index developed by the OECD (Botta & Kozluk, 2014), which covers 27 OECD countries. The EPS index combines both market-based and non-market (command-and-control) instruments, with each component weighed equally in the final aggregate score (Figure 10). The novelty and advantage of EPS index is also that it reduces a complex set of multidimensional policies into a comparable country-specific proxy and stimulates discussion on the impacts of environmental regulation policies in OECD countries (Albrizio et al., 2017).

Figure 10: Structure of the composite indicator of environmental policy stringency



Source: Botta & Kozluk, (2014)

Botta & Kozluk (2014) expand the list to measure environmental policy with the following approaches: stringency single policy change measures; composite measures of environmental regulation; surveys on the perceptions of stringency; survey-based data on firm or plant-level pollution abatement expenditures; estimated "shadow prices" of pollution; and environmental or related performance data as well as some less direct proxies, such as counts of international environmental treaties ratified or the number of environment-related inspections. Still, probably the most used classification of measures is the one from Brunel & Levison (2016) that classifies measures of regulatory stringency into five categories, namely: (1) private sector abatement costs, (2) indicators based on pollution and energy consumption, (3) composite indexes, (4) public sector initiatives, and (5) direct evaluations of specific policies. Many of these indicators encounter conceptual limitations, including restricted international comparability, insufficient sector-level data, and challenges in capturing the multidimensional nature of policy mixes (Brunel & Levison, 2016; Dechezleprêtre & Sato, 2017). However, according to Brunel & Levison (2016), the core difficulties are conceptual in nature and can be broadly categorized into four key issues:

- Multidimensionality — environmental regulations cannot easily be captured by one measure of "stringency".
- Simultaneity — countries with strong economies or bad pollution problems may impose the most stringent regulations.

- Industrial composition — countries where the mix of industries is on average more pollution intensive has higher average abatement costs and measured regulatory stringency.
- Capital vintage — regulatory standards are typically tighter for new sources of pollution, with implications for the environment, the economy, and measures of regulatory stringency.

According to Franco & Marin (2017), empirical literature often proxies environmental regulation using pollution abatement costs, based on two key assumptions: first, that these costs represent the main expenses firms incur to comply with environmental regulations, and second, that higher compliance costs indicate more stringent regulation. However, they caution that pollution abatement costs are likely endogenous due to potential confounding factors affecting both innovation (and productivity) and regulatory stringency, leading to omitted variable bias and possible reverse causality, as innovation may both influence and be influenced by regulatory requirements. Chen et al. (2022) also argue that no standard measure for the strength of environmental regulations in literature exists while the main measure is to use the pollution reduction costs of the private sector and the implementation rate of environmental regulations.

4.3 EUROPEAN UNION (EU) ENVIRONMENTAL POLICY FRAMEWORK

To reach the ambitious goal of climate neutrality until 2050 in the EU, policymakers need to implement a broad and varied strategies, which includes a combination of environmental taxes, more stringent regulations, and emission standards for industries as well as the implementation of carbon pricing mechanisms, promotion of investments in sustainable fuels and technologies, and the establishment of low-carbon emission infrastructure (Manta et al., 2023). To achieve EU's 2030 targets of cutting GHG emissions by 55 % by 2030 in comparison with the 1990 levels the environmental regulation needs to become fiercer, which has been primarily addressed by the "Fit for 55" package of legislation to make all sectors of the EU's economy fit to meet this target (European Commission, 2024). However, despite reaching a consensus at the EU level on targets, there is no consensus on harmonizing policies to achieve climate and energy policy objectives, as some member states are reluctant to transfer competencies in this area (Manta et al., 2023). Another aspect to consider is that different types of regulatory mechanisms, such as mandatory, market-based and voluntary ones, play varying roles in fostering innovation and productivity (Ambec et al., 2013). According to the 8th Environmental Action Policy (EAP), which serves as the EU's environmental agenda until 2030 and later followed by the mid-term review of EAP carried out in May 2024 (under Article 5.1), it underlines the importance of meeting

climate and environmental objectives also for their positive economic impact, including in terms of health, resilience, or autonomy in material use.

The European Union has been one of the most significant policymakers in the field of environmental protection in recent decades, aiming to ensure a high quality of life in all member states (Manello, 2017). According to Vogler (2005), two ongoing trends in environmental policies that expand the EU's role are the growing recognition that environmental policy is indistinguishably linked to trade and development and the rising political prominence of issues like climate change. Therefore, throughout decades the EU has established a comprehensive legal framework to address environmental issues, including air and water quality, waste management, biodiversity conservation, climate change mitigation, and more. However, despite all the advancements, the principle of subsidiarity continues to play an important role in the environmental field, where competence for policy and legislation is shared between the EU and its member states. It means that the member states have the primary responsibility for the protection of the environment, and the EU may act 'only in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States […] but can be better achieved at Union level' (2010 TFEU: Article 5). In practice, this enables member states to use this principle to block EU regulation in certain more sensitive areas. Furthermore, the TFEU allows for regional differentiation in the field of environmental policy as it does not aim at complete harmonization of domestic legislation, but rather sets common minimum environmental standards aimed at achieving convergence among national legislation and ensuring the optimum environmental improvement of the different regions (Krämer, 2000). Within this framework, differentiation and flexibility gradually became a main feature of EU environmental governance.

From the outset, EU environmental policy was absent from the founding treaties and had limited legal basis. However, it later evolved as a byproduct of economic integration and became one of the EU's most prominent policy areas. The policy has had a considerable impact on various policy domains at the member state level as well as the policy autonomy of national decision-makers and is now regarded as the world's most comprehensive regional environmental regime (Delreux & Happaerts, 2016). According to Delreux & Happaerts (2016) the evolution of EU environmental policy can be divided into five distinct phases. Building on their framework, this study introduces a sixth phase, reflecting the post-2019 developments shaped by the European Green Deal and subsequent policy initiatives:

- **Phase 1 (1957-1972): no transfer of any environmental competences to the EU level.** Early EU environmental measures were limited and lacked clear ecological goals, primarily serving the broader aim of establishing a common market. The initial focus was economic rather than protecting environment or

fighting environmental pollution. However, divergent national product standards threatened market unity, prompting harmonization efforts like limiting lead in petrol. Therefore, these early environmental actions were essentially side effects of economic integration. Moreover, according to Orlando (2014), the original EEC Treaty already contained some indications that EU competence could potentially extend far beyond the common market objective, such as the principles and objectives of the newly established Community the promotion of “harmonious development of economic activities”, the “raising of the standard of living”, and “the constant improvement of the living and working conditions of their people”.

- **Phase 2 (1972-1987): expansion of environmental policy.** Although the period was characterized by the continuing absence of an explicit legal basis of environmental protection action at the European level, it was also marked by a considerable growth in the number of pieces of European environmental legislation and expansion of the scope of environmental measures, which can be explained by four driving forces and dynamics:
    - the civil society began to get organized on environmental issues, becoming societally debated and more organized as well as institutionalized – e.g. being manifested in the rapid growth of NGOs at that time;
    - developments at the international level, such as the UN Conference on the Human Environment (also known as the Stockholm Conference) of 1972 and the resulting Stockholm declaration, reinforced the place of environmental concerns on the political agenda on a global and European level;
    - several environmental catastrophes, such as the accident at the chemical plant in Seveso or with the oil tanker Amoco Cadiz triggered policy initiatives to prevent recurrences of such accidents;
    - the inherent transnational character of environmental issues prompted the insight that solutions had to be found at the supranational level.

The expansion of European environmental policy from 1972 onwards took place in the context of the launch of the first Environmental Action Program (EAP). EAPs outline the priority goals for environmental action in the EU and give direction to the work of the European institutions that actually produce environmental policies. In the Article 8 of the “Statement from the Paris Summit (1972)”, which can be viewed as the beginning of an independent EU environmental policy (Knill & Liefferink, 2021) the heads of state and government emphasized the importance of a community environmental policy, and they invited the Community Institutions to establish, a program of action accompanied by a precise timetable. Key principles like preventive action and polluter-pays principle were included and laid the groundwork for modern EU environmental policy. In the absence of formal

Treaty provisions on the environment, this Statement can be considered as the first authorization by the member states to the European institutions to undertake more comprehensive environmental policy action, not necessarily being linked to the realization of the common market.

To implement its environmental agenda, the EC (European Community[12]) created a task force in DG Industry called the "Environment and Consumer Protection Service." Initially dismissed as "green fundamentalists," the unit evolved into the Directorate-General for the Environment in 1981. In the 1972-1987 period a remarkable expansion of environmental legislation took place as more than 100 legislative pieces on the environment were adopted, due to environmental policymaking in the EU still occurred without an explicit legal basis in the Treaty. However, the legal bases that could be used were the common market Article 100 TEEC and the catch-all Article 235 TEEC, which contained two constraints on the conduct of environmental policy. Both stated that legislation had to be adopted unanimously in the Council, making lowest common denominator outcomes more likely than strong environmentally friendly ones. Notwithstanding these constraints, European environmental policy developed quite substantially in this phase with legislation principally focusing on water, air, noise, waste and nature protection measures. This was mainly driven by member states that already had a considerable level of environmental legislation, e.g. Netherlands and Germany.

- **Phase 3 (1987-1992): Legal basis, supranational decision-making and the 1992 impetus.** The SEA (Single European Act), adopted in 1986, was the first substantial Treaty change since the Treaty of Rome. It did not only codify a number of existing practices in European decision making, but it also principally set the objective of establishing a single market by the end of 1992, comprising the four essential freedoms: free movement of goods, services, people and capital. The SEA introduced an explicit legal basis for environmental legislation at the European level. These provisions had a twofold relevance for European environmental policy and policymaking. First, it attributed new competences to the EEC, including environmental competences. It created an explicit legal basis for European environmental policy by adding a "Title VII – Environment" to the SEA. This also made it possible to adopt environmental measures at the European level that are not primarily instrumental for the realization of the common market. The EEC could now also adopt environmental policies from merely an environmental protection logic. Second, more effective decision-making rules and procedures were introduced by the SEA because they were needed to achieve the "1992"

[12] The European Community (EC), the predecessor of the European Union (EU), transitioned into the EU with the signing of the Maastricht Treaty in 1993, expanding its scope from economic cooperation to include broader political and social integration among its member states.

objective. These consisted of a bigger role for the European Parliament (EP) and a less stringent voting rule for the member states in the Council. The SEA strengthen the role of EP in the legislative process by introducing the “cooperation procedure”. The SEA also introduced qualified majority voting (QMV) for a number of environmental issues. Phase 3 was thus mainly characterized by the creation of a legal basis for European environmental policy, new decision-making rules and the impetus that was given by the “1992” goal of completing the single market. In this period, first steps towards the creation of the European Environmental Agency (EEA) were taken. Its main function is to collect information on the state of the environment in Europe, and to make this information publicly available. Also, in the late 1980s, the European Commission began to explore new environmental policy instruments aimed at enhancing the involvement of private actors in the implementation of environmental standards. Consequently, EU environmental law from this period includes the introduction of innovative measures such as eco-labelling, public access to environmental information, environmental impact assessments, and a proposed directive on civil liability for waste (Orlando, 2014).

- **Phase 4 (1992-2008): Legal, institutional and legislative consolidation.** The successive Treaty reforms such as Maastricht, Amsterdam, Nice and Lisbon consolidated and expanded the legal and institutional framework for EU environmental policy. This contributed to a steady growth in the number of environmental laws. Three components are particularly important: the environment is included among the general objectives of the EU, not limited to the environmental title; and the Maastricht Treaty introduced the co-decision procedure for a broader range of policy domains, including the environment. This policy-making procedure significantly updates the role of the EP as co-legislator. Under this procedure EP can act as a veto-player. Third, the Amsterdam Treaty also inserted the concept of “sustainable development” in the Treaty framework of the EU. The inclusion of sustainable development among the Union’s objectives, together with the explicit reference to 'the achievement of a high level of protection and improvement of the quality of the environment' as one of the Community’s tasks, represented a notable improvement over the more limited phrasing in the Maastricht Treaty, which referred merely to 'sustainable and non-inflationary growth respecting the environment' (Orlando, 2014). The fourth phase marked the rise of EU climate policy, with significant legislation on greenhouse gas emissions, energy efficiency, and biofuels. A key development was the introduction of the IPPC (Integrated Pollution Prevention and Control) framework in 1996, which was a set of directives, regulations, and decisions aimed at protecting the environment and reducing emissions by promoting technological innovation in relevant sectors, including the industrial and chemical sectors (Directive 1996/61/EC) directive as well as establishing the EU Emissions Trading Scheme in 2003, which created a market for emissions trading in the EU. EU enlargements also played a role, as

new member states were required to implement the environmental acquis, often in economies with high pollution levels. Despite institutional consolidation, member states increasingly resisted stricter EU environmental regulation, referring to concerns about international competitiveness and favoring more flexible national implementation over harmonized EU rules.

- **Phase 5: (2008 - 2018): "Green economy" and better implementation of a mature policy area**. Started by the global financial crisis in 2007, followed by European debt crisis (2009–2019), environmental policies lost political priority and were increasingly framed in economic terms, with "green growth" becoming the central concept of EU environmental initiatives. This shift reflected a broader transformation within EU policy discourse, where environmental objectives were increasingly legitimized through their contribution to economic recovery and competitiveness. Still, EU environmental policy was not as directly affected as other policies (e.g. social policies) by the financial-economic crisis. Environmental policy is regulatory in nature, which means that it mainly stipulates rules that limit the discretion of societal actors. Thus, it is not a policy area that primarily distributes or redistributes money between societal groups. However, it was indirectly influenced by the crisis in two ways: political attention and importance steadily declined, while the framing and discourse of EU environmental policy changed. Environmental issues are no longer primarily approached from the perspective of environmental protection, but they are framed as a contribution to economic growth or competitiveness. Such a shift was even more evident later on in flagship EU initiatives such as the Europe 2020 Strategy and the Roadmap to a Resource-Efficient Europe, which explicitly connected sustainability with innovation and job creation, integrating environmental dimension into the European growth model (Paleari, 2022). This aligns with the ecological modernization policy paradigm, which posits that ambitious environmental policies do not hinder economic growth but rather contribute to it, potentially even serving as a driver through mechanisms such as technological innovation in renewable energy (Albrizio et al., 2017). This analogy is also consistent with the Porter Hypothesis, which is discussed in detail in the following chapter. Such policies are increasingly regarded as integral to strategies for recovering from financial and economic crises. Catchphrases such as "green growth", "green economy", "green jobs", and "sustainable development" increasingly dominate the environmental debate and shape the way environmental issues are conceptualized within the EU. Moreover, it may be argued that the turn towards green economy once again places EU environmental policy in the service of broader economic objectives, echoing its orientation during the early decades of EU environmental policy. A similar pattern emerged during efforts to address the economic consequences of the COVID-19 crisis, where even greater emphasis was placed on green growth and green recovery.

In global environmental governance discourse, this phase was marked by a significant decline in the EU's influence at the 2009 Copenhagen Conference. Despite prioritizing climate change, it was sidelined in the final negotiations, revealing shifting power dynamics and the limitations of its 'lead by example' approach (Delreux & Happaerts, 2016).

- **Phase 6 (2019- now): Green transformation and climate neutrality.** On the contrary, it gained back its influence at the 2015 Paris Climate Summit, where EU played a key diplomatic role in brokering the final agreement, advocating for a legally binding and ambitious global climate framework. The EU emphasized multilateralism and led efforts to secure commitments to limit global warming to well below 2°C, with efforts to pursue 1.5°C. Furthermore, following the Paris Agreement, the EU reinforced its global environmental leadership by adopting the European Green Deal (EGD) in 2019, which outlines a comprehensive roadmap toward climate neutrality by 2050. According to Commission president von der Leyen at its introduction, the EGD represents a new growth strategy that is not based on fossil fuels and pollution[13]. Bongardt & Torres (2022) go even further and propose EGD to be regarded as a third building block in the making of the European economic model, alongside the single market and EMU. Moreover, they argue that it has the potential to contribute not only to environmental sustainability but also to the sustainability of the European integration process itself.

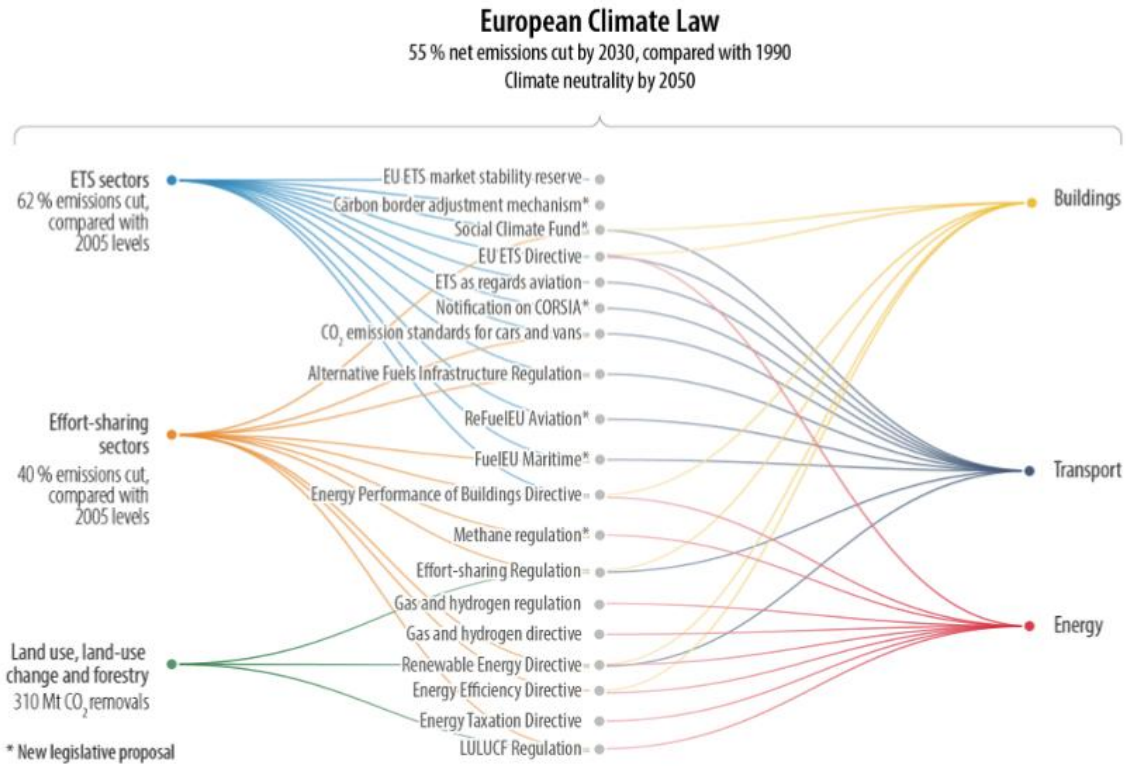
  EGD serves as a cornerstone of a comprehensive strategic package (European Green Deal Strategic Framework, EGDSF) that includes 20 strategic documents which aim at transforming the EU into a climate-neutral and competitive economy by 2050 (Paleari, 2022). It translates the EGD's overarching goals into 68 detailed objectives to be achieved between 2024 and 2050, covering all major environmental policy areas. Most objectives target GHG emissions and air pollution from transport and energy, followed by biodiversity and soil and climate change, whereas over 80% of objectives are scheduled for completion by 2030 (Paleari, 2022).

  There have been important developments, notably the increasing alignment of environment policy and instruments (such as the creation of the EU Emissions Trading System (ETS), a Union-wide cap-and-trade mechanism) with an efficiency rationale, driven by the internal market and the EU's role as a global climate leader (Bongardt & Torres, 2022). These policies have been packed under the climate EU's Fit for 55 Package, which is an unprecedented set of policies and instruments

[13] The EU's ambition plan, which von der Leyen even refers to as Europe's 'man on the moon' moment.

that translates the Green Deal's vision into binding legislation to reduce greenhouse gas emissions in 2030 by 55% compared to 1990 and to be on the road to net-zero by 2050. The package aims to speed up emissions cuts in sectors regulated by the EU Emissions Trading System (ETS) and the Effort-Sharing Regulation, while also enhancing carbon removals within the land use, land-use change, and forestry (LULUCF) sector as depicted in Figure 11 (Erbach & Jensen, 2022).

Figure 11: Legislative initiatives in the 'fit for 55' package



Source: Erbach & Jensen (2022)

Since the impact assessment already favoured a policy mix to meet the higher target, it is unsurprising that the Commission maintains its approach of combining instruments. However, carbon pricing would play a stronger role within this mix. If adopted as proposed, the legislative package would keep the EU's climate and energy framework characterized by a blend of price-based tools and regulatory measures. More specifically it addresses (Schlacke et al., 2022):

- How the existing EU ETS is proposed to be strengthened: the goal is to achieve an overall GHG emission reduction of 61% by 2030 (compared to 2005), instead of the current 43%, in sectors within the ETS scope. This includes specific measures such as extending the ETS coverage,

further reducing allowances, and consequently increasing the allowance price.

- Proposal to introduce a new supplementary emissions trading system (ETS-2) for buildings and transport: although these sectors are currently regulated under the Effort-Sharing Regulation (ESR), the Commission suggests adding future coverage through ETS-2, resulting in 'double regulation' of these sectors. Additionally, as implementation of ETS-2 will have economic and social impacts, the Commission proposes a 'Social Climate Fund', a financial support mechanism operating from 2025 to 2032, to mitigate the social effects of including buildings and road transport in emissions trading.
- Amendments to the ESR[14] and ETD[15]:
    - ESR: Increase the EU-wide GHG reduction target for buildings, transport, agriculture, and waste management from 30% to 40% by 2030 compared to 2005 levels.
    - ETD: Replace volume-based taxation for energy products and electricity with a system based on energy content and environmental performance.
- Proposals for amendments and new complementary measures (EED[16] and RED[17] II):
    - EED: Raise the EU's binding energy efficiency target for final and primary consumption by at least 9% by 2030 (compared to 2020 reference scenario), down from the previous 32.5%.
    - RED II: Increase the 2030 target for renewable energy share in gross final consumption from 32% to 40%.
- Proposed amendments to the LULUCF Regulation:
    - Increase carbon sinks by 2030: A higher net CO_2 sink target is set, including more afforestation, ecosystem restoration, sustainable forest management, and more accurate reporting on sinks.
    - Integration with other sectors and setting the path to net-zero: The LULUCF sector is more closely linked with agricultural emissions, with stricter national commitments introduced to ensure a stable, long-term net sink as part of the EU's path to climate neutrality by 2050.

[14] Effort-sharing Regulation

[15] Energy Taxation Directive

[16] Energy Efficiency directive

[17] Renewable Energy Directive

Alongside the Fit for 55 package, the Circular Economy Action Plan (2020) is another key pillar of the Green Deal. It sets out a forward-looking agenda to build a cleaner and more competitive EU through collaboration with businesses, consumers, citizens, and civil society. The plan aims to streamline the regulatory framework for a sustainable future, maximize opportunities from the transition, and minimize burdens on people and businesses (European Commission, 2020). Most of the legal acts under the second Circular Economy Action Plan have already been adopted and entered into force. This legislation covers the following areas: a sustainable product policy framework, key product value chains, and reducing waste while creating more value.
Lastly, the Clean Industrial Deal, launched on 26 February 2025 as part of the European Green Deal, sets out concrete actions to make decarbonization a driver of industrial growth. It focuses on lowering energy costs, creating quality jobs, and fostering conditions for businesses to thrive. The initiative aims to position the EU as a global leader in clean technologies and carbon reduction, with the ultimate goal of achieving climate neutrality by 2050. Its core elements include ensuring affordable energy through accelerated clean energy deployment, electrification, and improved efficiency to reduce reliance on imported fossil fuels. It also seeks to boost demand for EU-made clean products via sustainability and resilience criteria in procurement, supported by the Industrial Decarbonisation Accelerator Act. Globally, the Deal promotes Clean Trade and Investment Partnerships, strengthens trade defense tools, and simplifies the Carbon Border Adjustment Mechanism. Finally, it invests in skills and quality jobs through initiatives like the Union of Skills and enhanced Erasmus+ funding, while cutting red tape and leveraging the single market to ensure a competitive, resilient, and climate-neutral industrial base by 2050 (European Commission, 2025).

The sixth phase in the evolution of EU environmental policy can be seen as a shift from a predominantly regulatory approach to a more holistic, strategic, and transformative governance model. With the implementation of the EGD, supported by a range of complementary initiatives, climate objectives have been integrated across all major sectors, such as transport, energy, agriculture, and industry, at an unprecedented level.

4.4 EU LEGISLATION

Over time, the European Union has developed an extensive body of legislation addressing climate and energy policy. While the Governance Regulation and the EU Climate Law primarily establish overarching objectives and reporting obligations, other legal instruments define specific targets and operational measures required to achieve these goals. These include the EU Emissions Trading System (EU ETS), the Effort Sharing Regulation (ESR), the Renewable Energy Directive (RED II), the Energy

Efficiency Directive (EED), the LULUCF Regulation, and the Energy Taxation Directive (ETD). Together, these instruments form the core of the EU's climate and energy governance framework.

Among these, the Governance Regulation plays a central role by providing the main mechanism for monitoring progress toward greenhouse gas reduction targets and objectives related to renewable energy and energy efficiency. It requires member states to regularly report on implemented policies and measures through their National Energy and Climate Plans (NECPs), thereby ensuring transparency, consistency, and comparability across countries (Schlacke et al., 2022).

EU regulations apply directly in all Member States without the need for transposition into national law. This ensures uniform and binding rules across the EU, which is essential for consistent implementation, reporting, and enforcement. Because regulations are fully binding, they often specify detailed technical requirements, reporting frameworks, accounting standards, and compliance obligations, which can substantially influence both the magnitude and structure of compliance costs faced by firms. Their direct applicability promotes legal harmonization and reduces regulatory fragmentation between member states, thereby supporting the effective achievement of common EU environmental and climate policy objectives (European Commission, 2023).

Key EU environmental regulations relevant for business operations include, among others, the Regulation on European Environmental Economic Accounts, the Nature Restoration Regulation, the Regulation on deforestation-free supply chains, the Auctioning Regulation under the EU ETS framework, and the Sustainable Finance Taxonomy Regulation. These regulatory instruments impose varying information, financial, and substantive obligations on firms, shaping both actual compliance costs and managerial perceptions of regulatory burden.

4.4.1 Key EU directives

Unlike regulations, EU directives set binding objectives for member states but allow flexibility in implementation, requiring transposition into national law to achieve harmonized outcomes across the Union (European Commission, 2023). EU member states are required to comply with environmental directives, which establish binding standards in areas such as air and water quality, waste management, and biodiversity protection (European Commission, n.d.). These directives constitute a central legal instrument of EU environmental policy, translating overarching objectives into binding obligations while allowing flexibility in national implementation. They play a pivotal role in achieving the goals of the EGD (European Green Deal) by harmonizing standards

across sectors and ensuring coordinated progress toward climate neutrality. Furthermore, the establishment of the European Pollutant Release and Transfer Register (E-PRTR), which is similar to the U.S. Toxic Release Inventory introduced in the 1980s, reflects the so-called third wave of environmental policies, which emphasize public access to and disclosure of environmental information (Manello, 2017). Environmental directives also significantly shape the business environment by imposing compliance obligations, influencing production processes, and driving investment toward cleaner technologies, thereby affecting firms' costs, competitiveness, and innovation strategies. Looking at EU environmental legislation, neither the great financial crisis nor the calls for deregulation have actually led to a significant abolition of environmental legislation in the EU. Still, EU institutions and national governments were forced to think about more flexible and softer approaches to regulation. The increasing use of market-based environmental policy instruments illustrates this development. The evolution towards more flexibility in EU already started in 2000s with the launch of a "Better regulation" program, aiming to make EU legislation more efficient. Since 2010 it continued by "smart regulation", focusing on quality rather than quantity of regulation. Part of this better or smart regulation effort is the Commission's REFIT (Regulatory Fitness and Performance) program, aimed to simplify European regulatory framework and to reduce "red tape" (excessive regulation and administrative burden). In 2016, the Commission also launched the Environmental Implementation Review to support full enforcement of EU environmental law, alongside a REFIT evaluation aimed at simplifying and reducing the cost of monitoring and reporting obligations. The most recent initiative by the EC to reduce administrative burden is called 'one in, one out' which aims to offset new regulatory burden on businesses and citizens by reducing existing burdens in the same policy area. The approach emphasizes controlling the overall additional burden placed on businesses and citizens, rather than concentrating on the number of initiatives or the total accumulated costs. Nonetheless, Clean Industrial Deal exposes cutting red tape among main horizontal enablers necessary for a competitive economy. Making EU legislation "better" or "smarter" has led to the trend of bringing together multiple separate and already existing pieces of legislation into one single and simplified legislative instrument in the area of environment as well. For instance, the Industrial Emissions Directive merged seven existing directives[18] into one more integrated piece of legislation (Directive 2010/75/EU, 2010).

[18] Directive on Integrated Pollution Prevention and Control (IPPC) – 2008/1/EC; Large Combustion Plants Directive (LCP) – 2001/80/EC; Waste Incineration Directive – 2000/76/EC; Directive on VOCs from the Storage of Petrol – 94/63/EC; Directive on VOCs from Certain Activities and Use of Solvents – 1999/13/EC; Titanium Dioxide Industry Directive on Waste Management – 78/176/EEC; Titanium Dioxide Industry Emissions Directives – 82/883/EEC and 92/112/EE

EU environmental legislation is based primarily on the polluter-pays principle, meaning that firms and industries are responsible for the environmental damage they cause and must bear the costs of remediation or pollution prevention. Member states are responsible for transposing, applying, and enforcing EU environmental directives and regulations. By setting common standards and requiring national governments to incorporate these standards into their domestic legislation, EU environmental directives play a crucial role in driving collective environmental sustainability and fostering a cohesive approach to addressing environmental challenges across Europe. Several EU directives establish obligations for the environmental performance of firms, promoting sustainable business practices and environmental protection across various sectors within the EU. Most of the Directives have been transposed to Slovenia and Croatia within Environmental law, ZVO-2 in Slovenia and ZOO in Croatia (Table 2).

Table 2: Key EU Environmental Directives – Main objectives, Obligations for firms, Policy instruments and transposition in Slovenia and Croatia

Directive	Main objective	Obligations for firms	Policy instruments	SI	HR
2011/92/EU, 2014/52/EU – EIA Directive	Environmental impact assessment for major projects	Conduct EIAs; submit documentation; mitigation plans	Assessment procedure; permitting	✓	✓
2001/42/EC – SEA Directive	Strategic environmental assessments for plans/programmes	Assess plans/programmes with environmental impact	Assessment; public consultation	✓	–
2003/35/EC – Public participation	Improve access to environmental information & participation	Provide information; participate in procedures	Participation rights; transparency	✓	✓
2003/4/EC – Access to information	Ensure public access to environmental data	Provide environmental data upon request	Disclosure; transparency	✓	✓
2004/107/EC; 2008/50/EC – Air Quality Framework	Improve air quality & limit pollutants	Comply with emission limits; monitoring	Standards; monitoring; limits	✓	–
2015/2193/EU – Medium combustion plants	Reduce emissions from medium plants	Emission limits; monitoring	Command-and-control	✓	–
2016/2284/EU – NEC Directive	National emission ceilings	Emission reductions; reporting	Binding ceilings	✓	–

Directive	Main objective	Obligations for firms	Policy instruments	SI	HR
2009/126/EC; 94/63/EC – VOC emissions	Reduce VOC emissions from petrol storage/distribution	Use control equipment; reporting	Standards; permitting	–	✓
2010/75/EU – Industrial Emissions Directive (IED)	Integrated pollution prevention from industry	Permits; BAT; monitoring; reporting	Command-and-control; BAT	✓	✓
2003/87/EC – EU ETS	Reduce GHG emissions via cap-and-trade	Monitor & report emissions; hold allowances	Market-based instrument (ETS)	–	✓
98/70/EC – Fuel Quality Directive	Reduce GHG intensity of fuels	Monitor fuel quality; reduce GHG intensity	Standards; reporting	✓	✓
2009/31/EC – CCS Directive	CO_2 storage safety	Monitoring; permits	Permitting; monitoring	–	✓
2008/98/EC – Waste Framework Directive	Waste hierarchy; recycling	Proper waste handling; documentation	Producer responsibility; hierarchy	✓	✓
2006/21/EC – Mining waste	Safe management of extractive waste	Plans; monitoring; reporting	Permitting; plans	✓	–
2012/19/EU – WEEE Directive	Electronic waste management	EPR; collection; recycling	Producer responsibility	✓	–
2019/904/EU – Single-use plastics	Reduction of plastic waste	Product restrictions; EPR	Market restrictions; EPR	✓	–
2006/66/EC – Batteries	Battery waste management	EPR; recycling	Producer responsibility	✓	✓
2000/53/EC – End-of-life vehicles	ELV recycling	EPR; depollution	Producer responsibility	✓	–
1999/31/EC – Landfill Directive	Reduce landfill waste	Standards; permits; gas control	Command-and-control	–	✓
2000/60/EC – Water Framework Directive	Good water status	Permits; monitoring	Planning (RBMPs); standards	✓	–
2006/7/EC – Bathing Water Directive	Bathing water quality	Monitoring & reporting	Standards; monitoring	–	✓
2008/56/EC – Marine Strategy	Good marine environmental status	Monitoring & mitigation	Strategies; monitoring	–	✓

Directive	Main objective	Obligations for firms	Policy instruments	SI	HR
2001/18/EC; 2009/41/EC – GMO Directives	GMO handling & release	Permits; monitoring	Risk assessment	✓	–
2009/147/EC – Birds Directive	Conservation of birds	Assess impacts; mitigation	Conservation rules	✓	–
92/43/EEC – Habitats Directive	Natura 2000 protection	AA (appropriate assessment); mitigation	Conservation planning	✓	✓
2004/35/EC – Environmental Liability Directive (ELD)	Liability for environmental damage	Prevent & remedy damage; bear costs	Liability regime	✓	✓
2012/18/EU – Seveso III	Major accident prevention	Risk management; reporting	Safety management; inspections	–	✓
2002/49/EC – Noise Directive	Noise mapping & action plans	Noise assessments	Mapping; action plans	✓	–
91/692/EEC – Environmental reporting	Harmonization of environmental reporting	Standardized reporting	Reporting obligations	–	✓
2022/2464 – CSRD	Sustainability reporting	ESG reporting; ESRS standards	Disclosure; mandatory reporting	✓	✓

Source: own elaboration

4.5 ENVIRONMENTAL IMPLEMENTATION

4.5.1 Environmental regulation in Slovenia

Slovenia has been traditionally striving to be perceived as a green country, developing its first nature (not environmental) protection program already back in 1920 when direct detrimental effects on environment were far from being felt yet (Polajnar Horvat et al., 2014). Soon after the independence the first Slovenian environmental protection act was adopted in 1993, which was based on a standpoint that preventive action is required as well as careful deliberation in decision-making about causing new environmental impacts and exploitation of natural resources. Furthermore, it included the rule of integrity that environmental protection cannot be successfully implemented only partially without consensus and cooperation (Špes, 2008). After joining the EU in

2004, Slovenia committed itself to systematically integrate environmental principles into politics, economy and everyday life enabling environmental issues to become a subject of public policies and public debates, while concerns about environment became a positive value (Polajnar Horvat et al., 2014). Environmental awareness accompanied by the large share of protected areas, high forest cover and moderate intensity of farming contributes significantly to relatively good performance on main environmental indicators. Namely, Slovenia managed to achieve and even exceed 2020 targets for emission and energy use while the target for the share of renewables in total energy consumption was not achieved. On average, soil and water are still relatively well-preserved natural resources, while air quality, measured by the content of the finest dust particles, is more problematic, due to the inadequate combustion of wood biomass in individual heating systems and extensive road transport (Institute of Macroeconomic Analysis and Development, 2022).

Firms operating in Slovenia are subject to a comprehensive framework of environmental laws and regulations aimed at protecting the environment and promoting sustainable practices. This includes compliance with the Environmental Protection Act (ZVO-2) and its accompanying regulations, which outline requirements for pollution prevention, waste management, environmental impact assessments, and conservation efforts. Additionally, firms must adhere to specific sectoral regulations and permits related to air and water quality, hazardous substances, noise pollution, and biodiversity conservation. Compliance with these laws is overseen by various governmental agencies, and non-compliance can result in fines, penalties, or legal action. Therefore, it is essential for firms to stay informed about relevant environmental legislation and implement measures to minimize their environmental impact.

4.5.1.1 Environmental Protection Act of Slovenia

The key law concerning environmental protection in Slovenia is the Environmental Protection Act - ZVO-2 (Slovenian: *Zakon o varstvu okolja*), which promotes the reduction of waste production and establishes an efficient, transparent, and cost-effective waste management system. Entities must obtain environmental permits for waste processing activities (2nd part of the law). The law defines measures in the event of environmental accidents (Article 63), actions in cases of excessive environmental burdens due to deviations from prescribed practices (Article 64), and the role of an environmental protection custodian who advises and provides guidance to burden creators regarding environmental protection (Article 66). It also defines programs and interventions in the field of environmental protection. Comprehensive environmental impact assessments are conducted in cases of significant environmental impact. These assessments evaluate the impacts on the environment, including requirements for nature conservation, human protection, achieving climate goals, and climate

change resilience. Environmental impact assessors must provide an environmental report that identifies, describes, and evaluates the execution of the plan and its potential alternatives.

The most relevant section for understanding the financial obligations imposed by environmental law begins with Part 8 of the Environmental Protection Act (ZVO-2), which outlines the economic and financial instruments of environmental protection. Article 172 establishes that any person - legal or natural - who causes environmental pollution through emissions or waste, or who produces, uses, or places on the market materials containing harmful substances, is considered a polluter and is therefore obligated to pay environmental levies (Article 172, paragraph 1). The government is tasked with defining the types of pollution, waste categories, and substances subject to levies, as well as the basis for calculation, causes of pollution, and procedures for assessment and payment. It also sets conditions for exemptions, refunds, and exceptions, ensuring that the amount charged reflects the marginal cost of pollution (Article 172, paragraphs 3 and 4).

Environmental regulations may also directly reference national or EU standards, requiring firms to ensure compliance through accredited conformity assessment bodies (Article 55). To promote environmentally responsible practices, the Ministry may award the EU Ecolabel to products with lower environmental impacts (Article 67), and firms may participate in the EU Eco-Management and Audit Scheme (EMAS), subject to independent verification and ministry approval. While registered firms may benefit from incentives, non-compliance can result in exclusion from these schemes (Article 68).

4.5.2 Environmental regulation in Croatia

In accordance with Article 70 of the Croatian constitution, every citizen of Croatia has the right to a healthy life. The state is responsible for ensuring conditions for a healthy environment, and all individuals, within the scope of their authority and activities, are obliged to give special attention to the protection of human health, nature, and the human environment. The Parliament, within its constitutional powers, ensures sustainable development and environmental protection according to the Environmental Protection Act (Croatian: *Zakon o zaštiti okoliša* and hereafter ZZO) and other relevant laws. ZZO establishes the legal framework for safeguarding the environment, promoting sustainable development, and ensuring the responsible use of natural resources through comprehensive regulations and policies that align with both national and international environmental standards. It monitors and addresses environmental protection, while adopting measures for sustainable development (Article 35, paragraph 1 of the ZZO). The Government, in line with the ZZO and other laws, proposes strategies for sustainable development and environmental protection to

Parliament, promotes public education on these matters, secures financial resources, concludes international agreements, and establishes bodies to implement environmental tasks (Article 35, paragraph 2 of the ZZO).

In line with European directives, the central principle of the ZOO is the polluter-pays rule (Article 16), which places the financial burden of environmental harm directly on the polluter. This includes not only the direct costs of damage remediation but also the costs of monitoring, prevention, and implementation of protective measures, regardless of whether they arise from legal liability, emission discharges, or financial obligations imposed by environmental instruments.

4.6 COMPARISON OF ENVIRONMENTAL REGULATION OF SLOVENIA AND CROATIA

Environmental regulation in Slovenian and Croatia is primarily based on a command-and-control approach, with strong governmental oversight and enforcement of environmental standards. Environmental protection acts and other regulations mandate limits on emissions, establish protected areas, and control industrial activities. While some market-based instruments, like emissions trading schemes, have been introduced in line with EU policies, Slovenia's and Croatia's regulatory frameworks still rely heavily on direct regulation through permits, restrictions, and penalties. This reflects a more centralized approach to environmental governance, ensuring strict compliance with environmental goals.

Both Croatia and Slovenia have transposed the fundamental principles of EU environmental law into their national legislation, yet important differences emerge in their institutionalization and the scope of compliance obligations for firms. At the core, both legal systems preserve the polluter-pays principle, which requires operators to cover the costs of prevention, control, remediation, monitoring, and compensation for environmental damage. In Croatia, this obligation is defined broadly in the Zakon o zaštiti okoliša (ZOO, Article 16), whereas Slovenia's Zakon o varstvu okolja (ZVO-2, Article 11) codifies it more explicitly, directly linking it to the Treaty on the Functioning of the European Union and complementing it with the user pays principle.

Environmental permits represent another area of convergence, as both countries require integrated permits for installations with significant environmental impact. Croatia's okolišna dozvola and Slovenia's okoljevarstveno dovoljenje (OVD) cover emission limits for air, water, soil, noise, and waste, alongside obligations for monitoring and the use of best available techniques (BAT). However, Slovenia establishes a stronger link with EU BAT reference documents and explicitly integrates

requirements of the Industrial Emissions Directive, resulting in a more detailed and resource-intensive framework (ZVO-2, Article 116).

In the field of accident prevention, both states transpose the Seveso III Directive. Operators must adopt preventive measures, prepare protection plans, and notify competent authorities in case of major risks. Croatia's obligations are broadly defined, while Slovenia requires more formalised procedures, including safety reports and the submission of plans to the Administration for Civil Protection (ZVO-2, Article 19; ZOO, Articles 120-126). These additional procedural steps create higher compliance costs for Slovenian firms.

Liability for environmental damage is also addressed through transposition of the Environmental Liability Directive (2004/35/EC). In both countries, polluters must implement preventive and remedial measures at their own expense. Slovenia, however, goes further by obliging certain operators to provide financial guarantees or insurance to cover potential liabilities, thereby strengthening legal certainty but also increasing compliance costs (ZVO-2, Article 11 and Articles 34 – 37 (Slovenian: proizvajalčeva razširjena odgovornost)). It means that for certain waste streams that represent a significant share of household waste, the person who places the product on the market is also responsible for the waste product after it has been discarded by the consumer.

Voluntary instruments, such as EMAS and eco-labelling schemes, are encouraged in both frameworks. Besides EU Ecolabel Croatia also promotes participation through the "Prijatelj okoliša" label (ZOO, Articles 2013-2017), while Slovenia actively integrates the EU Ecolabel with green public procurement policies (ZVO-2, Article 23 (public procurement); Article 67 Slovene: znak EU za okolje; Articles 68-69 (EMAS)).

Information and reporting obligations reveal further divergence. In Croatia, producers are required to provide consumers with basic information on environmental impacts and waste disposal (Article 219). By contrast, Slovenia obliges firms to regularly report into centralized environmental information systems such as the PRO register (ZVO-2, Article 48), establishing a more data-driven compliance environment and increasing the administrative burden on companies. Firms whose activities cause environmental impacts are obliged to carry out operational monitoring of their effects on the environment (Article 150), which includes pollution, environmental status, risk reduction, and natural phenomena. They must report monitoring data at least annually to the ministry and the municipality, inform the public, and in the case of air emissions, provide real-time, monthly, and online publication of measurement results.

Overall, both countries share the same EU-based legal foundations, yet Slovenia has developed a more formalized and institutionalized compliance system. Compared to Croatia, Slovenian firms face stricter reporting duties, higher fiscal burdens through environmental taxes, and more extensive integration of EU-level regulatory instruments. This results in a comparatively heavier regulatory environment in Slovenia, while Croatia's framework, though substantively aligned with EU standards, imposes fewer administrative and financial demands. Thus, the high degree of legislative alignment between Slovenia and Croatia also provides a robust basis for comparing the two countries directly. Moreover, it further enables both to be examined together within empirical analysis, as will be the case in the later empirical testing of the Porter Hypothesis.

4.7 ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

Since the introduction of the European Emissions Trading System (ETS) in 2005, an increasing number of firms have been aware of growing environmental issues and are systematically addressing them by internalizing environmental costs and ensuring competitiveness (Letmathe & Balakrishnan, 2005). Furthermore, EU directives (e.g. IED, ELD, ETS, etc.) in general stimulate firms to adopt Environmental Management Systems (EMS) by making them a practical tool for compliance, risk reduction, and competitiveness. They achieve this by embedding EMS requirements into legislation, linking them to permits, and aligning them with voluntary schemes like EMAS. The increasing adoption of EMS is reflected in the rapid growth of firms that comply with the ISO 14001 standard, which enables them to demonstrate that they have implemented an appropriate environmental management system. The number of firms with the ISO 14001 standard in the EU has increased from 7,400 in 2000 to 84,316 in 2020. For example, during this period, the number of firms increased from 88 to 494 in Slovenia by 2020, while in Croatia the figure rose from 8 to 1,138, indicating a significant rise in environmental awareness among businesses. It can be expected that the tightening of climate obligations imposed by Fit for 55 and the EU Green Deal will further stimulate firms to adopt Environmental Management Systems (EMS), linking compliance to structured management and creating competitive incentives.

5 ENVIRONMENTAL REGULATION, PRODUCTIVITY AND THE PORTER HYPOTHESIS

"The prevailing view is that there is an inherent and fixed trade-off: ecology versus the economy. On one side of the trade-off are the social benefits that arise from strict environmental standards. On the other are industry's private costs for prevention and cleanup – costs that lead to higher prices and reduced competitiveness. The balance of power shifts one way or the other depending on the prevailing political winds. This static view of environmental regulation, in which everything except regulation is held constant, is incorrect" (Porter & Van der Linde, 1995).

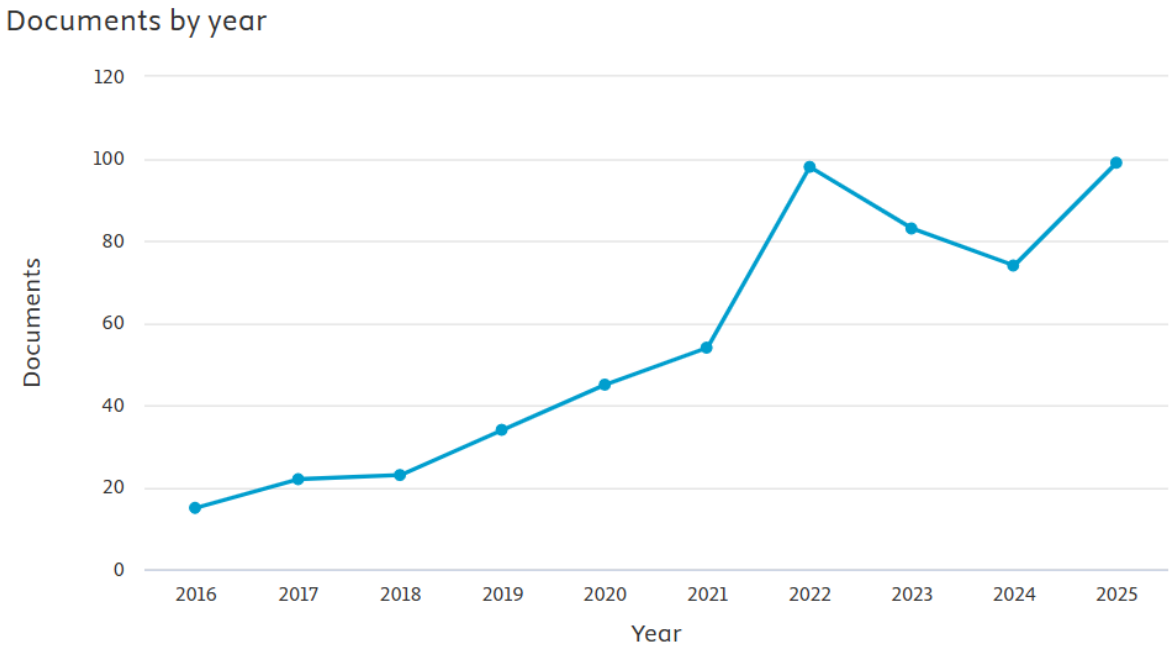
The relevance of the research aimed at examining the interaction between environmental regulation and productivity, as the main contributing factor increasing firm's competitiveness, is reflected in the recent increase of scientific publications in this field. Since 1990s interlinkage has been researched throughout the so-called Porter Hypothesis. It has been over 30 years since Michael Porter published his seminal work challenging the traditional neoclassical view that environmental regulation is detrimental to business by primarily increasing firms' costs, despite its broader social benefits. Conventional theory, grounded in neoclassical economics, argues that environmental regulation compels polluting firms to undertake abatement activities, thereby imposing additional financial burdens. From this perspective, compliance costs represent the resources that firms must allocate to mitigate negative environmental impacts (Nikos et al., 2024), thereby imposing an additional burden that may hinder their productive performance (Albrizio et al., 2017).

Such regulation is believed to restrict firms' choices regarding technology and production inputs, while also crowding out investment in other areas—ultimately hindering productivity (Jaffe et al., 1995). In contrast, Porter argued that environmental regulation could help firms identify inefficient use of costly resources, generate and disseminate new information, and overcome organizational inertia. "*It is not a static world of economic theory but rather a real world of dynamic competition, where companies operate and are encouraged to innovate when environmental regulation is properly designed"* (Porter & Van der Linde, 1995). This "win-win" scenario, where environmental regulation not only benefits the environment but also enhances firms' productivity by incentivizing innovation, improving product quality and production processes, and ultimately offsetting compliance costs, is widely recognized as the Porter Hypothesis, often simply referred to as PH. Although the PH was not the first theory to challenge conventional wisdom on innovation, its systematic explanation of the causal relationship between environmental regulation, innovation, and performance rekindled the debate on environmental regulations (Hu et al., 2018). For

policymakers, the prospect of a potential "win-win" solution has been highly appealing, as it alleviated the challenging trade-off between environmental objectives and other economic goals (Xepapadeas & de Zeeuw, 1999). Economists, however, have been generally skeptical of the notion of a "free lunch," and some critics of the PH argue that it diverts attention away from the cost-benefit analysis of environmental policy, which they consider to be the most crucial aspect. Managi et al. (2005) offered an intriguing perspective by underscoring the importance of identifying the direction of causality between technical efficiency and environmental regulations. While the PH suggests that stricter environmental regulations can lead to improved technical efficiency, Managi et al. (2005) propose that innovation could also occur first, potentially reducing the need for more stringent regulations.

From the introduction of the PH onwards, the relationships among environmental regulation, innovation, and competitiveness have been a fiercely debated area of research with different views among industries, regions, and countries. Quick overview of the scientific production of articles containing Porter Hypothesis in their abstract, title or keyword by year reveals an upward pattern, gaining a special momentum in the recent years. Since 2018, the number of relevant articles increased by 9,1% year over year, while the number more than doubled only from 2021 to 2022 (see Figure 12). However, this recent growth in publications remains geographically concentrated, with a strong focus on China (Lah & Kotnik, 2026). To date, the Porter Hypothesis has been tested only to a limited extent across EU countries, and research in other Central European economies has been very scarce (Prokop et al., 2022).

Figure 12: The number of published articles that include PH in their research



Source: own elaboration from Scopus database

5.1 NEOCLASSICAL VIEW

Under neoclassical assumptions, the traditional view holds that environmental regulations negatively impact competitiveness by imposing additional burdens on firms, as they face direct costs from pollution control activities. Environmental regulation not only increases firms' expenditure on environmental protection but also leads to opportunity costs, as limited financial budgets force firms to allocate resources to compliance rather than investing in other profitable opportunities (Xie et al., 2017). Also known as the “restriction hypothesis” (Gollop & Roberts, 1983), the “compliance cost hypothesis” (Wu & Lin, 2022; Chen et al., 2021), or the “costly regulation hypothesis” (Rassier & Earnhart, 2015), this theory posits that environmental regulation restricts technological innovation in enterprises (Fan et al., 2021) by increasing production costs and thereby reducing investments in research and development. The main counterargument to the PH, which claims that environmental regulation encourages firms to innovate, is that firms do not need regulatory incentives to seek opportunities for improving profitability, as they already do so voluntarily (Jaffe & Palmer, 1997). Or as Rassier & Earnhart (2015) put it: “*Rather than a catalyst, environmental regulation generally serves only to constrain firms' abilities to pursue profit-increasing opportunities*.” This was a prevailing belief in the 1970s and 1980s (Christainsen & Haveman, 1981), especially in the US, as some authors suggested that regulation might be (partly) responsible for the productivity slowdown of the

American economy in 1970s (Dufour et al., 1998). According to (Jaffe et al., 1995) the U.S. economy experienced a large trade deficit beginning in the 1970s, coinciding with the rise of the modern environmental movement. Some have suspected that environmental regulation played a major causal role in impairing the competitiveness of U.S. firms. The so-called structuralist approach (Iraldo et al., 2011) identifies two types of ultimate consequences that environmental regulation has on competitiveness, namely: reduced performance of an industry, measured by its growth parameters (sales, turnovers, etc.) and changed st+ructure of the industry as some of the companies shut down or move to the so called “pollution heavens” (Dechezleprêtre & Sato, 2017; Iraldo et al., 2011). That is why some authors refer to this approach also as the “pollution heaven hypothesis”, which predicts that more stringent environmental policies will increase compliance costs and, over time, shift pollution-intensive production toward low abatement cost regions, creating pollution heavens and causing policy-induced pollution linkage (Dechezleprêtre & Sato, 2017).

Some more recent studies support the compliance cost hypothesis. For example, Hancevic (2016) found that the Clean Air Act amendments reduced the efficiency of over 90% of coal-fired generators. Zhao & Sun (2016) argued that although environmental regulations had a significant positive effect on corporate innovation, they generally harmed the competitiveness of pollution-intensive firms in China. Albrizio et al. (2017), using a panel of 11 OECD countries and 22 manufacturing sectors, found that due to more stringent environmental policies most productive firms experienced a temporary boost in productivity, while it reduced productivity and forced less productive firms out of the market.

5.2 PORTER HYPOTHESIS

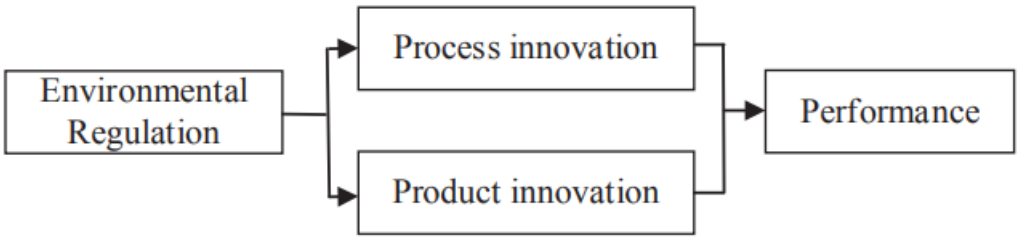
The relationship between environmental regulation, innovation and productivity has been a topic of significant debate, particularly in light of the Porter Hypothesis (PH), proposed by Porter (1991) and further developed together with Van der Linde (Porter & Van der Linde, 1995). Hu et al. (2017) noted that the evolution of the PH revitalized discussions on the interplay between environmental regulation and innovation. The PH posits that environmental regulations can enhance economic performance by prompting firms to innovate their production processes, thereby reducing costs through improved efficiency and resource allocation (Iraldo et al., 2011). Furthermore, (Hu et al., 2017) argue that Porter suggest not only innovation in production offsets, but innovation in product offsets as well, because innovation is not only technology changes but also new product design. Specifically, while environmental policies may impose compliance costs, they can also stimulate innovations that enhance product quality and lower production expenses, ultimately leading to increased efficiency (Wang et al., 2019). This view directly contradicted the prevailing perspective at the

time, as Porter & Van der Linde (1995) stated: *The prevailing view was that there was an inherent and fixed trade-off: ecology versus the economy.* They challenged this view by arguing instead that regulations if properly designed can help firms identify inefficient resource uses, generate new information, and combat organizational inertia. They contended that pollution represents a waste of resources that diminishes firm productivity; therefore, well-designed regulations could trigger innovations (Hu et al., 2017). Porter & Van der Linde (1995) explain that there are at least five reasons that properly formed environmental regulation may lead to the outcome of increase productivity, namely:

- regulation signals firms about likely resource inefficiencies and potential technological improvements,
- regulation based on information gathering can raise corporate awareness,
- regulation reduces the uncertainty that environmental investments will be valuable,
- regulation creates pressure that motivates innovation and progress,
- finally, regulation levels the transitional playing field.

Hence, the PH establishes a causal chain connecting environmental regulation to innovation and ultimately to improved performance, with innovation positioned as the pivotal factor. Innovation offsets can be categorized into process offsets, which enhance resource utilization, and product offsets, which arise from the design of more environmentally friendly products (Lopez-Gamero et al., 2010). Figure 13 depicts a schematic representation of the logical chain from environmental regulation to innovation, and subsequently to performance, based on the argument of the PH.

Figure 13: Schematic representation of the Porter Hypothesis



Source: Hu et al. (2017)

The theories explaining the PH are primarily rooted in behavioral economics, addressing various market and organizational failures (Peng et al., 2021). The PH can also be classified among revisionist hypotheses, which assume that environmental regulations create a win-win situation by improving environmental quality and enhancing productivity simultaneously. Among the revisionists hypotheses are also

Pollution halo hypothesis proposed by Zarsky (1999) and race-to-the-top hypothesis which is based on the famous 'California effect' proposed (Vogel, 2000)[19]. Thus far, empirical tests of the PH have yielded mixed results, with some studies demonstrating a positive relationship between environmental regulations and innovation, while others suggest potentially negative or neutral effects on competitiveness (Ambec et al., 2013). Although PH was not exactly clear-cut in the beginning and was based on a small number of company case studies in which firms were able to reduce both their pollution emissions and their production costs (Lanoie et al., 2011), it sparked a remarkable interest in the analysis of the relationship between environmental regulation and productivity. It should be emphasized that PH states that only well-designed regulation leads to innovation and that this innovation not necessarily offsets the cost of regulation, i.e. not necessarily represents a "free lunch" (Ambec et al., 2013). According to Rassier & Earnhart, (2015), there are three outcomes through which environmental regulation ultimately improves profitability, namely: innovation, measurable cost savings or revenue enhancements (i.e., "innovation offsets"), and improved financial performance. Based on these outcomes, accompanied by the type of regulation, which is an important determinant in the interpretation of the PH, Jaffe & Palmer (1997) elaborated the hypothesis into three different versions:

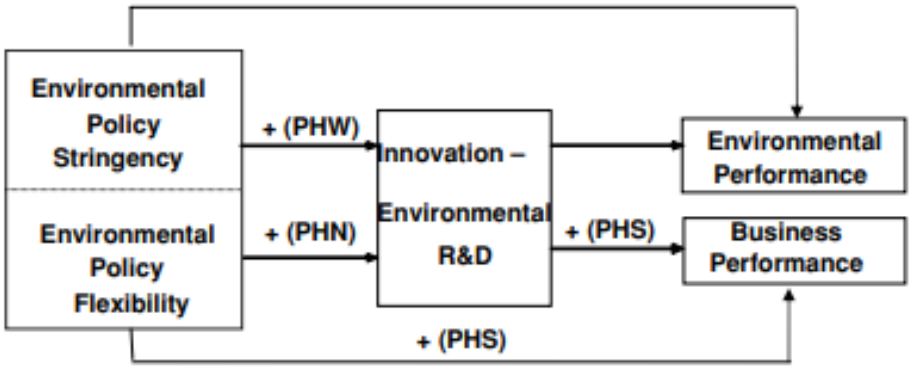
- The "weak" version states that regulation stimulates certain types of innovation, but it does not tell us whether this innovation is good or bad for firm's performance.
- The "strong" version claims that environmental regulation has positive effect on the overall economy because all the companies affected by the regulation will be reorganized to improve efficiency. The cost saved and the improved production processes will outweigh compliance costs leading to increased productivity. This view was elaborated on the following claim from Porter & Van der Linde (1995) regarding how the regulation-induced innovation increases firm competitiveness: *Innovation in response to environmental regulation can take two broad forms. The first is that companies simply get smarter about how to deal with pollution once it occurs … The second form of innovation addresses environmental impacts while simultaneously improving the affected product itself and/or related processes. In some cases, these innovation offsets can exceed the costs of compliance*.
- Finally, the "narrow" version argues that certain types of environmental regulation stimulate innovation, which are not necessarily beneficial, as environmental policy is designed to target the outcome rather than the production process (Martínez-Zarzoso et al., 2019). This version asserts that flexible regulations, such as market-based instruments, encourage productivity

[19] Market competition caused by trade liberalization facilitates the spillover of environmental standards from greener to less green nations (Vogel, 1997).

growth and innovation, while prescriptive regulations offer less incentive for firms to innovate (Xie et al., 2017; Franco & Marin, 2017). Thus, only certain types of environmental regulations (e.g. tradable permits or Pigouvian taxes), particularly those focusing on outcomes rather than on processes can stimulate innovation activities and overall economic performance (Franco & Marin, 2017).

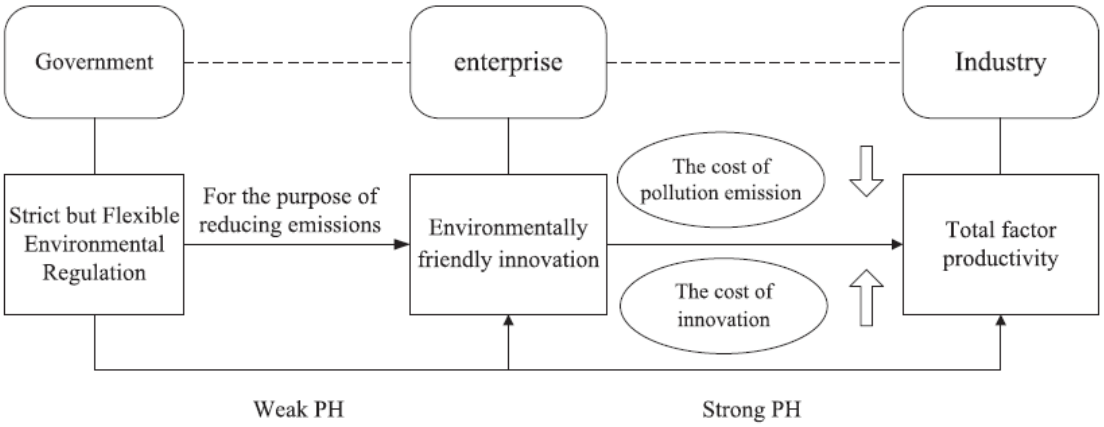
Figures 14 and 15 represent the schematic representation of the different versions of PH. Figure 14 from Lanoie et al. (2011) includes all three versions of the Porter Hypothesis (including the narrow version – PHN), while Figure 15 from Zhao et al. (2018) illustrates the interlinkages across various levels, i.e. government, enterprise, and industry, affected by the hypothesis. Importantly, the representation by Lanoie et al. (2011) includes the effect on environmental performance, which is often omitted, as research related to the PH typically focuses on financial performance outcomes, such as total-factor productivity.

Figure 14: Schematic representation of the Porter Hypothesis causality chain



Source: Lanoie et al. (2011)

Figure 15: The formation mechanism of Porter Hypothesis



Source: Zhao et al. (2018)

Most of the key research has employed this categorization when testing various versions of the PH. Table 3 presents some of the most significant recent empirical studies on the PH (Lah & Kotnik, 2026). Broadly, the literature can be divided into two groups: studies testing the weak version of the PH, which focuses on the relationship between environmental regulation and innovation; and studies testing the strong version, which examine the relationship between environmental regulation and competitiveness or productivity. Only a limited amount of research focuses on testing both versions (e.g. Ramanathan et al., 2018; Rubashkina et al., 2015; Sun et al., 2024).

Table 3: Content analysis of the top 10 most influential articles containing empirical PH research

TITLE / AUTHOR(S)	***AIM OF THE STUDY***	***DATA & METHODOLOGY***	***INDICATORS USED & MAIN RESULTS***
1.CAN THE GREEN CREDIT POLICY STIMULATE GREEN INNOVATION IN HEAVILY POLLUTING ENTERPRISES? EVIDENCE FROM A QUASI-NATURAL EXPERIMENT IN CHINA. ***Hu et al., 2021***	*Evaluates whether the 2012 Green Credit Guidelines (GCP) promoted green innovation in heavily polluting enterprises (HPEs) in China.*	*Emissions data on SO_2, dust, solid waste, and wastewater from the China Statistical Yearbook on Environment. DID model to estimate the impact of the 2012 policy.*	***ER:** Implementation of the 2012 Green Credit Guidelines;* ***IN:** Green innovation data using IPC-GI classification;* *The 2012 Guidelines positively impacted green patent output, especially in financially constrained HPEs.* ***Weak PH confirmed.***

2.DO CARBON EMISSION TRADING SCHEMES STIMULATE GREEN INNOVATION IN ENTERPRISES? EVIDENCE FROM CHINA. ***Chen et al., 2021***	*Assesses the impact of China's pilot Emissions Trading Scheme (ETS) on green innovation in listed firms in high-carbon industries.*	*Data from publicly listed firms on the Shanghai and Shenzhen Stock Exchanges (1990–2018). Multi-layered DID and DDD approach.*	***ER:** China's pilot ETS implementation;* ***IN:** Green patent data from the State Intellectual Property Office;* *ETS pilot policy reduced green patenting by ~9.26%, indicating a negative and delayed effect on green innovation.* ***Weak PH not confirmed.***
3.DIFFERENT TYPES OF ENVIRONMENTAL REGULATIONS AND HETEROGENEOUS INFLUENCE ON "GREEN" PRODUCTIVITY: EVIDENCE FROM CHINA ***Xie et al., 2017***	*Examines if the "strong" version of PH is supported in China by investigating how different regulatory instruments (CER, MBR, informal) and their stringency impact "green" productivity.*	*Province-level panel dataset including variables like industrial output value, CO_2 emissions, environmental investments, pollution fees, patents, etc. Directional slacks-based measure (SBM) to estimate the production frontier, and the Luenberger.*	***ER:** Environmental Investment (EI), Pollution Discharge Fee, public complaints, and employee education level;* ***PRO:** ETFP calculated using SBM and LPI; CER in China is too strict for optimal productivity. MBR is more effective and currently reasonable. IR, measured by education, boosts green productivity. Strong evidence supports the 'strong' PH: well-designed, stringent ER can enhance industrial competitiveness.* ***Strong PH confirmed.***
4.ENVIRONMENTAL REGULATION AND COMPETITIVENESS: EMPIRICAL EVIDENCE ON THE PORTER HYPOTHESIS FROM EUROPEAN MANUFACTURING SECTORS ***Rubashkina et al., 2013***	*Investigate the weak& the strong PH in the context of European manufacturing. The aim is to assess whether ER has a positive effect on innovation and TFP.*	*Data from 17 EU countries, 9 aggregated manufacturing sectors (1997-2009) from EUROSTAT, EUKLEMS, WIOD, OECD STAN, and OECD ANBERD. Fixed-effects regression models were applied. .*	***ER:** Proxied by pollution abatement and control expenditures;* ***IN:** Measured by R&D expenditures and patent counts;* ***PRO:** TFP;* ***Weak PH confirmed, strong PH not confirmed** as environmental regulation does not appear to improve productivity.*

5.HETEROGENEOUS IMPACTS OF ENVIRONMENTAL REGULATIONS AND FOREIGN DIRECT INVESTMENT ON GREEN INNOVATION ACROSS DIFFERENT REGIONS IN CHINA **Luo et al., 2021**	*Examines the effects of environmental regulations and foreign direct investment on green innovation across Chinese regions.*	*Panel data from 30 Chinese provinces (2003–2017). Classical panel regression using OLS, inclusion of lagged dependent variable, and System GMM estimator.*	***CER:** Environmental investments in new projects;* ***MBR:** Pollutant discharge fee;* ***IR:** Environmental proposals for NPC and CPPCC;* ***IN:** Green innovation patent counts.* *CER and IER have significant positive effects on green innovation, while MBR negatively affects it.* ***Weak PH partially confirmed.***
6.ENVIRONMENTAL POLICIES AND PRODUCTIVITY GROWTH: EVIDENCE ACROSS INDUSTRIES AND FIRMS **Albrizio et al., 2017**	*Tests the strong PH by assessing whether tightening environmental policy stringency impacts productivity growth at the industry and firm levels across OECD countries.*	*Industry-level data from OECD STAN and the Productivity database for 17 OECD countries and 10 manufacturing sectors (1990–2009). Firm-level data from OECD-ORBIS database. Industry- and firm-level regressions using DID analysis for policy shocks, lagged response models, and controls for sector- and country-specific traits.*	***ER:** OECD EPS composite Index. Energy Prices used as an alternative proxy for environmental policy pressure;* ***PRO:** TFP growth at industry level and firm-level productivity indicators;* *Stricter ER initially hinders productivity, especially in energy-intensive industries. In the medium term, advanced firms benefit from innovation and reallocation, leading to productivity gains. Mixed effects: laggard firms struggle, while leading firms adapt and thrive. The PH may apply conditionally, benefiting more productive firms under specific conditions.* ***Strong PH partially confirmed.***

7.CAN ENVIRONMENTAL REGULATION PROMOTE URBAN GREEN INNOVATION EFFICIENCY? AN EMPIRICAL STUDY BASED ON CHINESE CITIES ***Fan et al., 2021***	*Verifies the mechanism through which ER affects regional green innovation efficiency (GIE).*	*Panel data from 235 Chinese cities (2004-2016). Spatial econometric model using a geographic weight matrix.*	***ER:*** *Composite index of industrial SO_2 removal, domestic sewage treatment & industrial solid waste utilization rate;* ***IN:*** *GIE evaluated by input factors, expected & unexpected output. Significant spatial spillover effect of urban GIE. U-shaped relationship between ER and GIE, implying initial costs followed by gains.* ***Weak PH confirmed.***
8.ENVIRONMENTAL REGULATION AND GREEN PRODUCTIVITY GROWTH: EMPIRICAL EVIDENCE ON THE PORTER HYPOTHESIS FROM OECD INDUSTRIAL SECTORS ***Wang et al., 2019***	*Investigates the impact of ER on green productivity growth in OECD countries' industrial sectors.*	*Balanced panel data for 24 OECD countries' industrial sectors (2004–2010) from OECD. Dynamic panel regression using an extended Slack Based Model-Directional Distance Function (SBM-DDF) approach to estimate green productivity.*	***ER:*** *EPS using market-based and non-market policies indicators in a composite index****. PRO:*** *Improved Malmquist-Luenberger productivity index to measure GTFP growth. Environmental policy boosts green productivity at moderate stringency (below 3.08). Overly stringent policies have adverse effects due to high compliance costs.* ***Strong PH confirmed.***
9.ENVIRONMENTAL REGULATION, INDUSTRIAL INNOVATION AND GREEN DEVELOPMENT OF CHINESE MANUFACTURING: BASED ON AN EXTENDED CDM MODEL ***Yuan & Xiang, 2018***	*Investigates effects of ER on industrial innovation and green development. The analysis differentiates between patent and value-based innovation outputs. It also considers GTFP as a more comprehensive*	*Panel data from Chinese manufacturing industries covering the years 2003 to 2014. The authors construct and estimate an extended Crépon-Duguet-Mairesse (CDM) model to evaluate the effects of environmental regulation and better understand*	***ER:*** *The operating costs of pollution treatment facilities.* ***IN:*** *R&D investment pc & innovation outputs include the number of invention patents, the difference between total patents and invention patents, 6 sales from new products.* ***PRO****: Labor productivity, energy efficiency, environmental efficiency, GTFP In the long term, ER reduces R&D investment*

	measure of green development, going beyond conventional productivity metrics. Research compares the performance effects of substantive versus strategic innovation.	*the mechanisms behind the PH.*	*and suppresses patent outputs.* ***Weak PH not confirmed.*** *In the short term, regulation enhances labor productivity, energy efficiency, and environmental efficiency, though it does not improve GTFP. In the long term, only energy efficiency continues to improve, while labor productivity declines.* ***Strong PH partially confirmed.***
10. CAN A CARBON TRADING SYSTEM PROMOTE THE TRANSFORMATION OF A LOW-CARBON ECONOMY UNDER THE FRAMEWORK OF THE PORTER HYPOTHESIS? — EMPIRICAL ANALYSIS BASED ON THE PSM-DID METHOD ***Wang et al., 2019***	*Study investigates whether China's carbon trading system supports the shift toward a low-carbon economy. It evaluates system's effectiveness in improving carbon productivity and reducing emissions.*	*Panel data from 30 Chinese provinces covering the period from 2000-2016. The carbon emission data is calculated based on the IPCC methodology and energy statistics from the China Energy Statistical Yearbook. The study applies the Propensity Score Matching–DID (PSM-DID) method.*	***ER:*** *The carbon trading system serves as a proxy. A regional and time dummy identifies where and when the system was implemented.* ***PRO:*** *The main outcome indicator is the Carbon Productivity index, which reflects how much output is generated per unit of carbon emitted. The results show that China's carbon trading system has significantly improved carbon productivity. This suggests that environmental and economic benefits can be achieved simultaneously.* ***Strong PH confirmed.***

Note: ER – Environmental regulation, IN – Innovation; PRO – Productivity; TFP – Total factor productivity, ETFP – Environmental total factor productivity; GTFP – Green total factor productivity; DID - Difference in difference model; DDD - Difference in difference in difference model; ER – Environmental regulation; CER – Command and control regulation, MBR – Market-based regulation, IR – Informal regulation; TI – Technological innovation.

Source: own elaboration

Inconsistencies in empirical results reflect the complex interplay of factors influencing these dynamics (Costantini & Mazzanti, 2012; Zhu et al., 2014). Chen et al. (2018)

highlight the nuanced dimensions of institutional pressure that influence green innovation, suggesting that the intersection of firm characteristics and environmental regulation warrants further exploration. For example, Gray & Shadbegian (2003) concluded that environmental regulation measured by the level of pollution abatement costs have significantly lower productivity levels, while several other studies have found that, under certain conditions, environmental regulation can positively impact productivity (Berman and Bui, 2001; Lanoie et al., 2008). The empirical research of Rubashkina et al. (2015) on manufacturing sectors in 17 European countries supports the weak PH but does not support the strong version of PH. Empirical evidence supporting the narrow version indicates that flexible environmental regulations, like tradable permits and environmental taxes, positively influence firms' innovation activities by allowing greater freedom in technical solutions and reducing compliance costs (Caputo, 2014). Conversely, prescriptive policies tend to stifle innovation by limiting firms' incentives to optimize their responses to environmental goals (Lanoie et al., 2011).

However, according to Zhao et al., (2018) scholars have reached relatively consistent conclusions on the existence of weak version of the PH, that is, environmental regulation is positively related to firms' innovation. In contrast, there is not a consistency on the existence of the strong PH (B. Lin & Chen, 2020). Literature generally finds support for the narrow version of the PH, thus flexible market-oriented environmental regulation policy, such as environmental taxes and tradable permits, positively effects firms' innovation activity (Peng et al., 2021; Ramanathan et al., 2017; Yuan & Zhang, 2020; S. Zhang et al., 2021) as it provides firms with more freedom to find a technical solution and reduce compliance cost. On the other hand, "prescriptive" policies, such as setting environmental standards, give firms little incentive to identify the most efficient way to meet given environmental objectives (Lanoie et al., 2011). According to Bu et al. (2020), a key element influencing the validity of the PH is the diversity in environmental regulatory approaches. As Weiss et al. (2018) conclude empirical tests of the PH that overlook its dynamic nature and fail to capture the quality of regulation design may lead to misleading conclusions about its validity.

The lack of conclusive empirical evidence is also not surprising, given that the studies draw on data from various countries, industries, time periods, using variety of indicators (Qiu et al., 2018; Stavropoulos et al., 2018). Costantini & Mazzanti, (2012) expose four driving factors, that have impact on direction and robustness of empirical results, namely, (i) the economic dimension, (ii) level off sector aggregation (macro level, sector level or firm based), (iii) the choice on how to model the environmental regulatory framework (PACE, real taxation data), (iv) taking time lag into account when performing the research. A study of Zhu et al., (2014) emphasizes the importance of firms' characteristics on the validity of the hypotheses, aspect that is commonly

overlooked in the PH research. They argue that firms are mostly heterogeneous with different technological knowledge and upgrading capabilities, suggesting that research on PH should be more firm level based, taking firm' ability to respond to changes in external environment (changes in environmental regulations and their enforcement) to produce a positive (or negative) influence on innovation and productivity.

As environmental regulation continues to tighten globally, with notable developments in countries like China and the EU, the implications for innovation and productivity will be critical for both economic performance and sustainability efforts. Although the PH initially arose from a limited number of case studies, it has stimulated extensive research into the complex relationships between environmental regulation, innovation, and productivity (Lanoie et al., 2011; Jaffe & Palmer, 1997), particularly in Western European countries and, more recently, with a sharp increase in studies from China.

In contrast, empirical studies focusing on CEE remain limited. Existing evidence consistently shows that eco-innovation and productivity effects induced by environmental regulation are weaker in CEE economies than in Western Europe, largely due to institutional constraints that hinder firms' ability to translate regulatory pressure into competitive advantage (Prokop et al., 2022; Martínez-Zarzoso et al., 2019). For instance, Hojnik et al. (2022), using data from the World Bank Enterprise Survey 2019 showed that environmental regulations do not spur firms' R&D in the case of the Czech Republic or Slovenia. Similarly, Arouri et al. (2012) report that environmental regulation in Romania neither enhances nor harms competitiveness, suggesting that the mechanisms expected by the PH fail to materialize in this context. Radulescu et al. (2018) likewise show that environmental policy stringency has only marginal effects on green total factor productivity in the region, underscoring the limited capacity of CEE institutional settings to generate efficiency gains. Horváthová (2012) used firms' environmental performance as a proxy of environmental stringency for the Czech Republic. Her findings indicated that the effect of environmental performance on financial performance is negative when lagged by one year, but becomes positive with a two-year lag, providing support for the PH in the long run. The contrast with Western Europe is further illustrated by Rubashkina et al. (2015), who demonstrate that stricter environmental regulation significantly stimulates patenting activity in Western European countries, confirming the weak version of the Porter Hypothesis, while innovation responses in CEE remain noticeably weaker due to lower innovation intensity and persistent structural barriers. In addition, Prokop et al. (2022) analyze World Bank Enterprise Survey data for selected "catching-up" CEE countries (the Czech Republic, Slovakia, Poland, Estonia, Latvia, and Lithuania), which are characterized by lower innovation performance and environmental awareness than Western economies. Their findings do not confirm the strong version of the Porter

Hypothesis for these countries, again highlighting the institutional and structural limitations that constrain innovation-driven regulatory benefits across the region.

Overall, these studies indicate that Western European firms operate in more conducive institutional environments for innovation-driven adjustment to regulatory stringency, whereas CEE firms face persistent obstacles that diminish the competitiveness-enhancing potential of environmental regulation.

6 METHODOLOGY

6.1 SURVEY

The study employed an explanatory, cross-sectional online survey design, conducted in two countries, Slovenia and Croatia. For Slovenian data, the population consists of Slovenian firms registered for the payment of environmental levies with the Financial Administration of the Republic of Slovenia (Finančna uprava Republike Slovenije, 2023). In 2023, a total of 2,701 firms were identified, and valid contact details for 2,155 of them were obtained from the Business Register of Slovenia (AJPES). By matching data from both registers, a contact list of firms was compiled.

It should be noted that, in Slovenia, this register does not encompass all entities subject to environmental regulation, as environmental permit holders are maintained in a separate register and are therefore excluded due to the high fragmentation of administrative data sources. However, the methodology relies on the largest available administrative register in each country to ensure data consistency and cross-country comparability while preserving adequate population representativeness.

Data for Croatia were acquired using the same survey framework as in Slovenia, only slightly adapted to Croatian specifications. The population consists of firms registered in the Environmental Pollution Register (in Croatian: Registar onečišćavanja okoliša, ROO[20]). The Environmental Pollution Register is an information system established, managed, and maintained by the Ministry of Environment, Climate and Energy as a comprehensive digital and network-based solution. It consists of a database with an associated application for data entry, verification, review, analysis, and exchange, as well as viewers that provide the public with direct access to the data. For this research, it includes a list of firms that: discharge industrial wastewater, discharge municipal wastewater, transfer industrial wastewater, produce air emissions, produce soil emissions, generate waste, waste recovery/disposal, collect municipal waste, collect waste (excluding municipal waste), recycle yards/mobile recycling yards/retail waste traders. In 2023, a total of 3,317 firms were identified, and valid contact details for 2,685 of them were obtained from the Financial Agency of Croatia (Financijska agencija, 2023).

[20] For more information, see https://roo.azo.hr/rpt.html

6.2 QUESTIONNAIRE

Data was collected through an e-survey using a structured questionnaire between March 19 to June 19, 2024. The questionnaire was based on the OECD's questionnaire on Administrative and Regulatory Burdens (OECD, 2001), later adapted by Kotnik et al. (2020) to align with the specific context of this research. The validity of the questionnaire was ensured by grounding its structure and content in established methodologies and adapting it to the specific objectives of the study. Its validity was pilot tested with 30 firms, and the feedback from this phase was used to refine the instrument prior to full deployment. Besides, by achieving all validity and reliability coefficients (AVE, CR, Cronbach's alpha) for SEM, the validity of the questionnaire was confirmed for the constructs used, ensuring that it accurately measures the intended constructs.

The primary purpose of the survey was to measure the magnitude and structure of compliance costs of environmental regulation across different cost categories, as well as firms' perceptions of these costs and other context-specific variables. In addition, the structure of the survey allows for further analytical extension by linking compliance costs to different categories of environmental policy instruments. As suggested by the classification of survey questions, command-and-control regulatory instruments primarily generate substantive and information (administrative) compliance costs, while market-based instruments are associated with firms' financial compliance costs. Regarding voluntary instruments, the questionnaire could be further extended to capture costs related to capacity building and organizational adaptation.

Since the data relies entirely on survey respondents, there is a risk of methodological limitations, particularly because many firms have not developed internal cost accounting systems that would enable them to accurately calculate the costs related directly to environmental regulation. However, some potential deficiencies can be anticipated and mitigated to prevent them from distorting the results, including the following:

- The respondents may intentionally or unintentionally provide wrong estimates of time and costs related to complying with environmental regulations. Therefore, as noted previously, the total costs of environmental regulation were estimated by including financial compliance costs (e.g., tax payments, state-administered duties), substantive compliance costs (e.g., production and service costs), and information compliance costs (e.g., information transfer to third parties). In the survey, respondents were asked to estimate each specific cost category as well as the total compliance costs of environmental regulation. To minimize potential bias or invalid responses, the sum of each compliance costs category (i.e., financial, substantive, and information compliance costs)

had to align with the estimated total compliance costs range provided in a separate control question later in the survey. Few responses where the estimation deviated by more than one cost band (out of six total bands) were excluded from the analysis. This approach aligns with best practices in survey validation, such as ensuring consistency across related items, as discussed in statistical methodology literature. As according to (Callegaro et al., 2015): "*In business surveys, responses to different items need to be consistent (e.g., number of employees or turnover, when summed across organizational units, should not exceed the total institutional level*)".

- The respondents may exaggerate in critics especially when their business performance is poor; biases may occur since firms perform also administrative procedures for their own needs and not for the purpose of complying with regulation. Further, respondents' evaluations may not fully capture actual conditions and may therefore be underestimated when familiarity with the relevant procedures and their substantive content is limited. Therefore, the pilot versions of the questionnaires were extensively tested on a group of businesses to subsequently reorganize in a way to simplify and improve the comprehensibility of the questions.

6.3 SAMPLE AND DATA COLLECTION

To avoid sample selection bias, several points should be noted. In both countries, a full census approach was used, where all 2,155 firms in Slovenia, and 2,600 in Croatia with valid contact information were invited to participate in the study. Firms were contacted via personalized email with a link to the e-survey. Follow-up reminders were sent to increase the response rate and mitigate non-response bias.

To ensure the representativeness and generalizability of the findings, several points should be noted. Both countries have relatively high internet penetration rates, with Slovenia at 91.9% in 2024 and Croatia at 88.4% in 2024. In Slovenia, the mandatory use of the E-TROD system for electronic environmental tax reporting since 2018 imply that internet usage is widespread among businesses, reducing concerns about potential biases related to internet habits. Similarly, in Croatia, firms in the survey need to fill in reports online into the Environmental Pollution Register. Since the population targeted in this study is based on the official list of firms in Slovenia and Croatia, it might be argued that the use of digital tools, and internet, is a standard within their professional environment. Firms engaged with environmental levies need to have an administrative setup conducive to digital communication. Furthermore, Slovenia was ranked 35th, while Croatia was ranked 38th in the World in the Digital Economy Index 2024.

In Slovenia, out of 352 respondents, 198 firms provided sufficiently complete responses and met the survey's validation criteria i.e. the firm was required to obtain permits due to environmental regulations or to register as a payer of environmental charges in the past year, or it has incurred any costs related to environmental charges or environmental regulations in recent years, while the rest was excluded from the analysis. Thus, the final sample included 198 firms across various industries which represents 9,2% of the population. The sample size is consistent with that of comparable studies (Bannock, 2001; Klun & Blazic, 2005; Kotnik et al., 2020). Although responses were self-selected, the composition of the sample closely aligns with the population in terms of firm size and industry representation (Table 4). This indicates that any potential bias introduced by electronic survey methods did not significantly distort key demographic or structural characteristics of the sample, i.e. non-response bias was not a problem in the survey. Data were further screened for normality, multicollinearity, and other SEM assumptions. To further validate the survey results, costs of environmental levies from respondents were extrapolated to the national level. The estimated cost of these levies was 84,363,123 euros, compared to 111,716,721 euros reported in the 2023 annual report by FURS. The survey data, when extrapolated to the total population, accounted for 75.5% of this amount, which indicates a relatively accurate assessment and further supports the validity of the results obtained.

Table 4: Sample description by industries and size, Slovenia

Industries	Small (1-49)	Medium (50-249)	Large (250-)	**Total (Sample)**	**Total (Population)**
Agriculture, Forestry and Fishing	9	1	0	10 (5.1%)	3.6%
Mining and Quarrying; Manufacturing; Electricity, Gas, Steam and Air Conditioning Supply; Water Supply; Sewerage, Waste Management and Remediation Activities	28	9	10	45 (22.7%)	29.4%
Construction	10	2	1	13 (6.6%)	4.0%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles; Transportation and Storage; Accommodation and Food Service Activities	84	6	4	96 (48.5%)	45.2%
Information and Communication	10	1	1	12 (6.1%)	6.9%
Professional, Scientific and Technical Activities	10	5	3	18 (9.1%)	9.3%
Public Administration and Defense; Compulsory Social Security; Education; Human Health and Social Work Activities	4	0	0	4 (2.0%)	2.0%
Number of firms in research	155	24	19	198	
% of total sample	75.8%	12.1%	9.6%	100.0%	
Number of firms in total population	2,251	587	273	3,111	3,111
% of total population	72.4%	18.9%	8.8%	100.0%	100.0%

Source: own elaboration

Data for Croatia were collected using the same survey design, with only minor adaptations to reflect the specifics of the Croatian market. A full census approach was employed, whereby all 2,600 firms for which contact information was available were invited to participate in the study. The total number of firms listed in the Register of Environmental Pollution (Croatian: Registar onečišćavanja okoliša) amounts to 2,710. Out of 268 respondents, 76 firms provided sufficiently complete responses and met the survey's validation criteria, while the rest was excluded from the analysis. Thus, the response rate in the case of Croatia was lower, 2.9%, which may pose a potential limitation to the reliability of the results. Despite the small sample size, it is in line with

those used in similar studies (Bannock, 2001; Klun & Blazic, 2005; Kotnik et al., 2020). Further, as in the case of Slovenia, the composition of the sample for Croatian firms is closely aligned with the population in terms of firm size and industry representation (Table 5). Similar to the Slovenian data, the survey results were further validated by comparing the reported environmental levies, which were extrapolated to the national level, with official sources. For Croatia, the estimated sum of environmental levies based on the survey data amounts to 83,494,319 euros. This figure can be compared to the official data published by the Croatian Bureau of Statistics, which reports 58.1 million euros for the year 2023[21]. The extrapolated survey data thus represent approximately 143,7% of the official figure, suggesting a potential overestimation, while still indicating that the survey captured a substantial portion of the actual burden. This result supports the overall reliability of the data, while also highlighting several possible sources of discrepancy. Main among these is the limitation posed by the relatively small sample size used in the survey, which may affect the accuracy of extrapolated estimates. Additional factors include the potential inclusion of related payments by firms and the exclusion of certain levy components from official statistics.

[21] https://web.dzs.hr/PxWeb/pxweb/hr/Okolis/

Table 5: Sample description by industries and size, Croatia

Industries	Small (1-49)	Medium (50-249)	Large (250-)	**Total (sample)**	**Total (population)**
Agriculture, Forestry and Fishing		1		1	
Mining and Quarrying; Manufacturing; Electricity, Gas, Steam and Air Conditioning Supply; Water Supply; Sewerage, Waste Management and Remediation Activities	26	11	6	43	
Construction	1	3	1	5	
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles; Transportation and Storage; Accommodation and Food Service Activities	13	2	1	16	
Information and Communication Professional, Scientific and Technical Activities	4		1	5	
Public Administration and Defense; Compulsory Social Security; Education; Human Health and Social Work Activities	2	1	3	6	
Number of firms in research	46	18	12	76	
% of total sample	60,5%	23,7%	15,8%	100,0%	100,0%
Number of firms in total population	1,901	1,034	382	3,317	3,317
% of total population	57,3%	31,2%	11,5%	100,0%	100,0%

Source: own elaboration

6.4 METHODS

The research employs descriptive statistics, Mann–Whitney U test, and a structural equation modelling (SEM) approach, suitable for testing complex relationships between observed and latent variables (Kline, 2023). The data were analyzed using the statistical software IBM SPSS 29.0.0.0 Statistics Data Editor and AMOS 29.0.0. Descriptive statistics were examined through frequency distributions and percentage shares to provide more general information of results as well as answers to some research questions. To obtain population-level estimates of compliance costs of environmental regulation, a size-stratified extrapolation by firm size was applied. The

analysis of the results from the measurement scales includes means, standard deviations, skewness, and kurtosis to describe the basic characteristics of the response distribution.

The SEM procedure includes parameter estimation, testing their statistical significance, and evaluating the model's fit to empirical data as one of the key steps in the overall analytical process (Bentler & Yuan, 1999). The primary objective of SEM is to test theoretical assumptions by assessing whether the structure of relationships among variables corresponds to empirical observations. In this study, SEM is deemed appropriate due to the complexity of the model, which includes multiple dependent and independent variables, as well as mediating and moderating relationships. Multi-item scales were used to operationalize the main constructs. A five-point Likert scale, ranging from 1 'strongly disagree' to 5 'strongly agree', and five value bands were used to measure the items. For the Compliance Costs of Environmental Regulation (CER), respondents were asked to provide exact amounts of costs, which were later categorized into five value bands. Treating both Likert scales and value bands as ordinal indicators allows the SEM model to effectively capture the relationships between latent constructs while maintaining statistical validity. This ensures the model accurately reflects the underlying theoretical framework (Kline, 2023).

Following the evaluation of the theoretical model, final empirical models were estimated independently for Slovenia and Croatia, and an additional combined model was constructed to assess the aggregate effect of compliance costs of environmental regulation on productivity. The final Slovenian model includes five independent variables influencing two dependent variables, along with a statistically significant relationship between the dependent variables (see Table 10). Other independent variables, e.g. financial measures, digitalization level, etc. did not exhibit a significant effect and were therefore excluded from the model. The Croatian model was based on a smaller dataset, which constrained the ability to construct a more complex model. As a result, more latent constructs from the initial theoretical framework, namely economic sector, environmental obligations, non-financial measures, financial measures, digitalization level and international involvement, were excluded from the final structural equation model due to their limited empirical contribution. These variables showed no statistically significant effects on the endogenous constructs and did not enhance the explained variance (R^2) of the dependent variables. Furthermore, their inclusion reduced the model's parsimony and worsened the fit indices. It is likely that the exclusion of these variables is at least partially attributable to the limited sample size, which may have weakened the statistical power necessary to detect more nuanced effects. Future research with a larger sample may enable a more comprehensive model specification in which these constructs could be reintegrated and empirically validated.

The CER (Compliance Costs of Environmental Regulation)[22] variable was measured using the SCM Network (2006) framework, which categorizes costs into financial costs (e.g., levy payments, state-administered duties), substantive compliance costs (e.g., production and service processes costs), and information costs (e.g., information transfer to third parties). Respondents evaluated total environmental regulation costs and specific costs within each category. Perception of these costs (CER_P – Compliance Costs of Environmental Regulation Perception) was measured via a five-point Likert scale following Lin & Sheu's research (Lin & Sheu, 2012) on institutional isomorphism, which examined perceived coercive, normative, and mimetic pressure of firms. Quality of institutions (QI) was measured using the OECD's (2001) framework, which highlights six broad dimensions: ease of access to contact institutions, clarity of procedures, accessibility of officials, consistency of provided opinions, definitiveness of responses, and reasonable response times. Measures of regulatory complexity (RC) were based on (Mora-Sanguinetti & Pérez-Valls, 2021), who found that regulatory complexity, measured by the volume of new norms adopted per year, negatively affects business, with regulation hindering large competitors operating across regional markets, but having little impact on smaller, locally focused businesses. Firm size (FS) was determined by the number of employees and total revenue from previous years, using five value bands. Firm size as a latent variable represented by two standardized indicators: number of employees and annual company revenue. Both indicators are widely recognized measures for classifying firms by size (e.g., Eurostat, OECD).

Measurements of environmental obligation (EO) were based on Slovenian regulatory requirements for firms, such as environmental permits, record sheets, environmental tax calculations. Adapted from Lin & Sheu (2012), six items were used to measure non-financial initiatives through questions about the importance of non-financial initiatives aimed at raising firms' ecological awareness or helping them comply with environmental regulations.

Finally, the ultimate dependent variable is productivity (PROD_ACT), which is defined as a company's turnover per employee divided by the average turnover per employee in a given business activity of the firm (Slabe-Erker & Klun, 2012). Data on turnover and employees was acquired throughout survey.

[22] Sometimes referred simply as compliance costs.

7 EMPIRICAL RESULTS

Among the main aims of this research was to analyze the costs firms incur when complying with environmental regulation. The first part of the study examines data from Slovenia and Croatia, including estimates of the compliance costs borne by small, medium-sized, and large firms. The second part presents the SEM models developed to identify the factors influencing compliance costs of environmental regulation and their perception, as well as to assess the impact of these costs on firm productivity.

7.1 DESCRIPTIVE STATISTICS

The estimations are based on a final sample of 198 firms for Slovenia and 76 firms for Croatia, categorized by size classes (number of employees in the previous year[23]), which follow the structural business statistics classification used by Eurostat.

[23] 0-9 employees – micro firms; 10-49 employees – small firms; 50-249 employees – medium-sized firms; more than 250 employees – large firms

Table 6: Compliance costs of environmental regulation by types and levels (Firm level, Sample level, Total Population), Slovenia & Croatia

	Financial Compliance Costs	Substantive Compliance Costs	Information Compliance Costs	Compliance Costs (TOTAL)
			SLOVENIA	
Average annual costs per firm (TOTAL)	27,118 €	51,573 €	19,856 €	**98,546 €**
Extrapolation to the population	84,363,123 €	160,443,707 €	61,770,635 €	**306,577,467 €**
Share of specific compliance costs in total compliance costs	27.5%	52.3%	20.1%	**100.0%**
			CROATIA	
Average annual costs per firm (TOTAL)	25,172 €	18,554 €	6,508 €	**50,233 €**
Extrapolation to the population	83,494,319 €	61,543,605 €	21,586,515 €	**166,624,439 €**
Share of specific compliance costs in total compliance costs	50.1%	36.9%	13.0%	**100.0%**

Source: own elaboration

To estimate the population-level compliance costs for Slovenia and Croatia, a post-stratified extrapolation[24] by firm size was applied. This means that annual compliance costs averages were first calculated separately for each firm-size group and then multiplied by the actual number of firms in each size group in the population. The population totals were obtained by summing the three size-specific totals. This method is statistically appropriate because compliance costs differ substantially by the size of the firm, and it avoids the bias that arises when sample averages are projected directly onto the population without accounting for differences in size structure.

Population averages per firm were calculated by dividing the total cost estimates by the total number of firms in the population. Approximate 95-percent confidence intervals for each category of costs were derived using the standard stratified-sampling

[24] Post-stratified estimation ensures that the calculated totals reflect the true distribution of firm sizes in the population. Given that compliance costs increase strongly with firm size, this method provides a more accurate and defensible estimate than simple mean-based extrapolation.

variance with finite population correction. As is typical for compliance costs data, the intervals are wide because the distributions are heavily right-skewed and the number of medium-sized and large firms in the samples is relatively small.

For Slovenia, the population consisted of 2,251 small firms, 587 medium-sized firms, and 273 large firms, a total of 3,111 firms (see Table 4 for more details). For Croatia, the corresponding counts were 1,901 small firms, 1,034 medium-sized firms, and 382 large firms, a total of 3,317 firms (see Table 5 for more details). For each country, the analysis used size-specific average annual costs for three categories of compliance costs: financial, substantive, and information compliance costs.

The post-stratified totals for Slovenia are approximately 84.36 million euros for financial costs, 160.44 million euros for substantive costs, and 61.77 million euros for information compliance costs. Combined, the total annual compliance-cost burden is estimated at approximately 306.58 million euros. The corresponding post-stratified averages per firm are approximately 27,118 euros for financial costs, 51,573 euros for substantive costs, and 19,856 euros for information costs, with a total per-firm average of approximately 98,546 euros. The approximate 95-percent confidence intervals for the totals are wide (for example, roughly 40.5 to 128.2 million euros for financial costs, and 8.6 to 312.3 million euros for substantive costs), reflecting the variability of the data and the small number of medium-sized and large firms in the sample.

Using the same method, the estimated totals for Croatia are approximately 83.49 million euros for financial costs, 61.54 million for substantive costs, and 21.59 million euros for information costs. Combined, the total is approximately 166.62 million euros per year. The corresponding post-stratified averages per firm are approximately 25,172 euros for financial costs, 18,554 euros for substantive costs, and 6,508 euros for information costs, resulting in an overall per-firm average of approximately 50,233 euros. Approximate 95-percent confidence intervals again show substantial width (for example, roughly 22.8 to 144.2 million euros for financial costs and 18.9 to 104.2 million euros for substantive costs), consistent with the heavy-tailed distributions typical of cost data.

Overall compliance costs are higher in Slovenia than in Croatia, both in total and on a per-firm basis. Slovenia’s total burden is almost twice that of Croatia. At the firm level, Slovenia’s post-stratified average, which is about 98,546 euros per firm, is also substantially higher than Croatia’s (about 50,233 euros per firm). In structural terms, substantial compliance costs represent the highest share in Slovenia, reflecting a stronger emphasis on production-process adjustments and substantive obligations. In Croatia, financial costs constitute the largest share of the total, while substantive and information are comparatively lower. Although differences in total and per-firm costs

are clear, the wide confidence intervals indicate that results should be interpreted with due caution. However, as noted earlier, the Slovenian estimates for environmental levies amount to 75.5% of the actual levies collected by the Financial Administration of the Republic of Slovenia (FURS) in 2023, supporting the credibility of the survey data. In contrast, the Croatian financial cost estimates correspond to roughly 143,7% of the official figure, suggesting a potential overestimation, yet still indicating that the survey captured a substantial share of the actual burden.

In Slovenia, substantive compliance costs make up the largest share of the national total (52.3%), followed by financial costs (27.5%) and information costs (20.1%). This pattern indicates that Slovenian firms devote the greatest portion of resources to process and product adjustments and other technology-oriented measures. Substantive expenditures are concentrated among medium and large firms (together the vast majority of the substantive total), while information costs are driven mainly by medium firms; financial costs are split across sizes but are highest for large firms. In Croatia, the structure is more heavily weighted toward financial costs (50.1% of the total), with substantive (36.9%) and information (13.0%) playing a smaller relative role. Within Croatia, financial costs are largest among small firms, substantive costs are led by medium firms, while information costs are comparatively modest across all sizes.

To sum up, the comparison reveals that Slovenian firms experience a more financially intensive form of environmental regulation, both in terms of average compliance costs and the nature of obligations. Croatian firms, although widely affected by environmental requirements, face lower per-firm compliance costs and a cost structure more heavily dominated by levies. These differences likely reflect variation in enforcement practices, regulatory design, and industrial composition between the two countries.

7.1.1 Firms' perceptions of the magnitude of costs

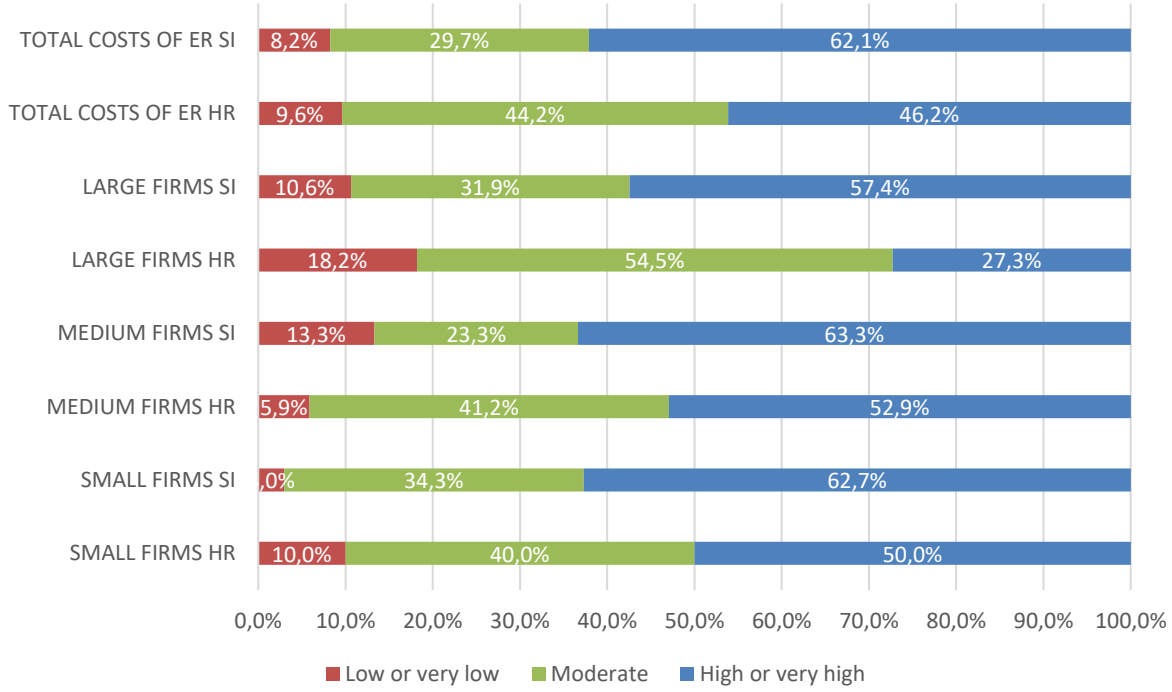
Slovenian firms generally perceive compliance costs of environmental regulation as a substantial burden. Only 8.2% consider total costs to be low or very low, while 29.7% view them as moderate. The majority, 62.1%, rate the overall burden as high or very high, indicating that environmental obligations are widely regarded as demanding. Environmental levies are perceived as the most burdensome category, with 51.6% of firms rating them high or very high. In contrast, adjustment or substantive compliance costs are more often seen as low or very low (33.3%). This contrast likely reflects differences across firm sizes: small and medium-sized firms predominantly face recurring levies, while substantive compliance costs are more typical for larger firms. Smaller firms therefore tend to perceive adjustment costs as relatively minor.

Substantive compliance costs, on the other hand, tend to be concentrated among larger firms that face stricter environmental requirements due to their scale.

Croatian firms also report significant environmental cost burdens, though perceptions are distributed more evenly. Only small share rates cost as low or very low (16.9% for financial compliance, 14.0% for substantive compliance, and 13.0% for information compliance). Just 9.6% perceive the total burden as low. Most firms classify costs as moderate, including 46.2% for financial compliance, 45.6% for substantive compliance, and 50.0% for information compliance. Still, a considerable portion perceives costs as high or very high: 36.9% for financial compliance, 40.4% for substantive compliance, 37.0% for information compliance, and 46.2% for total environmental costs. Comparing actual and perceived costs in Croatia shows that perceptions broadly reflect the cost structure. Financial compliance costs, the largest category at 46.6% of total costs (24,372 euros on average), are seen as high or very high by 36.9% of firms. Substantive compliance costs, which account for 30.4% of the burden (15,888 euros on average), are perceived similarly, with 40.4% viewing them as high or very high. Even information compliance costs, which are lower in absolute value at 5,294 euros per firm but administratively demanding, are perceived as high or very high by 37.0% of firms. This suggests that administrative complexity, not just monetary cost, shapes firms' perceptions of environmental compliance burdens.

In comparison, Slovenian firms perceive compliance costs of environmental regulation as more burdensome overall than Croatian firms. While most Slovenian firms rate the total and financial costs as high or very high, Croatian firms more frequently place these costs in the moderate range, although significant shares still report high burdens. Overall, perceptions in Slovenia are more concentrated toward the higher end of the scale, whereas Croatian firms express a more balanced but still notable sense of cost pressure. Detailed figures across the various firm-size categories are presented in Figure 16.

Figure 16: Firms' perception of specific compliance costs of environmental regulation by firm-size categories (in %), Slovenia & Croatia



Source: own elaboration

7.1.2 Share of compliance costs of environmental regulation in total regulatory costs

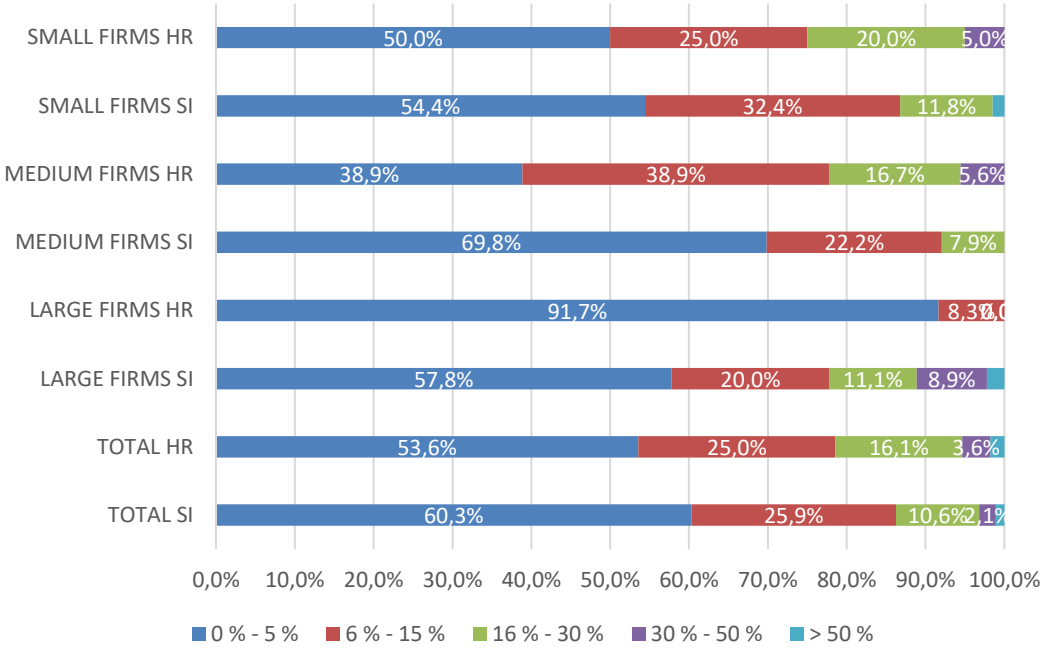
Slovenian firms generally perceive the share of compliance costs of environmental regulation within their total regulatory burden as relatively low. Majority (60.3%) estimate that environmental obligations account for only 0–5% of their total regulatory costs, a perception especially strong among medium-sized firms (69.8%) and small firms (54.4%). Larger firms, however, show a more dispersed pattern. While many also fall into the lowest cost range, 20.0% of large firms estimate that environmental compliance accounts for 6–15% of their regulatory burden, and 8.9% even report proportions between 30% and 50%. This indicates that although environmental compliance is typically a small component of overall regulatory costs, its relative importance increases with firm size, likely reflecting the greater complexity and scope of environmental requirements imposed on larger firms. Consequently, firm size tends to be an important factor when interpreting compliance costs results.

In Croatia, the perception of compliance costs of environmental regulation also suggests that these obligations form a relatively modest part of the broader regulatory burden. A slightly smaller majority than in Slovenia (53.6% of firms) report that

compliance costs of environmental regulation account for 0–5% of their total regulatory costs. Large Croatian firms appear to manage these costs particularly efficiently, with 91.7% falling within this lowest category. Medium-sized firms show a more even distribution, with equal shares (38.9%) reporting 0–5% and 6–15%. Small firms display the greatest variation, as half report 0–5%, but significant shares report higher cost proportions of 6–15% (25%) and 16–30% (20%). This variation suggests differences in capacity and resources to manage environmental obligations, with smaller firms experiencing more heterogeneity in cost pressures.

Overall, both Slovenian and Croatian firms tend to perceive compliance costs of environmental regulation as a relatively small share of their total regulatory burden, though the share is perceived as slightly lower in Croatia. In both countries, large firms report the lowest proportional cost burden, while smaller firms show more variability. However, Slovenia exhibits a somewhat greater share of firms, particularly among large firms, that report higher proportional compliance costs of environmental regulation, indicating that the relative weight of environmental obligations tends to be more substantial for larger firms in Slovenia than in Croatia. Detailed figures on the proportion of costs for complying with environmental regulations in relation to total regulatory costs across the various firm-size categories are presented in Figure 17.

Figure 17: The proportion of compliance costs of environmental regulation as a share of total regulatory costs by firm-size categories (in %), Slovenia & Croatia



Source: own elaboration

7.1.3 Average hours per month employees

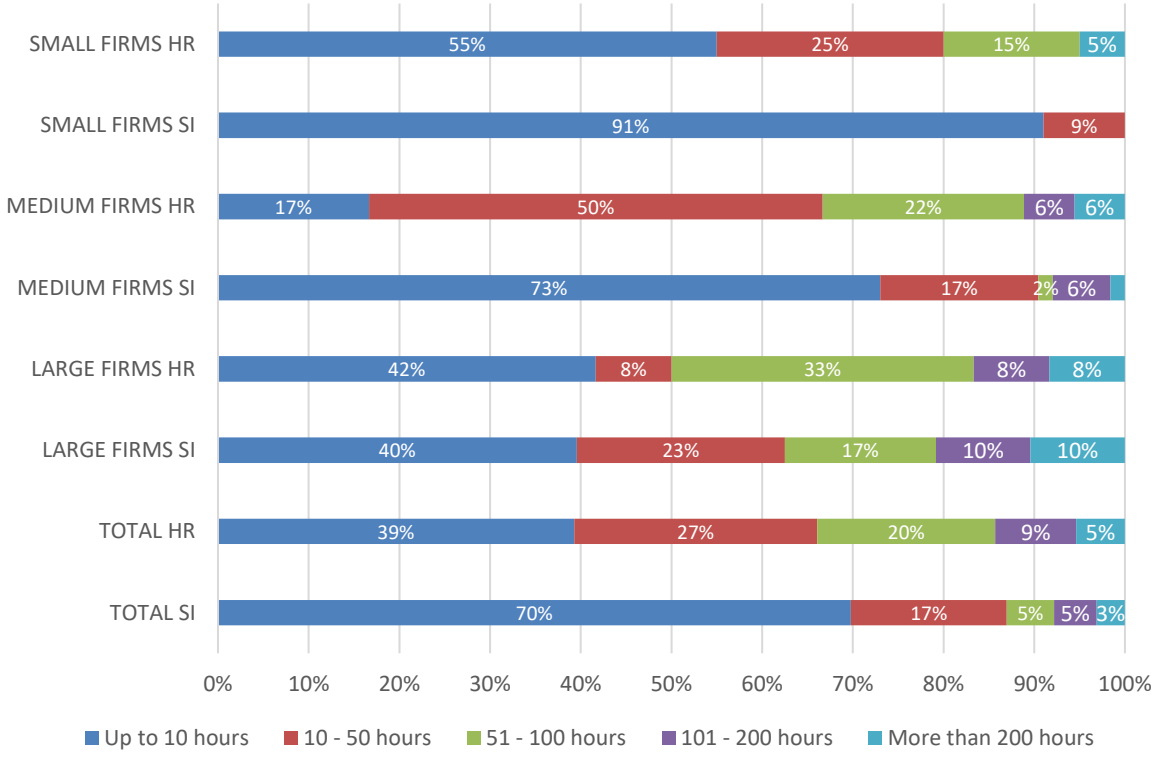
In Slovenia, most firms report spending relatively little time on activities related to compliance with environmental regulation. Overall, 69.8% of firms state that employees spend fewer than 10 hours per month on reporting obligations. This trend is particularly pronounced among small firms, where 91% fall into this lowest time-use category. Large firms display a more varied pattern: while nearly 40% also report spending up to 10 hours per month, a substantial share (22.9%) spends between 10 and 50 hours. This distribution reflects earlier findings showing that smaller firms tend to face simpler and more standardized reporting requirements, whereas larger enterprises are subject to more complex environmental obligations and allocate more internal resources to compliance tasks.

The Croatian data show a more dispersed distribution of time spent on complying with environmental regulation. Only 39.3% of Croatian firms report spending up to 10 hours per month on compliance activities, a considerably smaller share than in Slovenia. As in Slovenia, small firms are the most likely to fall within this lowest time range (55.0%). Medium-sized firms tend to spend more time on compliance, with half of them reporting 10–50 hours per month, which is significantly higher than the 26.8% average across Croatian firms in total. Large firms in Croatia are the most time-intensive: 33.3% report

devoting 51–100 hours per month to compliance tasks, compared to 19.6% of all firms. A smaller, but notable, proportion of firms spend 101–200 hours (8.9%) or even more than 200 hours (5.4%) per month on environmental reporting, with large firms slightly more represented in these upper ranges. These results suggest that Croatian firms, particularly medium and large ones, experience a broader and more demanding time burden associated with environmental reporting.

Overall, Slovenian firms spend considerably less time on environmental compliance than Croatian firms, with a much larger share reporting fewer than 10 hours per month. In both countries, small firms consistently report the lowest time requirements, reflecting simpler administrative duties. However, medium and especially large firms in Croatia devote substantially more hours to compliance than their Slovenian counterparts, suggesting more demanding or more fragmented administrative burden. This aligns with earlier observations that Croatian firms perceive information-related compliance as more demanding than its monetary value would suggest, while Slovenian firms tend to face a more standardized and predictable reporting framework. More detailed information on hours spent is provided in Figure 18.

Figure 18: Average hours per month employees spend on average to meet environmental regulation requirements by firm-size categories, Slovenia & Croatia



Source: own elaboration

7.1.4 The relevance of the collection of information for the needs of legislation

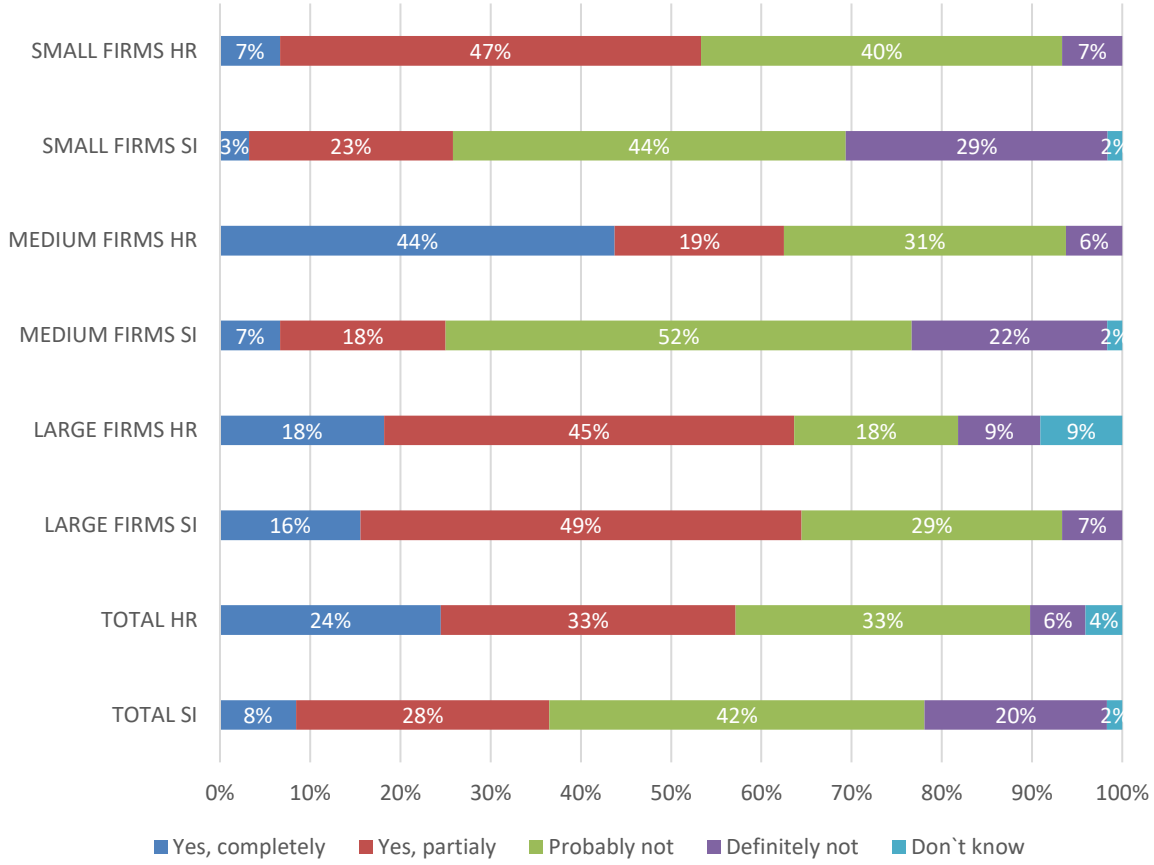
In Slovenia, the relevance of collecting information for legislative needs is perceived as relatively low in the absence of formal legal requirements. As shown in Figure 21, only 8.4% of firms report that they would fully collect the required environmental information even without legal obligation. Large firms demonstrate a somewhat greater willingness, with 15.6% indicating they would continue information collection voluntarily. In contrast, a clear majority of medium-sized firms (51.7%) and a substantial share of small firms (43.5%) state that they would probably not collect such information without legislative mandates. These findings suggest that compliance-driven reporting obligations are particularly important for small and medium-sized enterprises, which perceive such information collection as a regulatory requirement rather than an activity that brings direct managerial or operational value.

In Croatia, firms exhibit a higher preference to collect environmental information voluntarily. A notably larger share (24.5%) of firms indicate that they would fully collect

the required information even without legal obligations, with medium-sized firms showing the strongest commitment (43.8%). Smaller shares of large (18.2%) and especially small firms (6.7%) would do so independently. Partial voluntary collection is also more common in Croatia, with 32.7% of firms reporting that they would gather at least some of the information, particularly large firms (45.5%) and small firms (46.7%). Still, a considerable share of Croatian firms (32.7%) would probably not collect this information without legislation, with small firms (40.0%) and medium firms (31.3%) being most represented. Only a small fraction (6.1%) would not collect it, and a similarly small share (4.1%) remains uncertain. These results (see Figure 19) indicate that Croatian firms, especially medium-sized ones, display a greater degree of proactive information management, while small firms appear more dependent on legislative requirements to engage in systematic data collection.

Overall, Croatian firms show a stronger inclination than Slovenian firms to collect environmental information voluntarily, even without legal obligations. While only a small share of Slovenian firms would continue such data collection independently, a much larger share of Croatian firms, especially medium-sized ones, demonstrate a proactive approach. In both countries, small firms are the least willing to collect information in the absence of regulatory pressure, underscoring their reliance on legislative requirements to justify administrative effort. This pattern complements earlier findings showing that Croatian firms perceive informational obligations as relatively burdensome yet remain more motivated to carry them out autonomously, whereas Slovenian firms tend to comply primarily due to formal legal mandates.

Figure 19: Administrative burden - willingness to collect required information in the absence of legal obligation, by firm size, Slovenia & Croatia



Source: own elaboration

7.2 FACTORS AFFECTING COMPLIANCE COSTS AND THEIR PERCEPTION

To identify the factors influencing both the actual and perceived size of compliance costs of environmental regulation, and to assess their impact, several SEM models were developed. The SEM section aims to address research question 4 (RQ4): *What is the effect of various internal and external factors on the compliance costs of environmental regulation and perception of these costs?* as well as hypotheses *H2a, H2b, H3a, and H3b*.

Based on the literature review, a set of potential internal (firm size, economic sector, financial measures, non-financial measures, digitalization level and international involvement) and external (regulatory complexity, quality of institutions, and environmental obligations) factors were identified (see Section 3.2.3). Later in Section 8.6, the SEM model is also used to address research question 5 (RQ5): *What is the*

impact of estimated compliance costs of environmental regulation on the total productivity of firms? and test H4.

The measurement model focuses on examining the relationships between manifest variables and latent constructs, assessing whether the selected indicators reliably and validly capture the intended theoretical dimensions. This phase is presented through several stages of measurement model development, to ensure a comprehensive evaluation of construct reliability and validity, and to provide an empirically grounded representation of the data. For each conceptual domain, this part is elaborated in detail and culminates in a refined measurement model that adequately represents the constructs and their subdimensions, while maintaining parsimony.

The structural model then evaluates the causal relationships among latent constructs that were identified and validated in the measurement phase. These relationships are interpreted based on theoretical relevance and statistical robustness. As noted, the research employs a structural equation modelling (SEM) approach which is particularly suitable for testing complex relationships between observed and latent variables (Kline, 2023).

7.2.1 Measurement instruments (SEM) Slovenia

After testing the hypothesized model, which included various theory-based variables, a final model that includes four independent variables impacting two dependent variables, as well as the interrelation between the two dependent variables. Five of the variables initially included in the hypothesized model, namely economic sector, financial measures, international involvement, institutional quality and digitalization level, were excluded from the final empirical model as no impact was found on any of the dependent variables, namely costs of environmental regulation or costs of environmental perception.

All latent variables in the model were composed of two or three manifest variables. Although some latent variables could be formed from more manifest variables, literature recommendations (e.g. Hair, 2009; Kline, 2023) were followed regarding the number of manifest variables relative to the sample size. This ensured a ratio of 10 cases per parameter, which is generally considered acceptable for model estimation. Table 7 represents the descriptive statistics for all manifest variables used in the SEM model, including the number of observations (N), means, standard deviations, skewness, and kurtosis. The results indicate generally moderate levels of variation in responses across items, with standard deviations ranging from 1.01 to 2.32. The mean values suggest that most items were rated around the midpoint of the Likert scale (2 to 4), which reflects a relatively balanced distribution of perceptions across firms.

Skewness values vary from –1.00 to 0.77, indicating slight deviations from symmetry for some variables. Negative skewness is particularly evident for perception-related items (e.g., CER_P4, skewness = –1.00), suggesting a tendency among respondents to report higher perceived environmental costs. Positive skewness is more prevalent in regulatory complexity items (e.g., RC1–RC3), which may indicate lower perceived levels of complexity among a subset of firms. Kurtosis values range from –1.88 to 0.92, with several items (notably RC1–RC3 and NFM3) exhibiting negative kurtosis, indicating flatter distributions. These results suggest some variability in how firms interpret and report regulatory challenges and compliance costs. Overall, the distributional characteristics of the manifest variables remain within acceptable bounds for structural equation modelling, and no severe violations of normality are observed (Kline, 2023).

Table 7: Mean, Std. Deviation, Skewness and Kurtosis, Slovenia

Measures Items	N	Mean	Std. Deviation	Skewness	Kurtosis
RC1	198	2.21	0.13	0.13	-1.83
RC2	198	2.19	0.17	0.17	-1.80
RC3	198	2.32	0.08	0.08	-1.88
FS1	198	2.28	0.32	0.32	-0.84
FS2	198	2.56	-0.06	-0.06	-0.79
EO1	198	3.49	-0.09	-0.09	-0.09
EO3	198	2.17	0.38	0.38	-0.17
NFM1	191	2.48	0.77	0.77	-1.04
NFM2	192	2.65	0.57	0.57	-1.16
NFM3	192	2.76	0.43	0.43	-1.35
CER1	198	2.31	0.25	0.25	-0.01
CER3	198	1.90	0.00	0.00	-0.77
CER4	179	3.18	0.21	0.21	-0.78
CER_P1	198	3.35	-0.81	-0.81	0.41
CER_P3	198	3.51	-0.39	-0.39	-0.03
CER_P4	198	3.64	-1.00	-1.00	0.92

Source: own elaboration

Table 8 presents the bivariate Pearson correlation coefficients among the latent variables included in the structural model. The results indicate several expected and theoretically consistent relationships. Notably, the indicators of non-financial motivation (NFM1–NFM3) are highly correlated, with the strongest relationship observed between NFM2 and NFM3 (r = 0.88), supporting the internal consistency of the latent construct. Indicators of firm size (FS1 and FS2) also show strong correlation (r = 0.86), while they are moderately associated with indicators of compliance cost

(e.g., CER4: r = 0.46 with FS2), suggesting that firm size may influence the magnitude of reported environmental costs. Regulatory complexity indicators (RC1–RC3) are highly interrelated (r = 0.96), as expected for a well-defined latent dimension. These indicators are also moderately correlated with perceived compliance costs (e.g., RC2 with CER_P4: r = 0.59), indicating that firms perceiving regulation as more complex also tend to perceive compliance costs as higher. Furthermore, perceived and reported cost items (CER1, CER3, CER4 and CER_P1–P4) are moderately correlated with each other, reflecting internal consistency and conceptual alignment between objective and subjective cost dimensions. Overall, the correlation matrix supports the distinctiveness yet relatedness of the latent constructs, with no evidence of problematic multicollinearity among the indicators.

Table 8: Correlation bivariate Pearson coefficient of latent variables used in the model, Slovenia

Pearson Corr.	NFM2	CER1	FS2	CER4	NFM3	NFM1	CER3	FS1	EO3	EO1	RC1	RC2	RC3	CER_P3	CER_P4	CER_P1
NFM2	1.00															
CER1	-0.04	1.00														
FS2	0.00	0.25	1.00													
CER4	-0.08	0.41	0.46	1.00												
NFM3	0.88	-0.04	0.00	-0.08	1.00											
NFM1	0.84	-0.04	0.00	-0.08	0.82	1.0										
CER3	-0.06	0.28	0.31	0.51	-0.06	-0.05	1.00									
FS1	0.00	0.25	0.86	0.46	0.00	0.00	0.32	1.00								
EO3	0.00	0.14	0.00	0.25	0.00	0.00	0.17	0.00	1.00							
EO1	0.00	0.16	0.00	0.29	0.00	0.00	0.20	0.00	0.31	1.00						
RC1	0.00	0.20	0.00	0.37	0.00	0.00	0.25	0.00	0.00	0.00	1.00					
RC2	0.00	0.20	0.00	0.38	0.00	0.00	0.26	0.00	0.00	0.00	0.96	1.00				
RC3	0.00	0.20	0.00	0.38	0.00	0.00	0.26	0.00	0.00	0.00	0.96	0.96	1.00			
CER_P3	-0.02	0.15	0.00	0.28	-0.02	-0.02	0.19	0.00	0.07	0.08	0.46	0.47	0.47	1.00		
CER_P4	-0.03	0.19	0.00	0.36	-0.03	-0.03	0.24	0.00	0.09	0.10	0.59	0.59	0.59	0.6	1.0	
CER_P1	-0.02	0.14	0.00	0.26	-0.02	-0.02	0.18	0.00	0.07	0.08	0.43	0.44	0.43	0.6	0.6	1.0

Source: own elaboration

The measurement model was assessed using standard reliability and validity criteria (Table 9), including factor loadings, Average Variance Extracted (AVE), Cronbach's alpha, and Composite Reliability (CR) (Hair, 2009; Fornell & Larcker, 1981; Kline, 2023). All factor loadings exceeded the recommended threshold of 0.5, confirming

sufficient item reliability. Although several latent constructs could have included more indicators, the number of manifest variables was limited to ensure the recommended sample-to-parameter ratio of 10:1 (Kline, 2023). Maximum Likelihood extraction was applied for constructs with three indicators, while Principal Axis Factoring was used for two-item constructs (Costello & Osborne, 2005).

Despite lower AVE values for environmental obligations (EO = 0.321), firm size (FS = 0.479), and costs of environmental regulation (CER = 0.381), their CR values exceeded the 0.6 threshold, justifying inclusion based on theoretical relevance (Hair, 2009). Specifically, factor loadings ranged from 0.582 (EO items) to 0.924 (FS items), supporting the internal structure of each construct.

Cronbach's alpha values were generally satisfactory, exceeding 0.8 for most constructs. EO displayed lower reliability (α = 0.457) which is below the conventional threshold but still acceptable in exploratory or theory-driven research contexts and therefore remained in the model due to its conceptual significance. CER_P (CR = 0.881, AVE = 0.593) and NFM (CR = 0.837, AVE = 0.624) demonstrated strong convergent validity and internal consistency. Regulatory complexity (RC) yielded exceptionally high CR (0.918) and alpha (0.986), which may indicate item redundancy; however, given its theoretical importance and careful item construction, its inclusion is justified (Peterson, 1994).

Overall, the measurement model exhibits adequate psychometric properties, with reliability and validity indices that meet or exceed recommended guidelines, ensuring a valid basis for the subsequent structural model evaluation.

Table 9: Measurement items, factor loadings, AVEs, Cronbach's alphas, and composite reliability (CR), Slovenia

Measures Items	Factor loadings	AVE	Cronbach's alpha	CR
Firm size (FS)*		0.479	0.922	0.691
FS1: The number of employed	0.924			
FS2: The size of the revenue	0.924			
Non-Financial Measures (NFM)		0.624	0.932	0.837
NFM1: Certification of the source of energy and buildings (energy certificate)	0.907			
NFM2: Awareness, information, promotion and training programs, demonstration projects	0.925			
NFM4: Support for operators (non-refundable grants or free professional assistance) in implementing environmental standards and more demanding environmental legislation (e.g. IED, SEVESO, VOC).	0.887			
Environmental obligations (EO)		0.321	0.457	0.687
EO1: The number of tax returns per year	0.582			
EO2: The number of environmental permits/year	0.582			
EO3: The number of environmental record sheets/year	0.582			
Regulatory complexity (RC)		0.645	0.986	0.918
RC1: The complexity of existing regulation	0.974			
RC2: The extent of requirements in existing forms	0.983			
RC3: The introduction of new regulation	0.980			
Costs of Environmental Regulation (CER)		0.381	0.664	0.783
CER1: Costs of environmental taxes and environmental permits				
CER3: Information costs	0.718			
CER4: Total costs of environmental regulation	0.718			
Perception of Costs of Environmental Regulation (CER_P)		0.593	0.807	0.881
CER_P1: Perception of costs of environmental taxes and environmental permits	0.670			
CER_P3: Perception of information costs	0.752			
CER_P4: Perception of total costs of environmental regulation	0.874			

Source: own elaboration

7.2.2 Results for Slovenia

The SEM analysis was conducted using AMOS software, with Maximum Likelihood Estimation (MLE) as the estimation method. SEM allows for the simultaneous

examination of multiple relationships between variables, making it ideal for testing the complex hypotheses outlined in this study (Byrne, 2013). It enables simultaneous assessment of relationships among multiple latent and observed variables, tests the structure of these interrelationships, and accounts for measurement error in the evaluation process (Hair, 2009). Therefore, the SEM model was applied to examine all the hypothesized relationships across the selected dependent and independent latent variables.

Model fit was evaluated using multiple indices, all of which indicate a satisfactory alignment between the hypothesized model and the observed data (Hu & Bentler, 1999; Kline, 2023). The chi-square statistic ($\chi^2 = 173.773$, df = 91) yields a χ^2/df ratio of 1.910, well below the recommended threshold of 3.00, suggesting a good model fit (Kline, 2023). The RMSEA value of 0.068 falls within the acceptable range below 0.08, indicating a reasonable approximation of model error. Furthermore, the TLI (0.949) and CFI (0.966) both exceed the recommended cut-off of 0.95, confirming the model's strong incremental and comparative fit (Hu & Bentler, 1999; Schumacker & Lomax, 2004). Together, these indices confirm that the structural model adequately represents the empirical relationships between constructs under investigation.

Table 10: The resulting costs and perception of costs of environmental regulation model with estimated relationships, Slovenia

			Path coefficient	Standardized path coefficient	C.R.	P
CER	←	EO	0.561	0.319	3.998	0,000
CER	←	NFM	-0.118	0.043	-2.013	0.044
CER	←	FS	0.575	0.067	8.919	0,000
CER	←	RC	0.440	0.035	7.527	0,000
CER_P	←	RC	0.515	0.036	5.729	0,000
CER_P	←	FS	-0.203	0.063	-2.194	0.028
CER_P	←	CER	0.348	0.076	3.015	0,003
X^2	173,773		TLI	0.949		
df	91		CFI	0.966		
X^2/df	1,910		RMSEA	0.068		

Source: own elaboration

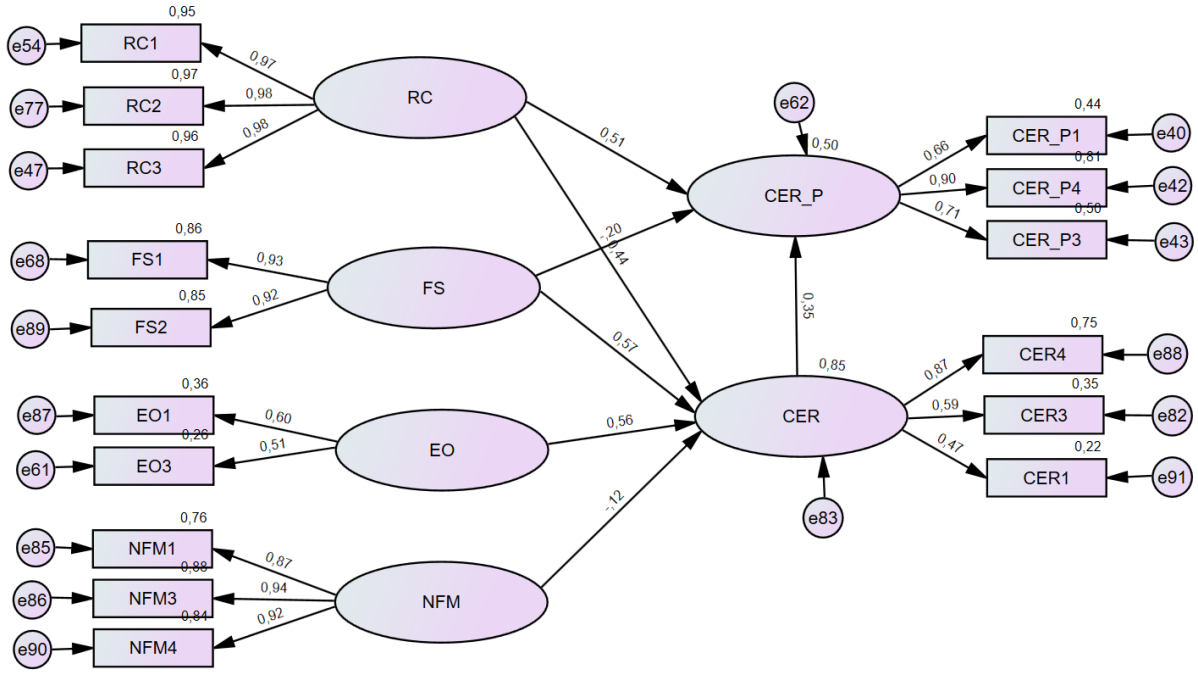
The structural model demonstrates a robust and statistically significant set of relationships between explanatory variables and both the actual and perceived costs of environmental regulation.

Among internal firm characteristics, firm size (FS) has a strong positive effect on compliance costs of environmental regulation (CER) ($\beta = 0.067$, $p < 0.001$), confirming that larger firms bear higher absolute compliance costs. Conversely, firm size negatively influences perceived costs (CER_P) ($\beta = –0.203$, $p = 0.028$), indicating that smaller firms perceive environmental regulation as relatively more burdensome in proportion to their resources and capacities. In terms of external determinants, environmental obligations (EO), such as the number of tax returns and environmental reports required, significantly increase actual costs ($\beta = 0.319$, $p < 0.001$). This confirms the substantial financial implications of administrative regulatory requirements.

Regulatory complexity (RC) exerts a positive and significant effect on both actual ($\beta = 0.035$, $p < 0.001$) and perceived costs ($\beta = 0.036$, $p < 0.001$). This underscores that a complex, frequently changing regulatory environment not only raises firms' costs but also amplifies their perception of these obligations as costly and demanding. Furthermore, non-financial measures (NFM), that include support programs and voluntary certifications, are associated with a modest reduction in actual compliance costs ($\beta = 0.043$, $p = 0.044$), suggesting that such instruments may provide some relief to firms, although the effect is relatively weak.

Lastly, the model confirms a positive relationship between compliance costs of environmental regulation (CER) and perceived costs (CER_P) (β = 0.076, p = 0.003), indicating that perceptions of regulatory burden are grounded, at least partially, in objective cost experience. These results support the conclusion that specific internal firm-level factors and external factors of the regulatory environment significantly shape the financial burden of environmental compliance and how burdensome it is perceived to be. Table 10 and Figure 20 represent the relationships and effects of various constructs in detail, as well as the explained variances of the independent constructs.

Figure 20: Structural equation model with path coefficients, Slovenia



Source: own elaboration

The analysis reveals significant relationships between several independent variables and the dependent variables, providing valuable insights into the dynamics of compliance costs of environmental regulation and their perception among Slovenian firms. Specifically, firm size, environmental obligations, and non-financial measures significantly impact compliance costs of environmental regulation, while regulatory complexity and the size of compliance costs themselves strongly influence the perception of these costs.

7.2.3 Measurement Instruments (SEM) - Croatia

The Croatian model was constructed using the same methodological approach as the Slovenian model. However, the substantially smaller sample size for the Croatian data imposes limitations on the inclusion of variables in the structural equation model. To maintain an appropriate ratio of at least 10 cases per estimated parameter, both the number of latent constructs and the number of indicators per construct were restricted. As a result, the final model includes three independent variables influencing two dependent variables, as well as the interrelationship between the two dependent variables. The following variables from the initial hypothesized model were excluded from the empirical model, as their effects on either of the dependent variables (i.e., CER or CER_P) were found to be negligible: economic sector, financial measures, non-financial measures, international involvement, environmental obligations, and digitalization level. Most latent variables could also have been formed using more manifest variables, however, due to the limited sample size and the need to maintain an appropriate ratio, each construct was formed using only two indicators. This modelling choice ensures parsimony and mitigates overfitting, which is crucial when working with smaller samples (Kline, 2023).

Table 11 presents descriptive statistics for the Croatian sample, including means, standard deviations, and skewness values for each manifest variable. Mean scores are generally low, particularly for regulatory complexity (RC1 and RC2) and institutional quality (QI2 and QI3), suggesting that firms perceive moderate levels of regulatory and institutional challenges. Several items (e.g., QI2, QI3, CER4) exhibit negative skewness, indicating a tendency toward lower ratings on these measures. Standard deviations are relatively small, especially for CER_P3 and CER_P4, pointing to consistent responses across firms. Overall, the data reflect a relatively uniform perception of regulatory and institutional environments within the Croatian sample.

Table 11: Mean, Std. Deviation, Skewness and Kurtosis, Croatia

Measures Items	N	Mean	Std. Deviation	Skewness
QI2	76	2.14	1.66	-0.08
QI3	76	2.01	1.62	0.15
RC1	76	1.28	2.02	1.07
RC2	76	1.26	2.02	1.07
FS1	76	2.33	1.96	-0.04
FS2	76	2.17	1.86	0.14
CER3	76	1.46	1.56	0.53
CER4	76	2.80	2.19	-0.02
CER_P3	76	2.43	1.75	-0.24
CER_P4	76	2.67	1.93	-0.23

Source: own elaboration

The Croatian measurement model was evaluated using standard reliability and validity indicators, including factor loadings, Average Variance Extracted (AVE), Cronbach's alpha, and Composite Reliability (CR) (see Table 13). All constructs demonstrated good psychometric properties. Factor loadings exceeded the recommended threshold of 0.5 (Fornell & Larcker, 1981), indicating strong item reliability, as for example, both indicators for firm size (FS) loaded at 0.922. Similarly high loadings were observed for quality of institutions (QI) and regulatory complexity (RC), with all values above 0.99.

Composite Reliability (CR) values ranged from 0.821 (CER) to 0.953 (CER_P), confirming strong internal consistency. Cronbach's alpha values followed a similar pattern, all exceeding 0.84. Average Variance Extracted (AVE) values ranged from 0.516 (CER) to 0.840 (CER_P), indicating adequate convergent validity. Although the AVE for regulatory complexity (RC) was moderate (0.549), it remained within acceptable limits, particularly given the high CR and theoretical relevance.

In sum, the Croatian measurement model demonstrates satisfactory reliability and validity, providing a solid foundation for structural model estimation.

Table 12: Measurement items, factor loadings, AVEs, Cronbach's alphas, and Composite reliability (CR) for latent variables, Croatia

Measures Items	Factor loadings	AVE	Cronbach's alpha	CR
Firm size (FS)*		0.737	0.934	0.935
FS1: The number of employed	0.922			
FS2: The size of the revenue	0.922			
Quality of institutions (QI)		0.663	0.949	0.889
QI2: It is entirely clear which institution to contact	0.927			
QI3: The responsible officials or the competent authority provides precise answers	0.969			
Regulatory complexity (RC)		0.549	0.993	0.840
RC1: The complexity of existing regulation	0.994			
RC2: The extent of requirements in existing forms	0.990			
Costs of Environmental Regulation (CER)		0.516	0.753	0.821
CER3: Information costs	0.851			
CER4: Total costs of environmental regulation	0.627			
Perception of Costs of Environmental Regulation (CER_P)				
CER_P3: Perception of information costs	0.959	0.840	0.912	0.953
CER_P4: Perception of total costs of environmental regulation	0.831			

Source: own elaboration

7.2.4 Results for Croatia

The Croatian structural model was evaluated using standard model fit indices, indicating an overall satisfactory correspondence between the hypothesized relationships and the empirical data (Hu & Bentler, 1999; Kline, 2023). The chi-square statistic ($\chi^2 = 39.880$) with 27 degrees of freedom yields a χ^2/df ratio of 1.477, which is well below the recommended maximum of 3.00, suggesting a good model fit (Kline, 2023).

The RMSEA value of 0.080 sits at the conventional upper bound, indicating an acceptable level of approximation error (Browne & Cudeck, 1992). This is further

supported by excellent values for incremental fit indices: the Tucker–Lewis Index (TLI = 0.973) and the Comparative Fit Index (CFI = 0.984) both exceed the commonly accepted threshold of 0.95, pointing to strong comparative and incremental fit (Hu & Bentler, 1999; Schumacker & Lomax, 2004).

Thus, the structural model for Croatia demonstrates a robust overall fit, with all major indices falling within acceptable or desirable ranges.

Table 13: The resulting costs and perception of costs of environmental regulation model with estimated relationships, Croatia

			Path coefficient	Standardized path coefficient	C.R.	P
CER	←	RC	0.345	0.048	3.305	0,000
CER	←	FS	0.636	0.067	4.718	0,000
CER_P	←	RC	0.385	0.036	4.533	0,000
CER_P	←	CER	0.434	0.063	3.534	0.000
CER_P	←	QI	0.419	0.064	4.582	0,000
X^2	39.880		TLI	0.973		
df	27		CFI	0.984		
X^2/df	1.477		RMSEA	0.080		

Source: own elaboration

The results of the Croatian structural model provide important insights into the drivers of both the absolute compliance costs of environmental regulation (CER) and the perception of these costs (CER_P). All estimated path coefficients in the model are statistically significant ($p < 0.05$), confirming the robustness of the relationships among the latent constructs.

First, firm size (FS) is positively associated with the actual compliance costs of environmental regulation ($\beta = 0.636$, $p < 0.001$), suggesting that larger firms tend to incur higher compliance costs. This is likely due to their broader range of regulated activities, higher exposure to environmental obligations, or more frequent interactions with regulatory authorities.

Regulatory complexity (RC) also exerts a significant positive effect on both cost-related outcomes. Its effect on compliance costs ($\beta = 0.345$, $p < 0.001$) implies that firms facing more complex or extensive regulatory frameworks tend to report higher compliance costs. Likewise, RC has a strong impact on the perceived burden of environmental regulation ($\beta = 0.385$, $p < 0.001$). These findings underscore the notion that not only

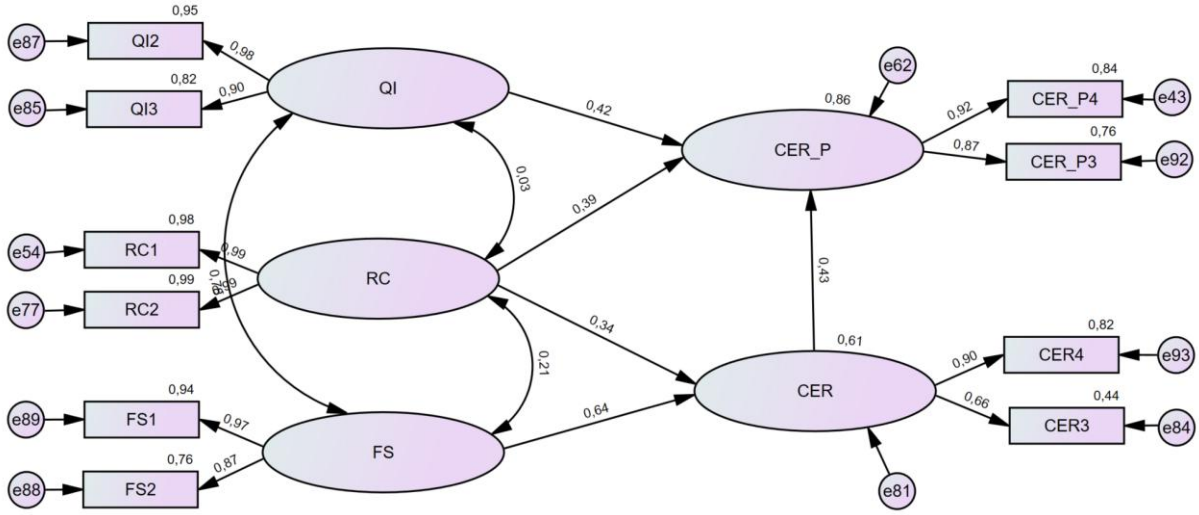
the content of regulation but also its design, clarity, and stability critically shape both financial and cognitive burdens on firms.

Interestingly, quality of institutions (QI) has a positive and statistically significant effect on the perception of compliance costs of environmental regulation ($\beta = 0.419$, $p < 0.001$). Although counterintuitive at first glance, since stronger institutions are typically associated with more predictable and efficient enforcement, this result may reflect the increased visibility and stringency of environmental obligations in better-governed systems. In such contexts, firms may be more aware of their duties and therefore report higher perceived burdens, even if the regulatory environment is more transparent.

Finally, the relationship between compliance costs and perceived costs of environmental regulation is also significant ($\beta = 0.434$, $p < 0.001$). This confirms that firms' subjective assessments of regulatory burden are closely tied to their concrete financial expenditures. Nevertheless, this relationship is not perfectly linear, indicating that perception is also shaped by other, non-financial factors, such as institutional context or regulatory design.

Overall, the Croatian model highlights the critical role of firm size, regulatory complexity, and institutional quality in shaping firms' regulatory experience, both in terms of actual compliance costs of environmental regulation and subjective perceptions. The findings are particularly relevant for policy efforts aimed at improving regulatory efficiency without undermining environmental standards.

Figure 21: Structural equation model with path coefficients, Croatia



Source: own elaboration

7.2.5 Comparison between model findings

The structural equation models (SEMs) for Slovenia and Croatia reveal consistent yet contextually important insights into the determinants of compliance costs of environmental regulation and their perception among firms.

In both countries, firm size (FS) significantly increases the compliance costs of environmental regulation (CER), indicating that larger firms bear higher compliance costs. This can be attributed to a broader scope of regulated operations and more formalized compliance structures. Simultaneously, in Slovenia, firm size also negatively influences the perception of compliance costs of environmental regulation (CER_P), suggesting that larger firms, although spending more, perceive the costs as less burdensome, most likely due to economies of scale or more advanced internal systems (Glaum et al., 2013; Schoonjans et al., 2011). In contrast, the impact of firm size on the perception of compliance costs was negligible in the Croatian model and was therefore not estimated.

In both models, regulatory complexity (RC) emerges as a strong and consistent determinant of both actual compliance costs and perceived costs. In Slovenia and Croatia alike, firms operating in more complex regulatory environments report higher compliance costs and perceive these costs more acutely. These findings emphasize the importance of regulatory clarity and stability (Ambec et al., 2013; Mendoza et al.,

2016) and suggest that simplification efforts could meaningfully ease both compliance costs as well as their perception.

Differences stem from the role of environmental obligations (EO) and non-financial measures (NFM). In Slovenia, both significantly influence compliance costs: EO increases them (indicating administrative burden), while NFM slightly reduces them (suggesting cost-efficiency gains through voluntary compliance tools). Compared to the Slovenian case, these variables, however, were not included in the Croatian model due to small sample size and their limited explanatory contribution, leaving open the question whether their exclusion reflects structural differences in firm behavior or methodological constraints.

Notably, in Croatia, quality of institutions (QI) has a significant positive effect on the perception of regulatory costs. While this may seem counterintuitive, it is plausible that higher institutional quality is associated with stricter, more transparent enforcement, thus increasing perceived burden, despite potentially reducing ambiguity (Ntangeki et al., 2023). This effect was considerably weaker in Slovenia, where QI was not included in the model due to less significant impact on perceived costs.

Finally, in both countries, the compliance costs of environmental regulation (CER) significantly influence the perception of these costs (CER_P), as expected. However, the research reveals that in Slovenia, the perception of compliance costs of environmental regulation is even more strongly affected by regulatory complexity than by the actual compliance costs themselves. In contrast, the perception is more evenly shaped in Croatia by the compliance costs, regulatory complexity, and the quality of institutions. This underscores the need for policymakers to consider both measured costs and perceived fairness or clarity of regulation when evaluating environmental policy impact (Daddi et al., 2020).

7.3 COMPLIANCE COSTS OF ENVIRONMENTAL REGULATION AND PRODUCTIVITY

Productivity is defined as a firm's turnover per employee divided by the average productivity of the activity in which the firm operates (Slabe-Erker & Klun, 2012). As explained in detail in Section 5.2, this analysis pertains to the strong version of the Porter Hypothesis, where compliance costs of environmental regulation serve as a proxy for regulatory stringency. According to this hypothesis, stricter environmental regulation stimulates innovation, which eventually leads to improved firm productivity. However, the original authors, Porter and Van der Linde (1995), were cautious in linking costs to productivity, noting: *"Innovation in response to environmental regulation can take two broad forms. The first is that companies simply get smarter about how to*

deal with pollution once it occurs … The second form of innovation addresses environmental impacts while simultaneously improving the affected product itself and/or related processes. In some cases, these innovation offsets can exceed the costs of compliance."

Contemporary empirical research testing the strong version of the Porter Hypothesis typically relies on robust methodological approaches. For instance, methodologies include difference-in-differences (DID) and difference-in-difference-in-differences (DDD) models (Chen et al., 2022), spatial econometric models (Fan et al., 2021), and dynamic panel regressions (Wang et al., 2019; Wu & Lin, 2022). Several studies apply advanced productivity measurement techniques, such as the Slack-Based Measure (SBM), Malmquist-Luenberger Index, and Data Envelopment Analysis (DEA), to capture green total factor productivity (GTFP) and energy-environmental performance (Wu & Lin, 2022; Zhang et al., 2022). Data regressions with fixed effects and lagged response models are also common in addressing endogeneity and time-related effects (Albrizio et al., 2017).

Structural Equation Modelling (SEM) is rarely used in testing the Porter Hypothesis. A notable exception is the study by Cai and Li (2018), which explored the drivers of eco-innovation and its effects on firm performance. Their findings indicate that competitive pressure, rather than environmental regulation, is the main driver of eco-innovation. Moreover, while eco-innovation significantly improves environmental performance, it does not have a direct positive impact on economic performance, such as productivity. Therefore, in the final model that includes productivity, data from both Slovenia and Croatia were pooled to increase the overall sample size and enhance the robustness of the analysis. In this model, productivity was introduced as a single-indicator (manifest) variable, which was operationalized as a turnover per employee divided by the average productivity of the activity in which the firm operates. While such operationalization is methodologically acceptable, particularly when supported by theoretical justification and when the variable functions as an outcome, it does present certain limitations. Most notably, single-item indicators do not allow for the estimation of measurement error, which can reduce the explanatory power (i.e., lead to low R^2 values) and adversely affect model fit indices. Nonetheless, this result is consistent with the theoretical proposition being tested, namely the strong version of the Porter Hypothesis, which posits that compliance costs of environmental regulation (CER) may positively affect firm productivity. According to empirical results, the weak association between CER and productivity suggests that such a relationship could not be empirically confirmed, thereby supporting the conclusion that low explained variance is not necessarily problematic within this theoretical context.

In order to incorporate productivity as a meaningful variable in the structural model, the sector- and size-adjusted approach based on official statistics was followed. Specifically, exogenous variable representing relative productivity was constructed by benchmarking each firm against its corresponding industry and size category. The conceptual logic builds on the notion that productivity comparisons should account for structural heterogeneity across sectors and firm sizes, as highlighted by Syverson (2011). To implement this, the following steps were taken:

Using official data from the Statistical Office of the Republic of Slovenia, the average productivity level is calculated for each group defined by industry (classified according to NACE categories) and firm size (e.g., small, medium, large). Productivity is measured as:

$$\mu_{a,s} = \frac{\text{Net sales revenues (in EUR 1000)}}{\text{Number of employees}}_{a,s}$$

where $\mu_{a,s}$ denotes the average productivity for activity a and size category s.
Based on firm-level information (i.e., net sales and number of employees), a relative productivity score was constructed for each firm as:

$$\text{RelProd}_i = \frac{\text{Productivity}_i}{\mu_{a,s}} = \frac{\frac{\text{Net sales}_i}{\text{Employees}_i}}{\mu_{a,s}}$$

This ratio reflects how productive a firm is relative to its structural peers and allows the inclusion of productivity as a standardized input variable while adjusting for inter-sectoral and size-related structural differences, which are otherwise a major source of endogeneity and bias in comparative productivity analysis.

The empirical evaluation of the latent constructs demonstrates generally strong psychometric properties, as evidenced by the factor loadings, internal consistency reliability, and convergent validity (Table 14). All constructs exhibit high standardized factor loadings, with most items exceeding 0.90, indicating that the observed indicators strongly reflect their respective latent constructs. The lowest loading is observed for the CER1 item (“Costs of environmental levies and environmental permits”) at 0.564, which remains above the minimum threshold of 0.50 but suggests a comparatively weaker association with the underlying construct of compliance costs of environmental regulation (CER).

The values of Cronbach's alpha indicate satisfactory internal consistency across constructs, ranging from 0.699 for CER to 0.986 for regulatory complexity (RC). These results are further corroborated by Composite Reliability (CR) values, all of which exceed the recommended threshold of 0.70, with construct-specific values ranging from 0.843 to 0.952.

Regarding convergent validity, the Average Variance Extracted (AVE) values are mostly above the 0.50 benchmark. The exception is again the CER construct, where the AVE is 0.380, indicating that less than half of the variance in the observed indicators is explained by the latent construct. While the construct's reliability remains acceptable ($\alpha = 0.699$; CR = 0.843), the relatively low AVE suggests limited convergent validity, warranting some caution in interpreting CER within the structural model. Nevertheless, the overall measurement model is robust and provides a solid foundation for subsequent structural analysis.

Table 14: Measurement items, factor loadings, AVEs, Cronbach's alphas, and Composite reliability (CR) for latent variables, Slovenia & Croatia

Measures Items	Factor loadings	AVE	Cronbach's alpha	CR
Quality of institutions (QI)		**0.639**	**0.939**	**0.889**
QI1: Ease of contacting the responsible officials or the competent authority.	0.963			
QI2: It is entirely clear which institution to contact	0.929			
QI4: The responsible officials or the competent authority provide answers in reasonable time	0.886			
Firm size (FS)*		**0.671**	**0.917**	**0.907**
FS1: The number of employed	0.927			
FS2: The size of the revenue	0.927			
Regulatory complexity (RC)		**0.776**	**0.986**	**0.952**
RC1: The complexity of existing regulation	0.979			
RC2: The extent of requirements in existing forms	0.987			
RC3: The introduction of new regulation	0.974			
Non-financial Measures (NFM)		**0.628**		**0.844**
NFM1: Certification of the source of energy and buildings (energy certificate)	0.918			
NFM2: Awareness, information, promotion and training programs, demonstration projects	0.936			
NFM4: Support for operators (non-refundable grants or free professional assistance) in implementing environmental standards and more demanding environmental legislation (e.g. IED, SEVESO, VOC, construction legislation).	0.903			
Compliance Costs of Environmental Regulation (CER)		**0.380**	**0.699**	**0.843**
CER1: Costs of environmental taxes and environmental permits	0.564			
CER3: Information costs	0.741			
CER4: Total costs of environmental regulation	0.827			
*Extraction Method: Principal Axis Factoring.				

Source: own elaboration

The structural model including the productivity variable, based on the pooled Slovenian and Croatian sample, demonstrates acceptable fit, though it is weaker than in country-specific models (Table 15). The chi-square statistic is significant ($\chi^2 = 217.508$, $df = 80$, $p < 0.001$), and the chi-square to degrees of freedom ratio ($\chi^2/df = 2.719$) remains within the acceptable range (< 3.00). The RMSEA is 0.079, indicating acceptable absolute fit. Incremental fit indices are also satisfactory, with the Tucker-Lewis Index

(TLI = 0.947) and Comparative Fit Index (CFI = 0.965) both above the recommended threshold of 0.90.

As anticipated, the inclusion of productivity, which is measured as a single-indicator variable, likely contributes to a somewhat constrained model fit. While it cannot account for measurement error, the path from the compliance costs of environmental regulation (CER) to productivity is statistically significant (standardized $\beta = 0.418$, $p < 0.001$), supporting the hypothesized relationship. Nonetheless, given the exploratory nature of the model and its theoretical focus on testing the strong version of the Porter Hypothesis, the slightly lower fit indices do not undermine the model's interpretive value.

Table 15: The productivity model with estimated relationships, Slovenia & Croatia

			Path coefficient	Standardized path coefficient	C.R.	P
CER	←	QI	0.206	0.052	3.905	0,000
CER	←	FS	0.596	0.059	9.940	0,000
CER	←	RC	0.521	0.035	9.572	0,000
CER	←	NFM	-0.050	0.039	-0.950	0.342
PROD_ACT	←	CER	0.418	0.000	6.332	0,000
X^2	217.508		TLI	0.947		
df	80		CFI	0.965		
X^2/df	2.719		RMSEA	0.079		

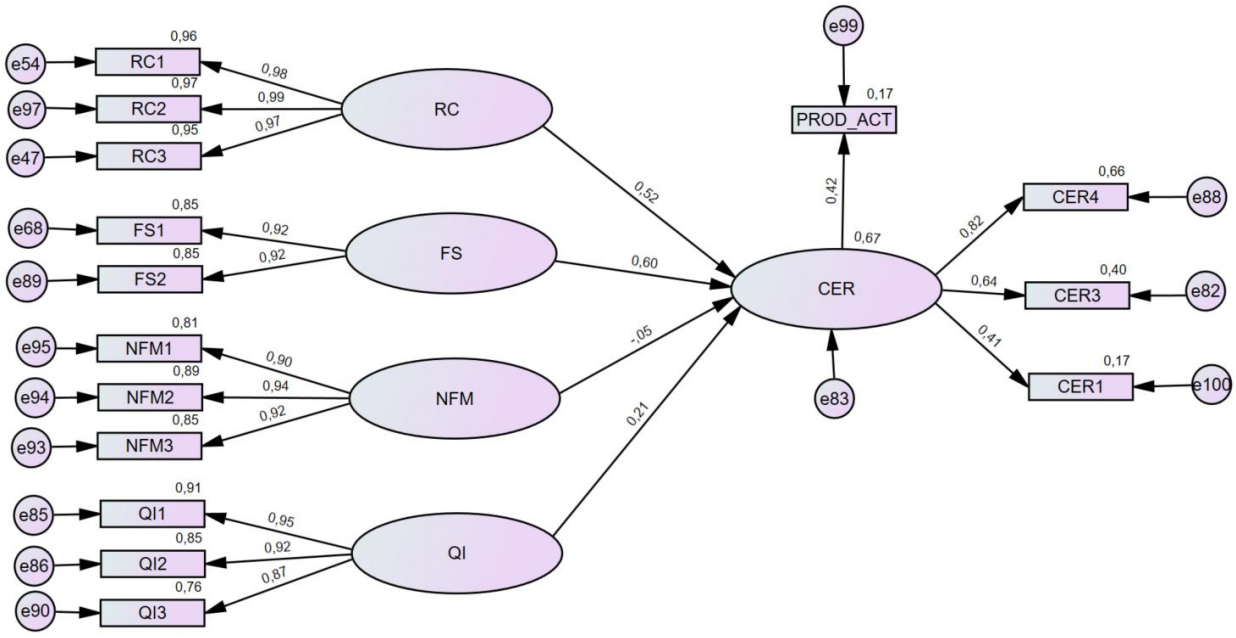
Source: own elaboration

The integrated structural models for Slovenia and Croatia provided insight into how compliance costs of environmental regulation influence firm performance (Table 15 and Figure 22). In both national contexts, regulatory complexity and firm size emerge as significant predictors of the compliance costs of environmental regulation (CER), suggesting that more complex administrative frameworks and larger firms are associated with higher regulatory burdens. Although institutional quality does not directly increase CER, it significantly shapes the perceived costs (CER_P) in the Croatian model, highlighting the role of public institutions in how firms interpret regulatory impact. Notably, non-financial measures were not statistically significant in either country, suggesting that soft support instruments may currently lack the capacity to mitigate cost burdens. These findings are embedded in a broader model in which eco-innovation positively affects environmental performance but does not directly enhance economic outcomes. Instead, environmental performance serves as a key intermediary, linking innovation to productivity. Altogether, the models indicate that

regulatory conditions indirectly shape economic performance via their effects on compliance costs of environmental regulation and firm behavior.

Finally, the path from compliance costs of environmental regulation (CER) to firm productivity (PROD_ACT) is positive and statistically significant ($\beta = 0.418$, $p < 0.001$), offering support to the strong version of the Porter Hypothesis. This finding suggests that, despite the initial compliance burdens, environmental regulation may positively affect productivity, potentially through channels such as innovation, process optimization, or enhanced resource efficiency. However, the relatively low explained variance ($R^2 = 0.17$) of the productivity construct indicates that the model accounts for only a modest share of the variation in firm productivity. It implies that other influential factors, not included in the present model, likely play a substantial role in determining productivity outcomes, which is to some extent expectable. Consequently, while the observed positive relationship between CER and PROD_ACT is statistically robust, the explanatory power of the model remains limited, which warrants cautious interpretation when generalizing the results.

Figure 22: Structural equation model including productivity with path coefficients, Slovenia & Croatia



Source: own elaboration

8 DISCUSSION

Among the main goals of the thesis was to estimate the size of compliance costs of environmental regulation and to conduct empirical models examining the interrelation between various factors impacting compliance costs of environmental regulation and their perception with a further link to productivity, using Structural Equation Modeling (SEM). Drawing on three theoretical approaches, institutional theory, resource-based view, and managerial cognition theory, the study provides a holistic view of the drivers of compliance costs of environmental regulation and their perception. Furthermore, by measuring the impact of the magnitude of compliance costs of environmental regulation, as a proxy for environmental stringency, on productivity levels, the research tests the strong version of the Porter Hypothesis (Jaffe & Palmer, 1997; Lanoie et al., 2011; Porter & Van der Linde, 1995). Based on the empirical results presented in Sections 7.1–7.3, the following sub-chapters address the research questions and use these findings as the basis for testing the validity of the hypotheses.

8.1 RESEARCH QUESTIONS

8.1.1 Research question 1 (RQ1)

The first research question addresses the estimated size of compliance costs firms must bear due to environmental regulation. The empirical results show that compliance costs of environmental regulation constitute a substantial financial burden for firms in both countries, Slovenia and Croatia, although their magnitude and composition differ considerably. In Slovenia, the post-stratified extrapolation indicates that firms incur an average of approximately 98,546 euros per year in compliance costs of environmental regulation. When aggregated to the national level, this corresponds to an estimated 306.6 million euros annually. These costs are composed of approximately 27,118 euros in financial costs, 51,573 euros in substantive compliance costs, and 19,856 euros in information compliance costs per firm. The cost structure is dominated by substantive compliance costs, which account for roughly 52% of the total burden, followed by financial costs at 27% and information costs at 20%. This distribution indicates that Slovenian firms invest more heavily in production-process adjustments, technological upgrades, and other substantive measures required to comply with environmental regulation. However, these data represent mean values of total population, while mean costs differ substantially across different firm sizes.

In Croatia, compliance costs of environmental regulation are lower both in absolute terms and on a per-firm basis. The post-stratified estimates show an average of approximately 50,233 euros per firm annually, corresponding to a total national burden of about 166.6 euros million. This consists of roughly 25,172 euros in financial costs,

18,554 euros in substantive costs, and 6,508 euros in information compliance costs per firm. Croatia's cost structure differs markedly from Slovenia's: financial costs account for approximately 50% of the total burden, substantive costs for 37%, and information-related costs for 13%. This indicates that Croatian firms face a regulatory environment in which direct financial charges (environmental levies, fees) constitute the dominant component of compliance, whereas substantive, technology-related adjustments are less prominent. In Croatia as well, substantial differences in the size of the costs were observed across different firm sizes.

Despite the relatively high compliance cost levels in both countries, the majority of firms perceive environmental regulation as a modest component of their overall regulatory load. Most Slovenian firms (about 60%) estimate that compliance costs of environmental regulation comprise only 0–5% of their total regulatory costs. A similar pattern is observed in Croatia, where more than 50% of firms report that compliance costs of environmental regulation fall within the same range. This suggests that although compliance costs of environmental regulation are economically meaningful, they are generally not viewed as the primary regulatory burden when compared with other administrative, fiscal, and labour-related requirements.

Answer to RQ1: Compliance costs of environmental regulation represent a significant financial burden in both Slovenia and Croatia. However, Slovenian firms incur substantially higher per-firm and aggregate costs. Slovenia's cost structure is dominated by substantive compliance obligations, whereas Croatia's is characterized primarily by direct financial charges. Yet, in both countries, firms perceive environmental regulation as a comparatively modest share of the total regulatory burden.

8.1.2 Research question 2 (RQ2)

Building on the findings related to RQ1, the second research question (RQ2) examines whether there are differences in the magnitude and structure of compliance costs of environmental regulation between Slovenia and Croatia. The evidence indeed reveals clear and meaningful differences between Slovenia and Croatia. Firstly, in terms of magnitude, Slovenian firms face a higher average annual financial burden than their Croatian counterparts. This difference is particularly pronounced in the category of substantive compliance costs, where Slovenian firms spend on average more than double the amount reported by Croatian firms (36,640 euros vs. 15,888 euros per firm annually). This suggests a more intensive regulatory environment in Slovenia concerning the adaptation of production processes and products to meet environmental standards.

Secondly, regarding the cost structure, Croatian firms allocate a larger share of their total compliance costs to direct financial obligations, such as environmental levies. This may reflect a regulatory model in Croatia that relies more heavily on market-based instruments to achieve environmental goals, whereas Slovenia's system appears to impose greater substantive compliance requirements at the operational level.

A further distinction emerges in information compliance costs. Slovenian firms report a higher occurrence of such costs, with 78.2% of firms indicating they face these types of costs, compared to 52.8% of Croatian firms. This may suggest more complex or frequent reporting obligations in Slovenia, which can impose additional administrative burdens. This observation is further supported by the results of the SEM model, where the factor environmental obligations is found to have a significant effect on the costs of environmental regulation in the Slovenian model, whereas no such effect is observed in the Croatian model. Another possible explanation would be that the level of compliance is higher in the case of Slovenia.

Answer to RQ2: Although descriptive results show clear differences in the magnitude and structure of compliance costs of environmental regulation between Slovenia and Croatia, these differences are not statistically significant at the firm level when tested with non-parametric methods (see results of H1 – section 9.2.1). The absence of significance is driven by extremely high variance and heavy-tailed distributions in the cost data, which substantially reduces the statistical power of mean-comparison tests. Thus, while the countries differ in cost composition and in aggregated population-level burdens, firm-level differences in raw compliance cost estimates are not statistically different.

8.1.3 Research question 3 (RQ3)

The research question 3 (RQ3) refers to finding potential reasons for the observed cross-country differences. The comparative analysis of Slovenia and Croatia underlines the complex relationship between regulatory frameworks, firm characteristics, and administrative capacities affecting the size of compliance costs of environmental regulation. Slovenian firms face higher overall compliance costs, driven primarily by substantive compliance obligations, while Croatian firms incur relatively lower costs dominated by direct financial costs. These findings highlight the importance of tailoring environmental policies to national contexts and firm capacities to minimize unnecessary burdens while achieving regulatory objectives. Several interrelated factors are exposed that contribute to the observed differences in compliance costs between Slovenia and Croatia. Based on the empirical results of descriptive statistics (Section 8.1), the following factors were found to contribute to the differences in the magnitude of compliance costs of environmental regulation:

- **Regulatory frameworks and policy design:** Slovenia and Croatia differ in the stringency, scope, and implementation of environmental regulation. Slovenian firms' higher substantive compliance costs suggest that their regulatory framework emphasizes environmental performance improvements through technological and process innovations. In contrast, Croatia appears to rely more on fiscal instruments, such as environmental levies, to achieve compliance. This aligns with evidence that Croatia records higher levy-imposed obligations, which increase direct financial costs even when they do not require substantive technological adjustments.
- **Administrative capacity and organizational culture:** the willingness of firms to voluntarily collect environmental information provides further insight. In Croatia, 24.5% of firms indicated they would fully collect compliance-related information even without legal mandates, compared to only 8.4% in Slovenia. This may reflect stronger internal administrative systems or a more proactive environmental management culture among Croatian firms, particularly medium-sized enterprises.
- **Time commitment and resource allocation:** employees in Croatian firms tend to dedicate more time to environmental compliance activities, with some large firms reporting over 200 hours per month. In Slovenia, the majority of firms (69.8%) report spending less than 10 hours per month on compliance, particularly small firms. This difference could result from varying degrees of process integration, administrative efficiency, or also complexity of reporting requirements. In general, Slovenian firms spend less time on administrative compliance activities, consequently their total compliance costs are significantly higher due to more substantive, technology-oriented compliance obligations rather than administrative burdens. Differences in the digital public information systems used for reporting, accounting, and environmental permitting may additionally contribute to variation in time burdens. Less integrated or less user-friendly e-reporting systems can increase administrative effort and prolong compliance procedures.
- **Economic context and policy maturity:** differences in economic development, industrial composition, and policy maturity between Slovenia and Croatia may also shape compliance cost patterns. Slovenia's longer membership in the EU and earlier exposure to EU environmental directives may have led to more advanced but also cost-intensive regulatory practices. In combination with a more industrially intensive economic structure, this results in a regulatory environment where compliance often requires substantive investments in cleaner technologies, equipment, and process modifications. Meanwhile, Croatia's reliance on fiscal obligations increases direct financial costs, shaping a different cost structure in which firms face more pronounced financial rather than technological burdens.

Answer to RQ3: Cross-country differences in compliance costs of environmental regulation between Slovenia and Croatia arise various factors: differences in regulatory design and instrument choice (substantive requirements versus fiscal instruments), administrative capacity and organizational compliance culture, differences in time commitments and administrative systems, as well as broader economic context and policy maturity. Collectively, these factors explain why Slovenia exhibits higher total compliance costs of environmental regulation driven mainly by substantive costs, while Croatia exhibits lower overall compliance costs with a stronger emphasis on direct financial charges. Importantly, while the results of SEM (see RQ4) indicate that compliance costs increase with firm size, firm-size composition does not account for the cross-country gap observed here. Surprisingly, Slovenia's research population contains a smaller share of medium and large firms than Croatia yet demonstrates higher aggregate compliance costs. This pattern implies that non-size factors are the primary drivers of the cross-country differences, namely, more demanding environmental obligations, greater regulatory complexity, and implementation practices that induce substantive adjustments (e.g., process upgrades, monitoring, product adaptation) in Slovenia. By contrast, Croatia's reliance on market-based instruments (levies) shifts the burden toward higher relative financial costs. Sectoral/industrial composition likewise does not explain the difference here, as sectoral profiles across the two samples are very similar.

8.1.4 Research question 4 (RQ4)

To better understand the main drivers behind the variation in compliance costs of environmental regulation among firms and the way they are perceived, the RQ4 was formulated: What is the effect of selected internal and external factors on compliance costs of environmental regulation and perception of these costs? In addition, hypotheses H2a, H2b, H3a, and H3b were developed to provide the basis for constructing the final holistic model of compliance costs of environmental regulation and firm productivity.

To address RQ4, a structural equation modelling (SEM) approach was applied to examine how selected internal and external factors influence the compliance costs of environmental regulation (CER) and firms' perceptions of these costs (CER_P). Separate models were estimated for Slovenia and Croatia to capture country-specific determinants and reflect differences in regulatory environments, economic structure, and administrative capacities, while both addressed the same factors, which were identified throughout literature review. The internal factors examined in both models included firm size (FS), economic sector (ES), financial measures (FM), non-financial measures (NFM), digitalization level (DL), and international involvement (II), while

external factors encompassed environmental obligations (EO), quality of institutions (QI), and regulatory complexity (RC).

The Slovenian SEM model demonstrates that specific internal and external factors significantly influence either the level of compliance costs of environmental regulation (CER) or the perception of these costs (CER_P). Among internal determinants, firm size (FS) exerts a strong and positive effect on compliance costs, indicating that larger firms incur higher expenditures. This could be due to economies of scale, better resources, and more sophisticated compliance mechanisms available to larger firms (Glaum et al., 2013) or because compliance costs are to a certain extent fixed (Glaum et al., 2013; Grediani, 2019; Schoonjans et al., 2011). On the other hand, smaller firms may struggle more with compliance, perceiving regulatory costs as more burdensome (Schiffer & Weder, 2001).

Non-financial measures (NFM), on the other hand, show a significant negative relationship with CER, suggesting that firms investing in “soft” compliance-oriented measures, such as capacity building, certification, and implementation support, may function as cost-mitigating mechanisms, complementing or partially substituting more expensive technological and procedural adjustments. Therefore, proactive environmental strategies may experience a slight reduction in regulatory costs, which underscores the potential benefits of encouraging non-financial measures, such as certifications and awareness programs, as part of a broader regulatory strategy (Mori et al., 2016), besides using only coercive pressures (Daddi et al., 2020). Other internal variables (economic sector, financial measures, digitalization level, international involvement) do not show significant direct effects in the final model, indicating that their influence on compliance costs of environmental regulation is weaker or indirect once more dominant factors are accounted for.

External factors play a central role in shaping compliance costs of environmental regulation. Environmental obligations (EO) exert a strong positive effect on CER, confirming that more demanding or extensive regulatory requirements directly increase the financial and time related burden on firm, arising from numerous environmental consents, record-keeping requirements, and environmental charges. The relationship highlights both the cost implications of environmental obligations and the strategic challenges of aligning internal processes with regulatory requirements. Policymakers should consider these findings when designing and implementing environmental policies to balance regulatory goals with the economic realities of firms, especially smaller ones (Ambec et al., 2013, Vickers et al. 2005).

Regulatory complexity (RC) also significantly increases compliance costs, implying that complex regulatory procedures produce additional administrative and

organizational burdens. Furthermore, it also significantly affects perception of compliance costs, underscoring the importance of simplifying and stabilizing environmental regulation. Research shows that regulatory complexity can lead to economically suboptimal decisions, influence risk-taking behavior, increase the demand for compliance assistance, and affect firms' willingness to adhere to environmental regulation (Eichfelder and Vaillancourt, 2014). Thus, policymakers should aim to reduce complexity and minimize regulatory changes to alleviate the perceived burden on firms, thereby enhancing overall compliance and effectiveness (Mendoza et al., 2016).

Quality of institutions (QI) does not significantly influence CER in Slovenian model suggesting that firms respond more directly to the structure and intensity of regulatory demands than to broader institutional perceptions.

The SEM model also provides insights into how firms perceive compliance costs of environmental regulation. Three variables significantly affect CER_P. As mentioned earlier, regulatory complexity (RC) increases perceived burden, while firm size (FS) shows a negative effect on CER_P, meaning that larger firms perceive compliance as less burdensome, likely because they possess greater administrative capacity, internal expertise, and economies of scale. Importantly, actual compliance costs (CER) significantly increase perceived burden, demonstrating that firms' subjective evaluations are not arbitrary but grounded in real financial costs. This underscores the importance of considering both actual costs and perceived burdens when assessing the impact of environmental regulations (Daddi et al., 2020). It also aligns with recent studies (e.g., Wang et al., 2023; Xing et al., 2019) that highlight environmental commitment as a critical factor in the relationship between external environmental regulation and environmental performance.

In the Croatian SEM model, both compliance costs of environmental regulation (CER) and the perceived burden of these costs (CER_P) are significantly shaped by a combination of regulatory and institutional conditions and firm-level characteristics. Compliance costs of environmental regulation are positively influenced by regulatory complexity (RC) ($\beta = 0.048$, $p < 0.001$) and firm size (FS) ($\beta = 0.067$, $p < 0.001$), indicating that firms operating in more complex regulatory environments and larger firms incur higher compliance costs of environmental regulation. This result is consistent with the expectation that larger firms typically have wider regulatory exposure and more regulated processes, while complex regulatory settings increase the resources required to interpret, manage, and fulfil compliance requirements.

Regarding perception of costs, the model indicates that CER_P increases significantly with regulatory complexity (RC) ($\beta = 0.036$, $p < 0.001$), suggesting that firms

experiencing a more complex regulatory environment also perceive compliance as more burdensome. Importantly, compliance costs of environmental regulation (CER) have a positive and statistically significant effect on CER_P ($\beta = 0.063$, $p < 0.001$), demonstrating that perceptions are grounded in real cost outlays: higher costs translate into stronger perceived burden. Finally, quality of institutions (QI) also exerts a statistically significant positive effect on perceived compliance costs ($\beta = 0.064$, $p < 0.001$). This indicates that institutional conditions, captured through firms' assessments of institutional quality, are relevant for how firms evaluate the burden of compliance. In substantive terms, the effect suggests that firms' perceptions of compliance burden are not determined only by direct cost and complexity, but also by broader institutional features that shape firms' experience of regulation (e.g., interactions with public authorities, predictability of procedures, administrative efficiency).

In sum, the research shows that the perception of compliance costs of environmental regulation is partly influenced by the size of these costs, with regulatory complexity identified as a major factor affecting perception. By incorporating managers' perception, the study offers new insights into managerial cognition theory, which views managers as key decision-makers shaping business strategies and investing in preventive environmental technologies (Lopez-Gamero et al., 2010). Furthermore, managerial perceptions of compliance costs of environmental regulation as a competitive opportunity are associated with a more proactive stance on environmental commitment (Berrone and Gomez-Mejia, 2009). This proactive stance positively affects process eco-innovation, as shown by Hojnik and Ruzzier (2016): managers who are environmentally concerned and aware of the adverse impacts of their companies' operations devote more attention to environmental issues and are more inclined to adopt process eco-innovations. On the other hand, if managers perceive regulatory costs as excessively high, particularly due to unnecessary regulatory complexity, it may lead to a broader aversion to regulation and other environmental practices. Based on the findings, key policy actions should focus on optimizing compliance costs, improving regulatory effectiveness, and strengthening managerial environmental awareness and engagement.

Answer to RQ4: Based on the results of SEM models, internal factors explain part of the variation in costs, while external factors consistently emerge as the stronger drivers of both actual and perceived compliance burdens across Slovenia and Croatia. Overall, these findings confirm that compliance outcomes arise from the interaction between firm-level capabilities and the design and complexity of the regulatory environment.

8.1.5 Research question 5 (RQ5)

To address RQ5, which asks about the impact of compliance costs of environmental regulation on firms' overall productivity, and to test H4 stating that the level of compliance costs affects firm productivity, the SEM specification was extended by introducing firm productivity (PROD_ACT) as the ultimate dependent construct. Furthermore, to increase the overall sample size and enhance the robustness of the analysis, data from both Slovenia and Croatia were combined.

The aim was to test the strong version of the PH, which remains highly dependent on the specific context and the indicators used in empirical studies (Brännlund & Lundgren, 2009). While SEM is not a common method for testing the PH, using the magnitude of compliance costs of environmental regulation as a proxy for environmental stringency (e.g. Manello 2017, Yuan et al., 2017, Wu & Lin, 2022) is well established, as is the use of a productivity measure defined as firm turnover per employee scaled by the average productivity of the firm's activity (Slabe-Erker & Klun, 2012).

The results from the combined Slovenia–Croatia SEM model indicate that the structural path from compliance costs of environmental regulation (CER) to firm productivity (PROD_ACT) is positive and statistically significant ($\beta = 0.418$, $p < 0.001$). This finding suggests that higher estimated compliance costs of environmental regulation are associated with higher levels of firm productivity. In substantive terms, the result is consistent with the argument that regulatory compliance, as a proxy of environmental regulation stringency, may be linked to increase in productivity within firms.

At the same time, the model explains only a modest share of productivity differences across firms ($R^2 = 0.17$). This indicates that while the CER - PROD_ACT relationship is statistically robust within the model, the overall explanatory power for productivity remains limited. In other words, a substantial proportion of firm productivity variation is likely driven by additional determinants not captured in the present model. Therefore, although the positive effect is clear in the estimated model, the results should be interpreted cautiously. Furthermore, viewing the relationship through a static rather than a dynamic perspective introduces additional uncertainty, reinforcing the need for careful interpretation.

Answer to RQ5: Compliance costs of environmental regulation exhibit a positive and statistically significant association with firm productivity in the combined-country SEM model, though the model accounts for only a limited portion of productivity variation ($R^2 = 0.17$), implying that other factors remain important. However, according to results,

the size of compliance costs shows marginal positive effects on productivity, which is in line with studies that employ traditional productivity measures and find limited support for the strong PH e.g., no or only weak effects using total factor productivity - TFP (Albrizio et al., 2017; Rubashkina et al., 2013; Tang et al., 2020). These findings are also in line with some previous research that used compliance costs as a proxy of environmental stringency and find a positive relationship with productivity growth (e.g., Gray & Shadbegian, 2003; Rubashkina et al., 2015; Zhao & Sun, 2016, Manello, 2017), More broadly, a recurring pattern in contemporary PH literature shows that studies offering stronger support for the strong PH often rely on productivity indicators with a green component, such as green total factor productivity (GTFP), environmental total factor productivity (ETFP), or carbon productivity. For example, Xie (2020) confirms the strong PH using ETFP, and Wang et al. (2019) validate it through green productivity under moderate policy stringency; related evidence indicates that ETS policies can significantly improve green development efficiency (Wang et al., 2019; Zhang et al., 2021).

8.2 TESTING HYPOTHESES

8.2.1 Hypothesis 1 (H1)

H1: There are significant differences in compliance costs between Slovenia and Croatia.

Hypothesis 1 (H1), which posits significant differences in compliance costs of environmental regulation between Slovenia and Croatia, was subject to statistical testing. To assess whether to use parametric or non-parametric tests, the normality of the compliance cost variables (financial, substantive, and information) was examined using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The results showed statistically significant deviations from normality ($p < 0.001$), indicating that the assumption of normal distribution was not met. Both natural logarithm (ln) and base-10 logarithm (log10) transformations were applied to reduce skewness in the compliance cost variables, and subsequent Kolmogorov–Smirnov and Shapiro–Wilk tests were conducted again to assess normality. However, even after transformation, the variables continued to exhibit significant deviations from a normal distribution. Since the independent sample t-test requires normally distributed data, and this assumption was clearly violated, a non-parametric alternative was required. Therefore, the Mann–Whitney U test was employed to test H1, as it does not rely on normality and is suitable for comparing differences in compliance costs of environmental regulation between two independent groups, in this case Slovenia and Croatia.

Results of Mann–Whitney U tests based on non-transformed compliance cost variables (Table 16) showed that differences were not significant for financial (U = 6806, Z = −1.225, p = .221) and substantive costs (U = 6918.5, Z = −1.106, p = .269). For information costs, Slovenian firms exhibited higher ranks than Croatian firms (U = 6295, Z = −2.119, p = .033; Monte Carlo two-tailed p = .033), indicating weak evidence that information-related compliance costs are higher in Slovenia. However, under a Bonferroni correction for three simultaneous tests (α ≈ .0167), this difference would not remain statistically significant.

Table 16: Mann–Whitney U tests for cross-country differences in compliance cost variables

Compliance Cost (CC) Category	Mean Rank (SI) (n=198)	Mean Rank (HR) (n=76)	U	Z	p (2-tailed)	Monte Carlo p (2-tailed)
Financial CC	141.13	128.05	6806.0	−1.225	0.221	0.225
Substantive CC	134.44	145.47	6918.5	−1.106	0.269	0.272
Information CC	143.71	121.33	6295.0	−2.119	0.034**	0.033

Note: Differences between groups are significant at the level <0.1 (*), <0.05 (**), <0.01 (***).

Source: own elaboration.

Therefore, according to the results of Mann–Whitney U-tests with a Bonferroni correction, no statistically significant country differences were identified for financial or substantive compliance costs, while weak evidence for higher information costs in Slovenia did not survive the conservative correction for multiple tests. Consequently, **Hypothesis 1 (H1) is rejected**, as it is not supported for financial, substantive, or information cost categories.

8.2.2 Hypothesis 2 (H2a & H2b)

In line with the research question 4 the following hypotheses were formed:

Hypothesis 2a (H2a): Internal factors affect the compliance costs of environmental regulation and their perception in Slovenia.

Firm size (FS) significantly increases CER (β = 0.067, p < 0.001) and significantly reduces CER_P (β = –0.203, p = 0.028), while non-financial measures (NFM) reduce CER (β = 0.043, p = 0.044). These results confirm that among a set of potential internal

firm characteristics influence only a few influences either compliance costs or their perception or both. Therefore, **Hypothesis H2a is partially supported.** Although not all internal variables in the model are significant, the presence of multiple meaningful internal predictors provides sufficient evidence to partially validate H2a. Internal factors, driven by firm size and non-financial measures, do affect compliance costs of environmental regulation and their perception. On the other hand, internal factors such as economic sector, financial measures, international involvement and digitalization level, were excluded from the final empirical model as no impact was found on any of the dependent variables, namely costs of environmental regulation or costs of environmental perception.

Hypothesis 3a (H3a): External factors significantly affect compliance costs of environmental regulation and their perception in Slovenia.
Environmental obligations (EO) ($\beta = 0.319$, $p < 0.001$) and regulatory complexity (RC) ($\beta = 0.035$, $p < 0.001$) significantly increase CER, and RC also increases CER_P ($\beta = 0.036$, $p < 0.001$). These findings provide strong empirical confirmation that external regulatory and institutional conditions influence both the financial burden of compliance and firms' subjective evaluations of regulatory pressure. However, not all of identified external factors were found to have significant impact, therefore **Hypothesis H3a is partially supported**. External factors significantly influence both compliance costs of environmental regulation and their perception in Slovenia, with environmental obligations and regulatory complexity emerging as key determinants. Institutional quality was not found to have any impact on compliance costs.

8.2.3 Hypothesis 3 (H3a & H3b)

H3a: Internal factors significantly affect compliance costs of environmental regulation and their perception in Croatia.

The Croatian model includes firm size (FS) as the internal determinant and shows a statistically significant positive effect on compliance costs of environmental regulation ($\beta = 0.636$; $p < 0.001$). This confirms that at least one key internal factor influences compliance costs. However, FS does not appear as a significant predictor of CER_P in the Croatian results provided, meaning that internal factors are confirmed primarily for objective costs, not for perceptions within this model specification. Consequently, H2b is best interpreted as supported with respect to compliance costs but not fully supported regarding their perceptions. **Hypothesis H2b is partially supported.** Only one internal factor was incorporated and only its effect on CER, while it did not affect CER_P at all, was significant. Internal characteristics clearly matter for compliance cost levels, but no impact was found on perceptions within the Croatian model specification. Note that the Croatian SEM model was constrained by the limited sample size, and

some constructs could not be included; these omitted constructs may nonetheless have had some influence on the dependent variables.

H3b: External factors significantly affect compliance costs of environmental regulation and their perception in Croatia.

External factors affect compliance costs of environmental regulation and their perception in Croatia. External factors in the Croatian model, such as regulatory complexity (RC) and quality of institutions (QI), significantly influence the dependent variables. RC significantly increases both absolute compliance costs ($\beta = 0.345$, $p < 0.001$) and perceived costs ($\beta = 0.385$, $p < 0.001$), confirming that regulatory conditions shape both objective burden and subjective evaluation. In addition, QI significantly affects CER_P ($\beta = 0.419$, $p < 0.001$), indicating that institutional context matters particularly for firms' perceptions of regulatory burden. Together, these results provide clear empirical confirmation of H3b. **Hypothesis H3b is partially supported**. External factors consistently influence both the objective and subjective dimensions of compliance costs of environmental regulation in Croatia.

8.2.4 Hypothesis 4 (H4)

H4: The level of compliance costs of environmental regulation affects firms' productivity.

The SEM results provide evidence that the level of compliance costs of environmental regulation (CER) significantly affects firm productivity (PROD_ACT) and does so in a positive direction ($\beta = 0.418$, $p < 0.001$). This outcome aligns with the strong version of the Porter Hypothesis, which posits that well-designed environmental regulation can induce efficiency improvements and innovation that ultimately enhance competitiveness and productivity. Nevertheless, given the modest explained variance of productivity, the supported hypothesis should be understood as evidence of a significant positive link rather than proof that compliance costs are among the main drivers of productivity outcomes. Therefore, **Hypothesis H4 is supported**.

Table 17: Decisions on hypotheses

Hypothesis	Decision
H1: There are significant differences in compliance costs of environmental regulation between Slovenia and Croatia.	Rejected
H2a: Internal factors affect compliance costs of environmental regulation and their perception in Slovenia.	Partially supported
H3a: External factors significantly affect compliance costs of environmental regulation and their perception in Slovenia.	Partially supported
H2b: Internal factors significantly affect compliance costs of environmental regulation and their perception in Croatia.	Partially supported
H3b: External factors significantly affect compliance costs of environmental regulation and their perception in Croatia.	Partially supported
H4: The level of compliance costs of environmental regulation affects firms' productivity	Supported

Source: own elaboration

9 CONCLUSION

“The Royal Swedish Academy of Science pointed out that “we can no longer discuss our economic future without considering the enormous costs of climate change”. This provides further confirmation to the fact that climate change is strongly affecting the global economy and points out an urgent need to reduce the environmental costs of production and consumption activities and better integrate the environmental issues in economic theories and practices.” (Ghisellini et al, 2021)

In line with recent EU strategic documents, such as the Draghi Report and the EU’s Competitive Compass, the findings of this thesis align with their central message: competitiveness must be strengthened through innovation, while clean technology producers require support to translate innovative activity into manufacturing leadership. The Draghi Report highlights three transformational imperatives: closing the innovation gap, establishing a joint roadmap for decarbonization and competitiveness, and reducing excessive dependencies while enhancing security. The first two imperatives emphasize the urgency of reviving Europe’s innovation cycle. To ensure that the future of industry is “made in Europe,” regulation, including environmental regulation, should be designed to actively support this transition. Furthermore, decarbonization policies, when aligned with industrial, competition, economic, and trade policies, can act as powerful drivers of growth. This perspective supports the Clean Industrial Deal, which seeks to position the EU as an attractive manufacturing hub, including for energy-intensive sectors, while promoting clean technologies and new circular business models.

To achieve these goals, EU regulation must remain proportionate, safeguarding industrial capacity in key technological sectors while reducing risks from external dependencies that threaten security and investment. The EU’s Competitive Compass identifies several horizontal enablers essential to competitiveness, foremost among them regulatory simplification, which includes reducing burdens, enhancing flexibility, and accelerating innovation. Complementary measures include removing barriers to the Single Market, mobilizing financing, investing in skills and quality jobs, and improving policy coordination. Among these, regulatory simplification is particularly critical for scaling innovation, strengthening resilience, and safeguarding Europe’s competitiveness in an uncertain geopolitical context.

Against this backdrop, environmental regulations, ranging from command-and-control instruments to market-based approaches, aim to balance environmental protection with economic development. Yet significant barriers remain to achieving both

objectives simultaneously (Nikos et al., 2024). Stricter regulation alone does not guarantee success, as the effectiveness of implementation plays a significant role. Efficiency must therefore be redefined beyond cost reduction and profitability to encompass sustainability, as reflected in the concept of green productivity (Koc & Şimşek, 2021). This doctoral thesis contributes to this debate by examining how firms in Slovenia and Croatia manage compliance costs of environmental regulation, the magnitude of these costs, their perception, and their impact on productivity when used as a proxy for regulatory stringency.

The thesis demonstrates that environmental regulation can influence firms through a combination of direct compliance burdens and broader institutional conditions. Across Slovenia and Croatia, firms experience both financial and administrative pressures, shaped not only by regulatory design but also by organizational capacity, institutional quality, and perceived regulatory complexity. These perceptions matter as they mediate how firms respond to regulatory demands, invest in capabilities, and evaluate the broader implications for competitiveness.

Using structural equation modelling (SEM), the study shows that certain internal factors, namely firm size and to some extend organizational environmental preparedness, and external factors such as regulatory complexity and environmental obligations significantly shape both compliance costs of environmental regulation and their perceived burden. The results also offer marginal support for the strong version of the Porter Hypothesis, as compliance costs of environmental regulation are positively associated with productivity, although many other determinants clearly influence productivity outcomes. This suggests that environmental regulation can motivate adaptive improvements, but its effects depend on regulatory clarity, proportionality, and the broader institutional environment.

Overall, the thesis contributes to understanding how firms in different institutional contexts navigate environmental regulation, showing that both objective costs and managerial perceptions shape compliance behavior and competitiveness. By highlighting the importance of clear, stable, and proportionate regulation, the findings offer guidance for policymakers seeking to reconcile competitiveness with sustainability and support a regulatory environment conducive to innovation, resilience, and long-term economic and environmental goals.

9.1 ORIGINAL CONTRIBUTION TO SCIENCE

This doctoral dissertation makes several original contributions to the scientific literature on environmental regulation and compliance costs. First, this dissertation represents the primary theoretical study, as reflected in its title “The holistic model of compliance

costs of environmental regulation and companies' productivity", that provides a comprehensive and in-depth examination of all internal and external determinants of compliance costs of environmental regulation and their perception by firms. Furthermore, it develops an integrated theoretical framework for assessing the impact of compliance costs on firm productivity.

Second, it builds upon, yet substantially extends, the study by Kotnik et al. (2020), in which binary logistic regression was employed to estimate factors affecting compliance costs. In contrast, the present research employs the Standard Cost Model (SCM) methodology, which is widely recognized as the most suitable approach for comprehensively estimating the size of compliance costs.

Third, the research goes beyond objective cost measurement by examining managers' perceptions of compliance costs and identifying the factors that shape these perceptions. This perspective makes a notable contribution to managerial cognition theory, which underscores the importance of managerial attitudes towards environmental issues and their role in shaping strategic responses.

Fourth, the dissertation further advances methodological practice by employing Structural Equation Modelling (SEM), identified as the most appropriate tool for examining and quantifying the relationships and impacts among multiple interrelated factors. The cross-country design, encompassing both Slovenia and Croatia, provides advancements in understanding compliance costs across different institutional and regulatory contexts.

Finally, by incorporating productivity into the analytical framework, the study enables an empirical test of the strong version of the Porter Hypothesis, thereby contributing to the ongoing academic debate on whether environmental regulation can simultaneously enhance environmental and economic performance.

9.2 POLICY IMPLICATIONS

Based on the research findings, the following policy measures are proposed. Firstly, policymakers should prioritize streamlining reporting by consolidating overlapping regulations and investing in digital systems to reduce administrative complexity. Furthermore, increasing transparency in compliance costs of environmental regulation reporting with clear categorization and user-friendly tools would help to improve compliance understanding and efficiency across firms of all sizes. Recognizing that smaller firms perceive regulatory costs as more burdensome due to limited resources and fixed compliance costs, tailored support for SMEs should be implemented to reduce financial strain. Measures such as exemptions, simplified compliance

procedures, tax benefits, green subsidies, and R&D tax credits could encourage innovation and promote sustainable practices. Additionally, integrating environmental accounting could help firms more effectively track environmental regulation costs and align them with their broader financial strategies. However, while these measures can enhance compliance efficiency, challenges such as limited administrative capacity, potential regulatory capture, or uneven access to digital tools and services may limit their effectiveness in practice.

Secondly, to enhance regulatory effectiveness, governments should adopt a multi-faceted approach that prioritizes collaboration, awareness, transparency, and adaptability. Emphasizing flexible and market-based environmental regulations, with a focus on quality over quantity, could help address the significant impact of regulatory complexity on firms' perceptions of costs. Initiatives like the EU Commission's REFIT program, designed to simplify the regulatory framework and reduce administrative burdens, provide a solid foundation for this approach. Additionally, in line with the Triple Helix model, which emphasizes regional partnerships among government, industry, and academia, regulatory objectives could be better aligned through shared compliance hubs that provide common resources and expertise (Kotnik & Klun, 2025). The findings that regulatory complexity and firm size significantly shape both perceived and actual compliance costs underscores the need for coordinated multi-stakeholder solutions within the Triple Helix framework to reduce administrative burdens effectively. Moreover, such hubs could standardize guidance, streamline digital reporting through one-stop portals, and offer targeted training for SMEs, thereby improving compliance quality while lowering costs. Promoting proactive disclosure frameworks that reward firms for exceeding reporting standards, such as through public recognition, fosters trust and accountability which could also spur positive results for environmental and financial measures as well.

Thirdly, to enhance managers’ awareness and engagement, policymakers should emphasize the long-term benefits of compliance, including waste reduction, efficiency gains, and business sustainability. Eco-industrial parks represent one potential solution for fostering collaboration and resource sharing among businesses, helping to reduce waste and pollution while supporting sustainable development and increasing overall awareness. As Qu et al. (2015) suggest, this can be achieved only through government support in establishing environmental norms and guidelines for key firms. Involving industry leaders in policy development would ensure practical insights inform decisions, while showcasing their success stories highlights the benefits of compliance. Furthermore, community engagement frameworks enhance the visibility of environmental efforts, encouraging firms to exceed standards and build trust with stakeholders (Lah & Kotnik, 2025).

9.3 THEORETICAL AND EMPIRICAL LIMITATIONS OF THE DISSERTATION

Despite the contributions made, several limitations should be acknowledged. From a theoretical perspective, the research primarily focused on objective factors influencing compliance costs, deliberately excluding subjective factors such as managerial traits, attitudes, and values. However, within the framework of managerial cognition theory, such subjective factors may play an important role in shaping perceptions and responses to environmental regulation. Including these variables in future research could enrich the explanatory power of the model and provide deeper insight into the behavioral aspects of regulatory compliance.

Further, the sample size for the Croatian model was relatively small, which may have reduced the statistical power of the analyses and limited the ability to detect smaller effects. As a result, multi-group analysis could not be performed due to the insufficient Croatian subsample. In an optimal scenario, a single structural model applicable across countries could be developed, ideally incorporating a larger number of manifest indicators forming latent constructs. However, this was not feasible within the constraints of the current dataset. Moreover, while both countries share similar environmental regulatory frameworks as other EU member states, due to the transposition of EU environmental directives, this geographical limitation may affect the generalizability of the results to different institutional, cultural, or economic contexts. Although the sectoral and size distribution of the sample aligns reasonably well with the overall population (see Table 4 and Table 5 for details), potential heterogeneity across sectors, firm sizes, or regional characteristics may still influence the statistical power of the analysis and limit the generalizability of the results.

An additional empirical limitation concerns the definition of the sampling frame in Slovenia. The study used the largest available administrative register of environmentally regulated firms; however, this register does not include all entities subject to environmental regulation, as environmental permit holders are recorded in fragmented administrative sources. Consequently, some regulated firms may be underrepresented in the sample, which should be taken into account when interpreting the findings.

Furthermore, as with all business surveys based on self-reported data, this study faces several inherent limitations: many firms lack internal cost-accounting systems to accurately isolate environmental-related costs, and respondents may misestimate the time and expenses of compliance either intentionally or unintentionally. Moreover, perceptions can be biased, with some respondents overstating criticisms, especially when business performance is weak. Besides, the survey results may also be affected

by selection bias if the sample disproportionately reflects firms that were more accessible or more willing to participate.

Additionally, the inclusion of productivity, which was measured as firm's turnover per employee divided by the average productivity of the activity in which the firm operates, as a single-indicator (manifest) variable posed methodological constraints. This approach limited the model's ability to capture the multidimensional nature of productivity and contributed to a lower model fit. Developing productivity and, in future extensions, innovation activity, as latent construction measured through multiple indicators would enhance the precision and robustness of the analysis.

Finally, the cross-sectional nature of the data restricts the capacity to draw causal inferences, as the observed relationships reflect associations at a single point in time. Collecting longitudinal data, combined with larger samples, a mix of objective and subjective measures, and alternative SEM approaches, would enable a more rigorous assessment of temporal dynamics, including potential lagged effects of environmental regulation on productivity and innovation, while also reducing the risk of systematic bias and enhancing the generalizability of the findings.

9.4 FUTURE RESEARCH

Future research could extend the present study in several meaningful directions, many of which have already been outlined in the discussion of research limitations. The questionnaire could be expanded to include items that measure the effects of environmental regulation on firms' innovation activities, sustainability practices, eco-efficiency, and long-term competitiveness, treating these as latent constructs rather than single-indicator (manifest) variables. As demonstrated in the present study, using productivity as a manifest variable posed limitations, including a lower overall model fit, which could potentially be addressed through a latent variable design. Such an extension would provide a stronger empirical basis for testing the Porter Hypothesis.

Regarding the interpretation of data, the survey structure of the questionnaire already allows interpreting compliance costs in relation to different policy types i.e. command and control, market-based, or voluntary. Such an approach has potential to more detailed assessment of how different regulatory instruments influence not only the level of compliance costs but also firms' investment behavior, innovation, and environmental efficiency, thereby enhancing the policy relevance of the analysis. However, to implement that, additional questions should be incorporated in the questionnaire that would allow to form new variables specifically related to innovation activities, eco-efficiency, and long-term competitiveness.

Additional questions might also explore managers' perceptions of how regulation influences innovation, productivity, strategic decision-making, resource allocation, and investment in green technologies, ideally supported by concrete examples to improve the accuracy and interpretability of responses. A qualitative component, such as in-depth interviews or case studies, could be incorporated to gain a richer understanding of the strategic importance that firms assign to compliance costs of environmental regulation and the mechanisms through which these costs influence managerial behavior, innovation adoption, and operational adjustments.

Furthermore, future research could broaden the cross-country scope to include additional national contexts, enabling more robust comparative analysis across diverse institutional, regulatory, and economic environments. Incorporating a longitudinal component by repeating the survey over a longer time span would further strengthen the ability to track dynamics in compliance costs and their effects over time.

Thus, combining objective and subjective measures, larger samples, mixed-method approaches, and longitudinal designs would reduce the risk of systematic bias, improve model robustness, enhance generalizability, and enable assessment of causal and lagged effects of environmental regulation. Such an approach would help determine whether firms ultimately experience only higher compliance costs or whether innovation, efficiency, and sustainability gains emerge over time to offset these costs, providing stronger evidence for policy and managerial decision-making.

DALJŠI POVZETEK

HOLISTIČNI MODEL STROŠKOV PREVERJANJA SKLADNOSTI OKOLJSKE REGULATIVE IN PRODUKTIVNOST PODJETIJ

Okoljska regulativa ima vse bolj pomembno vlogo pri oblikovanju strategij podjetij, njihove konkurenčnosti in dolgoročne vzdržnosti, zlasti v gospodarstvih, ki so šla skozi proces strukturnih transformacij in vključevanje v širše evropske regulativne okvirje. Medtem ko je okoljski in družbeni pomen tovrstnih regulativ že uveljavljen, njihove gospodarske posledice, zlasti stroški, ki jih okoljska regulativa povzroča podjetjem, ostajajo predmet stalnih akademskih in političnih razprav. Ta doktorska disertacija naslavlja tematiko z raziskavo dejavnikov, ki vplivajo na stroške skladnosti podjetij z okoljsko regulativo, ter zaznave menedžerjev o teh stroških, hkrati pa ocenjuje njihov vpliv na produktivnost podjetij v Sloveniji in na Hrvaškem. S tem odgovarja na potrebo po bolj celovitem in teoretično utemeljenem razumevanju, kako okoljska regulativa vpliva na podjetja v različnih institucionalnih okoljih.

Raziskava nadgrajuje obstoječe študije s področja okoljske ekonomike in regulativnega upravljanja z uporabo integriranega metodološkega okvira, ki vključuje večdimenzionalno naravo stroškov skladnosti z okoljsko regulativo. Predhodna literatura se je namreč osredotočala predvsem na določene dejavnike in določene vidike teh stroškov, najpogosteje na administrativne stroške, le malo študij je na holističen način ocenilo širši spekter stroškov skladnosti z okoljsko regulativo, medtem ko je sistematična vključitev vpliva na menedžerske zaznave ter produktivnost podjetij novost. Primerjalne meddržavne analize so še posebej redke, predvsem v kontekstu držav srednje in vzhodne Evrope, za katera je značilna raznolikost glede institucionalnih ureditev, administrativnih zmogljivostih in kakovosti regulativ.

Ta disertacija naslavlja vrzeli z analizo rezultatov anketnih podatkov, ki zajemajo 198 slovenskih podjetij in 76 hrvaških podjetij, zbranih z uporabo strukturiranega anketnega vprašalnika ter obdelanih z uporabo standardiziranih in teoretično konsistentnih pristopov meritev.

Za kvantifikacijo obsega in sestave stroškov skladnosti z okoljsko regulativo raziskava uporablja Standard Cost Model (SCM), uveljavljeno mednarodno metodologijo, ki omogoča oceno treh vrst stroškov skladnosti: finančnih, vsebinskih in informacijskih stroškov, povezanih z okoljsko regulativo. Ti zajemajo stroške, ki izhajajo iz obveznosti poročanja, monitoringa, pridobivanja dovoljenj, tehnoloških prilagoditev ter drugih regulativnih zahtev, s čimer je omogočena celovita ocena skupnih stroškov skladnosti

z okoljsko regulativo. Obenem so bile zbrane in analizirane tudi zaznave menedžerjev o teh stroških. Tovrsten dvojni pristop razkriva tako ekonomsko realnost regulativnih obveznosti kot tudi kognitivne okvire, skozi katere menedžerji interpretirajo te obveznosti. Dimenzija percepcije okoljskih stroškov namreč postaja vse pomembnejša pri razumevanju strateških odzivov podjetij na okoljsko regulativo.

Teoretični okvir disertacije združuje institucionalno teorijo, teorijo na temelju virov (RBV) ter teorijo menedžerske kognicije. Institucionalna teorija omogoča razumevanje, kako zunanji pritiski, kot so regulativna kompleksnost, okoljske obveznosti in splošna kakovost institucij, oblikujejo vedenje podjetij. Teorija na temelju virov (RBV) izpostavlja, kako notranje značilnosti podjetij, vključno z velikostjo, finančnimi in nefinančnimi kazalniki ter stopnjo digitalizacije, vplivajo na raven stroškov skladnosti in njihovo zaznavo. Teorija menedžerske kognicije pa povezuje objektivne in zaznane stroške ter pojasnjuje, kako odločevalci interpretirajo okoljske zahteve in kako te zaznave vplivajo na njihove strateške in operativne odločitve. Takšen integriran pristop omogoča celovitejše razumevanje, kako podjetja doživljajo, interpretirajo in se odzivajo na okoljsko regulativo.

Za empirično preverjanje relacij med različnimi notranjimi in zunanjimi dejavniki stroškov skladnosti z okoljsko regulativo, njihovim zaznanim bremenom ter produktivnostjo podjetij raziskava uporablja strukturno enačbeno modeliranje (SEM). Oblikovani modeli so bili najprej ocenjeni ločeno za Slovenijo in Hrvaško, kar je omogočilo meddržavne razlike v institucionalnem in gospodarskem kontekstu, na koncu pa je bil model za ocenjevanje vpliva stroškov skladnosti na produktivnost ocenjen tudi na skupnih podatkih z namenom zagotovitve večje robustnosti rezultatov.

S pregledom literature so bili identificirani sledeči notranji dejavniki: velikost podjetja (FS), gospodarska dejavnost (ES), finančni kazalniki (FM), nefinančni kazalniki (NFM), stopnja digitalizacije (DL) in mednarodna vključenost (II). Med zunanje dejavnike so se uvrstili: okoljske obveznosti (EO), kakovost institucij (QI) in kompleksnost regulativ (RC). Glede na rezultate raziskave, je med notranjimi dejavniki izstopal dejavnik velikost podjetja (FS), z močnim in pozitivnim vplivom na stroške skladnosti z okoljsko regulativo, kar kaže na to, da imajo večja podjetja višje stroške skladnosti. Hkrati pa dejavnik negativno vpliva na zaznavo teh stroškov, saj jih večja podjetja dojemajo kot manj obremenjujoča. To je lahko bodisi posledica ekonomij obsega, boljših razpoložljivih virov in bolj razvitih mehanizmov skladnosti, ki so na voljo večjim podjetjem, ali pa dejstva, da so stroški skladnosti do določene mere fiksni. Nasprotno se manjša podjetja pogosteje soočajo s težavami pri izpolnjevanju regulativnih zahtev ter zaznavajo regulativne stroške kot bolj obremenjujoče. Nefinančni kazalniki (NFM) kažejo statistično značilno negativno povezanost s stroški skladnosti z okoljsko regulativo, kar nakazuje, da vlaganja v »mehke« ukrepe skladnosti, kot so razvoj zmogljivosti, certificiranje in podpora pri implementaciji, delujejo kot mehanizmi za

zmanjševanje stroškov ter dopolnjujejo ali delno nadomeščajo dražje tehnološke in procesne prilagoditve. Posledično lahko podjetja s proaktivnimi okoljskimi strategijami dosežejo določeno znižanje regulativnih stroškov, kar poudarja potencialne koristi spodbujanja nefinančnih ukrepov, kot so certifikacijske sheme in programi ozaveščanja, kot dela širše regulativne strategije, poleg zgolj uporabe prisilnih regulativnih mehanizmov. Preostali notranji dejavniki (gospodarska dejavnost, finančni kazalniki, stopnja digitalizacije in mednarodno poslovanje) bodisi niso izkazovali osnovnih statističnih predpostavk za vključenost v model bodisi so zmanjšali stabilnost statističnega modela. To nakazuje, da je njihov vpliv na stroške skladnosti šibkejši ali posreden, ko so upoštevani dominantnejši dejavniki.

Empirični rezultati razkrivajo več pomembnih spoznanj, zlasti z vidika primerjave med državama. Prvič, velikost podjetja se v obeh državah izkazuje kot konsistenten dejavnik stroškov skladnosti, saj imajo večja podjetja višje absolutne stroške zaradi obsežnejšega poslovanja in bolj kompleksnih regulativnih zahtev. Vendar pa le v Sloveniji večja podjetja te stroške dojemajo kot manj obremenjujoče, kar nakazuje na razlike v administrativnih sposobnostih, izkušnjah z regulativnimi postopki ali strategijah razporejanja virov. Drugič, regulativna kompleksnost se je izkazala kot najmočnejši zunanji dejavnik, ki vpliva tako na dejanske kot na zaznane stroške v obeh državah, pri čemer je ta vpliv izrazitejši v Sloveniji. Tretjič, obseg okoljskih obveznosti pomembno povečuje dejanske in zaznane stroške skladnosti v Sloveniji, medtem ko je ta učinek na Hrvaškem zanemarljiv, kar lahko odraža razlike v intenzivnosti nadzora, strukturi gospodarstva ali stopnji uveljavljanja okoljskih predpisov. Četrtič, kakovost institucij vpliva zgolj na zaznane stroške skladnosti na Hrvaškem, kjer nižja raven zaupanja v institucije krepi subjektivni občutek regulativnega bremena.

Med pomembnejše prispevke disertacije sodi vključitev produktivnosti podjetij kot končnega odvisnega dejavnika, ki omogoča preverjanje močne različice Porterjeve hipoteze. V nasprotju s predpostavko, da okoljska regulacija zmanjšuje konkurenčnost podjetij, rezultati nakazujejo omejeno podporo predpostavki, da lahko stroški skladnosti z okoljsko regulativo, ki so uporabljeni kot približek strogosti regulative, vplivajo na višjo produktivnost. Čeprav so zaznani kot obremenjujoči, lahko ti stroški skladnosti, skladno s Porterjevo hipotezo, podjetja spodbudijo k izboljšanju učinkovitosti ter procesnim ali proizvodnim inovacijam, ki lahko delno ali v celoti izravnajo prvotno finančno breme. Ugotovljeni učinki na produktivnost, čeprav zmerni, govorijo v prid tej hipotezi, da lahko dobro zasnovane okoljske regulacije prispevajo k dolgoročnim izboljšavam poslovne uspešnosti, zlasti kadar podjetja razvijejo ustrezne notranje zmožnosti za upravljanje skladnosti.

Poleg empiričnih ugotovitev disertacija prispeva tudi nekaj teoretičnih novosti. Razvit je celovit konceptualni model, ki integrira notranje značilnosti podjetij, zunanje institucionalne pritiske ter menedžerske zaznave v enoten analitični okvir. To

predstavlja prvo sistematično modeliranje objektivnih stroškov skladnosti in njihove subjektivne percepcije skupaj z njihovimi učinki na produktivnost in s tem pomembno nadgrajuje obstoječe teoretične razprave o vplivu okoljske regulacije na gospodarstvo. Metodološko raziskava nadgrajuje uporabo Standard Cost Modela v povezavi s SEM-om ter prikazuje vrednost kombiniranja ekonomskih merilnih tehnik s kognitivnim in institucionalnim pristopom.

Raziskava se sooča tudi z določenimi omejitvami, ki hkrati predstavljajo izhodišča za prihodnje raziskave. Velikost vzorca, zlasti za Hrvaško, omejuje posploševanje pridobljenih rezultatov. Meddržavna primerjava v nasprotju s panelnimi podatki, preprečuje bolj celovito oceno dolgoročnih ali dinamičnih učinkov regulacij, kar je pomembno z vidika Porterjeve hipoteze. Tako bi lahko prihodnje študije na tem področju temeljile na večjih in bolj raznolikih vzorcih, longitudinalnim pristopom ter vključitvi dodatnih latentnih konstruktov, kot so inovacijske zmožnosti, eko-učinkovitost in prakse trajnosti. To bi hkrati omogočilo ocene vpliva posameznih vrst instrumentov na ključne kazalnike, ki jih naslavlja okoljska regulativa. Tudi razširitev geografske pokritosti na druge države bi omogočila bolj poglobljene primerjalne analize ter pripomogla k boljšemu razumevanju, kako institucionalne konfiguracije oblikujejo regulativne izkušnje podjetij.

Skratka, disertacija ponuja celovito in teoretično utemeljeno analizo stroškov okoljske skladnosti z okoljsko regulativo ter njihovih posledic za podjetja v Sloveniji in na Hrvaškem. Ugotovitve predstavljajo pomembne informacije tako za oblikovalce politik kot za podjetniški sektor. Poudarjajo pomen jasnosti regulativ, kakovosti institucij in menedžerskega vključevanja pri oblikovanju dejanskega in zaznanega bremena okoljske regulacije. V omejenem obsegu izpostavlja tudi podporo hipotezi, da lahko stroški skladnosti z okoljsko regulativo, kot približek strogosti okoljskih regulativ, ob ustreznem institucionalnem in organizacijskem okviru prispevajo k izboljšanju produktivnosti.

Ključne besede: Okoljska regulativa, Stroški usklajevanja, Produktivnost podjetja, Standardni stroškovni model (SCM), Modeliranje strukturnih enačb (SEM), Porterjeva hipoteza

EXTENDED ABSTRACT

Environmental regulation plays an increasingly prominent role in shaping the behavior, competitiveness, and long-term sustainability of firms, especially in economies that have undergone structural transitions and integration into broader European regulatory frameworks. While the environmental and societal importance of such regulations is well established, their economic implications, particularly the compliance costs imposed on firms, remain a subject of ongoing academic and policy debate. This dissertation investigates these issues by identifying the factors that influence both the compliance costs of environmental regulation borne by firms and managers' perceptions of these costs, as well as by evaluating their implications for productivity in Slovenia and Croatia. In doing so, it responds to the need for a more comprehensive and theoretically grounded understanding of how environmental regulations affect firms in diverse institutional contexts.

The research builds upon existing studies in environmental economics and regulatory governance by applying an integrated methodological framework to capture the multidimensional nature of compliance costs of environmental regulation. Prior literature has predominantly focused on specific factors and selected cost dimensions, most often administrative costs, while few studies have assessed the full spectrum of compliance costs in a holistic manner. The systematic incorporation of effects on managerial perceptions and on firms' productivity is, moreover, a novel contribution. Furthermore, cross-country comparisons in this domain remain scarce, especially in the context of Central and Eastern European economies, where institutional environments, administrative capacities, and regulatory quality vary considerably.

This dissertation addresses these gaps by analyzing a uniquely assembled dataset covering 198 Slovenian firms and 76 Croatian firms, collected via structured survey questionnaire and estimated through standardized and theoretically consistent measurement approaches.

To quantify the magnitude and composition of compliance costs of environmental regulation, the study employs the Standard Cost Model (SCM), an established international methodology that allows for reliable estimation of financial, substantive, and information costs associated with environmental regulation. These include costs arising from reporting obligations, monitoring, obtaining permits, technological adaptations, and other regulatory requirements, thereby enabling a comprehensive assessment of total compliance costs of environmental regulation. Parallel to this objective estimation, managers' perceptions of compliance costs were collected and analyzed. This dual approach highlights not only the economic reality of regulatory obligations but also the cognitive framing through which managers interpret these

obligations, which is an increasingly important dimension in understanding strategic corporate responses to environmental regulation.

The theoretical framework of the dissertation integrates institutional theory, the resource-based view (RBV), and managerial cognition theory. Institutional theory provides the basis for understanding how external pressures, such as regulatory complexity, environmental obligations, and the overall quality of institutions, shape firm behavior. The RBV highlights how internal firm characteristics, including size, financial and non-financial measures, and digitalization, influence the level of compliance costs and their perception. Managerial cognition serves as a bridge between objective and perceived costs, explaining how decisionmakers interpret environmental requirements and how these perceptions influence strategic and operational choices. This integrated perspective enables a more comprehensive understanding of how firms experience, interpret, and respond to environmental regulation.

To empirically test the relationships among the various internal and external determinants of compliance costs of environmental regulation, their perceived burden, and firm productivity, the dissertation employs Structural Equation Modeling (SEM). SEM is particularly well suited for this purpose, as it allows for simultaneous assessment of multiple latent constructs, complex causal pathways, and mediating effects. The model was first estimated separately for Slovenia and Croatia to account for cross-country differences in institutional and economic contexts. Finally, the model assessing the effect of compliance costs on productivity was also estimated using pooled data in order to ensure greater robustness of the results.

A literature review identified the following internal factors: firm size (FS), economic sector (ES), financial measures (FM), non-financial measures (NFM), level of digitalization (DL), and international involvement (II). External factors included environmental obligations (EO), quality of institutions (QI), and regulatory complexity (RC). According to the research results, firm size (FS) emerged as the most prominent internal factor, exerting a strong and positive effect on compliance costs of environmental regulation, indicating that larger firms incur higher compliance costs. At the same time, firm size negatively affects the perception of these costs, as larger firms tend to perceive them as less burdensome. This may be due to economies of scale, better availability of resources, and more developed compliance mechanisms accessible to larger firms, or to the fact that compliance costs are, to some extent, fixed. In contrast, smaller firms more frequently face difficulties in meeting regulatory requirements and perceive regulatory costs as more burdensome. Non-financial measures (NFM) show a statistically significant negative relationship with compliance costs of environmental regulation, suggesting that investments in “soft” compliance measures, such as capacity building, certification, and implementation support, act as cost-mitigating mechanisms and complement or partially substitute more expensive

technological and procedural adjustments. Consequently, firms pursuing proactive environmental strategies may achieve a certain reduction in regulatory costs, highlighting the potential benefits of promoting non-financial measures, such as certification schemes and awareness-raising programs, as part of a broader regulatory strategy, in addition to relying solely on coercive regulatory instruments. The remaining internal factors (economic sector, financial measures, level of digitalization, and international involvement) did not meet the basic statistical assumptions required for inclusion in the model or reduced the model's statistical stability. This indicates that their impact on compliance costs is weaker or indirect, once more dominant factors are considered.

The empirical results reveal several important insights, particularly from a cross-country comparative perspective. First, firm size proves to be a consistent determinant of compliance costs in both countries, as larger firms incur higher absolute costs due to more extensive operations and more complex regulatory requirements. However, only in Slovenia do larger firms perceive these costs as less burdensome, pointing to differences in administrative capacities, experience with regulatory procedures, or resource allocation strategies. Second, regulatory complexity emerges as the strongest external factor influencing both actual and perceived compliance costs in both countries, with a more pronounced effect in Slovenia. Third, the scope of environmental obligations significantly increases actual and perceived compliance costs in Slovenia, while this effect is negligible in Croatia, which may reflect differences in enforcement intensity, economic structure, or the degree of implementation of environmental regulations. Fourth, the quality of institutions affects only the perceived compliance costs in Croatia, where lower levels of trust in institutions reinforce the subjective sense of regulatory burden.

Furthermore, among the key contributions of the dissertation is the inclusion of firm productivity as an ultimate outcome variable, enabling the evaluation of the strong version of the Porter Hypothesis. Contrary to the assumption that environmental regulation necessarily hampers competitiveness, the findings provide limited support for the idea that compliance costs of environmental regulation may enhance productivity. Although perceived as burdensome, in line with the Porter Hypothesis, these costs can stimulate firms to improve efficiency, process or product innovation, potentially offsetting the initial financial burden. The observed productivity effects, while modest, indicate that well-designed environmental regulations may indeed contribute to long-term performance gains, particularly when firms develop adequate internal capacities to manage compliance requirements.

Beyond empirical findings, the dissertation makes several substantial theoretical contributions. It develops a holistic conceptual model that integrates internal characteristics, external institutional pressures, managerial perceptions, and

productivity outcomes into a coherent analytical framework. This represents the first attempt to systematically model both objective and subjective compliance costs alongside their productivity implications, thereby enriching existing theoretical discussions on the economic impact of environmental regulation. Methodologically, the study advances the use of the Standard Cost Model within a SEM framework and demonstrates the value of combining economic measurement techniques with cognitive and institutional perspectives.

Nonetheless, the study faces certain limitations that represent potential for future research. The sample size, particularly for Croatia, restricts generalizability, while the cross-sectional design prevents full assessment of long-term effects or dynamic perspective, which is important in terms of Porter Hypothesis. Future studies could benefit from larger and more diverse samples, longitudinal designs, and the incorporation of additional latent constructs such as innovation capabilities, eco-efficiency, and sustainability practices. This would simultaneously allow an assessment of the impact of different types of instruments on key indicators addressed by environmental regulation. Expanding the geographical scope to additional national contexts would enable more detailed comparative analyses and contribute to a deeper understanding of how institutional configurations shape firms' regulatory experiences.

In sum, this dissertation offers a comprehensive and theoretically grounded analysis of compliance costs of environmental regulation and their implications for firms in Slovenia and Croatia. The findings provide valuable insights for both policymakers and the business sector, highlighting the importance of regulatory clarity, institutional quality, and managerial engagement in shaping both the actual and perceived burden of environmental regulation. To a limited extent, the results also provide support to the hypothesis that costs of environmental regulation, used as a proxy for regulatory stringency, can, under appropriate institutional and organizational conditions, contribute to improvements in firm productivity.

Keywords: Environmental Regulation, Compliance Costs, Firm Productivity, Standard Cost Model (SCM), Structural Equation Modeling (SEM), Porter Hypothesis

PROŠIRENI SAŽETAK

HOLISTIČKI MODEL TROŠKOVA ISPUNJAVANJA OBVEZA IZ EKOLOŠKIH PROPISA I PRODUKTIVNOSTI PODUZEĆA

Okolišna regulacija ima sve važniju ulogu u oblikovanju strategija poduzeća, njihove konkurentnosti i dugoročne održivosti, osobito u gospodarstvima koja su prošla kroz proces strukturnih transformacija i uključivanja u šire europske regulatorne okvire. Dok je okolišna i društvena važnost takvih regulacija dobro utvrđena, njihove gospodarske posljedice, osobito troškovi usklađivanja s kojima se poduzeća suočavaju i dalje su predmet stalnih akademskih te političkih rasprava. Ova doktorska disertacija bavi se navedenom tematikom istraživanjem čimbenika koji utječu na troškove usklađivanja poduzeća s okolišnom regulativom, kao i percepcije menadžera o tim troškovima, uz istovremenu procjenu njihove povezanosti s produktivnošću u Sloveniji i Hrvatskoj. Time se odgovara na potrebu za cjelovitijim i teorijski utemeljenim razumijevanjem načina na koji okolišna regulacija djeluje na poduzeća u različitim institucionalnim okruženjima.

Istraživanje nadograđuje postojeće studije iz područja okolišne ekonomike i regulativnog upravljanja primjenom integriranog metodološkog okvira, koji obuhvaća višedimenzionalnu prirodu troškova usklađivanja s okolišnom regulativom. Prethodna literatura uglavnom se usmjeravala na pojedine čimbenike i aspekte troškova, najčešće administrativne troškove, dok je malo studija na holističan način procijenilo cjelokupan spektar troškova usklađivanja. Sustavna integracija učinaka na menadžerske percepcije i produktivnost poduzeća dodatno predstavlja važnu novost. Komparativne međudržavne analize posebno su rijetke, osobito u kontekstu srednjoistočno europskih gospodarstava, koja karakteriziraju raznolike institucionalne strukture, administrativne kapacitete i razine kvalitete regulacija.

Ova disertacija popunjava te nedostatke analizom rezultata anketnih podataka prikupljenih od 198 slovenskih i 76 hrvatskih poduzeća pomoću strukturiranog anketnog upitnika. Podaci su obrađenih standardiziranim i teorijski konzistentnim mjernim pristupima.

Za kvantifikaciju opsega i strukture troškova usklađivanja s okolišnom regulativom istraživanje koristi Standard Cost Model (SCM), međunarodno priznatu metodologiju koja omogućuje procjenu triju vrsta troškova usklađivanja: financijskih, sadržajnih i informacijskih troškova povezanih s okolišnim propisima. To su troškovi, koji proizlaze iz obveza izvještavanja, monitoringa, ishođenja dozvola, tehnoloških prilagodbi te

drugih regulatornih zahtjeva, čime se omogućuje cjelovita procjena ukupnih troškova usklađivanja poduzeća s okolišnom regulativom. Istodobno su prikupljene i analizirane te percepcije menadžera o tim troškovima. Ovaj dvojni pristup otkriva i ekonomsku stvarnost regulatornih obveza kako i kognitivne okvire kroz koje menadžeri interpretiraju te obveze. Percepcija okolišnih troškova postaje sve važnija dimenzija razumijevanja strateških reakcija poduzeća na okolišnu regulaciju.

Teorijski okvir disertacije integrira institucionalnu teoriju, teoriju temeljenu na resursima (RBV), te teoriju menadžerske kognicije. Institucionalna teorija objašnjava kako vanjski pritisci poput regulatorne složenosti, okolišnih obveza i opće kvalitete institucija oblikuju ponašanje poduzeća. Teorija temeljena na resursima (RBV) naglašava da unutarnje karakteristike poduzeća, uključujući veličinu, financijske i nefinancijske pokazatelje te razinu digitalizacije, određuju razinu troškova usklađenosti i njihovu percepciju. Teorija menadžerske kognicije povezuje objektivne i subjektivne troškove te objašnjava kako donositelji odluka interpretiraju okolišne zahtjeve i kako te percepcije utječu na strateške i operativne odluke. Ovakav integrirani pristup omogućuje cjelovitije razumijevanje toga kako poduzeća doživljavaju, tumače i odgovaraju na okolišnu regulaciju.

Za empirijsko ispitivanje odnosa između različitih unutarnjih i vanjskih čimbenika troškova usklađivanja s okolišnom regulativom, njihovog percipiranog opterećenja te produktivnosti poduzeća, istraživanje koristi strukturno jednadžbeno modeliranje (SEM). Razvijeni modeli su najprije procijenjeni odvojeno za Sloveniju i Hrvatsku, kako bi se uzele u obzir međudržavne razlike u institucionalnom i gospodarskom kontekstu, dok je u završnoj fazi model za procjenu utjecaja troškova usklađivanja na produktivnost procijenjen i na objednjenim podacima radi osiguravanja veće robusnosti rezultata.

Pregledom literature identificirani su sljedeći unutarnji čimbenici: veličina poduzeća (FS), gospodarska djelatnost (ES), financijski pokazatelji (FM), nefinancijski pokazatelji (NFM), razina digitalizacije (DL) i međunarodna uključenost (II). Među vanjske čimbenike ubrajaju se okolišne obveze (EO), kvaliteta institucija (QI) i regulatorna kompleksnost (RC). Prema rezultatima istraživanja, među unutarnjim čimbenicima posebno se istaknuo čimbenik veličine poduzeća (FS), koji ima snažan i pozitivan učinak na troškove usklađivanja poduzeća s okolišnom regulativom, što upućuje na to da veća poduzeća snose više apsolutne troškove usklađivanja. Istodobno, ovaj čimbenik ima negativan učinak na percepciju navedenih troškova, budući da ih veća poduzeća doživljavaju kao manje opterećujuće. To može biti posljedica ekonomija razmjera, boljih raspoloživih resursa i razvijenijih mehanizama usklađivanja koji su dostupni većim poduzećima, odnosno činjenice da su troškovi usklađivanja do određene mjere fiksni. Nasuprot tome, manja se poduzeća češće suočavaju s

poteškoćama u ispunjavanju regulatornih zahtjeva te percipiraju regulatorne troškove kao znatnije opterećenje. Nefinancijski pokazatelji (NFM) pokazuju statistički značajnu negativnu povezanost s troškovima usklađivanja poduzeća s okolišnom regulativom, što upućuje na to da ulaganja u „meke" mjere usklađivanja, poput razvoja kapaciteta, certificiranja i podrške pri provedbi, djeluju kao mehanizmi za smanjenje troškova te nadopunjuju ili djelomično zamjenjuju skuplje tehnološke i procesne prilagodbe. Posljedično, poduzeća s proaktivnim okolišnim strategijama mogu ostvariti određeno smanjenje regulatornih troškova, što naglašava potencijalne koristi poticanja nefinancijskih mjera, poput certifikacijskih sustava i programa podizanja svijesti, kao dijela šire regulatorne strategije, uz primjenu ne samo prisilnih regulatornih mehanizama. Preostali unutarnji čimbenici (gospodarska djelatnost, financijski pokazatelji, razina digitalizacije i međunarodna uključenost) ili nisu zadovoljili osnovne statističke pretpostavke za uključivanje u model ili su umanjivali statističku stabilnost modela. To upućuje na to da je njihov utjecaj na troškove usklađivanja slabiji ili posredan, kada se uzmu u obzir dominantniji čimbenici.

Empirijski rezultati otkrivaju više važnih spoznaja, osobito iz perspektive usporedbe između dviju zemalja. Prvo, veličina poduzeća u obje se zemlje pokazuje kao dosljedan čimbenik troškova usklađivanja, budući da veća poduzeća imaju više apsolutne troškove zbog većeg opsega poslovanja i složenijih regulatornih zahtjeva. Međutim, samo u Sloveniji veća poduzeća te troškove percipiraju kao manje opterećujuće, što upućuje na razlike u administrativnim kapacitetima, iskustvu s regulatornim postupcima ili strategijama raspodjele resursa. Drugo, regulatorna kompleksnost pokazala se kao najsnažniji vanjski čimbenik koji utječe i na stvarne i na percipirane troškove u obje zemlje, pri čemu je taj učinak izraženiji u Sloveniji. Treće, opseg okolišnih obveza značajno povećava stvarne i percipirane troškove usklađivanja u Sloveniji, dok je taj učinak u Hrvatskoj zanemariv, što može odražavati razlike u intenzitetu nadzora, strukturi gospodarstva ili razini primjene okolišnih propisa. Četvrto, kvaliteta institucija utječe isključivo na percipirane troškove usklađivanja u Hrvatskoj, gdje niža razina povjerenja u institucije pojačava subjektivni dojam regulatornog opterećenja.

Među važnijim doprinosima disertacije nalazi se uključivanje produktivnosti poduzeća kao završnog zavisnog konstrukta, što omogućuje testiranje jake verzije Porterove hipoteze. Suprotno pretpostavci da okolišna regulacija smanjuje konkurentnost poduzeća, rezultati upućuju na ograničenu potporu tezi da troškovi usklađivanja poduzeća s okolišnom regulativom, korišteni kao aproksimacija strogoće regulative, mogu imati pozitivan učinak na razinu produktivnosti. Iako se percipiraju kao opterećujući, ovi troškovi usklađivanja, u skladu s Porterovom hipotezom, mogu potaknuti poduzeća na povećanje učinkovitosti te na procesne ili proizvodne inovacije, koje mogu djelomično ili u cijelosti neutralizirati početno financijsko opterećenje.

Utvrđeni učinci na produktivnost, iako umjereni, idu u prilog hipotezi da dobro osmišljene okolišne regulative mogu doprinijeti dugoročnim poboljšanjima poslovne uspješnosti, osobito kada poduzeća razviju odgovarajuće unutarnje kapacitete za učinkovito upravljanje usklađenošću.

Osim empirijskih nalaza, disertacija donosi i nekoliko teorijskih doprinosa. Razvijen je cjeloviti konceptualni model koji integrira unutarnje karakteristike poduzeća, vanjske institucionalne pritiske te menadžerske percepcije u jedinstveni analitički okvir. Ovo predstavlja prvu sustavnu integraciju objektivnih i subjektivnih troškova usklađenosti zajedno s njihovim učincima na produktivnost, čime se značajno nadograđuju postojeće teorijske rasprave o učincima okolišne regulacije na gospodarstvo. Metodološki, istraživanje nadograđuje primjenu Standard Cost Modela (SCM) u kombinaciji sa Standard Equation Modeling (SEM) te prikazuje vrijednost spajanja ekonomskih mjernih tehnika s kognitivnim i institucionalnim pristupima.

Istraživanje se suočava i s određenim ograničenjima koja istodobno predstavljaju polazišta za daljnja istraživanja. Veličina uzorka, posebice u Hrvatskoj, ograničava mogućnost generalizacije rezultata. Usporedni presjek država, za razliku od panel-pristupa, onemogućuje potpuniju procjenu dugoročnih i dinamičnih učinaka regulacije, što je posebno važno u kontekstu Porterove hipoteze. Buduće studije mogle bi se temeljiti na većim i raznovrsnijim uzorcima, longitudinalnom pristupu te uključivanju dodatnih latentnih konstrukata poput inovacijskih sposobnosti, eko-učinkovitosti i praksi održivosti. To bi istovremeno omogućilo procjenu utjecaja pojedinih vrsta instrumenata na ključne pokazatelje koje obuhvaća okolišna regulativa. Proširenje geografskog obuhvata na druge države također bi omogućilo detaljnije komparativne analize i pridonijelo boljem razumijevanju načina na koji institucionalne konfiguracije oblikuju regulatorna iskustva poduzeća.

U cjelini, disertacija pruža sveobuhvatnu i teorijski utemeljenu analizu troškova usklađivanja s okolišnom regulativom te njihovih posljedica za poduzeća u Sloveniji i Hrvatskoj. Rezultati pružaju važne spoznaje za kreatore politika i poslovni sektor. Naglašavaju važnost jasnoće regulacije, kvalitete institucija i menadžerskog angažmana u oblikovanju stvarnog i percipiranog regulatornog opterećenja. U isto vrijeme, iako u ograničenom opsegu, ukazuju na moguću potporu tezi da troškovi usklađivanja s okolišnom regulativom, kao aproksimacija strogoće okolišne regulacije, mogu uz odgovarajuće institucionalne i organizacijske uvjete pridonijeti povećanju produktivnosti.

Ključne riječi: Okolišna regulacija, Troškovi usklađivanja, Produktivnost poduzeća, Standardni troškovni model (SCM), Modeliranje strukturnih jednadžbi (SEM), Porterova hipoteza

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ANNEX

English version of survey questionnaire.

Dear Sir/Madam,

The Faculty of Administration in Ljubljana is conducting a research project titled "Assessment of Environmental Regulatory Compliance Costs to Enhance Business Competitiveness." Your company was randomly selected from the AJPES business registry, and your answers are essential for ensuring relevant and reliable research results. All data will be processed only in aggregated form and used exclusively for research purposes. Data analysis will be carried out in a way that guarantees full anonymity.

A summary of the results will be sent to all participating companies that express interest in receiving it. The questionnaire is most easily completed by accounting staff (or directors, owners) and takes approximately 6–9 minutes. The survey is intentionally brief to respect your time, while a larger number of responses will increase the relevance of the findings.

We sincerely thank you for your time, cooperation, and opinions.

Survey Questions

Q1 – According to the Standard Classification of Activities (NACE), in which sector does your company's main activity fall? (Multiple answers possible.)

- Agriculture, hunting, forestry, fishing
- Mining, manufacturing, electricity and water supply, wastewater treatment, environmental remediation
- Construction
- Trade and vehicle repair, transport and storage, hospitality
- Information and communication activities
- Financial and insurance activities
- Real estate activities
- Professional, scientific, technical and other diverse business services
- Public administration and defense, education, health and social care
- Other: _____

Q2 – Has your company had to obtain any permits due to environmental regulations or register as a liable entity for environmental charges?

- Yes
- No

IF (1) Q2 = [2]

Q3 – Has your company incurred any costs in recent years related to environmental charges or environmental regulations?

- Yes
- No

IF (2) Q2 = [1] or Q3 = [1]

Q4 – How many environmental charge reports does your company submit per year?

- 1
- 2–5
- 6–10
- More than 10

IF (2) Q2 = [1] or Q3 = [1]

Q5 – How many different environmental permits does your company hold?

- 1
- 2–5
- 6–10
- 11–20
- More than 20

IF (2) Q2 = [1] or Q3 = [1]

Q6 – How many record sheets does your company complete per year?

_____

IF (3) Q4 = [2, 3, 4, 5] or Q5 = [2, 3, 4, 5]

Q7 – Please estimate the average annual amount your company pays for environmental charges and environmental permits (you may provide an approximate amount for the previous year):

_____

IF (3) Q4 = [2, 3, 4, 5] or Q5 = [2, 3, 4, 5]

Q7a

	Very low	Low	Moderate	High	Very high	I don't know
How would you assess the magnitude of these costs?	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q8 – Please estimate the average annual cost your company incurs for adjusting production processes and products to comply with environmental standards:

_____

IF (2) Q2 = [1] or Q3 = [1]

Q9

	Very low	Low	Moderate	High	Very high	I don't know
How would you assess the magnitude of these costs of adjustment?	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q10 – Please estimate the average annual amount your company pays for costs related to collecting, submitting, and publishing mandatory information for public records and third parties, as required by environmental regulations (include employee time):

_____

IF (2) Q2 = [1] or Q3 = [1]

Q11

	Very low	Low	Moderate	High	Very high	I don't know
How would you assess the magnitude of these costs of collecting and providing information?	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q12 – Would your company collect the required information even if the law did not oblige you to do so?

- Yes, fully
- Yes, partially
- Probably not
- Definitely not
- Don't know

IF (2) Q2 = [1] or Q3 = [1]

Q13 – Please estimate the approximate annual amount of all costs related to complying with environmental regulations (employee time for reporting; obtaining permits; adjustments of production or products; environmental charges and permits):

- 0–500 EUR
- 501–1,000 EUR
- 1,001–5,000 EUR

- 5,001–10,000 EUR
- 10,001–50,000 EUR
- More than 50,000 EUR

IF (2) Q2 = [1] or Q3 = [1]

Q14

	Very low	Low	Moderate	High	Very high	I don't know
How would you assess the magnitude of total compliance costs of environmental regulation?	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q15 – What proportion of compliance costs of environmental regulation does your company incur relative to all regulatory-related costs (e.g., taxes, payroll calculations, employment procedures)?

- 0–5%
- 6–15%
- 16–30%
- 30–50%
- More than 50%

IF (4) Q14a = [4, 5]

Q16 – In your opinion, what contributes to high compliance costs?

	Not at all influential	Not influential	Moderately influential	Influential	Very influential	I don't know
Complexity of existing regulations.	○	○	○	○	○	○

Scope of requirements in existing forms.	○	○	○	○	○	○
Introduction of new regulations.	○	○	○	○	○	○
Expansion of the company's own business activities.	○	○	○	○	○	○
Other:	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q17 – On average, how many hours per month do all employees in your company spend fulfilling requirements related to environmental regulations?

- Up to 10 hours
- 10–50 hours
- 50–100 hours
- 100–200 hours
- More than 200 hours

IF (2) Q2 = [1] or Q3 = [1]

Q18 – What share of external costs (lawyers, consultants, accounting services) does your company incur relative to total compliance costs of environmental regulation?

- 0–5%
- 6–15%
- 16–30%
- 31–50%
- More than 50%

IF (2) Q2 = [1] or Q3 = [1]

Q19 – Please evaluate the following statements regarding the work of institutions related to environmental regulations:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
It is easy to contact the responsible officials or competent authority.	○	○	○	○	○	○
It is completely clear which institution should be contacted.	○	○	○	○	○	○
The responsible officials or competent authority provide precise answers.	○	○	○	○	○	○
The response from the competent authority is given within a reasonable time.	○	○	○	○	○	○
The procedure for applications and appeals is understandable.	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q20 – In the past five years, has your company used any of the measures listed below, and how important were they for your investment decisions in eco-technologies?

	No, no impact	No, possible impact	Yes, but no impact occurred	Yes, there is an impact	Yes, a major impact	I don't know

Refund of paid environmental charges.	○	○	○	○	○	○
Exemption from environmental charges for energy efficiency.	○	○	○	○	○	○
Excise duty exemption for biofuels.	○	○	○	○	○	○
Emissions trading.	○	○	○	○	○	○
Energy and environmental labelling of technologies and products.	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q21 – In the past five years, has your company used any of the measures listed below, and how important were they for your investment decisions in eco-technologies?

	No, no impact	No, possible impact	Yes, but no impact occurred	Yes, there is an impact	Yes, a major impact	I don't know
Certification of the source of energy and buildings (energy performance certificate).	○	○	○	○	○	○
Promotion of voluntary certification agreements (EMAS, ISO 14001, EcoProfit, cleaner production, Responsible Care programmes, etc.).	○	○	○	○	○	○

Awareness-raising, information, promotion, and training programmes, as well as demonstration projects.	○	○	○	○	○	○
Assistance to operators (grants or free professional support) in implementing environmental standards and more demanding environmental legislation (e.g., IED, SEVESO, VOC, building legislation).	○	○	○	○	○	○

IF (2) Q2 = [1] or Q3 = [1]

Q22 – Please evaluate the following statements related to environmental regulations:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
Changes in regulations are predictable.	○	○	○	○	○	○
Regulations are sufficiently flexible to allow efficient implementation by businesses.	○	○	○	○	○	○
Regulations achieve their objectives in the simplest possible way.	○	○	○	○	○	○

Regulations are consistent with other regulations.	○	○	○	○	○	○
Regulations are understandable.	○	○	○	○	○	○

Q23 – Please assess to what extent the following apply to your company:

	Not at all	A little	Moderately	Quite a lot	Strongly	I don't know
R&D is supported by computer information systems.	○	○	○	○	○	○
Production processes are supported by computer information systems.	○	○	○	○	○	○
Logistics processes are supported by computer information systems.	○	○	○	○	○	○
Financial processes are supported by computer information systems.	○	○	○	○	○	○
Sales and procurement processes are supported by computer information systems.	○	○	○	○	○	○
Administrative processes are supported	○	○	○	○	○	○

by computer information
systems.

Demographics

Q25 – How many employees did your company have in the last financial year?

- 0–4
- 5–10
- 11–50
- 51–250
- More than 250
- Prefer not to answer

Q26 – Into which category did your company fall based on net sales revenue in the last financial year? (Multiple answers possible.)

- 0–200,000 EUR
- 200,000–700,000 EUR
- 700,000–8,000,000 EUR
- 8,000,000–40,000,000 EUR
- More than 40,000,000 EUR
- Prefer not to answer
- Don’t know

Q27 – Does your company operate abroad?

- No
- Yes, in one foreign country
- Yes, in two foreign countries
- Yes, in three or more foreign countries

Q28 – Under which financial office does your company fall?

- Ljubljana
- Brežice

- Maribor
- Murska Sobota
- Dravograd
- Kočevje
- Kranj
- Koper
- Celje
- Hrastnik
- Nova Gorica
- Velenje
- Ptuj
- Postojna
- Novo mesto
- Other: _____

Q29 – Finally, would you like to add any general comments regarding the costs related to environmental regulations?

You have answered all the questions in this survey. Thank you sincerely for your participation. If you would like to receive the results, please provide your e-mail address below: