A robust conditional assessment of European regions performance in light of the 2030 Strategic Framework for Education and Training

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Master's Dissertation

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Abstract

Education plays a vital role in societal development, and the European Union has set a goal to become the most competitive and dynamic knowledge-based economy globally (European Council, 2000). To achieve this, the European Union has formulated the 2030 Strategic Framework for Education and Training (European Union, 2021), which includes six indicators and corresponding goals to ensure sustainable and equitable growth in education throughout Europe.

This thesis focuses on assessing regional performance in achieving the ET2030 indicators using a Benefit-of-the-doubt composite indicator in a robust approach. The study also analyzes performance trends over time using a Global Malmquist Index and σ and β-convergence. It covers 33 countries and 105 regions from 2014 to 2019. The findings highlight persistent disparities between European regions, with Eastern regions performing relatively poorly compared to Northern regions. Over time, the best-performing regions continue to improve while the gap between the best and worst performers widens.

The study incorporates contextual factors, namely the unemployment rate and the percentage of the population with national citizenship, to ensure a fair comparison among regions facing different circumstances. This conditional analysis recognizes and rewards regions that achieve good results despite challenging conditions. Moreover, the research identifies best practices from high-performing regions that can serve as benchmarks for underperforming regions.

The study also examines performance disparities between regions within the same country and identifies patterns in these disparities. Capital regions generally exhibit better outcomes, while island regions tend to underperform. However, when contextual variables are considered, the analysis reveals that island regions can achieve better results.

In terms of methodology, this research introduces an innovative approach by combining a robust analysis with a σ and β-convergence assessment for the first time.

In conclusion, analyzing regional-level data is crucial for understanding disparities between European regions and within countries. Targeted support can be provided to overcome challenges by identifying regions on negative trajectories. Prioritizing investment in regions with unfavourable environments is essential to prevent further disparities and promote inclusive development.

Resumo

A educação desempenha um papel vital no desenvolvimento da sociedade, e a União Europeia estabeleceu o objetivo de se tornar a economia mais competitiva e dinâmica do mundo tendo por base a educação (European Council, 2000). Para o conseguir, a União Europeia formulou o Quadro Estratégico para a Educação e Formação 2030 (European Union, 2021), que inclui seis indicadores e objetivos correspondentes para assegurar um crescimento sustentável e equitativo da educação em toda a Europa.

Esta tese centra-se na avaliação do desempenho regional para atingir os indicadores do ET2030, utilizando um indicador composto do benefício da dúvida numa abordagem robusta. O estudo também analisa as tendências de desempenho ao longo do tempo utilizando um índice global de Malmquist e a convergência de σ e β. Abrange 33 países e 105 regiões de 2014 a 2019. As conclusões destacam disparidades persistentes entre as regiões europeias, com as regiões do Este a apresentarem um desempenho relativamente fraco em comparação com as regiões do Norte. Ao longo do tempo, as regiões com melhor desempenho continuam a melhorar, enquanto o fosso entre as regiões com melhor e pior desempenho aumenta.

Para garantir comparações justas entre regiões que enfrentam circunstâncias diferentes, o estudo incorpora fatores contextuais, nomeadamente a taxa de desemprego e a percentagem da população com cidadania nacional. Esta análise condicional reconhece e recompensa as regiões que alcançam bons resultados apesar das condições difíceis. Além disso, o estudo identifica as melhores práticas de regiões com elevado desempenho que podem servir de referência para as regiões com fraco desempenho.

O estudo também examina as disparidades entre regiões de um mesmo país e identifica padrões nessas disparidades. As regiões que incluem a capital apresentam geralmente melhores resultados, enquanto as regiões insulares tendem a ter um desempenho inferior. No entanto, quando as variáveis contextuais são consideradas, a análise revela que as regiões insulares podem alcançar melhores resultados.

Em termos de metodologia, esta investigação introduz uma abordagem inovadora ao combinar, pela primeira vez, uma análise robusta com uma avaliação de convergência σ e β.

Concluindo, a análise dos dados a nível regional é crucial para compreender as disparidades entre as regiões europeias e no interior dos países. Ao identificar as regiões com trajetórias negativas, pode ser prestado apoio específico para superar os desafios. Dar prioridade ao investimento em regiões com ambientes desfavoráveis é essencial para evitar mais disparidades e promover o desenvolvimento inclusivo.

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In a master's thesis focused on educational outcomes, it is only fitting to extend my profound "grad"-itude to those who have been important in helping me achieve the educational outcomes I did.

First and foremost, I want to give a heartfelt thank you to my parents for giving me a fishing rod instead of a fish. They always put my education first, no matter what environmental variables they faced. They went above and beyond to ensure I had every opportunity to succeed throughout my schooling. Your unwavering support and dedication truly inspire me, and I hope to be like you when I grow up! I also want to express my gratitude to the rest of my family for being amazing examples in my life. My grandmother for being an empowered woman who knew the importance of education and gave what she could to others, my grandfather for teaching me how to make a positive impact on our community, my aunts and uncles by showing me the true meaning of family unity, my cousins by inspiring me to believe that we can accomplish anything we set our minds to by dreaming big and keep up, and my brother for teaching me that my patience can reach even a little further. Each and every one of you holds a special place in my heart, and you will forever be my safe haven, the place where I feel the most loved and protected.

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With help from each of you, I have been able to excel as a top performer, achieving remarkable results in all of the ET2030 indicators, except for adult participation in lifelong learning. Nevertheless, I am determined to enhance my performance in this specific area in the future. Education is always the key to success.

I wish you a great reading!

"Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace."

Point 2, Article 26, United Nations (1948)

Contents

Acronyms and Symbols

ARI	Assurance Regions Type I
BoD	Benefit-of-the-Doubt
BPC	Best-Practice Change
BPF	Best-Practice Frontier
BPG	Best-Practice Gap
CI	Composite Indicator
CRS	Constant Returns to Scale
DDF	Direct Distance Function
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
EC	Efficiency Change
EELI	European Lifelong Learning Indicators
EFA	Education For All Development Index
ESCS	Index of economic, social, and cultural status
ET2010	2010 Strategic Framework for Education and Training
ET2020	2020 Strategic Framework for Education and Training
ET2030	2030 Strategic Framework for Education and Training
EU	European Union
FDH	Free Disposal Hull
GDP	Gross Domestic Product
GMI	Global Malmquist Index
HDI	Human Development Index
ICILS	International Computer and Information Literacy Study
INCoDe.2030	National e.2030 Digital Skills Initiative
ISCED	International Standard Classification of Education
LISA	Local Indicators of Spatial Association
MCE	Multiple Criteria Evaluation
NEET	Neither employed nor in education or training
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organization for Economic Cooperation and Development
OLS	Ordinal Least Squares
PISA	Programme for International Student Assessment
PSM	Propensity Score Matching
SFA	Stochastic Frontier Analysis
TAI	Technology Achievement Index
TFE	True Fixed Effects
TIMSS	Trends in International Mathematics and Science Study
UN	United Nations

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
VRS	Variable Returns to Scale
WPC	Worst Practice Change

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Chapter 1

Introduction

1.1 Importance of Quality Education

Education stands as one of the fundamental pillars of a more equitable, sustainable, and robust society, recognized as a fundamental human right by the United Nations (United Nations, 1948) and a child right by United Nations International Children's Emergency Fund (UNICEF, 1989).

The profound impact of quality education on multiple aspects of society cannot be overstated. It promotes peace by spreading tolerance and mutual respect, reducing society's susceptibility to violent conflicts (Thompson, 2015). Additionally, it has been proven to positively impact health, providing individuals with better health and a longer lifespan than their less educated peers (Raghupathi and Raghupathi, 2020). Despite divergences in research findings on the impact of education on economic growth, a clear bias toward its positive effect is evident (Benos and Zotou, 2014). Education empowers marginalized individuals to participate in community issues and break free from poverty cycles.

According to OECD (2022), individuals who do not have an upper secondary qualification are at a greater risk of being NEET (neither employed nor in education or training) compared to those with higher qualifications. In Organization for Economic Cooperation and Development (OECD) countries, the risk of being NEET for individuals aged 25-29 without an upper secondary qualification is 42.2%. However, this risk decreases for individuals with an upper secondary or post-secondary non-tertiary qualification (20%) and further decreases for tertiary graduates (12.1%). The study also emphasizes the impact of education and training on individuals' earnings. In 2020, full-time, full-year workers with short-cycle tertiary education earned 20% more than those with upper secondary attainment. This earnings advantage increased to 44% for individuals with a bachelor's or equivalent qualification and further rose to 88% for those with a master's or doctoral degree or equivalent. Therefore, it is evident that education plays a crucial role in improving individuals' quality of life.

Reflecting the significance of this topic, the United Nations has prioritized quality education as Sustainable Development Goal 4 (United Nations, 2015), focusing on ensuring inclusive and equitable quality education and lifelong learning opportunities for all. Thus, the importance of quality education for the long-term growth of society is indisputable.

1.2 Education in Europe's agenda

Recognizing that education is a key factor in the development of society, the European Council (2000) established the goal to be the most competitive and dynamic knowledge-based economy in the world. To ensure that action was taken, the 2010 Strategic Framework for Education and Training (ET2010) was established in 2001, determining the strategic objectives, benchmarks, and indicators to be achieved by 2010.

The progress made through this framework was acknowledged, resulting in the establishment of updated frameworks building upon previous ones, namely the 2020 Strategic Framework for Education and Training (ET2020), established in 2009 for the period between 2011 and 2020 (European Union, 2009), and the 2030 Strategic Framework for Education and Training (ET2030), established in 2021 for the period between 2021 and 2030 (European Union, 2021).

As a result, education currently has a place in Europe's agenda through the ET2030, a framework that highlights five strategic priorities:

1. *Improving quality, equity, inclusion, and success for all in education and training:* utilize resources effectively to ensure high-quality education, sustainably increase the basic skills level of the population and reduce inequality, promote diversity and fundamental rights;

2. *Making lifelong learning and mobility a reality for all:* make education and training more flexible and accessible to everyone, regardless of their age, by developing new ways of learning and adapting existing ones;

3. *Enhancing competencies and motivation in the education profession:* ensure that education professionals, who form the heart of education, are motivated, competent, and equipped with the necessary resources in order to have a good basis for building the remaining pillars of a good education and training system;

4. *Reinforcing European higher education:* encourage partnerships and alliances between higher education institutes to cooperate either in knowledge, resources, research and development, and mobility programs;

5. *Supporting the green and digital transitions in and through education and training:* invest in digital education ecosystems and turn them into the catalysts of a behaviour and skill change in people for a more green and digital society;

To monitor the progress on the five strategic priorities defined above, the ET2030 establishes six benchmarks, the respective indicators, the target year, and the target value. The specific details regarding these benchmarks can be found in table 1.1.

Table 1.1: Description of ET2030 benchmarks (European Union, 2021)

Benchmark	**Indicator**	**Year to achieve**	**Goal**
Early childhood education	Percentage of EU population between 3 years old and the age of starting compulsory primary education participating in early childhood education	2030	$\geq$ 96%
Early leavers from education and training	Percentage of EU population aged 18-24 with only secondary education or less and no longer in education or training	2030	$\leq$ 9%
Tertiary level attainment	Percentage of EU population aged 25-34 who have completed successfully tertiary level education	2025	$\geq$ 45%
Adult participation in lifelong learning	Percentage of EU population aged 25-64 participating in education and training in the last 12 months	2025	$\geq$ 47%
Low achieving eight-graders in digital skills	Percentage of EU eight-graders low-achieving in computer and information literacy	2030	$\leq$ 15%
Low achievers in basic skills	Percentage of EU population aged 15 with low-achieving in reading	2030	$\leq$ 15%
	Percentage of EU population aged 15 with low-achieving in mathematics	2030	$\leq$ 15%
	Percentage of EU population aged 15 with low-achieving in science	2030	$\leq$ 15%

1.3 Problem statement

The first strategic priority of ET2030 is to enhance the quality of education by utilizing resources efficiently. Consequently, decision-makers must formulate public policies that tackle the most pressing educational challenges. Identifying those key issues can be achieved by evaluating Europe's performance in attaining the ET2030 indicators presented in table 1.1.

Thus, it is necessary to synthesize the multidimensionality of the ET2030 into a single, easily comprehensible metric that provides important information for policy formulation. This metric must be reliable and equitable for all units under assessment. Since Europe aims to provide quality education to all, subdividing the performance measurement into different regions will be advantageous. It allows for better recognition of underperforming areas and enables targeted improvement efforts. Furthermore, it aids in identifying regions that excel in their educational practices.

Considering that the strategic framework extends to a distant time horizon, it is vital to provide decision-makers with information on the progress of different regions and Europe as a whole in achieving the defined indicators. It is also important to assess whether the gap between bad and good performers is narrowing or widening.

Last but not least, it is critical to ensure fairness and equity in the evaluation of geographic areas and understand what realistic benchmarks an underperforming region can, in fact, meet. For this, it is necessary to consider the context in which the regions are situated when evaluating each region's performance.

These aforementioned significant aspects give rise to three main research questions:

- What is the performance level of the various European regions concerning the ET2030 indicators, and how is it changing over time?

- How does considering the contextual environment for a fair and equitable comparison impact the performance of the geographies?

- Do significant performance disparities exist between regions within the same country or across Europe, and is there any discernible pattern in these disparities?

To address the challenge of understanding the performance of European regions regarding the ET2030 indicators, a Benefit-of-the-Doubt composite indicator will be constructed. Additionally, a Global Malmquist Index and a σ and β-convergence assessments will be developed to evaluate performance evolution and convergence over time. These methods will be applied in a robust approach that aims to overcome the deterministic limitation of the conventional Benefit-of-the-Doubt technique while accounting for outliers in the data.

In a subsequent phase, the methods will be applied in a robust conditional approach considering the contextual environment. This approach ensures a fair and equitable comparison by conditioning the robust approach with relevant contextual variables that are proven to influence educational outcomes.

By replicating the aforementioned methods while considering not only the regional level but also the country level simultaneously, it will be possible to analyze regional disparities within countries and identify potential patterns. This comprehensive approach will allow for an understanding of the baseline performance at the country level and the relationship of regions to that baseline.

The research results will provide analytical support for policy decisions and the design of strategies to promote equitable and sustainable development in education across Europe.

1.4 Dissertation structure

Chapter 2 of this master's thesis will provide a comprehensive overview of the progress made in the educational sector related to the assessment of performance using frontier techniques.

The methods and approaches mentioned briefly in section 1.3 will be presented theoretically and in detail in chapter 3. Chapter 4 will describe the process of gathering and processing the data and explain the model's specifications for the empirical application of the methodology to this study.

In chapter 5, the attention will turn towards presenting the results obtained through applying the models. These results will directly address the research questions introduced in section 1.3.

Finally, chapter 6 will present the study's main conclusions, highlighting the key findings and their significance. Additionally, the limitations of the present study and future work that should follow it will be outlined.

Chapter 2

Literature review

This chapter starts with a review of the most frequently employed methods for measuring efficiency in the field of education. Then, it focuses on studies conducted at the country and regional levels, particularly those that examine the evolution of performance over time, test the reliability of the models, or consider the contextual factors associated with the units under analysis.

Moreover, the chapter emphasises two studies that examine the performance measurement of the ET2020, given their direct relationship with the topic of this thesis.

Finally, the review highlights the knowledge gap in the literature and the key contributions this study envisages to make to the body of knowledge on performance measurement in the education sector.

2.1 Efficiency measurement in education

The most widely used methods for efficiency and performance assessment in the field of education are frontier methods (Johnes, 2015). Frontier methods allow for measuring the performance of the units under analysis, referred to as decision-making units (DMUs), relative to a best-practice frontier (BPF). The efficiency score of a DMU is standardised to range from 0 to 1, where a score of 1 indicates that the DMU is located on the BPF (Eling and Luhnen, 2010). The estimation method used to determine the best-practice frontier gives rise to two classifications of methods: parametric and non-parametric. While parametric methods have a specific function form that shapes the frontier, non-parametric methods do not require the specification of a functional form for the BPF.

Stochastic Frontier Analysis (SFA) (Aigner et al., 1977; Battese and Corra, 1977; Meeusen and van Den Broeck, 1977) is the prevalent approach among parametric methods, which accounts for stochastic errors in the data. It allows the estimation of technical efficiency for each DMU, providing insights into the factors that contribute to inefficiencies. Education economists more commonly use SFA since it enables the estimation of efficiency levels and random errors and allows the calculation of economies of scale and scope.

The non-parametric technique known as Data Envelopment Analysis (DEA) is the predominant frontier method used in the educational field. Education research also holds a prominent position within DEA studies, accounting for approximately 9% of the empirical research (Rostamzadeh et al., 2021). In contrast to SFA, DEA is more commonly used in management science literature and operational research as this technique is better at providing benchmarks and targets.

There are trade-offs between these two types of frontier methods, as explained in Witte and López-Torres (2017). Non-parametric frontier methods assume that all deviations from the frontier are due to inefficiency, which may not always be accurate. It is challenging to determine bounds on estimates, and statistical significance is not readily available in traditional non-parametric models. In contrast, parametric methods like SFA require selecting a specific functional form and making assumptions about the error structure. DEA also has the advantage of simply handling multiple inputs and outputs, making it suitable for analysing complex educational systems. Additionally, DEA does not require assumptions about the functional form or specification of the error term. This flexibility allows for a more straightforward efficiency analysis without imposing stringent modelling assumptions that are difficult to test in a real-world context.

In terms of the level of analysis, the majority of research on efficiency in education is at the school, high school, or university levels (Witte and López-Torres, 2017). The literature at the country or multi-country level is less extensive due to two reasons: first, the difficulty in obtaining information and reliable data at the country level to allow for reliable benchmarking; second, frontier efficiency methods assume that the units of comparison, in this case, countries, must have homogeneous production conditions and technologies, which may not be guaranteed given the specific circumstances surrounding each country. The efforts undertaken by the OECD and Eurostat, the statistical office of the European Union, in collecting similar data between nations and from countries participating in these collections facilitate analysis at this level. Furthermore, this study addresses the second issue by utilising contextual characteristics to make a more fair comparison between more homogeneous decision units.

2.2 Cross-country and regional evaluation

The present study conducts a comprehensive cross-country and regional analysis of education. Consequently, exploring the existing literature on efficiency measurement in education within this scope is crucial, with a notable emphasis on studies utilising Data Envelopment Analysis (DEA). By delving into this body of work, a deeper understanding of the existing knowledge and contribution to the field's advancement can be attained.

Table 2.1 overviews the literature on cross-country performance evaluation.

The International Standard Classification of Education (ISCED) provides a framework for categorising different levels of education (OECD et al., 2015). Within the ISCED system, several levels represent different stages of education. ISCED level 1 represents primary education, typically spanning four to seven years. Students enter ISCED level 2, which corresponds to lower secondary education, between the ages of 10 and 13. Following that, ISCED level 3 represents

Table 2.1: Studies on educational performance at country level

	Stage				Source					Method								
										Parametric		Non-parametric						
Study	P	S	T	W	PISA	TIMSS	OCDE	Eurostat	Other	SFA	Reg	DEA	FDH	DDF	Other	Trends	Reliability	Context
Afonso and Aubyn (2005)		X			X		X					X	X				X	
Afonso and St. Aubyn (2006)		X			X		X				X	X						X
Agasisti (2011)			X				X					X	X				X	X
Agasisti (2014)		X			X		X				X	X				X	X	X
Agasisti et al. (2019)	X	X		X	X		X	X				X					X	X
Ahec Šonje et al. (2018)		X	X		X				X			X				X	X	
Aristovnik (2013)	X	X	X		X		X		X			X						
Bogetoft et al. (2015)	X	X	X		*		X	X				X			X	X	X	
Camanho et al. (2023)				X	X		X	X				X				X		
Clements (2002)	X	X				X	X						X					
Giambona et al. (2011)		X			X							X			X		X	
Giménez et al. (2007)		X				X						X						X
Giménez et al. (2017)		X			X							X	X			X	X	
Giménez et al. (2019)		X				X						X		X		X		
Hanushek and Luque (2003)	X	X				X					X							
Kocher et al. (2006)			X						X			X						
Miningou (2019)	X	X					X		X	X							X	
Stumbriene et al. (2020)				X	X		X	X				X					X	
Sutherland et al. (2010)		X			X			X		X								
Thieme et al. (2012)		X			X									X				X

P: primary education, S: secondary education, T: tertiary education, W: whole education system

upper secondary education, with students entering this level between the ages of 14 and 16 and completing it around 17 or 18.

At these levels, two prominent international assessments are conducted: the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). PISA assesses students between the ages of 15 years and three months to 16 years and two months who enrolled in an educational institution at grade 7 or higher (OECD, 2019). This falls under the classification of secondary education, according to ISCED. On the other hand, the Trends in International Mathematics and Science Study (TIMSS) collects data from students in grades 4 and 8 (IEA, 2021). These grade levels represent, respectively, primary and secondary education stages, indicating that TIMSS gathers data specifically from these two levels. These two international assessments greatly facilitate the collection of relevant data at the primary and secondary education levels. Consequently, the literature extensively covers exclusively the secondary education stage and also both primary and secondary education combined.

Of the 20 studies examined, nine exclusively concentrate on secondary education. Among these studies, two utilise TIMSS results exclusively, three solely rely on PISA results, and the remaining four combine PISA results with other data from databases such as OECD or Eurostat.

Within the scope of the 20 studies under analysis, there are no studies covering exclusively primary education, and only two covering exclusively tertiary education, namely Agasisti (2011) that use data from OECD and Kocher et al. (2006) with data from other data sources, such as journals and published rankings.

Ahec Šonje et al. (2018) investigates the efficiency in both secondary and tertiary educational levels, using PISA, World Bank, and UNESCO (United Nations Educational, Scientific and Cultural Organization) data. Three studies analyse primary and secondary education, with Hanushek and Luque (2003) using only TIMSS results, Clements (2002) using TIMSS and also OCDE data,

Table 2.2: Studies on educational performance at regional level

	Stage				Source					Method								
										Parametric		Non-parametric						
Study	P	S	T	W	PISA	TIMSS	OCDE	Eurostat	Other	SFA	Reg	DEA	FDH	DDF	Other	Trends	Reliability	Context
Ferrera et al. (2011)		X			X					X								X
Agasisti and Cordero-Ferrera (2013)		X			X						X				X			
Crespo-Cebada et al. (2014)		X			X										X			X
Wu et al. (2019)			X						X	X		X						X
Camanho et al. (2021)		X							X			X			X		X	X
Le et al. (2021)		X							X			X						
Marto et al. (2022)			X					X			X	X			X			X

P: primary education, S: secondary education, T: tertiary education, W: whole education system

and, finally, Miningou (2019) using OECD, World Bank, and also World Development Indicators databases. Agasisti et al. (2019) covers not only primary and secondary education but also has variables regarding the education system as a whole, using data from PISA, OECD, and Eurostat. Aristovnik (2013) and Bogetoft et al. (2015) study the three levels of education, with the first using PISA, OECD, and World Bank data and the second mostly Eurostat and OECD data, also using PISA results as indicators of student input quality in upper secondary education.

Camanho et al. (2023) and Stumbriene et al. (2020) both analyse the educational system as a whole and consider the European strategic framework, in this case for 2020, being the most similar cases for this research. They both use PISA, OECD, and Eurostat data.

From a methodological perspective, and as stated before, DEA is the most frequently used technique, with 15 out of 20 studies using it. Of the 15 studies, seven used DEA exclusively, and the other eight included other techniques such as Free Disposal Hull (FDH) (Afonso and Aubyn, 2005; Agasisti, 2011; Giménez et al., 2017), Regression (Afonso and St. Aubyn, 2006; Agasisti, 2014; Bogetoft et al., 2015), Multiple Criteria Evaluation (MCE) (Agasisti et al., 2019) and Direct Distance Function (DDF) (Giménez et al., 2019). The remaining five studies that did not include DEA opted for different methodologies: Miningou (2019) and Sutherland et al. (2010) employed SFA, Thieme et al. (2012) utilised DDF, Hanushek and Luque (2003) employed linear regression, and Clements (2002) used FDH.

Table 2.2 overviews the literature on cross-region performance evaluation.

The literature on cross-region performance evaluation is limited, comprising only seven studies. Out of these, only two studies conducted analyses across multiple countries, with Marto et al. (2022) focusing on the European Union Regions at NUTS-II level using data from Eurostat and Agasisti and Cordero-Ferrera (2013) examining the Spanish and Italian Macroregions based on 2006 PISA Results. The remaining five studies were specific to individual countries: Crespo-Cebada et al. (2014) and Ferrera et al. (2011) in Spain utilising 2006 PISA results, Camanho et al. (2021) in Italy, Le et al. (2021) in Vietnam, and Wu et al. (2019) in China, with the latter three studies using national-level data.

The evaluation of cross-region performance remains predominant at the secondary level, with five out of the seven studies examining this stage and three utilising PISA data. Marto et al. (2022) and Wu et al. (2019) have concentrated on the tertiary level.

Regarding methodology, DEA emerged again as the most frequently used technique in four of the seven studies. However, only Camanho et al. (2021) exclusively used DEA. Wu et al. (2019) combined DEA with SFA, Marto et al. (2022) integrated Spatial Regression Modeling and Le et al. (2021) study employed inverse DEA instead of the conventional DEA technique.

The remaining three papers utilised parametric methods, with Crespo-Cebada et al. (2014) and Ferrera et al. (2011) using Parametric Distance Function, and Agasisti and Cordero-Ferrera (2013) employing Hierarchical Linear Modeling, a specific regression method.

2.2.1 Inputs and Outputs

To accurately measure efficiency using frontier methods, it is crucial to carefully select a set of input and output variables that reflect the reality being modelled. The frontier represents the optimal combination of inputs and outputs for maximum efficiency (Kalb, 2010). Normally, the objective is to minimise the inputs and maximise the outputs. However, the outputs can also be undesirable factors that should be reduced to ensure equity and various techniques are available to incorporate them.

Table 2.3 summarises the types of inputs and outputs used in each of the 27 studies under analysis and indicates whether they incorporate undesirable variables.

Table 2.3: Overview of inputs and outputs used in the studies under analysis

	Inputs			Outputs				
Study	Expenditures	School factors	Student factors	Student achievements	Educational results	Research activities	Economical indicators	Undesirable outputs
Afonso and Aubyn (2005)		X		X				
Afonso and St. Aubyn (2006)		X		X				
Agasisti (2011)	X	X		X	X		X	
Agasisti (2014)	X	X		X				
Agasisti et al. (2019)	X	X		X	X		X	
Ahec Šonje et al. (2018)	X			X		X		X
Aristovnik (2013)	X		X	X	X		X	
Bogetoft et al. (2015)	X				X		X	
Camanho et al. (2023)				X	X		X	X
Clements (2002)	X	X		X				
Giambona et al. (2011)			X	X				
Giménez et al. (2007)		X		X				
Giménez et al. (2017)		X	X	X				X
Giménez et al. (2019)		X		X				X
Hanushek and Luque (2003)		X	X	X				
Kocher et al. (2006)	X	X				X		
Miningou (2019)		X			X			
Stumbriene et al. (2020)				X	X		X	X
Sutherland et al. (2010)		X	X	X				
Thieme et al. (2012)		X		X				X
Ferrera et al. (2011)		X	X	X				
Agasisti and Cordero-Ferrera (2013)		X	X	X				
Crespo-Cebada et al. (2014)		X	X	X				
Wu et al. (2019)	X	X		X		X		
Camanho et al. (2021)			X	X				
Le et al. (2021)	X			X				
Marto et al. (2022)		X					X	

The inputs used in the papers under analysis can be categorised into three main clusters: expenditures, school factors, and student factors.

Expenditures serve as inputs in 10 out of the 27 studies reported in table 2.1 and table 2.2, with Ahec Šonje et al. (2018), Bogetoft et al. (2015), and Le et al. (2021) exclusively focusing on expenditure-related inputs. This cluster includes variables such as inside and outside expenditures paid by families for their children's education or government expenditures at different educational levels. These government expenditures can be expressed as the overall amount, a percentage compared to other levels, a percentage of the gross domestic product (GDP), or on a per-student basis.

The school factors cluster encompasses variables related to teachers (such as student-teacher ratio, teaching staff quality, and experience), financial and human resources, quality and availability of physical infrastructure, material consumption, annual hours spent in school per subject and overall, class characteristics (such as size and gender distribution), system accessibility, and entry rates into tertiary education by age. These factors play a prominent role in the studies, being present in 19 out of the 27 papers, with seven of them exclusively focusing on these variables.

The student factors cluster includes input variables such as the PISA index of economic, social, and cultural status (ESCS), availability of educational resources at home, and ownership of specific goods. Nine studies incorporate these variables, with Camanho et al. (2021) and Giambona et al. (2011) exclusively utilising them.

Regarding outputs, they can be categorised into four main clusters: student achievements, educational results, research activities, and economic factors.

The cluster of student achievements reflects the results that students could attain and includes variables such as PISA scores in the three components of reading, mathematics, and science, TIMMS scores, scores in national-level exams, and graduation rates. Almost every study (23 out of 27) incorporated one or more of these variables.

Educational results encompass the overall status of education and include variables such as enrollment rates, attendance rates and dropout rates at the three educational stages, and school life expectancy. Of the 27 studies, seven included this output category in their analysis.

Only Ahec Šonje et al. (2018), Kocher et al. (2006), and Wu et al. (2019) encompassed variables related to research activities that include the number of patents granted, publications in journals, and university rankings.

Finally, economic indicators reflect factors related to education and the economy, such as unemployment rates, percentage of the labour force with tertiary education, expected earnings, and GDP per capita. Seven studies from the 27 under analysis included this type of variable.

2.2.2 Assessment of trends over time

Out of the 27 studies analysed, only six examine educational efficiency changes over time. These evaluations were exclusively conducted at the country level using DEA.

An assessment of efficiency change can be performed by simply comparing and interpreting the results of DEA models run in different years. This approach is taken by Ahec Šonje et al. (2018) and Bogetoft et al. (2015).

Alternatively, a productivity change assessment allows for a deeper understanding of the changes in efficiency over time. This assessment measures efficiency change by decomposing it into pure efficiency gains and frontier shifts. To conduct such an assessment, a Malmquist Index is used, as done in Agasisti (2014).

In the study by Camanho et al. (2023), a Global Malmquist Index is employed. This version of the Malmquist Index is estimated using a metafrontier, encompassing all frontiers from each period. This approach overcomes the circularity problem associated with the traditional Malmquist Index.

Giménez et al. (2017) utilizes a global non-radial Malmquist Index proposed by Zhang and Choi (2013) and Zhang et al. (2013). This index allows for the incorporation of undesirable outputs and enables the determination of potential improvements for each output and input individually.

In the study by Giménez et al. (2019), a Global Malmquist Luenberg Index is employed. This index is the equivalent of the Global Malmquist Index but is adapted to be used with DDF. It also allows for the incorporation of undesirable outputs, as suggested by Chung et al. (1997) and Oh (2010).

2.2.3 Evaluation of the model reliability

Of the 27 papers analysed, 11 employed methods to ensure the reliability of their models.

Three studies conducted a reliability check by comparing the results of their main model with alternative methodologies. Agasisti et al. (2019) employed NAIADE as the alternative methodology, a specific multicriteria evaluation approach that integrates all input and output items together and defines efficiency as a compromise solution between inputs and outputs. In Afonso and Aubyn (2005) and Agasisti (2011), the DEA model results were compared with the FDH model results.

Another method commonly used to guarantee the model's reliability is introducing variations in the model's variables or assumptions, which has been employed in 7 studies. Agasisti (2011) varied the sample of countries and Ahec Šonje et al. (2018) replaced the variable *unemployed with tertiary education in total unemployment* by *best-ranked universities from observed countries in the world university ranking list*. Bogetoft et al. (2015) applied the same model to data from a different year, while Giménez et al. (2017) compared results under different returns to scale assumptions. Miningou (2019) tested different distributions for a specific parameter used in its model, and Stumbriene et al. (2020) examined different weight restrictions. Camanho et al. (2021) was the only study conducted at the regional level that performed a reliability check and ensured that the consistency of the comparison between different groups was as intended.

Another method employed to guarantee the model's reliability is through the robust approach using bootstrapping introduced in Simar and Wilson (1998, 2000a,b). This procedure helps overcome the outlier sensitivity of DEA and addresses the deterministic problem by considering the possibility of random noise. This method, which involves comparing the unit under analysis with subsamples of units and calculating the final efficiency based on the average efficiency obtained from each subsampling calculation, was utilised in the studies conducted by Agasisti (2014) and Giambona et al. (2011).

2.2.4 Inclusion of environmental factors

Contextual variables, also known as environmental or non-discretionary variables, were included in the analysis of 11 of the 27 studies, allowing for a more comprehensive and equitable comparison of countries and regions. The non-discretionary variables used in the 11 studies can be categorised into three key dimensions to facilitate analysis: student characteristics, demographic and national economic factors, and school characteristics. Since different studies have different scopes, variables that represent inputs, outputs, or indicators in some studies may be considered contextual variables in others.

Student characteristics include parental education attainment, parent occupational level, attitude toward studying, family income level, ESCE level, retention rate, immigrant status, gender and availability of resources at home.

Demographic and national economic factors are the most prominent dimension and include variables such as GDP per capita, government spending on different educational stages, inflation rate, countries' income group, public subsidies, population, and the percentage of the population with tertiary education.

Variables in the school dimension include the percentage of public and government-dependent private institutions, average teachers' ages and salaries, the number of students in the school, teacher-student ratio, number of foreign-invested enterprises, and student-to-high school ratio.

The studies employed various methods to ensure the contextual variables' incorporation and verification of relevance and impact on the analysis. These methods ranged from one-stage, two-stage, and three-stage approaches to simpler descriptive statistical analyses.

Giménez et al. (2007) and Thieme et al. (2012) employed a one-stage model similar to Lozano-Vivas et al. (2002a) and Lozano-Vivas et al. (2002b) to incorporate contextual variables from the category of student characteristics. This approach evaluated technical efficiency by considering only the inputs inherent in the productive process and its outputs. The environmental variables were included in a second linear program, which decomposed the efficiency scores to obtain the maximum potential output and incorporate the role of managerial efficiency.

Afonso and St. Aubyn (2006) incorporated student characteristics, as well as demographic and national economic factors, and Agasisti (2011) included demographic and national economic factors, along with school characteristics, both through the employment of a two-stage method. This approach involved utilising a Tobit analysis in the second stage, where the estimated efficiency scores from the first stage were corrected with the non-discretionary variables. The correction was based on regressions of the first-stage efficiency score estimates on these variables. Agasisti (2014) also utilised a regression model, specifically an Ordinal Least Squares (OLS) approach, to incorporate demographic and national economic factors and school characteristics.

In another approach, Marto et al. (2022) employed a spatial two-stage least squares model. They also utilised Local Indicators of Spatial Association (LISA) clusters to create more comparable groups, considering the values of non-discretionary variables included in the demographic and national economic factors.

Wu et al. (2019) utilised a three-stage model proposed by Fried et al. (2002) to include the influence of school characteristics and demographical and national economic factors. This involved including the environmental variables in the DEA model in the first stage. Then, the second stage employed SFA to regress the performance measures obtained from the first stage against a set of environmental variables. Finally, a traditional DEA model was used in the third step to re-evaluate the units' performance under analysis after removing the influence of environmental effects and statistical noise.

Other methodologies used to control the effect of non-discretionary variables included Propensity Score Matching (PSM), as employed by Crespo-Cebada et al. (2014) and Camanho et al. (2021) to consider school and student characteristics. PSM allowed for matching units based on characteristics in the reference group, enabling the correction of treatment effect estimation while controlling for differences between groups.

Simpler approaches were also employed, such as descriptively analysing the correlation of environmental variables from the three categories with efficiency scores, as done by Agasisti et al. (2019). Ferrera et al. (2011) utilised variance decomposition to understand the attribution of efficiency to different factors from the student and school characteristics categories.

2.2.5 Assessment of performance regarding the Strategic Framework on Education and Training

Two studies focused on evaluating the performance of European Union countries in achieving the targets set by the ET2020. These studies employed the Benefit-of-the-Doubt (BoD) technique, which employs DEA to construct a composite indicator to summarise multiple indicators into a single efficiency measure.

The study conducted by Stumbriene et al. (2020) aimed to assess the performance of European countries concerning the ET2020. This evaluation summarised the framework's indicators into a single performance measure using the BoD method. A sensitivity analysis was performed by varying the weight restrictions of the model from fully flexible to fixed weighting schemes. This analysis utilised data from 2014 and 2015 for a single evaluation. The study yielded noteworthy findings. Switzerland, Sweden, Denmark, and Finland consistently demonstrated high-efficiency results regardless of the imposed weight restrictions, aligning with existing literature on cross-country efficiency evaluations. Conversely, countries such as Slovakia, Italy, Croatia, Bulgaria, Greece, and Romania were significantly influenced by weight restrictions, indicating varying performance across different ET2020 targets. Countries that excelled in only a subset of indicators were more sensitive to the degree of freedom in weight restrictions. The study suggested that more stable countries, like Switzerland, are more suitable as benchmarks. Furthermore, the study indicated a misalignment between the ET2020 targets and actual performance, with certain variables demanding higher results for a country to be considered efficient while others had more lenient thresholds. One limitation of the study was the absence of considering multiple time periods in the evaluation.

Addressing this limitation, Camanho et al. (2023) conducted a study encompassing a broader time span by creating a Global Malmquist Index. This index evaluated trends from 2009 to 2018 at three-year intervals. Consistent with previous findings, Sweden emerged as an efficient country in all analysed years. Switzerland, Finland, and Denmark featured as efficient in three of the four years, and their performances aligned with the earlier results. Sweden and Finland improved over the years, while Denmark moved away from the efficiency frontier. Norway was also identified as an efficient country. Estonia and Luxembourg demonstrated significant performance improvements in 2018 compared to the previous year. The Global Malmquist Index revealed performance improvements for almost all countries from 2009 to 2018, except for Slovakia, which experienced a clear decline. Portugal, Spain, Malta, and Greece showcased notable performance improvements over the period analysed.

The study also examined σ and β-convergence over time. σ-convergence indicates whether countries are moving closer to the efficient frontier. Positive results were observed only from 2015 to 2018. On the other hand, β-convergence, which assesses the convergence of best and worst practice frontiers, showed negative results, implying a widening gap between countries' performance levels.

Similar to the study by Stumbriene et al. (2020), Camanho et al. (2023) also highlighted that achieving certain ET2020 target values at the country level may be impossible for some countries, suggesting a need to re-evaluate the values.

2.3 Conclusion: Knowledge gap and contribution envisaged

After conducting a comprehensive review of the existing literature on performance evaluation in education at both country and regional levels, several areas for improvement have been identified.

Firstly, a limited number of studies focus on performance at the regional level. In fact, only Marto et al. (2022) and Agasisti and Cordero-Ferrera (2013) have been found that examine regional performance encompassing multiple countries. Furthermore, there is a lack of studies that comprehensively analyse the educational systems as a whole at the regional level. These insights are crucial for policymakers and stakeholders seeking to address regional disparities within a country and implement targeted interventions to promote equitable educational outcomes. Examining regional performance makes it possible to pinpoint specific inefficiencies and tailor policy interventions accordingly, leading to more effective and equitable educational systems.

Turning to the examination of the strategic framework for education and training, Stumbriene et al. (2020) and Camanho et al. (2023) were identified as two pertinent studies for measuring performance at the country level using the ET2020 indicators and assessing its evolution over time. However, these studies can be enhanced by a robustness assessment that utilises statistical methods to overcome the deterministic limitations of the DEA and BoD approaches. Additionally, their evaluations do not consider contextual factors influencing a country's performance.

Furthermore, it should be noted that a new strategic framework for education and training for the period between 2021 and 2030, the ET2030, has recently been released but has not yet undergone evaluation.

The present study aims to capitalise on the identified opportunities and advance the existing research by incorporating a robust order-m approach. This incorporation will enhance the assessment of performance, evolution over time, and convergence, overcoming the deterministic limitations associated with the BoD technique. In this way, one significant contribution of this research to the literature is the exploration of the combination of a robust approach with a σ and β convergence assessment, which, to the best of the available knowledge, has not been previously explored.

Additionally, the study will conduct a robust conditional analysis to consider contextual variables that may impact the performance of different geographies. This method of incorporating environmental factors differs from the approaches described in section 2.2.4 that were used to incorporate contextual variables in other studies within the scope of analysis.

Finally, applying this approach in an innovative empirical context, utilising regional-level data for the ET2030 framework, extends the existing scope in the literature.

This study aims to equip policymakers with additional tools and information to identify inequalities and challenges different regions face in achieving good performance over time. The findings will serve as valuable inputs for designing targeted policies and interventions to address regional disparities and promote greater performance in education systems.

Chapter 3

Methodology

This chapter provides a comprehensive theoretical overview of the various methods employed in this study. Firstly, composite indicators (CI) and data envelopment analysis are introduced. Next, the chapter explores the Benefit-of-the-Doubt, which bridges CI and DEA and is the performance measurement methodology chosen for this study. It also explains the weight restriction considered in the model.

Moreover, it is introduced the concept of the Global Malmquist Index estimated through a metafrontier. It further explains the components of Efficiency Change and Best Practice change within the Global Malmquist Index, enabling an understanding of performance evolution over time. The chapter also explores the concepts of σ and β-convergence, providing insights into the analysis of convergence in performance results.

Finally, the chapter elucidates the procedures for the robust and conditional approaches. These approaches are implemented to overcome the Benefit-of-the-Doubt technique's deterministic limitation and to incorporate conditional variables into the analysis.

3.1 Composite Indicators

A composite indicator is a metric that combines the values of multiple individual indicators or variables into a single figure. It is intended to provide a thorough evaluation or summary of a complex reality, facilitating interpretation and effective comparison across entities or over time.

Composite indicators are becoming increasingly used as a valuable tool for benchmarking, policy analysis, and public communication, with applications ranging from the economy to environmental studies and education.

The United Nations Human Development Index (HDI) (United Nations, 2023), the Technology Achievement Index (TAI), which is well explored in Nardo et al. (2008), and the OECD's Composite Leading Indicator (OECD, 2023) are examples of widely used Composite Indicators. At the educational level, there is the Education For All Development Index (EFA) (EFA Global Monitoring Report Team, 2014) developed by UNESCO with indicators related to universal primary education, adult literacy, educational quality, and gender, as well as the European Commission's European Lifelong Learning Indicators (EELI) (Saisana, 2010).

There are several steps when constructing a Composite Indicator, as mentioned in Nardo et al. (2008). The first steps include the establishment of a theoretical framework and the data selection. The importance of having complete databases and reliable data is also explained in the treatment of missing data step, making the imputation of missing data a very delicate process.

Following those steps, data normalisation and weight selection are required before performing a final aggregation. The most common linear aggregation is the sum of weighted and normalised individual indicators, as shown in (3.1).

$$\begin{aligned} CI_c &= \sum_{i=1}^{m} w_i \cdot y^n_{c,i} \\ \text{with } &\sum_{i=1}^{m} w_i 1 \\ &0 \leq w_i \leq 1, \quad \forall i = 1, \ldots, m \end{aligned} \tag{3.1}$$

In this equation, CI_c represents the composite indicator for unit c in a sample of j units ($c = 1, \ldots, j$), w_i denotes the weight associated with indicator i, $y^n_{c,i}$ represents the value of the normalised indicator i for the unit c. The conditions ensure that the weights (w_i) sum up to 1 and lie between 0 and 1.

Both steps of data normalisation and weight selection bring problems and criticism to the composite indicators construction.

Data normalisation is required to ensure that indicators are comparable and of the same magnitude. Otherwise, the units of measurement used by each indicator will significantly impact the final aggregation. However, this process introduces new issues. On the one hand, it obscures the indicator's original purpose since it will no longer be summarising original data, but transformed data, reducing interpretability. On the other hand, there are several options for the normalisation process. As demonstrated in Cherchye et al. (2007), this choice significantly impacts the final scores of the different units and their rankings, introducing a source of uncertainty into the model.

When it comes to selecting weights, if using a standard fixed weighting scheme, they must be determined prior to running the model, typically through expert opinion. This is frequently criticised due to the inherent subjectivity involved in defining them. There is also frequently a lack of consensus among experts regarding the appropriate weights to be used in the aggregation functions. Furthermore, these methods are incapable of taking DMU-specific characteristics into account. As a result, the importance level assigned to each indicator by each unit is ignored, complicating the investigation of root causes of poor performance. Comparing the multidimensional performance of units and subjecting them to a fixed set of weights may prevent stakeholders from accepting the results. Each unit has its own characteristics, and inevitably different policy priorities will coexist that should be taken into account.

The use of Data Envelopment Analysis (Charnes et al., 1978) in constructing a composite indicator addresses the two previously mentioned problems. Thus, the next two sections will explain the DEA technique and the Benefit-of-the-Doubt, the name given to constructing composite indicators through DEA.

3.2 Data Envelopment Analysis

Data Envelopment Analysis is a linear programming method introduced by Charnes et al. (1978) for efficiency analysis. It is a non-parametric frontier technique that does not require a specific functional form of a production function to measure efficiency. Instead, it evaluates the relative efficiency of the production units under analysis, referred to as decision-making units. The DEA technique identifies a subset of efficient DMUs, known as the best practice units (or benchmarks), and constructs the frontier using them.

The fractional programming model that underlines the rationale of the efficiency estimation in DEA is shown in (3.2).

$$\begin{aligned} E_k = \max \quad & \frac{\sum_{r=1}^{s} u_r \cdot y_{rk}}{\sum_{i=1}^{m} v_i \cdot x_{ik}} \\ \text{s.t.} \quad & \frac{\sum_{r=1}^{s} u_r \cdot y_{rj}}{\sum_{i=1}^{m} v_i \cdot x_{ij}} \leq 1 \quad \forall j = 1, \ldots, n \\ & u_r \geq 0 \qquad\qquad \forall r = 1, \ldots, s \\ & v_i \geq 0 \qquad\qquad \forall i = 1, \ldots, m \end{aligned} \tag{3.2}$$

Here, it is considered a set of n DMUs ($j = 1, \ldots, n$) that consume m outputs in quantities x_{ij} ($i = 1, \ldots, m$) and produce s outputs in quantities y_{rj} ($r = 1, \ldots, s$). Model 3.2 is solved separately for each DMU k under analysis, with the objective of maximising its efficiency. The decision variables are the weights associated with each input and output. The maximum achievable efficiency is 1, indicating that the set of weights assigned to a DMU cannot yield an efficiency value greater than 1 when applied to all the DMUs. This is reflected in the first constraint of the model. The weights are also required to be greater than or equal to 0, as indicated by the second and third constraints. By using the optimal weights defined in the model, this technique aggregates multiple outputs into a virtual output and multiple inputs into a virtual input. The ratio of the virtual output to the virtual input represents a single measure of efficiency. The optimal weights are flexible and vary for each DMU, highlighting their best possible performance, which is reflected in the model by the maximisation of efficiency.

This fractional model can be easily transformed into a linear version and can be either input-oriented or output-oriented. The choice of orientation depends on the assessment context and objectives. The input-oriented approach evaluates whether a DMU uses the minimum amount of inputs to achieve its current output levels, and its linear programming formulation is shown in (3.3).

$$
\begin{aligned}
E_k = \max \quad & \sum_{r=1}^{s} u_r \cdot y_{rk} \\
\text{s.t.} \quad & \sum_{i=1}^{m} v_i \cdot x_{ik} = 1 \\
& \sum_{r=1}^{s} u_r \cdot y_{rj} - \sum_{i=1}^{m} v_i \cdot x_{ij} \leq 0 \quad && \forall j = 1, \ldots, n \\
& u_r \geq 0 && \forall r = 1, \ldots, s \\
& v_i \geq 0 && \forall i = 1, \ldots, m
\end{aligned} \tag{3.3}
$$

The output-oriented approach assesses whether a DMU maximises its output levels given the current inputs, and its linear programming formulation is shown in (3.4).

$$
\begin{aligned}
[E_k]^{-1} = \min \quad & \sum_{i=1}^{m} v_i \cdot x_{ik} \\
\text{s.t.} \quad & \sum_{r=1}^{s} u_r \cdot y_{rk} = 1 \\
& \sum_{i=1}^{m} v_i \cdot x_{ij} - \sum_{r=1}^{s} u_r \cdot y_{rj} \leq 0 \quad && \forall j = 1, \ldots, n \\
& u_r \geq 0 && \forall r = 1, \ldots, s \\
& v_i \geq 0 && \forall i = 1, \ldots, m
\end{aligned} \tag{3.4}
$$

Models (3.3) and (3.4) represent the primal linear programming formulation, also known as weights formulation or multiplier formulation. The dual formulation of these problems, commonly referred to as the envelopment formulation, is presented in (3.5) for the input-orientated approach and in (3.6) for the output-orientated approach.

$$
\begin{aligned}
E_k = \min_{\theta, \lambda} \quad & \theta \\
\text{s.t.} \quad & \theta \cdot x_{ik} - \sum_{j=1}^{n} \lambda_j \cdot x_{ij} \geq 0 \quad && \forall i = 1, \ldots, m \\
& \sum_{j=1}^{n} \lambda_j \cdot y_{rj} \geq y_{rk} && \forall r = 1, \ldots, s \\
& \theta \in \mathbb{R} \\
& \lambda_j \geq 0 && \forall j = 1, \ldots, n
\end{aligned} \tag{3.5}
$$

The input-oriented dual formulation involves decision variables θ, the efficiency level of the DMU k under analysis, and λ_j ($j = 1, \ldots, n$), the intensity variables. The λ_j values allow for the identification of peers of the DMU k under analysis. If the value is greater than 0, it means that DMU j is a peer of DMU k, and the value represents how relatively close DMU k is from DMU j when compared to other units in the frontier.

$$
\begin{aligned}
[E_k]^{-1} = \max_{\phi,\lambda} \quad & \phi \\
\text{s.t.} \quad & \sum_{j=1}^{n} \lambda_j \cdot x_{ij} \leq x_{ij} && \forall i = 1, \ldots, m \\
& \sum_{j=1}^{n} \lambda_j \cdot y_{rj} \geq \phi \cdot y_{rk} && \forall r = 1, \ldots, s \\
& \phi \in \mathbb{R} \\
& \lambda_j \geq 0 && \forall j = 1, \ldots, n
\end{aligned}
\tag{3.6}
$$

The output-oriented dual formulation also includes λ_j $(j = 1, \ldots, n)$ as decision variables, which have the same meaning as in the input-oriented dual formulation. It additionally incorporates ϕ as a decision variable, which is linked to the input-oriented model through the relationship $\phi = 1/\theta$.

In a DEA model, there are two types of scale considerations: constant returns to scale (CRS) and variable returns to scale (VRS). Constant returns to scale imply that an increase in inputs leads to an equally proportionate change in the outputs. On the other hand, variable returns to scale allow for a changing relationship between inputs and outputs, where the change in inputs can result in more or less than proportional growth in output values.

The models presented in (3.3), (3.4), (3.5) and (3.6) correspond to the CRS formulations. The VRS formulations can be found in Banker (1984). It is important to note that when assuming constant returns to scale, the input and output-oriented efficiency scores are identical. However, in the case of assuming variable returns to scale, the efficiency score may differ depending on whether it is measured from an input or output orientation.

Therefore, when using the DEA model, it is essential to consider whether CRS or VRS assumptions are appropriate for the specific context and objectives of the analysis. This can be determined by expert knowledge in the specific area or sector under assessment or using hypothesis tests as suggested by Banker (1996).

3.3 Benefit-of-the-Doubt

DEA has expanded its scope over the years as a promising efficiency measurement technique. One area where it has found application is in the construction of composite indicators through the Benefit-of-the-Doubt (Cherchye et al., 2007). This technique enables performance measurement while also addressing the previously mentioned gaps in normalisation and weight selection.

DEA is a unit invariance method, which means that its results are independent of the measurement units of its inputs and outputs or, in the case of BoD, of the indicators that comprise the final performance measure. Consequently, there is no need for normalisation. As stated by Cooper et al. (2004), the weights in DEA are endogenous, allowing for flexibility and adaptation to the units of measurement.

On top of that, since weights are not predetermined, subjective selection is eliminated, and units cannot blame poor performance on it. This property gives rise to the term Benefit-of-the-Doubt, as each unit is portrayed in the most favourable light. The underlying assumption is that a unit's superior performance in a particular indicator reflects a higher valuation or prioritisation of policies related to that indicator. A unit's poor performance, on the other hand, indicates that it is given less importance.

When comparing units, this technique allows them to assign different weights to the indicators. As a result, BoD allows different units to assign different weights to the indicators. If, even when viewed in its best light, the unit does not have the maximum efficiency, it indicates that it has room for improvement when compared to other units, as any other weighting scheme would place it in an even worse position.

Another crucial point to consider is that DEA, and consequently BoD, is a method that relies on direct comparisons among observed units. As a consequence, it is possible to conclude, based on observed evidence, that a poorly performing DMU could potentially achieve better performance when taking into account other DMUs observed in reality, regardless of whether the empirical frontier corresponds to the theoretical frontier.

Despite its strengths, BoD has some limitations. Due to the empirical nature of the method, it is not possible to state with certainty that the DMUs identified as the best performers have no potential for improvement, as the theoretical frontier remains unknown and may extend beyond what is observed and the empirical frontier. It also has a tendency to reinforce the status quo since the linear problem assigns higher weights to indicators in which a unit performs better.

While the flexible weighting of BoD offers various advantages, it also gives the model excessive freedom, allowing it to ignore indicators that indicate poor performance. To address this issue, it is possible to set weight restrictions to ensure the consideration of all indicators. Various types of weight restrictions can be applied to BoD problems.

The weight restriction proposed by Zanella et al. (2015) will be further explored. This formulation enables the incorporation of information about the relative importance of indicators by imposing bounds on the weight ratios, following the Assurance Regions Type I restriction (ARI) commonly used in DEA (Thompson et al., 1990). The specific type of restriction presented by Zanella et al. (2015) allows for the specification of bounds in percentage terms, thereby reflecting the relative importance of the output in the assessment.

Typically, the formulation of a BoD problem is analogous to an input-oriented DEA problem with constant returns to scale, where the outputs represent the indicators to be summarised, while a single dummy variable serves as the input (Cherchye et al., 2007). This choice is more intuitive as it focuses on the aggregation of the outputs. However, when weight restrictions are introduced, it is easier to explain the model using an output-oriented formulation, as described in Puyenbroeck (2018).

This way, the model used in the present study is presented in (3.7), adopting an output-oriented formulation with CRS.

$$
\begin{aligned}
\left[E_k^t(\mathbb{1},Y_k^t)\right]^{-1} = \min \quad & v \\
\text{s.t.} \quad & \sum_{r=1}^{s} u_r \cdot y_{rk}^t = 1 \\
& \sum_{r=1}^{s} u_r \cdot y_{rj}^t - v \leq 0 \qquad \forall j = 1,\ldots,n \\
& \frac{u_r \cdot \overline{y}_r}{\sum_{r=1}^{s} u_r \cdot \overline{y}_r} \geq \phi_r \qquad \forall r = 1,\ldots,s \\
& u_r \geq 0 \qquad \forall r = 1,\ldots,s \\
& v \geq 0
\end{aligned}
\tag{3.7}
$$

In this model, it is assessed the DMU k in a specific time period t. The notation already encompasses the concept of a time period, as it will be required in subsequent sections and will also be represented accordingly.

The output indicator vector for DMU k is represented by $Y_k^t = (y_{1k}^t, y_{2k}^t, \ldots, y_{sk}^t)$. The comparison of the DMU under analysis with others is based on the frontier defined by the technology set for period T_t.

The decision variables in this model are u_r ($r = 1,\ldots,s$) and v, representing the weights assigned to the output indicators and the unitary dummy input, respectively. These variables play a crucial role in the optimisation process.

The objective function of the model minimises the weight associated with the input, which in this case corresponds to its virtual weight since the input is a single dummy variable.

The model includes constraints that must be met. Firstly, the sum of the virtual weights of the indicators for the DMU under assessment must equal 1. Additionally, a constraint is imposed on the difference between the sum of the virtual weights of the indicators and the weight of the input. This constraint corresponds to the trivial linearisation of the first restriction presented in equation (3.2) and ensures that the value of v exceeds or is equal to 1, ultimately resulting in an efficiency measure that is less than or equal to 1. The efficiency measure $E_k^t(\mathbb{1},Y_k^t)$ is defined as the inverse of the input weight v. It quantifies the efficiency of the DMU under analysis, where a value closer to 1 indicates higher efficiency.

Additionally, a third constraint is imposed, which relates to the weight restriction. This constraint introduces an artificial DMU that has indicator values equal to the average of the indicator values of all DMUs across all years. It is important to note that even if the performance measure is not affected by the units of measurement, the final weights are affected, as stated in Cherchye et al. (2007). This means that the importance given to each indicator by the units should be seen through the virtual weights rather than the weight itself. This constraint ensures that the virtual weight of indicator r ($r = 1,\ldots,s$) in relation to the virtual weights of all indicators of the artificial DMU are at least ϕ_r. Here, ϕ_r is assumed to be 0.05, meaning that each indicator r has a minimum influence of 5% on the efficiency measure. This restriction serves to emphasise the importance of all indicators and consider all dimensions in the performance assessment. It also enhances the discriminatory power of the model.

The formulation presented in (3.7) is the primal form of linear programming, also known as the multiplier form. By utilising the duality of linear programming, it can be transformed into its dual/envelopment form, presented in (3.8).

$$
\begin{aligned}
\left(E_k^t(\mathbb{1},Y_k^t)\right)^{-1} = \max \quad & \varphi \\
\text{s.t.} \quad & \varphi \cdot y_{rk}^t - \sum_{j=1}^{n} y_{rj}^t \cdot \lambda_j + \delta_r \cdot \bar{y}_r - \sum_{r=1}^{s} \delta_r \cdot \bar{y}_r \leq 0 \quad \forall r = 1,\ldots,s \\
& \sum_{j=1}^{n} \lambda_j \leq 1
\end{aligned}
\tag{3.8}
$$

In the second formulation, the decision variables include φ, the intensity factors λ_j ($j = 1,...,n$), and the components associated with the weight restrictions δ_r ($r = 1,...,s$). This model allows to determine the peers of the DMU k under assessment. If the value of λ_j exceeds 0, it indicates that j is a peer of the DMU k. The targets $\sum_j y_{rj} \cdot \lambda_j$ represent the coordinates of the efficient projection point on the frontier, indicating the levels of output operation that would enable the corresponding inefficient DMU to perform efficiently. Therefore, the targets can provide valuable insights in practice as they can guide inefficient DMUs towards improving their performance.

The inverse of the performance measurement is given by φ and should have the same value as v in the primal formulation. δ_r ($r = 1,...,s$) are variables associated with each indicator, allowing the model to incorporate weight restrictions.

3.4 Global Malmquist Index

The current study also examines the evolution of educational performance in different geographical areas of Europe over time, applying the Global Malmquist Index (GMI).

The Malmquist Index is used to measure productivity change over time and was first proposed in Färe et al. (1992). In Pastor and Lovell (2005), it is presented an improved version known as the Global Malmquist Index, which overcomes the non-circularity limitation identified in Färe et al. (1992). Circularity is achieved by recurring to the estimation of a metafrontier.

The metafrontier was introduced in Battese and Rao (2002) and further refined in Battese et al. (2004). It compares groups with different technologies and measures efficiency. Each group has its own frontier based on its specific technology, but a metafrontier can be constructed to envelop all individual frontiers and facilitate group comparisons. As a result, Pastor and Lovell (2005) incorporates the metafrontier by treating the various years as groups with their own technology set T^p ($p = 1,...,t,t+1,...,P$) and constructing a metafrontier that envelopes all individual period frontiers $T^M = \bigcup_{t=1}^{P} T^t$. The index proposed in Pastor and Lovell (2005) for a multi-input multi-output setting is shown in (3.9).

$$
GMI_k^{t,t+1} = \frac{E_k^M(X_k^{t+1},Y_k^{t+1})}{E_k^M(X_k^t,Y_k^t)} \tag{3.9}
$$

The index presented in (3.9) can be adapted to the BoD context by replacing the multi-input variables with the dummy input variable employed in this approach. (3.10).

$$GMI_k^{t,t+1} = \frac{E_k^M(\mathbb{1}, Y_k^{t+1})}{E_k^M(\mathbb{1}, Y_k^t)} \tag{3.10}$$

$E_k^M(\mathbb{1}, Y_k^t)$ represents the performance of the DMU k in period t considering a metatechnology. This measure is calculated by modifying the second constraint of model (3.7). The constraint should be applied to all DMUs across all years rather than just the year under analysis, as shown in (3.11).

$$\begin{aligned}
& \left[E_k^M(\mathbb{1}, Y_k^t)\right]^{-1} && = \min v \\
\text{s.t.} \quad & \sum_{r=1}^{s} u_r \cdot y_{rk}^t && = 1 \\
& \sum_{r=1}^{s} u_r \cdot y_{rj}^t - v && \leq 0 \quad \forall j = 1, \dots, n \quad \forall t = 1, \dots, P \\
& \frac{u_r \cdot \overline{y}_r}{\sum_{r=1}^{s} u_r \cdot \overline{y}_r} && \geq \theta_r \quad \forall r = 1, \dots, s \\
& u_r && \geq 0 \quad \forall r = 1, \dots, s \\
& v && \geq 0
\end{aligned} \tag{3.11}$$

$E_k^M(\mathbb{1}, Y_k^{t+1})$ is calculated through the generalization of (3.11) for period $t+1$.

If the GMI of DMU k in periods t to $t+1$ is greater than 1, it indicates a positive evolution of the DMU performance. This evolution can be divided into two components: the Efficiency Change (EC) and the Best-Practice Change (BPC). Thus, the GMI can also be calculated by taking the product of those two components, as shown in (3.12).

$$GMI_k^{t,t+1} = EC_k^{t,t+1} \times BPC_k^{t,t+1} \tag{3.12}$$

The Efficiency Change component, denoted by $EC_k^{t,t+1}$, measures the evolution of the distance to the frontier of the DMU k between periods t and $t+1$. If there are no changes in the DMU's distance to the frontier, $EC_k^{t,t+1}$ equals 1. A value greater than one indicates that the DMU has improved its performance more than the other DMUs in the sample, regardless of overall frontier movement, and is thus closer to it. This component is calculated as the ratio of efficiency in period $t+1$ to efficiency in period t.

$$EC_k^{t,t+1} = \frac{E_k^{t+1}(\mathbb{1}, Y_k^{t+1})}{E_k^t(\mathbb{1}, Y_k^t)} \tag{3.13}$$

The Best-Practice Change measures the shift in the production frontier. It is calculated by dividing the Best-Practice Gap (BPG) in period $t+1$ by the BPG in period t. The formulation is presented in (3.14).

$$BPC_k^{t,t+1} = \frac{BPG_k^{t+1,M}(\mathbb{1}, Y_K^{t+1})}{BPG_k^{t,M}(\mathbb{1}, Y_K^t)} \tag{3.14}$$

The $BPG_k^{t,M}(\mathbb{1}, Y_K^t)$ can be calculated using the formula in (3.15).

$$BPG_k^{t,M}(1, Y_K^t) = \frac{E_k^M(\mathbb{1}, Y_k^t)}{E_k^t(\mathbb{1}, Y_k^t)} \tag{3.15}$$

Here, $BPG_k^{t,M}(\mathbb{1}, Y_K^t)$ represents the Best-Practice Gap between the frontier in period t and the metafrontier. This gap is measured based on the output mix of DMU k in period t. The interpretation of $BPG_k^{t+1,M}(\mathbb{1}, Y_k^{t+1})$ is equivalent, but for period $t+1$. $BPC_k^{t,t+1}$ indicates the change in BPG between periods t and $t+1$, providing an estimate of the frontier shift. If the value is greater than 1, it means that the benchmark technology in period $t+1$ is relatively closer to the global benchmark technology (metatechnology) compared to period t. This comparison is based on the output mix observed in period $t+1$ for DMU k and the output mix observed in period t for the same DMU k.

In this manner, by substituting (3.12) with (3.13), (3.14) and (3.15), the GMI for the period t to $t+1$ of DMU k can also be expressed as shown in (3.16).

$$\begin{aligned} GMI_k^{t,t+1} &= \frac{E_k^{t+1}(\mathbb{1}, Y_k^{t+1})}{E_k^t(\mathbb{1}, Y_k^t)} \times \frac{BPG_k^{t+1,M}(\mathbb{1}, Y_K^{t+1})}{BPG_k^{t,M}(\mathbb{1}, Y_K^t)} \\ &= \frac{E_k^{t+1}(\mathbb{1}, Y_k^{t+1})}{E_k^t(\mathbb{1}, Y_k^t)} \times \frac{\frac{E_k^M(\mathbb{1}, Y_k^{t+1})}{E_k^{t+1}(\mathbb{1}, Y_k^{t+1})}}{\frac{E_k^M(\mathbb{1}, Y_k^t)}{E_k^t(\mathbb{1}, Y_k^t)}} \end{aligned} \tag{3.16}$$

To calculate the GMI for non-consecutive periods, it is enough to do the product of $GMI^{t,t+1}$ by $GMI^{t+1,t+2}$.

$$GMI_k^{t,t+2} = GMI_k^{t,t+1} \times GMI_k^{t+1,t+2} \tag{3.17}$$

This property also applies to the calculation of its components, EC and BPC.

3.5 Convergence assessment

To analyse the evolution of total performance in European regions, this research utilises the non-parametric methodology proposed by Horta and Camanho (2015). This methodology allows for studying convergence.

There are two types of convergence measures, σ-convergence and β-convergence, which are related to the two components of the previously discussed GMI.

The σ-convergence specifically relates to the Efficiency Change and assesses whether the dispersion of the units' performance decreases over time. It is calculated by taking the geometric mean of the $EC_j^{t,t+1}$ for all DMUs in the sample, as shown in (3.18).

$$\sigma\text{-convergence} = \left(\prod_{j=1}^{n} EC_j^{t,t+1} \right)^{\frac{1}{n}} \tag{3.18}$$

If the value of σ-convergence is greater than 1, it indicates convergence, signifying that the DMUs are moving closer to the best practice frontier from period t to $t+1$. Conversely, if the value is less than 1, it implies divergence, suggesting that the DMUs are moving away from the best practice frontier from period t to $t+1$. When the value is equal to 1, it suggests that, on average, the DMUs maintain the same distance from the frontier.

To analyse the β-convergence, which is related to the Best-Practices Change component of the GMI and examines whether lower-performing units tend to improve their performance faster than the higher-performing units, it is necessary to assess the movements of DMUs along the best practice frontier and the worst practice frontier between periods t and $t+1$.

The β-convergence is calculated by taking the geometric mean of the ratio between the BPC and the Worst Practice Change (WPC) for all DMUs present in both periods t and $t+1$. Specifically, $BPC_j^{t,t+1}$ is calculated using the formula mentioned in equation (3.14). It is also necessary to determine $WPC_j^{t,t+1}$, which follows a similar procedure as (3.14) and (3.15).

$$WPC_k^{t,t+1} = \frac{WPG_k^{t+1,M}(\mathbb{1}, Y_K^{t+1})}{WPG_k^{t,M}(\mathbb{1}, Y_K^{t})} = \frac{\frac{W_k^M(\mathbb{1}, Y_k^{t+1})}{W_k^{t+1}(\mathbb{1}, Y_k^{t+1})}}{\frac{W_k^M(\mathbb{1}, Y_k^{t})}{W_k^{t}(\mathbb{1}, Y_k^{t})}} \tag{3.19}$$

To calculate $W_k^t(\mathbb{1}, Y_k^t)$, an inverted version of (3.7) is used as shown in (3.20)

$$\begin{aligned}
& \left[W_k^t(\mathbb{1}, Y_k^t)\right]^{-1} && = \max v \\
\text{s.t.} \quad & \sum_{r=1}^{s} u_r \cdot y_{rk}^t && = 1 \\
& v - \sum_{r=1}^{s} u_r \cdot y_{rj}^t && \leq 0 \quad \forall j = 1, \ldots, n \\
& \frac{u_r \cdot \bar{y}_r}{\sum_{r=1}^{s} u_r \cdot \bar{y}_r} && \geq \theta_r \quad \forall r = 1, \ldots, s \\
& u_r && \geq 0 \quad \forall r = 1, \ldots, s \\
& v && \geq 0
\end{aligned} \tag{3.20}$$

The estimation of $W_k^M(\mathbb{1}, Y_k^t)$ is carried out through (3.20), with the second restriction imposed on all DMUs $j = 1, \ldots, n$ for all periods $t = 1, \ldots, p$.

Thus, β-convergence can finally be calculated using the formula (3.21).

$$\beta\text{-convergence} = \left(\prod_{j=1}^{n} \frac{BPC_j^{t,t+1}}{WPC_j^{t,t+1}} \right)^{\frac{1}{n}} \tag{3.21}$$

If the value of β-convergence is less than 1, it indicates that the distance between the frontiers of the best and worst performing units is decreasing from t to $t+1$, indicating convergence. This convergence can be attributed to a retrogression in the best practice values or an improvement in the performance of the worst performers. Conversely, if the frontiers are diverging, the value of β will be greater than 1, indicating that the worst-performing units and the best-performing units are moving further away from each other.

3.6 Robust and robust conditional approaches

The deterministic nature of DEA, and consequently of BoD, implies that all deviations of observed units from the frontier are attributed solely to inefficiency. This makes the model susceptible to atypical observations, such as outliers or measurement errors, which significantly impact the evaluation of multiple units and distort the results. To address this limitation, a Monte Carlo simulation procedure is used to employ a robust version of the BoD technique based on the works of Cazals et al. (2002) and Daraio and Simar (2005).

First, a subsample b of m observations (where $m \leq n$) is randomly drawn with replacement from the observations. The efficiency of the DMU k under analysis, $[E_k^t(\mathbb{1}, Y_k^t)]^{b,m}$, is then computed based on the subsample. This process is repeated B times ($b = 1, \ldots, B$), and the final efficiency measure is obtained by calculating the arithmetic average of the efficiency values obtained for each subsample, as shown in (3.22).

$$[E_k^t(\mathbb{1}, Y_k^t)]^m = \frac{\sum_{b=1}^{B} [E_k^t(\mathbb{1}, Y_k^t)]^{(b,m)}}{B} \tag{3.22}$$

Using the same drawn subsamples, an identical procedure is followed for the calculation of $[W_k^t(\mathbb{1}, Y_k^t)]^m$, the indicators' weights u_r^m ($r = 1, \ldots, s$) and the intensity variables λ_j^m ($j = 1, ..., n$).

To ensure that the metafrontier is similar to the group frontier and therefore avoid sample size issues (De Witte and Marques, 2009), the calculations of $[E_k^M(\mathbb{1}, Y_k^t)]^m$ and $[W_k^M(\mathbb{1}, Y_k^t)]^m$ are done using the same value of m as in the calculation of the efficiency in the local frontier, but instead of drawing only from the sample of DMUs from the year under analysis, the units are drawn from a sample that includes all DMUs from all years.

It is important to note that this robust approach may result in the appearance of super-efficient units. This occurs when the DMU under analysis is not included in the subsample used to construct the frontier. Consequently, if the DMU is efficient, it will be located beyond the frontier, leading to an efficiency measure greater than 1. These indicate that the unit under assessment is performing better than the average of the m units in the reference sample, being called super-efficient.

The conditional version of the robust BoD estimator addresses the heterogeneity among Decision Making Units (DMUs) by considering the context in which they operate. This approach allows for the inclusion of contextual variables by conditioning the Monte Carlo procedure and increasing the probability of drawing units with similar contexts to the DMU k under analysis. The remaining steps of the efficiency calculation follow a similar process to the one described in the robust analysis. Naturally, the conditional case can also result in efficiency scores greater than 1.

Chapter 4

Empirical study

In this chapter, the empirical application of the methodology outlined in chapter 3 will be elucidated. It will commence by describing the data collection and treatment process for the study. Subsequently, the specific models employed, along with the assigned parameter values, will be detailed.

4.1 Data collection

As elucidated in chapter 1, the primary objective of this research is to analyze the European regions' performance and its trends over time regarding the attainment of the ET2030 indicators. It is also proposed to incorporate the contextual factors that surround these European geographies for a more fair and equitable comparison. Furthermore, an additional analysis is proposed, encompassing both the regional and country levels simultaneously, in order to gain insight into the disparities between regions within their respective countries.

Consequently, to effectively implement the methodology outlined in chapter 3, it is essential to gather data encompassing the ET2030 indicators as well as the relevant contextual variables for a specific timeframe across various European regions and countries.

Regarding the timeframe, it was defined to collect data from 2011 onwards. This will enable the examination of the evolution of performance trends over time ensuring a comprehensive analysis.

Concerning geographical areas, the Nomenclature of Territorial Units for Statistics (NUTS) classification (Eurostat, 2022) was adopted to collect data. This classification is an agreed-upon manner for the EU and the UK. It intends to segment the economic territory to allow the standardization of statistical data collection in Europe, the conduct of socioeconomic analysis at the regional level and the definition of EU regional policies.

The data collection was attempted for all the geographical areas comprised in the NUTS classification at country, NUTS-I and NUTS-II levels. For more information, table A.1 from appendix A contains all the countries and the corresponding number of regions at each NUTS level that is comprised in the NUTS classification.

4.1.1 Indicators

To apply the Benefit-of-the-Doubt technique to this specific study on the ET2030, it is necessary to collect data for the six indicators that make up the framework. Therefore, table 4.1 presents the ET2030 indicators and the corresponding data sources from which the data can be extracted. Additionally, the table includes information on the years and geographical areas for which data is available for each indicator.

Table 4.1: Description of available data for the ET2030 indicators

Indicator	Description	Source	Years	Geographies
Early childhood education	Percentage of EU population between 3 years old and the age of starting compulsory primary education participating in early childhood education	Eurostat	2013 to 2021	Countries, NUTS-I and NUTS-II
Early leavers from education and training	Percentage of EU population aged 18-24 with only secondary education or less and no longer in education or training	Eurostat	2011 to 2021	Countries, NUTS-I and NUTS-II
Tertiary level attainment	Percentage of EU population aged 25-34 who have completed successfully tertiary level education	Eurostat	2011 to 2021	Countries, NUTS-I and NUTS-II
Adult participation in lifelong learning	Percentage of EU population aged 25-64 participating in education and training in the last 12 months	Eurostat	2011 and 2016	Countries
Low achieving eighth-graders in digital skills	Percentage of EU eighth-graders low-achieving in computer and information literacy	ICILS	2013 and 2018	Countries
Low achievers in basic skills	Percentage of EU population aged 15 with low-achieving in reading	PISA	2012, 2015, and 2018	Countries and Spain NUTS-II
	Percentage of EU population aged 15 with low-achieving in mathematics			
	Percentage of EU population aged 15 with low-achieving in science			

The fourth indicator, 'Adult participation in lifelong learning' only had available data at the country level and for the years 2011 and 2016. Despite this, the ET2020 had an equivalent indicator, with the evaluation period changing from the previous 12 months to the previous 4 weeks of participation in education and training by the population aged 25-64, for which data was available from 2011 to 2021 at all required geographical levels. As a result, this indicator was used as a proxy for ET2030's fourth indicator.

The International Computer and Information Literacy Study (ICILS) provides the necessary data for the fifth indicator, 'Low achieving eighth-graders in digital skills'. However, this study only took place in 2013 and 2018, within the established data collection period. Furthermore, data is only available at the national level for 12 countries in 2013 and 7 countries in 2018.

To find a suitable proxy and maintain an indicator related to digital skills, the indicators of the National e.2030 Digital Skills Initiative (Portugal INCoDe.2030) with Eurostat as a source were analyzed (INCoDe.2030, 2017). 'Households without access to the internet at home' and 'Individuals who have never used the internet' were kept as indicators with enough data and good interpretability. Because it reflects the availability of an important resource for developing digital skills, the indicator referring to households was chosen as a more comprehensive measure of digital access. The indicator referring to never using the internet is less reliable because someone who only uses the internet once would be included in the other percentage, but they may not have good internet access and thus may not develop their digital skills. As a result, the fifth indicator used in the model was changed to something more inclusive, from 'Low-achieving eight-graders in digital skills' to 'Low-achieving in digital skills', and now reflects 'Households without access to the internet at home'.

Finally, the sixth indicator, 'Low achievement in basic skills', is supported by data from PISA. However, this assessment was not carried out on a yearly basis, and the data collected only covered the years 2012, 2015, and 2018. Furthermore, the results were at the country level, with only Spain providing regional-level data. As a result of the lack of information, this indicator was excluded.

The final indicators considered for the analysis are summarized in table 4.2.

Table 4.2: Description of indicators

Y	Indicator	Description	Years
Y1	Early childhood education	Percentage of the EU population between 3 years old and the age of starting compulsory primary education participating in early childhood education	Yearly from 2013 to 2021
Y2	Early leavers from education and training	Percentage of the EU population aged 18-24 with only secondary education or less and no longer in education or training	Yearly from 2011 to 2021
Y3	Tertiary level attainment	Percentage of the EU population aged 25-34 who have successfully completed tertiary-level education	Yearly from 2011 to 2021
Y4	Adult participation in lifelong learning	Percentage of the EU population aged 25-64 participating in education and training in the last 4 weeks	Yearly from 2011 to 2021
Y5	Low-achieving in digital skills	Percentage of households without access to the internet at home	Yearly from 2011 to 2022

4.1.2 Contextual variables

The application of the robust conditional approach requires choosing and collecting contextual variables. Therefore, it is necessary to do a comprehensive understanding of the environmental factors that can potentially influence educational outcomes.

Witte and López-Torres (2017) presents a systematic review of the contextual variables used in the literature, dividing them into four categories: student, family, educational institution, and community. The effects of the variables can be either positive or negative, depending on whether units with higher values on a particular variable exhibit better or worse results, respectively. In some cases, certain variables may yield mixed results, meaning their effects can vary across different studies.

Disabilities related to additional educational needs and race/ethnicity/minority/nationality are student-related variables that have been shown to have a negative impact on student outcomes. Other variables, such as free lunch, gender, and grants, have mixed results on the impact they have in the outcomes. Finally, the better a student's previous results, the better his or her future results should be.

In terms of family variables, the lower the parents' education, home resources, and socioeconomic status (including family income and employment), the worse the students' results. Variables that reflect family structure have mixed effects on the impact they have in the model.

Several educational institution variables, such as the type of institution, organization, religious orientation, class size, gender structure, and teacher characteristics, do not have consensual results on the influence of educational outcomes. The quality of teaching, research (innovation), and local/external funding are positive variables in education. Dropout rates and expulsion/suspension rates, on the other hand, have a negative impact on education.

Most of the variables at the community level have mixed effects, including competition, mortality rate/crime-violence, percentage of households with school-aged children, and population/district size. GDP per capita and percentage of population with higher education are both positive influences on educational outcomes. A detrimental neighborhood, a scarcity of jobs, and a high rate of immigrants all have a negative impact on educational outcomes.

It is important to acknowledge that including a large number of contextual variables in the model results in an excessive degree of freedom, resulting in a greater number of efficient DMUs. This abundance of variables diminishes the added value that the model provides. Therefore, it is crucial to carefully select a smaller set of variables that hold significant relevance within the given context. This achieves a balance between capturing environmental factors and maintaining the model's discriminatory power.

Given that the present research focuses on the educational system and the community as a whole, more emphasis was placed on community-level variables. To ensure the selection of truly significant variables, those that yielded mixed results in the literature were not further investigated.

Since different studies have different scopes, variables that represent inputs, outputs, or indicators in some studies may be considered as contextual variables in others. In this study, the percentage of the population with higher education is an indicator that is taken into consideration to construct the composite indicator, this variable is automatically excluded as a possible contextual variable.

According to the economic Okun's Law, economic growth (as measured by GDP per capita) and employment rate have a strict relationship (Ball and Leigh, 2013). As a consequence, it was decided to use only one of them, in this case, the unemployment rate, since data for this variable was available for a wider range of geographical areas.

Data regarding the population's citizenship composition was available, specifically the rate of the population with citizenship from the reported country, foreign country, stateless and no response. The variable with fewer missing values was the citizenship rate from the reported country. Therefore, it was chosen since it corresponds to the complement of the immigrant rate and derives the same effect on the model.

Thus, in order to ensure a more equitable comparison between geographical areas, this study takes into consideration the two contextual variables detailed in table 4.3, both of which are part of the community category.

Table 4.3: Description of contextual variables

Z	Contextual Variable	Description	Years
Z1	Unemployment	Percentage of population aged 15 or over unemployed	Yearly from 2011 to 2022
Z2	Citizenship	Percentage of population aged 15 or over with citizenship of the reported country	Yearly from 2011 to 2022

4.2 Data treatment

After collecting the data for the seven variables, namely the five indicators presented in table 4.2 and the two contextual variables presented in table 4.3, data treatment is required.

In this particular case, Y1 did not have available data for 2011 and 2012, and Y1, Y2, Y3, and Y4 did not have available data for 2022. As a result, those years were previously excluded from the analysis.

For applying the BoD model in a given year t, all the DMUs under analysis must have complete data for that year, meaning all values should be available in all seven variables. However, imputation of missing values should only be performed if it is reliable; otherwise, it is preferable to exclude the evaluated unit or, in cases where a significant amount of information is missing, not to perform the model for that specific year.

When a country is relatively small, its NUTS-I level can be equivalent to the entire geographical area of the country. Similarly, a NUTS-II region can cover the same territory as the NUTS-I region it is associated with. As a result, these equivalent regions share the same values for the variables, as observed by examining the data. In cases where one geographical level had available information while another equivalent level had missing data, the missing values were imputed using the available data. No other method of imputing missing values was possible without sacrificing the data reliability. Therefore, further analysis was conducted to determine which regions or years should be excluded.

During the analysis of the NUTS-II regional level, it was found that more than one-third of those regions had to be excluded each year due to missing data for at least one of the seven variables. Consequently, it was determined that the NUTS-II level was not adequately represented for inclusion in the analysis and was decided to be excluded from further analysis.

Next, the available data for each year was examined. It was observed that in the years 2013, 2020, and 2021, only half of the NUTS-I regions had complete data when compared with the years from 2014 to 2019. As a result, these three years were excluded from the analysis.

Finally, countries and NUTS-I regions that had missing values for at least one of the seven variables in every year from 2014 to 2019 were also eliminated from the analysis since they could not be assessed in any of the six years.

To maximize the inclusion of various geographies, an unbalanced database was chosen. This involved removing geographies from each year that lacked data for at least one of the indicators. However, if a geography had complete data for one year but not for others, it was retained for the year with complete data.

Table 4.4: List of final geographies considered in the analysis

Code	Name	Type
BE	Belgium	Country
BE1	Région de Bruxelles-Capitale	Region (Capital)
BE2	Vlaams Gewest	Region
BE3	Région wallonne	Region
BG	Bulgaria	Country
BG3	Severna i yugoiztochna	Region
BG4	Yugozapadna i yuzhna tsentralna	Region (Capital)
CZ	Czechia	Country
CZ0	Cesko	Region (Capital)
DK	Denmark	Country
DK0	Danmark	Region (Capital)
DE	Germany	Country
DE1	Baden-Württemberg	Region
DE2	Bayern	Region
DE3	Berlin	Region (Capital)
DE4	Brandenburg	Region
DE5	Bremen	Region
DE6	Hamburg	Region
DE7	Hessen	Region
DE8	Mecklenburg-Vorpommern	Region
DE9	Niedersachsen	Region
DEA	Nordrhein-Westfalen	Region
DEB	Rheinland-Pfalz	Region
DEC	Saarland	Region
DED	Sachsen	Region
DEE	Sachsen-Anhalt	Region
DEF	Schleswig-Holstein	Region
DEG	Thüringen	Region
EE	Estonia	Country
EE0	Eesti	Region (Capital)
IE	Ireland	Country
IE0	Éire/Ireland	Region (Capital)
EL	Greece	Country
EL3	Attiki	Region (Capital)
EL4	Nisia Aigaiou, Kriti	Region (Island)
EL5	Voreia Ellada	Region
EL6	Kentriki Ellada	Region
ES	Spain	Country
ES1	Noroeste	Region
ES2	Noreste	Region
ES3	Comunidad de Madrid	Region (Capital)
ES4	Centro	Region
ES5	Este	Region
ES6	Sur	Region
ES7	Canarias	Region (Island)
FR	France	Country
FR1	Île de France	Region (Capital)
FRB	Centre - Val de Loire	Region
FRC	Bourgogne - Franche-Comté	Region
FRD	Normandie	Region
FRE	Hauts-de-France	Region
FRF	Grand Est	Region
FRG	Pays-de-la-Loire	Region
FRH	Bretagne	Region
FRI	Nouvelle-Aquitaine	Region
FRJ	Occitanie	Region
FRK	Auvergne - Rhône-Alpes	Region
FRL	Provence-Alpes-Côte d'Azur	Region
FRM	Corse	Region (Island)
FRY	Régions ultrapériphériques françaises	Region (Island)
HR	Croatia	Country
HR0	Hrvatska	Region (Capital)
IT	Italy	Country
ITC	Nord-Ovest	Region
ITF	Sud	Region
ITG	Isole	Region (Island)
ITH	Nord-Est	Region
ITI	Centro	Region (Capital)
CY	Cyprus	Country

Code	Name	Type
CY0	Kypros	Region (Capital)
LV	Latvia	Country
LV0	Latvija	Region (Capital)
LT	Lithuania	Country
LT0	Lietuva	Region (Capital)
LU	Luxembourg	Country
LU0	Luxembourg	Region (Capital)
HU	Hungary	Country
HU1	Közép-Magyarország	Region (Capital)
HU2	Dunántúl	Region
HU3	Alföld és Észak	Region
MT	Malta	Country
MT0	Malta	Region (Capital)
NL	Netherlands	Country
AT	Austria	Country
AT1	Ostösterreich	Region (Capital)
AT2	Südösterreich	Region
AT3	Westösterreich	Region
PL	Poland	Country
PL2	Makroregion Poludniowy	Region
PL4	Makroregion Pólnocno-Zachodni	Region
PL5	Makroregion Poludniowo-Zachodni	Region
PL6	Makroregion Pólnocny	Region
PL7	Makroregion Centralny	Region
PL8	Makroregion Wschodni	Region
PL9	Makroregion Województwo Mazowieckie	Region (Capital)
PT	Portugal	Country
PT1	Continente	Region (Capital)
PT2	Região Autónoma dos Açores	Region (Island)
PT3	Região Autónoma da Madeira	Region (Island)
RO	Romania	Country
RO1	Macroregiunea unu	Region
RO2	Macroregiunea doi	Region
RO3	Macroregiunea trei	Region (Capital)
RO4	Macroregiunea patru	Region
SI	Slovenia	Country
SI0	Slovenija	Region (Capital)
SK	Slovakia	Country
SK0	Slovensko	Region (Capital)
FI	Finland	Country
FI1	Manner-Suomi	Region (Capital)
SE	Sweden	Country
SE1	Östra Sverige	Region (Capital)
SE2	Södra Sverige	Region
SE3	Norra Sverige	Region
IS	Iceland	Country
IS0	Ísland	Region (Capital)
NO	Norway	Country
NO0	Norge	Region (Capital)
CH	Switzerland	Country
CH0	Schweiz/Suisse/Svizzera	Region (Capital)
UK	United Kingdom	Country
UKC	North East	Region
UKD	North West	Region
UKE	Yorkshire and The Humber	Region
UKF	East Midlands	Region
UKG	West Midlands	Region
UKH	East of England	Region
UKI	London	Region (Capital)
UKJ	South East	Region
UKK	South West	Region
UKL	Wales	Region
UKM	Scotland	Region
UKN	Northern Ireland	Region
MK	North Macedonia	Country
MK0	Severna Makedonija	Region (Capital)
RS	Serbia	Country
RS1	Srbija - sever	Region (Capital)
RS2	Srbija - jug	Region

In the final analysis, a total of 33 countries and 105 NUTS-I level regions were included. Among them, 29 countries and 89 NUTS-I regions had complete data available for all six years. Details regarding the code, name, and type of each geography can be found in table 4.4. Additional sub-categorisation in the type of geography was applied to facilitate the analysis of disparities between regions within the same country and identify patterns in those disparities. Specifically, regions that included the capital cities of countries and regions corresponding to islands were further classified as capital and island regions, respectively.

Table 4.5: Descriptive statistics of indicators and contextual variables for all geographies

Variable	Statistics	2014	2015	2016	2017	2018	2019
Y1	Min	30.40	31.70	39.20	36.50	39.80	49.40
	25-percentile	85.95	86.00	87.88	87.55	88.80	89.25
	Average	89.66	90.50	91.19	91.00	91.78	91.07
	Median	92.50	94.10	94.10	94.40	94.00	93.50
	75-percentile	96.90	97.58	97.60	98.03	98.30	98.05
	Max	100.00	100.00	100.00	100.00	100.00	100.00
	Std Deviation	11.33	11.03	9.83	10.77	9.60	9.99
Y2	Min	2.80	2.80	2.80	2.80	2.80	3.00
	25-percentile	7.00	7.30	7.53	7.63	7.30	6.65
	Average	11.21	11.24	10.75	10.50	10.39	9.97
	Median	9.90	10.20	10.10	9.65	9.90	9.60
	75-percentile	13.45	13.28	12.85	12.58	12.40	11.90
	Max	32.80	28.80	26.90	27.80	28.30	27.00
	Std Deviation	5.36	5.14	4.71	4.45	4.65	4.46
Y3	Min	16.40	17.60	17.10	17.10	17.50	17.00
	25-percentile	29.85	30.85	32.30	33.00	33.60	33.35
	Average	36.93	37.38	38.04	38.82	39.86	40.69
	Median	38.00	38.50	39.00	38.80	40.70	40.80
	75-percentile	43.60	44.00	44.28	45.43	47.00	47.35
	Max	61.50	65.20	66.50	66.60	66.90	67.90
	Std Deviation	9.96	9.74	9.69	9.61	9.85	10.13
Y4	Min	0.80	0.90	0.90	0.90	0.70	0.80
	25-percentile	6.40	6.40	6.50	6.60	6.70	5.90
	Average	11.34	11.12	11.12	11.33	11.59	11.84
	Median	9.60	9.10	9.30	9.70	10.10	10.20
	75-percentile	16.30	16.05	15.30	16.00	15.80	16.40
	Max	31.90	31.50	31.00	31.30	32.10	35.20
	Std Deviation	7.30	7.08	6.88	7.11	6.99	7.89
Y5	Min	3.52	3.22	2.95	1.77	0.82	1.41
	25-percentile	10.48	10.07	8.21	7.17	6.48	5.15
	Average	19.94	18.45	15.66	14.42	12.09	10.72
	Median	18.42	18.17	14.52	14.18	11.75	10.09
	75-percentile	26.87	24.10	21.12	19.09	16.38	14.11
	Max	46.91	45.10	37.81	36.31	30.39	31.24
	Std Deviation	10.18	9.16	8.13	8.09	6.34	6.22
Z1	Min	2.90	2.90	2.50	2.30	2.20	2.00
	25-percentile	6.10	5.73	5.03	4.30	3.80	3.60
	Average	10.12	9.55	8.67	8.04	6.70	6.47
	Median	8.50	7.80	7.05	6.40	5.30	5.00
	75-percentile	11.40	10.93	10.10	9.45	8.30	7.70
	Max	33.50	30.50	27.50	24.40	22.90	20.50
	Std Deviation	6.06	5.66	5.22	5.37	4.39	4.26
Z2	Min	55.41	54.19	53.40	52.46	52.18	52.57
	25-percentile	90.23	89.90	89.46	89.62	89.16	88.97
	Average	93.06	92.73	92.48	92.31	92.18	91.84
	Median	94.22	93.76	93.56	93.63	93.43	93.32
	75-percentile	97.90	97.93	97.93	97.42	98.10	97.61
	Max	100.00	99.97	99.98	99.98	99.96	99.98
	Std Deviation	7.35	7.55	7.69	7.75	7.93	8.09

Early childhood education (Y1), tertiary level attainment (Y3), and adult participation in life-long learning (Y4) are indicators that are deemed desirable. This means that higher values of these indicators indicate better performance. On the other hand, early leavers from education and training (Y2) and low achievement in digital skills (Y5) are considered undesirable, where lower values indicate better performance. To incorporate all the indicators into the analysis using the

BoD, it is necessary to ensure that higher values correspond to better performance across all indicators. In order to achieve this, Y2 and Y5 were adjusted by subtracting them from 100%. This adjustment results in their complements, ensuring that higher values of these indicators also correspond to better performance in the model. table 4.5 provides the main descriptive statistics for the indicators and contextual variables over the years taken into consideration.

4.3 Model's specifications

To address the research questions proposed in chapter 1, the methodology described in chapter 3 was applied to the data collected and treated according to the procedures described in sections 4.1 and 4.2.

For the first research question, which focuses on the performance measurement of European regions, the BoD method was employed for each year from 2014 to 2019 using the five outlined indicators at the regional level.

The GMI and its components were utilized to assess the change in performance over time. Additionally, the assessment of σ and β-convergences were explored to understand the temporal convergence of the regions better. A robust approach was adopted to mitigate the influence of outliers, ensuring more reliable and stable performance measures for the evaluated units.

To employ the robust approach, the parameters B (number of sampling iterations) and m (number of observations in each sample) had to be determined first. To obtain reliable results and minimize the effect of outliers in calculating averages, B should be a very high number. Thus, $B = 2000$ was selected for this research. As for m, a small value can result in a large number of super-performing units, while a large value can quickly converge to the full-frontier results. Therefore, a sensitivity analysis was conducted to determine the appropriate value of m.

The range $m^s_{\text{NUTS-I}} = \{10, 20, 30, 40, 50, 60, 70, 80, 90\}$ was tested for the regional level analysis. After evaluating the proportion of super-performing units through fig. 4.1, a final value of $m_{\text{NUTS-I}} = 40$ was chosen as it reduces the presence of super-performing units while remaining relatively stable for higher values.

The definition of the parameters enabled the application of the robust approach, which in turn allowed for obtaining the performance metric $E^t_k(\mathbb{1}, Y^t_k)$ as well as the BoD by-products, which are the weights $u_r(r = 1, \dots, s)$, and intensity variables $(\lambda_j(j = 1, \dots, n)$. Only the peers with λ_j greater than 10% were considered relevant.

It was also possible to obtain the values of $E^M_k(\mathbb{1}, Y^t_k)$, $W^t_k(\mathbb{1}, Y^t_k)$, and $W^M_k(\mathbb{1}, Y^t_k)$ for each region k $(k = 1, \dots, n)$ in each time period t $(t = 2014, \dots, 2019)$. These values were necessary for calculating the GMI, EC and BPC measures, as well as the σ and β-convergences. It is important to emphasize that due to the unbalanced nature of the data, the calculation of metrics from time t to $t+1$ was only possible for regions where data was available in both years. Similarly, when calculating the metrics from 2014 to 2019, only the units that had data for all six years under analysis were considered.

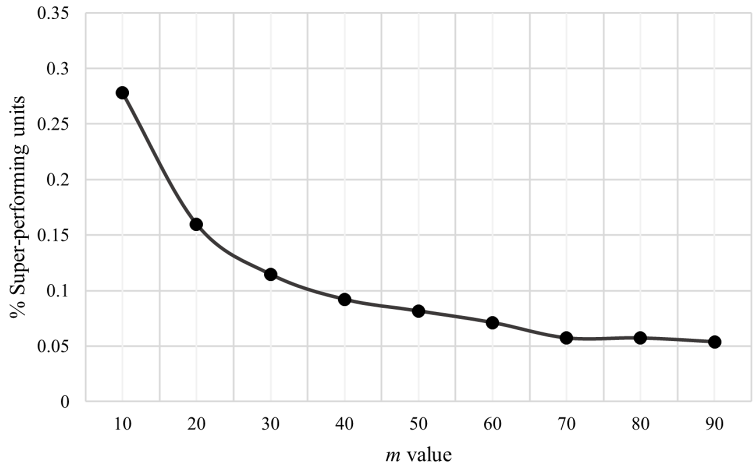

Figure 4.1: Percentage of super-performing units for NUTS I data relative to the value of m

The second research question regarding the influence of contextual variables on the performance measurement of European regions was addressed by adopting a robust conditional approach to employ the BoD method. The data from the five specified indicators at the regional level for each year between 2014 and 2019 was utilized again. However, in this case, the data from the two contextual variables was also considered to condition the sample drawing.

It was necessary to define once again the values of B and m for the robust conditional approach. Since this approach is applied to the same data as the robust approach, it encompasses an equal number of DMUs. Therefore, the parameter values were assumed to be the same, with $B = 2000$ and $m_{\text{NUTS-I}} = 40$.

By conducting this analysis, it was possible to obtain the performance metric $E_k^t(\mathbb{1}, Y_k^t)$ for each region k ($k = 1, \ldots, n$) in each time period t ($t = 2014, \ldots, 2019$), as well as the BoD by-products, which are the weights $u_r(r = 1, \ldots, s)$, and intensity variables ($\lambda_j(j = 1, \ldots, n)$, all these conditioned by the contextual variables. These metrics allowed for straightforward comparison with the values obtained using the robust approach. Once more, only the peers with λ_j greater than 10% were considered relevant.

Finally, the third research question wanted to identify if there were significant disparities between regions within the same country or across Europe and if there was a discernible pattern in these disparities. To address this question, the BoD method was employed, considering not only the regional-level data but also the country-level data simultaneously. This comprehensive application provides a better understanding of the baseline performance at the country level and the relationship of regions to that baseline.

The employment of the BoD was carried out using both the robust approach and the robust conditional approach. Consequently, it was necessary to redefine the parameters B and m. Once again, the parameter B needed to be set to a significantly high value to ensure accurate results and reduce the impact of outliers when calculating averages. As a result, $B = 2000$ was maintained.

Due to the inclusion of countries, the number of DMUs under consideration differs from the previous analyses. Therefore, a similar sensitivity analysis was conducted to determine the appropriate value of parameter m. The range $m^s_{\text{All data}} = \{15, 30, 45, 60, 75, 90, 105, 120\}$ was tested. After evaluating the proportion of super-performing units through fig. 4.2, a final value of $m_{\text{All data}} = 60$ was chosen as it reduces the presence of super-performing units while remaining relatively stable for higher values.

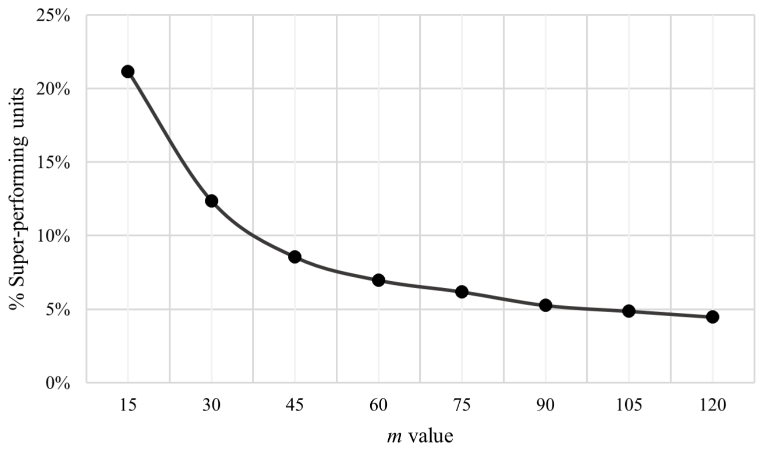

Figure 4.2: Percentage of super-performing units for all data relative to the value of m

By employing these approaches, it was possible to acquire the performance metric $E^t_k(\mathbb{1}, Y^t_k)$ for each region and country k ($k = 1, \ldots, N$) in each time period t ($t = 2014, \ldots, 2019$), both conditioned and not conditioned by the contextual variables. The obtained results will enable a subsequent analysis of the disparities between regions within the same country and identify patterns in those disparities.

Chapter 5

Results and discussion

In this chapter, the results obtained from the empirical study will be presented and discussed to achieve the final goal of addressing the three main research questions.

In section 5.1, the performance level of the European regions and their trends over time will be outlined. Additionally, special attention will be given to the convergence of Europe as a whole in attaining the ET2030 indicators.

The impact of the contextual environment will be explored in section 5.2 by outlining the differences between the results of the robust and robust conditional approaches. This includes analyzing the performance level and the benchmarks provided to the regions for improvement.

Moving on to section 5.3, the focus will shift towards comparing the positioning of the regions in relation to their respective countries. This aims to understand if there are significant disparities and discernible patterns in these disparities.

5.1 Performance and temporal trends analysis at the regional level

5.1.1 BoD results

First, conclusions will be drawn from the results of the BoD composite indicator. As a recall, the BoD score represents a single measure indicating the position of each region in relation to the best practice frontier. This frontier is determined by the top-performing units in the five indicators associated with the ET2030. It is noteworthy that BoD scores greater than 1 can occur as a result of applying the robust approach. Such scores indicate that the region is classified as a super-performer, surpassing the best practice frontier.

Figure 5.1 provides a visual overview of the distribution of the BoD scores across European regions in 2019. The eastern areas exhibit the poorest performances, while the northern areas show better results, which is consistent with the conclusions put forth in Stumbriene et al. (2020) and Camanho et al. (2023).

It is important to note that within several countries, there exist regions that fall into different performance ranges. This variation cannot be observed through a country-level analysis alone, highlighting the importance of conducting studies at the regional level to identify specific areas that require improvement.

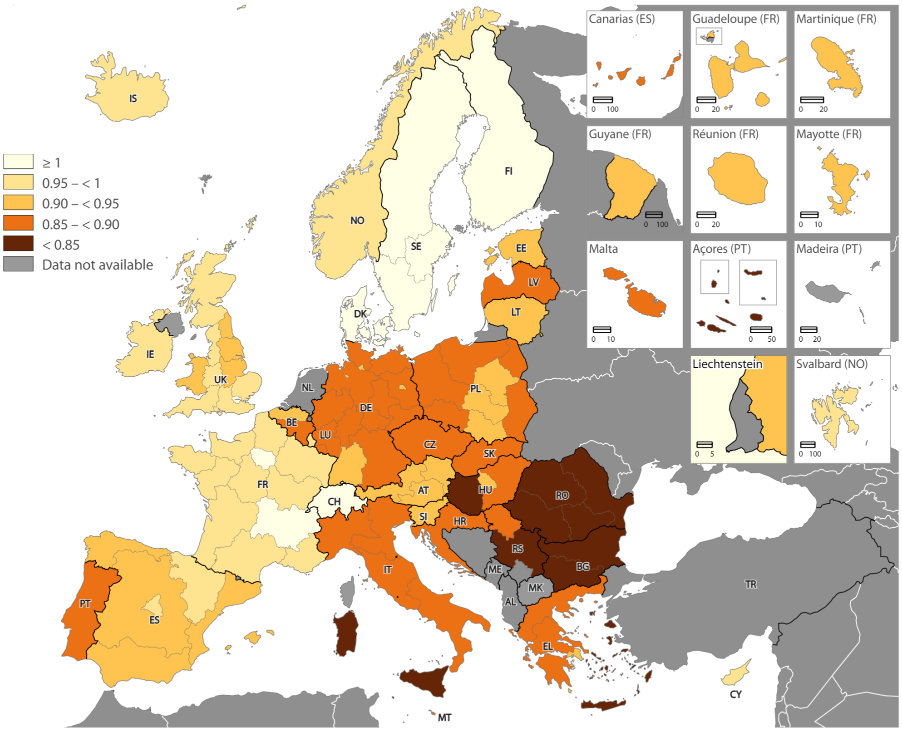

Figure 5.1: 2019 Robust BoD scores for regions

For a comprehensive overview of the BoD performance scores and ranks of the 105 NUTS-I regions under analysis, table B.5 in appendix B can be consulted. The 10 regions with the best results in the six years, as well as the 10 regions with the worst results, along with the general descriptive statistics of the BoD scores, can be found in table 5.1.

Of the 89 regions with complete data, only 6 were super-performers over the six years. These regions include Östra Sverige (SE1) and Södra Sverige (SE2) from Sweden, London (UKI) from the UK, Île de France (FR1) and Auvergne - Rhône-Alpes (FRK) from France, and Danmark (DK0) from Denmark. Schweiz/Suisse/Svizzera (CH0) from Switzerland only has information available for 2019, but it also appears as a super performer region in that year.

It is worth noting that Norra Sverige (SE3) from Sweden underperformed in 2014 with a score of 0.977. However, in the subsequent five years, it was a super performer. In contrast, Ísland from Iceland (IS0) only has data for 2014, 2017, 2018, and 2019, and it achieved super-performer status in all years except the last, with a score of 0.980.

Macroregiunea doi from Romania (RO2) consistently ranked as the worst performer, with scores hovering around 0.735, followed by Severna i yugoiztochna (BG3) Bulgaria, with scores around 0.760. All four Romanian regions (RO1, RO2, RO3 and RO4) fall among the 10 worst performers in the BoD composite indicator, consistently scoring below 0.85.

A regional-level assessment should be conducted for all low-achieving regions to comprehend

Table 5.1: Robust BoD scores for the 10 best and worst-performing regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E^t_k(\mathbb{1},Y^t_k)$	Rank	$E^t_k(\mathbb{1},Y^t_k)$	Rank	$E^t_k(\mathbb{1},Y^t_k)$	Rank	$E^t_k(\mathbb{1},Y^t_k)$	Rank	$E^t_k(\mathbb{1},Y^t_k)$	Rank	$E^t_k(\mathbb{1},Y^t_k)$	Rank
SE1	1.104	1	1.115	2	1.126	1	1.117	1	1.129	1	1.143	1
SE2	1.055	4	1.062	4	1.060	3	1.079	3	1.099	3	1.109	2
UKI	1.091	3	1.116	1	1.116	2	1.107	2	1.100	2	1.087	3
CH0											1.067	4
FR1	1.014	6	1.037	5	1.035	5	1.051	4	1.044	4	1.062	5
SE3	0.977	14	1.023	6	1.008	7	1.022	6	1.030	5	1.038	6
FRK	1.010	8	1.008	8	1.014	6	1.008	7	1.010	7	1.013	7
FI1	0.978	13	0.984	13	0.999	8	1.006	8	1.029	6	1.008	8
DK0	1.099	2	1.096	3	1.051	4	1.032	5	1.008	8	1.001	9
IS0	1.028	5					1.005	9	1.006	10	0.980	14
EL4							0.832	91			0.849	92
RS2											0.838	94
HU2	0.826	85	0.855	81	0.857	83	0.849	88	0.842	90	0.835	95
MK0	0.791	90	0.805	89	0.825	88	0.835	90	0.848	88		
RO4	0.796	89	0.811	88	0.808	90	0.795	95	0.810	92	0.815	96
PT2	0.772	92	0.783	92	0.792	92	0.803	94	0.821	91	0.813	97
RO3	0.782	91	0.794	91	0.799	91	0.811	92	0.808	93	0.803	98
RO1	0.809	88	0.802	90	0.810	89	0.806	93	0.788	94	0.775	99
BG3	0.765	93	0.762	93	0.758	93	0.771	96	0.766	95	0.736	100
RO2	0.733	94	0.739	94	0.737	94	0.731	97	0.734	96	0.733	101
N	94		94		94		97		96		101	
Min	0.733		0.739		0.737		0.731		0.734		0.733	
25-perc	0.880		0.880		0.887		0.882		0.896		0.881	
Average	0.914		0.919		0.922		0.922		0.930		0.919	
Median	0.908		0.914		0.918		0.914		0.925		0.910	
75-perc	0.952		0.960		0.960		0.960		0.967		0.958	
Max	1.104		1.116		1.126		1.117		1.129		1.143	
Std Dev	0.068		0.068		0.066		0.066		0.066		0.068	

the underlying causes of their underperformance and the factors contributing to their lagging positions. This assessment would enable the European Union and individual countries to develop tailored strategies and policies that assist these regions in overcoming challenges and equipping them with the necessary resources to approach the best practice frontier.

In addition to implementing policies aimed at improving underperforming regions, the European Union can also design incentives to encourage regions to excel in specific indicators. It is important to identify the indicators in which European regions are performing poorly when compared to the best practitioners.

The direct interpretation of indicator values does not provide a straightforward understanding of which indicators offer greater potential for improvement. This is due to the variations in the order of magnitude among the different indicators, which implicates data normalization for meaningful comparisons. However, the process of data normalization introduces uncertainty as it requires selecting a specific method from several available options.

The analysis of virtual weights can provide valuable insights into understanding which indicators have greater potential for improvement. The assignment of a higher virtual weight to an indicator by a region means that the region is better positioned in that specific indicator relative to the best practitioners of that indicator compared to its position in other indicators when compared with the best practitioners of those indicators. Therefore, when regions consistently assign low virtual weights to an indicator, it means that the generality of the regions is in a weaker position in relation to the best practitioners of that specific indicator than when compared to their position in other indicators relative to the best practitioners of those indicators. Consequently, there is a greater potential for improvement in the indicators that consistently receive lower values, as the regions have more ground to cover to reach the level of performance achieved by the best practitioners in those indicators.

The distribution of the virtual weights across the five indicators that compose the composite indicator can be analyzed through the boxplot presented in fig. 5.2. Early childhood education (Y1) emerges as the indicator with better virtual weights, indicating that regions are achieving relatively good results in comparison to one another. Approximately 81% of the DMUs assigned more than 50% of the virtual weight to a single indicator, with 52% of those DMUs assigning it to Y1.

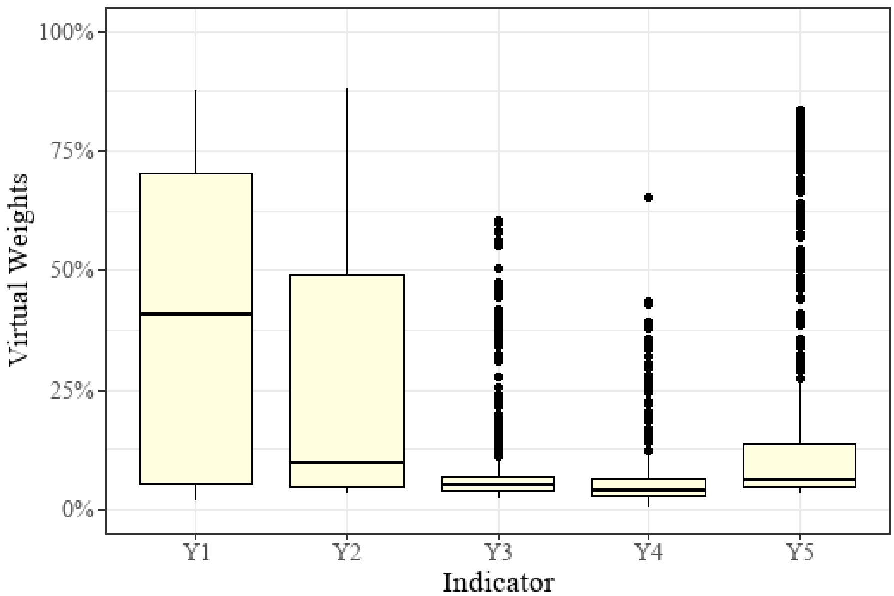

Figure 5.2: Robust virtual weights distribution across the five indicators for regions

On the other hand, tertiary level attainment (Y3) and adult participation in lifelong learning (Y4) received the lowest virtual weight values. For both indicators, more than half of the DMUs assigned less than 5% of the virtual weight, suggesting that if weight restrictions did not exist, these indicators would likely be disregarded in many cases. This indicates that only a few regions excel in these indicators and assign high virtual weights to them, as can be seen by the points placed outside the whiskers in the boxplot, while most regions perform considerably worse when compared to those DMUs.

London stands out as the only region consistently assigning a virtual weight greater than 50% to tertiary level attainment and doing so in all six years, naturally reflecting its superior performance in this indicator in the original data when compared to other regions. Denmark assigned a virtual weight greater than 50% to Y4 once in 2014, and only the three Swedish regions, Manner-Suomi in Finland and the Swiss region have virtual weights surpassing 30% to that same indicator.

Therefore, when designing policies to promote progress in specific areas, it is crucial to prioritize increasing tertiary level attainment and adult participation in lifelong learning. This is because these factors demonstrate the highest potential for improvement compared to the top performers in each respective indicator, as evident from the virtual weights.

5.1.2 GMI results

The Global Malmquist Index provides a comprehensive perspective on the performance evolution of regions over the years being analyzed. A visual overview of the GMI results in the period 2014-2019 is presented in fig. 5.3.

Most regions, as depicted in the map, have GMI values above 1, indicating an improvement in their performance from 2014 to 2019. However, it is important to acknowledge that certain regions have experienced a decline in performance, as evidenced by GMI values below 1. It is crucial to prioritize these regions and develop targeted policies to support their recovery and prevent them from being left behind.

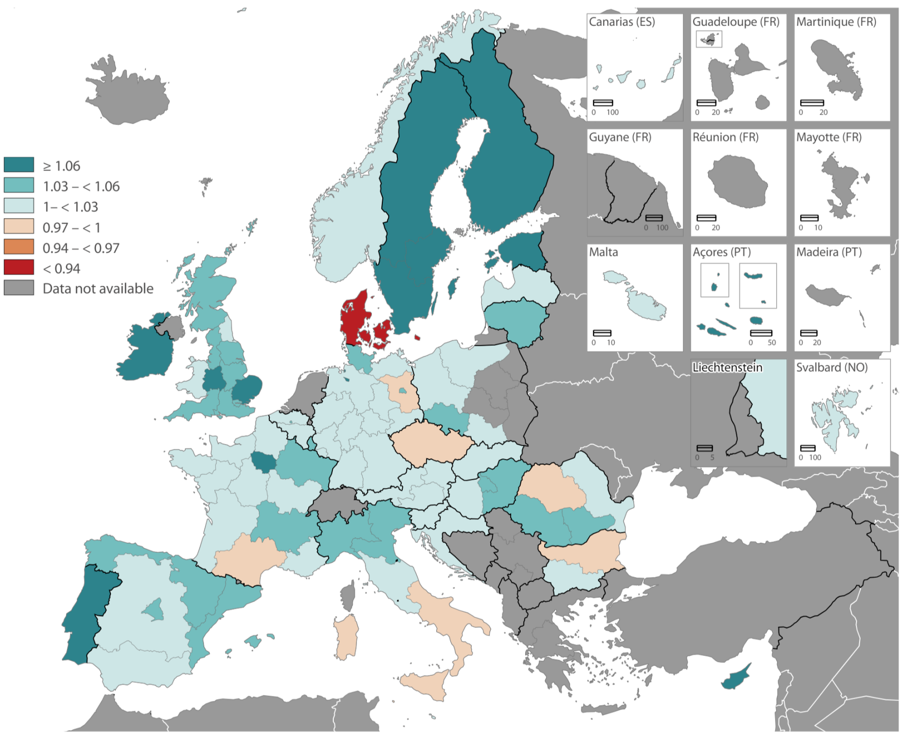

Figure 5.3: 2014-2019 Robust GMI results for regions

To gain a more comprehensive understanding of the factors driving these performance trends, it is essential to analyze the GMI of each region during different period transitions. Additionally, studying the two components of the GMI, namely the EC and the BPC, can provide valuable insights into the specific drivers of performance improvement or decline.

Table 5.2 provides an overview of the regions that require further examination due to their performance evolution, whether it demonstrates positive or negative trends, along with the general descriptive statistics of the GMI, EC and BPC over the years. For a more comprehensive analysis the results for all the regions can be found in appendix B, table B.7.

Table 5.2: Robust GMI, EC and BPC results for relevant regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI	EC	BPC	GMI	EC	BPC	GMI	EC	BPC	GMI	EC	BPC	GMI	EC	BPC	GMI	EC	BPC
SE3	1.098	1.062	1.034	1.038	1.047	0.992	0.986	0.986	1.001	1.025	1.013	1.012	1.003	1.008	0.995	1.042	1.008	1.034
PT1	1.079	1.062	1.016	1.031	1.035	0.997	1.001	0.998	1.003	1.019	1.018	1.001	1.007	1.006	1.000	1.019	1.004	1.015
CY0	1.072	1.018	1.053	1.024	1.016	1.008	0.998	0.991	1.008	1.009	1.004	1.005	1.022	1.016	1.006	1.017	0.992	1.025
FI1	1.071	1.031	1.039	1.002	1.006	0.996	1.024	1.015	1.009	1.017	1.007	1.010	1.015	1.023	0.992	1.011	0.980	1.032
PT2	1.069	1.054	1.015	1.016	1.015	1.001	1.007	1.011	0.996	1.021	1.014	1.006	1.020	1.022	0.998	1.004	0.991	1.013
IE0	1.069	1.030	1.038	1.004	0.998	1.006	1.010	1.004	1.006	1.029	1.026	1.003	1.028	1.022	1.006	0.997	0.981	1.016
UKH	1.062	1.026	1.035	1.039	1.038	1.001	1.008	0.998	1.010	0.999	0.994	1.005	1.006	1.006	0.999	1.009	0.990	1.018
ITG	0.989	0.976	1.013	0.997	0.996	1.001	1.004	1.007	0.997	0.974	0.972	1.002	0.998	0.997	1.001	1.016	1.004	1.013
BG3	0.980	0.962	1.018	0.993	0.996	0.997	0.997	0.995	1.002	1.015	1.017	0.999	0.997	0.994	1.002	0.979	0.960	1.019
RO1	0.980	0.958	1.023	0.994	0.991	1.003	1.007	1.010	0.997	0.997	0.995	1.002	0.977	0.978	0.999	1.006	0.984	1.023
DK0	0.934	0.911	1.026	0.997	0.997	1.000	0.956	0.959	0.997	0.994	0.982	1.013	0.972	0.978	0.994	1.014	0.992	1.022
Min	0.934	0.911	1.012	0.960	0.960	0.981	0.956	0.959	0.993	0.974	0.972	0.995	0.970	0.972	0.991	0.979	0.957	1.012
25-percentile	1.012	0.993	1.016	0.997	0.999	0.996	1.000	0.997	0.997	0.997	0.993	1.001	1.000	1.000	0.998	0.999	0.983	1.015
Average	1.030	1.005	1.024	1.006	1.007	0.999	1.005	1.003	1.002	1.005	1.002	1.003	1.006	1.006	1.000	1.008	0.989	1.019
Median	1.026	1.006	1.021	1.004	1.006	1.000	1.003	1.003	1.001	1.003	1.000	1.003	1.006	1.006	1.001	1.007	0.990	1.018
75-percentile	1.045	1.017	1.029	1.011	1.014	1.002	1.009	1.008	1.004	1.012	1.008	1.005	1.013	1.012	1.003	1.012	0.995	1.021
Max	1.112	1.062	1.060	1.052	1.047	1.012	1.113	1.120	1.020	1.038	1.037	1.013	1.037	1.043	1.008	1.075	1.017	1.063
Std Deviation	0.028	0.023	0.011	0.015	0.014	0.005	0.015	0.016	0.006	0.011	0.012	0.004	0.011	0.011	0.004	0.015	0.012	0.008

The first column of table 5.2 shows the GMI values for the period 2014-2019. On average, the change in performance in that period was observed to be positive, with an improvement of 3%, as shown in the descriptive statistics.

The positive performance change was primarily driven by productivity gains from a frontier shift. This can be observed through the average BPC value from 2014-2019, which was 1.024, indicating an average improvement of 2.4%. It is also worth noting that all regions demonstrated a positive frontier shift in the period 2014-2019, with a BPC value superior to 1. For a visual representation of the BPC results from 2014 to 2019, fig. B.1 in appendix B can be consulted. However, the average BPC value dipped slightly below 1 only from 2014 to 2015 (0.999), representing a minimal decline of 0.1%.

There was also an average gain in production through efficiency improvements from 2014 to 2019, indicating that the units were generally closer to the local frontier in 2019 compared to their position relative to the local frontier in 2014. However, it is important to note that the efficiency gain was relatively smaller than the improvement in BPC, with an average EC improvement of only 0.5%. In contrast to the BPC results, the EC component showed that many regions had values below 1, as depicted in fig. 5.4. This indicates a mixed trend where, although the local frontier is generally converging towards the overall frontier, certain regions are moving further away from the local frontier each year. In the specific period of 2018-2019, the EC value declined on average by 0.9%, falling below 1. This trend raises concerns, and it is crucial to closely monitor if this decline persists in the coming years and take necessary measures to address it.

Figure 5.5 visually depicts the performance trends for the regions included in table 5.2 by presenting the values of the composite indicator against the metafrontier $E_k^M(\mathbb{1}, Y_k^t)$, capturing both the frontier shift and efficiency improvement aspects.

Danmark (DK0) exhibits the poorest performance evolution, as indicated by its GMI value of 0.934 and the downward trendline. However, it is important to note that despite this decline, it still

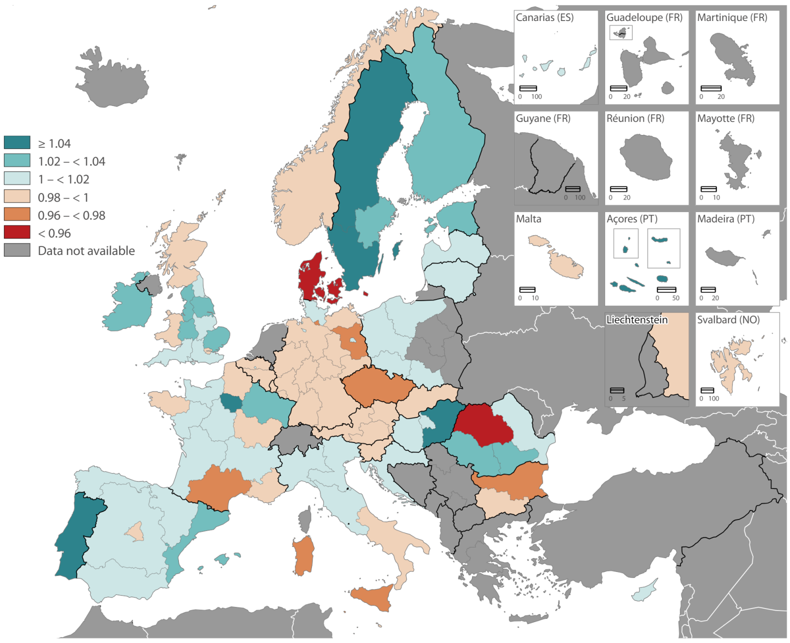

Figure 5.4: 2014-2019 Robust EC results for regions

maintains a super-performance level. In fact, in the last year, there is even an improvement in its performance value, suggesting that it may not be a cause for immediate concern.

On the contrary, Macroregiunea doi (RO2) and Severna i yugoiztochna (BG3) are indeed concerning cases. As previously mentioned, they consistently rank as the worst-performing regions throughout all years, and their performance trend is deteriorating. Although there was a slight improvement of 0.6% in the period 2018-2019 for Macroregiunea doi (RO2), primarily attributed to a frontier shift gain, this improvement is relatively minimal. It is crucial to implement effective policies and interventions to help these regions bridge the performance gap with other regions and closely monitor their progress to ensure positive developments.

Isole (ITG) in Italy exhibited a negative performance trend from 2014 to 2018, having a slight improvement in its trend from 2018 to 2019. Despite this improvement, the region has not yet reached its 2014 performance level, reflected in its 0.989 GMI value in the 2014-2019 period. The positive frontier shift of 1.3% was insufficient to compensate for the 2.4% decline in efficiency change. It is important to monitor the sustainability of the recent improving trend in future years. It is also important to assess whether intervention is necessary in order to prevent Isole from lagging behind and to support its continued progress.

During the 2014-2019 period, several regions demonstrated significant improvements in their performance. Notably, Norra Sverige (SE3) and Manner-Suomi (FI1) passed from underperforming to super-performing units. Norra Sverige (SE3) exhibited the most substantial improvement with a GMI increase of 9.8%, while Manner-Suomi (FI1) achieved an improvement of 7.1%.

Similarly, Continente (PT1) and Região Autónoma dos Açores (PT3) from Portugal showcased remarkable advancements despite having lower performance scores compared to other regions. These improvements were predominantly driven by Efficiency Change, indicating that each year

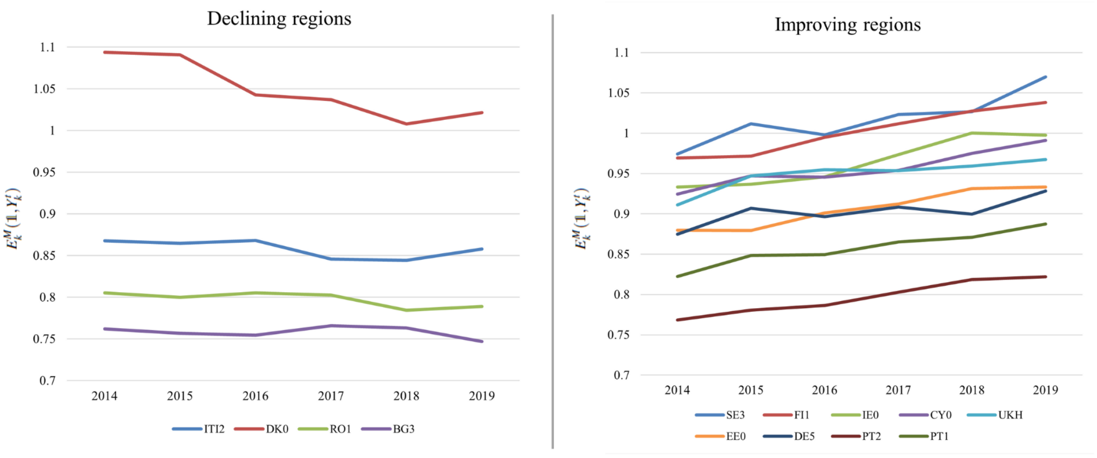

Figure 5.5: Comparison of $E_k^M(\mathbb{1}, Y_k^t)$ for improving and declining regions from 2014 to 2019

they moved closer to the local frontier.

In general, the results show an overall improvement over the years. However, it is essential to closely monitor regions not meeting expectations by understanding the underlying reasons for their underperformance, namely Macroregiunea doi (RO2) and Severna i yugoiztochna (BG3). Achieving equality among nations is a key priority in Europe, and it is important to address any disparities among regions to ensure balanced development. Vigilance and proactive measures are essential to prevent regions from being left behind and promote inclusivity and equal opportunities.

5.1.3 Assessment of convergence

The convergence metrics offer valuable insights into the progression of Europe over time and aid in assessing the achievement of the first priority outlined in the ET2030 framework, which aims to enhance equity, inclusion, and success in education and training for all.

Table 5.3 presents the results of both σ and β-convergences over the years, along with the averages of the BPC and WPC, which are components used in calculating β-convergence.

When assessing σ-convergence, values greater than 1 are desirable as they indicate that the regions are moving closer to the best practice frontier from period t to $t+1$. With the exception of the year 2018-2019, all years exhibited values greater than 1, suggesting positive convergence. However, it is crucial to closely monitor this metric to determine whether the deviation in 2018-2019 was an isolated occurrence or may have a recurring pattern in subsequent years.

In order to foster greater homogeneity among regions, β-convergence values lower than 1 are desirable, indicating a narrowing gap between the BPC and the WPC. However, the metric consistently demonstrated values greater than 1, suggesting an expanding gap over time. Although the BPC average showed values above 1 for all years except the first, and these values exhibited continuous improvement, with a 2014-2019 average of 1.024, the WPC average remained consistently below 1. This indicates a worsening position of the Worst Practice Frontier. Consequently, the widening gap between regions is attributed to both an improvement in the BPC and a deterioration of the WPC. This trend is clearly visible in fig. 5.5, which illustrates that underperforming regions such as RO2 and BG3 are experiencing a further decline in their performance, while high-performing regions like SE3 and FI1 are continuing to improve. Therefore, it is imperative to prioritize this metric and implement policies that assist regions lagging behind in order to enhance their performance and reduce this gap.

Table 5.3: Robust convergence results for regions

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.007	1.009	0.999	0.990
2015/2016	1.003	1.021	1.002	0.982
2016/2017	1.001	1.006	1.003	0.998
2017/2018	1.006	1.014	1.000	0.986
2018/2019	0.989	1.023	1.019	0.996
2014/2019	1.005	1.074	1.024	0.954

5.2 Contextual environment impact on performance assessment

The conditional model takes into account contextual variables to address the environmental heterogeneity among DMUs by enabling comparisons between units that share similar environments. In this study, unemployment and citizenship from the reported country (as the complement to the immigrant rate) were chosen as contextual variables since they have been shown in the literature to influence performance outcomes.

Figure 5.6 displays scatter plots depicting the robust and conditional BoD scores and ranks for all NUTS-I level regions over the 6-year period under analysis. The plots are accompanied by a 45-degree line, which allows for an evaluation of the impact of using a conditional model compared to a robust model.

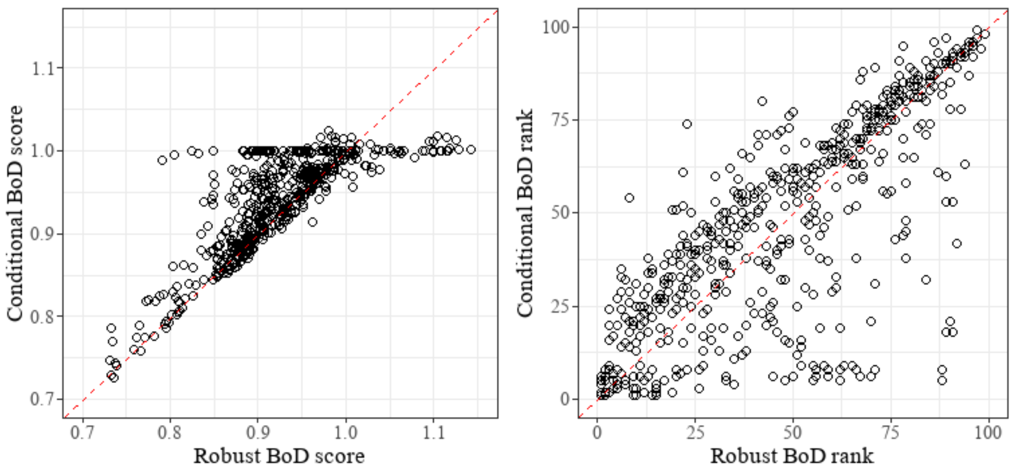

Figure 5.6: Scatter plots of robust BoD and conditional BoD scores and ranks

The spread of data points indicates significant variations in results when comparing the robust and conditional models. While some data points maintain similar BoD scores, the scatter plot reveals that many regions exhibited improved performance in the conditional model, with a notable number of regions joining the best practice frontier and becoming best performers. Additionally, there are fewer super-performing units in the conditional model; instead, they move closer to the frontier while still remaining among the best performers. Only a small number of regions experienced worse results in the conditional model.

The scatter plot of ranks reveals a considerable dispersion of points, indicating substantial changes in the regional rankings. Therefore, it is evident that the conditional assessment has a notable impact on performance results.

To better understand this impact and the main differences between the approaches, a thorough analysis will be conducted by examining the variations in results among different regions. Additionally, the peers identified for each region by the robust and conditional models will be compared.

5.2.1 BoD results

In this phase, a comparison will be conducted between the BoD results obtained from the robust and conditional models.

Figure 5.7 provides a visual representation of the distribution of the conditional BoD scores across European regions in 2019. Overall, there is a noticeable positive difference in results across all of Europe when compared to the robust results.

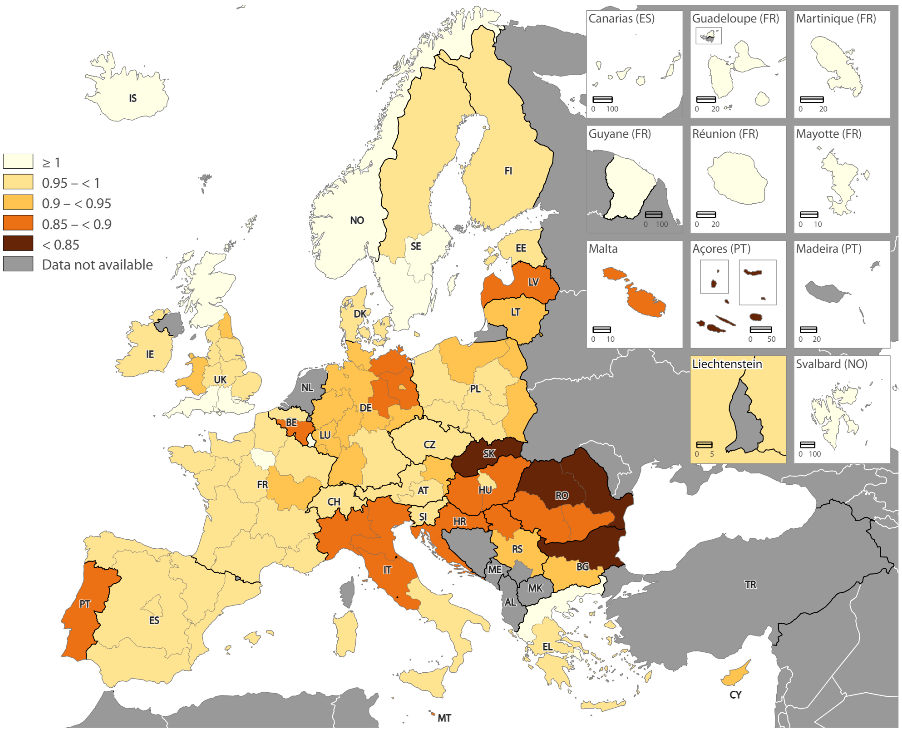

Figure 5.7: 2019 Conditional BoD scores for regions

The results of the robust and conditional models of the regions that will be further examined and descriptive statistics for the overall data can be found in table 5.4. For a comprehensive overview of the conditional BoD performance scores and ranks of the 105 NUTS-I regions under analysis, table B.9 from appendix B can be consulted.

Table 5.4: Robust and conditional BoD scores comparison for relevant regions

Geography	2014		2015		2016		2017		2018		2019		Average difference
(k)	Robust	Cond	Robust	Cond	Robust	Cond	Robust	Cond	Robust	Cond	Robust	Cond	
MK0	0.791	0.989	0.805	0.995	0.825	1.000	0.835	0.900	0.848	1.000			0.156
EL4							0.832	0.997			0.849	0.971	0.144
EL5							0.887	0.995			0.891	1.000	0.108
EL6							0.849	0.947			0.870	0.977	0.103
RS2											0.838	0.938	0.100
ES4	0.904	1.000	0.906	1.000	0.910	0.999	0.914	1.000	0.919	1.000	0.914	1.000	0.089
FRY			0.913	0.997	0.918	1.000	0.912	1.000	0.914	1.000	0.910	1.000	0.086
ITG	0.871	0.941	0.867	0.943	0.873	0.953	0.849	0.935	0.847	0.942	0.850	0.959	0.086
ITF	0.891	0.957	0.889	0.959	0.895	0.972	0.884	0.978	0.877	0.961	0.875	0.975	0.082
ES5	0.897	0.964	0.895	0.970	0.898	0.967	0.905	0.971	0.918	0.967	0.917	0.976	0.064
ES1	0.915	0.988	0.922	0.989	0.923	0.986	0.930	0.993	0.934	0.985	0.931	0.990	0.062
ES3	0.957	1.000	0.939	1.000	0.937	1.000	0.944	1.000	0.954	1.000	0.955	0.997	0.052
PL9									0.966	1.005	0.935	0.995	0.050
ES7	0.884	1.000	0.882	1.000	0.894	1.000	0.894	1.000	0.900	1.000	0.892	1.000	0.109
ES6	0.895	1.000	0.898	1.000	0.903	1.000	0.904	1.000	0.910	1.000	0.905	1.000	0.097
EL3							0.928	1.000			0.902	1.000	0.085
BE1	0.947	1.000	0.946	1.000	0.949	1.000	0.972	1.000	0.974	1.000	0.957	1.000	0.042
SE3	0.978	0.952	0.984	0.968	0.999	0.973	1.006	0.988	1.029	0.974	1.008	0.956	-0.032
UKI	1.014	1.000	1.037	1.001	1.035	1.001	1.051	1.000	1.044	1.000	1.062	1.000	-0.040
DK0	0.977	0.957	1.023	0.983	1.008	0.970	1.022	0.982	1.030	0.981	1.038	0.977	-0.041
SE2	1.099	1.011	1.096	1.012	1.051	1.004	1.032	0.996	1.008	0.999	1.001	0.995	-0.045
UKJ											1.067	1.000	-0.067
FI1	1.055	0.997	1.062	0.997	1.060	0.999	1.079	0.993	1.099	0.999	1.109	1.000	-0.080
BG3	1.091	1.000	1.116	1.000	1.116	1.000	1.107	1.000	1.100	1.000	1.087	1.000	-0.103
FRK	1.104	1.019	1.115	1.017	1.126	1.013	1.117	1.003	1.129	1.002	1.143	1.002	-0.113
Min	0.733	0.730	0.739	0.740	0.737	0.743	0.731	0.748	0.734	0.759	0.733	0.727	
25-percentile	0.880	0.879	0.880	0.885	0.887	0.890	0.882	0.903	0.896	0.914	0.881	0.910	
Average	0.914	0.924	0.919	0.929	0.922	0.933	0.922	0.942	0.930	0.945	0.919	0.944	
Median	0.908	0.926	0.914	0.939	0.918	0.946	0.914	0.961	0.925	0.961	0.910	0.961	
75-percentile	0.952	0.972	0.960	0.983	0.960	0.978	0.960	0.991	0.967	0.989	0.958	0.981	
Max	1.104	1.019	1.116	1.017	1.126	1.014	1.117	1.019	1.129	1.017	1.143	1.024	
Std Deviation	0.068	0.062	0.068	0.061	0.066	0.059	0.066	0.058	0.066	0.055	0.068	0.055	

In general, the minimum, 25-percentile, average, median and 75-percentile conditional statistics exhibit higher values compared to the robust model. On the other hand, the maximum value is always greater in the robust model, since as depicted in fig. 5.6 the conditional model shows fewer super-performing units, but most of the super-performing units from the robust model remain among the best performers.

For instance, Norra Sverige (SE3) in Sweden was a super-performer in the robust model in all years except from 2014, but in the conditional model, it is slightly farther from the best practice frontier, with results ranging between 0.957 and 0.983. Similarly, Manner-Suomin (FI1) in Finland was a super-performer from 2017 to 2019 in the robust model and also achieved BoD results between 0.952 and 0.999 in the conditional model.

Canarias (ES7) and Sur (ES6) in Spain, Région de Bruxelles-Capitale (BE1) in Belgium, and Attiki (EL3) in Greece did not reach the status of best performers or surpass the frontier in the robust analysis. However, in the conditional model, these regions were consistently best-performers in the six-year analysis period.

Severna Makedonija (MK0) in North Macedonia displayed the largest average absolute difference in the BoD score, transitioning from values ranging between 0.791 and 0.848 to values ranging from 0.900 to 1. It achieved the best practice frontier in 2016 and 2018 in the conditional model. Nisia Aigaiou Kriti (EL4) from Greece also experienced a substantial average absolute difference, transitioning from scores around 0.84 to values around 0.98 in the conditional model.

In addition, all the other Greek regions (EL3, EL5, EL6), the Spanish regions except Noreste (ES1, ES3, ES4, ES5, ES6, ES7), Srbija - jug in Serbia (RS2), Régions ultrapériphériques françaises in France (FRY), Isole and Sur in Italy (ITG and ITF), and Makroregion Województwo Mazowieckie in Poland (PL9) exhibited average absolute differences in the BoD scores ranging from 0.05 to 0.11. Further investigation reveals that these regions, with the exception of the Polish region (PL9), were among the top 15 regions with the highest unemployment rates in 2019.

As explained earlier, the unemployment rate is closely correlated with GDP per capita and serves as an indicator of overall economic well-being. High unemployment rates often signify a struggling economy, which can have implications for educational performance due to limited investment in education.

By setting realistic expectations based on a region's economic capacity, regions demonstrate that they are performing well within their respective contexts. In light of this, it becomes crucial to address environmental inequalities through policies that aim to enhance educational opportunities, promote economic growth, and reduce unemployment rates. These measures will help create a more equitable educational landscape and pave the way for sustainable development.

5.2.2 Peers analysis

In order to determine the regions from which to learn and search for best practices, the intensity variables' results λ_j $(j = 1, \ldots, n)$ need to be analyzed. If λ_j is greater than 0, it indicates that region j is a peer of the region k under analysis. The closer the value is to 1, the closer DMU k is to DMU j compared to any other region in the frontier. This closer proximity suggests that DMU k should prioritize learning from DMU j, as it is an easily accessible peer and likely to offer valuable insights and best practices.

For the year 2019, a comparative analysis will be conducted on the results of peers and intensity variables obtained from both robust and conditional models. It is important to focus on the most recent year to identify regions that have recently achieved superior results and should be considered as benchmarks.

Table 5.5 provides indicators that aim to reflect the importance of the regions considered as peers for learning best practices in the robust and conditional approaches. The grey-shaded cells indicate that the DMUs in those values are only peers of themselves.

The frequency represents the number of times a region is considered a peer by other regions, highlighting its reach and presence within the peer network. The partial intensity average is determined by dividing the sum of the intensity variable values of the peer j, λ_j, by the frequency of its appearance as a peer. This metric provides insight into the significance of the peer within the specific regions it reaches. Finally, the absolute intensity average is obtained by dividing the sum of the intensity variable values of the peer j, λ_j, by the total number of regions analyzed in the model (101 regions in the case of 2019). This metric reflects the overall importance of the peer as a source of learning best practices for Europe as a whole, considering both its reach and significance in influencing other regions.

Therefore, a peer that appears frequently but with low-intensity values, or a peer that appears infrequently but with high-intensity values, will have a similar level of importance as a benchmark for Europe reflected by the absolute intensity average. However, further examination can be conducted to understand whether this level of importance is attributed to a high frequency of appearance or high-intensity values.

Table 5.5: Indicators of importance for the peers of the robust and conditional analysis in 2019

Region	Robust			Conditional		
j	Frequency	Partial intensity avg	Absolute intensity avg	Frequency	Partial intensity avg	Absolute intensity avg
SE1	101	30.68%	30.68%	29	57.70%	16.57%
SE2	91	23.11%	20.82%	20	33.02%	6.54%
FRK	53	13.54%	7.11%	10	15.17%	1.50%
FR1	23	13.70%	3.12%	6	50.82%	3.02%
UKI	20	14.58%	2.89%	12	39.74%	4.72%
SE3	17	13.65%	2.30%			
CH0	4	16.05%	0.64%	2	55.57%	1.10%
FI1	4	11.10%	0.44%	3	12.93%	0.38%
LU0	2	10.73%	0.21%	1	100.00%	0.99%
DK0	1	12.25%	0.12%	24	39.25%	9.33%
IS0	1	10.40%	0.10%	3	34.96%	1.04%
UKJ				33	43.92%	14.35%
NO0				26	24.78%	6.38%
ES3				3	74.33%	2.21%
EL5				2	94.07%	1.86%
ES4				2	79.47%	1.57%
ES6				2	71.92%	1.42%
BE2				8	16.85%	1.34%
ES1				3	43.44%	1.29%
UKM				3	40.99%	1.22%
FRY				2	60.54%	1.20%
EL3				2	55.65%	1.10%
FRE				2	53.18%	1.05%
BE1				1	100.00%	0.99%
ES7				1	100.00%	0.99%
FRJ				2	43.96%	0.87%
SI0				5	15.39%	0.76%
ITF				2	32.50%	0.64%
IE0				2	24.07%	0.48%
UKK				2	23.96%	0.47%
ES2				1	37.45%	0.37%
PL9				1	33.40%	0.33%
FRI				1	29.73%	0.29%
LT0				1	28.20%	0.28%
FRH				1	12.25%	0.12%
FRL				1	11.28%	0.11%
N	11	11	11	35	35	35
Min	1	10.40%	0.10%	1	11.28%	0.11%
Average	29	15.44%	6.22%	6	45.44%	2.48%
Median	17	13.65%	2.30%	2	39.74%	1.10%
Max	101	30.68%	30.68%	33	100.00%	16.57%

The robust analysis has 11 peers, with only 9 of them being peers of other DMUs besides themselves. In contrast, the conditional model shows a significant increase in the number of peers, reaching 35, with 29 being peers of other regions besides themselves.

Upon analyzing the frequency of regions appearing as peers, Östra Sverige emerges as a peer of every region, while Södra Sverige is a peer for nearly every region (91 out of 101) in the robust approach. These regions exhibit partial and absolute intensity averages exceeding 20%, having the highest values of all peers by a significant margin. This means the target values are mainly concentrated in these two regions for the robust model.

In the conditional approach, South East has the maximum frequency, appearing as a peer 33 times. Although there are more peers compared to the robust approach, their frequency is relatively lower. Consequently, the overall importance of these peers as benchmarks for Europe diminishes. The maximum absolute intensity value decreases from 30.68% in the robust model to 16.57% in the conditional model. Similarly, the average value among all peers decreases from 6.22% to 2.48%. Therefore, they hold less significance as benchmarks for Europe as a whole.

Nevertheless, it is noteworthy that the partial intensity average is higher, with an average among all peers passing from 15.44% in the robust model to 45.44% in the conditional model. This implies that when a peer is associated with a particular region, it exhibits closer proximity to that region compared to other regions that are part of the frontier. Therefore, it is advisable to prioritize learning and adopting the best practices of such peers.

The increased number of peers and their higher partial intensity average reflect more tailored guidance on best practices by considering the unique environments experienced by each region. This is crucial to ensure that policies are sought from other regions with similar contextual variables, rather than relying on regions with significantly more favourable conditions where the effectiveness of their policies may not be applicable or realistic for implementation in less favourable conditions.

Table 5.6: 2019 Robust and conditional peers and intensity variables for German regions

Code	Robust Peers	Conditional Peers
DE1	SE1(0.34), SE2(0.226), SE3(0.134)	UKJ(0.669), UKI(0.141), NO0(0.105)
DE2	SE2(0.33), SE1(0.218), SE3(0.114)	UKJ(0.81)
DE3	SE1(0.295), SE2(0.222), UKI(0.119)	UKI(0.398), SE1(0.367)
DE4	SE1(0.326), SE2(0.217), FR1(0.106)	UKJ(0.492), DK0(0.22), NO0(0.143)
DE5	SE2(0.31), SE1(0.242), SE3(0.16)	UKI(0.319), SE1(0.314), CH0(0.125), SE2(0.102)
DE6	SE2(0.336), SE1(0.212), SE3(0.143)	UKI(0.637), NO0(0.242)
DE7	SE2(0.326), SE1(0.224), SE3(0.153)	UKJ(0.461), UKI(0.361), NO0(0.101)
DE8	SE1(0.316), SE2(0.242), UKI(0.14)	DK0(0.542), UKJ(0.192), NO0(0.121)
DE9	SE2(0.308), SE1(0.232), SE3(0.168)	NO0(0.707), UKJ(0.154)
DEA	SE2(0.331), SE1(0.218), SE3(0.143), UKI(0.106)	UKJ(0.344), NO0(0.281), UKI(0.241)
DEB	SE1(0.308), SE2(0.248), SE3(0.136), UKI(0.103)	UKJ(0.605), NO0(0.302)
DEC	SE2(0.321), SE1(0.217), SE3(0.154)	NO0(0.759), UKI(0.109)
DED	SE1(0.334), SE2(0.222), SE3(0.119)	DK0(0.451), UKJ(0.244), NO0(0.142)
DEE	SE2(0.332), SE1(0.218), SE3(0.15)	NO0(0.366), DK0(0.291), IS0(0.139)
DEF	SE2(0.326), SE1(0.222), SE3(0.148)	NO0(0.482), UKJ(0.41)
DEG	SE1(0.321), SE2(0.234), SE3(0.114), UKI(0.105)	UKJ(0.371), DK0(0.34), NO0(0.165)

Table 5.6 provides an overview of the peers and their corresponding λ_j values for each German region in both the robust and conditional analyses. It is evident that many German regions have

shifted their main peers from Östra Sverige (SE1) and Södra Sverige (SE2) in Sweden to London (UKI) and South East (UKJ) in the United Kingdom. This shift can be attributed to the closer alignment of contextual variables between German and UK regions. Furthermore, it is worth noting that the λ_j values for the first peer are consistently higher in the conditional approach compared to the robust approach. This suggests a stronger influence and importance of the first peer in the conditional model.

For a more comprehensive analysis of the peers and respective λ_j values for all the European regions, table B.13 in appendix B can be consulted.

Thus, it becomes apparent that considering the context is essential for a more accurate assessment of realistic regions from which others can learn best practices.

5.3 Regional performance disparities within the same country

At this stage, the results of the models with all geographies, including countries and regions, will be used to understand the disparities between regions within the same country and if there are any discernible patterns in those disparities. This analysis will focus on countries with more than one region, resulting in 15 countries being under scrutiny.

The BoD results of the robust approach for all the data for 2019 are presented in fig. 5.8. For a deeper analysis, the geographies were sub-categorized and visually identified as countries, capitals, islands, or other regions. The country unit provides a valuable baseline for understanding and comparing the positioning of its regions in relation to that baseline.

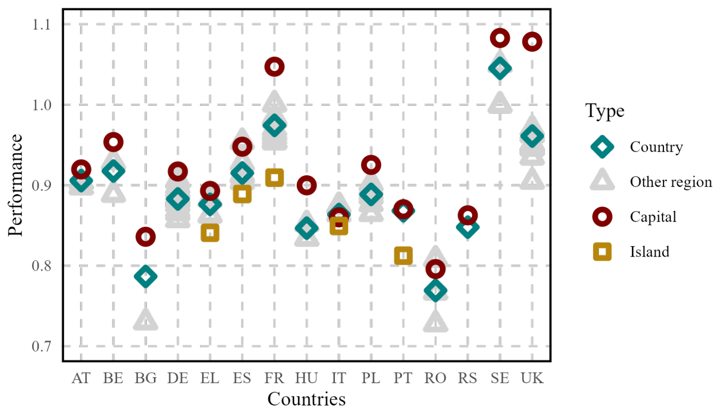

Figure 5.8: 2019 Robust BoD scores for countries and regions

When examining the robust results, it becomes clear that the worst performance is observed in all islands within their respective countries. Conversely, the capitals of almost every country emerge as the best or among the best-performing regions, consistently surpassing the performance of their respective countries. The only exception to this pattern is Italy, where the region containing the capital performs slightly below the country's average.

It is worth noting that the majority of capitals are contained within NUTS-I regions that either consist solely of the capital city itself, such as London, Berlin, Comunidade de Madrid, and Région de Bruxelles-Capitale, or if there are other cities within the region, the NUTS-I region containing the capital tends to be smaller in size compared to other regions. However, Portugal and Italy deviate from this trend. In Portugal, the other region is an island with poorer performance. In Italy, the NUTS-I region that includes Rome incorporates a significant number of other cities. This broader scope of the region encompassing the capital may contribute to the lower performance observed. Nevertheless, conducting further analysis at a more granular level, such as the NUTS-II level, is necessary to validate this observation.

Descriptive statistics on the score deviations among countries and their respective regions are shown in table 5.7.

Table 5.7: Statistics on score deviations among countries and their respective regions

Country	AvgD		|LMD|		|UMC|	
	Robust	Cond	Robust	Cond	Robust	Cond
Austria	0.008	0.023	0.008	0.040	0.014	0.014
Belgium	0.025	0.059	0.029	0.032	0.036	0.084
Bulgaria	0.053	0.083	0.057	0.104	0.049	0.063
France	0.020	0.011	0.065	0.030	0.073	0.020
Germany	0.012	0.015	0.026	0.029	0.034	0.027
Greece	0.018	0.012	0.035	0.020	0.017	0.005
Hungary	0.024	0.039	0.013	0.029	0.053	0.069
Italy	0.008	0.055	0.014	0.029	0.011	0.108
Poland	0.014	0.016	0.024	0.025	0.037	0.040
Portugal	0.019	0.015	0.056	0.044	0.002	0.000
Romania	0.027	0.029	0.042	0.045	0.039	0.037
Serbia	0.007	0.026	0.000	0.033	0.015	0.019
Spain	0.018	0.005	0.026	0.018	0.039	0.000
Sweden	0.029	0.009	0.046	0.019	0.038	0.004
United Kingdom	0.023	0.021	0.056	0.056	0.117	0.014

AvgD: The average absolute difference between the scores of a country and its regions;
LMD: The maximum deviation between the country and the regions with performances below the country's performance;
UMD: The maximum deviation between the country and the regions with performances above the country's performance

Bulgaria shows the highest average deviation between the country's score and the scores of its regions, indicating a greater level of heterogeneity.

France exhibits the largest lower maximum deviation, indicating the highest deviation between the country's score and the performance of its worst-performing region. This region refers to the Régions Ultrapériphériques Françaises, which are islands located outside of the European continent despite being part of the EU. Similarly, Bulgaria's region Severna i yugoiztochna Bulgaria, the United Kingdom's Wales, and Portugal's Região Autónoma dos Açores also show significant disparities between their worst-performing regions and the country's score.

France and the UK are notable when considering the upper maximum differences, as their capitals demonstrate significant positive deviations from their respective country scores. These differences are primarily attributed to their status as super-performers. Hungary follows a similar pattern, with its capital also displaying a considerable upper difference in performance compared to the country's score.

Turning to the conditional approach, the 2019 BoD results for the countries and regions are displayed in fig. 5.9. The conclusions of this analysis on the disparities of results within each country, compared to the robust model, vary. Greece and Spain exhibit improved overall results, leading to a reduction in heterogeneity among their regions. On the contrary, Bulgaria experiences an increased performance level gap between its regions.

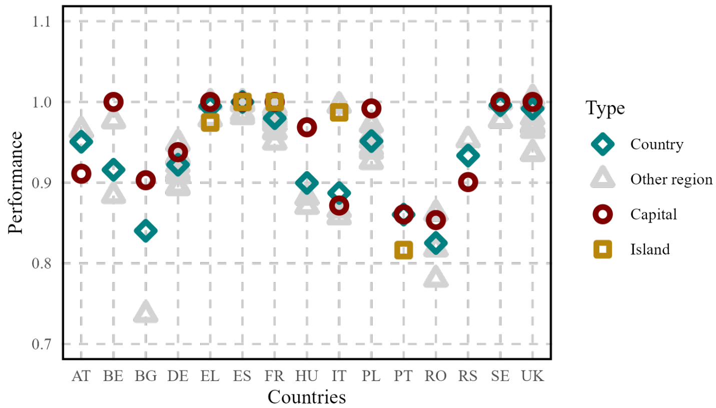

Figure 5.9: 2019 Conditional BoD scores for countries and regions

In Austria and Romania, the trend of the capital outperforming other regions is reversed, and the capitals themselves become the worst performers. This suggests that the more favourable context within the capitals contributes to their better performance compared to the rest of the country.

Furthermore, all islands demonstrate better scores in the conditional model. Except for Região Autónoma dos Açores, these islands surpass a BoD score of 0.97, indicating their improved performance. In Spain, France, and Italy, the islands even emerge as the top performers within their respective countries. This underscores the impact of challenging conditions faced by the islands, which can influence their overall performance and outcomes.

Upon revisiting table 5.7, Italy stands out with the highest deviation between the country and its best-performing region, primarily due to the Isole regions. In contrast, Severna i yugoiztochna Bulgaria, a region in Bulgaria that is not the capital region, exhibits the largest deviation between the country and the worst-performing region. This region performs poorly and significantly contributes to the observed deviation within Bulgaria.

Analyzing data at the regional level is crucial for understanding disparities within countries. Capitals generally outperform other regions, potentially due to better environments or higher achievement in indicators. However, this highlights the need for policies fostering greater homogeneity and addressing environmental gaps in underperforming regions, particularly islands. Prioritizing investment in strategically less important regions is essential to prevent widening gaps and ensure inclusive development.

The European Union monitoring reports on the strategic framework for education and training have been instrumental in providing valuable insights through country-level analyses of indicators over the years. However, as demonstrated by this analysis, behind the seemingly good performance at the country level, significant disparities exist between regions. Merely analyzing performance at the country level is insufficient to ensure fairness and equity in education. It is essential to conduct an in-depth analysis at the regional level, comprehend the underlying causes of low-performance scores, and implement targeted policies and strategies to address them. By doing so, European Union can work towards achieving a fair and equitable education system across Europe as a whole.

Chapter 6

Conclusion and final remarks

The existing literature on educational performance measurement has seen significant development. However, research in this area is still limited when considering regions across multiple countries. Within the European framework of education and training, two studies have been conducted, namely Stumbriene et al. (2020) and Camanho et al. (2021), both focusing on country-level analysis. This thesis bridges part of the knowledge gap by explicitly focusing on the scope and methodology required to evaluate the strategic framework.

First, this study incorporates indicators for ET2030, enabling more updated and forward-thinking results for the future. Subsequently, it proposes collecting and analyzing data at the regional level. By doing so, the study identifies and addresses heterogeneity within countries and across Europe. The data is collected over consecutive years, allowing for a more precise understanding of trends over time. This approach facilitates a comprehensive evaluation of the educational landscape and contributes to a better understanding of the dynamics and variations within and between regions.

From a methodological perspective, this dissertation addressed the deterministic limitations in the DEA and BoD approaches, which were not previously explored in the studies conducted by Stumbriene et al. (2020) and Camanho et al. (2023). Additionally, this study contributed to the literature by exploring the combination of the robust approach with σ and β-convergence assessment, which, to the best of the available knowledge, has not been previously explored. It also employed a robust conditional analysis to consider contextual variables that may impact the performance of different geographies. This method of incorporating environmental factors differs from the approaches taken by the studies outlined in chapter 2.

The dissertation successfully addressed the three research questions proposed in chapter 1 and provided analytical support for policy decision-making and the design of strategies to promote equitable and sustainable development in education across Europe.

To understand the performance of European regions regarding the ET2030 indicators, a Benefit-of-the-Doubt composite indicator was constructed. The performance assessment revealed that northern regions demonstrate strong performance levels, while eastern regions exhibit lower performance levels. The analysis also identified both the best and worst-performing regions, enabling targeted policy interventions to support the improvement of underperforming regions and contribute to bridging the gap, promoting a more equitable educational landscape across Europe.

Furthermore, the study highlighted indicators where there is significant room for improvement compared to the observed practices. Specifically, it suggested that the European Union should implement policies that encourage and incentivize countries to enhance their tertiary attainment levels and increase adult participation in lifelong learning.

Additionally, a Global Malmquist Index and a σ and β-convergence assessments were developed to evaluate performance evolution and convergence over time. The analysis revealed that while the best practice frontier has been improving, there is a growing gap between the worst-performing regions and the best-performing regions. This trend is concerning as it indicates a divergence from the objective of achieving a more fair and equitable education system in Europe.

In a subsequent phase, the robust conditional approach allowed for an answer to the second research question on how considering contextual variables for a fair and equitable comparison would impact the performance of the geographies. The inclusion of conditional variables shed light on the correlation between the contextual environment and the performance differences in the robust and conditional approaches. By considering the context, more realistic expectations were set regarding the performance required from each region. This resulted in the worst-performing units in the robust approach demonstrating strong performance within their respective contexts in the conditional approach. It is crucial to develop policies that target environmental inequalities and strive to create a level playing field for all regions. Implementing such policies can mitigate the adverse effects of unfavourable contexts. Additionally, the conditional approach helped identify more tailored and adequate peers from which regions can learn best practices, further enhancing the potential for knowledge exchange and improvement across regions.

By replicating the aforementioned methods while considering not only the regional level but also the country level simultaneously, it was possible to analyze regional disparities within countries, identify potential patterns, and consequently answer the third research question. This comprehensive approach allowed for an understanding of the baseline performance at the country level and the relationship of regions to that baseline. In particular, the analysis highlighted that islands lag behind other regions within their countries, while capitals outperform the national baseline. These findings underscore the existence of regional disparities across countries. Moreover, the conditional approach revealed an inversion of these results, indicating that the unfavourable contexts experienced by islands contribute to their lagging performance. Consequently, it becomes imperative to implement policies aimed at mitigating and counterbalancing these environmental effects. By addressing the specific challenges faced by island regions, it is possible to foster their development and ensure more equitable outcomes within countries.

While the conclusions drawn from this analysis are significant, it is important to acknowledge the limitations of the study and identify areas for future work.

Firstly, it is worth noting that further enhancing this analysis would require a deeper understanding of the underlying causes behind the performance disparities between regions and over time, as well as the proposal of specific policies to address these identified causes. However, a more comprehensive exploration at this level was not feasible due to time limitations. Collecting regional-level information for all regions to grasp their trends would be a challenging and time-consuming task. Nonetheless, this study provides a valuable data-driven tool that can assist policymakers in identifying areas for improvement and guide their efforts towards building a better Europe.

Additionally, the study faced constraints related to data availability, preventing a full exploration of other contextual variables that may influence educational outcomes. This highlights a common challenge in research of this nature: data gathering. Future work could involve examining alternative methods for incorporating contextual variables to compare and strengthen the reliability of the results. Consistent outcomes across different models would add credibility to the conclusions.

Another limitation is the exclusion of Europe's established goals when evaluating regional performance. For future work, a goal programming model that considers European goals in constructing the frontier could provide additional insights into how regions position themselves in relation to established targets. Exploring alternative approaches to weight restrictions, such as incorporating expert input, could also yield fruitful results.

It is important to acknowledge that the work conducted extends beyond the presentation of models, approaches, and results discussed in this study. The analysis involved using the BoD technique, which yielded weights and intensity variables, as well as the assessment of the GMI and its EC and BPC components and the σ and β-convergences. Additionally, these methods were performed using three different approaches: the robust approach presented in this study, the partially presented conditional approach, and a deterministic approach. Furthermore, these methods and approaches were applied at three distinct data levels: country level, NUTS-I level, and a combined analysis incorporating both levels. The results at the NUTS-I level can be found in appendix B, the country level in appendix C, and the comprehensive analysis in appendix D. Each appendix is subdivided into the deterministic, robust, and robust conditional approaches. A similar analysis to that conducted in the preceding sections of this chapter can be applied to the other results, providing further insights. However, due to constraints in time and space, this was not addressed within the scope of this master's thesis.

In conclusion, much work must be done to achieve greater homogeneity and equal opportunities for all European citizens. Regional interventions will play a crucial role in providing targeted support. Hopefully, this research will contribute to the design of data-driven policies that improve educational outcomes across Europe.

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Appendix A

Geographies

Table A.1: Countries comprised in the NUTS classification and corresponding number of regions at each NUTS level (Eurostat, 2022)

N	Code	Country	Category	NUTS I	NUTS II
1	BE	Belgium	European Union	3	11
2	BG	Bulgaria	European Union	2	6
3	CZ	Czechia	European Union	1	8
4	DK	Denmark	European Union	1	5
5	DE	Germany	European Union	16	38
6	EE	Estonia	European Union	1	1
7	IE	Ireland	European Union	1	3
8	EL	Greece	European Union	4	13
9	ES	Spain	European Union	7	18
10	FR	France	European Union	14	27
11	HR	Croatia	European Union	1	4
12	IT	Italy	European Union	5	21
13	CY	Cyprus	European Union	1	1
14	LV	Latvia	European Union	1	1
15	LT	Lithuania	European Union	1	2
16	LU	Luxembourg	European Union	1	1
17	HU	Hungary	European Union	3	8
18	MT	Malta	European Union	1	1
19	NL	Netherlands	European Union	4	12
20	AT	Austria	European Union	3	9
21	PL	Poland	European Union	7	17
22	PT	Portugal	European Union	3	7
23	RO	Romania	European Union	4	8
24	SI	Slovenia	European Union	1	2
25	SK	Slovakia	European Union	1	4
26	FI	Finland	European Union	2	5
27	SE	Sweden	European Union	3	8
28	IS	Iceland	EFTA	1	1
29	LI	Liechtenstein	EFTA	1	1
30	NO	Norway	EFTA	1	7
31	CH	Switzerland	EFTA	1	7
32	UK	United Kingdom	Previous EU member	12	41
33	ME	Montenegro	EU Candidate	1	1
34	MK	North Macedonia	EU Candidate	1	1
35	RS	Serbia	EU Candidate	2	4
36	AL	Albania	EU Candidate	1	3
37	TR	Turkiye	EU Candidate	12	26

Appendix B

NUTS I Results

B.1 Deterministic model

Table B.1: BoD results of the deterministic model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
BE1	0.936	23	0.928	30	0.937	29	0.957	19	0.961	23	0.938	30
BE2	0.925	27	0.913	40	0.928	32	0.930	36	0.935	35	0.919	36
BE3	0.881	56	0.875	68	0.892	55	0.896	54	0.903	54	0.882	55
BG3	0.754	93	0.752	93	0.749	93	0.757	96	0.751	95	0.714	100
BG4	0.842	82	0.843	83	0.838	87	0.847	85	0.850	86	0.819	94
CZ0	0.890	53	0.890	53	0.890	57	0.893	56	0.887	69	0.858	80
DK0	1.000	1	1.000	1	1.000	1	0.994	5	0.996	6	0.973	11
DE1	0.900	42	0.900	49	0.910	45	0.907	48	0.905	53	0.888	52
DE2	0.892	50	0.901	46	0.889	60	0.892	58	0.886	71	0.877	61
DE3	0.902	41	0.912	41	0.910	44	0.913	41	0.915	48	0.902	43
DE4	0.867	73	0.863	75	0.875	69	0.860	79	0.865	79	0.849	85
DE5	0.879	59	0.923	34	0.879	66	0.888	62	0.887	70	0.894	51
DE6	0.913	33	0.914	39	0.915	41	0.913	42	0.925	39	0.895	49
DE7	0.880	57	0.906	45	0.889	59	0.887	64	0.897	60	0.881	57
DE8	0.867	72	0.864	74	0.880	64	0.872	71	0.872	78	0.861	78
DE9	0.871	64	0.886	59	0.872	74	0.886	65	0.888	68	0.869	70
DEA	0.868	70	0.878	65	0.874	70	0.871	73	0.894	65	0.865	75
DEB	0.890	52	0.888	55	0.898	51	0.893	57	0.896	63	0.873	65
DEC	0.875	62	0.880	63	0.882	63	0.869	74	0.879	74	0.870	69
DED	0.892	49	0.886	58	0.895	53	0.887	63	0.893	66	0.874	64
DEE	0.868	71	0.860	77	0.859	79	0.852	83	0.855	83	0.854	83
DEF	0.868	68	0.883	60	0.873	73	0.867	75	0.895	64	0.871	67
DEG	0.891	51	0.879	64	0.883	62	0.891	59	0.898	58	0.876	62
EE0	0.868	69	0.882	62	0.892	54	0.899	53	0.913	49	0.896	47
IE0	0.909	37	0.910	42	0.916	38	0.940	32	0.970	16	0.952	21
EL3							0.911	44			0.875	63
EL4							0.817	91			0.826	93
EL5							0.871	72			0.867	73
EL6							0.834	89			0.847	86
ES1	0.904	39	0.906	44	0.916	40	0.919	39	0.929	37	0.918	37
ES2	0.929	26	0.926	31	0.940	28	0.942	30	0.953	31	0.935	32
ES3	0.937	22	0.915	37	0.924	34	0.925	37	0.940	33	0.925	35
ES4	0.893	48	0.893	51	0.906	48	0.909	46	0.917	45	0.906	40
ES5	0.887	54	0.883	61	0.895	52	0.900	51	0.916	47	0.902	44
ES6	0.885	55	0.886	57	0.899	50	0.899	52	0.909	52	0.898	46
ES7	0.874	63	0.870	70	0.890	58	0.890	61	0.897	61	0.881	58
FR1	0.992	6	0.986	7	0.991	6	0.995	3	0.995	8	0.999	4
FRB	0.946	17	0.948	20	0.962	14	0.961	18	0.975	13	0.957	16
FRC	0.946	18	0.933	28	0.959	18	0.954	22	0.958	26	0.947	25
FRD	0.934	25	0.945	22	0.957	20	0.951	27	0.960	25	0.949	22
FRE	0.947	16	0.939	26	0.956	21	0.951	26	0.962	22	0.948	23
FRF	0.935	24	0.943	24	0.960	17	0.954	23	0.968	18	0.960	13
FRG	0.962	12	0.964	12	0.979	9	0.989	7	0.988	9	0.974	10
FRH	0.980	9	0.968	11	0.981	8	0.974	11	0.995	7	0.977	6
FRI	0.951	15	0.955	15	0.968	13	0.971	13	0.977	12	0.963	12
FRJ	0.992	5	0.968	10	0.985	7	0.983	8	0.998	5	0.975	9
FRK	0.991	7	0.982	8	0.998	4	0.995	4	1.000	3	0.990	5
FRL	0.954	13	0.959	14	0.969	10	0.962	16	0.963	20	0.953	20

Table B.1: BoD results of the deterministic model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
FRM	0.852	80	0.818	87	0.907	47						
FRY			0.901	48	0.914	42	0.907	49	0.913	50	0.903	42
HR0	0.876	61	0.888	56	0.888	61	0.883	66	0.883	72	0.865	74
ITC	0.841	83	0.841	85	0.859	80	0.857	80	0.864	80	0.856	82
ITF	0.880	58	0.877	66	0.892	56	0.880	68	0.875	77	0.868	72
ITG	0.861	76	0.855	79	0.870	76	0.845	86	0.845	88	0.843	90
ITH	0.854	78	0.862	76	0.874	72	0.867	76	0.879	75	0.862	77
ITI	0.846	81	0.851	80	0.857	81	0.854	81	0.851	85	0.850	84
CY0	0.899	43	0.921	35	0.906	49	0.905	50	0.920	43	0.907	39
LV0	0.865	74	0.866	73	0.879	67	0.882	67	0.880	73	0.870	68
LT0	0.899	44	0.914	38	0.919	37	0.917	40	0.925	38	0.907	38
LU0	0.972	10	0.991	6	0.959	19	0.956	20	0.956	29	0.948	24
HU1	0.877	60	0.891	52	0.877	68	0.891	60	0.896	62	0.881	56
HU2	0.814	85	0.844	81	0.849	85	0.844	87	0.838	89	0.827	92
HU3	0.805	87	0.826	86	0.849	84	0.850	84	0.855	84	0.845	89
MT0	0.869	67	0.877	67	0.879	65	0.877	69	0.890	67	0.865	76
AT1	0.920	29	0.923	33	0.931	31	0.924	38	0.924	41	0.906	41
AT2	0.915	32	0.920	36	0.920	36	0.931	35	0.923	42	0.887	53
AT3	0.897	45	0.907	43	0.914	43	0.913	43	0.902	55	0.880	59
PL2	0.894	46	0.896	50	0.907	46	0.908	47	0.918	44	0.885	54
PL4	0.864	75	0.870	71	0.874	71	0.873	70	0.878	76	0.859	79
PL5	0.870	65	0.872	69	0.870	75	0.896	55	0.910	51	0.871	66
PL6	0.857	77	0.868	72	0.867	78	0.866	77	0.860	81	0.847	87
PL7									0.897	59	0.877	60
PL8									0.901	56	0.868	71
PL9									0.937	34	0.895	48
PT1	0.814	86	0.844	82	0.842	86	0.853	82	0.856	82	0.857	81
PT2	0.763	92	0.772	92	0.787	92	0.797	94	0.814	91	0.806	96
PT3	0.836	84	0.842	84	0.853	83						
RO1	0.799	88	0.791	90	0.807	89	0.802	92	0.777	94	0.755	99
RO2	0.724	94	0.729	94	0.735	94	0.727	97	0.719	96	0.713	101
RO3	0.770	91	0.785	91	0.789	91	0.798	93	0.790	93	0.780	98
RO4	0.784	89	0.801	88	0.798	90	0.781	95	0.794	92	0.792	97
SI0	0.920	28	0.925	32	0.926	33	0.933	34	0.925	40	0.902	45
SK0	0.852	79	0.859	78	0.855	82	0.843	88	0.849	87	0.830	91
FI1	0.942	21	0.951	18	0.961	16	0.961	17	0.968	17	0.954	19
SE1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
SE2	0.991	8	0.993	5	0.996	5	0.992	6	0.999	4	1.000	1
SE3	0.952	14	0.979	9	0.969	11	0.981	9	0.981	11	0.977	7
IS0	0.999	4					0.980	10	0.987	10	0.956	18
NO0	0.969	11	1.000	1	0.968	12	0.964	15	0.967	19	0.957	17
CH0											0.975	8
UKC	0.912	35	0.941	25	0.951	25	0.943	29	0.949	32	0.929	33
UKD	0.916	31	0.946	21	0.961	15	0.956	21	0.958	27	0.944	26
UKE	0.904	40	0.944	23	0.954	23	0.953	25	0.961	24	0.938	31
UKF	0.917	30	0.953	17	0.952	24	0.954	24	0.963	21	0.940	29
UKG	0.909	38	0.938	27	0.945	26	0.942	31	0.954	30	0.941	27
UKH	0.912	34	0.955	16	0.955	22	0.950	28	0.956	28	0.941	28
UKI	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
UKJ	0.945	19	0.961	13	0.935	30	0.970	14	0.974	14	0.960	14
UKK	0.943	20	0.949	19	0.920	35	0.971	12	0.974	15	0.958	15
UKL	0.893	47	0.901	47	0.916	39	0.910	45	0.934	36	0.894	50
UKM	0.911	36	0.931	29	0.941	27	0.933	33	0.916	46	0.927	34
UKN	0.870	66	0.889	54	0.868	77	0.863	78	0.900	57		
MK0	0.780	90	0.796	89	0.815	88	0.820	90	0.832	90		
RS1											0.846	88
RS2											0.817	95
N	94		94		94		97		96		101	
Min	0.724		0.729		0.735		0.727		0.719		0.713	
25-perc	0.868		0.869		0.874		0.870		0.881		0.863	
Average	0.895		0.900		0.906		0.905		0.913		0.896	
Median	0.893		0.901		0.907		0.907		0.914		0.894	
75-perc	0.935		0.943		0.952		0.953		0.960		0.945	
Max	1.000		1.000		1.000		1.000		1.000		1.000	
Std Dev	0.058		0.057		0.055		0.057		0.057		0.058	

Table B.2: BoD results against the metafrontiers of the deterministic model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE1	0.919	0.781	0.919	0.785	0.918	0.774	0.941	0.754	0.942	0.742	0.938	0.749
BE2	0.911	0.750	0.906	0.758	0.909	0.750	0.915	0.745	0.917	0.742	0.919	0.733
BE3	0.873	0.808	0.869	0.811	0.874	0.792	0.881	0.784	0.886	0.775	0.882	0.780
BG3	0.742	1.000	0.735	0.991	0.722	0.946	0.733	0.934	0.731	0.928	0.714	0.946
BG4	0.815	0.894	0.811	0.874	0.808	0.867	0.819	0.841	0.828	0.827	0.819	0.833
CZ0	0.862	0.796	0.856	0.794	0.859	0.785	0.864	0.776	0.864	0.776	0.858	0.780
DK0	0.990	0.683	0.993	0.683	0.980	0.688	0.977	0.695	0.977	0.710	0.973	0.703
DE1	0.889	0.761	0.894	0.758	0.892	0.761	0.892	0.759	0.887	0.765	0.888	0.761
DE2	0.864	0.763	0.867	0.759	0.864	0.766	0.864	0.762	0.867	0.762	0.877	0.763
DE3	0.886	0.781	0.892	0.780	0.891	0.767	0.897	0.772	0.894	0.778	0.902	0.765
DE4	0.858	0.879	0.857	0.860	0.857	0.816	0.845	0.835	0.848	0.807	0.849	0.814
DE5	0.844	0.805	0.872	0.794	0.861	0.790	0.873	0.789	0.865	0.809	0.894	0.818
DE6	0.903	0.769	0.908	0.774	0.896	0.771	0.897	0.766	0.903	0.763	0.895	0.776
DE7	0.870	0.775	0.872	0.774	0.870	0.775	0.873	0.771	0.876	0.776	0.881	0.772
DE8	0.859	0.838	0.858	0.834	0.862	0.817	0.858	0.807	0.855	0.796	0.861	0.793
DE9	0.860	0.793	0.860	0.795	0.853	0.802	0.871	0.793	0.866	0.793	0.869	0.796
DEA	0.860	0.794	0.864	0.794	0.855	0.791	0.856	0.793	0.872	0.794	0.865	0.791
DEB	0.881	0.782	0.882	0.791	0.881	0.785	0.878	0.787	0.879	0.783	0.873	0.786
DEC	0.866	0.814	0.863	0.816	0.865	0.793	0.854	0.799	0.858	0.797	0.870	0.792
DED	0.878	0.768	0.879	0.778	0.876	0.764	0.873	0.772	0.876	0.762	0.874	0.765
DEE	0.859	0.872	0.854	0.858	0.842	0.853	0.838	0.859	0.838	0.867	0.854	0.833
DEF	0.843	0.821	0.852	0.809	0.854	0.793	0.847	0.784	0.873	0.787	0.871	0.792
DEG	0.877	0.782	0.873	0.796	0.866	0.778	0.877	0.771	0.879	0.767	0.876	0.774
EE0	0.851	0.784	0.854	0.789	0.873	0.764	0.884	0.757	0.896	0.749	0.896	0.744
IE0	0.879	0.780	0.881	0.780	0.890	0.764	0.925	0.727	0.953	0.712	0.952	0.711
EL3							0.882	0.812			0.875	0.802
EL4							0.790	0.888			0.826	0.871
EL5							0.843	0.866			0.867	0.807
EL6							0.807	0.916			0.847	0.831
ES1	0.890	0.815	0.898	0.802	0.898	0.794	0.904	0.785	0.911	0.773	0.918	0.761
ES2	0.907	0.783	0.915	0.773	0.921	0.766	0.927	0.749	0.934	0.743	0.935	0.741
ES3	0.912	0.790	0.905	0.780	0.905	0.775	0.910	0.766	0.922	0.763	0.925	0.748
ES4	0.884	0.853	0.887	0.836	0.889	0.832	0.894	0.822	0.900	0.810	0.906	0.798
ES5	0.876	0.853	0.877	0.833	0.877	0.823	0.885	0.815	0.898	0.803	0.902	0.796
ES6	0.876	0.898	0.880	0.868	0.882	0.854	0.885	0.849	0.891	0.837	0.898	0.827
ES7	0.865	0.871	0.864	0.852	0.873	0.827	0.875	0.817	0.880	0.827	0.881	0.822
FR1	0.966	0.713	0.975	0.712	0.975	0.707	0.983	0.701	0.983	0.701	0.999	0.690
FRB	0.937	0.735	0.942	0.731	0.943	0.729	0.945	0.733	0.956	0.720	0.957	0.731
FRC	0.937	0.744	0.926	0.755	0.940	0.735	0.939	0.741	0.940	0.743	0.947	0.735
FRD	0.925	0.752	0.939	0.736	0.938	0.731	0.935	0.743	0.941	0.739	0.949	0.737
FRE	0.938	0.754	0.932	0.766	0.937	0.756	0.935	0.754	0.943	0.746	0.948	0.738
FRF	0.926	0.745	0.936	0.742	0.941	0.730	0.938	0.734	0.949	0.729	0.960	0.716
FRG	0.951	0.717	0.955	0.714	0.960	0.716	0.973	0.704	0.969	0.705	0.974	0.698
FRH	0.962	0.707	0.955	0.716	0.959	0.703	0.958	0.710	0.976	0.697	0.977	0.693
FRI	0.941	0.732	0.945	0.724	0.949	0.723	0.955	0.718	0.958	0.718	0.963	0.713
FRJ	0.972	0.709	0.961	0.726	0.965	0.720	0.966	0.720	0.979	0.698	0.975	0.708
FRK	0.976	0.706	0.974	0.712	0.978	0.703	0.978	0.704	0.981	0.699	0.990	0.687
FRL	0.944	0.750	0.952	0.738	0.950	0.742	0.946	0.741	0.945	0.736	0.953	0.718
FRM	0.839	0.815	0.813	0.960	0.874	0.773						
FRY			0.895	0.853	0.896	0.854	0.892	0.859	0.895	0.849	0.903	0.820
HR0	0.849	0.877	0.854	0.828	0.856	0.823	0.854	0.816	0.860	0.808	0.865	0.798
ITC	0.833	0.825	0.833	0.823	0.842	0.805	0.843	0.801	0.848	0.801	0.856	0.787
ITF	0.871	0.873	0.871	0.865	0.874	0.854	0.865	0.848	0.858	0.849	0.868	0.840
ITG	0.853	0.942	0.850	0.934	0.853	0.897	0.831	0.881	0.829	0.887	0.843	0.879
ITH	0.839	0.808	0.839	0.802	0.848	0.787	0.853	0.789	0.862	0.777	0.862	0.773
ITI	0.836	0.820	0.831	0.812	0.837	0.800	0.833	0.799	0.834	0.792	0.850	0.787
CY0	0.871	0.830	0.892	0.790	0.887	0.790	0.890	0.779	0.905	0.761	0.907	0.765
LV0	0.840	0.802	0.846	0.802	0.861	0.791	0.867	0.781	0.863	0.778	0.870	0.770
LT0	0.868	0.819	0.886	0.797	0.893	0.780	0.895	0.773	0.903	0.761	0.907	0.752
LU0	0.925	0.728	0.939	0.738	0.940	0.724	0.943	0.728	0.930	0.721	0.948	0.718
HU1	0.850	0.791	0.857	0.777	0.845	0.782	0.862	0.770	0.873	0.761	0.881	0.754
HU2	0.799	0.849	0.824	0.821	0.832	0.816	0.830	0.828	0.822	0.835	0.827	0.833
HU3	0.795	0.876	0.820	0.853	0.833	0.852	0.836	0.846	0.838	0.846	0.845	0.833
MT0	0.861	0.829	0.871	0.822	0.862	0.817	0.862	0.795	0.873	0.789	0.865	0.785
AT1	0.891	0.748	0.892	0.745	0.897	0.737	0.908	0.733	0.907	0.732	0.906	0.733
AT2	0.887	0.777	0.885	0.776	0.887	0.768	0.901	0.751	0.898	0.753	0.887	0.760
AT3	0.869	0.773	0.873	0.770	0.881	0.758	0.883	0.752	0.878	0.755	0.880	0.753
PL2	0.866	0.807	0.862	0.799	0.875	0.775	0.879	0.772	0.893	0.757	0.885	0.760
PL4	0.837	0.823	0.836	0.813	0.843	0.803	0.844	0.804	0.854	0.787	0.859	0.784

Table B.2: BoD results against the metafrontiers of the deterministic model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
PL5	0.843	0.814	0.838	0.812	0.839	0.799	0.866	0.784	0.885	0.765	0.871	0.767
PL6	0.830	0.833	0.835	0.828	0.836	0.811	0.838	0.813	0.838	0.804	0.847	0.787
PL7									0.873	0.777	0.877	0.768
PL8									0.877	0.775	0.868	0.770
PL9									0.910	0.733	0.895	0.753
PT1	0.805	0.864	0.817	0.827	0.820	0.821	0.839	0.805	0.837	0.796	0.857	0.782
PT2	0.755	1.000	0.767	0.956	0.771	0.935	0.784	0.939	0.799	0.939	0.806	0.950
PT3	0.827	0.900	0.836	0.890	0.836	0.874						
RO1	0.791	0.966	0.786	0.919	0.791	0.910	0.788	0.905	0.762	0.933	0.755	0.921
RO2	0.717	1.000	0.724	1.000	0.720	1.000	0.715	0.998	0.700	1.000	0.713	1.000
RO3	0.746	0.918	0.755	0.905	0.761	0.894	0.772	0.888	0.769	0.891	0.780	0.877
RO4	0.769	0.978	0.773	0.872	0.771	0.883	0.757	0.907	0.773	0.927	0.792	0.887
SI0	0.891	0.765	0.890	0.763	0.893	0.759	0.903	0.747	0.900	0.743	0.902	0.737
SK0	0.826	0.842	0.826	0.843	0.825	0.842	0.815	0.844	0.826	0.828	0.830	0.825
FI1	0.907	0.741	0.910	0.738	0.926	0.721	0.942	0.718	0.946	0.712	0.954	0.700
SE1	0.978	0.677	0.965	0.683	0.984	0.680	0.987	0.677	0.981	0.674	1.000	0.658
SE2	0.968	0.684	0.960	0.688	0.966	0.684	0.975	0.684	0.980	0.680	1.000	0.667
SE3	0.935	0.720	0.949	0.697	0.949	0.708	0.965	0.698	0.962	0.699	0.977	0.691
IS0	0.958	0.751					0.964	0.744	0.963	0.771	0.956	0.751
NO0	0.947	0.727	0.949	0.719	0.949	0.724	0.949	0.721	0.948	0.719	0.957	0.719
CH0											0.975	0.734
UKC	0.903	0.765	0.935	0.755	0.932	0.763	0.927	0.758	0.931	0.747	0.929	0.766
UKD	0.907	0.762	0.940	0.751	0.942	0.739	0.940	0.741	0.939	0.744	0.944	0.747
UKE	0.895	0.777	0.938	0.754	0.935	0.750	0.937	0.759	0.942	0.757	0.938	0.752
UKF	0.881	0.756	0.947	0.736	0.933	0.762	0.938	0.746	0.944	0.738	0.940	0.745
UKG	0.891	0.789	0.932	0.761	0.927	0.771	0.926	0.767	0.936	0.757	0.941	0.743
UKH	0.879	0.763	0.920	0.747	0.936	0.755	0.934	0.762	0.938	0.753	0.941	0.754
UKI	0.979	0.700	0.997	0.691	0.997	0.694	0.999	0.693	0.996	0.697	1.000	0.696
UKJ	0.900	0.749	0.909	0.762	0.916	0.749	0.954	0.725	0.955	0.722	0.960	0.716
UKK	0.899	0.743	0.899	0.757	0.901	0.748	0.955	0.723	0.955	0.723	0.958	0.734
UKL	0.884	0.765	0.888	0.768	0.898	0.755	0.895	0.753	0.911	0.759	0.894	0.767
UKM	0.887	0.775	0.902	0.774	0.924	0.773	0.918	0.767	0.896	0.779	0.927	0.758
UKN	0.831	0.829	0.841	0.809	0.850	0.806	0.845	0.803	0.878	0.785		
MK0	0.755	1.000	0.765	1.000	0.786	0.946	0.793	0.989	0.809	0.939		
RS1											0.846	0.813
RS2											0.817	0.876
N	94	94	94	94	94	94	97	97	96	96	101	101
Min	0.717	0.677	0.724	0.683	0.720	0.680	0.715	0.677	0.700	0.674	0.713	0.658
25-perc	0.844	0.752	0.851	0.755	0.853	0.750	0.850	0.744	0.862	0.740	0.863	0.737
Average	0.876	0.803	0.881	0.797	0.884	0.787	0.887	0.785	0.893	0.777	0.896	0.775
Median	0.876	0.787	0.881	0.789	0.882	0.775	0.885	0.772	0.895	0.765	0.894	0.766
75-perc	0.908	0.834	0.928	0.828	0.932	0.817	0.938	0.814	0.942	0.800	0.945	0.798
Max	0.990	1.000	0.997	1.000	0.997	1.000	0.999	0.998	0.996	1.000	1.000	1.000
Std Dev	0.056	0.074	0.056	0.068	0.056	0.061	0.058	0.064	0.058	0.062	0.058	0.060

Table B.3: Performance evolution assessment of the deterministic model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE1	1.021	1.003	1.018	1.000	0.991	1.008	1.000	1.010	0.990	1.024	1.021	1.004	1.002	1.004	0.997	0.996	0.977	1.020
BE2	1.009	0.993	1.015	0.994	0.987	1.008	1.004	1.016	0.988	1.006	1.002	1.003	1.002	1.005	0.997	1.002	0.983	1.019
BE3	1.011	1.001	1.010	0.996	0.993	1.003	1.006	1.019	0.987	1.008	1.005	1.003	1.005	1.008	0.997	0.996	0.977	1.019
BG3	0.963	0.948	1.016	0.991	0.997	0.993	0.982	0.996	0.987	1.015	1.011	1.003	0.998	0.992	1.006	0.978	0.951	1.027
BG4	1.004	0.973	1.032	0.995	1.002	0.993	0.997	0.994	1.002	1.014	1.010	1.003	1.010	1.004	1.006	0.990	0.963	1.027
CZ0	0.995	0.964	1.032	0.993	1.000	0.993	1.002	1.000	1.002	1.007	1.003	1.003	0.999	0.993	1.006	0.993	0.967	1.027
DK0	0.983	0.973	1.010	1.003	1.000	1.003	0.987	1.000	0.987	0.997	0.994	1.003	0.999	1.002	0.997	0.996	0.977	1.019
DE1	0.998	0.987	1.012	1.005	1.001	1.004	0.998	1.010	0.988	1.001	0.997	1.003	0.994	0.997	0.997	1.001	0.981	1.019
DE2	1.014	0.983	1.032	1.003	1.010	0.993	0.996	0.986	1.010	1.000	1.003	0.998	1.004	0.994	1.010	1.011	0.989	1.022
DE3	1.018	1.000	1.018	1.007	1.011	0.996	0.999	0.998	1.001	1.007	1.003	1.004	0.997	1.003	0.994	1.009	0.986	1.024
DE4	0.990	0.980	1.010	0.999	0.996	1.003	1.000	1.013	0.987	0.986	0.983	1.003	1.003	1.006	0.997	1.001	0.982	1.019
DE5	1.059	1.017	1.041	1.034	1.050	0.984	0.987	0.953	1.036	1.014	1.011	1.004	0.991	0.998	0.993	1.033	1.008	1.025
DE6	0.991	0.980	1.012	1.005	1.001	1.005	0.987	1.002	0.985	1.002	0.997	1.005	1.006	1.014	0.993	0.991	0.967	1.025
DE7	1.013	1.001	1.011	1.002	1.029	0.974	0.998	0.982	1.016	1.003	0.997	1.006	1.003	1.012	0.991	1.007	0.982	1.025
DE8	1.003	0.993	1.010	1.000	0.997	1.003	1.004	1.018	0.987	0.995	0.991	1.003	0.997	1.000	0.997	1.007	0.987	1.019
DE9	1.010	0.998	1.012	0.999	1.017	0.982	0.992	0.984	1.008	1.021	1.016	1.005	0.995	1.002	0.993	1.003	0.979	1.025
DEA	1.007	0.997	1.010	1.005	1.012	0.994	0.990	0.995	0.995	1.001	0.996	1.005	1.019	1.027	0.993	0.992	0.968	1.025
DEB	0.990	0.981	1.010	1.001	0.998	1.003	0.999	1.012	0.988	0.997	0.994	1.003	1.001	1.003	0.997	0.993	0.974	1.019
DEC	1.005	0.995	1.010	0.996	1.006	0.990	1.003	1.003	1.000	0.988	0.985	1.003	1.004	1.012	0.992	1.013	0.989	1.025
DED	0.995	0.979	1.016	1.001	0.993	1.008	0.996	1.010	0.986	0.997	0.992	1.005	1.003	1.006	0.997	0.998	0.979	1.019
DEE	0.994	0.984	1.010	0.994	0.991	1.003	0.987	0.999	0.987	0.995	0.991	1.003	1.000	1.003	0.997	1.018	0.999	1.019
DEF	1.033	1.003	1.030	1.010	1.017	0.993	1.002	0.988	1.015	0.992	0.993	0.998	1.031	1.032	0.999	0.997	0.973	1.025
DEG	1.000	0.983	1.016	0.996	0.986	1.009	0.992	1.005	0.987	1.013	1.009	1.004	1.003	1.007	0.995	0.997	0.976	1.022
EE0	1.053	1.032	1.021	1.003	1.015	0.988	1.022	1.012	1.010	1.013	1.008	1.006	1.013	1.016	0.997	1.000	0.981	1.019
IE0	1.082	1.047	1.034	1.002	1.001	1.001	1.010	1.007	1.003	1.039	1.026	1.013	1.030	1.032	0.998	0.999	0.981	1.018
EL3																		
EL4																		
EL5																		
EL6																		
ES1	1.032	1.015	1.016	1.008	1.002	1.007	1.000	1.011	0.989	1.007	1.004	1.003	1.007	1.010	0.997	1.008	0.989	1.019
ES2	1.030	1.007	1.023	1.009	0.997	1.012	1.006	1.015	0.991	1.007	1.003	1.004	1.008	1.011	0.997	1.000	0.981	1.020
ES3	1.014	0.987	1.027	0.993	0.977	1.016	1.000	1.010	0.991	1.006	1.002	1.004	1.013	1.016	0.997	1.003	0.984	1.019
ES4	1.025	1.015	1.010	1.003	1.000	1.003	1.001	1.015	0.987	1.006	1.003	1.003	1.006	1.009	0.997	1.008	0.989	1.019
ES5	1.030	1.017	1.013	1.002	0.996	1.006	1.000	1.013	0.987	1.009	1.006	1.003	1.015	1.017	0.997	1.004	0.985	1.019
ES6	1.025	1.015	1.010	1.005	1.002	1.003	1.002	1.015	0.987	1.003	1.000	1.003	1.008	1.010	0.997	1.007	0.988	1.019
ES7	1.018	1.008	1.010	0.999	0.995	1.003	1.010	1.023	0.987	1.003	1.000	1.003	1.006	1.008	0.997	1.001	0.982	1.019
FR1	1.034	1.007	1.027	1.010	0.994	1.016	1.000	1.005	0.995	1.009	1.004	1.004	1.000	1.000	1.000	1.016	1.004	1.013
FRB	1.021	1.011	1.010	1.005	1.002	1.003	1.001	1.015	0.987	1.002	0.998	1.003	1.012	1.015	0.997	1.001	0.981	1.019
FRC	1.011	1.001	1.010	0.989	0.986	1.003	1.015	1.029	0.987	0.998	0.995	1.003	1.002	1.004	0.997	1.007	0.988	1.019
FRD	1.027	1.016	1.010	1.015	1.012	1.003	0.999	1.013	0.987	0.997	0.993	1.003	1.007	1.009	0.997	1.008	0.989	1.019
FRE	1.011	1.001	1.010	0.994	0.991	1.003	1.005	1.018	0.987	0.998	0.995	1.003	1.008	1.011	0.997	1.005	0.986	1.019
FRF	1.036	1.026	1.010	1.011	1.008	1.003	1.006	1.019	0.987	0.997	0.993	1.003	1.012	1.015	0.997	1.011	0.991	1.019
FRG	1.024	1.012	1.012	1.004	1.001	1.003	1.005	1.016	0.989	1.013	1.010	1.003	0.996	0.999	0.997	1.005	0.986	1.019
FRH	1.015	0.996	1.019	0.992	0.987	1.005	1.004	1.013	0.991	0.999	0.993	1.006	1.019	1.022	0.997	1.000	0.981	1.019
FRI	1.024	1.013	1.010	1.004	1.005	0.999	1.004	1.013	0.991	1.006	1.003	1.003	1.004	1.006	0.997	1.005	0.986	1.019
FRJ	1.003	0.982	1.021	0.989	0.976	1.014	1.004	1.017	0.988	1.001	0.998	1.003	1.013	1.015	0.997	0.996	0.977	1.019
FRK	1.014	0.999	1.016	0.997	0.991	1.006	1.005	1.016	0.989	1.000	0.996	1.003	1.003	1.005	0.997	1.009	0.990	1.019
FRL	1.009	0.999	1.010	1.008	1.005	1.003	0.998	1.010	0.988	0.996	0.993	1.003	0.998	1.001	0.997	1.008	0.989	1.019
FRM				0.969	0.961	1.008	1.076	1.108	0.971									
FRY							1.002	1.015	0.987	0.996	0.992	1.003	1.004	1.006	0.997	1.008	0.989	1.019
HR0	1.019	0.988	1.032	1.006	1.013	0.993	1.003	1.001	1.002	0.998	0.994	1.003	1.007	1.000	1.006	1.006	0.980	1.027
ITC	1.028	1.017	1.010	1.001	0.999	1.002	1.010	1.022	0.988	1.002	0.998	1.004	1.006	1.008	0.997	1.009	0.990	1.019
ITF	0.996	0.986	1.010	0.999	0.996	1.003	1.004	1.017	0.987	0.990	0.986	1.003	0.992	0.995	0.997	1.011	0.992	1.019
ITG	0.988	0.978	1.010	0.996	0.993	1.003	1.004	1.017	0.987	0.975	0.971	1.003	0.998	1.001	0.997	1.016	0.997	1.019
ITH	1.028	1.010	1.018	1.001	1.010	0.991	1.010	1.013	0.997	1.006	0.992	1.013	1.011	1.014	0.997	1.000	0.981	1.019
ITI	1.017	1.005	1.012	0.994	1.007	0.988	1.007	1.007	1.000	0.996	0.996	1.000	1.001	0.997	1.004	1.020	0.999	1.021
CY0	1.041	1.008	1.032	1.023	1.025	0.999	0.994	0.983	1.011	1.004	0.999	1.005	1.017	1.016	1.001	1.002	0.986	1.016
LV0	1.035	1.005	1.030	1.006	1.001	1.005	1.018	1.015	1.003	1.008	1.003	1.004	0.995	0.998	0.997	1.008	0.989	1.019
LT0	1.045	1.009	1.036	1.021	1.017	1.004	1.008	1.005	1.003	1.002	0.998	1.004	1.009	1.009	1.000	1.005	0.980	1.025
LU0	1.026	0.976	1.051	1.016	1.020	0.995	1.001	0.967	1.035	1.003	0.997	1.006	0.986	1.000	0.986	1.020	0.992	1.028
HU1	1.037	1.005	1.032	1.009	1.016	0.993	0.986	0.984	1.002	1.019	1.016	1.003	1.013	1.006	1.006	1.010	0.983	1.027
HU2	1.035	1.016	1.019	1.031	1.037	0.994	1.010	1.006	1.004	0.998	0.994	1.004	0.991	0.993	0.997	1.006	0.987	1.019
HU3	1.064	1.050	1.013	1.032	1.026	1.006	1.015	1.029	0.987	1.004	1.001	1.003	1.002	1.005	0.997	1.009	0.989	1.019
MT0	1.005	0.995	1.010	1.012	1.008	1.003	0.990	1.003	0.987	1.000	0.997	1.003	1.013	1.015	0.997	0.990	0.972	1.019
AT1	1.016	0.984	1.032	1.001	1.003	0.997	1.006	1.008	0.998	1.011	0.993	1.019	0.999	1.000	0.999	0.999	0.980	1.019
AT2	1.000	0.969	1.032	0.997	1.005	0.993	1.003	1.000	1.002	1.016	1.013	1.003	0.996	0.990	1.006	0.988	0.961	1.027
AT3	1.012	0.980	1.032	1.003	1.011	0.993	1.010	1.008	1.002	1.002	0.998	1.003	0.994	0.988	1.006	1.002	0.975	1.027
PL2	1.021	0.989	1.032	0.995	1.002	0.993	1.015	1.013	1.002	1.005	1.001	1.003	1.017	1.010	1.006	0.990	0.964	1.027
PL4	1.026	0.994	1.032	0.999	1.006	0.993	1.007	1.005	1.002	1.002	0.999	1.003	1.012	1.006	1.006	1.005	0.978	1.027
PL5	1.033	1.001	1.032	0.994	1.002	0.993	1.001	0.999	1.002	1.032	1.029	1.003	1.022	1.016	1.006	0.984	0.958	1.027
PL6	1.020	0.988	1.032	1.005	1.013	0.993	1.002	1.000	1.002	1.002	0.999	1.003	0.999	0.993	1.006	1.011	0.984	1.027
PL7																1.005	0.978	1.027
PL8																0.990	0.964	1.027
PL9																0.983	0.956	1.029
PT1	1.065	1.054	1.011	1.015	1.038	0.979	1.003	0.997	1.006	1.024	1.014	1.010	0.997	1.003	0.994	1.024	1.001	1.023
PT2	1.067	1.056	1.010	1.015	1.012	1.003	1.006	1.019	0.987	1.017	1.013	1.003	1.018	1.021	0.997	1.009	0.990	1.019
PT3				1.011	1.008	1.003	1.000	1.013	0.987									
RO1	0.954	0.945	1.010	0.993	0.990	1.003	1.006	1.020	0.987	0.997	0.994	1.003	0.966	0.969	0.997	0.991	0.972	1.019
RO2	0.994	0.985	1.010	1.010	1.007	1.003	0.995	1.008	0.987	0.993	0.990	1.003	0.979	0.989	0.990	1.018	0.991	1.027
RO3	1.046	1.013	1.032	1.012	1.019	0.993	1.008	1.006	1.002	1.014	1.011	1.003	0.996	0.990	1.006	1.015	0.988	1.027
RO4	1.031	1.011	1.020	1.006	1.022	0.985	0.997	0.997	1.001	0.982	0.978	1.004	1.020	1.016	1.004	1.026	0.998	1.027
SI0	1.011	0.980	1.032	0.998	1.006	0.993	1.003	1.001	1.002	1.011	1.008	1.003	0.997	0.991	1.006	1.002	0.975	1.027
SK0	1.005	0.974	1.032	1.000	1.008	0.993	0.999	0.996	1.002	0.988	0.985	1.003	1.013	1.007	1.006	1.005	0.978	1.027
FI1	1.052	1.013	1.039	1.004	1.010	0.994	1.018	1.010	1.008	1.017	1.000	1.017	1.004	1.008	0.996	1.008	0.985	1.023
SE1	1.023	1.000	1.023	0.987	1.000	0.987	1.020	1.000	1.020	1.003	1.000	1.003	0.994	1.000	0.994	1.019	1.000	1.019
SE2	1.033	1.009	1.024	0.992	1.002	0.990	1.006	1.003	1.002	1.010	0.996	1.015	1.004	1.007	0.997	1.021	1.001	1.019
SE3	1.044	1.025	1.019	1.015	1.028	0.988	0.999	0.989	1.010	1.017	1.013	1.004	0.997	1.000	0.997	1.015	0.996	1.019

Table B.3: Performance evolution assessment of the deterministic model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
IS0													0.999	1.008	0.991	0.993	0.969	1.025
NO0	1.011	0.987	1.024	1.003	1.032	0.972	1.000	0.968	1.032	1.000	0.996	1.004	1.000	1.003	0.997	1.009	0.989	1.019
CH0																		
UKC	1.029	1.019	1.010	1.036	1.032	1.003	0.997	1.010	0.987	0.994	0.991	1.003	1.004	1.007	0.997	0.998	0.979	1.019
UKD	1.041	1.031	1.010	1.037	1.033	1.003	1.002	1.015	0.987	0.998	0.995	1.003	0.999	1.002	0.997	1.005	0.986	1.019
UKE	1.048	1.037	1.010	1.047	1.044	1.003	0.998	1.011	0.987	1.002	0.999	1.003	1.005	1.008	0.997	0.995	0.976	1.019
UKF	1.067	1.026	1.041	1.075	1.040	1.033	0.985	0.998	0.987	1.006	1.002	1.003	1.007	1.009	0.997	0.996	0.977	1.019
UKG	1.057	1.035	1.021	1.046	1.032	1.014	0.995	1.008	0.987	0.999	0.996	1.003	1.010	1.013	0.997	1.006	0.987	1.019
UKH	1.070	1.032	1.038	1.047	1.047	1.000	1.017	1.000	1.017	0.998	0.995	1.003	1.005	1.007	0.997	1.003	0.984	1.019
UKI	1.022	1.000	1.022	1.019	1.000	1.019	1.000	1.000	1.000	1.002	1.000	1.002	0.997	1.000	0.997	1.004	1.000	1.004
UKJ	1.066	1.015	1.050	1.010	1.017	0.993	1.008	0.973	1.036	1.042	1.037	1.004	1.001	1.004	0.997	1.005	0.986	1.019
UKK	1.065	1.016	1.049	1.001	1.007	0.994	1.002	0.969	1.034	1.060	1.056	1.004	1.000	1.002	0.997	1.003	0.984	1.019
UKL	1.011	1.001	1.010	1.004	1.009	0.996	1.010	1.016	0.994	0.997	0.993	1.004	1.019	1.027	0.992	0.982	0.958	1.025
UKM	1.045	1.018	1.027	1.017	1.022	0.995	1.025	1.011	1.014	0.993	0.991	1.002	0.976	0.982	0.994	1.034	1.012	1.022
UKN				1.013	1.022	0.992	1.010	0.976	1.035	0.994	0.994	1.000	1.039	1.043	0.996			
MK0				1.013	1.021	0.993	1.027	1.025	1.002	1.009	1.006	1.003	1.020	1.014	1.006			
RS1																		
RS2																		
N	89	89	89	93	93	93	94	94	94	92	92	92	93	93	93	94	94	94
Min	0.954	0.945	1.010	0.969	0.961	0.972	0.982	0.953	0.971	0.975	0.971	0.998	0.966	0.969	0.986	0.978	0.951	1.004
25-perc	1.008	0.987	1.010	0.998	0.998	0.993	0.998	1.000	0.987	0.997	0.994	1.003	0.998	1.000	0.997	0.998	0.977	1.019
Average	1.022	1.002	1.021	1.007	1.008	0.999	1.003	1.006	0.998	1.005	1.001	1.004	1.004	1.006	0.998	1.004	0.983	1.022
Median	1.021	1.001	1.018	1.003	1.006	1.003	1.002	1.008	0.993	1.002	0.998	1.003	1.004	1.006	0.997	1.005	0.984	1.019
75-perc	1.035	1.015	1.032	1.011	1.017	1.003	1.007	1.015	1.002	1.009	1.004	1.004	1.011	1.011	0.999	1.009	0.989	1.025
Max	1.082	1.056	1.051	1.075	1.050	1.033	1.076	1.108	1.036	1.060	1.056	1.019	1.039	1.043	1.010	1.034	1.012	1.029
Std Dev	0.024	0.021	0.011	0.015	0.016	0.009	0.011	0.018	0.013	0.012	0.012	0.003	0.011	0.011	0.004	0.010	0.011	0.004

Table B.4: Convergence results of the deterministic model for NUTS I regions

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.007	1.012	0.999	0.987
2015/2016	1.006	1.014	0.998	0.983
2016/2017	1.000	1.015	1.004	0.989
2017/2018	1.006	1.015	0.998	0.984
2018/2019	0.983	1.032	1.022	0.990
2014/2019	1.001	1.091	1.021	0.935

B.2 Robust model

Table B.5: BoD results of the robust model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
BE1	0.947	26	0.946	33	0.949	33	0.972	20	0.974	20	0.957	27
BE2	0.938	30	0.929	41	0.936	38	0.939	40	0.941	43	0.934	39
BE3	0.892	59	0.888	68	0.896	60	0.901	61	0.905	68	0.891	67
BG3	0.765	93	0.762	93	0.758	93	0.771	96	0.766	95	0.736	100
BG4	0.853	83	0.853	85	0.849	87	0.863	83	0.868	85	0.843	93
CZ0	0.902	53	0.901	55	0.901	56	0.909	53	0.906	66	0.883	75
DK0	1.099	2	1.096	3	1.051	4	1.032	5	1.008	8	1.001	9
DE1	0.916	43	0.918	44	0.919	47	0.916	48	0.917	54	0.904	57
DE2	0.908	47	0.913	49	0.904	54	0.908	54	0.908	64	0.898	61
DE3	0.918	42	0.924	42	0.925	44	0.931	41	0.934	46	0.926	43
DE4	0.878	74	0.876	75	0.879	76	0.864	82	0.871	83	0.859	88
DE5	0.894	57	0.929	40	0.901	57	0.905	58	0.903	69	0.911	49
DE6	0.932	36	0.931	39	0.933	39	0.929	43	0.943	40	0.913	48
DE7	0.901	54	0.915	47	0.908	50	0.906	56	0.915	58	0.899	60
DE8	0.879	72	0.879	72	0.887	71	0.880	76	0.879	77	0.872	82
DE9	0.889	63	0.895	61	0.891	65	0.901	62	0.906	67	0.886	73
DEA	0.887	64	0.892	65	0.891	64	0.887	69	0.911	61	0.882	76
DEB	0.906	51	0.904	53	0.907	52	0.903	60	0.909	63	0.889	69
DEC	0.891	60	0.892	62	0.890	67	0.876	78	0.897	72	0.887	72
DED	0.907	48	0.901	54	0.907	51	0.898	64	0.907	65	0.891	64
DEE	0.882	70	0.874	76	0.867	80	0.861	84	0.871	81	0.871	83
DEF	0.883	67	0.892	64	0.890	66	0.883	72	0.912	60	0.888	70
DEG	0.907	49	0.897	59	0.893	63	0.901	63	0.917	55	0.891	66
EE0	0.885	65	0.892	63	0.906	53	0.914	49	0.931	47	0.917	45
IE0	0.950	24	0.948	32	0.952	30	0.976	19	0.998	12	0.979	16
EL3							0.928	45			0.902	58
EL4							0.832	91			0.849	92
EL5							0.887	70			0.891	65
EL6							0.849	89			0.870	84
ES1	0.915	44	0.922	43	0.923	45	0.930	42	0.934	45	0.931	40
ES2	0.946	27	0.950	31	0.957	27	0.961	24	0.967	24	0.959	25
ES3	0.957	23	0.939	35	0.937	37	0.944	38	0.954	36	0.955	29
ES4	0.904	52	0.906	51	0.910	49	0.914	50	0.919	52	0.914	46
ES5	0.897	55	0.895	60	0.898	59	0.905	57	0.918	53	0.917	44
ES6	0.895	56	0.898	56	0.903	55	0.904	59	0.910	62	0.905	55
ES7	0.884	66	0.882	70	0.894	62	0.894	67	0.900	71	0.892	63
FR1	1.014	6	1.037	5	1.035	5	1.051	4	1.044	4	1.062	5
FRB	0.959	21	0.964	20	0.967	18	0.966	22	0.977	19	0.966	22
FRC	0.958	22	0.946	34	0.964	20	0.959	27	0.960	33	0.955	30
FRD	0.945	28	0.960	24	0.962	21	0.956	31	0.961	31	0.958	26
FRE	0.959	20	0.952	30	0.960	24	0.956	30	0.963	29	0.956	28
FRF	0.948	25	0.957	26	0.966	19	0.960	26	0.970	21	0.969	20
FRG	0.978	12	0.983	14	0.987	14	0.999	10	0.992	13	0.986	13
FRH	0.998	9	0.987	11	0.997	11	0.985	14	1.003	11	0.991	10
FRI	0.963	18	0.971	16	0.974	15	0.979	17	0.979	17	0.973	18
FRJ	1.010	7	0.985	12	0.991	13	0.991	11	1.007	9	0.987	12
FRK	1.010	8	1.008	8	1.014	6	1.008	7	1.010	7	1.013	7
FRL	0.965	16	0.973	15	0.974	16	0.967	21	0.965	28	0.961	24
FRM	0.864	80	0.829	87	0.929	42						
FRY			0.913	48	0.918	48	0.912	52	0.914	59	0.910	52
HR0	0.889	62	0.898	57	0.899	58	0.898	65	0.902	70	0.890	68
ITC	0.853	82	0.854	83	0.867	81	0.867	81	0.871	82	0.868	86
ITF	0.891	61	0.889	66	0.895	61	0.884	71	0.877	79	0.875	79
ITG	0.871	76	0.867	79	0.873	78	0.849	87	0.847	89	0.850	91
ITH	0.867	78	0.874	77	0.885	73	0.880	77	0.890	76	0.880	77
ITI	0.858	81	0.863	80	0.870	79	0.869	79	0.870	84	0.866	87
CY0	0.945	29	0.960	22	0.951	32	0.955	33	0.970	22	0.962	23
LV0	0.878	73	0.878	74	0.888	70	0.896	66	0.894	74	0.888	71
LT0	0.935	31	0.955	27	0.955	29	0.955	32	0.959	34	0.944	36
LU0	0.997	10	1.004	9	0.992	12	0.986	13	0.989	14	0.990	11
HU1	0.893	58	0.905	52	0.889	68	0.907	55	0.915	57	0.907	53
HU2	0.826	85	0.855	81	0.857	83	0.849	88	0.842	90	0.835	95
HU3	0.817	87	0.839	86	0.853	86	0.855	86	0.856	87	0.853	90
MT0	0.880	71	0.889	67	0.883	74	0.882	73	0.892	75	0.874	80
AT1	0.934	32	0.938	36	0.943	35	0.942	39	0.942	41	0.928	42
AT2	0.929	38	0.931	38	0.931	40	0.948	36	0.942	42	0.913	47

Table B.5: BoD results of the robust model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
AT3	0.911	46	0.918	45	0.926	43	0.929	44	0.922	49	0.906	54
PL2	0.907	50	0.907	50	0.919	46	0.925	46	0.937	44	0.910	51
PL4	0.876	75	0.880	71	0.885	72	0.888	68	0.896	73	0.885	74
PL5	0.883	68	0.882	69	0.881	75	0.912	51	0.929	48	0.899	59
PL6	0.869	77	0.878	73	0.878	77	0.882	74	0.878	78	0.873	81
PL7									0.916	56	0.904	56
PL8									0.920	50	0.894	62
PL9									0.966	26	0.935	38
PT1	0.826	86	0.854	82	0.853	85	0.868	80	0.874	80	0.877	78
PT2	0.772	92	0.783	92	0.792	92	0.803	94	0.821	91	0.813	97
PT3	0.846	84	0.854	84	0.856	84						
RO1	0.809	88	0.802	90	0.810	89	0.806	93	0.788	94	0.775	99
RO2	0.733	94	0.739	94	0.737	94	0.731	97	0.734	96	0.733	101
RO3	0.782	91	0.794	91	0.799	91	0.811	92	0.808	93	0.803	98
RO4	0.796	89	0.811	88	0.808	90	0.795	95	0.810	92	0.815	96
SI0	0.933	33	0.937	37	0.938	36	0.951	34	0.944	39	0.929	41
SK0	0.864	79	0.870	78	0.866	82	0.857	85	0.866	86	0.853	89
FI1	0.978	13	0.984	13	0.999	8	1.006	8	1.029	6	1.008	8
SE1	1.104	1	1.115	2	1.126	1	1.117	1	1.129	1	1.143	1
SE2	1.055	4	1.062	4	1.060	3	1.079	3	1.099	3	1.109	2
SE3	0.977	14	1.023	6	1.008	7	1.022	6	1.030	5	1.038	6
IS0	1.028	5					1.005	9	1.006	10	0.980	14
NO0	0.996	11	1.015	7	0.997	10	0.988	12	0.988	15	0.979	15
CH0											1.067	4
UKC	0.927	39	0.955	28	0.959	26	0.947	37	0.953	37	0.937	37
UKD	0.932	35	0.960	21	0.968	17	0.963	23	0.961	32	0.954	32
UKE	0.923	41	0.960	23	0.962	23	0.959	28	0.967	25	0.948	35
UKF	0.933	34	0.971	17	0.957	28	0.960	25	0.969	23	0.949	34
UKG	0.925	40	0.953	29	0.951	31	0.949	35	0.965	27	0.954	31
UKH	0.929	37	0.964	19	0.962	22	0.956	29	0.962	30	0.953	33
UKI	1.091	3	1.116	1	1.116	2	1.107	2	1.100	2	1.087	3
UKJ	0.964	17	0.969	18	0.959	25	0.980	16	0.983	16	0.978	17
UKK	0.962	19	0.960	25	0.944	34	0.979	18	0.979	18	0.969	21
UKL	0.911	45	0.917	46	0.929	41	0.921	47	0.952	38	0.911	50
UKM	0.975	15	0.988	10	0.998	9	0.983	15	0.956	35	0.972	19
UKN	0.882	69	0.897	58	0.889	69	0.881	75	0.919	51		
MK0	0.791	90	0.805	89	0.825	88	0.835	90	0.848	88		
RS1											0.870	85
RS2											0.838	94
N	94		94		94		97		96		101	
Min	0.733		0.739		0.737		0.731		0.734		0.733	
25-perc	0.880		0.880		0.887		0.882		0.896		0.881	
Average	0.914		0.919		0.922		0.922		0.930		0.919	
Median	0.908		0.914		0.918		0.914		0.925		0.910	
75-perc	0.952		0.960		0.960		0.960		0.967		0.958	
Max	1.104		1.116		1.126		1.117		1.129		1.143	
Std Dev	0.068		0.068		0.066		0.066		0.066		0.068	

Table B.6: BoD results against the metafrontiers of the robust model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE1	0.939	0.854	0.939	0.860	0.940	0.849	0.968	0.825	0.977	0.811	0.972	0.820
BE2	0.930	0.820	0.924	0.827	0.930	0.820	0.935	0.814	0.941	0.812	0.947	0.805
BE3	0.888	0.885	0.885	0.888	0.890	0.868	0.897	0.856	0.903	0.848	0.899	0.853
BG3	0.762	1.225	0.757	1.188	0.754	1.112	0.766	1.097	0.763	1.077	0.747	1.098
BG4	0.852	1.031	0.846	0.999	0.845	0.988	0.856	0.957	0.865	0.932	0.855	0.940
CZ0	0.901	0.909	0.895	0.893	0.898	0.874	0.902	0.861	0.902	0.864	0.897	0.869
DK0	1.094	0.747	1.091	0.748	1.043	0.755	1.037	0.760	1.008	0.776	1.022	0.768
DE1	0.910	0.835	0.913	0.831	0.913	0.834	0.915	0.832	0.914	0.837	0.921	0.833
DE2	0.903	0.840	0.906	0.835	0.899	0.843	0.905	0.839	0.908	0.839	0.915	0.839
DE3	0.909	0.854	0.913	0.854	0.919	0.838	0.934	0.844	0.932	0.850	0.943	0.837
DE4	0.874	0.991	0.873	0.975	0.873	0.917	0.861	0.943	0.867	0.903	0.868	0.913
DE5	0.875	0.882	0.907	0.868	0.897	0.872	0.908	0.867	0.900	0.888	0.928	0.898
DE6	0.923	0.841	0.925	0.846	0.927	0.843	0.933	0.838	0.939	0.834	0.931	0.847
DE7	0.893	0.851	0.900	0.849	0.903	0.849	0.909	0.843	0.910	0.850	0.918	0.846
DE8	0.875	0.948	0.874	0.942	0.881	0.915	0.877	0.907	0.874	0.885	0.886	0.879
DE9	0.881	0.886	0.883	0.877	0.885	0.891	0.905	0.876	0.902	0.875	0.903	0.873
DEA	0.880	0.877	0.884	0.873	0.885	0.869	0.891	0.869	0.907	0.870	0.900	0.868
DEB	0.898	0.866	0.900	0.868	0.902	0.861	0.903	0.864	0.907	0.857	0.906	0.860
DEC	0.883	0.915	0.883	0.923	0.883	0.868	0.873	0.889	0.893	0.882	0.905	0.870
DED	0.903	0.848	0.897	0.852	0.902	0.843	0.895	0.848	0.904	0.838	0.904	0.839
DEE	0.876	0.981	0.870	0.968	0.863	0.959	0.863	0.969	0.871	0.978	0.888	0.938
DEF	0.869	0.918	0.878	0.908	0.886	0.889	0.883	0.883	0.909	0.877	0.905	0.886
DEG	0.902	0.880	0.892	0.894	0.889	0.873	0.901	0.855	0.915	0.842	0.905	0.849
EE0	0.880	0.860	0.879	0.865	0.901	0.839	0.912	0.831	0.931	0.821	0.933	0.817
IE0	0.933	0.879	0.937	0.885	0.946	0.856	0.973	0.796	1.000	0.778	0.997	0.778
EL3							0.922	1.047			0.919	0.983
EL4							0.826	1.032			0.862	1.029
EL5							0.881	1.004			0.905	0.949
EL6							0.843	1.080			0.884	0.988
ES1	0.908	0.898	0.916	0.877	0.916	0.867	0.927	0.857	0.934	0.845	0.944	0.833
ES2	0.935	0.859	0.942	0.844	0.948	0.836	0.957	0.819	0.969	0.813	0.979	0.810
ES3	0.943	0.867	0.929	0.853	0.927	0.847	0.941	0.838	0.956	0.833	0.976	0.818
ES4	0.900	0.942	0.904	0.920	0.904	0.915	0.911	0.905	0.916	0.889	0.924	0.874
ES5	0.892	0.939	0.893	0.916	0.893	0.905	0.902	0.895	0.917	0.881	0.931	0.872
ES6	0.892	0.992	0.896	0.960	0.898	0.948	0.901	0.941	0.908	0.926	0.915	0.911
ES7	0.881	0.960	0.879	0.938	0.888	0.909	0.891	0.896	0.897	0.908	0.904	0.901
FR1	1.001	0.780	1.027	0.777	1.031	0.774	1.049	0.766	1.051	0.768	1.097	0.755
FRB	0.955	0.803	0.960	0.799	0.961	0.797	0.962	0.800	0.975	0.789	0.977	0.798
FRC	0.953	0.811	0.943	0.829	0.958	0.803	0.956	0.810	0.957	0.811	0.964	0.804
FRD	0.942	0.826	0.956	0.804	0.956	0.798	0.952	0.812	0.959	0.808	0.967	0.806
FRE	0.955	0.824	0.949	0.837	0.953	0.826	0.952	0.823	0.961	0.816	0.966	0.806
FRF	0.943	0.814	0.954	0.808	0.959	0.798	0.956	0.802	0.968	0.797	0.979	0.781
FRG	0.975	0.784	0.978	0.781	0.981	0.782	0.997	0.769	0.990	0.772	0.999	0.764
FRH	0.996	0.780	0.980	0.786	0.993	0.772	0.982	0.776	1.004	0.763	1.004	0.760
FRI	0.960	0.798	0.966	0.792	0.968	0.790	0.975	0.786	0.977	0.785	0.984	0.781
FRJ	1.003	0.773	0.981	0.794	0.986	0.786	0.988	0.785	1.005	0.764	1.000	0.773
FRK	1.003	0.772	1.000	0.777	1.006	0.767	1.007	0.769	1.010	0.763	1.033	0.754
FRL	0.961	0.818	0.970	0.805	0.967	0.811	0.964	0.811	0.962	0.805	0.971	0.785
FRM	0.861	0.927	0.827	1.064	0.920	0.858						
FRY			0.910	0.939	0.912	0.940	0.908	0.945	0.911	0.933	0.919	0.903
HR0	0.886	1.047	0.892	1.002	0.894	0.987	0.893	0.967	0.898	0.939	0.904	0.916
ITC	0.851	0.911	0.851	0.902	0.862	0.883	0.864	0.877	0.867	0.878	0.877	0.864
ITF	0.887	1.003	0.887	0.989	0.889	0.966	0.880	0.947	0.874	0.949	0.884	0.943
ITG	0.868	1.083	0.865	1.074	0.868	1.022	0.846	0.997	0.844	1.005	0.858	0.995
ITH	0.864	0.900	0.866	0.884	0.881	0.869	0.877	0.865	0.886	0.854	0.890	0.849
ITI	0.855	0.905	0.857	0.891	0.866	0.879	0.864	0.878	0.868	0.872	0.874	0.864
CY0	0.925	0.976	0.947	0.899	0.945	0.887	0.954	0.862	0.975	0.841	0.991	0.840
LV0	0.876	0.892	0.871	0.883	0.884	0.868	0.894	0.856	0.892	0.853	0.899	0.843
LT0	0.920	0.932	0.941	0.906	0.949	0.880	0.954	0.863	0.960	0.846	0.964	0.834
LU0	0.979	0.806	0.983	0.815	0.988	0.807	0.989	0.804	0.990	0.798	1.018	0.794
HU1	0.890	0.877	0.897	0.856	0.885	0.863	0.902	0.853	0.913	0.841	0.922	0.834
HU2	0.824	0.976	0.849	0.912	0.853	0.908	0.846	0.916	0.838	0.939	0.844	0.930
HU3	0.814	1.001	0.836	0.960	0.848	0.949	0.851	0.937	0.853	0.930	0.861	0.917
MT0	0.876	0.908	0.887	0.903	0.878	0.893	0.879	0.870	0.890	0.863	0.884	0.859
AT1	0.933	0.822	0.930	0.816	0.938	0.809	0.939	0.805	0.940	0.804	0.941	0.805
AT2	0.926	0.886	0.925	0.883	0.926	0.869	0.941	0.850	0.938	0.851	0.926	0.854
AT3	0.908	0.857	0.912	0.853	0.921	0.841	0.922	0.833	0.917	0.836	0.921	0.831
PL2	0.905	0.924	0.900	0.905	0.914	0.865	0.918	0.861	0.934	0.841	0.923	0.843
PL4	0.874	0.939	0.874	0.916	0.880	0.900	0.882	0.900	0.893	0.872	0.897	0.865

Table B.6: BoD results against the metafrontiers of the robust model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
PL5	0.881	0.922	0.876	0.913	0.877	0.884	0.906	0.881	0.925	0.851	0.914	0.848
PL6	0.868	0.957	0.872	0.944	0.874	0.910	0.876	0.911	0.875	0.899	0.886	0.868
PL7									0.912	0.868	0.917	0.851
PL8									0.916	0.867	0.907	0.850
PL9									0.966	0.805	0.952	0.832
PT1	0.822	0.967	0.848	0.918	0.849	0.902	0.865	0.882	0.871	0.873	0.887	0.857
PT2	0.769	1.150	0.781	1.062	0.786	1.032	0.803	1.035	0.818	1.041	0.822	1.087
PT3	0.842	0.997	0.851	0.988	0.851	0.965						
RO1	0.805	1.197	0.800	1.086	0.805	1.063	0.802	1.064	0.784	1.134	0.789	1.112
RO2	0.729	1.225	0.737	1.320	0.733	1.307	0.729	1.297	0.732	1.292	0.745	1.282
RO3	0.780	1.059	0.789	1.040	0.795	1.027	0.806	1.032	0.807	1.032	0.817	0.990
RO4	0.793	1.219	0.806	1.074	0.805	1.085	0.790	1.117	0.807	1.168	0.828	1.095
SI0	0.931	0.856	0.930	0.852	0.933	0.844	0.944	0.826	0.940	0.819	0.943	0.813
SK0	0.862	0.990	0.862	0.987	0.861	0.972	0.852	0.961	0.863	0.936	0.867	0.933
FI1	0.969	0.830	0.971	0.827	0.995	0.802	1.012	0.797	1.027	0.787	1.038	0.774
SE1	1.099	0.744	1.089	0.750	1.115	0.745	1.117	0.743	1.120	0.740	1.205	0.722
SE2	1.058	0.751	1.045	0.757	1.056	0.750	1.080	0.749	1.099	0.746	1.176	0.731
SE3	0.974	0.789	1.012	0.766	0.998	0.776	1.023	0.765	1.026	0.767	1.070	0.756
IS0	1.015	0.821					1.012	0.815	1.006	0.846	1.002	0.823
NO0	0.983	0.795	0.994	0.786	0.994	0.790	0.990	0.789	0.988	0.786	0.998	0.786
CH0											1.121	0.943
UKC	0.920	0.837	0.952	0.827	0.951	0.835	0.944	0.829	0.949	0.817	0.946	0.838
UKD	0.924	0.832	0.957	0.822	0.961	0.809	0.960	0.811	0.958	0.812	0.965	0.814
UKE	0.915	0.849	0.954	0.824	0.954	0.821	0.956	0.831	0.963	0.828	0.959	0.822
UKF	0.917	0.829	0.965	0.806	0.950	0.836	0.956	0.817	0.966	0.806	0.959	0.816
UKG	0.914	0.862	0.948	0.835	0.944	0.844	0.947	0.839	0.961	0.828	0.969	0.812
UKH	0.911	0.836	0.947	0.816	0.955	0.826	0.954	0.834	0.959	0.824	0.967	0.825
UKI	1.066	0.771	1.102	0.757	1.106	0.760	1.110	0.758	1.111	0.762	1.126	0.761
UKJ	0.942	0.825	0.947	0.848	0.955	0.820	0.981	0.793	0.981	0.789	0.995	0.782
UKK	0.944	0.820	0.941	0.856	0.941	0.826	0.977	0.789	0.976	0.791	0.982	0.802
UKL	0.906	0.838	0.909	0.841	0.924	0.825	0.921	0.825	0.948	0.828	0.928	0.838
UKM	0.953	0.864	0.972	0.881	0.993	0.855	0.983	0.860	0.953	0.873	0.997	0.851
UKN	0.865	0.919	0.878	0.907	0.887	0.902	0.882	0.895	0.915	0.881		
MK0	0.788	1.690	0.799	1.640	0.821	1.407	0.828	1.478	0.846	1.383		
RS1											0.884	0.941
RS2											0.853	1.117
N	94	94	94	94	94	94	97	97	96	96	101	101
Min	0.729	0.744	0.737	0.748	0.733	0.745	0.729	0.743	0.732	0.740	0.745	0.722
25-perc	0.875	0.826	0.874	0.827	0.881	0.821	0.880	0.813	0.893	0.809	0.894	0.808
Average	0.907	0.905	0.912	0.896	0.916	0.879	0.920	0.879	0.928	0.866	0.936	0.865
Median	0.904	0.877	0.907	0.875	0.913	0.862	0.912	0.856	0.921	0.845	0.923	0.846
75-perc	0.943	0.943	0.950	0.921	0.954	0.906	0.956	0.906	0.966	0.882	0.974	0.899
Max	1.099	1.690	1.102	1.640	1.115	1.407	1.117	1.478	1.120	1.383	1.205	1.282
Std Dev	0.066	0.132	0.066	0.123	0.065	0.102	0.067	0.111	0.067	0.103	0.075	0.092

Table B.7: Performance evolution assessment of the robust model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE1	1.035	1.011	1.024	1.000	0.999	1.001	1.002	1.003	0.998	1.030	1.024	1.005	1.009	1.002	1.007	0.994	0.983	1.012
BE2	1.018	0.996	1.023	0.994	0.990	1.004	1.006	1.008	0.998	1.006	1.003	1.003	1.006	1.002	1.003	1.007	0.993	1.015
BE3	1.012	0.998	1.014	0.996	0.995	1.001	1.006	1.009	0.997	1.008	1.006	1.002	1.006	1.005	1.001	0.995	0.984	1.012
BG3	0.980	0.962	1.018	0.993	0.996	0.997	0.997	0.995	1.002	1.015	1.017	0.999	0.997	0.994	1.002	0.979	0.960	1.019
BG4	1.004	0.988	1.016	0.994	1.000	0.993	0.998	0.995	1.003	1.014	1.016	0.998	1.010	1.006	1.005	0.989	0.971	1.018
CZ0	0.996	0.979	1.018	0.993	0.998	0.995	1.003	1.000	1.003	1.005	1.009	0.995	1.001	0.996	1.004	0.994	0.975	1.020
DK0	0.934	0.911	1.026	0.997	0.997	1.000	0.956	0.959	0.997	0.994	0.982	1.013	0.972	0.978	0.994	1.014	0.992	1.022
DE1	1.012	0.987	1.025	1.004	1.003	1.001	1.000	1.000	0.999	1.003	0.997	1.006	0.999	1.001	0.998	1.007	0.986	1.021
DE2	1.012	0.988	1.024	1.003	1.005	0.999	0.992	0.990	1.002	1.007	1.004	1.002	1.003	1.000	1.002	1.008	0.989	1.019
DE3	1.038	1.008	1.030	1.004	1.006	0.998	1.007	1.001	1.007	1.016	1.007	1.009	0.998	1.004	0.994	1.012	0.991	1.021
DE4	0.994	0.978	1.016	0.998	0.998	1.001	1.001	1.004	0.997	0.986	0.983	1.004	1.007	1.008	0.999	1.002	0.986	1.016
DE5	1.061	1.020	1.040	1.037	1.040	0.997	0.988	0.969	1.020	1.013	1.005	1.008	0.991	0.998	0.993	1.032	1.009	1.022
DE6	1.008	0.980	1.029	1.002	0.999	1.003	1.001	1.003	0.998	1.007	0.995	1.012	1.007	1.015	0.992	0.991	0.969	1.023
DE7	1.027	0.998	1.029	1.008	1.016	0.992	1.004	0.993	1.012	1.006	0.998	1.009	1.001	1.010	0.992	1.008	0.983	1.026
DE8	1.013	0.992	1.021	1.000	1.000	1.000	1.008	1.010	0.998	0.995	0.992	1.003	0.997	0.998	0.999	1.013	0.992	1.021
DE9	1.026	0.997	1.029	1.003	1.007	0.996	1.002	0.995	1.007	1.022	1.012	1.011	0.996	1.005	0.991	1.002	0.978	1.024
DEA	1.023	0.995	1.028	1.004	1.005	0.999	1.001	0.999	1.002	1.007	0.996	1.011	1.018	1.027	0.991	0.993	0.968	1.026
DEB	1.008	0.981	1.028	1.002	0.998	1.004	1.002	1.003	0.999	1.002	0.995	1.007	1.004	1.007	0.997	0.999	0.978	1.021
DEC	1.025	0.996	1.029	0.999	1.002	0.997	1.001	0.997	1.004	0.989	0.984	1.005	1.022	1.025	0.998	1.013	0.988	1.025
DED	1.002	0.983	1.019	0.994	0.994	1.000	1.006	1.007	0.999	0.991	0.990	1.001	1.011	1.010	1.001	1.000	0.983	1.017
DEE	1.014	0.988	1.026	0.994	0.992	1.002	0.991	0.992	0.999	1.001	0.993	1.009	1.008	1.012	0.997	1.020	1.000	1.020
DEF	1.041	1.006	1.036	1.009	1.010	1.000	1.009	0.998	1.012	0.996	0.992	1.004	1.029	1.033	0.996	0.996	0.974	1.023
DEG	1.003	0.982	1.021	0.989	0.989	0.999	0.996	0.995	1.001	1.014	1.009	1.005	1.015	1.018	0.997	0.989	0.971	1.019
EE0	1.061	1.036	1.024	0.999	1.009	0.991	1.025	1.015	1.010	1.012	1.009	1.003	1.021	1.018	1.003	1.002	0.984	1.018
IE0	1.069	1.030	1.038	1.004	0.998	1.006	1.010	1.004	1.006	1.029	1.026	1.003	1.028	1.022	1.006	0.997	0.981	1.016
EL3																		
EL4																		
EL5																		
EL6																		
ES1	1.039	1.018	1.022	1.009	1.008	1.000	1.000	1.001	0.998	1.012	1.007	1.005	1.007	1.004	1.003	1.011	0.996	1.015
ES2	1.046	1.014	1.032	1.007	1.005	1.002	1.007	1.007	1.000	1.009	1.004	1.005	1.013	1.006	1.007	1.010	0.992	1.018
ES3	1.035	0.998	1.038	0.986	0.981	1.005	0.998	0.997	1.000	1.015	1.007	1.007	1.015	1.011	1.004	1.022	1.001	1.021
ES4	1.026	1.011	1.014	1.004	1.002	1.002	1.001	1.004	0.997	1.007	1.005	1.002	1.005	1.005	1.000	1.009	0.995	1.013
ES5	1.044	1.022	1.021	1.001	0.999	1.003	1.000	1.003	0.997	1.010	1.008	1.002	1.017	1.015	1.002	1.016	0.998	1.017
ES6	1.026	1.012	1.014	1.005	1.004	1.001	1.002	1.005	0.997	1.003	1.001	1.002	1.008	1.007	1.001	1.008	0.995	1.013
ES7	1.026	1.009	1.017	0.998	0.997	1.001	1.010	1.013	0.997	1.003	1.000	1.003	1.007	1.006	1.001	1.008	0.992	1.016
FR1	1.097	1.047	1.047	1.027	1.023	1.003	1.004	0.997	1.007	1.017	1.016	1.002	1.002	0.993	1.008	1.044	1.017	1.027
FRB	1.023	1.008	1.015	1.006	1.005	1.001	1.001	1.004	0.997	1.001	0.999	1.002	1.013	1.012	1.001	1.002	0.989	1.014
FRC	1.011	0.997	1.014	0.989	0.987	1.002	1.016	1.020	0.996	0.997	0.995	1.003	1.002	1.001	1.001	1.007	0.995	1.013
FRD	1.027	1.013	1.013	1.015	1.015	1.000	1.000	1.003	0.997	0.996	0.993	1.003	1.007	1.006	1.001	1.009	0.997	1.012
FRE	1.011	0.997	1.014	0.994	0.993	1.001	1.005	1.008	0.997	0.999	0.996	1.002	1.009	1.007	1.001	1.005	0.993	1.013
FRF	1.038	1.023	1.015	1.011	1.010	1.000	1.006	1.009	0.997	0.996	0.994	1.003	1.013	1.011	1.002	1.012	0.999	1.013
FRG	1.024	1.008	1.016	1.003	1.006	0.997	1.003	1.004	0.999	1.016	1.012	1.004	0.994	0.993	1.001	1.009	0.994	1.015
FRH	1.008	0.992	1.016	0.984	0.989	0.995	1.013	1.010	1.004	0.989	0.989	1.000	1.022	1.018	1.004	1.000	0.987	1.013
FRI	1.026	1.010	1.016	1.007	1.008	0.999	1.001	1.003	0.998	1.007	1.005	1.002	1.003	1.000	1.002	1.007	0.993	1.014
FRJ	0.996	0.977	1.020	0.978	0.975	1.002	1.005	1.006	0.999	1.002	0.999	1.003	1.018	1.016	1.002	0.994	0.980	1.014
FRK	1.030	1.003	1.027	0.996	0.999	0.998	1.006	1.005	1.001	1.001	0.995	1.006	1.003	1.002	1.001	1.023	1.003	1.021
FRL	1.010	0.996	1.014	1.009	1.008	1.000	0.997	1.001	0.997	0.997	0.993	1.003	0.998	0.997	1.001	1.009	0.996	1.013
FRM				0.960	0.960	1.000	1.113	1.120	0.993									
FRY							1.002	1.005	0.998	0.995	0.993	1.002	1.004	1.003	1.001	1.008	0.995	1.013
HR0	1.021	1.001	1.020	1.006	1.010	0.996	1.002	1.000	1.002	0.999	1.000	0.999	1.006	1.004	1.001	1.007	0.986	1.021
ITC	1.031	1.017	1.014	1.000	1.001	0.999	1.014	1.015	0.999	1.002	1.001	1.001	1.004	1.005	0.999	1.011	0.996	1.016
ITF	0.996	0.983	1.013	1.000	0.998	1.001	1.003	1.007	0.996	0.990	0.987	1.003	0.993	0.992	1.001	1.011	0.999	1.012
ITG	0.989	0.976	1.013	0.997	0.996	1.001	1.004	1.007	0.997	0.974	0.972	1.002	0.998	0.997	1.001	1.016	1.004	1.013
ITH	1.031	1.015	1.016	1.003	1.008	0.996	1.017	1.013	1.004	0.995	0.995	1.000	1.011	1.011	1.000	1.005	0.989	1.016
ITI	1.022	1.009	1.012	1.002	1.006	0.996	1.011	1.009	1.001	0.998	0.998	1.000	1.004	1.001	1.003	1.007	0.995	1.012
CY0	1.072	1.018	1.053	1.024	1.016	1.008	0.998	0.991	1.008	1.009	1.004	1.005	1.022	1.016	1.006	1.017	0.992	1.025
LV0	1.027	1.011	1.015	0.995	1.000	0.995	1.014	1.011	1.003	1.011	1.009	1.002	0.998	0.998	1.000	1.008	0.993	1.015
LT0	1.048	1.010	1.037	1.023	1.021	1.002	1.008	1.000	1.008	1.006	1.000	1.005	1.007	1.004	1.003	1.003	0.984	1.019
LU0	1.040	0.993	1.047	1.004	1.007	0.998	1.005	0.988	1.017	1.000	0.994	1.006	1.002	1.003	0.999	1.028	1.001	1.027
HU1	1.036	1.016	1.020	1.009	1.014	0.995	0.986	0.982	1.004	1.019	1.020	0.999	1.013	1.009	1.003	1.009	0.991	1.019
HU2	1.025	1.011	1.014	1.031	1.035	0.996	1.005	1.002	1.003	0.992	0.991	1.001	0.991	0.992	1.000	1.006	0.992	1.015
HU3	1.057	1.044	1.013	1.027	1.027	1.000	1.014	1.016	0.998	1.004	1.003	1.001	1.002	1.002	1.001	1.009	0.996	1.013
MT0	1.009	0.993	1.016	1.012	1.010	1.002	0.990	0.993	0.997	1.002	0.999	1.002	1.012	1.011	1.001	0.994	0.980	1.014
AT1	1.009	0.993	1.017	0.997	1.004	0.993	1.010	1.006	1.004	1.001	0.999	1.002	1.001	1.000	1.001	1.001	0.985	1.017
AT2	1.000	0.984	1.017	0.999	1.002	0.996	1.002	1.001	1.001	1.016	1.018	0.999	0.996	0.993	1.003	0.988	0.970	1.018
AT3	1.014	0.995	1.019	1.004	1.007	0.996	1.010	1.009	1.002	1.001	1.003	0.998	0.994	0.992	1.002	1.004	0.983	1.021
PL2	1.020	1.004	1.016	0.995	1.000	0.994	1.016	1.013	1.002	1.004	1.007	0.998	1.017	1.013	1.004	0.989	0.971	1.018
PL4	1.026	1.009	1.016	1.000	1.005	0.995	1.007	1.005	1.002	1.002	1.004	0.998	1.012	1.008	1.004	1.004	0.988	1.017
PL5	1.038	1.018	1.019	0.995	0.999	0.996	1.001	0.999	1.002	1.033	1.035	0.998	1.022	1.019	1.003	0.988	0.968	1.020
PL6	1.021	1.005	1.016	1.005	1.011	0.994	1.003	1.000	1.003	1.002	1.004	0.997	1.000	0.995	1.004	1.012	0.994	1.018
PL7																1.005	0.987	1.018
PL8																0.990	0.973	1.018
PL9																0.986	0.968	1.019
PT1	1.079	1.062	1.016	1.031	1.035	0.997	1.001	0.998	1.003	1.019	1.018	1.001	1.007	1.006	1.000	1.019	1.004	1.015
PT2	1.069	1.054	1.015	1.016	1.015	1.001	1.007	1.011	0.996	1.021	1.014	1.006	1.020	1.022	0.998	1.004	0.991	1.013
PT3				1.010	1.009	1.001	1.000	1.003	0.997									
RO1	0.980	0.958	1.023	0.994	0.991	1.003	1.007	1.010	0.997	0.997	0.995	1.002	0.977	0.978	0.999	1.006	0.984	1.023
RO2	1.022	1.001	1.021	1.011	1.008	1.002	0.994	0.998	0.997	0.994	0.992	1.002	1.005	1.004	1.001	1.017	0.998	1.019
RO3	1.047	1.027	1.020	1.011	1.016	0.996	1.009	1.007	1.002	1.013	1.015	0.998	1.001	0.996	1.005	1.012	0.994	1.019
RO4	1.044	1.024	1.020	1.016	1.019	0.997	0.999	0.996	1.003	0.981	0.984	0.997	1.021	1.020	1.002	1.026	1.005	1.021
SI0	1.013	0.995	1.018	0.999	1.004	0.995	1.004	1.001	1.002	1.012	1.014	0.998	0.996	0.992	1.004	1.003	0.984	1.018
SK0	1.005	0.987	1.018	1.000	1.006	0.994	0.999	0.995	1.003	0.989	0.990	0.998	1.013	1.010	1.002	1.005	0.985	1.021
FI1	1.071	1.031	1.039	1.002	1.006	0.996	1.024	1.015	1.009	1.017	1.007	1.010	1.015	1.023	0.992	1.011	0.980	1.032
SE1	1.096	1.036	1.059	0.991	1.010	0.981	1.024	1.010	1.014	1.002	0.992	1.010	1.003	1.011	0.992	1.075	1.012	1.063
SE2	1.112	1.051	1.058	0.988	1.007	0.982	1.010	0.998	1.012	1.022	1.017	1.005	1.018	1.019	0.999	1.070	1.009	1.061
SE3	1.098	1.062	1.034	1.038	1.047	0.992	0.986	0.986	1.001	1.025	1.013	1.012	1.003	1.008	0.995	1.042	1.008	1.034

Table B.7: Performance evolution assessment of the robust model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
IS0													0.994	1.001	0.993	0.996	0.974	1.022
NO0	1.015	0.983	1.033	1.011	1.019	0.992	1.000	0.983	1.018	0.996	0.990	1.006	0.997	1.000	0.998	1.010	0.992	1.019
CH0																		
UKC	1.029	1.010	1.018	1.035	1.030	1.005	0.999	1.004	0.995	0.992	0.988	1.004	1.006	1.006	1.000	0.997	0.983	1.015
UKD	1.044	1.023	1.021	1.035	1.030	1.005	1.005	1.008	0.996	0.999	0.994	1.004	0.998	0.998	1.000	1.007	0.993	1.015
UKE	1.048	1.026	1.021	1.043	1.039	1.003	1.000	1.002	0.998	1.002	0.997	1.005	1.007	1.008	1.000	0.996	0.981	1.015
UKF	1.046	1.017	1.029	1.052	1.040	1.012	0.984	0.986	0.999	1.007	1.003	1.003	1.011	1.010	1.001	0.993	0.979	1.014
UKG	1.060	1.032	1.027	1.038	1.031	1.007	0.996	0.998	0.997	1.003	0.997	1.006	1.015	1.017	0.997	1.008	0.989	1.019
UKH	1.062	1.026	1.035	1.039	1.038	1.001	1.008	0.998	1.010	0.999	0.994	1.005	1.006	1.006	0.999	1.009	0.990	1.018
UKI	1.056	0.996	1.060	1.034	1.023	1.011	1.004	1.000	1.004	1.003	0.992	1.011	1.002	0.994	1.008	1.013	0.988	1.026
UKJ	1.056	1.014	1.041	1.004	1.005	1.000	1.009	0.990	1.019	1.027	1.022	1.005	1.000	1.003	0.997	1.015	0.994	1.020
UKK	1.041	1.007	1.033	0.997	0.998	0.999	1.000	0.983	1.017	1.038	1.037	1.001	0.999	1.000	0.998	1.006	0.990	1.016
UKL	1.025	1.000	1.025	1.004	1.006	0.998	1.017	1.014	1.003	0.996	0.991	1.005	1.029	1.033	0.996	0.980	0.957	1.024
UKM	1.046	0.997	1.049	1.020	1.014	1.006	1.022	1.010	1.012	0.990	0.985	1.004	0.970	0.972	0.998	1.046	1.017	1.029
UKN				1.016	1.017	0.999	1.010	0.991	1.020	0.994	0.991	1.003	1.037	1.043	0.994			
MK0				1.014	1.018	0.996	1.027	1.024	1.002	1.009	1.012	0.997	1.021	1.016	1.005			
RS1																		
RS2																		
N	89	89	89	93	93	93	94	94	94	92	92	92	93	93	93	94	94	94
Min	0.934	0.911	1.012	0.960	0.960	0.981	0.956	0.959	0.993	0.974	0.972	0.995	0.970	0.972	0.991	0.979	0.957	1.012
25-perc	1.012	0.993	1.016	0.997	0.999	0.996	1.000	0.997	0.997	0.997	0.993	1.001	1.000	1.000	0.998	0.999	0.983	1.015
Average	1.030	1.005	1.024	1.006	1.007	0.999	1.005	1.003	1.002	1.005	1.002	1.003	1.006	1.006	1.000	1.008	0.989	1.019
Median	1.026	1.006	1.021	1.004	1.006	1.000	1.003	1.003	1.001	1.003	1.000	1.003	1.006	1.006	1.001	1.007	0.990	1.018
75-perc	1.045	1.017	1.029	1.011	1.014	1.002	1.009	1.008	1.004	1.012	1.008	1.005	1.013	1.012	1.003	1.012	0.995	1.021
Max	1.112	1.062	1.060	1.052	1.047	1.012	1.113	1.120	1.020	1.038	1.037	1.013	1.037	1.043	1.008	1.075	1.017	1.063
Std Dev	0.028	0.023	0.011	0.015	0.014	0.005	0.015	0.016	0.006	0.011	0.012	0.004	0.011	0.011	0.004	0.015	0.012	0.008

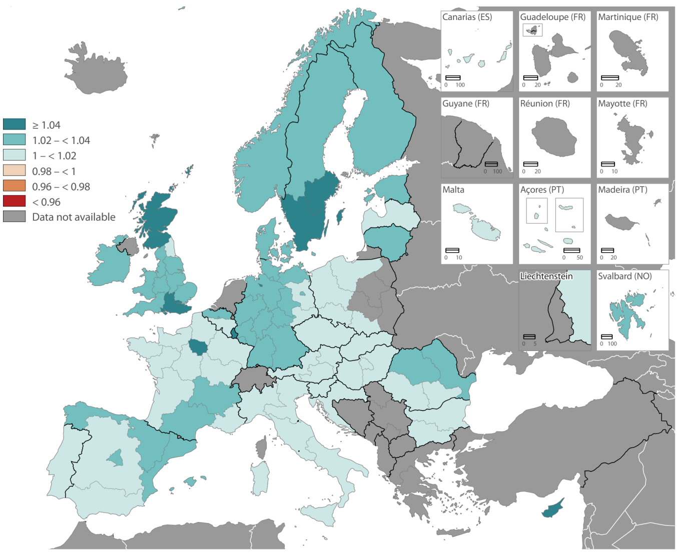

Figure B.1: 2014-2019 Robust BPC results for regions

Table B.8: Convergence results of the robust model for NUTS I regions

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.007	1.009	0.999	0.990
2015/2016	1.003	1.021	1.002	0.982
2016/2017	1.001	1.006	1.003	0.998
2017/2018	1.006	1.014	1.000	0.986
2018/2019	0.989	1.023	1.019	0.996
2014/2019	1.005	1.074	1.024	0.954

B.3 Conditional model

Table B.9: BoD results of the conditional model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
BE1	1.000	8	1.000	6	1.000	5	1.000	6	1.000	8	1.000	9
BE2	0.944	42	0.929	51	0.944	48	0.963	46	0.974	36	0.981	26
BE3	0.896	63	0.895	63	0.899	64	0.904	73	0.904	78	0.883	86
BG3	0.790	92	0.775	93	0.759	93	0.775	96	0.759	96	0.727	101
BG4	0.859	83	0.849	86	0.845	88	0.903	74	0.913	74	0.910	78
CZ0	0.900	61	0.903	60	0.932	52	0.961	48	0.957	52	0.952	56
DK0	1.011	2	1.012	2	1.004	3	0.996	20	0.999	21	0.995	21
DE1	0.954	37	0.940	47	0.954	43	0.955	52	0.943	58	0.943	61
DE2	0.958	32	0.946	43	0.960	40	0.961	49	0.957	51	0.952	57
DE3	0.920	52	0.929	52	0.915	61	0.914	71	0.917	71	0.922	71
DE4	0.871	78	0.873	80	0.886	75	0.875	86	0.888	81	0.897	82
DE5	0.882	68	0.924	55	0.895	68	0.920	68	0.914	73	0.915	73
DE6	0.933	44	0.935	49	0.942	49	0.946	54	0.955	54	0.932	67
DE7	0.914	54	0.920	56	0.928	56	0.941	57	0.932	64	0.926	69
DE8	0.879	72	0.876	78	0.881	78	0.883	83	0.886	82	0.897	81
DE9	0.891	65	0.894	64	0.899	65	0.919	70	0.923	69	0.910	76
DEA	0.878	74	0.886	69	0.897	66	0.906	72	0.926	67	0.907	79
DEB	0.915	53	0.911	57	0.924	58	0.921	67	0.926	66	0.914	75
DEC	0.880	69	0.885	72	0.891	70	0.886	81	0.913	75	0.910	77
DED	0.898	62	0.895	62	0.908	62	0.922	66	0.942	59	0.936	64
DEE	0.878	73	0.873	81	0.861	85	0.853	91	0.865	86	0.891	83
DEF	0.883	67	0.892	66	0.905	63	0.928	64	0.932	65	0.916	72
DEG	0.903	59	0.890	68	0.891	71	0.920	69	0.941	62	0.925	70
EE0	0.873	77	0.884	74	0.894	69	0.902	76	0.917	72	0.951	58
IE0	0.957	34	0.938	48	0.931	53	0.957	51	0.990	23	0.980	27
EL3							1.000	6			1.000	9
EL4							0.997	18			0.971	42
EL5							0.995	21			1.000	9
EL6							0.947	53			0.977	32
ES1	0.988	22	0.989	20	0.986	21	0.993	23	0.985	26	0.990	23
ES2	1.000	13	0.999	13	0.999	17	0.997	19	0.971	39	0.968	44
ES3	1.000	8	1.000	11	1.000	12	1.000	13	1.000	17	0.997	19
ES4	1.000	14	1.000	12	0.999	15	1.000	6	1.000	16	1.000	18
ES5	0.964	28	0.970	29	0.967	37	0.971	38	0.967	43	0.976	35
ES6	1.000	8	1.000	6	1.000	5	1.000	6	1.000	8	1.000	9
ES7	1.000	8	1.000	6	1.000	5	1.000	6	1.000	8	1.000	9
FR1	1.000	7	1.001	5	1.001	4	1.000	5	1.000	7	1.000	8
FRB	0.956	36	0.976	27	0.970	31	0.964	44	0.976	33	0.961	52
FRC	0.959	30	0.947	42	0.962	39	0.961	47	0.959	50	0.949	60
FRD	0.947	41	0.964	36	0.970	33	0.966	43	0.960	49	0.966	45
FRE	0.971	24	0.968	31	0.977	25	0.979	30	0.966	45	0.982	24
FRF	0.950	39	0.966	34	0.979	23	0.969	40	0.970	41	0.961	51
FRG	0.971	25	0.984	22	0.983	22	0.990	25	0.989	24	0.976	34
FRH	0.990	20	0.979	25	0.988	20	0.976	34	0.996	22	0.978	31
FRI	0.961	29	0.974	28	0.974	27	0.988	27	0.978	31	0.973	39
FRJ	1.002	5	0.988	21	0.992	18	0.997	17	1.001	6	0.980	28
FRK	0.996	18	0.999	14	1.000	14	0.995	22	1.000	15	0.990	22
FRL	0.964	27	0.979	26	0.978	24	0.984	28	0.965	46	0.963	50
FRM	0.860	82	0.838	88	0.925	57						
FRY			0.997	16	1.000	5	1.000	14	1.000	8	1.000	9
HR0	0.996	19	0.994	19	0.952	46	0.934	63	0.911	76	0.875	88
ITC	0.848	86	0.850	85	0.861	86	0.857	88	0.864	87	0.856	96
ITF	0.957	33	0.959	38	0.972	30	0.978	31	0.961	48	0.975	38
ITG	0.941	43	0.943	45	0.953	44	0.935	61	0.942	60	0.959	53
ITH	0.856	85	0.864	83	0.874	81	0.867	87	0.879	84	0.866	91
ITI	0.865	81	0.871	82	0.884	77	0.892	80	0.889	80	0.862	93
CY0	0.999	16	0.998	15	0.990	19	0.972	36	0.941	61	0.915	74
LV0	0.889	66	0.884	75	0.895	67	0.899	79	0.881	83	0.870	89
LT0	0.959	31	0.983	23	0.968	35	0.967	42	0.976	34	0.950	59
LU0	1.000	15	1.000	6	1.000	5	1.000	6	1.000	8	1.000	9
HU1	0.892	64	0.911	58	0.924	59	0.960	50	0.967	44	0.978	30
HU2	0.825	87	0.857	84	0.887	74	0.880	84	0.874	85	0.880	87
HU3	0.823	88	0.844	87	0.851	87	0.853	90	0.859	88	0.869	90
MT0	0.875	75	0.885	70	0.889	72	0.901	77	0.901	79	0.889	84
AT1	0.923	50	0.925	54	0.936	51	0.927	65	0.925	68	0.907	80
AT2	0.930	46	0.928	53	0.929	54	0.968	41	0.979	29	0.972	41

Table B.9: BoD results of the conditional model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
AT3	0.950	40	0.940	46	0.959	41	0.976	35	0.968	42	0.966	47
PL2	0.904	57	0.903	61	0.923	60	0.969	39	0.986	25	0.982	25
PL4	0.871	79	0.877	77	0.888	73	0.936	60	0.945	56	0.953	55
PL5	0.879	70	0.879	76	0.885	76	0.937	59	0.978	32	0.964	49
PL6	0.869	80	0.874	79	0.871	82	0.883	82	0.919	70	0.936	65
PL7									0.938	63	0.965	48
PL8									0.910	77	0.932	68
PL9									1.005	3	0.995	20
PT1	0.859	84	0.885	73	0.871	83	0.878	85	0.859	89	0.860	95
PT2	0.819	89	0.818	89	0.827	89	0.829	92	0.840	91	0.811	99
PT3	0.879	71	0.885	71	0.876	80						
RO1	0.806	90	0.803	91	0.818	90	0.823	93	0.824	93	0.821	98
RO2	0.730	94	0.740	94	0.743	94	0.748	97	0.770	95	0.787	100
RO3	0.777	93	0.791	92	0.793	92	0.808	94	0.836	92	0.861	94
RO4	0.795	91	0.807	90	0.802	91	0.786	95	0.817	94	0.862	92
SI0	0.931	45	0.933	50	0.929	55	0.935	62	0.943	57	0.975	37
SK0	0.904	58	0.893	65	0.870	84	0.854	89	0.853	90	0.850	97
FI1	0.952	38	0.968	30	0.973	29	0.988	26	0.974	35	0.956	54
SE1	1.019	1	1.017	1	1.013	2	1.003	4	1.002	5	1.002	4
SE2	0.997	17	0.997	17	0.999	16	0.993	24	0.999	20	1.000	6
SE3	0.957	35	0.983	24	0.970	32	0.982	29	0.981	27	0.977	33
IS0	1.008	3					1.008	3	1.017	1	1.024	1
NO0	1.000	6	1.009	4	1.000	13	1.016	2	1.010	2	1.004	3
CH0											1.000	17
UKC	0.923	49	0.953	40	0.952	45	0.946	55	0.955	53	0.933	66
UKD	0.920	51	0.955	39	0.968	36	0.977	32	0.972	37	0.976	36
UKE	0.909	56	0.951	41	0.956	42	0.963	45	0.970	40	0.966	46
UKF	0.926	48	0.968	32	0.963	38	0.976	33	0.978	30	0.972	40
UKG	0.911	55	0.945	44	0.947	47	0.944	56	0.964	47	0.968	43
UKH	0.927	47	0.962	37	0.975	26	0.971	37	0.980	28	0.980	29
UKI	1.000	8	1.000	6	1.000	5	1.000	6	1.000	8	1.000	9
UKJ	0.970	26	0.966	33	0.974	28	0.999	15	0.999	19	1.002	5
UKK	0.973	23	0.965	35	0.969	34	0.998	16	0.999	18	1.000	7
UKL	0.901	60	0.909	59	0.938	50	0.940	58	0.971	38	0.940	62
UKM	1.005	4	1.011	3	1.014	1	1.019	1	1.004	4	1.016	2
UKN	0.874	76	0.891	67	0.877	79	0.903	75	0.947	55		
MK0	0.989	21	0.995	18	1.000	5	0.900	78	1.000	8		
RS1											0.884	85
RS2											0.938	63
N	94		94		94		97		96		101	
Min	0.730		0.740		0.743		0.748		0.759		0.727	
25-perc	0.879		0.885		0.890		0.903		0.914		0.910	
Average	0.924		0.929		0.933		0.942		0.945		0.944	
Median	0.926		0.939		0.946		0.961		0.961		0.961	
75-perc	0.972		0.983		0.978		0.991		0.989		0.981	
Max	1.019		1.017		1.014		1.019		1.017		1.024	
Std Dev	0.062		0.061		0.059		0.058		0.055		0.055	

Table B.10: BoD results against the metafrontiers of the conditional model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE1	0.996	1.000	0.978	1.000	0.991	1.000	1.000	0.979	1.000	0.989	1.000	0.998
BE2	0.929	0.992	0.917	1.004	0.929	0.988	0.940	0.962	0.959	0.964	0.971	0.946
BE3	0.996	0.998	0.979	1.000	0.986	0.990	0.992	0.978	0.992	0.967	0.944	0.993
BG3	0.916	1.000	0.899	1.001	0.876	1.000	0.859	1.000	0.850	0.999	0.844	0.994
BG4	0.939	0.936	0.927	0.932	0.917	0.937	0.921	0.937	0.929	0.922	0.919	0.919
CZ0	0.914	1.000	0.911	0.999	0.944	0.993	0.984	0.988	0.979	0.992	0.978	1.000
DK0	1.002	0.868	1.002	0.874	1.000	0.869	1.002	0.864	0.991	0.900	1.000	0.883
DE1	0.995	0.989	0.971	0.976	0.991	0.991	0.994	0.999	0.991	1.000	0.995	1.000
DE2	0.954	0.995	0.960	0.991	0.998	1.000	0.997	0.998	0.996	1.000	0.999	1.000
DE3	0.926	1.000	0.996	1.000	0.996	0.977	1.000	0.965	0.997	0.999	1.000	0.994
DE4	0.878	1.001	0.878	1.000	0.922	0.986	0.907	1.003	0.922	1.002	0.928	1.000
DE5	0.938	1.000	0.937	1.000	0.970	1.000	0.973	1.000	0.959	1.000	0.991	1.000
DE6	0.997	0.989	0.975	0.998	1.000	0.990	1.000	0.981	1.000	0.950	0.999	0.969
DE7	0.962	0.998	0.963	0.985	0.981	0.994	0.979	0.992	0.979	0.998	0.988	0.991
DE8	0.883	0.999	0.880	0.994	0.896	0.991	0.924	0.984	0.929	0.986	0.938	0.981
DE9	0.875	1.014	0.880	1.003	0.888	0.998	0.904	0.996	0.902	1.000	0.907	1.000
DEA	0.897	1.000	0.915	0.997	0.991	1.000	0.985	1.000	0.995	1.000	0.985	1.000
DEB	0.912	0.981	0.908	0.995	0.907	0.986	0.922	0.981	0.926	0.980	0.932	0.987
DEC	0.885	1.002	0.879	1.005	0.870	1.004	0.874	1.000	0.903	1.000	0.910	0.999
DED	0.911	0.963	0.904	0.972	0.964	0.961	0.960	0.976	0.972	0.962	0.973	0.961
DEE	0.882	0.999	0.876	1.001	0.874	1.001	0.891	1.001	0.932	1.004	0.922	1.001
DEF	0.893	1.000	0.877	0.996	0.886	1.002	0.894	1.001	0.921	0.994	0.918	1.000
DEG	0.911	0.958	0.897	0.973	0.931	0.972	0.961	0.960	0.970	0.957	0.960	0.962
EE0	0.952	0.994	0.952	1.000	0.975	0.973	0.987	0.962	1.000	0.949	1.000	0.947
IE0	0.970	1.000	0.946	1.000	0.956	0.993	0.968	0.965	0.984	0.921	0.987	0.909
EL3							1.000	1.000			1.000	1.000
EL4							0.922	1.000			0.900	1.000
EL5							1.000	1.000			1.000	1.000
EL6							0.968	1.000			1.000	0.982
ES1	0.992	0.927	1.000	0.924	0.990	0.925	0.988	0.955	0.990	0.992	1.000	0.990
ES2	0.998	0.998	0.994	0.911	0.989	0.871	0.991	0.877	0.978	0.938	0.966	0.946
ES3	1.000	0.993	0.998	0.999	0.992	0.999	0.998	0.978	1.000	0.989	1.000	0.990
ES4	1.000	1.000	1.000	0.995	0.993	1.000	0.993	0.989	0.992	0.982	0.999	0.976
ES5	1.000	1.000	1.000	1.000	0.991	1.000	0.985	0.991	0.944	0.986	0.966	0.996
ES6	0.995	1.000	1.000	0.995	0.997	1.000	0.992	0.997	0.993	0.993	1.000	0.992
ES7	1.000	1.000	0.997	1.000	1.000	1.000	1.000	0.998	0.999	1.000	1.000	0.999
FR1	0.984	0.943	0.998	0.937	0.996	0.923	0.991	0.927	0.989	0.919	1.000	0.900
FRB	0.963	0.992	0.984	0.984	0.988	0.968	0.981	0.969	0.996	0.937	0.986	0.962
FRC	0.980	0.979	0.963	1.002	0.982	0.966	0.975	0.984	0.973	0.987	0.983	0.951
FRD	0.954	0.947	0.976	0.965	0.979	0.949	0.974	0.996	0.979	0.965	0.976	0.929
FRE	0.995	0.985	0.986	1.000	0.988	0.994	0.986	0.990	0.990	0.975	0.991	0.969
FRF	0.947	0.996	0.956	0.869	0.985	0.875	0.954	0.908	0.961	0.933	0.967	0.940
FRG	0.978	0.884	0.981	0.881	0.984	0.887	0.996	0.874	1.000	0.879	1.001	0.870
FRH	1.000	0.907	0.984	0.892	1.000	0.869	0.985	0.881	1.001	0.867	1.001	0.866
FRI	0.985	0.968	0.987	0.980	0.990	0.972	0.995	0.969	1.001	0.948	1.000	0.949
FRJ	1.000	0.941	0.982	0.976	0.984	0.947	0.981	0.948	0.999	0.923	0.985	0.921
FRK	0.996	0.950	0.993	0.951	0.998	0.930	0.993	0.922	0.998	0.918	1.003	0.888
FRL	0.962	0.992	0.989	0.854	0.977	0.859	0.975	0.894	0.966	0.919	0.963	0.938
FRM	0.857	1.000	0.848	1.000	0.987	1.001						
FRY			0.998	1.000	1.000	1.000	0.991	1.000	0.994	1.000	0.993	0.989
HR0	0.999	0.997	0.999	0.978	1.000	0.927	0.990	0.925	0.985	0.960	0.981	0.934
ITC	0.854	1.000	0.849	1.001	0.860	0.989	0.845	0.988	0.848	0.988	0.857	0.975
ITF	0.971	0.994	0.970	0.993	0.974	0.978	0.964	0.971	0.958	0.983	0.970	0.983
ITG	0.964	1.000	0.951	1.000	0.954	0.988	0.935	1.000	0.948	1.000	0.949	0.997
ITH	0.847	1.000	0.845	0.993	0.850	0.981	0.853	0.977	0.862	0.970	0.864	0.969
ITI	0.985	0.999	0.972	1.000	0.980	0.993	0.961	0.997	0.956	0.997	0.966	0.979
CY0	0.980	1.000	1.000	0.979	0.995	0.999	0.987	1.000	1.000	0.999	1.000	1.000
LV0	0.957	1.000	0.949	1.000	0.965	0.989	0.972	0.976	0.965	0.995	0.918	0.993
LT0	0.988	0.871	0.990	0.869	0.993	0.852	0.997	0.846	1.000	0.861	1.000	0.868
LU0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.992
HU1	0.941	0.920	1.003	0.855	0.963	0.931	0.989	0.887	0.988	0.938	1.000	0.979
HU2	0.946	0.888	0.975	0.864	0.983	0.858	0.979	0.866	0.970	0.873	0.975	0.878
HU3	0.967	0.935	0.992	0.909	0.989	0.890	0.990	0.873	0.990	0.876	0.999	0.869
MT0	0.878	1.003	0.907	1.000	0.991	1.000	0.905	1.000	0.986	1.000	0.997	1.000
AT1	0.988	0.975	1.000	0.946	1.000	0.989	1.000	0.970	1.000	0.993	1.000	0.987
AT2	0.923	1.001	0.922	1.002	0.904	1.001	0.913	0.990	0.928	0.989	0.944	0.999
AT3	0.969	1.000	0.999	0.998	0.995	0.999	1.000	0.991	0.988	0.998	0.995	0.995
PL2	0.990	0.908	0.981	0.877	0.994	0.843	0.996	0.848	0.999	0.840	0.996	0.834
PL4	0.957	0.924	0.954	0.887	0.962	0.861	0.952	0.868	0.971	0.843	0.975	0.842
PL5	0.974	0.905	0.958	0.883	0.964	0.854	0.969	0.871	0.989	0.854	0.981	0.869
PL6	0.966	0.956	0.952	0.939	0.966	0.897	0.973	0.910	0.971	0.879	0.982	0.834
PL7									0.986	0.853	1.001	0.817
PL8									1.001	0.859	1.005	0.814
PL9									1.000	0.883	0.999	0.916
PT1	0.953	1.000	0.893	0.983	0.861	0.985	0.873	0.987	0.883	0.995	0.900	0.983

Table B.10: BoD results against the metafrontiers of the conditional model for NUTS I regions

Region	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
PT2	0.915	1.000	0.941	0.994	0.964	0.986	0.986	0.999	0.996	0.999	0.987	1.008
PT3	1.000	0.996	1.000	0.902	1.000	0.910						
RO1	0.938	0.992	0.931	0.929	0.934	0.921	0.931	0.916	0.917	0.938	0.936	0.929
RO2	0.853	1.021	0.856	1.025	0.850	1.008	0.845	1.001	0.814	1.008	0.863	1.010
RO3	0.855	1.005	0.874	0.990	0.900	0.966	0.904	0.968	0.945	0.952	0.943	0.943
RO4	0.912	0.991	0.936	0.948	0.933	0.946	0.922	0.935	0.925	0.943	0.946	0.925
SI0	0.947	0.997	0.947	0.993	0.946	0.994	0.963	0.981	0.985	0.976	1.001	0.963
SK0	0.991	0.943	0.982	0.944	0.967	0.972	0.961	0.977	0.955	0.948	0.959	0.940
FI1	0.967	1.000	0.972	0.998	0.985	0.958	0.993	0.950	0.995	0.932	1.001	0.912
SE1	1.000	0.837	0.997	0.844	1.000	0.843	0.998	0.851	0.984	0.847	1.004	0.827
SE2	1.000	0.886	0.996	0.885	1.000	0.875	1.000	0.857	0.998	0.838	1.000	0.832
SE3	0.978	0.985	0.988	0.928	0.966	0.917	0.983	0.886	0.977	0.900	1.000	0.858
IS0	1.000	0.943					1.001	0.934	1.000	0.975	0.993	0.941
NO0	0.998	0.899	0.987	0.885	0.990	0.886	0.995	0.890	0.997	0.899	1.000	0.900
CH0											1.000	1.000
UKC	0.932	0.962	0.960	0.951	0.989	0.945	0.979	0.953	0.990	0.921	0.980	0.948
UKD	0.925	0.973	0.948	0.968	0.951	0.935	0.955	0.939	0.957	0.940	0.963	0.951
UKE	0.910	0.987	0.947	0.961	0.944	0.949	0.947	0.968	0.956	0.963	0.953	0.957
UKF	0.914	0.952	0.971	0.916	0.961	0.939	0.962	0.942	0.969	0.908	0.969	0.926
UKG	0.905	0.996	0.952	0.928	0.940	0.945	0.938	0.943	0.940	0.962	0.950	0.939
UKH	0.909	0.939	0.942	0.932	0.958	0.956	0.962	0.948	0.974	0.944	0.976	0.959
UKI	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	1.000
UKJ	0.952	0.926	0.955	0.956	0.957	0.943	0.991	0.899	0.991	0.897	0.997	0.898
UKK	0.963	0.937	0.957	0.987	0.949	0.935	0.978	0.912	0.984	0.915	0.996	0.920
UKL	0.924	0.952	0.961	0.953	0.990	0.938	0.987	0.940	0.989	0.938	0.970	0.948
UKM	0.998	0.999	1.000	0.995	1.004	0.950	0.994	0.972	0.968	0.982	1.001	0.958
UKN	0.859	1.003	0.877	1.004	0.876	1.002	0.882	1.002	0.936	0.986		
MK0	1.000	1.000	0.972	1.000	1.000	0.973	0.980	1.000	1.000	0.979		
RS1											1.009	0.968
RS2											0.954	1.001
N	94	94	94	94	94	94	97	97	96	96	101	101
Min	0.847	0.837	0.845	0.844	0.850	0.843	0.845	0.846	0.814	0.838	0.844	0.814
25-perc	0.915	0.950	0.930	0.932	0.945	0.931	0.950	0.931	0.956	0.921	0.959	0.923
Average	0.951	0.973	0.955	0.964	0.963	0.957	0.964	0.957	0.969	0.952	0.973	0.951
Median	0.963	0.994	0.967	0.989	0.982	0.973	0.980	0.976	0.984	0.965	0.987	0.963
75-perc	0.995	1.000	0.992	1.000	0.993	0.998	0.993	0.997	0.996	0.995	1.000	0.995
Max	1.002	1.021	1.003	1.025	1.004	1.008	1.002	1.003	1.001	1.008	1.009	1.010
Std Dev	0.045	0.039	0.044	0.047	0.042	0.048	0.041	0.046	0.038	0.048	0.036	0.052

Table B.11: Performance evolution assessment of the conditional model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE1	1.004	1.000	1.004	0.981	1.000	0.981	1.014	1.000	1.014	1.009	1.000	1.009	1.000	1.000	1.000	1.000	1.000	1.000
BE2	1.045	1.039	1.005	0.987	0.985	1.002	1.013	1.016	0.997	1.012	1.019	0.993	1.020	1.012	1.008	1.013	1.007	1.006
BE3	0.948	0.985	0.962	0.983	0.998	0.984	1.007	1.005	1.002	1.007	1.005	1.002	1.000	1.000	1.000	0.951	0.977	0.974
BG3	0.922	0.920	1.002	0.982	0.981	1.000	0.974	0.980	0.994	0.981	1.021	0.961	0.990	0.979	1.011	0.993	0.957	1.037
BG4	0.978	1.059	0.924	0.987	0.989	0.998	0.988	0.995	0.994	1.005	1.069	0.940	1.009	1.011	0.997	0.989	0.996	0.993
CZ0	1.070	1.058	1.011	0.997	1.004	0.993	1.037	1.032	1.005	1.043	1.031	1.011	0.995	0.995	0.999	0.998	0.996	1.003
DK0	0.997	0.984	1.014	0.999	1.001	0.998	0.999	0.991	1.007	1.002	0.993	1.010	0.988	1.003	0.986	1.009	0.996	1.013
DE1	1.000	0.988	1.012	0.976	0.985	0.990	1.021	1.015	1.005	1.002	1.000	1.002	0.997	0.987	1.010	1.004	1.000	1.004
DE2	1.047	0.993	1.055	1.006	0.987	1.019	1.039	1.015	1.024	0.999	1.001	0.998	0.999	0.996	1.003	1.003	0.994	1.009
DE3	1.080	1.002	1.078	1.075	1.009	1.065	1.000	0.985	1.016	1.004	1.000	1.004	0.997	1.003	0.994	1.003	1.005	0.998
DE4	1.056	1.029	1.026	0.999	1.002	0.997	1.050	1.015	1.035	0.984	0.988	0.996	1.016	1.014	1.002	1.006	1.010	0.996
DE5	1.057	1.038	1.018	0.999	1.048	0.953	1.035	0.968	1.069	1.003	1.029	0.975	0.985	0.993	0.992	1.034	1.002	1.032
DE6	1.002	0.998	1.004	0.978	1.002	0.977	1.026	1.008	1.017	1.000	1.004	0.996	1.000	1.009	0.991	0.999	0.976	1.024
DE7	1.027	1.013	1.014	1.001	1.006	0.995	1.019	1.008	1.010	0.998	1.014	0.984	1.000	0.991	1.009	1.009	0.994	1.016
DE8	1.063	1.021	1.040	0.997	0.998	0.999	1.018	1.005	1.013	1.031	1.002	1.029	1.005	1.004	1.002	1.010	1.013	0.997
DE9	1.037	1.022	1.014	1.006	1.004	1.003	1.008	1.005	1.003	1.018	1.023	0.995	0.999	1.004	0.995	1.005	0.987	1.018
DEA	1.098	1.033	1.063	1.021	1.010	1.011	1.083	1.012	1.070	0.994	1.010	0.984	1.010	1.022	0.988	0.990	0.979	1.011
DEB	1.021	0.999	1.022	0.996	0.996	1.000	0.998	1.014	0.985	1.016	0.997	1.020	1.005	1.006	0.999	1.006	0.987	1.019
DEC	1.029	1.033	0.996	0.994	1.005	0.989	0.989	1.007	0.982	1.004	0.994	1.010	1.033	1.030	1.003	1.008	0.996	1.012
DED	1.068	1.042	1.025	0.993	0.997	0.996	1.066	1.014	1.052	0.996	1.015	0.981	1.012	1.023	0.990	1.001	0.994	1.007
DEE	1.045	1.015	1.030	0.993	0.994	0.999	0.997	0.986	1.011	1.020	0.990	1.030	1.046	1.014	1.031	0.989	1.030	0.960
DEF	1.028	1.038	0.991	0.982	1.011	0.971	1.011	1.014	0.997	1.008	1.025	0.984	1.030	1.004	1.026	0.997	0.983	1.015
DEG	1.054	1.024	1.029	0.985	0.985	0.999	1.038	1.001	1.038	1.032	1.033	0.999	1.010	1.022	0.988	0.989	0.983	1.006
EE0	1.050	1.090	0.964	1.000	1.014	0.987	1.024	1.011	1.013	1.012	1.009	1.003	1.013	1.017	0.996	1.000	1.037	0.964
IE0	1.017	1.025	0.992	0.975	0.981	0.995	1.010	0.993	1.017	1.012	1.028	0.985	1.017	1.035	0.983	1.003	0.990	1.013
EL3																		
EL4																		
EL5																		
EL6																		
ES1	1.008	1.002	1.006	1.008	1.001	1.007	0.990	0.998	0.992	0.998	1.007	0.992	1.002	0.992	1.010	1.010	1.005	1.005
ES2	0.967	0.968	0.999	0.996	0.999	0.996	0.996	0.999	0.996	1.002	0.998	1.004	0.987	0.975	1.012	0.987	0.997	0.991
ES3	1.000	0.997	1.003	0.998	1.000	0.998	0.994	1.000	0.994	1.007	1.000	1.007	1.002	1.000	1.002	1.000	0.997	1.003
ES4	0.999	1.000	1.000	1.000	1.000	1.000	0.993	1.000	0.994	1.000	1.001	1.000	0.999	1.000	0.999	1.007	1.000	1.008
ES5	0.966	1.012	0.954	1.000	1.006	0.994	0.991	0.998	0.993	0.994	1.003	0.991	0.958	0.996	0.962	1.023	1.009	1.014
ES6	1.005	1.000	1.005	1.005	1.000	1.005	0.997	1.000	0.997	0.995	1.000	0.995	1.002	1.000	1.002	1.007	1.000	1.007
ES7	1.000	1.000	1.000	0.997	1.000	0.997	1.003	1.000	1.003	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
FR1	1.016	1.000	1.016	1.014	1.001	1.013	0.998	1.000	0.998	0.995	0.999	0.996	0.999	1.000	0.999	1.011	1.000	1.011
FRB	1.024	1.005	1.018	1.022	1.021	1.001	1.004	0.994	1.010	0.993	0.994	0.999	1.015	1.013	1.002	0.990	0.984	1.006
FRC	1.003	0.990	1.013	0.982	0.988	0.994	1.020	1.017	1.003	0.993	0.999	0.994	0.998	0.997	1.001	1.011	0.990	1.021
FRD	1.023	1.021	1.002	1.023	1.018	1.005	1.003	1.006	0.997	0.994	0.996	0.998	1.005	0.994	1.011	0.997	1.006	0.991
FRE	0.996	1.011	0.986	0.991	0.996	0.995	1.002	1.010	0.992	0.998	1.003	0.995	1.004	0.986	1.019	1.001	1.017	0.985
FRF	1.021	1.012	1.009	1.009	1.017	0.993	1.030	1.014	1.016	0.969	0.989	0.980	1.006	1.001	1.005	1.007	0.991	1.016
FRG	1.023	1.005	1.017	1.003	1.014	0.989	1.003	1.000	1.004	1.012	1.007	1.005	1.004	0.999	1.004	1.001	0.986	1.015
FRH	1.001	0.988	1.013	0.984	0.989	0.995	1.016	1.009	1.007	0.985	0.987	0.998	1.016	1.021	0.995	1.000	0.982	1.019
FRI	1.016	1.012	1.003	1.002	1.013	0.989	1.003	1.000	1.003	1.005	1.015	0.990	1.006	0.989	1.017	1.000	0.995	1.005
FRJ	0.985	0.979	1.006	0.982	0.987	0.995	1.002	1.004	0.998	0.997	1.004	0.993	1.019	1.004	1.015	0.986	0.980	1.006
FRK	1.007	0.995	1.012	0.997	1.003	0.994	1.005	1.001	1.004	0.995	0.995	1.000	1.005	1.005	1.000	1.005	0.991	1.015
FRL	1.001	0.998	1.003	1.028	1.016	1.012	0.988	0.998	0.989	0.998	1.006	0.992	0.990	0.981	1.010	0.997	0.997	1.000
FRM				0.989	0.974	1.016	1.164	1.104	1.054									
FRY							1.002	1.003	0.999	0.991	1.000	0.991	1.003	1.000	1.003	1.000	1.000	1.000
HR0	0.982	0.879	1.117	1.000	0.998	1.002	1.001	0.958	1.045	0.990	0.982	1.009	0.994	0.975	1.020	0.996	0.961	1.037
ITC	1.004	1.009	0.994	0.994	1.002	0.992	1.013	1.012	1.000	0.983	0.996	0.987	1.003	1.008	0.995	1.011	0.990	1.021
ITF	1.000	1.019	0.981	0.999	1.003	0.996	1.004	1.013	0.991	0.990	1.006	0.984	0.994	0.983	1.011	1.013	1.014	0.999
ITG	0.984	1.019	0.966	0.986	1.002	0.984	1.003	1.011	0.993	0.980	0.982	0.999	1.014	1.007	1.007	1.001	1.018	0.983
ITH	1.020	1.012	1.008	0.998	1.010	0.988	1.005	1.011	0.994	1.003	0.992	1.011	1.011	1.013	0.998	1.001	0.985	1.016
ITI	0.980	0.995	0.985	0.987	1.007	0.980	1.008	1.014	0.993	0.981	1.009	0.972	0.995	0.996	0.999	1.010	0.970	1.042
CY0	1.020	0.915	1.115	1.020	0.999	1.022	0.995	0.992	1.004	0.992	0.982	1.010	1.013	0.969	1.046	1.000	0.972	1.029
LV0	0.960	0.979	0.981	0.992	0.994	0.998	1.017	1.013	1.004	1.007	1.004	1.003	0.993	0.980	1.013	0.951	0.988	0.963
LT0	1.012	0.991	1.022	1.002	1.026	0.977	1.003	0.984	1.019	1.004	0.999	1.004	1.003	1.009	0.995	1.000	0.973	1.027
LU0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
HU1	1.063	1.097	0.969	1.067	1.021	1.045	0.959	1.014	0.946	1.027	1.040	0.988	1.000	1.007	0.993	1.011	1.012	0.999
HU2	1.030	1.066	0.967	1.031	1.038	0.993	1.008	1.035	0.974	0.996	0.993	1.003	0.991	0.993	0.998	1.005	1.006	0.999
HU3	1.033	1.056	0.978	1.026	1.026	0.999	0.997	1.008	0.989	1.001	1.003	0.998	1.000	1.007	0.993	1.009	1.011	0.998
MT0	1.135	1.016	1.117	1.033	1.012	1.021	1.092	1.004	1.087	0.914	1.014	0.901	1.090	1.000	1.090	1.011	0.987	1.024
AT1	1.012	0.983	1.030	1.012	1.003	1.009	1.000	1.011	0.989	1.000	0.990	1.010	1.000	0.998	1.002	1.000	0.980	1.021
AT2	1.022	1.045	0.978	0.999	0.998	1.001	0.980	1.001	0.979	1.010	1.042	0.969	1.017	1.011	1.006	1.017	0.993	1.024
AT3	1.027	1.017	1.010	1.031	0.990	1.041	0.996	1.020	0.976	1.005	1.017	0.988	0.988	0.992	0.996	1.008	0.998	1.010
PL2	1.005	1.086	0.925	0.991	0.999	0.991	1.013	1.023	0.991	1.002	1.050	0.955	1.003	1.017	0.986	0.996	0.996	1.001
PL4	1.019	1.094	0.931	0.997	1.007	0.990	1.008	1.012	0.996	0.990	1.054	0.940	1.020	1.010	1.011	1.003	1.009	0.995
PL5	1.008	1.097	0.919	0.984	0.999	0.985	1.006	1.007	0.999	1.005	1.059	0.949	1.021	1.043	0.979	0.992	0.987	1.005
PL6	1.017	1.077	0.944	0.986	1.006	0.980	1.015	0.997	1.019	1.007	1.014	0.993	0.997	1.040	0.959	1.012	1.019	0.993
PL7																1.016	1.030	0.987
PL8																1.004	1.023	0.981
PL9																0.999	0.990	1.009
PT1	0.944	1.002	0.942	0.936	1.030	0.909	0.964	0.985	0.979	1.014	1.008	1.007	1.011	0.979	1.033	1.019	1.002	1.017
PT2	1.079	0.991	1.089	1.028	0.999	1.029	1.025	1.011	1.013	1.023	1.002	1.020	1.010	1.013	0.997	0.991	0.965	1.027
PT3				1.000	1.007	0.993	1.000	0.989	1.011									
RO1	0.998	1.019	0.980	0.992	0.996	0.996	1.003	1.019	0.985	0.997	1.006	0.991	0.986	1.002	0.984	1.020	0.996	1.024
RO2	1.012	1.079	0.938	1.004	1.014	0.990	0.993	1.004	0.989	0.993	1.006	0.987	0.964	1.030	0.936	1.059	1.022	1.037
RO3	1.102	1.109	0.994	1.022	1.018	1.004	1.030	1.003	1.027	1.005	1.019	0.986	1.045	1.035	1.010	0.998	1.030	0.968
RO4	1.037	1.084	0.956	1.026	1.016	1.011	0.997	0.994	1.003	0.989	0.980	1.009	1.003	1.040	0.965	1.022	1.054	0.969
SI0	1.057	1.048	1.009	1.000	1.002	0.998	0.999	0.995	1.003	1.018	1.007	1.011	1.023	1.009	1.014	1.016	1.034	0.983
SK0	0.968	0.940	1.029	0.991	0.988	1.002	0.985	0.974	1.011	0.994	0.982	1.012	0.994	0.998	0.996	1.004	0.996	1.008
FI1	1.036	1.005	1.031	1.005	1.017	0.989	1.014	1.005	1.009	1.008	1.016	0.992	1.001	0.986	1.016	1.007	0.982	1.025
SE1	1.004	0.984	1.021	0.997	0.998	0.999	1.003	0.997	1.007	0.998	0.990	1.008	0.986	0.999	0.987	1.020	1.000	1.020
SE2	1.000	1.003	0.997	0.996	0.999	0.996	1.004	1.002	1.002	1.000	0.994	1.006	0.998	1.006	0.992	1.002	1.001	1.001
SE3	1.022	1.021	1.001	1.010	1.027	0.983	0.978	0.987	0.991	1.018	1.013	1.005	0.994	0.999	0.995	1.023	0.995	1.028

Table B.11: Performance evolution assessment of the conditional model for NUTS I regions

Region	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
IS0													0.999	1.008	0.991	0.993	1.007	0.986
NO0	1.002	1.004	0.998	0.990	1.009	0.981	1.003	0.991	1.012	1.005	1.016	0.989	1.002	0.994	1.008	1.003	0.994	1.009
CH0																		
UKC	1.051	1.010	1.041	1.031	1.032	0.998	1.030	0.999	1.031	0.989	0.993	0.996	1.012	1.010	1.002	0.989	0.976	1.013
UKD	1.042	1.060	0.982	1.025	1.038	0.987	1.004	1.013	0.991	1.004	1.010	0.994	1.002	0.994	1.008	1.006	1.004	1.002
UKE	1.047	1.063	0.985	1.041	1.047	0.994	0.996	1.005	0.991	1.004	1.007	0.997	1.009	1.007	1.002	0.997	0.996	1.002
UKF	1.060	1.050	1.010	1.062	1.045	1.017	0.990	0.995	0.995	1.001	1.014	0.988	1.008	1.002	1.005	0.999	0.993	1.006
UKG	1.050	1.062	0.988	1.052	1.037	1.014	0.987	1.003	0.985	0.998	0.997	1.001	1.001	1.021	0.981	1.011	1.004	1.008
UKH	1.074	1.058	1.015	1.037	1.038	0.999	1.016	1.014	1.002	1.005	0.996	1.009	1.012	1.010	1.003	1.002	1.000	1.003
UKI	1.005	1.000	1.005	1.005	1.000	1.005	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
UKJ	1.047	1.033	1.014	1.003	0.995	1.008	1.003	1.008	0.995	1.036	1.026	1.009	0.999	1.000	0.999	1.006	1.003	1.003
UKK	1.035	1.028	1.006	0.994	0.992	1.001	0.992	1.004	0.988	1.031	1.030	1.000	1.006	1.001	1.005	1.013	1.001	1.012
UKL	1.050	1.043	1.006	1.040	1.009	1.031	1.030	1.032	0.998	0.997	1.002	0.995	1.002	1.033	0.970	0.981	0.967	1.014
UKM	1.003	1.011	0.992	1.002	1.006	0.996	1.004	1.003	1.001	0.990	1.004	0.986	0.974	0.986	0.988	1.034	1.012	1.022
UKN				1.020	1.019	1.001	1.000	0.985	1.015	1.006	1.029	0.978	1.062	1.049	1.012			
MK0				0.972	1.007	0.965	1.029	1.005	1.025	0.980	0.900	1.089	1.020	1.111	0.918			
RS1																		
RS2																		
N	89	89	89	93	93	93	94	94	94	92	92	92	93	93	93	94	94	94
Min	0.922	0.879	0.919	0.936	0.974	0.909	0.959	0.958	0.946	0.914	0.900	0.901	0.958	0.969	0.918	0.951	0.957	0.960
25-perc	1.000	0.999	0.985	0.991	0.998	0.990	0.997	0.998	0.993	0.994	0.996	0.988	0.998	0.996	0.993	0.999	0.987	0.999
Average	1.021	1.018	1.004	1.004	1.006	0.998	1.009	1.004	1.005	1.001	1.006	0.995	1.005	1.005	1.000	1.004	0.997	1.006
Median	1.019	1.012	1.005	0.999	1.002	0.997	1.003	1.004	1.002	1.001	1.004	0.997	1.002	1.002	1.000	1.003	0.996	1.007
75-perc	1.046	1.041	1.017	1.013	1.014	1.002	1.016	1.012	1.012	1.007	1.015	1.005	1.012	1.012	1.008	1.010	1.005	1.016
Max	1.135	1.109	1.117	1.075	1.048	1.065	1.164	1.104	1.087	1.043	1.069	1.089	1.090	1.111	1.090	1.059	1.054	1.042
Std Dev	0.035	0.039	0.037	0.021	0.015	0.018	0.026	0.016	0.021	0.016	0.020	0.021	0.017	0.019	0.020	0.014	0.017	0.016

Table B.12: Convergence results of the conditional model for NUTS I regions

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.006	1.001	0.998	0.997
2015/2016	1.004	1.011	1.005	0.995
2016/2017	1.006	0.998	0.995	0.997
2017/2018	1.005	0.997	1.000	1.003
2018/2019	0.997	1.015	1.006	0.992
2014/2019	1.017	1.021	1.004	0.984

B.4 Models Comparison

Table B.13: 2019 Robust and conditional peers and intensity variables for NUTS I regions

Code	Robust Peers	Conditional Peers
BE1	SE1(0.332), FR1(0.14), FRK(0.113), SE2(0.111)	BE1(1)
BE2	SE1(0.316), SE2(0.172), FRK(0.161)	UKJ(0.613), DK0(0.133), NO0(0.119)
BE3	SE1(0.336), SE2(0.223), FRK(0.141), FR1(0.1)	SE1(0.959)
BG3	SE1(0.314), SE2(0.225), FRK(0.147)	SE1(0.558), FRK(0.198), SE2(0.19)
BG4	SE1(0.318), SE2(0.237), FRK(0.119)	UKJ(0.524), BE2(0.209)
CZ0	SE1(0.348), SE2(0.224), FRK(0.121)	UKJ(0.603), BE2(0.208)
DK0	SE1(0.326), SE2(0.233), DK0(0.122)	DK0(0.602), SE1(0.296)
DE1	SE1(0.34), SE2(0.226), SE3(0.134)	UKJ(0.669), UKI(0.141), NO0(0.105)
DE2	SE2(0.33), SE1(0.218), SE3(0.114)	UKJ(0.81)
DE3	SE1(0.295), SE2(0.222), UKI(0.119)	UKI(0.398), SE1(0.367)
DE4	SE1(0.326), SE2(0.217), FR1(0.106)	UKJ(0.492), DK0(0.22), NO0(0.143)
DE5	SE2(0.31), SE1(0.242), SE3(0.16)	UKI(0.319), SE1(0.314), CH0(0.125), SE2(0.102)
DE6	SE2(0.336), SE1(0.212), SE3(0.143)	UKI(0.637), NO0(0.242)
DE7	SE2(0.326), SE1(0.224), SE3(0.153)	UKJ(0.461), UKI(0.361), NO0(0.101)
DE8	SE1(0.316), SE2(0.242), UKI(0.14)	DK0(0.542), UKJ(0.192), NO0(0.121)
DE9	SE2(0.308), SE1(0.232), SE3(0.168)	NO0(0.707), UKJ(0.154)
DEA	SE2(0.331), SE1(0.218), SE3(0.143), UKI(0.106)	UKJ(0.344), NO0(0.281), UKI(0.241)
DEB	SE1(0.308), SE2(0.248), SE3(0.136), UKI(0.103)	UKJ(0.605), NO0(0.302)
DEC	SE2(0.321), SE1(0.217), SE3(0.154)	NO0(0.759), UKI(0.109)
DED	SE1(0.334), SE2(0.222), SE3(0.119)	DK0(0.451), UKJ(0.244), NO0(0.142)
DEE	SE2(0.332), SE1(0.218), SE3(0.15)	NO0(0.366), DK0(0.291), IS0(0.139)
DEF	SE2(0.326), SE1(0.222), SE3(0.148)	NO0(0.482), UKJ(0.41)
DEG	SE1(0.321), SE2(0.234), SE3(0.114), UKI(0.105)	UKJ(0.371), DK0(0.34), NO0(0.165)
EE0	SE1(0.319), SE2(0.228)	UKI(0.273), DK0(0.261), NO0(0.169)
IE0	SE1(0.337), FR1(0.146), FRK(0.102)	IE0(0.344), SE1(0.29), UKI(0.275)
EL3	SE1(0.317), CH0(0.168), SE2(0.136), FRK(0.117)	EL3(1)
EL4	SE1(0.327), SE2(0.216), FRK(0.12), CH0(0.109)	ES1(0.863)
EL5	SE1(0.347), SE2(0.222), FRK(0.132)	EL5(1)
EL6	SE1(0.333), SE2(0.226), FRK(0.11)	EL5(0.881), EL3(0.113)
ES1	SE1(0.316), FRK(0.185), SE2(0.155), FR1(0.111)	ES3(0.406), ES1(0.32), FRE(0.242)
ES2	SE1(0.326), FR1(0.144), UKI(0.112)	FR1(0.534), ES2(0.374)
ES3	SE1(0.291), UKI(0.184)	ES3(0.908)
ES4	SE1(0.336), SE2(0.235), FRK(0.138)	ES4(0.984)
ES5	SE1(0.33), SE2(0.168), UKI(0.135)	ES3(0.915)
ES6	SE1(0.322), SE2(0.226), FRK(0.135), FR1(0.107)	ES6(1)
ES7	SE1(0.326), SE2(0.224), UKI(0.123)	ES7(1)
FR1	FR1(0.267), UKI(0.214), SE1(0.171)	FR1(0.999)
FRB	SE1(0.34), SE2(0.214), FRK(0.149)	SE2(0.438), SE1(0.35), FRK(0.108)
FRC	SE1(0.32), SE2(0.228), FRK(0.14), FR1(0.109)	SE1(0.543), SE2(0.38)
FRD	SE1(0.31), SE2(0.225), FRK(0.156)	FRJ(0.429), FR1(0.158), SE2(0.156)
FRE	SE1(0.324), SE2(0.23), FRK(0.149)	FRJ(0.45), FRI(0.297), FRL(0.113)
FRF	SE1(0.331), SE2(0.224), FRK(0.147)	SE1(0.543), SE2(0.384)
FRG	SE1(0.344), SE2(0.205), FRK(0.104)	SE1(0.597), SE2(0.33)
FRH	SE1(0.329), SE2(0.21), FRK(0.132)	SE1(0.701), SE2(0.222)
FRI	SE1(0.324), SE2(0.216), FRK(0.136)	SE2(0.374), SE1(0.158), FRK(0.143)
FRJ	SE1(0.323), SE2(0.215), FRK(0.146)	SE2(0.488), SE1(0.264), FRK(0.119)
FRK	SE1(0.318), FRK(0.198), SE2(0.159)	SE1(0.925)
FRL	SE1(0.329), SE2(0.22), FRK(0.148)	SE2(0.347), FR1(0.272), FRK(0.128), SE1(0.104)
FRY	SE1(0.31), SE2(0.225), FRK(0.148), FR1(0.107)	FRY(1)
HR0	SE1(0.329), SE2(0.221), FRK(0.133)	SE1(0.641), SE2(0.22), FRK(0.128)
ITC	SE1(0.319), SE2(0.218), FRK(0.129)	SE1(0.973)
ITH	SE1(0.321), SE2(0.226), FRK(0.105)	SE1(0.807)
ITI	SE1(0.326), SE2(0.224), FRK(0.128)	SE2(0.447), SE1(0.198), FR1(0.195)
ITF	SE1(0.314), SE2(0.229), FRK(0.15), FR1(0.102)	ES4(0.606), ITF(0.388)
ITG	SE1(0.32), SE2(0.205), FRK(0.16)	ES6(0.438), ITF(0.263), FRY(0.211)
CY0	FR1(0.267), UKI(0.202), SE1(0.184)	FR1(0.891)
LV0	SE1(0.317), SE2(0.231), FRK(0.142)	SE1(0.966)
LT0	SE1(0.293), FR1(0.136)	SE1(0.662), LT0(0.282)
LU0	SE1(0.273), UKI(0.129), FR1(0.124), LU0(0.112)	LU0(1)
HU1	SE1(0.337), SE2(0.222), FRK(0.143)	UKJ(0.592), BE2(0.185)
HU2	SE1(0.326), SE2(0.225), FR1(0.115), FRK(0.108)	UKJ(0.542), BE2(0.167), UKK(0.107)

Table B.13: 2019 Robust and conditional peers and intensity variables for NUTS I regions

Code	Robust Peers	Conditional Peers
HU3	SE1(0.344), SE2(0.228), FRK(0.145), FR1(0.105)	DK0(0.571)
MT0	SE1(0.34), SE2(0.209), FR1(0.113)	UKI(0.906)
AT1	SE1(0.325), SE2(0.246)	SE1(0.903)
AT2	SE1(0.312), SE2(0.245), FRK(0.124)	UKJ(0.462), DK0(0.201), IE0(0.138), NO0(0.111)
AT3	SE1(0.341), SE2(0.218), FRK(0.143)	UKJ(0.667), UKI(0.109)
PL2	SE1(0.328), SE2(0.22), FRK(0.134)	UKJ(0.526), BE2(0.178), NO0(0.1)
PL4	SE1(0.33), SE2(0.222), FRK(0.136)	UKJ(0.518), BE2(0.179), NO0(0.103)
PL5	SE1(0.327), SE2(0.199), FRK(0.146)	UKJ(0.427), NO0(0.136), DK0(0.131), BE2(0.116)
PL6	SE1(0.331), SE2(0.22), FRK(0.134)	UKJ(0.399), SI0(0.164), NO0(0.13), DK0(0.112), BE2(0.107)
PL7	SE1(0.323), SE2(0.218), FRK(0.14)	DK0(0.328), UKJ(0.227), SI0(0.208), NO0(0.129)
PL8	SE1(0.337), SE2(0.232), FRK(0.145)	DK0(0.485), FI1(0.119)
PL9	SE1(0.292), FR1(0.15)	PL9(0.334), UKM(0.323), UKJ(0.181)
PT1	SE1(0.335), SE2(0.221), FRK(0.144)	SE1(0.786), SE2(0.154)
PT2	SE1(0.316), SE2(0.212), FR1(0.122)	SE2(0.412), SE1(0.304), FRK(0.131)
RO1	SE2(0.315), SE1(0.235), SE3(0.118)	DK0(0.413), UKJ(0.152), NO0(0.117)
RO2	SE1(0.326), SE2(0.236), FRK(0.121)	DK0(0.275), UKJ(0.246), SI0(0.133), NO0(0.133)
RO3	SE1(0.34), SE2(0.212), FRK(0.101), FI1(0.101)	DK0(0.274), UKJ(0.25), NO0(0.14), SI0(0.125), UKM(0.1)
RO4	SE1(0.322), SE2(0.236), FRK(0.133)	DK0(0.533), SI0(0.14)
SI0	SE1(0.322), SE2(0.212), FRK(0.137)	DK0(0.647)
SK0	SE1(0.338), SE2(0.228), FRK(0.116)	SE1(0.474), FRK(0.234), SE2(0.156), FI1(0.12)
FI1	SE1(0.299), SE2(0.27), FI1(0.134)	SE1(0.522), SE2(0.447)
SE1	SE1(0.321), SE2(0.177), FI1(0.107)	SE1(0.978)
SE2	SE2(0.328), SE1(0.207), SE3(0.126)	SE2(0.977)
SE3	SE1(0.345), SE2(0.223), SE3(0.136), FI1(0.102)	SE1(0.944)
IS0	SE2(0.325), SE1(0.22), IS0(0.104)	IS0(0.798)
NO0	SE2(0.302), SE1(0.231)	NO0(0.835)
CH0	SE1(0.336), CH0(0.228), SE2(0.104)	CH0(0.986)
UKC	SE1(0.334), SE2(0.214), FRK(0.149)	SE1(0.608), FRK(0.176), SE2(0.118)
UKD	SE1(0.337), SE2(0.204), UKI(0.11), FR1(0.101)	DK0(0.597), UKJ(0.176)
UKE	SE1(0.355), SE2(0.212), UKI(0.102)	DK0(0.682)
UKF	SE1(0.329), SE2(0.236), FR1(0.132)	DK0(0.522), UKJ(0.242)
UKG	SE1(0.338), SE2(0.221), UKI(0.139)	DK0(0.594)
UKH	SE1(0.352), SE2(0.218), UKI(0.142)	UKJ(0.797)
UKI	UKI(0.313), FR1(0.216), SE1(0.146)	UKI(1)
UKJ	SE1(0.336), SE2(0.191), UKI(0.13)	UKJ(0.858)
UKK	SE1(0.324), SE2(0.216), UKI(0.117)	UKJ(0.468), UKK(0.372), IS0(0.112)
UKL	SE1(0.328), SE2(0.23), SE3(0.104)	NO0(0.304), UKJ(0.27), DK0(0.216)
UKM	SE1(0.248), UKI(0.191), FR1(0.129), LU0(0.103)	UKM(0.806)
RS1	SE1(0.318), SE2(0.224), FRK(0.133)	SE2(0.264), FRK(0.154), FI1(0.148), FRH(0.122)
RS2	SE1(0.323), SE2(0.239), CH0(0.137), FRK(0.102)	FRE(0.822), ES1(0.12)

Appendix C

Countries results

C.1 Deterministic model

Table C.1: BoD results of the deterministic model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
Belgium	0.922	15	0.906	14	0.922	14	0.932	14	0.936	13	0.921	14
Bulgaria	0.807	29	0.805	28	0.805	29	0.814	30	0.814	30	0.785	31
Czechia	0.902	16	0.897	16	0.899	18	0.903	19	0.898	20	0.873	25
Denmark	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	0.980	6
Germany	0.884	20	0.886	19	0.893	20	0.892	22	0.905	19	0.881	20
Estonia	0.878	21	0.883	20	0.900	17	0.908	17	0.922	17	0.904	17
Ireland	0.972	7	0.999	7	0.989	7	1.000	1	1.000	1	1.000	1
Greece	0.841	26	0.856	25	0.875	24	0.880	24			0.875	23
Spain	0.898	17	0.898	15	0.911	15	0.920	16	0.928	15	0.918	15
France	0.970	8	0.970	10	0.979	9	0.983	9	0.986	8	0.976	7
Croatia	0.888	19	0.894	18	0.896	19	0.893	20	0.894	22	0.881	21
Italy	0.863	25	0.859	24	0.876	23	0.872	25	0.872	24	0.869	26
Cyprus	0.970	9	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
Latvia	0.877	22	0.870	22	0.884	22	0.892	21	0.888	23	0.880	22
Lithuania	0.948	11	1.000	1	0.991	6	0.987	7	0.965	12	0.956	13
Luxembourg	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
Hungary	0.835	27	0.852	26	0.852	26	0.856	27	0.858	28	0.850	28
Malta	0.875	23	0.882	21	0.884	21	0.886	23	0.897	21	0.874	24
Netherlands	0.976	6	0.986	8	0.981	8	0.983	8	0.988	7	0.964	10
Austria	0.923	14	0.923	13	0.931	13	0.932	15	0.926	16	0.903	18
Poland	0.893	18	0.896	17	0.902	16	0.903	18	0.909	18	0.886	19
Portugal	0.816	28	0.842	27	0.845	27	0.862	26	0.861	25	0.867	27
Romania	0.759	31	0.756	30	0.768	30	0.765	31	0.773	31	0.768	32
Slovenia	0.932	13	0.931	12	0.934	12	0.943	13	0.936	14	0.917	16
Slovakia	0.864	24	0.865	23	0.863	25	0.852	28	0.859	26	0.844	30
Finland	0.949	10	0.954	11	0.970	11	0.973	11	0.984	9	0.963	11
Sweden	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
Iceland	1.000	1					0.995	6	1.000	1	0.964	8
Norway	1.000	1	1.000	1	0.993	5	0.978	10	0.979	10	0.964	9
Switzerland											1.000	1
United Kingdom	0.940	12	0.979	9	0.973	10	0.973	12	0.975	11	0.962	12
North Macedonia	0.789	30	0.800	29	0.822	28	0.828	29	0.840	29		
Serbia									0.859	27	0.848	29
N	31		30		30		31		31		32	
Min	0.759		0.756		0.768		0.765		0.773		0.768	
25-percentile	0.864		0.863		0.875		0.880		0.872		0.873	
Average	0.909		0.913		0.918		0.923		0.924		0.915	
Median	0.902		0.897		0.906		0.920		0.926		0.910	
75-percentile	0.970		0.989		0.983		0.983		0.986		0.964	
Max	1.000		1.000		1.000		1.000		1.000		1.000	
Standard deviation	0.068		0.069		0.065		0.064		0.063		0.063	

Table C.2: BoD results against the metafrontiers of the deterministic model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
Belgium	0.910	0.850	0.906	0.856	0.910	0.843	0.917	0.836	0.920	0.832	0.921	0.830
Bulgaria	0.785	1.000	0.783	0.982	0.783	0.949	0.793	0.934	0.796	0.929	0.785	0.941
Czechia	0.878	0.846	0.872	0.849	0.874	0.845	0.880	0.839	0.879	0.840	0.873	0.846
Denmark	0.997	0.756	1.000	0.756	0.987	0.761	0.984	0.770	0.984	0.792	0.980	0.781
Germany	0.881	0.860	0.883	0.863	0.879	0.861	0.877	0.859	0.877	0.860	0.881	0.858
Estonia	0.860	0.860	0.862	0.871	0.881	0.841	0.892	0.835	0.903	0.826	0.904	0.821
Ireland	0.923	0.838	0.927	0.840	0.937	0.828	0.971	0.798	1.000	0.784	0.995	0.784
Greece	0.818	0.947	0.833	0.914	0.851	0.894	0.857	0.877			0.875	0.856
Spain	0.895	0.951	0.898	0.932	0.899	0.923	0.905	0.911	0.914	0.901	0.918	0.891
France	0.959	0.804	0.965	0.805	0.967	0.801	0.967	0.801	0.970	0.797	0.976	0.789
Croatia	0.864	0.909	0.869	0.863	0.872	0.860	0.870	0.858	0.875	0.852	0.881	0.845
Italy	0.860	0.960	0.858	0.935	0.864	0.915	0.858	0.905	0.858	0.905	0.869	0.896
Cyprus	0.916	0.865	0.937	0.831	0.947	0.843	0.959	0.842	0.982	0.831	1.000	0.838
Latvia	0.853	0.863	0.856	0.869	0.870	0.860	0.877	0.848	0.873	0.848	0.880	0.844
Lithuania	0.910	0.866	0.934	0.843	0.941	0.827	0.946	0.827	0.953	0.816	0.956	0.809
Luxembourg	0.962	0.795	0.955	0.807	0.962	0.787	0.964	0.795	0.978	0.786	1.000	0.784
Hungary	0.813	0.905	0.834	0.888	0.842	0.896	0.842	0.895	0.843	0.895	0.850	0.888
Malta	0.872	0.926	0.882	0.919	0.873	0.909	0.872	0.883	0.883	0.876	0.874	0.870
Netherlands	0.935	0.803	0.940	0.796	0.945	0.794	0.961	0.785	0.958	0.790	0.964	0.787
Austria	0.898	0.823	0.897	0.822	0.905	0.815	0.908	0.812	0.906	0.813	0.903	0.816
Poland	0.869	0.856	0.871	0.851	0.877	0.842	0.880	0.841	0.890	0.830	0.886	0.833
Portugal	0.813	0.938	0.826	0.898	0.827	0.896	0.848	0.881	0.847	0.872	0.867	0.857
Romania	0.746	1.000	0.752	1.000	0.758	1.000	0.752	0.998	0.757	1.000	0.768	0.980
Slovenia	0.907	0.816	0.906	0.816	0.908	0.813	0.918	0.804	0.916	0.806	0.917	0.804
Slovakia	0.840	0.887	0.841	0.888	0.839	0.888	0.830	0.896	0.841	0.883	0.844	0.879
Finland	0.922	0.803	0.926	0.800	0.943	0.784	0.949	0.781	0.953	0.777	0.963	0.766
Sweden	0.973	0.755	0.972	0.756	0.974	0.756	0.983	0.754	0.983	0.751	1.000	0.735
Iceland	0.965	0.848					0.971	0.840	0.972	0.876	0.964	0.847
Norway	0.964	0.809	0.958	0.798	0.958	0.804	0.956	0.800	0.956	0.798	0.964	0.798
Switzerland											1.000	0.763
United Kingdom	0.890	0.832	0.960	0.820	0.957	0.826	0.957	0.822	0.959	0.820	0.962	0.819
North Macedonia	0.768	1.000	0.778	1.000	0.799	0.957	0.806	1.000	0.823	0.952		
Serbia									0.840	0.893	0.848	0.883
N	31	31	30	30	30	30	31	31	31	31	32	32
Min	0.746	0.755	0.752	0.756	0.758	0.756	0.752	0.754	0.757	0.751	0.768	0.735
25-percentile	0.853	0.816	0.852	0.814	0.861	0.811	0.858	0.801	0.858	0.798	0.873	0.791
Average	0.885	0.870	0.889	0.862	0.894	0.854	0.902	0.849	0.906	0.846	0.915	0.836
Median	0.890	0.860	0.890	0.853	0.890	0.843	0.905	0.840	0.906	0.832	0.910	0.835
75-percentile	0.923	0.926	0.938	0.902	0.946	0.896	0.959	0.883	0.959	0.883	0.964	0.867
Max	0.997	1.000	1.000	1.000	0.987	1.000	0.984	1.000	1.000	1.000	1.000	0.980
Standard deviation	0.062	0.068	0.061	0.064	0.059	0.059	0.061	0.060	0.062	0.056	0.063	0.053

Table C.3: Performance evolution assessment of the deterministic model for countries

Country	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.011	0.999	1.013	0.995	0.983	1.012	1.004	1.017	0.987	1.008	1.011	0.997	1.004	1.004	1.000	1.000	0.984	1.017
BG	1.000	0.973	1.028	0.996	0.997	0.999	1.000	1.000	1.000	1.014	1.012	1.002	1.004	0.999	1.005	0.986	0.965	1.022
CZ	0.995	0.968	1.028	0.993	0.994	0.999	1.002	1.002	1.000	1.006	1.005	1.002	0.999	0.995	1.005	0.993	0.972	1.022
DK	0.983	0.980	1.003	1.003	1.000	1.003	0.987	1.000	0.987	0.997	1.000	0.997	1.000	1.000	1.000	0.996	0.980	1.016
DE	1.001	0.997	1.003	1.003	1.002	1.001	0.995	1.008	0.987	0.998	0.999	1.000	1.000	1.015	0.985	1.005	0.974	1.032
EE	1.051	1.029	1.022	1.003	1.006	0.998	1.022	1.019	1.002	1.013	1.008	1.005	1.012	1.015	0.997	1.000	0.980	1.020
IE	1.077	1.029	1.047	1.003	1.028	0.976	1.011	0.991	1.021	1.036	1.011	1.025	1.030	1.000	1.030	0.995	1.000	0.995
EL				1.017	1.018	0.999	1.022	1.022	1.000	1.007	1.005	1.002						
ES	1.025	1.021	1.003	1.003	1.000	1.003	1.001	1.014	0.987	1.007	1.010	0.997	1.010	1.009	1.000	1.004	0.989	1.016
FR	1.018	1.007	1.011	1.007	1.001	1.006	1.002	1.010	0.993	1.000	1.003	0.997	1.003	1.003	1.000	1.006	0.990	1.016
HR	1.020	0.992	1.028	1.006	1.007	0.999	1.003	1.003	1.000	0.998	0.996	1.002	1.006	1.002	1.005	1.007	0.985	1.022
IT	1.010	1.006	1.003	0.998	0.995	1.003	1.007	1.020	0.987	0.992	0.995	0.997	1.001	1.000	1.000	1.012	0.996	1.016
CY	1.092	1.031	1.059	1.023	1.031	0.992	1.010	1.000	1.010	1.013	1.000	1.013	1.024	1.000	1.024	1.019	1.000	1.019
LV	1.031	1.003	1.028	1.003	0.992	1.011	1.017	1.016	1.001	1.008	1.010	0.998	0.995	0.995	1.000	1.008	0.990	1.017
LT	1.051	1.008	1.042	1.027	1.055	0.974	1.007	0.991	1.016	1.006	0.996	1.010	1.008	0.978	1.031	1.003	0.990	1.012
LU	1.040	1.000	1.040	0.993	1.000	0.993	1.008	1.000	1.008	1.001	1.000	1.001	1.015	1.000	1.015	1.022	1.000	1.022
HU	1.046	1.017	1.028	1.026	1.020	1.006	1.009	1.001	1.008	1.000	1.004	0.997	1.002	1.002	1.000	1.008	0.991	1.017
MT	1.002	0.999	1.003	1.012	1.008	1.003	0.989	1.002	0.987	0.999	1.002	0.997	1.012	1.012	1.000	0.990	0.974	1.016
NL	1.031	0.988	1.044	1.005	1.010	0.995	1.006	0.994	1.012	1.016	1.002	1.014	0.997	1.006	0.991	1.007	0.975	1.032
AT	1.005	0.978	1.028	1.000	1.000	0.999	1.009	1.008	1.000	1.003	1.001	1.002	0.998	0.994	1.005	0.996	0.975	1.022
PL	1.020	0.992	1.028	1.003	1.003	0.999	1.007	1.007	1.000	1.003	1.001	1.002	1.012	1.007	1.005	0.995	0.974	1.022
PT	1.066	1.062	1.003	1.016	1.033	0.983	1.002	1.003	0.999	1.024	1.020	1.005	0.999	0.999	1.000	1.023	1.006	1.017
RO	1.029	1.012	1.017	1.007	0.996	1.012	1.008	1.016	0.992	0.991	0.996	0.996	1.007	1.011	0.996	1.015	0.993	1.022
SI	1.011	0.984	1.028	0.998	0.999	0.999	1.003	1.003	1.000	1.011	1.009	1.002	0.997	0.993	1.005	1.002	0.980	1.022
SK	1.005	0.978	1.028	1.000	1.001	0.999	0.999	0.998	1.000	0.988	0.987	1.002	1.013	1.008	1.005	1.004	0.983	1.022
FI	1.044	1.014	1.029	1.004	1.004	0.999	1.019	1.017	1.002	1.006	1.004	1.002	1.004	1.011	0.993	1.011	0.978	1.033
SE	1.028	1.000	1.028	0.999	1.000	0.999	1.002	1.000	1.002	1.009	1.000	1.009	1.000	1.000	1.000	1.017	1.000	1.017
IS													1.001	1.005	0.996	0.992	0.964	1.029
NO	1.000	0.964	1.037	0.993	1.000	0.993	1.001	0.993	1.007	0.998	0.984	1.014	1.000	1.001	0.999	1.009	0.986	1.023
CH																		
UK	1.081	1.023	1.057	1.079	1.041	1.037	0.996	0.994	1.002	1.000	0.999	1.001	1.003	1.003	1.000	1.003	0.986	1.017
MK				1.013	1.014	0.999	1.027	1.027	1.000	1.009	1.007	1.002	1.020	1.016	1.005			
RS																1.009	0.987	1.022
N	28	28	28	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Min	0.983	0.964	1.003	0.993	0.983	0.974	0.987	0.991	0.987	0.988	0.984	0.996	0.995	0.978	0.985	0.986	0.964	0.995
25-perc	1.005	0.985	1.012	0.999	1.000	0.997	1.001	1.000	0.992	0.999	0.999	0.997	1.000	1.000	0.999	0.996	0.975	1.016
Average	1.028	1.002	1.026	1.008	1.008	1.000	1.006	1.006	1.000	1.005	1.003	1.003	1.006	1.003	1.003	1.004	0.985	1.020
Median	1.022	1.000	1.028	1.003	1.002	0.999	1.005	1.003	1.000	1.006	1.002	1.002	1.004	1.002	1.000	1.005	0.985	1.021
75-perc	1.045	1.017	1.035	1.012	1.015	1.003	1.009	1.016	1.003	1.010	1.008	1.005	1.012	1.009	1.005	1.009	0.992	1.022
Max	1.092	1.062	1.059	1.079	1.055	1.037	1.027	1.027	1.021	1.036	1.020	1.025	1.030	1.016	1.031	1.023	1.006	1.033
Std dev	0.028	0.022	0.016	0.016	0.016	0.011	0.009	0.010	0.009	0.010	0.007	0.007	0.008	0.008	0.010	0.009	0.011	0.007

Table C.4: Convergence results of the deterministic model for countries

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.008	1.002	1.000	0.998
2015/2016	1.006	1.015	1.000	0.985
2016/2017	1.003	1.009	1.003	0.994
2017/2018	1.003	1.019	1.003	0.985
2018/2019	0.985	1.032	1.020	0.988
2014/2019	1.002	1.075	1.026	0.954

C.2 Robust model

Table C.5: BoD results of the robust model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
Belgium	0.931	14	0.918	14	0.928	14	0.936	15	0.942	14	0.930	15
Bulgaria	0.814	29	0.810	28	0.811	29	0.823	30	0.824	30	0.799	31
Czechia	0.909	16	0.903	16	0.905	18	0.912	18	0.909	20	0.888	23
Denmark	1.052	1	1.056	1	1.028	2	1.016	2	1.009	4	0.998	6
Germany	0.896	19	0.897	19	0.901	20	0.898	22	0.913	19	0.896	21
Estonia	0.888	21	0.891	21	0.908	16	0.917	17	0.935	16	0.922	17
Ireland	0.983	7	1.001	7	0.996	7	1.009	4	1.017	2	1.008	5
Greece	0.847	26	0.862	25	0.880	24	0.888	24			0.886	24
Spain	0.908	17	0.910	15	0.916	15	0.922	16	0.931	17	0.927	16
France	0.979	9	0.982	10	0.986	9	0.986	11	0.990	9	0.985	8
Croatia	0.894	20	0.899	18	0.902	19	0.902	21	0.905	21	0.894	22
Italy	0.873	24	0.870	24	0.881	23	0.875	25	0.875	25	0.877	27
Cyprus	0.979	8	1.004	5	1.009	3	1.009	3	1.008	6	1.011	4
Latvia	0.885	22	0.881	22	0.892	21	0.902	20	0.903	22	0.897	20
Lithuania	0.958	11	1.003	6	0.997	6	0.993	8	0.973	12	0.965	13
Luxembourg	1.014	3	1.006	4	1.007	4	1.004	5	1.008	5	1.014	3
Hungary	0.843	27	0.861	26	0.860	26	0.861	27	0.866	28	0.861	28
Malta	0.884	23	0.895	20	0.890	22	0.890	23	0.901	23	0.885	25
Netherlands	0.985	6	0.991	8	0.985	10	0.987	9	0.994	8	0.979	11
Austria	0.930	15	0.930	13	0.937	13	0.942	14	0.938	15	0.920	18
Poland	0.899	18	0.902	17	0.908	17	0.912	19	0.922	18	0.902	19
Portugal	0.827	28	0.851	27	0.853	27	0.870	26	0.876	24	0.883	26
Romania	0.768	31	0.767	30	0.775	30	0.774	31	0.784	31	0.781	32
Slovenia	0.939	13	0.938	12	0.940	12	0.952	13	0.949	13	0.935	14
Slovakia	0.870	25	0.871	23	0.869	25	0.860	28	0.870	26	0.857	30
Finland	0.966	10	0.972	11	0.988	8	0.996	7	1.017	3	0.994	7
Sweden	1.032	2	1.041	2	1.044	1	1.055	1	1.075	1	1.079	1
Iceland	1.012	4					1.003	6	1.005	7	0.980	9
Norway	1.012	5	1.008	3	1.001	5	0.986	10	0.989	10	0.980	10
Switzerland											1.038	2
United Kingdom	0.950	12	0.987	9	0.980	11	0.977	12	0.981	11	0.973	12
North Macedonia	0.795	30	0.806	29	0.827	28	0.836	29	0.851	29		
Serbia									0.870	27	0.859	29
N	31		30		30		31		31		32	
Min	0.768		0.767		0.775		0.774		0.784		0.781	
25-percentile	0.873		0.871		0.881		0.888		0.876		0.885	
Average	0.920		0.924		0.927		0.932		0.936		0.931	
Median	0.909		0.906		0.912		0.922		0.935		0.924	
75-percentile	0.979		0.993		0.990		0.993		0.994		0.984	
Max	1.052		1.056		1.044		1.055		1.075		1.079	
Standard deviation	0.072		0.073		0.068		0.067		0.067		0.069	

Table C.6: BoD results against the metafrontiers of the robust model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
Belgium	0.925	0.881	0.920	0.889	0.925	0.874	0.934	0.867	0.940	0.861	0.940	0.859
Bulgaria	0.809	1.107	0.807	1.089	0.806	1.038	0.817	1.011	0.820	0.987	0.809	1.007
Czechia	0.903	0.918	0.898	0.906	0.900	0.888	0.906	0.878	0.905	0.880	0.899	0.889
Denmark	1.070	0.782	1.063	0.782	1.028	0.786	1.025	0.798	1.005	0.819	1.014	0.808
Germany	0.896	0.904	0.898	0.902	0.897	0.898	0.899	0.893	0.906	0.891	0.910	0.890
Estonia	0.883	0.892	0.882	0.901	0.905	0.871	0.914	0.864	0.930	0.855	0.932	0.850
Ireland	0.954	0.882	0.959	0.886	0.969	0.868	1.004	0.827	1.037	0.813	1.029	0.813
Greece	0.841	1.063	0.856	1.013	0.875	0.984	0.881	0.967			0.899	0.929
Spain	0.908	0.983	0.910	0.963	0.911	0.954	0.918	0.943	0.928	0.931	0.937	0.920
France	0.974	0.833	0.981	0.835	0.982	0.829	0.982	0.828	0.989	0.825	0.997	0.816
Croatia	0.888	1.018	0.893	0.978	0.896	0.956	0.894	0.961	0.900	0.921	0.906	0.905
Italy	0.872	1.016	0.870	0.995	0.877	0.970	0.870	0.952	0.871	0.946	0.881	0.939
Cyprus	0.946	0.948	0.968	0.897	0.982	0.894	0.996	0.879	1.020	0.865	1.045	0.869
Latvia	0.881	0.910	0.876	0.908	0.889	0.898	0.899	0.884	0.897	0.882	0.903	0.874
Lithuania	0.939	0.936	0.964	0.912	0.971	0.886	0.979	0.875	0.985	0.859	0.986	0.848
Luxembourg	1.000	0.827	0.989	0.839	0.999	0.823	0.999	0.827	1.016	0.818	1.051	0.817
Hungary	0.839	0.955	0.856	0.927	0.857	0.935	0.857	0.933	0.859	0.931	0.865	0.923
Malta	0.884	0.960	0.895	0.952	0.885	0.941	0.885	0.915	0.896	0.906	0.889	0.900
Netherlands	0.965	0.833	0.971	0.825	0.977	0.822	0.992	0.813	0.990	0.820	0.998	0.817
Austria	0.924	0.860	0.924	0.857	0.932	0.850	0.935	0.844	0.934	0.845	0.931	0.847
Poland	0.894	0.917	0.897	0.905	0.903	0.887	0.907	0.885	0.917	0.869	0.913	0.869
Portugal	0.826	0.992	0.848	0.942	0.849	0.933	0.867	0.917	0.872	0.904	0.889	0.890
Romania	0.766	1.162	0.766	1.143	0.772	1.149	0.771	1.148	0.780	1.197	0.792	1.102
Slovenia	0.934	0.863	0.932	0.861	0.935	0.855	0.946	0.842	0.944	0.840	0.945	0.836
Slovakia	0.864	0.980	0.864	0.966	0.863	0.958	0.853	0.951	0.865	0.933	0.869	0.930
Finland	0.957	0.842	0.962	0.838	0.984	0.818	0.996	0.815	1.005	0.808	1.016	0.796
Sweden	1.027	0.782	1.033	0.784	1.040	0.783	1.052	0.780	1.070	0.777	1.133	0.761
Iceland	1.007	0.876					1.009	0.868	1.002	0.907	0.998	0.875
Norway	0.998	0.836	0.994	0.825	0.994	0.832	0.989	0.828	0.988	0.825	0.997	0.825
Switzerland											1.096	0.882
United Kingdom	0.925	0.862	0.978	0.849	0.975	0.855	0.976	0.850	0.980	0.849	0.987	0.848
North Macedonia	0.788	1.438	0.799	1.406	0.821	1.221	0.828	1.298	0.845	1.210		
Serbia									0.864	0.986	0.871	0.964
N	31	31	30	30	30	30	31	31	31	31	32	32
Min	0.766	0.782	0.766	0.782	0.772	0.783	0.771	0.780	0.780	0.777	0.792	0.761
25-percentile	0.872	0.860	0.869	0.847	0.876	0.845	0.881	0.828	0.872	0.825	0.891	0.828
Average	0.913	0.937	0.915	0.926	0.920	0.908	0.928	0.901	0.934	0.896	0.948	0.878
Median	0.908	0.910	0.904	0.903	0.908	0.887	0.918	0.878	0.930	0.869	0.934	0.872
75-percentile	0.957	0.983	0.969	0.964	0.978	0.954	0.992	0.943	0.990	0.931	0.998	0.916
Max	1.070	1.438	1.063	1.406	1.040	1.221	1.052	1.298	1.070	1.210	1.133	1.102
Standard deviation	0.070	0.129	0.069	0.122	0.066	0.097	0.068	0.104	0.070	0.097	0.078	0.067

Table C.7: Performance evolution assessment of the robust model for countries

Country	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.017	0.999	1.017	0.994	0.986	1.008	1.006	1.011	0.994	1.010	1.008	1.002	1.007	1.007	1.000	1.000	0.987	1.013
BG	0.999	0.982	1.018	0.997	0.996	1.001	0.999	1.001	0.998	1.013	1.015	0.998	1.004	1.001	1.002	0.987	0.970	1.017
CZ	0.995	0.977	1.019	0.994	0.993	1.001	1.003	1.002	1.001	1.006	1.009	0.998	0.999	0.996	1.003	0.993	0.977	1.017
DK	0.948	0.949	0.999	0.994	1.004	0.990	0.966	0.973	0.993	0.998	0.988	1.010	0.981	0.993	0.987	1.009	0.989	1.019
DE	1.016	1.001	1.015	1.002	1.002	1.000	1.000	1.004	0.996	1.002	0.997	1.005	1.007	1.017	0.990	1.004	0.981	1.023
EE	1.055	1.038	1.016	0.999	1.004	0.995	1.025	1.019	1.006	1.011	1.009	1.002	1.017	1.020	0.997	1.002	0.986	1.016
IE	1.079	1.025	1.052	1.005	1.019	0.986	1.010	0.995	1.016	1.036	1.014	1.022	1.033	1.008	1.025	0.993	0.991	1.002
EL				1.018	1.017	1.000	1.022	1.021	1.001	1.007	1.009	0.999						
ES	1.032	1.021	1.011	1.003	1.002	1.001	1.001	1.007	0.994	1.007	1.006	1.001	1.011	1.009	1.001	1.009	0.996	1.014
FR	1.024	1.007	1.017	1.007	1.003	1.004	1.001	1.004	0.997	1.001	1.000	1.000	1.007	1.004	1.002	1.009	0.995	1.014
HR	1.020	1.000	1.020	1.005	1.006	1.000	1.003	1.002	1.001	0.998	1.000	0.998	1.007	1.003	1.003	1.006	0.988	1.019
IT	1.010	1.005	1.005	0.998	0.997	1.000	1.007	1.013	0.995	0.992	0.992	1.000	1.002	1.001	1.001	1.012	1.002	1.010
CY	1.104	1.032	1.069	1.022	1.025	0.998	1.015	1.005	1.010	1.014	1.001	1.013	1.024	0.998	1.026	1.024	1.004	1.021
LV	1.026	1.013	1.012	0.995	0.995	0.999	1.015	1.013	1.002	1.011	1.011	1.000	0.998	1.001	0.997	1.007	0.993	1.014
LT	1.050	1.007	1.042	1.027	1.047	0.981	1.006	0.994	1.013	1.009	0.996	1.013	1.006	0.980	1.026	1.002	0.992	1.010
LU	1.051	1.000	1.051	0.989	0.992	0.997	1.010	1.002	1.008	1.000	0.997	1.003	1.017	1.003	1.014	1.034	1.006	1.028
HU	1.032	1.022	1.010	1.021	1.021	1.000	1.000	0.999	1.001	1.000	1.001	0.999	1.003	1.006	0.997	1.007	0.995	1.013
MT	1.006	1.000	1.005	1.012	1.012	1.000	0.989	0.994	0.995	1.000	1.000	1.000	1.012	1.012	1.000	0.992	0.982	1.011
NL	1.034	0.993	1.041	1.006	1.005	1.001	1.005	0.994	1.011	1.016	1.003	1.013	0.997	1.007	0.990	1.009	0.984	1.025
AT	1.007	0.990	1.018	1.000	1.000	0.999	1.009	1.008	1.000	1.003	1.005	0.998	0.998	0.996	1.002	0.997	0.980	1.017
PL	1.021	1.003	1.018	1.003	1.003	1.000	1.006	1.007	1.000	1.004	1.004	1.000	1.011	1.010	1.000	0.997	0.979	1.018
PT	1.076	1.068	1.007	1.026	1.029	0.998	1.001	1.003	0.999	1.021	1.020	1.001	1.006	1.007	0.999	1.020	1.008	1.011
RO	1.034	1.017	1.017	1.000	0.998	1.002	1.007	1.011	0.996	0.999	0.998	1.001	1.011	1.014	0.998	1.015	0.996	1.019
SI	1.013	0.996	1.017	0.998	1.000	0.999	1.003	1.002	1.001	1.012	1.013	0.998	0.998	0.996	1.002	1.002	0.985	1.017
SK	1.006	0.984	1.022	1.000	1.001	0.999	0.999	0.997	1.002	0.988	0.990	0.998	1.014	1.011	1.002	1.005	0.985	1.020
FI	1.062	1.029	1.032	1.005	1.006	0.999	1.023	1.016	1.006	1.012	1.008	1.004	1.009	1.021	0.989	1.011	0.977	1.035
SE	1.103	1.046	1.055	1.005	1.009	0.996	1.007	1.003	1.004	1.012	1.011	1.001	1.017	1.019	0.998	1.059	1.004	1.055
IS													0.994	1.002	0.991	0.996	0.975	1.021
NO	0.999	0.968	1.032	0.996	0.996	1.000	1.000	0.992	1.008	0.995	0.986	1.010	0.999	1.003	0.996	1.009	0.991	1.019
CH																		
UK	1.066	1.025	1.041	1.057	1.039	1.018	0.997	0.994	1.004	1.000	0.996	1.004	1.005	1.005	1.000	1.006	0.992	1.015
MK				1.014	1.014	1.000	1.027	1.025	1.001	1.009	1.011	0.998	1.020	1.018	1.002			
RS																1.008	0.987	1.022
N	28	28	28	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Min	0.948	0.949	0.999	0.989	0.986	0.981	0.966	0.973	0.993	0.988	0.986	0.998	0.981	0.980	0.987	0.987	0.970	1.002
25-perc	1.008	0.994	1.013	0.997	0.998	0.998	1.000	0.996	0.997	1.000	0.997	0.999	0.999	1.001	0.997	0.999	0.982	1.013
Average	1.032	1.007	1.024	1.006	1.007	0.999	1.005	1.004	1.002	1.006	1.003	1.003	1.007	1.006	1.001	1.007	0.989	1.018
Median	1.025	1.004	1.018	1.003	1.003	1.000	1.006	1.003	1.001	1.007	1.004	1.001	1.007	1.005	1.000	1.007	0.989	1.017
75-perc	1.054	1.024	1.039	1.013	1.015	1.001	1.010	1.011	1.006	1.012	1.009	1.004	1.013	1.012	1.002	1.010	0.995	1.021
Max	1.104	1.068	1.069	1.057	1.047	1.018	1.027	1.025	1.016	1.036	1.020	1.022	1.033	1.021	1.026	1.059	1.008	1.055
Std Dev	0.034	0.025	0.017	0.014	0.014	0.006	0.011	0.010	0.006	0.009	0.008	0.006	0.010	0.009	0.010	0.014	0.010	0.009

Table C.8: Convergence results of the robust model for countries

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.007	1.010	0.999	0.990
2015/2016	1.004	1.022	1.002	0.980
2016/2017	1.003	1.012	1.003	0.991
2017/2018	1.006	1.015	1.001	0.987
2018/2019	0.989	1.032	1.018	0.987
2014/2019	1.006	1.089	1.024	0.941

C.3 Conditional model

Table C.9: BoD results of the conditional model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank
Belgium	0.925	18	0.914	18	0.924	18	0.933	18	0.938	16	0.925	19
Bulgaria	0.819	30	0.808	29	0.806	29	0.817	30	0.821	30	0.809	31
Czechia	0.903	20	0.898	19	0.903	20	0.918	19	0.920	20	0.925	20
Denmark	1.008	1	1.008	1	1.003	2	1.002	2	1.002	3	0.988	10
Germany	0.887	24	0.888	21	0.896	22	0.896	24	0.913	21	0.908	22
Estonia	0.881	26	0.885	23	0.902	21	0.911	20	0.929	18	0.926	17
Ireland	1.000	5	1.000	4	1.000	8	1.002	3	1.005	2	1.001	2
Greece	1.000	6	1.000	6	1.000	4	1.000	4			1.000	5
Spain	1.000	6	1.000	6	1.000	4	0.999	7	0.972	14	0.995	7
France	0.977	12	0.987	10	0.989	10	0.985	10	0.988	10	0.977	14
Croatia	0.975	13	0.967	13	0.933	16	0.909	22	0.899	23	0.887	24
Italy	0.888	23	0.884	24	0.892	24	0.879	26	0.876	26	0.872	27
Cyprus	0.998	9	1.000	6	1.000	4	1.000	4	1.000	5	1.000	4
Latvia	0.884	25	0.882	26	0.895	23	0.897	23	0.893	24	0.884	25
Lithuania	0.991	10	1.001	3	1.000	3	0.996	9	0.982	12	0.986	11
Luxembourg	1.000	6	1.000	6	1.000	4	1.000	4	1.000	6	1.000	5
Hungary	0.836	29	0.854	28	0.854	28	0.859	28	0.867	28	0.874	26
Malta	0.877	27	0.885	22	0.886	25	0.888	25	0.901	22	0.896	23
Netherlands	0.980	11	0.987	11	0.981	11	0.984	11	0.993	8	0.989	9
Austria	0.924	19	0.924	17	0.933	17	0.936	17	0.935	17	0.925	21
Poland	0.895	22	0.897	20	0.903	19	0.909	21	0.924	19	0.926	18
Portugal	0.865	28	0.877	27	0.869	27	0.866	27	0.868	27	0.871	28
Romania	0.761	31	0.759	30	0.769	30	0.770	31	0.785	31	0.794	32
Slovenia	0.935	17	0.934	16	0.935	15	0.945	16	0.943	15	0.939	16
Slovakia	0.898	21	0.884	25	0.869	26	0.855	29	0.864	29	0.853	30
Finland	0.954	15	0.960	14	0.973	14	0.978	13	0.989	9	0.966	15
Sweden	1.005	2	1.004	2	1.005	1	1.011	1	1.021	1	1.007	1
Iceland	1.000	4					0.999	8	1.001	4	0.990	8
Norway	1.001	3	1.000	5	0.997	9	0.984	12	0.986	11	0.986	12
Switzerland											1.000	3
United Kingdom	0.948	16	0.980	12	0.976	13	0.975	14	0.979	13	0.979	13
North Macedonia	0.956	14	0.948	15	0.976	12	0.974	15	0.999	7		
Serbia									0.886	25	0.865	29
N	31		30		30		31		31		32	
Min	0.761		0.759		0.769		0.770		0.785		0.794	
25-percentile	0.887		0.885		0.894		0.896		0.893		0.884	
Average	0.935		0.934		0.936		0.938		0.938		0.936	
Median	0.948		0.941		0.934		0.945		0.938		0.933	
75-percentile	1.000		1.000		1.000		0.999		0.993		0.990	
Max	1.008		1.008		1.005		1.011		1.021		1.007	
Standard deviation	0.065		0.066		0.064		0.063		0.061		0.061	

Table C.10: BoD results against the metafrontiers of the conditional model for countries

Country	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
Belgium	0.950	0.977	0.971	1.000	0.966	0.990	0.969	0.954	0.962	0.953	0.962	0.952
Bulgaria	0.926	1.002	0.902	0.998	0.883	0.988	0.875	0.994	0.880	0.995	0.877	0.995
Czechia	0.971	0.966	0.960	0.948	0.979	0.918	0.994	0.939	0.997	0.958	0.997	0.974
Denmark	1.000	0.973	1.000	0.935	0.998	0.961	1.000	0.955	0.991	0.961	0.993	0.957
Germany	0.897	1.001	0.920	0.997	0.926	1.000	0.930	1.000	0.952	1.000	0.968	0.998
Estonia	0.956	0.995	0.953	1.000	0.975	0.975	0.986	0.964	1.000	0.953	1.000	0.953
Ireland	0.998	1.000	0.972	1.000	0.959	0.993	0.983	0.932	1.000	0.911	1.000	0.909
Greece	0.968	1.000	0.975	0.983	0.994	0.970	1.000	0.978			1.000	1.000
Spain	1.000	1.000	0.999	1.000	0.990	1.000	0.988	0.993	0.996	0.988	1.000	0.989
France	0.972	0.927	0.980	0.901	0.978	0.892	0.974	0.890	0.981	0.887	0.986	0.885
Croatia	0.996	1.000	0.999	0.998	0.999	0.994	0.986	0.997	0.976	0.967	0.972	0.957
Italy	0.893	1.000	0.886	1.000	0.891	0.993	0.879	1.000	0.876	0.999	0.877	0.988
Cyprus	0.978	1.000	1.000	0.975	0.994	0.985	0.997	0.988	1.000	0.982	1.000	1.000
Latvia	0.978	1.000	0.967	1.000	0.983	0.990	0.978	0.976	0.956	0.986	0.931	0.991
Lithuania	0.983	0.906	0.986	0.889	0.989	0.876	0.997	0.870	1.002	0.865	1.005	0.856
Luxembourg	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.990
Hungary	0.953	0.919	0.982	0.896	0.987	0.901	0.990	0.902	0.991	0.904	1.000	0.899
Malta	0.872	1.003	0.918	1.001	0.921	1.000	0.911	0.999	0.977	1.000	1.000	1.000
Netherlands	0.968	0.981	0.970	0.980	0.975	0.971	0.989	0.964	0.989	0.992	0.998	0.990
Austria	0.987	1.000	0.985	0.991	0.988	0.991	0.993	0.985	0.985	0.986	0.984	0.985
Poland	0.967	0.931	0.962	0.915	0.971	0.892	0.978	0.902	0.998	0.877	1.001	0.866
Portugal	0.974	1.000	0.967	0.967	0.951	0.966	0.954	0.951	0.934	0.952	0.942	0.972
Romania	0.878	1.016	0.885	1.004	0.891	1.003	0.885	0.999	0.897	1.008	0.924	1.002
Slovenia	0.951	0.982	0.945	0.981	0.945	0.988	0.968	0.974	0.952	0.989	0.962	0.992
Slovakia	0.989	1.000	0.982	0.999	0.973	0.993	0.964	0.983	0.952	0.974	0.959	0.974
Finland	0.963	0.991	0.969	0.992	0.983	0.955	0.991	0.946	0.994	0.930	1.000	0.913
Sweden	0.998	0.948	0.996	0.954	0.991	0.927	0.992	0.898	0.984	0.884	1.000	0.867
Iceland	0.992	1.000					1.000	0.975	1.000	1.000	0.993	0.983
Norway	0.991	0.920	0.967	0.913	0.967	0.915	0.968	0.916	1.000	0.917	1.000	0.915
Switzerland											1.000	1.000
United Kingdom	0.891	0.980	0.966	0.916	0.979	0.925	0.987	0.925	0.985	0.925	0.994	0.924
North Macedonia	1.000	1.000	0.970	1.000	1.000	0.972	0.980	1.000	1.000	0.978		
Serbia									0.965	1.000	0.989	0.993
N	31	31	30	30	30	30	31	31	31	31	32	32
Min	0.872	0.906	0.885	0.889	0.883	0.876	0.875	0.870	0.876	0.865	0.877	0.856
25-percentile	0.951	0.973	0.959	0.945	0.957	0.926	0.968	0.932	0.956	0.925	0.964	0.917
Average	0.963	0.981	0.964	0.971	0.968	0.964	0.970	0.960	0.973	0.959	0.979	0.958
Median	0.972	1.000	0.970	0.991	0.978	0.980	0.986	0.974	0.985	0.974	0.995	0.978
75-percentile	0.992	1.000	0.985	1.000	0.990	0.993	0.993	0.994	0.999	0.995	1.000	0.992
Max	1.000	1.016	1.000	1.004	1.000	1.003	1.000	1.000	1.002	1.008	1.005	1.002
Standard deviation	0.039	0.030	0.032	0.038	0.033	0.039	0.036	0.038	0.035	0.043	0.034	0.046

Table C.11: Performance evolution assessment of the conditional model for countries

Country	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.013	1.000	1.014	1.022	0.988	1.035	0.995	1.012	0.984	1.003	1.009	0.994	0.993	1.006	0.987	1.000	0.986	1.014
BG	0.947	0.988	0.959	0.973	0.987	0.987	0.979	0.997	0.982	0.991	1.014	0.977	1.006	1.004	1.001	0.998	0.985	1.012
CZ	1.026	1.024	1.002	0.989	0.994	0.995	1.020	1.006	1.014	1.015	1.016	0.999	1.003	1.003	1.000	0.999	1.005	0.995
DK	0.993	0.980	1.014	1.000	1.000	1.000	0.998	0.995	1.003	1.002	0.999	1.003	0.991	1.000	0.991	1.003	0.985	1.017
DE	1.080	1.024	1.055	1.026	1.001	1.024	1.007	1.008	0.999	1.004	1.000	1.004	1.023	1.019	1.004	1.018	0.995	1.023
EE	1.046	1.051	0.995	0.997	1.004	0.992	1.023	1.020	1.004	1.011	1.010	1.002	1.014	1.020	0.994	1.000	0.997	1.003
IE	1.002	1.001	1.001	0.974	1.000	0.974	0.987	0.999	0.988	1.024	1.002	1.022	1.017	1.003	1.014	1.000	0.997	1.003
EL				1.007	1.000	1.007	1.020	1.000	1.020	1.006	1.000	1.006						
ES	1.000	0.995	1.005	0.999	1.000	0.999	0.991	1.000	0.991	0.998	0.999	0.999	1.008	0.973	1.036	1.004	1.024	0.980
FR	1.015	0.999	1.016	1.008	1.010	0.998	0.999	1.002	0.996	0.996	0.996	1.000	1.007	1.003	1.004	1.006	0.989	1.017
HR	0.976	0.909	1.074	1.003	0.991	1.012	1.000	0.965	1.036	0.986	0.974	1.013	0.990	0.989	1.002	0.996	0.986	1.010
IT	0.982	0.982	1.000	0.992	0.996	0.996	1.005	1.008	0.997	0.986	0.986	1.000	0.997	0.996	1.001	1.002	0.995	1.006
CY	1.023	1.002	1.021	1.023	1.002	1.021	0.994	1.000	0.994	1.003	1.000	1.003	1.003	1.000	1.003	1.000	1.000	1.000
LV	0.952	1.000	0.952	0.988	0.998	0.990	1.017	1.014	1.002	0.995	1.002	0.993	0.978	0.996	0.982	0.973	0.989	0.984
LT	1.022	0.995	1.027	1.003	1.011	0.993	1.003	0.999	1.004	1.007	0.996	1.012	1.005	0.986	1.020	1.003	1.004	0.999
LU	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
HU	1.049	1.045	1.004	1.030	1.021	1.009	1.005	1.000	1.005	1.003	1.006	0.996	1.002	1.008	0.993	1.009	1.009	1.000
MT	1.146	1.021	1.122	1.052	1.009	1.043	1.004	1.001	1.003	0.988	1.002	0.986	1.072	1.014	1.058	1.024	0.995	1.029
NL	1.030	1.009	1.021	1.001	1.007	0.994	1.006	0.994	1.012	1.014	1.003	1.011	0.999	1.009	0.991	1.009	0.996	1.014
AT	0.997	1.000	0.997	0.997	1.000	0.998	1.004	1.009	0.994	1.005	1.004	1.002	0.992	0.999	0.993	0.999	0.989	1.010
PL	1.036	1.035	1.001	0.995	1.003	0.993	1.010	1.007	1.002	1.007	1.007	1.000	1.020	1.016	1.004	1.004	1.002	1.002
PT	0.968	1.008	0.960	0.993	1.015	0.979	0.983	0.990	0.993	1.003	0.997	1.006	0.980	1.002	0.978	1.009	1.004	1.005
RO	1.052	1.044	1.008	1.007	0.998	1.010	1.007	1.013	0.994	0.993	1.001	0.992	1.014	1.019	0.995	1.030	1.012	1.017
SI	1.011	1.005	1.007	0.994	0.999	0.995	1.000	1.002	0.998	1.024	1.011	1.013	0.984	0.998	0.986	1.010	0.996	1.015
SK	0.970	0.950	1.021	0.993	0.984	1.009	0.991	0.984	1.007	0.991	0.984	1.007	0.988	1.011	0.977	1.007	0.987	1.020
FI	1.038	1.013	1.025	1.005	1.006	0.999	1.015	1.014	1.001	1.008	1.006	1.003	1.003	1.011	0.992	1.006	0.977	1.029
SE	1.002	1.002	1.000	0.998	1.000	0.998	0.995	1.001	0.994	1.001	1.005	0.995	0.992	1.010	0.982	1.017	0.986	1.030
IS													1.000	1.003	0.997	0.993	0.989	1.004
NO	1.009	0.985	1.024	0.977	1.000	0.977	1.000	0.997	1.003	1.000	0.987	1.013	1.033	1.002	1.031	1.000	1.000	1.000
CH																		
UK	1.116	1.033	1.080	1.085	1.035	1.048	1.013	0.995	1.018	1.008	0.999	1.009	0.998	1.005	0.993	1.009	1.000	1.010
MK				0.970	0.992	0.977	1.031	1.030	1.002	0.980	0.998	0.982	1.021	1.026	0.995			
RS																1.024	0.976	1.050
N	28	28	28	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Min	0.947	0.909	0.952	0.970	0.984	0.974	0.979	0.965	0.982	0.980	0.974	0.977	0.978	0.973	0.977	0.973	0.976	0.980
25-perc	0.994	0.995	1.000	0.993	0.997	0.993	0.995	0.997	0.994	0.994	0.998	0.996	0.992	1.000	0.991	1.000	0.987	1.001
Average	1.018	1.004	1.014	1.003	1.002	1.002	1.003	1.002	1.001	1.002	1.000	1.001	1.004	1.004	1.000	1.005	0.995	1.010
Median	1.012	1.002	1.007	0.999	1.000	0.998	1.003	1.001	1.001	1.003	1.001	1.002	1.002	1.003	0.996	1.003	0.996	1.010
75-perc	1.038	1.023	1.024	1.008	1.006	1.009	1.010	1.009	1.004	1.008	1.006	1.008	1.014	1.011	1.004	1.009	1.001	1.017
Max	1.146	1.051	1.122	1.085	1.035	1.048	1.031	1.030	1.036	1.024	1.016	1.022	1.072	1.026	1.058	1.030	1.024	1.050
Std Dev	0.045	0.029	0.035	0.023	0.010	0.018	0.012	0.011	0.011	0.010	0.009	0.010	0.018	0.011	0.017	0.011	0.010	0.014

Table C.12: Convergence results of the conditional model for countries

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.002	1.003	1.002	0.998
2015/2016	1.002	1.006	1.001	0.996
2016/2017	1.000	1.002	1.001	0.999
2017/2018	1.004	1.005	1.000	0.995
2018/2019	0.995	1.016	1.010	0.994
2014/2019	1.003	1.032	1.014	0.984

Appendix D

All data results

D.1 Deterministic model

Table D.1: BoD results of the deterministic model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank
BE	0.913	44	0.903	59	0.918	49	0.924	50	0.929	48	0.912	49
BE1	0.937	31	0.928	38	0.938	37	0.958	27	0.962	32	0.940	41
BE2	0.926	35	0.914	52	0.929	40	0.931	47	0.935	45	0.920	47
BE3	0.883	73	0.877	89	0.893	73	0.898	71	0.904	71	0.884	73
BG	0.796	117	0.799	116	0.797	119	0.806	121	0.804	121	0.772	129
BG3	0.755	123	0.753	123	0.749	123	0.757	126	0.751	126	0.715	132
BG4	0.842	108	0.843	110	0.839	113	0.847	112	0.850	111	0.819	124
CZ	0.890	69	0.891	68	0.891	75	0.893	75	0.888	90	0.858	107
CZ0	0.890	69	0.891	68	0.891	75	0.893	75	0.888	90	0.858	107
DK	1.000	1	1.000	1	1.000	1	0.994	5	0.996	7	0.974	13
DK0	1.000	1	1.000	1	1.000	1	0.994	5	0.996	7	0.974	13
DE	0.879	77	0.883	80	0.887	81	0.883	89	0.889	87	0.872	85
DE1	0.900	55	0.901	63	0.911	58	0.909	63	0.906	70	0.890	69
DE2	0.893	66	0.902	61	0.889	78	0.892	78	0.887	92	0.877	80
DE3	0.903	54	0.913	53	0.911	57	0.913	56	0.916	63	0.903	59
DE4	0.868	95	0.865	97	0.876	91	0.862	104	0.866	102	0.851	112
DE5	0.879	78	0.923	42	0.880	87	0.889	81	0.888	89	0.895	68
DE6	0.914	43	0.915	49	0.917	52	0.913	55	0.926	49	0.895	66
DE7	0.881	76	0.906	58	0.891	77	0.888	83	0.898	77	0.882	75
DE8	0.869	94	0.866	96	0.881	84	0.874	93	0.873	101	0.863	101
DE9	0.872	84	0.887	77	0.873	96	0.887	84	0.889	88	0.870	92
DEA	0.870	89	0.879	85	0.876	92	0.872	95	0.895	83	0.866	97
DEB	0.892	68	0.889	72	0.900	66	0.895	73	0.898	79	0.874	83
DEC	0.876	82	0.881	83	0.884	83	0.871	98	0.881	97	0.871	90
DED	0.893	65	0.887	76	0.896	68	0.889	82	0.894	84	0.876	81
DEE	0.869	90	0.862	99	0.861	103	0.854	108	0.857	106	0.855	110
DEF	0.869	91	0.884	78	0.874	93	0.867	100	0.896	82	0.872	84
DEG	0.892	67	0.881	84	0.885	82	0.893	77	0.899	75	0.878	78
EE	0.869	92	0.882	81	0.893	71	0.900	69	0.914	66	0.897	63
EE0	0.869	92	0.882	81	0.893	71	0.900	69	0.914	66	0.897	63
IE	0.909	50	0.910	54	0.916	53	0.941	41	0.971	21	0.953	30
IE0	0.909	50	0.910	54	0.916	53	0.941	41	0.971	21	0.953	30
EL	0.831	110	0.851	105	0.868	101	0.871	97			0.860	102
EL3							0.911	59			0.875	82
EL4							0.817	120			0.826	123
EL5							0.871	96			0.867	94
EL6							0.834	117			0.848	113
ES	0.895	61	0.895	65	0.907	60	0.911	58	0.922	56	0.909	50
ES1	0.905	52	0.907	57	0.917	51	0.921	52	0.929	47	0.920	48
ES2	0.929	34	0.926	39	0.940	36	0.943	39	0.954	41	0.936	43
ES3	0.937	30	0.916	48	0.924	43	0.926	48	0.941	43	0.926	46
ES4	0.895	62	0.895	66	0.908	59	0.911	61	0.918	59	0.908	51
ES5	0.888	71	0.884	79	0.896	67	0.902	67	0.917	61	0.903	58
ES6	0.886	72	0.887	75	0.901	65	0.901	68	0.910	69	0.899	62
ES7	0.875	83	0.871	91	0.891	74	0.891	79	0.898	78	0.883	74
FR	0.962	19	0.964	17	0.978	12	0.975	14	0.981	15	0.969	15
FR1	0.992	8	0.986	11	0.991	8	0.995	4	0.995	10	0.999	4
FRB	0.947	24	0.949	28	0.963	19	0.962	24	0.975	17	0.958	20

Table D.1: BoD results of the deterministic model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
FRC	0.947	25	0.933	36	0.960	24	0.956	31	0.959	35	0.948	34
FRD	0.935	33	0.946	30	0.958	27	0.952	36	0.960	34	0.951	32
FRE	0.948	23	0.940	34	0.957	29	0.952	35	0.962	31	0.950	33
FRF	0.936	32	0.943	32	0.961	22	0.955	32	0.969	26	0.961	17
FRG	0.963	18	0.964	18	0.980	11	0.990	9	0.988	11	0.975	10
FRH	0.981	12	0.968	16	0.982	10	0.975	15	0.996	9	0.978	7
FRI	0.951	22	0.955	22	0.968	17	0.972	17	0.977	16	0.965	16
FRJ	0.993	7	0.969	15	0.985	9	0.984	10	0.998	5	0.976	9
FRK	0.992	9	0.983	13	0.998	5	0.995	3	1.000	1	0.991	6
FRL	0.955	20	0.960	21	0.970	13	0.963	23	0.964	29	0.954	26
FRM	0.853	103	0.819	114	0.907	62						
FRY			0.902	60	0.916	55	0.909	62	0.914	65	0.905	57
HR	0.876	80	0.888	73	0.888	79	0.883	87	0.884	93	0.866	98
HR0	0.876	80	0.888	73	0.888	79	0.883	87	0.884	93	0.866	98
IT	0.858	100	0.854	103	0.871	98	0.862	103	0.865	104	0.859	103
ITC	0.843	107	0.841	111	0.860	104	0.859	105	0.866	103	0.858	109
ITF	0.882	74	0.879	86	0.893	70	0.882	90	0.877	100	0.870	91
ITG	0.863	99	0.857	102	0.872	97	0.847	111	0.847	116	0.845	117
ITH	0.855	102	0.863	98	0.874	94	0.868	99	0.880	98	0.864	100
ITI	0.847	106	0.852	104	0.858	105	0.854	107	0.852	110	0.852	111
CY	0.899	56	0.921	44	0.906	63	0.905	65	0.919	57	0.906	55
CY0	0.899	56	0.921	44	0.906	63	0.905	65	0.919	57	0.906	55
LV	0.865	96	0.866	94	0.880	88	0.883	85	0.881	95	0.871	87
LV0	0.865	96	0.866	94	0.880	88	0.883	85	0.881	95	0.871	87
LT	0.899	58	0.914	50	0.919	47	0.917	53	0.925	50	0.907	52
LT0	0.899	58	0.914	50	0.919	47	0.917	53	0.925	50	0.907	52
LU	0.972	13	0.991	9	0.959	25	0.956	29	0.956	38	0.948	35
LU0	0.972	13	0.991	9	0.959	25	0.956	29	0.956	38	0.948	35
HU	0.824	111	0.847	106	0.849	111	0.846	113	0.850	112	0.841	118
HU1	0.877	79	0.891	67	0.877	90	0.891	80	0.897	81	0.882	76
HU2	0.815	112	0.845	107	0.851	110	0.846	114	0.840	117	0.829	122
HU3	0.806	115	0.827	113	0.851	109	0.852	110	0.856	108	0.847	114
MT	0.871	85	0.878	87	0.881	85	0.878	91	0.891	85	0.866	95
MT0	0.871	85	0.878	87	0.881	85	0.878	91	0.891	85	0.866	95
NL	0.972	15	0.986	12	0.957	28	0.969	19	0.973	20	0.957	21
AT	0.911	48	0.917	47	0.923	44	0.922	51	0.915	64	0.887	70
AT1	0.920	39	0.923	43	0.931	39	0.924	49	0.925	52	0.907	54
AT2	0.916	42	0.920	46	0.920	46	0.932	46	0.923	55	0.887	71
AT3	0.898	60	0.907	56	0.914	56	0.913	57	0.902	72	0.880	77
PL	0.882	75	0.890	70	0.894	69	0.894	74	0.899	76	0.871	89
PL2	0.894	63	0.896	64	0.907	61	0.908	64	0.918	60	0.885	72
PL4	0.864	98	0.870	92	0.874	95	0.873	94	0.878	99	0.859	104
PL5	0.870	88	0.872	90	0.871	99	0.896	72	0.910	68	0.871	86
PL6	0.857	101	0.868	93	0.868	102	0.867	101	0.861	105	0.847	115
PL7									0.897	80	0.878	79
PL8									0.901	73	0.868	93
PL9									0.936	44	0.895	67
PT	0.812	114	0.838	112	0.838	114	0.853	109	0.855	109	0.858	106
PT1	0.814	113	0.845	108	0.842	112	0.855	106	0.856	107	0.859	105
PT2	0.764	122	0.773	121	0.788	121	0.799	123	0.816	120	0.808	126
PT3	0.837	109	0.844	109	0.854	108						
RO	0.751	124	0.754	122	0.764	122	0.756	127	0.764	125	0.754	131
RO1	0.801	116	0.793	119	0.808	117	0.804	122	0.778	124	0.756	130
RO2	0.725	125	0.731	124	0.736	124	0.729	128	0.720	127	0.713	133
RO3	0.770	121	0.785	120	0.789	120	0.798	124	0.790	123	0.780	128
RO4	0.785	118	0.802	115	0.799	118	0.781	125	0.794	122	0.793	127
SI	0.920	37	0.925	40	0.926	41	0.933	44	0.925	53	0.902	60
SI0	0.920	37	0.925	40	0.926	41	0.933	44	0.925	53	0.902	60
SK	0.852	104	0.859	100	0.856	106	0.843	115	0.849	113	0.830	120
SK0	0.852	104	0.859	100	0.856	106	0.843	115	0.849	113	0.830	120
FI	0.942	29	0.951	26	0.962	20	0.961	26	0.969	25	0.954	29
FI1	0.942	28	0.951	25	0.961	23	0.961	25	0.969	24	0.954	28
SE	0.988	11	0.994	7	0.992	7	0.994	7	0.997	6	0.996	5
SE1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
SE2	0.991	10	0.993	8	0.996	6	0.992	8	0.999	4	1.000	1
SE3	0.953	21	0.980	14	0.969	16	0.982	11	0.981	14	0.977	8
IS	1.000	5					0.980	12	0.988	12	0.956	24
IS0	1.000	5					0.980	12	0.988	12	0.956	24
NO	0.969	16	1.000	1	0.969	14	0.965	20	0.968	27	0.957	22
NO0	0.969	16	1.000	1	0.969	14	0.965	20	0.968	27	0.957	22
CH											0.975	11
CH0											0.975	11
UK	0.923	36	0.960	20	0.967	18	0.965	22	0.969	23	0.954	27
UKC	0.913	45	0.942	33	0.952	33	0.944	38	0.950	42	0.930	44
UKD	0.916	41	0.947	29	0.962	21	0.957	28	0.958	36	0.945	37

Table D.1: BoD results of the deterministic model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
UKE	0.905	53	0.945	31	0.955	31	0.954	34	0.962	33	0.940	42
UKF	0.917	40	0.954	24	0.952	32	0.955	33	0.964	30	0.942	40
UKG	0.910	49	0.939	35	0.946	34	0.943	40	0.955	40	0.943	38
UKH	0.912	46	0.955	23	0.956	30	0.951	37	0.958	37	0.942	39
UKI	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
UKJ	0.945	26	0.962	19	0.936	38	0.971	18	0.975	18	0.961	18
UKK	0.943	27	0.949	27	0.920	45	0.972	16	0.974	19	0.959	19
UKL	0.894	64	0.902	62	0.917	50	0.911	60	0.934	46	0.896	65
UKM	0.911	47	0.931	37	0.941	35	0.933	43	0.916	62	0.927	45
UKN	0.870	87	0.889	71	0.868	100	0.863	102	0.900	74		
MK	0.780	119	0.796	117	0.815	115	0.820	118	0.831	118		
MK0	0.780	119	0.796	117	0.815	115	0.820	118	0.831	118		
RS									0.849	115	0.833	119
RS1											0.846	116
RS2											0.817	125
N	125		124		124		128		127		133	
Min	0.725		0.731		0.736		0.729		0.720		0.713	
25-perc	0.869		0.867		0.874		0.871		0.881		0.863	
Average	0.895		0.901		0.905		0.906		0.913		0.897	
Median	0.894		0.901		0.906		0.907		0.915		0.895	
75-perc	0.936		0.945		0.955		0.955		0.962		0.949	
Max	1.000		1.000		1.000		1.000		1.000		1.000	
Std Dev	0.059		0.058		0.055		0.057		0.058		0.058	

Table D.2: BoD results against the metafrontiers of the deterministic model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE	0.902	0.772	0.897	0.778	0.901	0.766	0.909	0.758	0.912	0.753	0.912	0.750
BE1	0.920	0.782	0.920	0.786	0.920	0.775	0.942	0.755	0.943	0.742	0.940	0.749
BE2	0.912	0.751	0.907	0.758	0.911	0.751	0.916	0.745	0.918	0.743	0.920	0.734
BE3	0.874	0.808	0.871	0.811	0.876	0.792	0.883	0.784	0.888	0.776	0.884	0.780
BG	0.772	0.944	0.769	0.927	0.769	0.900	0.779	0.882	0.783	0.870	0.772	0.881
BG3	0.744	1.000	0.737	0.991	0.722	0.947	0.733	0.934	0.731	0.928	0.715	0.946
BG4	0.816	0.895	0.811	0.874	0.809	0.867	0.820	0.841	0.828	0.827	0.819	0.833
CZ	0.862	0.796	0.857	0.794	0.859	0.785	0.864	0.777	0.864	0.776	0.858	0.780
CZ0	0.862	0.796	0.857	0.794	0.859	0.785	0.864	0.777	0.864	0.776	0.858	0.780
DK	0.991	0.684	0.994	0.683	0.981	0.689	0.978	0.696	0.978	0.710	0.974	0.704
DK0	0.991	0.684	0.994	0.683	0.981	0.689	0.978	0.696	0.978	0.710	0.974	0.704
DE	0.871	0.779	0.874	0.780	0.869	0.780	0.868	0.778	0.868	0.779	0.872	0.778
DE1	0.891	0.761	0.895	0.759	0.894	0.761	0.894	0.759	0.889	0.765	0.890	0.762
DE2	0.865	0.763	0.868	0.759	0.865	0.766	0.865	0.762	0.868	0.763	0.877	0.763
DE3	0.888	0.782	0.894	0.781	0.893	0.767	0.898	0.772	0.895	0.778	0.903	0.766
DE4	0.860	0.878	0.860	0.860	0.860	0.816	0.848	0.835	0.850	0.807	0.851	0.814
DE5	0.846	0.805	0.873	0.794	0.862	0.790	0.874	0.789	0.866	0.809	0.895	0.818
DE6	0.904	0.769	0.909	0.775	0.897	0.772	0.898	0.767	0.903	0.763	0.895	0.777
DE7	0.872	0.776	0.874	0.774	0.872	0.775	0.874	0.771	0.876	0.776	0.882	0.772
DE8	0.861	0.838	0.861	0.833	0.864	0.817	0.860	0.807	0.857	0.796	0.863	0.793
DE9	0.863	0.793	0.862	0.795	0.855	0.802	0.872	0.793	0.867	0.793	0.870	0.796
DEA	0.862	0.794	0.866	0.794	0.857	0.792	0.857	0.793	0.873	0.794	0.866	0.791
DEB	0.883	0.782	0.884	0.791	0.883	0.785	0.880	0.787	0.881	0.784	0.874	0.786
DEC	0.868	0.814	0.865	0.816	0.867	0.793	0.856	0.799	0.859	0.797	0.871	0.793
DED	0.880	0.768	0.881	0.778	0.877	0.764	0.875	0.772	0.878	0.762	0.876	0.765
DEE	0.861	0.871	0.856	0.857	0.845	0.852	0.840	0.858	0.841	0.866	0.855	0.833
DEF	0.845	0.821	0.854	0.809	0.856	0.793	0.849	0.784	0.875	0.787	0.872	0.792
DEG	0.879	0.782	0.875	0.795	0.868	0.778	0.879	0.772	0.881	0.767	0.878	0.774
EE	0.852	0.785	0.855	0.789	0.874	0.764	0.885	0.757	0.897	0.749	0.897	0.745
EE0	0.852	0.785	0.855	0.789	0.874	0.764	0.885	0.757	0.897	0.749	0.897	0.745
IE	0.879	0.781	0.881	0.780	0.890	0.765	0.926	0.728	0.954	0.713	0.953	0.712
IE0	0.879	0.781	0.881	0.780	0.890	0.765	0.926	0.728	0.954	0.713	0.953	0.712
EL	0.805	0.920	0.819	0.885	0.837	0.864	0.843	0.849			0.860	0.817
EL3							0.882	0.813			0.875	0.803
EL4							0.790	0.888			0.826	0.872
EL5							0.843	0.866			0.867	0.807
EL6							0.807	0.917			0.848	0.831
ES	0.887	0.843	0.889	0.826	0.890	0.817	0.896	0.807	0.905	0.798	0.909	0.790
ES1	0.892	0.816	0.899	0.802	0.899	0.794	0.906	0.786	0.912	0.774	0.920	0.761
ES2	0.909	0.784	0.917	0.774	0.922	0.767	0.928	0.749	0.935	0.744	0.936	0.741
ES3	0.913	0.790	0.906	0.780	0.906	0.776	0.911	0.767	0.923	0.763	0.926	0.749
ES4	0.886	0.854	0.889	0.837	0.890	0.833	0.896	0.823	0.901	0.811	0.908	0.798
ES5	0.877	0.853	0.879	0.833	0.879	0.824	0.887	0.815	0.900	0.803	0.903	0.796
ES6	0.878	0.898	0.882	0.869	0.884	0.854	0.886	0.850	0.893	0.838	0.899	0.828
ES7	0.867	0.871	0.866	0.853	0.874	0.827	0.877	0.818	0.882	0.827	0.883	0.822
FR	0.951	0.731	0.957	0.731	0.959	0.725	0.959	0.724	0.963	0.719	0.969	0.711
FR1	0.967	0.714	0.976	0.713	0.975	0.708	0.983	0.702	0.983	0.702	0.999	0.691
FRB	0.938	0.735	0.943	0.731	0.945	0.730	0.946	0.734	0.958	0.721	0.958	0.731
FRC	0.938	0.744	0.928	0.755	0.942	0.735	0.940	0.741	0.942	0.743	0.948	0.735
FRD	0.926	0.752	0.940	0.736	0.940	0.731	0.937	0.743	0.943	0.740	0.951	0.738
FRE	0.939	0.755	0.934	0.766	0.938	0.756	0.937	0.754	0.945	0.746	0.950	0.739
FRF	0.927	0.746	0.937	0.742	0.943	0.731	0.940	0.734	0.951	0.729	0.961	0.716
FRG	0.952	0.717	0.956	0.715	0.961	0.717	0.974	0.704	0.970	0.706	0.975	0.699
FRH	0.963	0.707	0.956	0.717	0.960	0.704	0.959	0.711	0.977	0.698	0.978	0.694
FRI	0.942	0.732	0.946	0.724	0.950	0.723	0.956	0.718	0.959	0.718	0.965	0.713
FRJ	0.972	0.710	0.962	0.727	0.966	0.721	0.968	0.721	0.980	0.699	0.976	0.708
FRK	0.977	0.707	0.974	0.713	0.979	0.704	0.979	0.705	0.982	0.699	0.991	0.688
FRL	0.945	0.750	0.953	0.739	0.951	0.742	0.948	0.742	0.946	0.736	0.954	0.719
FRM	0.841	0.815	0.814	0.960	0.874	0.774						
FRY			0.897	0.853	0.898	0.855	0.894	0.859	0.897	0.849	0.905	0.820
HR	0.849	0.877	0.854	0.828	0.857	0.823	0.855	0.817	0.860	0.808	0.866	0.798
HR0	0.849	0.877	0.854	0.828	0.857	0.823	0.855	0.817	0.860	0.808	0.866	0.798
IT	0.850	0.840	0.849	0.836	0.855	0.821	0.848	0.819	0.849	0.815	0.859	0.806
ITC	0.835	0.826	0.835	0.823	0.843	0.805	0.845	0.801	0.850	0.801	0.858	0.788
ITF	0.874	0.873	0.873	0.865	0.876	0.854	0.867	0.848	0.861	0.849	0.870	0.840
ITG	0.855	0.942	0.852	0.934	0.855	0.897	0.833	0.881	0.832	0.887	0.845	0.879
ITH	0.841	0.808	0.841	0.802	0.850	0.787	0.854	0.790	0.864	0.778	0.864	0.773
ITI	0.837	0.821	0.833	0.812	0.838	0.800	0.835	0.799	0.835	0.792	0.852	0.787
CY	0.871	0.831	0.891	0.790	0.886	0.791	0.890	0.780	0.905	0.762	0.906	0.766
CY0	0.871	0.831	0.891	0.790	0.886	0.791	0.890	0.780	0.905	0.762	0.906	0.766
LV	0.842	0.802	0.847	0.803	0.862	0.792	0.869	0.782	0.865	0.779	0.871	0.770
LV0	0.842	0.802	0.847	0.803	0.862	0.792	0.869	0.782	0.865	0.779	0.871	0.770
LT	0.867	0.820	0.885	0.798	0.892	0.781	0.894	0.773	0.903	0.762	0.907	0.753
LT0	0.867	0.820	0.885	0.798	0.892	0.781	0.894	0.773	0.903	0.762	0.907	0.753
LU	0.925	0.728	0.939	0.739	0.940	0.725	0.943	0.728	0.930	0.721	0.948	0.719

Table D.2: BoD results against the metafrontiers of the deterministic model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
LU0	0.925	0.728	0.939	0.739	0.940	0.725	0.943	0.728	0.930	0.721	0.948	0.719
HU	0.802	0.840	0.825	0.820	0.832	0.820	0.833	0.816	0.834	0.814	0.841	0.809
HU1	0.850	0.792	0.857	0.777	0.846	0.782	0.862	0.771	0.873	0.762	0.882	0.754
HU2	0.801	0.849	0.826	0.821	0.834	0.817	0.832	0.828	0.824	0.835	0.829	0.833
HU3	0.797	0.876	0.822	0.853	0.835	0.852	0.838	0.846	0.840	0.846	0.847	0.833
MT	0.863	0.829	0.873	0.822	0.864	0.817	0.864	0.796	0.875	0.789	0.866	0.786
MT0	0.863	0.829	0.873	0.822	0.864	0.817	0.864	0.796	0.875	0.789	0.866	0.786
NL	0.927	0.731	0.932	0.724	0.937	0.721	0.953	0.713	0.950	0.722	0.957	0.719
AT	0.882	0.763	0.882	0.760	0.890	0.751	0.892	0.743	0.891	0.744	0.887	0.746
AT1	0.891	0.749	0.893	0.745	0.898	0.737	0.909	0.733	0.908	0.732	0.907	0.734
AT2	0.887	0.778	0.885	0.776	0.887	0.769	0.901	0.751	0.898	0.754	0.887	0.760
AT3	0.870	0.773	0.873	0.770	0.882	0.758	0.883	0.753	0.878	0.756	0.880	0.754
PL	0.854	0.810	0.857	0.800	0.862	0.785	0.865	0.784	0.875	0.770	0.871	0.770
PL2	0.866	0.807	0.862	0.799	0.875	0.776	0.879	0.773	0.893	0.757	0.885	0.760
PL4	0.837	0.824	0.837	0.813	0.843	0.804	0.845	0.804	0.855	0.787	0.859	0.785
PL5	0.843	0.815	0.839	0.812	0.839	0.800	0.867	0.784	0.886	0.765	0.871	0.767
PL6	0.830	0.833	0.835	0.829	0.837	0.811	0.838	0.813	0.838	0.805	0.847	0.788
PL7									0.874	0.777	0.878	0.768
PL8									0.877	0.776	0.868	0.771
PL9									0.910	0.733	0.895	0.754
PT	0.805	0.869	0.817	0.833	0.819	0.826	0.839	0.810	0.839	0.800	0.858	0.785
PT1	0.806	0.865	0.819	0.828	0.821	0.822	0.841	0.806	0.838	0.797	0.859	0.782
PT2	0.757	1.000	0.769	0.956	0.773	0.935	0.786	0.939	0.801	0.939	0.808	0.950
PT3	0.829	0.900	0.838	0.890	0.838	0.874						
RO	0.737	0.951	0.743	0.928	0.749	0.921	0.743	0.919	0.743	0.933	0.754	0.907
RO1	0.793	0.966	0.788	0.919	0.793	0.910	0.791	0.905	0.764	0.933	0.756	0.922
RO2	0.719	1.000	0.726	1.000	0.722	1.000	0.717	0.998	0.701	1.000	0.713	1.000
RO3	0.746	0.919	0.755	0.905	0.761	0.894	0.772	0.888	0.769	0.891	0.780	0.877
RO4	0.771	0.978	0.775	0.873	0.773	0.884	0.759	0.907	0.773	0.927	0.793	0.887
SI	0.892	0.765	0.890	0.763	0.893	0.759	0.903	0.747	0.900	0.743	0.902	0.738
SI0	0.892	0.765	0.890	0.763	0.893	0.759	0.903	0.747	0.900	0.743	0.902	0.738
SK	0.826	0.842	0.826	0.843	0.825	0.842	0.815	0.844	0.826	0.828	0.830	0.825
SK0	0.826	0.842	0.826	0.843	0.825	0.842	0.815	0.844	0.826	0.828	0.830	0.825
FI	0.907	0.741	0.910	0.739	0.927	0.721	0.942	0.718	0.946	0.712	0.954	0.701
FI1	0.907	0.741	0.910	0.739	0.926	0.722	0.943	0.718	0.946	0.712	0.954	0.701
SE	0.967	0.687	0.961	0.688	0.969	0.686	0.977	0.684	0.978	0.681	0.996	0.668
SE1	0.978	0.678	0.965	0.684	0.984	0.680	0.987	0.678	0.981	0.675	1.000	0.658
SE2	0.969	0.684	0.961	0.688	0.966	0.684	0.976	0.684	0.980	0.681	1.000	0.667
SE3	0.936	0.720	0.950	0.698	0.949	0.708	0.966	0.698	0.963	0.700	0.977	0.692
IS	0.959	0.751					0.965	0.745	0.964	0.771	0.956	0.752
IS0	0.959	0.751					0.965	0.745	0.964	0.771	0.956	0.752
NO	0.947	0.727	0.950	0.720	0.949	0.724	0.949	0.721	0.949	0.720	0.957	0.720
NO0	0.947	0.727	0.950	0.720	0.949	0.724	0.949	0.721	0.949	0.720	0.957	0.720
CH											0.975	0.735
CH0											0.975	0.735
UK	0.882	0.755	0.952	0.734	0.949	0.739	0.949	0.736	0.951	0.734	0.954	0.733
UKC	0.904	0.765	0.936	0.755	0.934	0.763	0.929	0.758	0.932	0.748	0.930	0.766
UKD	0.908	0.763	0.941	0.751	0.943	0.739	0.942	0.742	0.941	0.744	0.945	0.747
UKE	0.897	0.777	0.939	0.755	0.937	0.750	0.939	0.760	0.944	0.757	0.940	0.753
UKF	0.882	0.756	0.948	0.737	0.934	0.762	0.940	0.747	0.946	0.738	0.942	0.746
UKG	0.892	0.790	0.933	0.762	0.928	0.771	0.928	0.768	0.937	0.758	0.943	0.743
UKH	0.880	0.763	0.921	0.747	0.938	0.755	0.935	0.763	0.940	0.754	0.942	0.754
UKI	0.979	0.701	0.997	0.692	0.997	0.695	0.999	0.694	0.996	0.697	1.000	0.697
UKJ	0.900	0.750	0.909	0.763	0.916	0.749	0.955	0.725	0.956	0.723	0.961	0.716
UKK	0.899	0.743	0.900	0.758	0.901	0.749	0.956	0.723	0.956	0.723	0.959	0.735
UKL	0.885	0.766	0.889	0.768	0.899	0.755	0.896	0.754	0.912	0.759	0.896	0.767
UKM	0.887	0.776	0.902	0.775	0.925	0.774	0.919	0.768	0.896	0.779	0.927	0.759
UKN	0.831	0.829	0.842	0.809	0.851	0.806	0.846	0.803	0.879	0.785		
MK	0.755	1.000	0.765	1.000	0.786	0.946	0.793	0.990	0.809	0.940		
MK0	0.755	1.000	0.765	1.000	0.786	0.946	0.793	0.990	0.809	0.940		
RS									0.826	0.858	0.833	0.839
RS1											0.846	0.813
RS2											0.817	0.876
N	125	125	124	124	124	124	128	128	127	127	133	133
Min	0.719	0.678	0.726	0.683	0.722	0.680	0.717	0.678	0.701	0.675	0.713	0.658
25-perc	0.846	0.752	0.849	0.755	0.855	0.750	0.850	0.742	0.861	0.738	0.863	0.735
Average	0.876	0.804	0.881	0.798	0.884	0.787	0.888	0.785	0.893	0.777	0.897	0.773
Median	0.877	0.790	0.881	0.790	0.883	0.779	0.887	0.773	0.896	0.765	0.895	0.766
75-perc	0.908	0.840	0.926	0.828	0.932	0.817	0.940	0.814	0.944	0.801	0.949	0.798
Max	0.991	1.000	0.997	1.000	0.997	1.000	0.999	0.998	0.996	1.000	1.000	1.000
Std Dev	0.057	0.074	0.057	0.069	0.056	0.061	0.058	0.064	0.058	0.061	0.058	0.058

Table D.3: Performance evolution assessment of the deterministic model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.012	0.999	1.013	0.995	0.989	1.006	1.004	1.017	0.987	1.009	1.006	1.003	1.004	1.006	0.998	1.000	0.982	1.019
BE1	1.021	1.003	1.017	1.000	0.991	1.008	1.000	1.010	0.990	1.024	1.021	1.003	1.001	1.004	0.997	0.996	0.977	1.019
BE2	1.009	0.994	1.015	0.994	0.987	1.008	1.004	1.016	0.988	1.006	1.003	1.003	1.002	1.005	0.998	1.002	0.984	1.019
BE3	1.011	1.002	1.009	0.996	0.993	1.003	1.006	1.019	0.987	1.008	1.005	1.003	1.005	1.007	0.998	0.996	0.978	1.019
BG	1.000	0.969	1.032	0.996	1.004	0.993	1.000	0.998	1.002	1.014	1.010	1.003	1.004	0.998	1.006	0.986	0.960	1.027
BG3	0.961	0.947	1.015	0.991	0.997	0.994	0.980	0.995	0.985	1.015	1.011	1.003	0.998	0.992	1.006	0.978	0.952	1.027
BG4	1.004	0.973	1.032	0.994	1.002	0.993	0.997	0.994	1.002	1.014	1.010	1.003	1.010	1.004	1.006	0.990	0.963	1.027
CZ	0.995	0.964	1.032	0.993	1.001	0.993	1.002	1.000	1.002	1.007	1.003	1.003	0.999	0.993	1.006	0.993	0.967	1.027
CZ0	0.995	0.964	1.032	0.993	1.001	0.993	1.002	1.000	1.002	1.007	1.003	1.003	0.999	0.993	1.006	0.993	0.967	1.027
DK	0.983	0.974	1.009	1.003	1.000	1.003	0.987	1.000	0.987	0.997	0.994	1.003	1.000	1.002	0.998	0.996	0.978	1.019
DK0	0.983	0.974	1.009	1.003	1.000	1.003	0.987	1.000	0.987	0.997	0.994	1.003	1.000	1.002	0.998	0.996	0.978	1.019
DE	1.001	0.992	1.009	1.003	1.004	0.999	0.995	1.004	0.991	0.999	0.995	1.003	1.000	1.008	0.992	1.005	0.981	1.025
DE1	0.998	0.988	1.011	1.005	1.001	1.004	0.998	1.011	0.987	1.001	0.998	1.003	0.994	0.997	0.997	1.000	0.982	1.019
DE2	1.015	0.983	1.032	1.004	1.010	0.994	0.996	0.986	1.010	1.000	1.003	0.998	1.003	0.994	1.009	1.011	0.990	1.022
DE3	1.017	1.000	1.017	1.007	1.011	0.996	0.999	0.999	1.000	1.006	1.002	1.003	0.997	1.003	0.994	1.009	0.985	1.024
DE4	0.989	0.980	1.009	0.999	0.996	1.003	1.000	1.013	0.987	0.986	0.983	1.003	1.003	1.006	0.998	1.001	0.982	1.019
DE5	1.058	1.017	1.040	1.033	1.050	0.983	0.987	0.953	1.035	1.014	1.011	1.004	0.991	0.998	0.993	1.033	1.008	1.025
DE6	0.990	0.980	1.010	1.005	1.001	1.004	0.987	1.002	0.985	1.001	0.996	1.004	1.006	1.014	0.993	0.991	0.967	1.025
DE7	1.011	1.001	1.010	1.002	1.029	0.974	0.998	0.983	1.015	1.003	0.997	1.006	1.003	1.012	0.991	1.007	0.982	1.025
DE8	1.002	0.993	1.009	1.000	0.997	1.003	1.004	1.017	0.987	0.995	0.992	1.003	0.997	0.999	0.998	1.007	0.988	1.019
DE9	1.008	0.998	1.011	0.999	1.017	0.982	0.992	0.985	1.007	1.020	1.015	1.005	0.995	1.002	0.993	1.003	0.979	1.025
DEA	1.005	0.996	1.009	1.005	1.011	0.994	0.990	0.996	0.994	1.000	0.995	1.005	1.019	1.027	0.992	0.992	0.968	1.025
DEB	0.990	0.981	1.009	1.000	0.997	1.003	0.999	1.012	0.987	0.997	0.995	1.003	1.000	1.003	0.997	0.993	0.974	1.019
DEC	1.003	0.994	1.009	0.997	1.006	0.991	1.002	1.003	0.999	0.988	0.985	1.003	1.003	1.011	0.992	1.013	0.989	1.025
DED	0.995	0.980	1.015	1.001	0.992	1.009	0.996	1.010	0.985	0.997	0.992	1.004	1.003	1.006	0.998	0.998	0.979	1.019
DEE	0.992	0.983	1.009	0.994	0.991	1.003	0.986	0.999	0.987	0.995	0.992	1.003	1.000	1.003	0.997	1.017	0.998	1.019
DEF	1.032	1.003	1.028	1.010	1.017	0.993	1.002	0.989	1.014	0.992	0.992	1.000	1.030	1.033	0.997	0.997	0.973	1.025
DEG	0.999	0.984	1.015	0.996	0.987	1.009	0.991	1.005	0.987	1.013	1.010	1.003	1.002	1.007	0.996	0.997	0.977	1.021
EE	1.052	1.032	1.020	1.003	1.015	0.988	1.022	1.013	1.010	1.013	1.008	1.005	1.013	1.015	0.997	1.000	0.981	1.019
EE0	1.052	1.032	1.020	1.003	1.015	0.988	1.022	1.013	1.010	1.013	1.008	1.005	1.013	1.015	0.997	1.000	0.981	1.019
IE	1.084	1.048	1.034	1.002	1.001	1.001	1.010	1.007	1.003	1.041	1.027	1.013	1.030	1.032	0.998	0.999	0.981	1.018
IE0	1.084	1.048	1.034	1.002	1.001	1.001	1.010	1.007	1.003	1.041	1.027	1.013	1.030	1.032	0.998	0.999	0.981	1.018
EL				1.017	1.025	0.993	1.022	1.020	1.002	1.007	1.004	1.003						
EL3																		
EL4																		
EL5																		
EL6																		
ES	1.026	1.016	1.010	1.003	0.999	1.004	1.001	1.014	0.987	1.007	1.004	1.003	1.010	1.012	0.998	1.005	0.986	1.019
ES1	1.031	1.016	1.015	1.008	1.002	1.007	1.000	1.011	0.989	1.007	1.004	1.003	1.007	1.010	0.998	1.008	0.990	1.019
ES2	1.030	1.007	1.022	1.009	0.997	1.012	1.006	1.015	0.991	1.006	1.003	1.003	1.008	1.011	0.997	1.000	0.981	1.019
ES3	1.014	0.988	1.027	0.993	0.977	1.016	1.000	1.010	0.991	1.005	1.002	1.003	1.013	1.016	0.997	1.003	0.984	1.019
ES4	1.025	1.015	1.009	1.003	1.000	1.003	1.002	1.015	0.987	1.006	1.004	1.003	1.006	1.008	0.998	1.008	0.989	1.019
ES5	1.030	1.017	1.012	1.002	0.996	1.006	1.000	1.013	0.987	1.009	1.006	1.003	1.014	1.017	0.998	1.004	0.985	1.019
ES6	1.025	1.015	1.009	1.005	1.002	1.003	1.002	1.015	0.987	1.003	1.000	1.003	1.008	1.010	0.998	1.007	0.989	1.019
ES7	1.018	1.009	1.009	0.999	0.995	1.003	1.010	1.023	0.987	1.003	1.000	1.003	1.005	1.008	0.998	1.001	0.983	1.019
FR	1.019	1.006	1.012	1.007	1.001	1.005	1.002	1.014	0.988	1.000	0.997	1.003	1.004	1.006	0.998	1.006	0.988	1.019
FR1	1.033	1.006	1.027	1.009	0.994	1.015	1.000	1.005	0.995	1.008	1.004	1.004	1.000	1.000	1.000	1.016	1.003	1.013
FRB	1.021	1.012	1.009	1.005	1.002	1.003	1.002	1.015	0.987	1.002	0.999	1.003	1.012	1.014	0.998	1.001	0.982	1.019
FRC	1.011	1.002	1.009	0.989	0.986	1.003	1.015	1.028	0.987	0.998	0.995	1.003	1.002	1.004	0.998	1.007	0.989	1.019
FRD	1.027	1.017	1.009	1.015	1.012	1.003	1.000	1.013	0.987	0.997	0.994	1.003	1.007	1.009	0.998	1.008	0.990	1.019
FRE	1.011	1.002	1.009	0.994	0.991	1.003	1.005	1.018	0.987	0.998	0.996	1.003	1.008	1.010	0.998	1.005	0.987	1.019
FRF	1.036	1.026	1.009	1.011	1.008	1.003	1.006	1.019	0.987	0.997	0.994	1.003	1.012	1.014	0.998	1.011	0.992	1.019
FRG	1.024	1.013	1.011	1.004	1.001	1.003	1.005	1.016	0.989	1.013	1.010	1.003	0.996	0.998	0.998	1.005	0.987	1.019
FRH	1.015	0.997	1.018	0.993	0.987	1.006	1.004	1.014	0.990	0.999	0.993	1.006	1.019	1.021	0.998	1.001	0.982	1.019
FRI	1.023	1.014	1.009	1.004	1.004	1.000	1.004	1.014	0.991	1.006	1.003	1.003	1.004	1.006	0.998	1.005	0.987	1.019
FRJ	1.003	0.983	1.021	0.989	0.976	1.014	1.004	1.017	0.988	1.001	0.999	1.003	1.013	1.015	0.998	0.996	0.977	1.019
FRK	1.014	0.999	1.015	0.997	0.991	1.006	1.005	1.016	0.989	1.000	0.997	1.003	1.003	1.005	0.998	1.009	0.991	1.019
FRL	1.009	0.999	1.010	1.008	1.005	1.003	0.998	1.010	0.988	0.996	0.994	1.003	0.998	1.000	0.998	1.008	0.990	1.019
FRM				0.968	0.961	1.008	1.074	1.107	0.970									
FRY							1.002	1.015	0.987	0.996	0.993	1.003	1.004	1.006	0.998	1.008	0.990	1.019
HR	1.020	0.988	1.032	1.006	1.013	0.993	1.003	1.001	1.002	0.998	0.994	1.003	1.007	1.000	1.006	1.006	0.980	1.027
HR0	1.020	0.988	1.032	1.006	1.013	0.993	1.003	1.001	1.002	0.998	0.994	1.003	1.007	1.000	1.006	1.006	0.980	1.027
IT	1.010	1.001	1.009	0.998	0.995	1.003	1.007	1.020	0.987	0.992	0.990	1.003	1.001	1.003	0.998	1.012	0.993	1.019
ITC	1.027	1.018	1.009	1.001	0.998	1.002	1.010	1.023	0.987	1.002	0.999	1.003	1.006	1.008	0.998	1.009	0.991	1.019
ITF	0.996	0.987	1.009	0.999	0.996	1.003	1.004	1.017	0.987	0.990	0.987	1.003	0.992	0.994	0.998	1.011	0.993	1.019
ITG	0.988	0.979	1.009	0.996	0.993	1.003	1.004	1.017	0.987	0.974	0.972	1.003	0.998	1.000	0.998	1.016	0.998	1.019
ITH	1.027	1.010	1.017	1.000	1.009	0.991	1.010	1.013	0.997	1.006	0.994	1.012	1.011	1.013	0.998	1.000	0.981	1.019
ITI	1.017	1.006	1.011	0.994	1.006	0.988	1.007	1.007	1.000	0.996	0.996	1.000	1.001	0.997	1.004	1.020	1.000	1.020
CY	1.041	1.008	1.032	1.024	1.025	0.999	0.994	0.983	1.011	1.004	0.999	1.005	1.017	1.016	1.001	1.002	0.986	1.016
CY0	1.041	1.008	1.032	1.024	1.025	0.999	0.994	0.983	1.011	1.004	0.999	1.005	1.017	1.016	1.001	1.002	0.986	1.016
LV	1.035	1.007	1.028	1.006	1.001	1.005	1.018	1.016	1.002	1.008	1.004	1.004	0.995	0.998	0.997	1.008	0.989	1.019
LV0	1.035	1.007	1.028	1.006	1.001	1.005	1.018	1.016	1.002	1.008	1.004	1.004	0.995	0.998	0.997	1.008	0.989	1.019
LT	1.046	1.009	1.036	1.021	1.017	1.003	1.008	1.005	1.003	1.002	0.998	1.004	1.009	1.009	1.000	1.005	0.980	1.025
LT0	1.046	1.009	1.036	1.021	1.017	1.003	1.008	1.005	1.003	1.002	0.998	1.004	1.009	1.009	1.000	1.005	0.980	1.025
LU	1.025	0.976	1.051	1.016	1.020	0.995	1.001	0.967	1.035	1.003	0.997	1.006	0.986	1.000	0.986	1.020	0.992	1.028
LU0	1.025	0.976	1.051	1.016	1.020	0.995	1.001	0.967	1.035	1.003	0.997	1.006	0.986	1.000	0.986	1.020	0.992	1.028
HU	1.048	1.020	1.027	1.029	1.028	1.000	1.009	1.002	1.007	1.000	0.997	1.003	1.002	1.004	0.998	1.008	0.989	1.019
HU1	1.037	1.005	1.032	1.009	1.016	0.993	0.986	0.984	1.002	1.019	1.016	1.003	1.012	1.006	1.006	1.010	0.983	1.027
HU2	1.035	1.017	1.018	1.031	1.036	0.994	1.010	1.007	1.003	0.998	0.994	1.003	0.991	0.993	0.998	1.006	0.987	1.019
HU3	1.064	1.051	1.012	1.032	1.026	1.006	1.016	1.029	0.987	1.004	1.001	1.003	1.002	1.004	0.998	1.008	0.990	1.019
MT	1.004	0.995	1.009	1.012	1.008	1.003	0.990	1.003	0.987	1.000	0.997	1.003	1.013	1.015	0.998	0.990	0.972	1.019
MT0	1.004	0.995	1.009	1.012	1.008	1.003	0.990	1.003	0.987	1.000	0.997	1.003	1.013	1.015	0.998	0.990	0.972	1.019
NL	1.033	0.985	1.049	1.005	1.014	0.991	1.006	0.971	1.036	1.016	1.012	1.004	0.997	1.004	0.993	1.008	0.984	1.025
AT	1.005	0.974	1.032	1.000	1.007	0.993	1.009	1.006	1.002	1.003	0.999	1.003	0.998	0.992	1.006	0.996	0.970	1.027
AT1	1.017	0.985	1.032	1.002	1.004	0.998	1.006	1.008	0.998	1.011	0.993	1.019	0.999	1.001	0.998	0.999	0.980	1.019
AT2	1.000	0.969	1.032	0.997	1.005	0.993	1.003	1.000	1.002	1.016	1.013	1.003	0.996	0.990	1.006	0.988	0.961	1.027
AT3	1.012	0.980	1.032	1.003	1.011	0.993	1.010	1.008	1.002	1.002	0.998	1.003	0.994	0.988	1.006	1.002	0.976	1.027

Table D.3: Performance evolution assessment of the deterministic model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
PL	1.019	0.988	1.032	1.003	1.010	0.993	1.007	1.004	1.002	1.003	1.000	1.003	1.011	1.005	1.006	0.995	0.969	1.027
PL2	1.021	0.989	1.032	0.995	1.002	0.993	1.015	1.013	1.002	1.005	1.001	1.003	1.017	1.010	1.006	0.990	0.964	1.027
PL4	1.026	0.994	1.032	0.999	1.006	0.993	1.007	1.005	1.002	1.002	0.999	1.003	1.012	1.006	1.006	1.005	0.978	1.027
PL5	1.033	1.001	1.032	0.994	1.002	0.993	1.001	0.999	1.002	1.032	1.029	1.003	1.022	1.016	1.006	0.984	0.958	1.027
PL6	1.020	0.988	1.032	1.005	1.013	0.993	1.002	1.000	1.002	1.002	0.999	1.003	0.999	0.993	1.006	1.011	0.984	1.027
PL7																1.005	0.978	1.027
PL8																0.990	0.964	1.027
PL9																0.983	0.956	1.029
PT	1.067	1.057	1.009	1.016	1.032	0.984	1.002	0.999	1.003	1.024	1.019	1.006	0.999	1.002	0.997	1.023	1.004	1.019
PT1	1.065	1.055	1.010	1.015	1.037	0.979	1.003	0.997	1.006	1.024	1.015	1.009	0.997	1.002	0.995	1.024	1.003	1.021
PT2	1.067	1.057	1.009	1.015	1.012	1.003	1.006	1.019	0.987	1.017	1.014	1.003	1.018	1.021	0.998	1.009	0.990	1.019
PT3				1.011	1.008	1.003	0.999	1.012	0.987									
RO	1.023	1.004	1.019	1.007	1.003	1.004	1.008	1.014	0.994	0.992	0.990	1.002	1.001	1.010	0.991	1.015	0.988	1.027
RO1	0.953	0.944	1.009	0.993	0.990	1.003	1.006	1.020	0.987	0.997	0.994	1.003	0.966	0.968	0.998	0.990	0.971	1.019
RO2	0.992	0.983	1.009	1.010	1.007	1.003	0.995	1.008	0.987	0.993	0.990	1.003	0.977	0.987	0.989	1.018	0.991	1.027
RO3	1.046	1.013	1.032	1.012	1.019	0.993	1.008	1.006	1.002	1.014	1.010	1.003	0.996	0.990	1.006	1.015	0.988	1.027
RO4	1.028	1.010	1.018	1.006	1.021	0.985	0.997	0.996	1.001	0.982	0.978	1.004	1.018	1.016	1.002	1.026	0.998	1.027
SI	1.011	0.980	1.032	0.998	1.006	0.993	1.003	1.001	1.002	1.011	1.008	1.003	0.997	0.991	1.006	1.002	0.975	1.027
SI0	1.011	0.980	1.032	0.998	1.006	0.993	1.003	1.001	1.002	1.011	1.008	1.003	0.997	0.991	1.006	1.002	0.975	1.027
SK	1.005	0.974	1.032	1.000	1.008	0.993	0.999	0.996	1.002	0.988	0.985	1.003	1.013	1.007	1.006	1.005	0.978	1.027
SK0	1.005	0.974	1.032	1.000	1.008	0.993	0.999	0.996	1.002	0.988	0.985	1.003	1.013	1.007	1.006	1.005	0.978	1.027
FI	1.052	1.013	1.039	1.004	1.010	0.994	1.019	1.011	1.008	1.017	0.999	1.017	1.004	1.008	0.996	1.008	0.985	1.024
FI1	1.052	1.013	1.039	1.004	1.010	0.994	1.018	1.010	1.008	1.017	1.000	1.017	1.004	1.008	0.996	1.008	0.985	1.024
SE	1.030	1.008	1.022	0.993	1.006	0.987	1.008	0.998	1.011	1.009	1.002	1.007	1.000	1.003	0.997	1.019	0.999	1.019
SE1	1.022	1.000	1.022	0.987	1.000	0.987	1.019	1.000	1.019	1.003	1.000	1.003	0.994	1.000	0.994	1.019	1.000	1.019
SE2	1.032	1.009	1.023	0.992	1.002	0.990	1.006	1.003	1.002	1.010	0.996	1.014	1.004	1.007	0.997	1.020	1.001	1.019
SE3	1.044	1.026	1.018	1.015	1.028	0.988	0.999	0.989	1.010	1.017	1.013	1.004	0.997	0.999	0.998	1.015	0.996	1.019
IS													0.999	1.008	0.991	0.993	0.968	1.025
IS0													0.999	1.008	0.991	0.993	0.968	1.025
NO	1.010	0.987	1.023	1.003	1.032	0.972	0.999	0.969	1.031	1.000	0.996	1.005	1.000	1.003	0.997	1.008	0.989	1.019
NO0	1.010	0.987	1.023	1.003	1.032	0.972	0.999	0.969	1.031	1.000	0.996	1.005	1.000	1.003	0.997	1.008	0.989	1.019
CH																		
CH0																		
UK	1.081	1.033	1.046	1.079	1.040	1.038	0.996	1.007	0.989	1.000	0.997	1.003	1.003	1.005	0.998	1.003	0.984	1.019
UKC	1.029	1.019	1.009	1.036	1.032	1.003	0.997	1.010	0.987	0.995	0.992	1.003	1.004	1.007	0.998	0.998	0.979	1.019
UKD	1.041	1.031	1.009	1.037	1.034	1.003	1.002	1.015	0.987	0.998	0.995	1.003	0.999	1.001	0.998	1.005	0.986	1.019
UKE	1.048	1.038	1.009	1.047	1.044	1.003	0.998	1.011	0.987	1.002	0.999	1.003	1.005	1.008	0.998	0.996	0.977	1.019
UKF	1.068	1.027	1.040	1.075	1.040	1.033	0.986	0.998	0.987	1.005	1.003	1.003	1.007	1.009	0.998	0.996	0.977	1.019
UKG	1.057	1.036	1.020	1.046	1.032	1.013	0.995	1.008	0.987	1.000	0.997	1.003	1.010	1.012	0.997	1.006	0.987	1.019
UKH	1.071	1.033	1.037	1.047	1.047	1.000	1.017	1.000	1.017	0.998	0.995	1.003	1.005	1.007	0.998	1.003	0.984	1.019
UKI	1.022	1.000	1.022	1.019	1.000	1.019	1.000	1.000	1.000	1.002	1.000	1.002	0.997	1.000	0.997	1.004	1.000	1.004
UKJ	1.067	1.016	1.050	1.010	1.017	0.993	1.008	0.973	1.036	1.042	1.038	1.004	1.001	1.003	0.998	1.005	0.986	1.019
UKK	1.066	1.017	1.049	1.001	1.007	0.994	1.002	0.969	1.034	1.061	1.056	1.004	1.000	1.002	0.998	1.003	0.984	1.019
UKL	1.011	1.002	1.010	1.004	1.009	0.996	1.011	1.017	0.994	0.997	0.994	1.003	1.018	1.026	0.992	0.982	0.958	1.025
UKM	1.045	1.018	1.027	1.017	1.022	0.995	1.025	1.011	1.014	0.993	0.991	1.002	0.976	0.982	0.994	1.034	1.012	1.022
UKN				1.013	1.022	0.991	1.010	0.976	1.035	0.994	0.994	1.001	1.039	1.044	0.996			
MK				1.013	1.021	0.993	1.027	1.025	1.002	1.009	1.006	1.003	1.020	1.014	1.006			
MK0				1.013	1.021	0.993	1.027	1.025	1.002	1.009	1.006	1.003	1.020	1.014	1.006			
RS																1.009	0.982	1.027
RS1																		
RS2																		
N	117	117	117	123	123	123	124	124	124	122	122	122	123	123	123	124	124	124
Min	0.953	0.944	1.009	0.968	0.961	0.972	0.980	0.953	0.970	0.974	0.972	0.998	0.966	0.968	0.986	0.978	0.952	1.004
25-perc	1.007	0.986	1.009	0.999	1.000	0.993	0.999	0.999	0.987	0.998	0.994	1.003	0.999	1.000	0.997	0.998	0.978	1.019
Average	1.023	1.002	1.021	1.007	1.008	0.999	1.004	1.005	0.999	1.005	1.001	1.004	1.004	1.006	0.999	1.004	0.983	1.022
Median	1.021	1.002	1.018	1.004	1.006	1.000	1.003	1.007	1.000	1.003	0.999	1.003	1.003	1.006	0.998	1.005	0.984	1.019
75-perc	1.036	1.015	1.032	1.012	1.017	1.003	1.008	1.015	1.003	1.009	1.005	1.004	1.010	1.010	1.000	1.008	0.989	1.025
Max	1.084	1.057	1.051	1.079	1.050	1.038	1.074	1.107	1.036	1.061	1.056	1.019	1.039	1.044	1.009	1.034	1.012	1.029
Std Dev	0.024	0.022	0.012	0.015	0.015	0.010	0.011	0.017	0.013	0.012	0.011	0.003	0.010	0.010	0.005	0.010	0.011	0.004

Table D.4: Convergence results of the deterministic model for all data

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.008	1.012	0.999	0.987
2015/2016	1.005	1.017	0.999	0.982
2016/2017	1.001	1.014	1.004	0.990
2017/2018	1.006	1.015	0.999	0.984
2018/2019	0.983	1.032	1.022	0.990
2014/2019	1.001	1.093	1.021	0.987

D.2 Robust model

Table D.5: BoD results of the robust model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
BE	0.919	54	0.909	60	0.920	58	0.928	55	0.931	58	0.918	57
BE1	0.944	32	0.942	44	0.945	40	0.968	29	0.971	30	0.954	39
BE2	0.933	41	0.923	52	0.933	48	0.936	52	0.939	51	0.929	51
BE3	0.888	75	0.883	89	0.895	77	0.901	77	0.906	81	0.889	81
BG	0.804	117	0.805	116	0.803	119	0.815	121	0.815	121	0.787	129
BG3	0.761	123	0.758	123	0.755	123	0.766	126	0.762	126	0.730	132
BG4	0.850	107	0.849	110	0.845	113	0.857	110	0.862	110	0.836	123
CZ	0.899	70	0.897	69	0.897	75	0.905	72	0.899	88	0.875	101
CZ0	0.899	69	0.896	71	0.897	73	0.904	74	0.899	89	0.875	99
DK	1.033	4	1.035	3	1.014	6	1.006	7	1.000	9	0.984	10
DK0	1.034	3	1.034	4	1.012	7	1.006	6	1.000	9	0.984	12
DE	0.888	76	0.891	78	0.892	82	0.889	89	0.902	84	0.883	87
DE1	0.909	59	0.909	59	0.914	61	0.914	65	0.912	71	0.898	73
DE2	0.902	63	0.908	63	0.897	74	0.903	75	0.901	85	0.890	79
DE3	0.909	58	0.918	55	0.919	59	0.924	58	0.927	61	0.917	58
DE4	0.875	95	0.871	97	0.878	97	0.865	106	0.870	103	0.857	115
DE5	0.885	79	0.925	51	0.895	79	0.899	79	0.898	90	0.905	67
DE6	0.922	50	0.923	54	0.927	52	0.924	59	0.937	54	0.906	65
DE7	0.890	73	0.910	58	0.902	66	0.899	80	0.910	76	0.894	76
DE8	0.875	94	0.874	93	0.884	91	0.879	97	0.877	101	0.869	106
DE9	0.880	84	0.890	79	0.885	85	0.896	82	0.900	86	0.881	95
DEA	0.878	86	0.886	83	0.884	88	0.881	96	0.906	80	0.876	97
DEB	0.899	68	0.897	68	0.903	65	0.899	78	0.904	82	0.883	86
DEC	0.883	82	0.887	82	0.887	84	0.874	101	0.892	93	0.881	93
DED	0.901	64	0.894	72	0.902	68	0.896	83	0.902	83	0.886	84
DEE	0.877	90	0.869	98	0.864	104	0.858	109	0.866	106	0.866	108
DEF	0.876	93	0.887	81	0.884	86	0.878	98	0.907	79	0.883	89
DEG	0.900	66	0.890	80	0.888	83	0.898	81	0.912	74	0.886	85
EE	0.878	87	0.886	85	0.900	71	0.908	67	0.924	63	0.908	64
EE0	0.878	88	0.886	84	0.900	70	0.908	68	0.924	62	0.908	63
IE	0.944	33	0.942	43	0.945	42	0.969	27	0.989	18	0.972	20
IE0	0.944	34	0.943	42	0.945	43	0.968	30	0.990	17	0.971	21
EL	0.838	110	0.857	105	0.874	99	0.882	92			0.876	98
EL3							0.922	60			0.893	77
EL4							0.826	120			0.841	122
EL5							0.882	93			0.883	88
EL6							0.843	117			0.863	112
ES	0.901	65	0.901	65	0.909	64	0.914	63	0.923	64	0.915	59
ES1	0.912	57	0.918	56	0.921	57	0.927	56	0.933	57	0.927	52
ES2	0.942	36	0.946	41	0.953	35	0.956	39	0.963	36	0.954	37
ES3	0.953	30	0.933	46	0.932	50	0.940	51	0.950	48	0.948	45
ES4	0.900	67	0.901	66	0.909	63	0.914	64	0.919	66	0.913	60
ES5	0.893	71	0.891	77	0.898	72	0.905	71	0.918	67	0.912	61
ES6	0.892	72	0.894	74	0.902	67	0.904	73	0.911	75	0.904	69
ES7	0.881	83	0.878	90	0.893	81	0.894	84	0.900	87	0.889	80
FR	0.969	20	0.972	19	0.980	17	0.979	18	0.982	20	0.974	19
FR1	1.009	7	1.030	5	1.027	3	1.042	3	1.036	5	1.047	4
FRB	0.953	28	0.957	28	0.965	25	0.966	32	0.977	28	0.963	31
FRC	0.953	31	0.941	45	0.962	28	0.959	34	0.960	41	0.954	38
FRD	0.941	37	0.954	31	0.960	29	0.955	40	0.962	38	0.956	35
FRE	0.954	26	0.947	40	0.958	31	0.956	38	0.963	35	0.955	36
FRF	0.942	35	0.950	35	0.963	27	0.959	36	0.970	31	0.966	29
FRG	0.970	18	0.973	18	0.982	14	0.995	10	0.990	16	0.981	14
FRH	0.992	12	0.977	17	0.990	9	0.982	14	1.000	9	0.984	11
FRI	0.958	23	0.963	23	0.971	24	0.976	25	0.979	26	0.970	25
FRJ	1.004	10	0.978	15	0.987	11	0.988	13	1.001	8	0.982	13
FRK	1.000	11	0.997	11	1.003	8	1.001	8	1.004	6	1.001	8
FRL	0.961	22	0.968	21	0.972	22	0.967	31	0.965	33	0.960	34
FRM	0.859	105	0.825	114	0.922	55						
FRY			0.909	62	0.917	60	0.912	66	0.915	68	0.909	62
HR	0.884	81	0.894	73	0.895	80	0.893	86	0.896	91	0.882	90
HR0	0.885	80	0.893	75	0.895	78	0.894	85	0.896	92	0.882	91
IT	0.864	101	0.860	103	0.873	102	0.865	103	0.866	107	0.864	111
ITC	0.849	108	0.848	111	0.863	105	0.865	105	0.869	104	0.864	110
ITF	0.888	77	0.885	86	0.895	76	0.885	90	0.878	100	0.875	100
ITG	0.869	99	0.864	102	0.873	101	0.850	115	0.848	116	0.849	117
ITH	0.863	102	0.869	99	0.880	95	0.877	100	0.886	99	0.874	102
ITI	0.853	106	0.858	104	0.865	103	0.865	104	0.864	109	0.860	114
CY	0.938	39	0.952	34	0.944	44	0.949	43	0.962	37	0.952	40
CY0	0.939	38	0.954	30	0.945	41	0.948	44	0.959	43	0.950	43
LV	0.874	97	0.873	95	0.884	89	0.892	87	0.890	97	0.882	92
LV0	0.874	96	0.873	96	0.884	87	0.892	88	0.890	98	0.881	94

Table D.5: BoD results of the robust model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank
LT	0.929	43	0.948	38	0.948	38	0.948	45	0.952	46	0.937	48
LT0	0.928	46	0.950	36	0.947	39	0.949	42	0.951	47	0.937	49
LU	0.989	14	0.997	10	0.981	16	0.977	23	0.981	21	0.979	15
LU0	0.990	13	0.996	12	0.982	15	0.977	20	0.981	22	0.979	16
HU	0.832	111	0.853	106	0.851	111	0.851	114	0.853	115	0.847	119
HU1	0.887	78	0.899	67	0.884	90	0.902	76	0.909	78	0.900	72
HU2	0.822	112	0.851	107	0.854	109	0.849	116	0.842	119	0.834	124
HU3	0.813	115	0.834	113	0.853	110	0.855	111	0.857	114	0.852	116
MT	0.877	89	0.885	87	0.882	94	0.882	94	0.892	95	0.872	104
MT0	0.876	91	0.885	88	0.882	93	0.882	95	0.892	94	0.872	103
NL	0.979	17	0.988	14	0.974	19	0.980	15	0.986	19	0.970	27
AT	0.919	53	0.923	53	0.929	51	0.934	54	0.928	60	0.906	66
AT1	0.930	42	0.931	49	0.938	45	0.936	53	0.936	55	0.920	56
AT2	0.924	48	0.926	50	0.927	53	0.943	50	0.936	56	0.904	70
AT3	0.906	60	0.913	57	0.921	56	0.924	57	0.914	69	0.898	74
PL	0.890	74	0.896	70	0.900	69	0.905	70	0.912	73	0.889	82
PL2	0.903	61	0.902	64	0.914	62	0.920	61	0.930	59	0.902	71
PL4	0.872	98	0.875	92	0.880	96	0.883	91	0.890	96	0.877	96
PL5	0.879	85	0.877	91	0.877	98	0.907	69	0.923	65	0.891	78
PL6	0.865	100	0.873	94	0.874	100	0.877	99	0.873	102	0.865	109
PL7									0.910	77	0.896	75
PL8									0.913	70	0.886	83
PL9									0.959	44	0.925	53
PT	0.818	114	0.844	112	0.844	114	0.861	108	0.865	108	0.868	107
PT1	0.820	113	0.850	108	0.849	112	0.863	107	0.869	105	0.870	105
PT2	0.769	122	0.779	121	0.790	121	0.803	124	0.819	120	0.812	126
PT3	0.843	109	0.850	109	0.856	108						
RO	0.758	124	0.759	122	0.767	122	0.765	127	0.775	125	0.769	130
RO1	0.806	116	0.799	119	0.810	117	0.806	123	0.784	124	0.767	131
RO2	0.730	125	0.736	124	0.738	124	0.732	128	0.730	127	0.728	133
RO3	0.777	121	0.790	120	0.795	120	0.807	122	0.802	123	0.796	128
RO4	0.792	118	0.807	115	0.805	118	0.791	125	0.805	122	0.808	127
SI	0.928	44	0.932	48	0.932	49	0.945	48	0.938	53	0.921	54
SI0	0.928	45	0.932	47	0.933	47	0.944	49	0.938	52	0.920	55
SK	0.860	103	0.864	101	0.862	106	0.853	112	0.861	112	0.846	120
SK0	0.860	104	0.864	100	0.861	107	0.853	113	0.861	111	0.846	121
FI	0.955	25	0.961	25	0.973	20	0.979	17	0.993	14	0.976	17
FI1	0.953	29	0.961	26	0.972	21	0.980	16	0.992	15	0.976	18
SE	1.011	6	1.020	6	1.022	4	1.032	5	1.039	4	1.045	5
SE1	1.062	2	1.062	2	1.077	2	1.070	2	1.074	2	1.083	1
SE2	1.015	5	1.015	7	1.021	5	1.034	4	1.045	3	1.050	3
SE3	0.963	21	0.992	13	0.978	18	0.996	9	1.001	7	1.000	9
IS	1.005	8					0.992	12	0.998	12	0.970	23
IS0	1.005	9					0.993	11	0.998	13	0.969	28
NO	0.987	16	1.004	8	0.987	13	0.977	22	0.979	25	0.970	24
NO0	0.988	15	1.004	9	0.987	12	0.977	19	0.979	23	0.970	26
CH											1.013	7
CH0											1.014	6
UK	0.935	40	0.972	20	0.971	23	0.969	28	0.973	29	0.961	33
UKC	0.920	51	0.949	37	0.954	34	0.947	46	0.952	45	0.935	50
UKD	0.924	47	0.954	29	0.964	26	0.961	33	0.960	42	0.952	41
UKE	0.913	56	0.953	33	0.958	32	0.958	37	0.964	34	0.946	47
UKF	0.924	49	0.962	24	0.955	33	0.959	35	0.967	32	0.947	46
UKG	0.916	55	0.947	39	0.949	37	0.947	47	0.960	39	0.950	42
UKH	0.920	52	0.958	27	0.958	30	0.955	41	0.960	40	0.950	44
UKI	1.085	1	1.103	1	1.101	1	1.097	1	1.089	1	1.078	2
UKJ	0.956	24	0.963	22	0.951	36	0.976	26	0.979	24	0.970	22
UKK	0.954	27	0.953	32	0.937	46	0.977	24	0.977	27	0.966	30
UKL	0.902	62	0.909	61	0.922	54	0.917	62	0.946	50	0.905	68
UKM	0.969	19	0.978	16	0.989	10	0.977	21	0.946	49	0.963	32
UKN	0.876	92	0.892	76	0.883	92	0.874	102	0.912	72		
MK	0.786	120	0.801	118	0.821	116	0.830	119	0.843	117		
MK0	0.787	119	0.801	117	0.821	115	0.830	118	0.843	118		
RS									0.861	113	0.848	118
RS1											0.863	113
RS2											0.831	125
N	125		124		124		128		127		133	
Min	0.730		0.736		0.738		0.732		0.730		0.728	
25-perc	0.875		0.874		0.882		0.880		0.890		0.875	
Average	0.907		0.911		0.915		0.918		0.924		0.912	
Median	0.902		0.908		0.912		0.914		0.923		0.905	
75-perc	0.949		0.954		0.958		0.964		0.967		0.960	
Max	1.085		1.103		1.101		1.097		1.089		1.083	
Std Dev	0.064		0.064		0.061		0.062		0.061		0.063	

Table D.6: BoD results against the metafrontiers of the robust model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE	0.915	0.833	0.910	0.840	0.914	0.826	0.922	0.818	0.927	0.814	0.927	0.811
BE1	0.936	0.847	0.935	0.853	0.936	0.842	0.963	0.817	0.970	0.805	0.967	0.813
BE2	0.927	0.810	0.921	0.818	0.926	0.810	0.932	0.805	0.936	0.801	0.941	0.795
BE3	0.886	0.873	0.883	0.878	0.888	0.856	0.895	0.845	0.900	0.836	0.896	0.845
BG	0.800	1.058	0.797	1.037	0.798	0.998	0.808	0.973	0.811	0.953	0.800	0.962
BG3	0.759	1.174	0.752	1.140	0.749	1.062	0.761	1.050	0.758	1.028	0.742	1.046
BG4	0.846	0.997	0.841	0.971	0.839	0.960	0.850	0.925	0.859	0.907	0.849	0.911
CZ	0.894	0.879	0.888	0.867	0.891	0.852	0.896	0.843	0.896	0.845	0.890	0.851
CZ0	0.894	0.879	0.888	0.866	0.891	0.852	0.896	0.842	0.896	0.845	0.890	0.850
DK	1.038	0.739	1.036	0.739	1.010	0.744	1.011	0.750	0.995	0.769	1.000	0.760
DK0	1.043	0.739	1.036	0.740	1.009	0.745	1.011	0.752	0.995	0.770	1.000	0.762
DE	0.885	0.844	0.888	0.844	0.888	0.844	0.889	0.841	0.895	0.844	0.900	0.841
DE1	0.906	0.824	0.909	0.822	0.908	0.823	0.910	0.820	0.908	0.827	0.913	0.823
DE2	0.898	0.826	0.900	0.822	0.892	0.829	0.897	0.826	0.900	0.825	0.907	0.826
DE3	0.904	0.846	0.908	0.845	0.913	0.828	0.925	0.835	0.923	0.842	0.935	0.827
DE4	0.872	0.982	0.872	0.961	0.871	0.908	0.860	0.932	0.863	0.891	0.865	0.901
DE5	0.868	0.870	0.900	0.858	0.889	0.857	0.900	0.854	0.893	0.874	0.922	0.886
DE6	0.919	0.832	0.922	0.839	0.920	0.834	0.926	0.828	0.931	0.823	0.923	0.840
DE7	0.887	0.840	0.893	0.837	0.896	0.838	0.901	0.833	0.904	0.839	0.909	0.834
DE8	0.872	0.942	0.872	0.934	0.878	0.906	0.873	0.898	0.871	0.875	0.880	0.868
DE9	0.877	0.875	0.878	0.865	0.878	0.878	0.898	0.866	0.894	0.862	0.896	0.862
DEA	0.875	0.867	0.880	0.863	0.878	0.858	0.884	0.859	0.900	0.859	0.894	0.855
DEB	0.896	0.857	0.896	0.858	0.897	0.852	0.898	0.854	0.901	0.848	0.898	0.848
DEC	0.881	0.904	0.879	0.908	0.880	0.859	0.870	0.880	0.886	0.870	0.897	0.857
DED	0.898	0.835	0.894	0.842	0.896	0.831	0.891	0.836	0.898	0.825	0.896	0.829
DEE	0.874	0.971	0.868	0.962	0.859	0.948	0.858	0.961	0.862	0.961	0.881	0.927
DEF	0.863	0.906	0.872	0.895	0.878	0.876	0.874	0.869	0.901	0.863	0.899	0.872
DEG	0.897	0.869	0.889	0.882	0.884	0.863	0.895	0.844	0.906	0.830	0.898	0.839
EE	0.873	0.848	0.872	0.854	0.895	0.827	0.905	0.819	0.920	0.810	0.921	0.806
EE0	0.874	0.847	0.873	0.854	0.894	0.826	0.905	0.819	0.920	0.810	0.921	0.805
IE	0.925	0.854	0.928	0.856	0.937	0.834	0.965	0.786	0.991	0.769	0.988	0.770
IE0	0.925	0.855	0.927	0.856	0.937	0.835	0.966	0.786	0.993	0.770	0.988	0.769
EL	0.833	1.060	0.848	1.004	0.867	0.977	0.872	0.961			0.891	0.917
EL3							0.914	0.960			0.911	0.915
EL4							0.819	0.985			0.856	0.981
EL5							0.874	0.968			0.899	0.903
EL6							0.836	1.033			0.879	0.938
ES	0.899	0.921	0.902	0.902	0.902	0.889	0.909	0.880	0.918	0.868	0.925	0.859
ES1	0.905	0.888	0.913	0.869	0.913	0.859	0.922	0.850	0.930	0.838	0.939	0.825
ES2	0.931	0.848	0.937	0.836	0.943	0.828	0.951	0.810	0.964	0.806	0.969	0.803
ES3	0.937	0.862	0.925	0.846	0.923	0.840	0.935	0.830	0.950	0.826	0.968	0.810
ES4	0.898	0.931	0.901	0.912	0.902	0.910	0.908	0.897	0.913	0.883	0.921	0.869
ES5	0.889	0.932	0.891	0.909	0.891	0.896	0.900	0.888	0.914	0.873	0.924	0.864
ES6	0.890	0.984	0.894	0.956	0.895	0.940	0.898	0.934	0.905	0.920	0.912	0.905
ES7	0.879	0.952	0.877	0.933	0.886	0.901	0.889	0.888	0.894	0.902	0.898	0.893
FR	0.965	0.788	0.971	0.788	0.973	0.782	0.973	0.782	0.978	0.777	0.985	0.770
FR1	0.994	0.771	1.017	0.771	1.020	0.765	1.040	0.759	1.040	0.759	1.083	0.747
FRB	0.951	0.793	0.957	0.788	0.958	0.786	0.959	0.791	0.971	0.779	0.972	0.794
FRC	0.951	0.803	0.940	0.818	0.955	0.792	0.952	0.801	0.955	0.802	0.962	0.795
FRD	0.939	0.814	0.953	0.794	0.952	0.790	0.950	0.802	0.956	0.800	0.964	0.798
FRE	0.952	0.816	0.947	0.828	0.951	0.818	0.950	0.817	0.958	0.811	0.963	0.800
FRF	0.940	0.804	0.950	0.800	0.956	0.788	0.952	0.793	0.964	0.789	0.974	0.775
FRG	0.969	0.774	0.972	0.771	0.975	0.773	0.989	0.760	0.985	0.763	0.990	0.757
FRH	0.987	0.767	0.973	0.774	0.984	0.760	0.975	0.766	0.996	0.754	0.995	0.751
FRI	0.956	0.791	0.961	0.781	0.963	0.781	0.970	0.775	0.973	0.775	0.979	0.772
FRJ	0.995	0.765	0.976	0.784	0.980	0.778	0.982	0.779	0.997	0.755	0.992	0.765
FRK	0.994	0.763	0.991	0.769	0.997	0.760	0.995	0.761	1.000	0.756	1.015	0.744
FRL	0.958	0.811	0.967	0.800	0.964	0.805	0.961	0.804	0.959	0.798	0.968	0.778
FRM	0.857	0.913	0.825	1.049	0.915	0.841						
FRY			0.909	0.929	0.910	0.932	0.907	0.938	0.910	0.926	0.917	0.897
HR	0.879	0.995	0.885	0.948	0.887	0.933	0.886	0.921	0.891	0.895	0.898	0.882
HR0	0.880	1.000	0.885	0.947	0.888	0.933	0.886	0.922	0.892	0.897	0.897	0.882
IT	0.862	0.923	0.860	0.910	0.866	0.892	0.860	0.887	0.861	0.883	0.871	0.874
ITC	0.847	0.897	0.847	0.889	0.858	0.871	0.860	0.866	0.863	0.868	0.872	0.854
ITF	0.886	0.989	0.885	0.974	0.888	0.957	0.879	0.938	0.872	0.941	0.882	0.932
ITG	0.867	1.067	0.864	1.062	0.867	1.009	0.845	0.985	0.842	0.993	0.857	0.983
ITH	0.859	0.885	0.861	0.868	0.874	0.852	0.872	0.854	0.881	0.841	0.884	0.837
ITI	0.852	0.891	0.851	0.879	0.860	0.864	0.859	0.864	0.861	0.860	0.869	0.853
CY	0.916	0.931	0.939	0.872	0.938	0.865	0.943	0.845	0.963	0.826	0.977	0.828
CY0	0.916	0.931	0.938	0.873	0.937	0.864	0.944	0.845	0.964	0.826	0.976	0.828
LV	0.870	0.875	0.866	0.870	0.880	0.855	0.888	0.845	0.886	0.841	0.892	0.831
LV0	0.870	0.874	0.866	0.871	0.880	0.856	0.888	0.844	0.886	0.841	0.892	0.832
LT	0.913	0.908	0.933	0.880	0.939	0.858	0.943	0.845	0.950	0.829	0.955	0.817
LT0	0.912	0.905	0.932	0.882	0.940	0.858	0.943	0.844	0.952	0.829	0.955	0.817
LU	0.970	0.791	0.974	0.800	0.978	0.789	0.979	0.789	0.981	0.784	1.004	0.780

Table D.6: BoD results against the metafrontiers of the robust model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
LU0	0.969	0.790	0.973	0.800	0.978	0.788	0.978	0.790	0.981	0.785	1.005	0.779
HU	0.829	0.914	0.845	0.887	0.846	0.885	0.847	0.883	0.848	0.881	0.855	0.873
HU1	0.882	0.859	0.890	0.841	0.878	0.848	0.894	0.838	0.905	0.827	0.914	0.819
HU2	0.819	0.946	0.845	0.896	0.849	0.894	0.843	0.905	0.836	0.923	0.842	0.915
HU3	0.811	0.977	0.834	0.942	0.846	0.933	0.850	0.924	0.852	0.918	0.859	0.905
MT	0.875	0.900	0.884	0.893	0.875	0.884	0.876	0.860	0.887	0.854	0.880	0.851
MT0	0.874	0.899	0.885	0.892	0.875	0.884	0.876	0.861	0.887	0.853	0.880	0.850
NL	0.957	0.792	0.963	0.784	0.968	0.780	0.984	0.771	0.980	0.783	0.988	0.778
AT	0.915	0.827	0.915	0.822	0.923	0.813	0.925	0.806	0.924	0.807	0.920	0.809
AT1	0.925	0.809	0.922	0.804	0.932	0.795	0.932	0.794	0.933	0.793	0.933	0.795
AT2	0.920	0.856	0.917	0.851	0.920	0.842	0.935	0.826	0.931	0.826	0.920	0.831
AT3	0.902	0.839	0.906	0.836	0.915	0.823	0.915	0.817	0.911	0.820	0.913	0.817
PL	0.886	0.893	0.888	0.880	0.894	0.854	0.897	0.854	0.907	0.835	0.903	0.833
PL2	0.898	0.895	0.893	0.880	0.907	0.846	0.912	0.841	0.927	0.822	0.918	0.825
PL4	0.868	0.909	0.867	0.888	0.874	0.874	0.877	0.873	0.886	0.853	0.890	0.847
PL5	0.875	0.894	0.870	0.889	0.870	0.867	0.899	0.856	0.919	0.831	0.906	0.832
PL6	0.861	0.921	0.866	0.913	0.868	0.884	0.869	0.885	0.869	0.874	0.879	0.850
PL7									0.906	0.846	0.910	0.831
PL8									0.910	0.844	0.901	0.833
PL9									0.960	0.793	0.942	0.818
PT	0.816	0.952	0.837	0.906	0.839	0.893	0.857	0.873	0.861	0.864	0.878	0.847
PT1	0.819	0.947	0.843	0.900	0.844	0.888	0.860	0.869	0.865	0.860	0.881	0.843
PT2	0.768	1.138	0.779	1.053	0.784	1.022	0.799	1.025	0.815	1.035	0.820	1.074
PT3	0.841	0.987	0.850	0.979	0.849	0.957						
RO	0.754	1.075	0.757	1.045	0.763	1.031	0.761	1.025	0.771	1.057	0.783	1.013
RO1	0.804	1.141	0.799	1.036	0.804	1.017	0.801	1.017	0.780	1.072	0.782	1.058
RO2	0.728	1.187	0.736	1.251	0.732	1.244	0.727	1.224	0.727	1.232	0.741	1.220
RO3	0.774	1.017	0.783	0.995	0.789	0.982	0.801	0.984	0.800	0.987	0.810	0.954
RO4	0.789	1.157	0.800	1.028	0.800	1.031	0.785	1.055	0.802	1.110	0.822	1.048
SI	0.924	0.835	0.923	0.830	0.926	0.824	0.936	0.810	0.935	0.804	0.935	0.798
SI0	0.925	0.833	0.923	0.832	0.926	0.825	0.936	0.810	0.933	0.805	0.936	0.798
SK	0.856	0.943	0.856	0.939	0.855	0.930	0.845	0.927	0.857	0.905	0.860	0.902
SK0	0.856	0.944	0.856	0.938	0.855	0.931	0.846	0.925	0.857	0.906	0.860	0.902
FI	0.944	0.809	0.949	0.807	0.968	0.785	0.978	0.781	0.987	0.773	0.997	0.760
FI1	0.945	0.810	0.948	0.807	0.966	0.784	0.980	0.780	0.986	0.773	1.001	0.760
SE	1.007	0.743	1.008	0.745	1.016	0.742	1.026	0.740	1.038	0.738	1.104	0.721
SE1	1.046	0.735	1.047	0.741	1.068	0.736	1.065	0.732	1.072	0.730	1.144	0.713
SE2	1.013	0.740	1.006	0.745	1.013	0.741	1.028	0.740	1.045	0.736	1.117	0.721
SE3	0.959	0.778	0.982	0.755	0.972	0.766	0.994	0.755	0.990	0.757	1.022	0.748
IS	0.991	0.816					0.996	0.809	0.993	0.840	0.987	0.815
IS0	0.989	0.817					0.995	0.808	0.994	0.840	0.987	0.815
NO	0.974	0.786	0.982	0.777	0.981	0.781	0.980	0.778	0.977	0.778	0.988	0.778
NO0	0.973	0.786	0.981	0.778	0.982	0.782	0.979	0.779	0.977	0.778	0.988	0.778
CH											1.060	0.870
CH0											1.060	0.864
UK	0.912	0.816	0.967	0.795	0.964	0.801	0.965	0.796	0.969	0.795	0.973	0.794
UKC	0.917	0.830	0.949	0.817	0.947	0.828	0.941	0.821	0.946	0.809	0.943	0.832
UKD	0.921	0.825	0.954	0.816	0.957	0.800	0.955	0.803	0.954	0.805	0.961	0.809
UKE	0.911	0.842	0.952	0.819	0.951	0.813	0.952	0.824	0.959	0.821	0.954	0.815
UKF	0.908	0.817	0.961	0.799	0.947	0.828	0.953	0.809	0.962	0.799	0.956	0.808
UKG	0.909	0.854	0.946	0.827	0.941	0.838	0.943	0.834	0.956	0.821	0.963	0.803
UKH	0.903	0.827	0.941	0.808	0.951	0.818	0.949	0.826	0.955	0.817	0.961	0.817
UKI	1.051	0.759	1.085	0.748	1.094	0.751	1.092	0.750	1.096	0.755	1.109	0.754
UKJ	0.932	0.812	0.937	0.829	0.945	0.811	0.974	0.784	0.975	0.781	0.986	0.773
UKK	0.932	0.806	0.931	0.830	0.931	0.811	0.972	0.782	0.971	0.783	0.976	0.796
UKL	0.900	0.829	0.903	0.831	0.917	0.817	0.914	0.814	0.940	0.820	0.919	0.829
UKM	0.940	0.844	0.960	0.849	0.983	0.840	0.972	0.840	0.945	0.849	0.985	0.829
UKN	0.857	0.900	0.870	0.883	0.878	0.880	0.874	0.873	0.906	0.856		
MK	0.782	1.435	0.792	1.386	0.814	1.225	0.821	1.295	0.838	1.216		
MK0	0.782	1.443	0.792	1.401	0.814	1.233	0.822	1.283	0.837	1.218		
RS									0.856	0.972	0.863	0.945
RS1											0.877	0.899
RS2											0.846	1.046
N	125	125	124	124	124	124	128	128	127	127	133	133
Min	0.728	0.735	0.736	0.739	0.732	0.736	0.727	0.732	0.727	0.730	0.741	0.713
25-perc	0.869	0.816	0.869	0.817	0.875	0.811	0.874	0.803	0.886	0.799	0.887	0.798
Average	0.900	0.889	0.904	0.879	0.909	0.863	0.913	0.860	0.920	0.851	0.927	0.845
Median	0.898	0.859	0.901	0.858	0.905	0.847	0.908	0.842	0.919	0.830	0.920	0.831
75-perc	0.936	0.931	0.948	0.909	0.951	0.891	0.958	0.888	0.964	0.873	0.974	0.872
Max	1.051	1.443	1.085	1.401	1.094	1.244	1.092	1.295	1.096	1.232	1.144	1.220
Std Dev	0.062	0.117	0.062	0.107	0.061	0.090	0.063	0.095	0.062	0.090	0.068	0.077

Table D.7: Performance evolution assessment of the robust model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.013	0.998	1.015	0.995	0.989	1.005	1.005	1.012	0.993	1.009	1.008	1.001	1.005	1.003	1.002	1.000	0.986	1.014
BE1	1.033	1.010	1.023	0.999	0.997	1.002	1.001	1.003	0.998	1.028	1.025	1.003	1.008	1.003	1.005	0.996	0.982	1.014
BE2	1.015	0.995	1.020	0.994	0.989	1.004	1.005	1.010	0.995	1.006	1.004	1.003	1.004	1.003	1.001	1.006	0.989	1.017
BE3	1.011	1.001	1.010	0.996	0.994	1.002	1.006	1.013	0.992	1.008	1.007	1.001	1.006	1.005	1.000	0.996	0.982	1.014
BG	1.000	0.979	1.022	0.996	1.001	0.995	1.000	0.998	1.002	1.013	1.015	0.998	1.004	1.000	1.004	0.986	0.965	1.022
BG3	0.978	0.960	1.019	0.991	0.996	0.995	0.996	0.996	1.000	1.015	1.015	1.000	0.997	0.994	1.002	0.979	0.958	1.021
BG4	1.004	0.984	1.021	0.995	0.999	0.996	0.997	0.995	1.002	1.013	1.015	0.998	1.011	1.006	1.005	0.989	0.970	1.020
CZ	0.995	0.974	1.022	0.993	0.998	0.995	1.003	1.000	1.002	1.006	1.008	0.998	1.000	0.994	1.005	0.994	0.973	1.022
CZ0	0.995	0.974	1.022	0.994	0.997	0.996	1.002	1.001	1.001	1.006	1.007	0.999	0.999	0.995	1.004	0.993	0.973	1.021
DK	0.963	0.953	1.011	0.998	1.001	0.997	0.975	0.980	0.996	1.001	0.992	1.008	0.985	0.994	0.990	1.004	0.985	1.020
DK0	0.958	0.951	1.008	0.993	1.000	0.994	0.974	0.979	0.995	1.001	0.994	1.008	0.984	0.994	0.990	1.005	0.984	1.021
DE	1.017	0.994	1.023	1.003	1.003	1.001	1.000	1.002	0.998	1.002	0.997	1.005	1.007	1.014	0.993	1.005	0.979	1.027
DE1	1.007	0.989	1.019	1.004	1.001	1.003	0.999	1.005	0.994	1.002	0.999	1.002	0.998	0.999	0.999	1.005	0.985	1.021
DE2	1.010	0.987	1.024	1.003	1.007	0.997	0.991	0.988	1.003	1.006	1.006	0.999	1.003	0.998	1.005	1.008	0.988	1.020
DE3	1.034	1.008	1.026	1.005	1.010	0.995	1.005	1.001	1.004	1.014	1.005	1.009	0.998	1.004	0.994	1.012	0.989	1.023
DE4	0.991	0.980	1.012	0.999	0.996	1.003	1.000	1.007	0.992	0.987	0.985	1.002	1.004	1.006	0.999	1.002	0.986	1.016
DE5	1.062	1.023	1.038	1.038	1.046	0.993	0.987	0.967	1.020	1.013	1.004	1.009	0.992	0.999	0.992	1.032	1.008	1.024
DE6	1.004	0.983	1.021	1.003	1.001	1.002	0.998	1.005	0.993	1.006	0.996	1.010	1.006	1.015	0.991	0.991	0.967	1.025
DE7	1.025	1.004	1.021	1.006	1.022	0.985	1.004	0.992	1.012	1.006	0.996	1.010	1.003	1.013	0.990	1.007	0.982	1.025
DE8	1.009	0.993	1.015	1.000	0.999	1.001	1.006	1.011	0.995	0.995	0.995	1.000	0.997	0.998	0.999	1.011	0.991	1.020
DE9	1.021	1.001	1.020	1.000	1.012	0.988	1.000	0.994	1.006	1.023	1.013	1.010	0.996	1.004	0.992	1.002	0.979	1.024
DEA	1.021	0.998	1.023	1.005	1.009	0.997	0.999	0.998	1.000	1.006	0.997	1.009	1.018	1.028	0.991	0.993	0.968	1.027
DEB	1.003	0.982	1.021	1.000	0.998	1.002	1.001	1.006	0.995	1.001	0.996	1.005	1.003	1.005	0.998	0.997	0.977	1.021
DEC	1.018	0.997	1.021	0.998	1.004	0.994	1.001	1.000	1.002	0.988	0.986	1.002	1.018	1.020	0.998	1.013	0.987	1.026
DED	0.999	0.983	1.016	0.996	0.992	1.003	1.003	1.009	0.994	0.994	0.993	1.000	1.008	1.007	1.001	0.998	0.982	1.017
DEE	1.009	0.987	1.021	0.994	0.992	1.003	0.989	0.994	0.995	1.000	0.994	1.006	1.005	1.009	0.996	1.022	0.999	1.023
DEF	1.041	1.008	1.033	1.010	1.014	0.997	1.007	0.997	1.011	0.995	0.993	1.002	1.031	1.033	0.998	0.997	0.973	1.025
DEG	1.001	0.983	1.018	0.990	0.988	1.003	0.995	0.999	0.996	1.013	1.011	1.002	1.012	1.015	0.997	0.991	0.971	1.020
EE	1.055	1.034	1.020	0.999	1.009	0.990	1.026	1.016	1.009	1.011	1.009	1.002	1.017	1.017	1.000	1.001	0.983	1.018
EE0	1.054	1.035	1.018	0.999	1.009	0.990	1.024	1.016	1.007	1.012	1.009	1.003	1.016	1.017	0.999	1.001	0.983	1.018
IE	1.068	1.030	1.037	1.004	0.998	1.005	1.009	1.002	1.007	1.031	1.026	1.005	1.026	1.021	1.006	0.997	0.983	1.015
IE0	1.068	1.029	1.038	1.002	0.999	1.003	1.010	1.001	1.009	1.031	1.025	1.006	1.028	1.022	1.006	0.995	0.981	1.014
EL				1.018	1.022	0.996	1.022	1.021	1.002	1.006	1.009	0.996						
EL3																		
EL4																		
EL5																		
EL6																		
ES	1.029	1.016	1.013	1.003	1.000	1.003	1.000	1.009	0.992	1.008	1.006	1.002	1.011	1.010	1.001	1.007	0.991	1.016
ES1	1.038	1.017	1.020	1.010	1.007	1.002	1.000	1.003	0.997	1.009	1.007	1.002	1.009	1.006	1.003	1.011	0.994	1.016
ES2	1.042	1.013	1.028	1.006	1.005	1.002	1.007	1.007	1.000	1.008	1.003	1.005	1.014	1.008	1.006	1.006	0.991	1.015
ES3	1.033	0.995	1.038	0.987	0.979	1.008	0.998	0.998	1.000	1.013	1.009	1.004	1.016	1.010	1.005	1.018	0.998	1.020
ES4	1.025	1.014	1.011	1.003	1.001	1.003	1.001	1.009	0.992	1.006	1.005	1.001	1.006	1.005	1.000	1.008	0.993	1.015
ES5	1.039	1.020	1.018	1.002	0.997	1.005	1.000	1.008	0.992	1.010	1.008	1.001	1.016	1.015	1.002	1.010	0.993	1.017
ES6	1.025	1.014	1.011	1.005	1.002	1.002	1.002	1.010	0.992	1.003	1.002	1.001	1.008	1.007	1.000	1.008	0.993	1.015
ES7	1.022	1.009	1.013	0.999	0.997	1.002	1.010	1.017	0.993	1.003	1.002	1.001	1.005	1.006	1.000	1.005	0.988	1.017
FR	1.020	1.006	1.015	1.006	1.003	1.003	1.002	1.008	0.994	1.000	0.999	1.001	1.005	1.003	1.002	1.007	0.992	1.015
FR1	1.089	1.037	1.050	1.023	1.020	1.003	1.003	0.997	1.006	1.020	1.015	1.004	1.000	0.994	1.006	1.041	1.011	1.030
FRB	1.022	1.010	1.011	1.006	1.004	1.002	1.001	1.009	0.993	1.001	1.000	1.001	1.012	1.012	1.000	1.001	0.986	1.015
FRC	1.012	1.001	1.010	0.989	0.987	1.002	1.016	1.023	0.993	0.997	0.997	1.000	1.003	1.001	1.001	1.007	0.993	1.014
FRD	1.027	1.016	1.011	1.015	1.014	1.001	1.000	1.006	0.993	0.997	0.995	1.001	1.007	1.006	1.000	1.008	0.994	1.014
FRE	1.011	1.000	1.011	0.995	0.992	1.002	1.005	1.012	0.993	0.998	0.998	1.001	1.008	1.008	1.001	1.005	0.991	1.014
FRF	1.036	1.025	1.011	1.011	1.009	1.002	1.006	1.013	0.993	0.996	0.995	1.001	1.012	1.012	1.000	1.011	0.996	1.015
FRG	1.023	1.011	1.012	1.003	1.003	1.000	1.004	1.009	0.995	1.014	1.013	1.001	0.996	0.995	1.001	1.005	0.991	1.015
FRH	1.008	0.992	1.016	0.986	0.985	1.001	1.012	1.013	0.998	0.991	0.992	0.999	1.021	1.018	1.003	0.999	0.985	1.014
FRI	1.024	1.013	1.011	1.006	1.006	1.000	1.002	1.008	0.994	1.007	1.006	1.001	1.003	1.003	1.001	1.006	0.991	1.015
FRJ	0.997	0.978	1.020	0.981	0.974	1.007	1.004	1.009	0.995	1.001	1.000	1.001	1.016	1.013	1.002	0.995	0.981	1.014
FRK	1.021	1.001	1.020	0.997	0.997	1.000	1.006	1.007	0.999	0.998	0.997	1.001	1.005	1.003	1.002	1.015	0.997	1.018
FRL	1.010	0.999	1.011	1.009	1.007	1.002	0.997	1.004	0.993	0.996	0.995	1.001	0.998	0.998	1.000	1.009	0.994	1.015
FRM				0.963	0.960	1.003	1.108	1.117	0.992									
FRY							1.002	1.009	0.992	0.996	0.995	1.001	1.003	1.003	1.000	1.008	0.994	1.015
HR	1.021	0.998	1.023	1.006	1.011	0.995	1.003	1.001	1.002	0.999	0.999	1.000	1.007	1.003	1.003	1.007	0.984	1.023
HR0	1.020	0.997	1.023	1.006	1.010	0.996	1.003	1.002	1.002	0.997	0.999	0.998	1.007	1.002	1.004	1.007	0.984	1.022
IT	1.011	1.000	1.011	0.998	0.996	1.002	1.007	1.015	0.993	0.993	0.992	1.001	1.001	1.001	1.000	1.011	0.997	1.015
ITC	1.029	1.018	1.011	1.000	0.999	1.001	1.012	1.018	0.995	1.002	1.002	1.000	1.004	1.005	0.998	1.011	0.994	1.017
ITF	0.996	0.986	1.011	0.999	0.998	1.002	1.004	1.011	0.993	0.990	0.989	1.001	0.992	0.992	1.000	1.011	0.997	1.014
ITG	0.988	0.978	1.011	0.996	0.994	1.002	1.004	1.011	0.993	0.974	0.974	1.001	0.997	0.997	1.000	1.017	1.001	1.015
ITH	1.029	1.013	1.015	1.002	1.008	0.995	1.015	1.013	1.002	0.998	0.996	1.002	1.010	1.011	0.999	1.003	0.987	1.017
ITI	1.021	1.008	1.012	1.000	1.006	0.994	1.011	1.008	1.003	0.998	1.000	0.998	1.003	0.999	1.004	1.010	0.996	1.014
CY	1.066	1.014	1.051	1.025	1.015	1.010	0.999	0.991	1.008	1.005	1.005	1.000	1.021	1.014	1.007	1.014	0.989	1.026
CY0	1.066	1.011	1.054	1.024	1.016	1.008	0.999	0.990	1.009	1.008	1.004	1.004	1.021	1.012	1.009	1.013	0.990	1.023
LV	1.025	1.009	1.015	0.995	0.999	0.996	1.015	1.013	1.002	1.010	1.009	1.001	0.997	0.997	1.000	1.007	0.991	1.016
LV0	1.025	1.008	1.016	0.995	0.999	0.996	1.015	1.013	1.002	1.010	1.008	1.001	0.998	0.998	1.000	1.007	0.990	1.017
LT	1.046	1.008	1.038	1.023	1.020	1.002	1.006	1.000	1.007	1.004	1.000	1.003	1.008	1.004	1.004	1.005	0.984	1.021
LT0	1.047	1.009	1.038	1.022	1.024	0.998	1.009	0.996	1.013	1.002	1.003	0.999	1.010	1.002	1.008	1.004	0.985	1.019
LU	1.036	0.990	1.046	1.004	1.008	0.996	1.004	0.985	1.020	1.002	0.995	1.006	1.002	1.004	0.998	1.024	0.998	1.026
LU0	1.038	0.989	1.049	1.004	1.006	0.998	1.005	0.985	1.020	1.000	0.995	1.005	1.003	1.004	0.999	1.025	0.998	1.027
HU	1.031	1.017	1.014	1.020	1.025	0.995	1.001	0.998	1.004	1.001	1.000	1.000	1.001	1.002	0.999	1.008	0.992	1.016
HU1	1.036	1.014	1.022	1.009	1.013	0.996	0.986	0.983	1.003	1.019	1.020	0.999	1.012	1.008	1.004	1.010	0.990	1.021
HU2	1.027	1.014	1.013	1.031	1.035	0.996	1.005	1.003	1.002	0.993	0.994	0.999	0.992	0.992	1.000	1.006	0.991	1.016
HU3	1.060	1.049	1.010	1.029	1.026	1.002	1.015	1.022	0.992	1.004	1.003	1.001	1.003	1.002	1.000	1.008	0.994	1.014
MT	1.006	0.994	1.012	1.011	1.009	1.002	0.990	0.997	0.993	1.001	0.999	1.001	1.012	1.012	1.000	0.992	0.977	1.016
MT0	1.006	0.995	1.011	1.012	1.009	1.003	0.989	0.997	0.992	1.001	0.999	1.001	1.013	1.012	1.000	0.992	0.977	1.015
NL	1.033	0.991	1.042	1.006	1.010	0.996	1.006	0.985	1.021	1.016	1.007	1.009	0.997	1.005	0.992	1.008	0.984	1.024
AT	1.006	0.985	1.021	1.000	1.004	0.996	1.009	1.007	1.002	1.002	1.004	0.997	0.999	0.994	1.004	0.996	0.976	1.021
AT1	1.009	0.989	1.020	0.997	1.001	0.996	1.010	1.008	1.002	1.000	0.998	1.003	1.002	1.000	1.001	1.000	0.982	1.018
AT2	1.000	0.978	1.022	0.997	1.002	0.996	1.003	1.001	1.002	1.016	1.017	0.999	0.996	0.993	1.003	0.988	0.966	1.022
AT3	1.012	0.991	1.021	1.004	1.009	0.995	1.010	1.008	1.002	1.001	1.003	0.998	0.995	0.989	1.006	1.003	0.982	1.021

Table D.7: Performance evolution assessment of the robust model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
PL	1.019	0.999	1.021	1.002	1.007	0.994	1.007	1.004	1.003	1.003	1.005	0.998	1.012	1.008	1.004	0.996	0.974	1.022
PL2	1.022	0.999	1.023	0.994	0.999	0.995	1.016	1.013	1.003	1.005	1.006	0.999	1.017	1.012	1.005	0.990	0.969	1.021
PL4	1.026	1.005	1.021	1.000	1.003	0.996	1.008	1.006	1.002	1.003	1.003	0.999	1.011	1.008	1.003	1.004	0.985	1.020
PL5	1.036	1.014	1.021	0.994	0.999	0.995	1.001	0.999	1.001	1.033	1.034	0.999	1.022	1.018	1.004	0.986	0.965	1.022
PL6	1.021	1.000	1.021	1.006	1.010	0.996	1.003	1.001	1.002	1.001	1.004	0.998	0.999	0.995	1.004	1.012	0.991	1.021
PL7																1.005	0.985	1.020
PL8																0.990	0.970	1.020
PL9																0.982	0.964	1.018
PT	1.076	1.061	1.014	1.026	1.032	0.994	1.002	1.000	1.003	1.021	1.020	1.001	1.005	1.005	1.001	1.020	1.004	1.016
PT1	1.076	1.061	1.014	1.029	1.037	0.992	1.002	0.998	1.004	1.018	1.018	1.001	1.006	1.007	0.999	1.018	1.001	1.017
PT2	1.068	1.057	1.011	1.015	1.013	1.001	1.006	1.014	0.992	1.019	1.015	1.004	1.020	1.021	0.999	1.006	0.992	1.015
PT3				1.011	1.009	1.002	0.999	1.007	0.993									
RO	1.038	1.015	1.022	1.003	1.002	1.001	1.008	1.010	0.998	0.998	0.997	1.001	1.013	1.013	1.000	1.016	0.993	1.023
RO1	0.972	0.952	1.021	0.993	0.991	1.002	1.007	1.014	0.993	0.997	0.996	1.001	0.973	0.972	1.001	1.002	0.979	1.024
RO2	1.017	0.997	1.020	1.010	1.008	1.003	0.995	1.002	0.992	0.994	0.992	1.001	0.999	0.998	1.002	1.019	0.997	1.023
RO3	1.047	1.024	1.022	1.011	1.016	0.995	1.009	1.007	1.002	1.014	1.015	0.999	0.999	0.994	1.005	1.013	0.992	1.021
RO4	1.042	1.021	1.021	1.013	1.019	0.995	1.000	0.997	1.003	0.982	0.983	0.999	1.022	1.018	1.004	1.025	1.004	1.021
SI	1.012	0.992	1.020	0.998	1.003	0.995	1.003	1.001	1.002	1.011	1.013	0.998	0.998	0.992	1.006	1.001	0.982	1.019
SI0	1.012	0.991	1.021	0.998	1.004	0.995	1.004	1.001	1.003	1.011	1.012	0.999	0.997	0.994	1.003	1.002	0.981	1.022
SK	1.005	0.984	1.021	1.000	1.005	0.996	0.999	0.997	1.002	0.988	0.990	0.999	1.014	1.010	1.004	1.004	0.983	1.021
SK0	1.005	0.984	1.022	1.001	1.005	0.996	0.999	0.997	1.002	0.989	0.990	0.999	1.013	1.010	1.004	1.004	0.983	1.021
FI	1.055	1.022	1.033	1.005	1.006	0.998	1.021	1.012	1.009	1.010	1.006	1.004	1.009	1.014	0.995	1.010	0.983	1.027
FI1	1.059	1.024	1.034	1.003	1.008	0.995	1.019	1.011	1.007	1.015	1.008	1.006	1.007	1.012	0.995	1.015	0.984	1.031
SE	1.097	1.034	1.061	1.001	1.009	0.992	1.008	1.001	1.007	1.011	1.010	1.001	1.012	1.007	1.004	1.063	1.006	1.058
SE1	1.093	1.020	1.072	1.000	1.000	1.001	1.020	1.015	1.006	0.997	0.994	1.004	1.006	1.003	1.003	1.067	1.008	1.058
SE2	1.103	1.035	1.066	0.993	1.000	0.993	1.007	1.006	1.002	1.014	1.013	1.001	1.017	1.011	1.007	1.068	1.005	1.063
SE3	1.065	1.038	1.027	1.024	1.030	0.994	0.990	0.986	1.004	1.022	1.018	1.004	0.996	1.005	0.991	1.032	0.998	1.034
IS													0.998	1.006	0.992	0.994	0.972	1.022
IS0													0.999	1.005	0.994	0.992	0.971	1.022
NO	1.015	0.983	1.033	1.008	1.017	0.991	1.000	0.983	1.017	0.998	0.990	1.008	0.997	1.002	0.995	1.011	0.991	1.020
NO0	1.015	0.982	1.034	1.008	1.017	0.992	1.001	0.983	1.018	0.997	0.990	1.006	0.999	1.002	0.997	1.011	0.991	1.021
CH																		
CH0																		
UK	1.067	1.028	1.037	1.060	1.040	1.019	0.997	0.999	0.998	1.001	0.998	1.003	1.004	1.004	1.000	1.005	0.988	1.017
UKC	1.029	1.017	1.012	1.035	1.032	1.003	0.998	1.005	0.993	0.993	0.993	1.001	1.005	1.005	1.000	0.997	0.982	1.015
UKD	1.043	1.029	1.013	1.036	1.033	1.003	1.003	1.010	0.993	0.999	0.997	1.002	0.999	0.999	1.000	1.006	0.991	1.016
UKE	1.048	1.035	1.012	1.045	1.043	1.002	0.999	1.005	0.994	1.002	1.001	1.001	1.007	1.007	1.000	0.995	0.981	1.015
UKF	1.052	1.025	1.026	1.058	1.042	1.015	0.986	0.992	0.994	1.006	1.005	1.001	1.009	1.008	1.001	0.994	0.980	1.014
UKG	1.060	1.037	1.022	1.041	1.034	1.007	0.995	1.001	0.994	1.002	0.999	1.003	1.014	1.014	1.000	1.008	0.989	1.018
UKH	1.064	1.033	1.031	1.042	1.042	1.000	1.011	1.000	1.011	0.998	0.996	1.002	1.006	1.006	1.000	1.006	0.989	1.017
UKI	1.055	0.994	1.061	1.032	1.017	1.015	1.008	0.998	1.010	0.998	0.996	1.002	1.003	0.993	1.011	1.012	0.990	1.022
UKJ	1.059	1.015	1.043	1.006	1.008	0.998	1.008	0.987	1.021	1.030	1.026	1.004	1.001	1.003	0.998	1.012	0.991	1.021
UKK	1.047	1.012	1.035	0.999	0.999	1.000	1.000	0.983	1.017	1.044	1.043	1.001	1.000	1.000	0.999	1.005	0.989	1.016
UKL	1.022	1.003	1.019	1.004	1.007	0.997	1.015	1.015	1.001	0.997	0.994	1.003	1.028	1.032	0.997	0.978	0.956	1.022
UKM	1.048	0.993	1.055	1.021	1.009	1.012	1.023	1.011	1.012	0.989	0.988	1.001	0.972	0.968	1.004	1.042	1.017	1.024
UKN				1.015	1.019	0.996	1.010	0.990	1.020	0.996	0.990	1.006	1.036	1.043	0.993			
MK				1.013	1.018	0.995	1.028	1.025	1.002	1.008	1.011	0.997	1.021	1.016	1.005			
MK0				1.014	1.018	0.996	1.028	1.025	1.003	1.009	1.011	0.998	1.019	1.015	1.004			
RS																1.009	0.985	1.024
RS1																		
RS2																		
N	117	117	117	123	123	123	124	124	124	122	122	122	123	123	123	124	124	124
Min	0.958	0.951	1.008	0.963	0.960	0.985	0.974	0.967	0.992	0.974	0.974	0.996	0.972	0.968	0.990	0.978	0.956	1.014
25-perc	1.010	0.991	1.014	0.998	0.999	0.995	1.000	0.998	0.994	0.998	0.996	1.000	0.999	1.000	0.999	0.998	0.982	1.016
Average	1.028	1.005	1.023	1.007	1.007	0.999	1.005	1.004	1.001	1.005	1.003	1.002	1.006	1.006	1.001	1.007	0.987	1.020
Median	1.025	1.004	1.021	1.003	1.006	1.000	1.003	1.004	1.002	1.003	1.002	1.001	1.005	1.005	1.000	1.006	0.988	1.020
75-perc	1.047	1.017	1.026	1.011	1.014	1.002	1.008	1.010	1.004	1.011	1.009	1.003	1.012	1.012	1.004	1.011	0.993	1.022
Max	1.103	1.061	1.072	1.060	1.046	1.019	1.108	1.117	1.021	1.044	1.043	1.010	1.036	1.043	1.011	1.068	1.017	1.063
Std Dev	0.027	0.021	0.013	0.015	0.014	0.005	0.013	0.014	0.008	0.011	0.011	0.003	0.010	0.010	0.004	0.014	0.011	0.007

Table D.8: Convergence results of the robust model for all data

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.007	1.009	0.999	0.990
2015/2016	1.004	1.022	1.001	0.979
2016/2017	1.003	1.010	1.002	0.992
2017/2018	1.005	1.012	1.001	0.989
2018/2019	0.986	1.028	1.020	0.993
2014/2019	1.004	1.080	1.023	0.990

D.3 Conditional model

Table D.9: BoD results of the conditional model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank	$E_k^t(\mathbb{1}, Y_k^t)$	Rank
BE	0.914	77	0.909	76	0.919	80	0.924	84	0.929	85	0.916	94
BE1	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
BE2	0.953	56	0.923	72	0.940	64	0.955	67	0.971	49	0.977	48
BE3	0.900	86	0.899	85	0.902	86	0.905	95	0.904	103	0.884	112
BG	0.838	116	0.814	118	0.801	120	0.811	123	0.829	122	0.840	128
BG3	0.821	120	0.782	122	0.762	123	0.780	127	0.764	127	0.737	133
BG4	0.874	107	0.849	114	0.844	116	0.892	105	0.905	100	0.903	103
CZ	0.902	84	0.903	79	0.934	66	0.956	65	0.949	70	0.950	77
CZ0	0.902	83	0.902	80	0.933	67	0.957	64	0.949	71	0.950	78
DK	1.000	3	1.000	3	1.000	3	0.995	27	0.997	26	0.995	29
DK0	1.000	3	1.000	3	1.000	3	0.995	26	0.997	25	0.995	30
DE	0.905	80	0.893	89	0.915	81	0.925	83	0.924	88	0.922	92
DE1	0.965	47	0.948	57	0.961	56	0.956	66	0.942	74	0.948	80
DE2	0.970	42	0.956	54	0.962	55	0.960	59	0.953	69	0.949	79
DE3	0.952	57	0.959	53	0.920	79	0.916	89	0.926	86	0.938	83
DE4	0.869	112	0.867	109	0.882	103	0.873	114	0.885	106	0.896	106
DE5	0.880	102	0.925	71	0.899	89	0.920	87	0.916	95	0.930	90
DE6	0.959	51	0.944	62	0.946	62	0.947	69	0.957	65	0.933	87
DE7	0.939	64	0.927	69	0.936	65	0.942	72	0.932	84	0.931	89
DE8	0.885	96	0.873	107	0.881	104	0.881	110	0.884	107	0.894	108
DE9	0.903	82	0.892	90	0.898	90	0.913	91	0.917	93	0.909	101
DEA	0.877	105	0.882	99	0.900	87	0.904	96	0.924	89	0.909	102
DEB	0.929	70	0.914	74	0.925	76	0.921	86	0.925	87	0.914	97
DEC	0.877	104	0.881	100	0.888	98	0.883	108	0.911	99	0.910	100
DED	0.895	90	0.888	93	0.903	85	0.914	90	0.937	80	0.932	88
DEE	0.880	103	0.871	108	0.862	112	0.855	120	0.862	114	0.894	107
DEF	0.890	94	0.891	91	0.904	84	0.917	88	0.924	90	0.913	98
DEG	0.900	85	0.883	98	0.887	99	0.913	92	0.934	82	0.922	93
EE	0.882	98	0.887	95	0.895	92	0.903	99	0.921	91	0.958	67
EE0	0.881	100	0.887	94	0.895	91	0.903	100	0.920	92	0.958	69
IE	0.969	43	0.943	63	0.931	68	0.960	61	0.997	28	0.993	34
IE0	0.968	45	0.943	64	0.931	69	0.960	60	0.997	29	0.993	33
EL	1.000	3	1.000	3	1.000	3	0.981	43			0.995	31
EL3							1.000	3			1.000	3
EL4							0.999	20			0.975	52
EL5							0.998	23			1.000	3
EL6							0.949	68			0.979	46
ES	1.000	3	1.000	3	1.000	3	1.000	3	0.999	20	1.000	3
ES1	0.999	26	0.996	25	0.992	28	0.995	28	0.986	36	0.998	26
ES2	1.000	3	1.000	3	1.000	3	0.999	18	0.980	40	0.986	39
ES3	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
ES4	1.000	3	1.000	3	0.998	20	1.000	3	0.995	32	0.998	25
ES5	0.998	27	0.977	37	0.970	49	0.974	50	0.972	48	0.982	42
ES6	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
ES7	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
FR	0.975	37	0.983	33	0.988	30	0.989	34	0.982	38	0.980	44
FR1	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
FRB	0.959	52	0.981	35	0.974	43	0.966	55	0.977	44	0.964	65
FRC	0.962	48	0.948	58	0.963	53	0.964	56	0.959	62	0.950	76
FRD	0.951	58	0.967	45	0.977	38	0.970	54	0.961	60	0.974	54
FRE	0.990	30	0.973	41	0.984	32	0.984	40	0.965	56	0.994	32
FRF	0.954	54	0.972	42	0.986	31	0.973	51	0.970	51	0.963	66
FRG	0.971	41	0.987	31	0.984	33	0.991	32	0.990	33	0.977	51
FRH	0.988	32	0.977	39	0.991	29	0.976	44	0.997	27	0.979	45
FRI	0.965	46	0.977	38	0.976	41	0.993	30	0.978	42	0.982	41
FRJ	1.000	3	0.989	30	0.996	22	0.998	22	1.000	4	0.985	40
FRK	0.994	28	0.998	24	0.999	19	0.995	25	1.000	4	0.991	37
FRL	0.968	44	0.982	34	0.981	34	0.988	37	0.965	55	0.973	55
FRM	0.863	113	0.843	116	0.926	75						
FRY			1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
HR	1.000	3	1.000	3	0.974	44	0.939	74	0.913	98	0.883	113
HR0	1.000	3	1.000	3	0.974	42	0.940	73	0.914	96	0.883	114
IT	0.882	97	0.878	103	0.884	101	0.881	109	0.869	112	0.887	111
ITC	0.851	115	0.848	115	0.861	113	0.859	116	0.866	113	0.858	126
ITF	0.972	40	0.967	46	0.976	40	0.971	52	0.960	61	0.996	28
ITG	0.958	53	0.947	60	0.955	59	0.936	75	0.968	53	0.987	38
ITH	0.855	114	0.863	110	0.874	108	0.869	115	0.880	110	0.866	120
ITI	0.875	106	0.883	97	0.893	93	0.893	103	0.889	104	0.872	116
CY	1.000	3	1.000	3	1.000	3	0.988	36	0.942	73	0.915	96
CY0	1.000	3	1.000	3	0.999	18	0.988	35	0.942	72	0.916	95
LV	0.916	76	0.904	77	0.908	82	0.906	93	0.883	108	0.871	118
LV0	0.917	74	0.903	78	0.907	83	0.906	94	0.883	109	0.871	117

Table D.9: BoD results of the conditional model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank	$E_k^t(\mathbb{1},Y_k^t)$	Rank
LT	0.960	50	0.993	28	0.978	37	0.975	48	0.987	35	0.974	53
LT0	0.961	49	0.993	27	0.978	35	0.975	46	0.986	37	0.972	58
LU	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
LU0	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
HU	0.831	118	0.853	112	0.853	114	0.878	113	0.888	105	0.900	105
HU1	0.897	88	0.911	75	0.927	74	0.957	62	0.957	64	0.969	61
HU2	0.829	119	0.857	111	0.890	96	0.878	112	0.875	111	0.882	115
HU3	0.834	117	0.849	113	0.852	115	0.856	119	0.860	116	0.871	119
MT	0.872	109	0.880	102	0.890	95	0.904	98	0.905	102	0.889	109
MT0	0.872	108	0.880	101	0.890	94	0.904	97	0.905	101	0.889	110
NL	0.973	39	0.987	32	0.964	52	0.985	39	1.001	2	1.001	2
AT	0.933	68	0.922	73	0.924	77	0.928	81	0.938	78	0.951	75
AT1	0.926	71	0.928	68	0.945	63	0.930	80	0.932	83	0.911	99
AT2	0.941	63	0.926	70	0.927	73	0.961	57	0.970	50	0.965	63
AT3	0.974	38	0.954	55	0.971	48	0.974	49	0.964	58	0.965	62
PL	0.896	89	0.897	87	0.899	88	0.923	85	0.955	67	0.952	74
PL2	0.906	79	0.902	82	0.921	78	0.957	63	0.977	43	0.972	57
PL4	0.872	110	0.877	105	0.887	100	0.926	82	0.937	79	0.943	81
PL5	0.882	99	0.878	104	0.883	102	0.930	79	0.969	52	0.952	73
PL6	0.881	101	0.874	106	0.871	111	0.883	106	0.913	97	0.926	91
PL7									0.940	75	0.958	68
PL8									0.916	94	0.939	82
PL9									1.002	1	0.992	35
PT	0.893	93	0.886	96	0.876	106	0.879	111	0.858	117	0.860	125
PT1	0.898	87	0.894	88	0.881	105	0.883	107	0.861	115	0.861	124
PT2	0.885	95	0.833	117	0.835	117	0.838	121	0.843	120	0.816	131
PT3	0.895	91	0.897	86	0.888	97						
RO	0.758	124	0.760	123	0.766	122	0.781	126	0.810	125	0.825	129
RO1	0.808	121	0.800	120	0.817	118	0.824	122	0.823	124	0.818	130
RO2	0.729	125	0.738	124	0.742	124	0.748	128	0.765	126	0.780	132
RO3	0.777	123	0.791	121	0.792	121	0.808	124	0.834	121	0.854	127
RO4	0.803	122	0.808	119	0.802	119	0.787	125	0.823	123	0.862	122
SI	0.937	66	0.933	67	0.928	72	0.935	77	0.939	76	0.977	50
SI0	0.937	65	0.933	66	0.928	71	0.935	76	0.939	77	0.977	49
SK	0.946	61	0.902	84	0.873	110	0.858	118	0.858	118	0.863	121
SK0	0.945	62	0.902	83	0.873	109	0.858	117	0.858	119	0.862	123
FI	0.950	60	0.970	44	0.974	45	0.987	38	0.975	46	0.956	71
FI1	0.950	59	0.971	43	0.974	46	0.990	33	0.975	45	0.957	70
SE	0.989	31	0.994	26	0.992	27	0.994	29	0.997	30	0.996	27
SE1	1.001	2	1.001	2	1.002	2	1.001	2	1.000	4	1.000	3
SE2	0.992	29	0.993	29	0.996	21	0.992	31	0.999	21	1.000	3
SE3	0.954	55	0.980	36	0.969	50	0.982	42	0.981	39	0.977	47
IS	1.000	3					1.000	3	1.000	4	1.000	3
IS0	1.000	3					1.000	3	1.000	4	1.000	3
NO	1.000	3	1.000	3	0.995	23	0.999	21	0.999	23	1.000	3
NO0	1.000	3	1.000	3	0.995	24	0.999	19	0.999	22	1.000	3
CH											1.000	3
CH0											1.000	3
UK	0.934	67	0.976	40	0.978	36	0.984	41	0.987	34	0.992	36
UKC	0.924	72	0.950	56	0.952	60	0.947	70	0.954	68	0.936	85
UKD	0.916	75	0.948	59	0.963	54	0.975	45	0.965	57	0.972	56
UKE	0.905	81	0.945	61	0.955	58	0.960	58	0.967	54	0.965	64
UKF	0.921	73	0.960	52	0.960	57	0.975	47	0.975	47	0.971	59
UKG	0.910	78	0.939	65	0.946	61	0.945	71	0.959	63	0.970	60
UKH	0.931	69	0.961	51	0.976	39	0.970	53	0.979	41	0.981	43
UKI	1.000	3	1.000	3	1.000	3	1.000	3	1.000	4	1.000	3
UKJ	0.981	36	0.965	48	0.972	47	0.999	17	0.997	24	1.000	3
UKK	0.985	35	0.965	47	0.967	51	0.998	24	0.996	31	1.000	3
UKL	0.894	92	0.902	81	0.930	70	0.931	78	0.963	59	0.937	84
UKM	1.001	1	1.003	1	1.006	1	1.008	1	1.001	3	1.005	1
UKN	0.871	111	0.889	92	0.875	107	0.893	104	0.934	81		
MK	0.987	33	0.964	49	0.994	26	0.900	101	1.000	4		
MK0	0.987	34	0.964	50	0.995	25	0.900	102	1.000	4		
RS									0.956	66	0.934	86
RS1											0.901	104
RS2											0.953	72
N	125		124		124		128		127		133	
Min	0.729		0.738		0.742		0.748		0.764		0.737	
25-perc	0.888		0.887		0.891		0.904		0.914		0.910	
Average	0.932		0.931		0.934		0.940		0.943		0.945	
Median	0.941		0.944		0.946		0.956		0.957		0.958	
75-perc	0.988		0.987		0.985		0.991		0.995		0.993	
Max	1.001		1.003		1.006		1.008		1.002		1.005	
Std Dev	0.060		0.061		0.060		0.057		0.054		0.054	

Table D.10: BoD results against the metafrontiers of the conditional model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
BE	0.943	0.983	0.983	0.977	0.980	0.966	0.987	0.961	0.960	0.949	0.961	0.947
BE1	1.000	1.000	0.983	1.000	0.991	1.000	1.000	0.984	1.000	0.990	1.000	0.999
BE2	0.930	0.996	0.915	1.001	0.925	0.985	0.934	0.966	0.953	0.964	0.965	0.947
BE3	0.993	1.000	0.971	1.000	0.972	0.991	0.971	0.991	0.972	0.977	0.942	0.995
BG	0.935	0.961	0.919	0.967	0.897	0.956	0.889	0.958	0.888	0.953	0.876	0.944
BG3	0.929	1.000	0.904	1.001	0.880	0.999	0.866	0.999	0.853	0.998	0.846	0.992
BG4	0.944	0.934	0.932	0.930	0.920	0.937	0.923	0.938	0.931	0.921	0.920	0.915
CZ	0.936	1.000	0.932	1.000	0.964	0.996	0.994	0.990	0.992	0.993	0.994	1.000
CZ0	0.935	1.000	0.933	1.000	0.964	0.996	0.994	0.990	0.992	0.993	0.994	1.000
DK	1.000	0.869	1.000	0.878	1.000	0.870	1.000	0.862	0.988	0.902	0.998	0.888
DK0	1.000	0.869	1.000	0.878	1.000	0.870	1.000	0.863	0.988	0.902	0.998	0.887
DE	0.875	0.990	0.882	0.975	0.926	0.985	0.999	0.989	1.000	0.990	1.000	0.989
DE1	0.999	0.998	0.968	0.977	0.999	0.990	0.996	0.999	0.991	1.000	0.996	1.000
DE2	0.957	0.995	0.960	0.994	1.000	1.000	0.999	0.999	0.997	1.000	1.000	1.000
DE3	0.937	1.000	1.000	1.000	0.996	0.978	1.000	0.965	1.000	1.000	1.000	1.000
DE4	0.880	1.000	0.880	1.000	0.925	0.986	0.911	1.000	0.921	1.000	0.927	1.000
DE5	0.943	1.000	0.940	1.000	0.974	1.000	0.976	1.000	0.959	1.000	0.996	1.000
DE6	1.000	0.991	0.995	1.000	1.000	0.992	1.000	0.982	1.000	0.950	1.000	0.970
DE7	0.963	1.000	0.966	0.990	0.983	0.994	0.980	0.996	0.981	0.998	0.990	0.993
DE8	0.884	0.998	0.883	0.995	0.896	0.993	0.930	0.983	0.933	0.985	0.939	0.982
DE9	0.873	1.004	0.877	1.000	0.881	0.996	0.904	0.999	0.909	1.000	0.912	1.000
DEA	0.907	1.000	0.931	1.000	0.986	1.000	0.989	1.000	0.996	1.000	0.987	1.000
DEB	0.909	0.976	0.909	0.999	0.910	0.990	0.927	0.979	0.928	0.980	0.960	0.988
DEC	0.887	1.000	0.870	1.001	0.873	1.000	0.885	1.000	0.903	1.000	0.911	1.000
DED	0.911	0.964	0.907	0.973	0.971	0.961	0.961	0.985	0.970	0.963	0.975	0.962
DEE	0.882	0.998	0.878	1.000	0.874	1.000	0.901	1.000	0.932	1.000	0.919	1.000
DEF	0.895	1.000	0.876	0.999	0.881	1.000	0.887	1.000	0.921	0.996	0.918	1.000
DEG	0.911	0.966	0.897	0.976	0.933	0.972	0.964	0.960	0.968	0.957	0.962	0.963
EE	0.952	0.993	0.953	1.000	0.975	0.974	0.987	0.963	1.000	0.950	1.000	0.949
EE0	0.952	0.994	0.953	1.000	0.975	0.974	0.987	0.963	1.000	0.950	1.000	0.949
IE	0.998	1.000	0.970	1.000	0.956	0.993	0.981	0.972	0.992	0.921	0.987	0.909
IE0	0.998	1.000	0.970	1.000	0.956	0.993	0.981	0.972	0.992	0.921	0.988	0.909
EL	0.994	1.000	0.979	0.996	0.994	0.977	1.000	0.994			1.000	0.995
EL3							1.000	0.999			1.000	1.000
EL4							0.932	1.000			0.909	1.000
EL5							1.000	1.000			1.000	1.000
EL6							0.959	1.000			0.991	0.977
ES	1.000	1.000	1.000	0.999	0.993	1.000	0.991	0.993	0.998	0.990	1.000	0.993
ES1	0.992	0.953	1.000	0.930	0.990	0.931	0.991	0.966	0.990	0.992	1.000	0.991
ES2	0.999	0.998	0.994	0.914	0.991	0.882	0.994	0.878	0.981	0.906	0.965	0.912
ES3	1.000	1.000	0.998	0.999	0.994	1.000	0.999	0.992	1.000	0.997	1.000	1.000
ES4	1.000	1.000	1.000	0.995	0.993	1.000	0.994	0.989	0.993	0.982	1.000	0.987
ES5	1.000	1.000	1.000	1.000	0.991	1.000	0.993	0.991	0.958	0.994	0.972	1.000
ES6	0.995	1.000	1.000	0.995	0.997	1.000	0.992	0.997	0.994	0.993	1.000	0.992
ES7	1.000	1.000	0.998	1.000	1.000	1.000	1.000	0.999	1.000	1.000	1.000	1.000
FR	0.968	0.953	0.975	0.937	0.973	0.928	0.971	0.888	0.978	0.902	0.982	0.925
FR1	0.992	0.958	1.000	0.942	1.000	0.929	0.991	0.928	0.989	0.920	1.000	0.900
FRB	0.973	0.997	0.986	0.990	0.997	0.970	0.982	0.972	0.996	0.945	0.990	0.972
FRC	0.990	0.982	0.965	1.000	0.983	0.970	0.975	0.988	0.976	0.995	0.984	0.957
FRD	0.958	0.975	0.990	0.967	0.986	0.948	0.976	0.998	0.981	0.976	0.975	0.935
FRE	0.997	0.986	0.989	1.000	0.989	0.996	0.989	0.989	0.993	0.976	0.991	0.972
FRF	0.949	1.000	0.960	0.926	0.979	0.874	0.955	0.910	0.964	0.935	0.967	0.953
FRG	0.978	0.879	0.980	0.880	0.983	0.890	0.996	0.875	1.000	0.886	1.000	0.874
FRH	1.000	0.904	0.987	0.885	1.000	0.864	0.985	0.881	1.000	0.871	1.000	0.866
FRI	0.986	0.975	0.995	0.987	0.991	0.972	1.000	0.973	1.000	0.954	1.000	0.959
FRJ	1.000	0.950	0.982	0.980	0.984	0.955	0.980	0.953	0.999	0.928	0.984	0.934
FRK	0.996	0.951	0.993	0.953	0.998	0.935	0.994	0.920	1.000	0.917	1.000	0.892
FRL	0.963	0.997	0.983	0.854	0.977	0.857	0.979	0.892	0.968	0.897	0.964	0.950
FRM	0.855	1.000	0.843	1.000	0.991	1.000						
FRY			0.998	1.000	1.000	1.000	0.998	1.000	0.997	1.000	0.999	0.995
HR	0.999	0.999	0.999	0.984	1.000	0.929	0.991	0.926	0.988	0.954	0.985	0.935
HR0	0.999	0.999	0.999	0.984	1.000	0.928	0.990	0.926	0.988	0.954	0.985	0.934
IT	0.895	1.000	0.896	1.000	0.906	0.992	0.897	0.999	0.882	0.998	0.879	0.986
ITC	0.850	1.000	0.852	1.000	0.867	0.989	0.846	0.988	0.850	0.987	0.859	0.974
ITF	0.972	0.999	0.971	1.000	0.975	0.986	0.967	0.984	0.980	0.997	0.995	0.992
ITG	0.995	1.000	0.974	1.000	0.969	0.988	0.939	1.000	0.947	1.000	0.949	0.999
ITH	0.853	1.000	0.848	0.993	0.850	0.982	0.854	0.977	0.864	0.972	0.864	0.968
ITI	0.985	0.999	0.971	1.000	0.987	0.993	0.972	0.997	0.977	0.997	0.993	0.982
CY	0.980	1.000	1.000	0.980	0.998	1.000	0.991	1.000	1.000	1.000	1.000	1.000
CY0	0.980	1.000	1.000	0.980	0.998	1.000	0.991	1.000	1.000	1.000	1.000	1.000
LV	0.970	1.000	0.952	1.000	0.967	0.990	0.973	0.978	0.969	0.999	0.962	1.000
LV0	0.970	1.000	0.952	1.000	0.968	0.990	0.972	0.978	0.969	0.999	0.962	0.999
LT	0.985	0.873	0.988	0.889	0.991	0.868	0.996	0.885	1.000	0.934	1.000	0.939
LT0	0.985	0.873	0.988	0.889	0.991	0.869	0.996	0.885	1.000	0.933	1.000	0.940
LU	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.992

Table D.10: BoD results against the metafrontiers of the conditional model for all data

Geo	2014		2015		2016		2017		2018		2019	
(k)	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M	E_k^M	W_k^M
LU0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.992
HU	0.955	0.904	0.992	0.878	0.978	0.907	0.986	0.887	0.982	0.916	0.961	0.954
HU1	0.941	0.996	1.000	0.912	0.963	0.982	0.989	0.956	0.988	0.973	1.000	0.997
HU2	0.947	0.889	0.980	0.878	0.987	0.870	0.982	0.873	0.973	0.879	0.981	0.892
HU3	0.970	0.940	0.992	0.912	0.991	0.906	0.991	0.882	0.992	0.887	1.001	0.883
MT	0.871	1.000	0.919	1.000	0.998	1.000	0.907	1.000	0.998	1.000	1.000	1.000
MT0	0.871	1.000	0.919	1.000	0.998	1.000	0.907	1.000	0.998	1.000	1.000	1.000
NL	0.989	0.952	0.986	0.911	0.990	0.901	1.000	0.890	0.994	0.913	1.000	0.902
AT	1.000	0.996	0.993	0.999	0.944	1.000	0.980	0.988	0.999	0.982	1.000	0.972
AT1	1.000	0.977	1.000	0.946	1.000	0.992	1.000	0.973	1.000	1.000	1.000	0.993
AT2	0.921	1.000	0.915	1.000	0.905	1.000	0.916	0.998	0.936	0.996	0.952	1.000
AT3	0.988	1.000	0.992	1.000	0.997	1.000	1.000	0.994	0.988	1.000	0.985	0.996
PL	0.984	0.907	0.979	0.881	0.987	0.858	0.978	0.868	0.988	0.856	0.996	0.855
PL2	0.995	0.904	0.984	0.875	0.997	0.843	0.999	0.849	1.001	0.857	1.000	0.849
PL4	0.960	0.921	0.956	0.887	0.963	0.860	0.954	0.868	0.974	0.844	0.982	0.857
PL5	0.977	0.900	0.961	0.882	0.965	0.855	0.971	0.885	0.994	0.878	0.981	0.935
PL6	0.967	0.942	0.955	0.936	0.967	0.896	0.974	0.910	0.978	0.881	0.988	0.840
PL7									0.988	0.855	1.001	0.817
PL8									1.002	0.858	1.004	0.813
PL9									1.000	0.917	0.999	0.959
PT	0.977	1.000	0.941	0.984	0.865	0.988	0.869	0.986	0.878	0.996	0.895	0.985
PT1	0.977	1.000	0.940	0.983	0.865	0.984	0.874	0.978	0.883	0.997	0.902	0.986
PT2	0.914	1.000	0.942	0.999	0.962	0.988	0.985	1.000	0.997	1.000	0.992	1.007
PT3	1.000	0.999	1.000	0.908	1.000	0.913						
RO	0.883	0.980	0.888	0.962	0.888	0.944	0.877	0.940	0.900	0.945	0.926	0.943
RO1	0.941	0.987	0.933	0.925	0.935	0.917	0.931	0.913	0.921	0.935	0.943	0.926
RO2	0.855	1.012	0.858	1.014	0.852	1.003	0.846	0.999	0.817	1.002	0.870	1.003
RO3	0.858	1.003	0.873	0.989	0.902	0.966	0.907	0.967	0.950	0.949	0.950	0.940
RO4	0.914	0.987	0.944	0.940	0.939	0.941	0.926	0.931	0.931	0.937	0.951	0.918
SI	0.952	1.000	0.952	0.993	0.944	0.997	0.963	0.981	0.993	0.977	1.000	0.965
SI0	0.952	1.000	0.952	0.993	0.944	0.997	0.963	0.981	0.992	0.977	1.000	0.965
SK	0.991	0.945	0.983	0.944	0.966	0.964	0.960	0.970	0.956	0.948	0.960	0.942
SK0	0.992	0.944	0.982	0.944	0.966	0.963	0.960	0.970	0.956	0.948	0.960	0.943
FI	0.967	0.999	0.970	0.997	0.982	0.959	0.991	0.951	0.994	0.933	1.000	0.915
FI1	0.968	1.000	0.971	0.998	0.982	0.960	0.992	0.952	0.994	0.933	1.000	0.914
SE	0.999	0.895	0.999	0.885	0.998	0.887	1.000	0.865	0.998	0.835	1.000	0.838
SE1	1.000	0.835	0.999	0.842	1.000	0.862	1.000	0.862	0.990	0.855	1.001	0.828
SE2	1.000	0.892	0.995	0.887	1.000	0.891	1.000	0.863	0.985	0.846	1.000	0.840
SE3	0.988	0.990	0.991	0.937	0.966	0.918	0.983	0.887	0.977	0.904	1.000	0.863
IS	1.000	0.945					1.000	0.934	1.000	0.978	0.993	0.942
IS0	1.000	0.945					1.000	0.934	1.000	0.979	0.993	0.942
NO	0.997	0.896	0.975	0.884	0.984	0.883	0.989	0.893	1.000	0.902	1.000	0.903
NO0	0.997	0.897	0.975	0.884	0.984	0.883	0.989	0.893	1.000	0.902	1.000	0.903
CH											1.000	1.000
CH0											1.000	1.000
UK	0.888	0.951	0.956	0.934	0.953	0.936	0.958	0.930	0.971	0.933	0.979	0.930
UKC	0.936	0.962	0.961	0.959	0.996	0.948	0.981	0.967	0.994	0.921	0.991	0.947
UKD	0.926	0.977	0.947	0.969	0.950	0.939	0.952	0.941	0.957	0.938	0.958	0.952
UKE	0.913	0.991	0.948	0.962	0.943	0.950	0.945	0.972	0.953	0.965	0.950	0.960
UKF	0.912	0.956	0.971	0.923	0.958	0.940	0.962	0.949	0.959	0.907	0.961	0.926
UKG	0.906	0.999	0.953	0.924	0.933	0.946	0.933	0.952	0.943	0.966	0.953	0.942
UKH	0.903	0.939	0.941	0.939	0.958	0.959	0.957	0.950	0.972	0.948	0.983	0.962
UKI	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UKJ	0.939	0.923	0.946	0.955	0.953	0.949	0.989	0.896	0.985	0.895	0.996	0.902
UKK	0.960	0.942	0.947	0.997	0.944	0.945	0.976	0.911	0.983	0.916	0.997	0.923
UKL	0.934	0.952	0.963	0.956	0.995	0.939	0.991	0.942	0.988	0.939	0.969	0.949
UKM	1.000	1.000	1.000	1.000	1.001	0.950	0.996	0.979	0.970	0.987	1.000	0.959
UKN	0.858	1.000	0.876	1.000	0.877	1.000	0.874	1.000	0.931	0.991		
MK	1.000	1.000	0.972	1.000	1.000	0.973	0.980	1.000	1.000	0.979		
MK0	1.000	1.000	0.972	1.000	1.000	0.973	0.980	1.000	1.000	0.979		
RS									0.971	0.966	0.981	0.963
RS1											1.006	0.952
RS2											0.954	1.000
N	125	125	124	124	124	124	128	128	127	127	133	133
Min	0.850	0.835	0.843	0.842	0.850	0.843	0.846	0.849	0.817	0.835	0.846	0.813
25-perc	0.930	0.952	0.940	0.936	0.946	0.932	0.955	0.928	0.959	0.921	0.961	0.928
Average	0.957	0.973	0.959	0.965	0.965	0.958	0.966	0.957	0.972	0.954	0.976	0.954
Median	0.970	0.997	0.971	0.989	0.981	0.974	0.982	0.973	0.988	0.966	0.993	0.962
75-perc	0.997	1.000	0.993	1.000	0.997	0.996	0.994	0.998	0.998	0.997	1.000	0.998
Max	1.000	1.012	1.000	1.014	1.001	1.003	1.000	1.000	1.002	1.002	1.006	1.007
Std Dev	0.045	0.040	0.041	0.044	0.040	0.046	0.040	0.045	0.037	0.046	0.035	0.048

Table D.11: Performance evolution assessment of the conditional model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
BE	1.019	1.002	1.017	1.042	0.994	1.048	0.997	1.011	0.986	1.007	1.005	1.002	0.973	1.006	0.967	1.001	0.985	1.015
BE1	1.000	1.000	1.000	0.984	1.000	0.984	1.008	1.000	1.008	1.009	1.000	1.009	1.000	1.000	1.000	1.000	1.000	1.000
BE2	1.037	1.025	1.012	0.984	0.968	1.016	1.011	1.018	0.993	1.010	1.016	0.994	1.020	1.017	1.003	1.013	1.006	1.006
BE3	0.949	0.982	0.966	0.978	0.998	0.979	1.001	1.004	0.997	0.999	1.003	0.996	1.001	1.000	1.001	0.969	0.977	0.992
BG	0.937	1.002	0.934	0.983	0.972	1.012	0.975	0.984	0.992	0.991	1.013	0.979	0.999	1.022	0.978	0.986	1.014	0.973
BG3	0.911	0.897	1.015	0.973	0.953	1.022	0.974	0.974	0.999	0.983	1.023	0.961	0.985	0.980	1.006	0.992	0.964	1.029
BG4	0.974	1.033	0.943	0.987	0.972	1.016	0.987	0.994	0.993	1.002	1.057	0.949	1.009	1.015	0.994	0.989	0.997	0.992
CZ	1.061	1.053	1.007	0.995	1.001	0.994	1.034	1.034	1.001	1.031	1.024	1.006	0.998	0.993	1.006	1.001	1.001	1.001
CZ0	1.062	1.053	1.009	0.997	1.000	0.997	1.033	1.034	0.999	1.031	1.025	1.006	0.998	0.992	1.006	1.002	1.001	1.001
DK	0.998	0.995	1.002	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995	1.005	0.988	1.002	0.986	1.010	0.998	1.012
DK0	0.998	0.995	1.003	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995	1.005	0.988	1.002	0.986	1.010	0.998	1.012
DE	1.142	1.019	1.122	1.008	0.986	1.022	1.050	1.025	1.024	1.079	1.010	1.068	1.001	1.000	1.001	1.000	0.998	1.003
DE1	0.997	0.983	1.014	0.969	0.983	0.985	1.032	1.013	1.019	0.996	0.995	1.001	0.996	0.985	1.011	1.004	1.007	0.998
DE2	1.045	0.979	1.068	1.004	0.986	1.017	1.042	1.006	1.036	0.999	0.998	1.001	0.998	0.992	1.006	1.003	0.996	1.007
DE3	1.067	0.986	1.083	1.067	1.008	1.059	0.996	0.959	1.039	1.004	0.996	1.008	1.000	1.011	0.989	1.000	1.012	0.988
DE4	1.053	1.030	1.022	1.000	0.998	1.002	1.052	1.016	1.035	0.984	0.990	0.994	1.011	1.014	0.997	1.006	1.012	0.995
DE5	1.056	1.057	0.999	0.996	1.050	0.949	1.036	0.973	1.065	1.002	1.024	0.979	0.983	0.995	0.987	1.039	1.015	1.023
DE6	1.000	0.973	1.028	0.995	0.984	1.011	1.005	1.002	1.003	1.000	1.001	0.999	1.000	1.010	0.990	1.000	0.975	1.025
DE7	1.028	0.992	1.036	1.002	0.987	1.015	1.018	1.010	1.008	0.997	1.005	0.991	1.001	0.990	1.012	1.009	0.999	1.010
DE8	1.063	1.010	1.052	0.999	0.987	1.013	1.014	1.010	1.004	1.038	1.000	1.038	1.004	1.003	1.001	1.006	1.011	0.995
DE9	1.045	1.007	1.037	1.005	0.987	1.018	1.005	1.006	0.998	1.026	1.018	1.008	1.005	1.004	1.001	1.003	0.991	1.012
DEA	1.089	1.037	1.050	1.026	1.006	1.020	1.060	1.020	1.039	1.003	1.005	0.998	1.006	1.022	0.985	0.992	0.983	1.009
DEB	1.057	0.984	1.074	1.000	0.984	1.016	1.001	1.012	0.989	1.018	0.996	1.023	1.001	1.004	0.997	1.036	0.988	1.048
DEC	1.026	1.038	0.989	0.981	1.005	0.976	1.004	1.007	0.996	1.014	0.995	1.020	1.020	1.032	0.989	1.008	0.999	1.009
DED	1.071	1.041	1.029	0.996	0.991	1.004	1.071	1.017	1.053	0.989	1.013	0.977	1.009	1.024	0.985	1.006	0.995	1.011
DEE	1.041	1.016	1.025	0.996	0.990	1.006	0.995	0.989	1.006	1.030	0.992	1.039	1.035	1.009	1.026	0.985	1.037	0.950
DEF	1.026	1.025	1.001	0.979	1.000	0.979	1.006	1.015	0.991	1.007	1.014	0.992	1.037	1.007	1.030	0.997	0.988	1.010
DEG	1.055	1.024	1.031	0.984	0.980	1.004	1.040	1.004	1.035	1.034	1.029	1.004	1.004	1.023	0.981	0.993	0.987	1.007
EE	1.050	1.087	0.966	1.001	1.005	0.996	1.023	1.009	1.014	1.012	1.010	1.002	1.013	1.019	0.994	1.000	1.041	0.961
EE0	1.050	1.087	0.966	1.001	1.007	0.994	1.023	1.009	1.014	1.012	1.010	1.003	1.013	1.019	0.994	1.000	1.041	0.961
IE	0.990	1.026	0.965	0.973	0.974	0.999	0.986	0.987	0.999	1.026	1.031	0.995	1.011	1.038	0.974	0.995	0.996	0.999
IE0	0.990	1.026	0.964	0.972	0.974	0.998	0.986	0.987	0.999	1.026	1.031	0.995	1.011	1.038	0.974	0.995	0.997	0.999
EL				0.985	1.000	0.985	1.015	1.000	1.015	1.006	0.981	1.025						
EL3																		
EL4																		
EL5																		
EL6																		
ES	1.000	1.000	1.000	1.000	1.000	1.000	0.993	1.000	0.993	0.998	1.000	0.998	1.008	0.999	1.008	1.002	1.001	1.001
ES1	1.008	0.998	1.010	1.008	0.996	1.012	0.990	0.996	0.994	1.001	1.003	0.998	1.000	0.991	1.008	1.010	1.012	0.998
ES2	0.966	0.986	0.980	0.995	1.000	0.995	0.997	1.000	0.997	1.003	0.999	1.004	0.987	0.981	1.006	0.984	1.006	0.979
ES3	1.000	1.000	1.000	0.998	1.000	0.998	0.996	1.000	0.996	1.005	1.000	1.005	1.001	1.000	1.002	1.000	1.000	1.000
ES4	1.000	0.998	1.001	1.000	1.000	1.000	0.993	0.998	0.996	1.001	1.002	0.999	0.998	0.996	1.003	1.007	1.003	1.004
ES5	0.972	0.984	0.988	1.000	0.980	1.021	0.991	0.992	0.999	1.002	1.004	0.998	0.965	0.998	0.967	1.015	1.010	1.004
ES6	1.005	1.000	1.005	1.005	1.000	1.005	0.997	1.000	0.997	0.995	1.000	0.995	1.002	1.000	1.002	1.006	1.000	1.006
ES7	1.000	1.000	1.000	0.998	1.000	0.998	1.002	1.000	1.002	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
FR	1.015	1.005	1.010	1.008	1.008	1.000	0.998	1.004	0.994	0.997	1.001	0.996	1.008	0.993	1.015	1.004	0.998	1.007
FR1	1.008	1.000	1.008	1.008	1.000	1.008	1.000	1.000	1.000	0.991	1.000	0.991	0.999	1.000	0.999	1.011	1.000	1.011
FRB	1.017	1.006	1.012	1.013	1.023	0.991	1.011	0.993	1.018	0.985	0.991	0.994	1.015	1.011	1.003	0.994	0.987	1.006
FRC	0.993	0.988	1.005	0.974	0.985	0.989	1.019	1.016	1.003	0.991	1.001	0.990	1.001	0.995	1.007	1.008	0.991	1.017
FRD	1.019	1.024	0.995	1.034	1.017	1.017	0.996	1.010	0.986	0.990	0.993	0.997	1.005	0.991	1.015	0.994	1.013	0.981
FRE	0.994	1.004	0.991	0.992	0.982	1.009	1.000	1.011	0.989	1.000	1.000	0.999	1.004	0.981	1.024	0.998	1.030	0.969
FRF	1.020	1.009	1.010	1.012	1.019	0.994	1.019	1.014	1.005	0.976	0.987	0.988	1.009	0.997	1.012	1.004	0.992	1.011
FRG	1.023	1.006	1.016	1.001	1.016	0.985	1.004	0.997	1.007	1.013	1.007	1.005	1.004	0.999	1.006	1.000	0.987	1.013
FRH	1.000	0.992	1.009	0.987	0.989	0.998	1.013	1.014	0.999	0.985	0.986	0.999	1.015	1.021	0.994	1.000	0.982	1.018
FRI	1.014	1.018	0.996	1.009	1.013	0.996	0.996	0.999	0.997	1.009	1.017	0.992	1.000	0.985	1.015	1.000	1.004	0.996
FRJ	0.984	0.985	0.999	0.982	0.989	0.993	1.001	1.007	0.995	0.996	1.002	0.994	1.020	1.002	1.018	0.985	0.985	0.999
FRK	1.004	0.997	1.007	0.997	1.004	0.993	1.006	1.001	1.004	0.996	0.996	0.999	1.006	1.005	1.001	1.001	0.991	1.010
FRL	1.001	1.005	0.996	1.021	1.014	1.007	0.993	0.999	0.994	1.002	1.006	0.995	0.989	0.978	1.011	0.997	1.008	0.989
FRM				0.985	0.976	1.009	1.175	1.099	1.069									
FRY							1.002	1.000	1.001	0.998	1.000	0.998	0.999	1.000	0.999	1.002	1.000	1.002
HR	0.986	0.883	1.117	1.000	1.000	1.000	1.001	0.974	1.027	0.991	0.964	1.027	0.998	0.972	1.027	0.997	0.967	1.030
HR0	0.986	0.883	1.117	1.000	1.000	1.000	1.001	0.974	1.027	0.990	0.965	1.027	0.998	0.972	1.026	0.997	0.966	1.031
IT	0.982	1.006	0.976	1.000	0.995	1.006	1.012	1.008	1.004	0.990	0.997	0.993	0.984	0.986	0.997	0.996	1.021	0.976
ITC	1.010	1.008	1.001	1.001	0.997	1.004	1.018	1.016	1.003	0.976	0.997	0.979	1.004	1.008	0.996	1.011	0.991	1.020
ITF	1.024	1.025	1.000	0.999	0.995	1.004	1.004	1.009	0.995	0.992	0.996	0.996	1.013	0.988	1.025	1.016	1.037	0.980
ITG	0.953	1.030	0.925	0.979	0.989	0.990	0.995	1.008	0.987	0.969	0.980	0.989	1.009	1.035	0.975	1.002	1.020	0.982
ITH	1.013	1.013	1.000	0.995	1.009	0.985	1.002	1.013	0.989	1.005	0.994	1.011	1.011	1.013	0.998	1.001	0.984	1.017
ITI	1.008	0.996	1.012	0.985	1.009	0.977	1.017	1.011	1.006	0.985	1.000	0.984	1.005	0.995	1.011	1.016	0.981	1.036
CY	1.020	0.915	1.114	1.020	1.000	1.020	0.998	1.000	0.998	0.993	0.988	1.005	1.009	0.954	1.058	1.000	0.972	1.029
CY0	1.020	0.916	1.114	1.020	1.000	1.020	0.998	0.999	0.999	0.993	0.988	1.005	1.009	0.954	1.058	1.000	0.972	1.029
LV	0.992	0.951	1.043	0.981	0.986	0.995	1.016	1.004	1.012	1.005	0.998	1.007	0.996	0.974	1.023	0.993	0.987	1.006
LV0	0.992	0.950	1.044	0.981	0.985	0.996	1.017	1.004	1.012	1.005	0.998	1.007	0.997	0.975	1.023	0.993	0.987	1.006
LT	1.015	1.014	1.002	1.003	1.034	0.970	1.003	0.984	1.019	1.005	0.997	1.008	1.004	1.012	0.992	1.000	0.987	1.013
LT0	1.016	1.012	1.004	1.003	1.034	0.970	1.003	0.985	1.018	1.005	0.997	1.008	1.004	1.011	0.993	1.000	0.985	1.015
LU	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
LU0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.001	1.000	1.001
HU	1.006	1.083	0.929	1.039	1.027	1.012	0.986	1.001	0.985	1.008	1.029	0.979	0.996	1.012	0.985	0.978	1.013	0.966
HU1	1.063	1.080	0.984	1.063	1.015	1.047	0.963	1.017	0.946	1.027	1.033	0.994	1.000	1.000	1.000	1.012	1.012	0.999
HU2	1.037	1.063	0.975	1.035	1.033	1.001	1.008	1.038	0.971	0.995	0.987	1.007	0.991	0.996	0.995	1.008	1.008	1.001
HU3	1.032	1.043	0.990	1.023	1.018	1.005	0.999	1.003	0.996	1.000	1.005	0.996	1.001	1.006	0.996	1.009	1.012	0.997
MT	1.149	1.019	1.127	1.055	1.009	1.047	1.086	1.011	1.074	0.909	1.016	0.895	1.100	1.001	1.099	1.002	0.983	1.020
MT0	1.149	1.019	1.127	1.055	1.008	1.047	1.086	1.012	1.073	0.909	1.015	0.895	1.100	1.001	1.099	1.002	0.982	1.020
NL	1.012	1.029	0.983	0.997	1.014	0.983	1.004	0.978	1.026	1.010	1.021	0.989	0.995	1.016	0.979	1.006	1.001	1.005
AT	1.000	1.019	0.981	0.993	0.988	1.004	0.951	1.002	0.949	1.038	1.005	1.033	1.020	1.011	1.009	1.001	1.013	0.988
AT1	1.000	0.984	1.016	1.000	1.002	0.998	1.000	1.019	0.982	1.000	0.984	1.016	1.000	1.003	0.997	1.000	0.977	1.023
AT2	1.033	1.026	1.007	0.994	0.984	1.009	0.989	1.001	0.988	1.011	1.037	0.975	1.022	1.010	1.012	1.017	0.994	1.023
AT3	0.997	0.991	1.006	1.004	0.980	1.024	1.006	1.017	0.989	1.003	1.003	1.000	0.988	0.990	0.998	0.997	1.001	0.996

Table D.11: Performance evolution assessment of the conditional model for all data

Geo	2014/2019			2014/2015			2015/2016			2016/2017			2017/2018			2018/2019		
(k)	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k	GMI_k	EC_k	BPC_k
PL	1.012	1.062	0.953	0.996	1.001	0.995	1.008	1.003	1.005	0.991	1.027	0.965	1.009	1.034	0.976	1.008	0.997	1.011
PL2	1.005	1.073	0.937	0.989	0.996	0.993	1.014	1.021	0.993	1.002	1.039	0.964	1.001	1.021	0.981	0.999	0.995	1.004
PL4	1.023	1.082	0.946	0.997	1.006	0.991	1.007	1.011	0.996	0.990	1.045	0.948	1.021	1.012	1.009	1.009	1.006	1.002
PL5	1.004	1.080	0.930	0.984	0.995	0.988	1.004	1.006	0.998	1.006	1.053	0.955	1.024	1.041	0.984	0.987	0.983	1.004
PL6	1.022	1.051	0.972	0.987	0.992	0.995	1.013	0.996	1.016	1.008	1.015	0.993	1.004	1.034	0.972	1.010	1.014	0.996
PL7																1.014	1.019	0.995
PL8																1.002	1.025	0.978
PL9																0.999	0.990	1.009
PT	0.917	0.964	0.951	0.963	0.993	0.970	0.919	0.988	0.930	1.005	1.004	1.001	1.011	0.977	1.035	1.020	1.002	1.017
PT1	0.924	0.958	0.964	0.962	0.995	0.967	0.921	0.985	0.935	1.009	1.002	1.007	1.011	0.975	1.036	1.021	0.999	1.022
PT2	1.085	0.922	1.177	1.031	0.941	1.095	1.021	1.002	1.019	1.024	1.004	1.020	1.012	1.006	1.006	0.995	0.968	1.028
PT3				1.000	1.003	0.997	1.000	0.990	1.010									
RO	1.050	1.088	0.964	1.006	1.002	1.004	1.000	1.007	0.992	0.988	1.020	0.969	1.026	1.038	0.989	1.029	1.019	1.010
RO1	1.002	1.013	0.990	0.992	0.991	1.001	1.002	1.021	0.981	0.996	1.009	0.988	0.989	0.999	0.991	1.024	0.994	1.030
RO2	1.018	1.070	0.951	1.004	1.012	0.992	0.992	1.006	0.986	0.993	1.007	0.986	0.967	1.023	0.945	1.065	1.020	1.044
RO3	1.107	1.098	1.007	1.018	1.018	1.000	1.033	1.002	1.031	1.005	1.020	0.985	1.048	1.031	1.016	0.999	1.024	0.976
RO4	1.041	1.074	0.969	1.033	1.007	1.026	0.995	0.993	1.002	0.986	0.981	1.005	1.005	1.045	0.962	1.022	1.048	0.976
SI	1.050	1.043	1.007	1.000	0.996	1.004	0.991	0.995	0.996	1.021	1.007	1.013	1.031	1.005	1.026	1.007	1.040	0.968
SI0	1.050	1.043	1.007	1.000	0.996	1.004	0.991	0.995	0.997	1.021	1.007	1.013	1.030	1.005	1.025	1.008	1.040	0.969
SK	0.968	0.912	1.062	0.991	0.953	1.041	0.983	0.968	1.015	0.994	0.983	1.011	0.995	1.000	0.996	1.004	1.006	0.999
SK0	0.968	0.912	1.062	0.990	0.954	1.038	0.984	0.968	1.017	0.994	0.983	1.010	0.996	0.999	0.996	1.004	1.005	1.000
FI	1.034	1.007	1.027	1.003	1.021	0.982	1.013	1.004	1.009	1.009	1.013	0.996	1.002	0.988	1.015	1.006	0.981	1.026
FI1	1.033	1.006	1.026	1.003	1.022	0.982	1.012	1.003	1.009	1.010	1.017	0.993	1.002	0.985	1.017	1.006	0.981	1.026
SE	1.001	1.007	0.993	1.000	1.006	0.995	0.999	0.998	1.001	1.002	1.002	1.000	0.998	1.003	0.995	1.002	0.999	1.002
SE1	1.001	0.999	1.002	0.999	1.000	0.999	1.001	1.000	1.001	1.000	0.999	1.001	0.990	1.000	0.990	1.011	1.000	1.011
SE2	1.000	1.008	0.992	0.995	1.002	0.994	1.005	1.003	1.002	1.000	0.996	1.004	0.985	1.007	0.979	1.015	1.001	1.014
SE3	1.012	1.025	0.988	1.003	1.028	0.976	0.975	0.989	0.986	1.018	1.014	1.004	0.994	0.999	0.995	1.024	0.996	1.028
IS													1.000	1.000	1.000	0.993	1.000	0.993
IS0													1.000	1.000	1.000	0.993	1.000	0.992
NO	1.003	1.000	1.003	0.978	1.000	0.978	1.009	0.995	1.013	1.005	1.003	1.002	1.011	1.000	1.012	1.000	1.001	0.999
NO0	1.003	1.000	1.003	0.978	1.000	0.978	1.009	0.995	1.014	1.004	1.004	1.001	1.012	1.000	1.012	1.000	1.001	0.999
CH																		
CH0																		
UK	1.103	1.061	1.039	1.076	1.044	1.031	0.997	1.002	0.995	1.006	1.006	1.000	1.013	1.003	1.010	1.008	1.005	1.003
UKC	1.058	1.013	1.044	1.026	1.028	0.998	1.037	1.002	1.034	0.986	0.995	0.991	1.012	1.007	1.005	0.997	0.981	1.016
UKD	1.035	1.061	0.976	1.023	1.034	0.990	1.002	1.016	0.987	1.002	1.013	0.990	1.005	0.990	1.015	1.002	1.008	0.994
UKE	1.041	1.066	0.977	1.038	1.044	0.995	0.995	1.011	0.985	1.002	1.005	0.996	1.009	1.007	1.002	0.997	0.998	0.999
UKF	1.053	1.054	1.000	1.064	1.042	1.021	0.987	0.999	0.988	1.005	1.016	0.989	0.997	1.000	0.997	1.002	0.996	1.006
UKG	1.052	1.066	0.986	1.052	1.032	1.019	0.979	1.008	0.972	1.000	0.999	1.001	1.010	1.015	0.995	1.011	1.011	1.000
UKH	1.089	1.053	1.034	1.042	1.032	1.009	1.018	1.016	1.001	0.999	0.994	1.006	1.016	1.009	1.007	1.011	1.002	1.009
UKI	1.002	1.000	1.002	1.002	1.000	1.002	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UKJ	1.061	1.020	1.041	1.008	0.984	1.024	1.007	1.007	1.000	1.038	1.028	1.010	0.996	0.998	0.999	1.011	1.003	1.008
UKK	1.039	1.014	1.024	0.987	0.980	1.007	0.997	1.002	0.995	1.034	1.031	1.003	1.006	0.999	1.008	1.014	1.003	1.011
UKL	1.038	1.047	0.991	1.032	1.009	1.023	1.033	1.032	1.001	0.996	1.001	0.995	0.997	1.034	0.964	0.981	0.972	1.009
UKM	1.000	1.004	0.996	1.000	1.002	0.998	1.001	1.003	0.998	0.995	1.002	0.993	0.974	0.993	0.981	1.031	1.005	1.026
UKN				1.022	1.022	1.000	1.001	0.984	1.017	0.996	1.020	0.977	1.066	1.046	1.019			
MK				0.972	0.977	0.995	1.029	1.031	0.998	0.980	0.905	1.083	1.020	1.111	0.919			
MK0				0.972	0.977	0.995	1.029	1.032	0.998	0.980	0.905	1.083	1.020	1.111	0.918			
RS																1.010	0.977	1.034
RS1																		
RS2																		
N	117	117	117	123	123	123	124	124	124	122	122	122	123	123	123	124	124	124
Min	0.911	0.883	0.925	0.962	0.941	0.949	0.919	0.959	0.930	0.909	0.905	0.895	0.965	0.954	0.918	0.969	0.964	0.950
25-perc	1.000	0.996	0.988	0.989	0.988	0.994	0.996	0.998	0.994	0.994	0.996	0.992	0.998	0.995	0.991	0.999	0.988	0.997
Average	1.020	1.012	1.009	1.003	1.000	1.003	1.007	1.004	1.003	1.002	1.004	0.998	1.006	1.005	1.001	1.004	1.000	1.004
Median	1.014	1.008	1.002	1.000	1.000	1.000	1.002	1.003	1.000	1.001	1.002	0.999	1.004	1.001	1.000	1.002	1.000	1.005
75-perc	1.043	1.037	1.024	1.008	1.009	1.012	1.014	1.011	1.012	1.008	1.014	1.006	1.011	1.012	1.011	1.009	1.008	1.014
Max	1.149	1.098	1.177	1.076	1.050	1.095	1.175	1.099	1.074	1.079	1.057	1.083	1.100	1.111	1.099	1.065	1.048	1.048
Std Dev	0.040	0.043	0.044	0.022	0.019	0.020	0.028	0.016	0.022	0.019	0.020	0.024	0.018	0.022	0.024	0.012	0.016	0.017

Table D.12: Convergence results of the conditional model for all data

Period	σ-convergence	β-convergence	Average BPC	Average WPC
2014/2015	1.000	1.000	1.003	1.003
2015/2016	1.004	1.006	1.003	0.998
2016/2017	1.004	0.997	0.998	1.002
2017/2018	1.005	1.000	1.001	1.001
2018/2019	1.000	1.015	1.004	0.990
2014/2019	1.010	1.018	1.009	1.003