Scale, congestion, and technical efficiency of European countries: a sector-based nonparametric approach*

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Abstract

In this paper, we investigate three aspects of economic growth of European countries: scale, congestion, and technical efficiency. The distinguishing features of the methodology used are, one, countries are exclusively defined in terms of their sectors, and, two, no specific assumptions on any aspect of the growth process (in particular the production function) are required. As such, we can better understand the performances of the countries for each of the three aspects studied, and avoid the drawbacks of specifying the production function. Our results reveal some important patterns useful for policy-makers. Firstly, we highlight the key sectors for each of the three aspects in every country. Next, our analysis reveals that, for each of the three aspects, higher progresses occur more often when more inefficient or non-optimal behaviour is present. Finally, we demonstrate that there is a relationship between these three aspects. All in all, we argue for the need of sector-specific multi-level policies. That is, policies that target the three aspects simultaneously for each sector individually.

Keywords: growth; sectors; Europe; congestion; scale; technical efficiency; Data Envelopment Analysis.

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1 Introduction

Two main approaches are typically used to study economic growth of countries. The first approach, initiated by Solow (1956), decomposes economic growth into different components to determine its sources. The second approach, initiated by Baumol (1986) and Barro (1991), uses econometric tools to investigate the causes of economic growth differences. Amongst the alternative techniques used to study economic growth, Data Envelopment Analysis (DEA)-based methods have gained in popularity.[1] DEA is a nonparametric approach used to evaluate technical efficiency of Decision Making Units (such as firms, plants, utilities) by comparing their input-output performance. DEA is intrinsically nonparametric as it does not require a parametric/functional specification of the (typically unknown) production technology, but, rather, DEA reconstructs the technology using (only) the data.[2]

The growing popularity of DEA-based methods for empirical macroeconomics is mainly due to their nonparametric nature. Indeed, more standard methods are heavily model driven: they depend on particular assumptions on the growth process, and in particular, they require the specification of the production function. Clearly, those assumptions could have huge impacts on the results, and in the worst case, bias the results. DEA-based methods do not present these drawbacks: DEA-based methods reconstruct the production function of the countries using the data. Therefore, in a macroeconomic context, the Decision Making Units are the countries, and technical efficiency represents the potential output or economic growth. In other words, DEA-based methods detect whether, given the production factor levels, countries could reach a higher output level or a larger economic growth. Besides technical efficiency, DEA-based methods have been used to investigate other aspects of economic growth, for example, scale efficiency (i.e. the optimal scale of production achieved), congestion (i.e. an excessive investment in production factors causing output falls), decomposition of economic growth in different components, aggregation of economic growth, relationship between economic growth, energy, and pollution.[3]

Recently, increasing attention has been given to the study of economic growth at the sector level. See, Ciccone and Papaioannou (2009), Rodrik (2013), Cherchye et al (2014), Miao and Wang (2014), Zschille (2014), Iscan (2015), Zeira and Zoabi (2015), Battisti,

[1] See Färe, Grosskopf and Lovell (1994), Cooper, Seiford and Zhu (2004), Cooper, Seiford and Tone (2007), Fried, Lovell and Schmidt (2008) and Cook and Seiford (2009) for extensive reviews of DEA.

[2] In practice, technology axioms (such as monotonicity, convexity, returns-to-scale) are also imposed to avoid trivial reconstructions. See Section 2 for more details.

[3] For empirical macroeconomic works using DEA-based methods, refer, for example, to Wu (2001), Kumar and Russell (2002), Henderson and Russell (2005), Enflo and Hjertstrand (2009), Cherchye (2011), Zelenyuk (2011), Zhang et al (2011), Bampatsou, Papadopoulos and Zervas (2013), Badunenko, Henderson and Russell (2013), Song et al. (2013), Wang, Lu and Wei (2013), Wu and An (2013), Apergis et al (2015), Wang and Feng (2015), Cantore, Cali and te Velde (2016), Dai, Guo and Jiang (2016), Chen, Wang and Wang (2016), and Zhou et al (2017).

Del Gatto and Parmeter (2017), Magalhaes and Afonso (2017), Stauvermann and Kumar (2017), to cite only a few.[4] Typically, sector-level empirical works are built on similar or directly inspired methodologies as those used for countries. As a consequence, these empirical works also depend on specific assumptions of the growth process. Moreover, most of these empirical studies are focused on a particular or a group of sectors. Building on the increasing importance of the sectors in empirical macroeconomic studies, Walheer (2016a, b) suggested a DEA-based macroeconomic model for the countries based on sector-level technologies. That is, instead of modelling each country, he models every sector in each country separately. As such, each country is directly defined in terms of its sectors. This modelling offers several advantages: the heterogeneity and interdependence of the sectors are taken into account, the realism of the growth analysis is increased, more detailed results are provided, all sectors are taken into consideration, and less restrictive assumptions are required (assumption of the sector-level technologies are less restrictive than assumptions of country-level technology).

In this paper, using the modelling of Walheer (2016a, b), we study economic growth of 19 European countries for the period 1995-2015, where each country contains 10 sectors. We use the OECD Detailed National Account database; this very detailed database represents a unique opportunity to study countries based on sectors over a large period, as sector-level data are, in general, more difficult to find and to rely on than country-level data.[5] We focus on three aspects of the growth process: scale, congestion, and technical efficiency. More precisely, we investigate the three following questions: Do countries combine the production factors efficiently to generate output? Is scale at its optimal level? And, are there excessive investments in production factors causing output falls? As the model used defines countries in terms of its sectors, we can better understand the answer to those questions. In particular, for each country, we can identify the key sectors for each of the three aspects. We believe that this decomposition is attractive for policy-makers as it allows a better understanding of the economic growth of countries, and therefore to better target policy implementations. Finally, we investigate the relationships between levels and changes for each of the three aspects, and also between the three aspects, at both the country and sector levels. Those results have an impact on policy, as they reveal whether policy implementation should target one or more aspects of economic growth, and this is for every sector.

The rest of the paper is structured as follows. In Section 2, we present our methodology. In Section 3, we present the results. Section 4, we present our conclusions.

[4] Note that the importance of sectors for growth and convergence empirical works is not new and dates to Bernard and Jones (1996), Rajan and Zingales (1998), Claessens and Laeven (2003), and Fisman and Love (2003).

[5] This also explains why most of the sector-level empirical studies are focused on a particular or a group of sectors.

2 Methodology

The following methodology has been introduced by Walheer (2016a, b). He suggested a nonparametric model to study economic growth of countries building on sector-level technologies. While his model was focused on technical efficiency, it is straightforward to extend to scale and congestion. In this Section, we start by defining our indicators for scale, congestion, and technical efficiency for the sectors. Next, we show how to obtain the country-level indicators using exclusively the sector-level counterparts.

We assume that we observe J countries during T periods, and that each country contains I sectors. We consider a very general production process: every sector i in country j at time t uses n production factors, contained in the vector $\mathbf{X}_{ijt}$, to produce output Y_{ijt}. Therefore, the production function is given by $Y(\mathbf{X}_{ijt})$. As explained in the Introduction, our method is nonparametric in nature, that is we do not make specific assumptions about the production function $Y(\mathbf{X}_{ijt})$, but rather we reconstruct the technology using the data. Nevertheless, to avoid a trivial reconstruction and to match with the common practice in empirical macroeconomics, we impose some regularity conditions. In particular, we assume that the production function is quasi-concave, continuous and strictly increasing. As we focus our analysis on technical efficiency, scale, and congestion of the growth process, two features of the production function are of interest: disposability of the production factors and returns-to-scale. The imposed regularity conditions imply that the production factors are strongly (or freely) disposable: more production factors never reduce the output, and that variable returns-to-scale is assumed. As such, we denote the production function satisfying our regularity conditions by $Y_{vrs,sdo}(\mathbf{X}_{ijt})$.

Sector-level indicators. Our first indicator ER_{ijt} captures the technical efficiency of sector i in country j at time t. In general, two ways are available to define technical efficiency: the maximal level of output given the production factors, or the minimal level of the production factors given the output. In a macroeconomic context, it is more natural to choose the former way. In practice, technical efficiency is evaluated by comparing the potential level of output, captured by $Y_{crs,sdo}(\mathbf{X}_{ijt})$, to the actual output level Y_{ijt}. This yields to the following ratio:

$$ER(\mathbf{X}_{ijt}) = \frac{Y_{vrs,sdo}(\mathbf{X}_{ijt})}{Y_{ijt}}. \tag{1}$$

Clearly, the actual value, Y_{ijt} cannot exceed the potential value, $Y_{vrs,sdo}(\mathbf{X}_{ijt})$, making the efficiency ratio greater or equal to unity. When $ER_{ijt} = 1$, it reveals that sector i produces the maximal value of output given the production factor $\mathbf{X}_{ijt}$. When the ratio is larger than 1, sector i can, in principle, increase its output without increasing the production factors.

Our second indicator, $SR(\mathbf{X}_{ijt})$ reflects the scale optimally or efficiency of sector i in country j at time t. In practice, we compare the production function $Y_{vrs,sdo}(\mathbf{X}_{ijt})$ to the production function when the hypothetical assumption of constant returns-to-scale is assumed, denoted by $Y_{crs,sdo}(\mathbf{X}_{ijt})$. As done before, we define a ratio:

$$SR(\mathbf{X}_{ijt}) = \frac{Y_{crs,sdo}(\mathbf{X}_{ijt})}{Y_{vrs,sdo}(\mathbf{X}_{ijt})}. \tag{2}$$

If $Y_{crs,sdo}(\mathbf{X}_{ijt})$ coincides with $Y_{vrs,sdo}(\mathbf{X}_{ijt})$, the scale ratio $SR(\mathbf{X}_{ijt})$ is equal to 1. That is, sector i presents scale optimality. If they do not coincide, $SR(\mathbf{X}_{ijt})$ is, in general, greater than 1. Indeed, we have that $Y_{crs,sdo}(\mathbf{X}_{ijt}) \geq Y_{vrs,sdo}(\mathbf{X}_{ijt})$ as the technology under constant returns-to-scale is always the greatest.[6] When $SR(\mathbf{X}_{ijt}) < 1$, it reveals that scale under-optimality is present, and that sector i exhibits decreasing or increasing returns-to-scale.[7]

Our third and last indicator $CR(\mathbf{X}_{ijt})$ captures the presence of congestion of the production factors in sector i in country j at time t. Congestion occurs when an excessive level of the production factors cause a fall for the output. In our context, it means that excessive investments and/or an excessive number of workers cause output to decrease. This is captured by assuming that the production factors are weak disposable. Let us denote the production function under this assumption by $Y_{vrs,wdo}(\mathbf{X}_{ijt})$. To formally test for the presence of congestion, we compare the production function under both strong and weak disposability. This gives the following ratio:

$$CR(\mathbf{X}_{ijt}) = \frac{Y_{vrs,sdo}(\mathbf{X}_{ijt})}{Y_{vrs,wdo}(\mathbf{X}_{ijt})}. \tag{3}$$

By definition, $Y_{vrs,sdo}(\mathbf{X}_{ijt}) \geq Y_{vrs,wdo}(\mathbf{X}_{ijt})$, meaning that the technology when assuming strong disposability is larger than the technology under weak disposability. Therefore, the ratio is greater than one. A ratio of one indicates that no congestion is present for sector i, while larger values imply more congestion of the production factors.

As a final remark, we point out that our indicators of the three concepts are in line with well-known indicators in the literature: see Farrell (1957) for the technical efficiency ratio, Färe and Grosskopf (1985) for the scale ratio, and Färe and Grosskopf (1983) for the congestion ratio. The distinguishing feature of the suggested indicators is that they are

[6] Let $T_{vrs,sdo}$ and $T_{crs,sdo}$ be the technology under variable and constant returns-to-scale, respectively. By construction, we have that $T_{crs,sdo} = \{\lambda(\mathbf{X}, \mathbf{Y}) : (\mathbf{X}, \mathbf{Y}) \in T_{vrs,sdo}, \forall \lambda > 0\}$. This reflects that $T_{vrs,sdo}$ is included in $T_{crs,sdo}$, implying that $Y_{crs,sdo}(\mathbf{X}) \geq Y_{vrs,sdo}(\mathbf{X})$. Intuitively, this reflects that only more technically inefficient behaviour can be found when assuming constant returns-to-scale.

[7] In practice, it is enough to evaluate $Y_{nirs,sdo}(\mathbf{X}_{ijt})$ (i.e. when assuming non-increasing returns-to-scale) and compare to $Y_{vrs,sdo}(\mathbf{X}_{ijt})$. If they are equal, decreasing returns-to-scale is present. Otherwise, increasing returns-to-scale is present. Note that $Y_{vrs,sdo}(\mathbf{X}_{ijt})$ can also be estimated by a linear program.

based on sector-level technology.

Country-level indicators. Let $ER(\mathbf{X}_{jt})$, $SR(\mathbf{X}_{jt})$, and $CR(\mathbf{X}_{jt})$ be, respectively, the technical efficiency, scale, and congestion ratios of country j at time t (where $\mathbf{X}_{jt} = (\mathbf{X}_{1jt}, \ldots \mathbf{X}_{Ijt})$ contains the production factors of all the sectors). Attractively, those ratios can be exclusively defined in terms of their sector-level counterparts:

$$ER(\mathbf{X}_{jt}) = \sum_{i=1}^{I} \omega_{ijt}^{E} \times ER(\mathbf{X}_{ijt}), \tag{4}$$

$$SR(\mathbf{X}_{jt}) = \sum_{i=1}^{I} \omega_{ijt}^{S} \times SR(\mathbf{X}_{ijt}), \tag{5}$$

$$CR(\mathbf{X}_{jt}) = \sum_{i=1}^{I} \omega_{ijt}^{C} \times CR(\mathbf{X}_{ijt}), \tag{6}$$

where, we define: $\omega_{ijt}^{E} = \frac{Y_{ijt}}{\sum_{i=1}^{I} Y_{ijt}}$, $\omega_{ijt}^{S} = \frac{Y_{vrs,sdo}(\mathbf{X}_{ijt})}{\sum_{i=1}^{I} Y_{vrs,sdo}(\mathbf{X}_{ijt})}$, and $\omega_{ijt}^{C} = \frac{Y_{vrs,wdo}(\mathbf{X}_{ijt})}{\sum_{i=1}^{I} Y_{vrs,wdo}(\mathbf{X}_{ijt})}$. It implies, that the country-level indicators are obtained by a weighted average of the sector-level indicators; where the weights capture the relative importance of each sector for every indicator. Those weights have some desirable properties: they are natural, keep the same interpretation for the country-level indicators as their sector-level counterparts, and fit with economic intuition. Note that it is also intuitive that the weights are different for the three concepts, as nothing guarantees that the relative importance of the sectors is the same for the three aspects. As a final remark, those weights are coherent with several works on disaggregation (i.e., in our context, from country to sectors) and aggregation (i.e., in our context, from sectors to country) in the efficiency literature. Refer, for example, for disaggregation to Cherchye, De Rock, and Walheer (2015, 2016) and Walheer (2018a, b), and for aggregation to Färe and Zelenyuk (2005), Zelenyuk (2016), and Färe and Karagiannis (2017).

Nonparametric estimators. Our three ratios depend only on the three specifications of the production function: $Y_{crs,sdo}(\mathbf{X}_{ijt})$, $Y_{vrs,sdo}(\mathbf{X}_{ijt})$, and $Y_{vrs,wdo}(\mathbf{X}_{ijt})$. Attractively, these three production functions can be estimated using similar linear programs. We can generalise our three production functions by defining $Y_{c_1,c_2}(\mathbf{X}_{ijt})$, where $c_1 = \{crs, vrs\}$ and $c_2 = \{sdo, wdo\}$. The estimators $\widehat{Y}_{c_1,c_2}(\mathbf{X}_{i_0 j_0 t_0})$ for sector $i_0 \in (1, \ldots, I)$, country

$j_0 \in (1, \ldots, J)$, and time $t_0 \in (1, \ldots, T)$ are obtained using the following linear program:

$$\widehat{Y}_{c_1,c_2}(\mathbf{X}_{i_0j_0t_0}) = \max_{\lambda_{i_0jt_0}\ (j\in\{1,\ldots J\})} Y$$

$$\text{(C-1)}\ Y \leq \sum_{j=1}^{J} \lambda_{i_0jt_0} Y_{i_0jt_0},$$

$$\text{(C-2)}\ \mathbf{X}_{i_0j_0t_0} \geq \sum_{j=1}^{J} \lambda_{i_0jt_0} \mathbf{X}_{i_0jt_0}, \text{if } c_2 = sdo,$$

$$\text{(C-3)}\ \delta\mathbf{X}_{i_0j_0t_0} = \sum_{j=1}^{J} \lambda_{i_0jt_0} \mathbf{X}_{i_0jt_0}, \text{if } c_2 = wdo,$$

$$\text{(C-4)}\ \sum_{j=1}^{J} \lambda_{i_0jt_0} = 1, \text{if } c_1 = vrs,$$

$$\text{(C-5)}\ 0 \leq \delta \leq 1, \text{if } c_2 = wdo,$$

$$\text{(C-6)}\ \forall j : \lambda_{i_0jt_0} \geq 0,$$

$$\text{(C-7)}\ Y \geq 0.$$

By plugging-in our nonparametric estimators of the three production functions in (1) – (6), we obtain our estimators of the technical efficiency, scale, and congestion indicators for the sectors and the countries. The estimators have to be interpreted in the analogous manner to their theoretical counterparts. As a final remark, note that no particular constraint is required when constant returns-to-scale is chosen (i.e. $c_1 = crs$). In fact, (C-6) is enough in that case.

Confidence intervals. While the nonparametric approach is attractive given it avoids specifying a functional form for the technology of the sectors, several well-known issues may disproportionately influence the estimation process. Indeed, as all the observations are used by the linear program, outliers or measurement errors may create a bias for the estimated sector-level potential output values. A well-established method to decrease this influence has been suggested by Simar (2003) and Daraio and Simar (2007), among others. A second well-known problem is the downward bias of the estimated potential outputs. Again, there exists a solution that has been suggested by Simar and Wilson (1998, 2000), among others.

Moreover, in our sector-level context, the weights, and thus the country-level indicators, are also potentially influenced by these issues. Indeed, the weights and the country-level indicators are exclusively defined in terms of the estimated sector-level potential outputs. As it is a desirable property of the method, it means that we have to be careful when interpreting these indicators.

Fortunately, a procedure to deal with these issues has been suggested by Simar and Zelenyuk (2007). They proposed a simple technique to create confidence intervals for aggregates of technical efficiency ratios (similar to our country-level technical efficiency ratios in (4)). It is straightforward to adapt their technique for the scale and congestion ratios. As such, we make use of their procedure to construct bounds for the country-level indicators.[8] We refer to their paper for more detail on the computational aspect.

3 Application

We apply our methodology to the case of 19 European countries (Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, and Sweden) during the period 1995-2015, where each country contains ten sectors (Agriculture, Mining, Manufacturing, Electricity, Gas and Water, Construction, Wholesale, Transport, Public Administration, Education, and Health).

We consider two different specifications for the production factors. The first setting considers that every sector i in each country j at time t uses capital K_{ijt} and labour L_{ijt} to produce output (i.e. $n = 2$ and $\mathbf{X}_{ijt} = (K_{ijt}, L_{ijt})'$). This setting, while simple, is the most used for empirical macroeconomics, and dates to Solow (1956). The second setting includes human capital, captured for every sector i in each country j at time t by H_{ijt}. In particular, human capital is not included as a new production factor, but enters the technology as a multiplicative augmentation of labour (i.e. $n = 2$ and $\mathbf{X}_{ijt} = (K_{ijt}, \hat{L}_{ijt})'$) . That is, labour is defined in efficient unit: $\hat{L}_{ijt} = H_{ijt} \times L_{ijt}$. This modelling has been considered in several previous works based on the nonparametric approach (e.g. Henderson and Russell (2005), Badunenko, Henderson and Russell (2013), and Walheer (2016a, b)).

At this point, we remark that some authors include extra production factors (such as energy) or take pollution (such as air, water, solid waste pollution) into account. We prefer to stay with these two simple specifications for four main reasons. One, while there is a theoretical consensus of taking labour and capital, it is not true for other production factors. For example, energy is often modelled as an intermediate obtained via technological combinations of labour and capital. Two, given our sector setting, including more production factors would imply that they are important for all the sectors. Three, while data for capital, labour, human capital are available at the sector level, it is not true for other production factors. Finally, including pollution is beyond the scope of this paper, as it would require a modification of the methodology.

[8] Note that it is also possible to construct confidence intervals for the sector-level indicators. This case is not considered in the paper as country-level indicators are the most important indicators, and for the sake of compactness.

The data for output, capital, and labour are taken from the OECD Detailed National Accounts database. This database proxies output by the Gross Added Value and capital by the Gross Capital Formation (both in millions of the current national currency). We apply a double correction to those two variables: inflation and purchasing power parity. Labour is measured in thousands of people employed. No correction is required for this production factor. The growths of output and capital per unit of labour between the final and initial years (i.e. 2015 and 1995) for every country and sector are provided in Tables A.1 and A.2 in Appendix A, respectively. These two Tables reveal how the growth for capital is associated with the growth for output. That is, whether higher investments are associated with higher economic growth. Also, they highlight the higher growth for Scandinavian countries, and for Eastern and Central European countries. Clearly, these Tables are only descriptive and several important aspects are missing. Nevertheless, they show that Eastern and Central European countries have placed much effort into drawing near to richer European countries.

Human capital at the sector level is obtained by multiplying human capital at the country level (H_{jt}) by the sector-level human capital intensity (h_{it}): $H_{ijt} = H_{jt} \times h_{it}$. As a result, the sectors are interdependent as they share the education system of the country, captured by H_{jt}. Human capital for country j at time t is obtained using the construction of Hall and Jones (1999): $H_{jt} = e^{\phi(edu_{jt})}$, where ϕ is a piecewise-linear function, with a zero intercept and a slope of 0.134 through the fourth year of education, 0.101 for the next four years, and 0.068 for education beyond the eighth year; and edu_{jt} is the average number of years of education of the adult population for country j at time t. Data are given by Barro and Lee (2013). We refer to Hall and Jones (1999) for more discussion. The human capital intensity of the sectors (h_{it}) are obtained by the procedure used in Ciccone and Papaioannou (2009). This procedure requires observing the average years of employee schooling for the sectors. As these data are not provided by the OECD Detailed National Accounts database, we use the strategy of Ciccone and Papaioannou (2009). That is, we use the US data to compute the human capital intensity of the sectors, provided by the Integrated Public Use Microdata Series. This also comes with two advantages: the US data are of high quality, and the US labor markets are less regulated than those of the European countries. We refer to Ciccone and Papaioannou (2009) for more discussion.

We estimate the technical efficiency, scale and congestion ratios using the linear program of Section 2 for the 10 sectors in each of the 19 countries for every year. We present first the results without human capital, and then when considering human capital. For each of these two cases, before presenting the ratio results, we start by providing the weights. Those weights will highlight the relative importance of the sectors for each of the three aspects studied. We also test for the existence of a relationship between the three indicators. Finally, we propose a summary and present policy advice.

3.1 Results without human capital

We discuss the main results in the following. Detailed results are available in Appendix B.

Relative importance of the sectors for each indicator. We present in Tables B.1, B.2, and B.3 the (average) weights for the technical efficiency, scale, and congestion ratios for the period 1995-2015. These weights capture the relative importance of each sector in every country for the three indicators. As such they contextualise the ratio results. The weights are rather close for the three indicators. Of course the rankings are slightly different, but the main patterns are kept.[9] The most important sectors are, on average, Manufacturing (around 30%-25%) and Wholesale (around 20%-15%). This also explains why most of empirical works considering a group of sectors are mostly about the manufacturing sector (see, for example, Ciccone and Papaioannou (2009) and Battisti, Del Gatto and Parmeter (2017)). Next around 10%, we find Transport, Construction, Public Administration, Education, and Health.

Note also the importance of specific sectors for some countries: Agriculture for Hungary and Poland; Mining for Norway; Manufacturing for Ireland Germany, the Czech Republic, Slovenia, Slovakia, and Hungary; Construction for Austria, Spain, and Luxembourg; Transport for Estonia and Luxembourg; Public Administration for Spain, France, and Belgium; Education for Belgium and France, Denmark, Luxembourg, and Sweden; and Health for Sweden, France, Finland, the Netherlands, Luxembourg, and Denmark. Finally, sectors have a smaller weight for some countries, as Agriculture for Luxembourg, Norway, Germany, and Belgium; Manufacturing for Norway and Luxembourg; Construction for Hungary, Norway, and Sweden; Wholesale for Norway and Finland; Transport for Ireland; Public Administration for Ireland, Sweden, Norway, Finland, and the Czech Republic; Education for Slovakia, the Czech Republic, Poland, and Spain; and Health for the Czech Republic, Estonia, Hungary, and Poland.

Finally, we present in Tables B.4, B.5, and B.6 the change in the weights for the technical efficiency, scale, and congestion ratios between the final and initial years (i.e. 2015 and 1995). As the weights are endogenously defined when using the linear programs, they may vary over time. Also, variation in the weights will indicate the presence of structural change in the countries. An initial observation is that the changes in the weights are rather small, and close to 0 for all sectors-countries. This indicates the presence of structural stability in Europe. We point out the decreasing importance of Agriculture, and the increasing importance of the service-oriented sectors for all countries for the three dimensions.

[9] The Spearman correlations are 0.9928 ($p-$value of 0) between the weights of the scale and congestion ratios, 0.9859 ($p-$value of 0) between the weights of technical efficiency and congestion ratios, and 0.9850 ($p-$value of 0) between the weights of technical efficiency and scale ratios.

Technical efficiency. We present the results for the country-level indicators in Table B.7. Specifically, we compute the average of the technical efficiency ratios for the period. We rely on the average, rather than the median, to avoid trivial results, as most of the ratios are close to 1. In that Table, we also present the lower and upper bounds of the confidence intervals and the standard errors, as explained in Section 2. The total average for the period is 1.44, indicating the presence of technically inefficient behaviour. The most inefficient countries are the Central and Eastern countries, except Austria; while the most efficient are Luxembourg, France, Belgium, Italy, the Netherlands, and Sweden. At this point, we remark that to be fully efficient (indicator value of 1), a country has to be efficient in every sector during the whole period 1995-2015. Finally, the standard errors are rather small and the same holds true for the size of the confidence intervals. This indicates that we can be confident when interpreting the country-level indicators.

Similar results could be found by using methods based on country-level technology; the distinguishing feature of the methodology used is to rely on sectors. As such, we can better understand the performances found for the countries. We present the results in Table B.8. Luxembourg is efficient because this country is efficient in every sector. Next, France is very close to the efficient situation as the performances in all sectors are rather good. Policy implementation should target first the Manufacturing, Electricity, Gas, and Water, and Mining sectors. Similar conclusions hold for Belgium, Italy, the Netherlands, and Sweden. In Belgium, policy implementations should be taken to reduce the inefficiencies in Health, Electricity, Gas, and Water, and Manufacturing. In Italy, the Construction, Manufacturing, Mining and Agriculture sectors are the most inefficient sectors; in the Netherlands, it is the Health, Electricity, Gas, and Water, Wholesale, and Manufacturing sectors; in Sweden, it is the Mining, Education, and Public Administration sectors. Except Austria that has relatively good performances, especially in both the Public Administration and Construction sectors, the Eastern and Central European countries have relatively poor performances in all sectors. Nevertheless, the most inefficient sectors are different in each country: Mining, Construction, and Wholesale in the Czech Republic; Manufacturing and Electricity, Gas, and Water in Estonia; Construction, Mining, and Manufacturing in Hungary; Health, Construction and Manufacturing in Poland; Manufacturing and Electricity, Gas, and Water in Slovenia; and Construction and Transport in Slovakia.

Overall, the most efficient sectors are Public Administration, Health, Transport, and Wholesale. The most inefficient are Mining, Manufacturing, Electricity, Gas, and Water, and Agriculture. As shown in Table B.1, Manufacturing is the most important sector for the majority of countries. Clearly, policy should be taken to target this sector as it is not efficient enough, especially in the Eastern and Central European countries. The second most important sector is Wholesale that presents good results, on average. There are between two and four countries that are efficient in each sector. Clearly, those numbers should be raised.

We also present, in Table B.9, the (average) changes per year for the technical efficiency ratios. Our previous results, based on the technical efficiency level, highlighted in which country and sector inefficiency is more present, but do not show if efforts have been made to reduce inefficiency for the period. The numbers in Table B.9 have to be read as follows: a positive value shows that the efficiency ratio has increased, and thus implies more technically inefficient behaviour; a negative value implies the opposite. Overall, there is a reduction of inefficiency of 0.11% per year. Eleven countries present an efficiency progress. The highest values are for Estonia (due to Public Administration and Health); Sweden (due to all sectors except Electricity, Gas, and Water, Mining and Agriculture); and the Czech Republic (due to Health, Wholesale, and Manufacturing); while the smallest is for Hungary (due to all sectors, especially to Public Administration, Mining, and Agriculture). Note the good performances of Ireland in the Transport sector; Slovenia in Wholesale; Poland in Construction and in Electricity, Gas, and Water; Slovenia in Manufacturing; Denmark in Mining; Finland in Agriculture; and the poor performances of Slovakia in Mining and Manufacturing; Slovakia in Manufacturing, Transport and Electricity, Gas, and Water; Estonia in Electricity, Gas, and Water and Construction. The best performing sectors are Education, Transport, and Wholesale. Finally, note that Agriculture and Mining present only two improvements.

Our previous discussion reveals that efficiency improvements occur, more often, in country and sector presenting more inefficient behaviour. To formally test this finding, we rely on Spearman correlations. We choose this statistic rather than, for example, the Pearson correlation or linear regression, as endogeneity is present between those two indicators. Indeed, changes are computed using levels making a direct connection between these two measures. Capturing this endogeneity is rather complex, and clearly beyond the scope of this paper. The correlation of Spearman is by nature nonparametric, and thus better fits in this context. We compute both the correlations for the country and sector. The results are shown in Table B.10. A $p-$value smaller than 0.05 indicates that the Spearman correlation is significantly different from zero. It implies that changes and levels are related. The correlation coefficients are all negative and significant, showing that, indeed, higher efficiency progress occurs when more inefficient behaviour is present. Note that, the highest correlations are in the Public Administration, Health, Mining, Education, and Transport sectors.

Scale. As done previously for technical efficiency ratio, we start with the country-level indicators, and then present both the (average) level and change over the period for our scale ratio. Let us start with the level, available in Table B.11 for the country-level indicators and in Table B.12 for the sector-level indicators. An initial observation is that again the confidence intervals and the standard errors are rather smalls for every country. Also, there is no country that is scale efficient for the period. This also holds true for the sectors: zero or one country is efficient in each sector. The overall average is 1.21, showing that scale optimally is not reached. The most scale optimal countries include Ireland, Denmark, and Finland; and the best sectors are Construction, Wholesale, and Agriculture. The least scale optimal countries are Estonia, Germany, Italy, Poland and Spain; and the worst sectors are Manufacturing and Electricity, Gas, and Water. Finally, we point out some sectors in specific countries that present poor performances: Agriculture in Luxembourg and Estonia; Mining in Norway and Luxembourg; Manufacturing in Poland, Spain, Luxembourg, and Italy; Electricity, Gas, and Water in Estonia, Luxembourg; Construction, Wholesale, Public Administration, Health, and Transport in Estonia; Education in Slovakia and Slovenia.

The results for the scale ratio changes are given in Table B.13. There are no improvements at the country level, but some sectors present important changes over the period. In Public Administration, 13 countries have progressed, nine in Education, seven in Construction, six in Agriculture and Electricity, Gas, and Water. For the sectors, the worst results are found for Transport, Health and Wholesale. Finally, note the worse performances of almost all sectors in Estonia and Luxembourg; of Electricity, Gas, and Water for Slovakia; and the best performances of Germany for Agriculture, Electricity, Gas, and Water, Construction, and Public Administration; of Slovenia for Manufacturing; of Belgium for Public Administration; and of Spain for Education.

Finally, we compute the Spearman correlations between the levels and changes of our scale ratio at both the country and sector levels. The results, displayed in Table B.14, indicate that, as for the technical efficiency ratio, the relationship between the level and change is negative and significant. Again, a $p-$value smaller than 0.05 indicates that the Spearman correlation is significantly different from zero. In this case, it means that scale progress occurs more often when more scale non-optimality is present. This is true for both the country and sector levels. The largest correlations are found in the Mining, Transport, Public Administration, and Wholesale sectors. Finally, overall, the correlations for our scale ratio are close to the ones for our technical efficiency ratio.

Congestion. The (average) results of our last ratio are available in Tables B.15 and B.16 for both the country- and sector-level indicators, and in Table B.17 for the changes. An initial observation is that, at the country-level, congestion has the lowest average (1.10) and median (1.03) of our three indicators. It means that this phenomenon is probably the least important for the European countries. Next, only two countries present no congestion

(Luxembourg and Germany), but several are very close to the efficient situation. In fact, only the Eastern and Central countries present congestion (except, Austria and the Czech Republic). Note the important ratios of Hungary and Poland. Finally, the confidence intervals and the standard errors are rather small for every country. At the sector level, more congestions occur in the Electricity, Gas, and Water and Manufacturing sectors; and less in the Public Administration, Education, and Health sectors. Finally, the worse performances of the Eastern and Central countries are mainly due to Manufacturing, Electricity, Gas, and Water and Wholesale.

The congestion ratio changes show that eight countries present an improvement. The highest improvements are for Slovakia and Spain; and the smallest for Hungary. We point out the good performance of the Public Administration, Education, and Manufacturing sectors. Also, the good performances of Slovakia are mainly due to Manufacturing, and the good performance of Spain to Manufacturing and Education. Finally, the poor performances of Hungary are due to all sectors, except Electricity, Gas, and Water and Manufacturing.

The Spearman correlations between the level and change of our congestion ratio, in Table B.18, reveal that more congestion is associated with higher changes for the countries and the sectors. Indeed, all the correlation coefficients are negative and significant. The $p-$values are smaller than 0.05 indicating that the Spearman correlation is significantly different from zero. The highest correlations are in the Public Administration, Mining, Health, and Electricity, Gas, and Water sectors. Interestingly, the range of the correlations is similar to those of both the technical efficiency and scale ratios.

Testing for a relationship between scale, congestion, and technical efficiency. In the previous parts, we highlight important findings for each of the three ratios. We also test for a relationship within each ratio. In this last part, we investigate if there are relationships between the three ratios. As done previously, we make use of the Spearman correlations, and test for a relationship for both the level and change of the ratios. The results are available in Table B.19. As for our previous tests, the $p-$values reflect whether the Spearman correlation are significantly different from zero. When it is the case, it implies for the presence of a relationship between the ratios.

Let us start with the correlations between the ratio levels. At the country level, there are no relationships between technical efficiency and scale ($p-$value greater than 0.05), while there is one between efficiency and congestion, and congestion and scale ($p-$values smaller than 0.05). For these two cases, the coefficients are significant and positive (0.68 for technical efficiency and congestion, and 0.10 for congestion and scale). It means that, in general, more congestion increases the technically inefficient behaviour, and reciprocally; and that more congestion implies more non-optimal scale. At the sector level, when significant, the sign of the correlations are the same. The correlations between the technical efficiency and scale ratios are only significant for the Transport and Construction sectors. The correlations between the technical efficiency and congestion ratios are significant for all sectors, and the ranges are close between sectors. The correlations between the congestion and scale ratios are not significant for the Mining, Manufacturing, and Electricity, Gas, and Water sectors.

For the correlation between the ratio changes, it is negative and significant for the relationship between technical efficiency and scale ($p-$value smaller than 0.05), positive and significant between technical efficiency and congestion ($p-$value smaller than 0.05), and not significant between congestion and scale ($p-$value greater than 0.05). This reveals that the changes in technical efficiency and scale go in opposite directions, while those between technical efficiency and congestion go in the same direction. At the sector level, again when significant, the correlations have the same sign as the one for countries. Note that the correlations between technical efficiency and scale are not significant in the Mining, Manufacturing, and Agriculture sectors; the correlations between technical efficiency and congestion is significant for all the sectors; and the correlations between congestion and scale is significant and negative only in two sectors: Mining and Manufacturing.

3.2 Results with human capital

We discuss the main results when including human capital as a multiplicative augmentation of labour in the following. Attractively, most of our previous results and conclusions of Section 3.1 remain true. This gives a robustness feature to our findings. Detailed results are available in Appendix C.

Relative importance of the sectors for each indicator. The average weights for the technical efficiency, scale, and congestion ratios for the period 1995-2015 are available in Tables C.1, C.2, and C.3. For the technical efficiency ratio, the weights are very similar to the ones when human capital was not considered (see Table B.1). This shows that considering human capital does not add much to the technical efficiency dimension. Of course, this can also be due to the sample considered, the method used for the estimation, and using the US data to construct the human capital intensity of the sectors. For the scale and congestion ratios, we see small differences with the weights found before (see Tables B.2 and B.3). These differences may highlight sectors and countries for which human capital is more important. Next, we present in Tables C.4, C.5, and C.6 the change in the weights for the technical efficiency, scale, and congestion ratios between the final and initial years. Overall the changes are not high. We see a decreasing importance of Agriculture for the three indicators, and an increasing importance of Wholesale, Education, and Health.

Technical efficiency. We present the results in Table C.7 for the country-level indicators, in Table C.8 for the sector-level indicators, and in Table C.9 for the changes of the indicators. Confidence intervals and standard errors for the country-level indicators are also provided in Table C.7. The overall average is 1.46 (i.e. a bit higher than when human capital was not considered, 1.44). Again, the most inefficient countries are the Central and Eastern countries, except Austria; while the most efficient are Luxembourg, France, Belgium, Italy, the Netherlands, and Sweden. The sector-level technical efficiency indicators highlight the better performance of the Public Administration and Education sectors, and the worse performances of Agriculture and Mining. The changes for both the country- and sector-level indicators show a reduction of the inefficient behaviour. Twelve countries present an efficiency progress, and, in particular, Eastern and Central European countries. The sectors with more improvements are Education, Transport, and Wholesale, while Agriculture and Mining present only two improvements. Finally, it is also confirmed that higher technical efficiency progress occurs when more inefficient behaviour is present, see Table C.10.

Scale. We present the results in Table C.11 for the country-level indicators, in Table C.12 for the sector-level indicators, and in Table C.13 for the changes of the indicators. No country is scale efficient; this is also confirmed by the confidence intervals. A similar finding holds true for the sectors. The overall average is 1.20, revealing possible improvement. The best sectors are Construction, Wholesale, and Agriculture, and the worst sectors are Manufacturing and Electricity, Gas, and Water. Next, we find a regress in scale efficiency over the period. Nevertheless, improvements occur for some sectors: Public Administration, Education, Construction, Agriculture, and Electricity, Gas, and Water. Finally, as shown in Table C.14, all $p-$values are less than 0.05. It indicates that scale progress occurs more often when more scale non-optimality is present.

Congestion. The results for the congestion ratio are available in Tables C.15 and C.16 for the country- and sector-level indicators, and in Table C.17 for the changes. It is confirmed that congestion is probably the least important aspect for our study. Indeed, the average and median are the lowest for this ratio. In fact, only the Eastern and Central countries present congestion. Also, more congestion occurs in the Electricity, Gas, and Water and Manufacturing sectors; and less in the Public Administration, Education, and Health sectors. The congestion ratio changes show that eight countries present an improvement; especially for the Public Administration, Education, and Manufacturing sectors. The Spearman correlations between the level and change of our congestion ratio, in Table C.18, reveal that more congestion is associated with higher changes for the countries and the sectors. Indeed, all the correlation coefficients are negative and significant. All the $p-$values are smaller than 0.05.

Testing for a relationship between scale, congestion, and technical efficiency. Adding human capital has an impact for our tests for the relationships between the three ratios. Indeed, most of the Spearman correlations are, in absolute value, greater; and thus the $p-$values are smaller. Nevertheless, our main finding remains true. That is, for the levels, there are no relationship between technical efficiency and scale, while there is one between efficiency and congestion, and congestion and scale. For the changes, we find a negative and significant relationship between technical efficiency and scale, a positive and significant relationship between technical efficiency and congestion, and no significant relationship between congestion and scale.

3.3 Summary and policy advice

We summarise our main findings for the three aspects (scale, congestion, and technical efficiency) in five main points:

- Overall, there is room for improvement for the three aspects, and higher levels are associated with larger changes; implying a convergence between countries and sectors.
- Eastern and Central European countries (except Austria) are the most technically inefficient countries, and are the only countries with a congestion issue. No country is scale efficient, and none have an improvement in this aspect.
- Manufacturing, the most important sector, presents poor performances in the three aspects. This also holds true for Electricity, Gas, and Water, and Agriculture. Wholesale, the second most important sector, presents poor performances in scale optimality.
- There is a relationship between the three aspects for both the changes and the levels; the sizes of the relationships are close for the three aspects.
- Our findings are robust when adding human capital, and are confirmed by the use of confidence intervals.

All in all, our findings argue for the need of multi-level policies. That is, policies that target technical inefficiency, scale non-optimality, and congestion at the same time, rather than focusing only on one aspect. Also, the differences between the sectors suggest that the multi-level policies should also be sector-specific. The current main policy implementation in Europe is the Europe 2020 strategy.[10] The main, though not sole, aim of this new

[10] For recent studies about the Europe 2020 strategy refer, for example, to Pasimeni and Pasimeni (2016), Rappai (2016), and Walheer (2017).

strategy is to boost the economic growth in Europe in the long term. Targets for the economic growth, and for the other objectives of the strategy, are country-specific. In light of our findings, opting for sector-specific targets would improve the impact of the strategy.

4 Conclusion

In this paper, we investigated the scale, congestion, and technical efficiency of the growth process of 19 European countries during the period 1995-2015, using the recent methodology of Walheer (2016a, b). The distinguishing feature of his approach is that countries are defined in terms of their sectors (in our case, each country contains ten sectors). As such, we can better understand the performances of the countries for each of the three aspects studied. Moreover, we avoid the drawbacks of specifying the production function. Indeed, the method of Walheer (2016a, b) is nonparametric in nature: no specific assumptions for any aspect of the growth process, and in particular for the production function, are required.

Our results reveal some important patterns useful for policy-makers. In particular, we highlight the importance of sector-level policies that take the relationships between scale, congestion, and technical efficiency into account. Indeed, for each country, we pointed out the key sectors; we have shown that improvements are possible; and we demonstrated that, in general, higher progresses occur more often when more inefficient or non-optimal behaviour is present.

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Appendix A[11]

[11]We make use of the following abbreviations in Appendix A: Agriculture (A), Mining (Mi), Manufacturing (Ma), Electricity, Gas and Water (EG), Construction (C), Wholesale (W), Transport (T), Public Administration (PA), Education (E), and Health (H); in 19 European countries: Austria (A), Belgium (B), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FIN), France (F), Germany (D), Hungary (H), Ireland (IRL), Italy (I), Luxembourg (L), Netherlands (NL), Norway (N), Poland (PL), Slovakia (SK), Slovenia (SI), Spain (E), and Sweden (S). (Av) corresponds to the average.

Table A.1: Added value per labour growth

	A	**B**	**CZ**	**DK**	**EE**	**FIN**	**F**	**D**	**H**	**IRL**	**I**	**L**	**NL**	**N**	**PL**	**SK**	**SI**	**E**	**S**
A	45.68	9.74	34.22	8.66	146.15	50.58	8.76	34.88	20.31	32.50	14.25	34.94	27.54	36.46	23.90	166.76	14.28	24.57	16.09
Mi	32.45	21.15	45.03	249.79	164.20	35.87	12.12	17.65	84.26	24.82	73.15	2.91	80.70	61.60	26.35	77.40	46.77	48.20	186.37
Ma	51.78	31.52	45.97	96.52	52.94	30.99	36.04	70.81	19.20	80.42	5.23	15.07	51.58	59.46	2.92	28.62	38.37	32.22	85.05
EG	10.03	22.69	26.10	104.32	187.01	101.50	76.69	94.68	15.23	183.96	71.88	20.57	75.05	156.65	85.99	100.37	57.76	17.10	47.64
C	16.38	42.40	28.88	18.82	0.97	34.05	28.81	36.80	48.39	10.90	3.19	23.10	24.73	56.66	12.86	102.64	10.00	34.77	57.20
W	13.67	46.37	21.89	19.22	41.94	36.27	10.58	26.36	49.57	44.91	13.03	74.00	45.02	28.73	10.04	6.93	0.75	0.04	70.42
T	29.94	8.08	20.28	40.62	50.56	3.22	6.83	30.92	29.52	25.88	9.54	34.27	28.04	44.17	8.74	6.02	0.41	14.79	43.36
PA	10.71	41.42	46.14	40.50	44.24	80.17	38.80	65.30	54.41	13.68	56.10	25.26	49.22	100.30	26.82	43.10	19.65	92.38	93.25
E	21.02	29.25	22.75	44.30	7.02	49.53	34.37	32.15	25.22	47.51	7.41	32.85	32.54	77.66	2.23	70.29	23.19	6.81	61.60
H	16.16	6.76	31.29	42.29	37.21	40.76	13.95	11.97	45.59	16.52	8.10	15.16	20.73	77.12	53.29	46.72	22.98	14.68	92.39
Av	24.78	25.94	32.26	66.50	73.23	46.29	26.70	42.15	39.17	48.11	26.19	27.81	43.52	69.88	25.31	64.89	23.42	28.56	75.34

Table A.2: Capital per labour growth

	A	**B**	**CZ**	**DK**	**EE**	**FIN**	**F**	**D**	**H**	**IRL**	**I**	**L**	**NL**	**N**	**PL**	**SK**	**SI**	**E**
A	112.55	123.97	61.36	12.80	130.74	81.55	60.22	19.20	152.33	47.63	17.78	132.52	120.02	38.81	35.05	62.47	212.56	14.04
Mi	17.43	25.45	24.62	2.43	123.04	242.05	12.45	48.39	34.86	152.34	66.25	0.41	90.59	48.02	30.00	64.36	299.52	111.39
Ma	151.88	79.99	82.34	145.15	45.73	62.46	133.15	49.57	129.34	53.85	1.65	23.04	76.46	84.58	2.35	63.52	96.03	22.79
EG	43.57	24.83	112.14	40.80	195.03	196.18	155.82	38.75	9.36	187.83	51.62	121.67	213.47	266.23	10.08	182.06	396.05	79.40
C	0.52	94.97	64.77	35.51	62.69	48.06	75.33	29.52	3.19	18.30	21.60	35.22	65.08	329.93	31.05	58.52	55.43	2.48
W	2.95	61.36	313.70	25.66	59.43	66.08	6.33	23.76	23.03	70.49	25.41	5.14	5.37	12.03	0.99	55.47	54.49	38.94
T	23.70	24.62	14.13	1.93	58.31	61.29	4.75	54.41	3.02	170.79	33.93	0.88	2.04	2.48	13.19	8.55	43.31	53.95
PA	24.79	64.77	72.34	178.57	36.20	448.39	49.49	12.25	56.67	165.15	35.99	51.33	92.97	219.60	134.09	81.88	39.75	64.13
E	117.25	313.70	117.28	280.05	30.83	167.43	19.42	34.20	84.92	133.80	25.03	149.22	64.28	193.99	26.38	28.13	16.54	84.28
H	35.53	6.78	17.59	76.71	46.71	103.96	11.77	32.50	0.39	7.16	43.23	46.74	38.50	72.94	29.51	157.20	39.39	68.66
Av	53.02	82.04	88.03	79.96	78.87	147.74	52.87	34.25	49.71	100.73	32.25	56.62	76.88	126.86	31.27	76.22	125.31	54.01

Appendix B[12]

Table B.1: Weights for the technical efficiency ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	2.69	0.63	28.64	3.43	10.51	18.98	9.63	8.74	8.00	8.75
Belgium	1.57	0.18	25.61	3.40	7.80	18.79	11.15	11.07	10.05	10.39
Czech Republic	4.18	1.83	33.83	5.48	8.72	15.51	11.98	7.79	5.51	5.17
Denmark	2.69	3.88	21.37	3.23	7.33	17.92	10.35	9.09	8.49	15.65
Estonia	5.42	1.82	24.32	4.76	9.43	18.43	15.65	8.65	6.93	4.60
Finland	4.32	0.48	31.54	3.17	8.69	13.82	10.86	7.63	7.23	12.26
France	3.71	0.24	22.09	2.68	9.18	17.14	9.45	12.88	8.98	13.66
Germany	1.56	0.40	35.17	3.38	7.44	16.16	8.31	9.73	6.98	10.87
Hungary	7.07	0.37	31.25	4.13	6.41	15.04	10.51	12.09	6.98	6.14
Ireland	3.60	0.69	38.92	2.23	8.83	14.46	7.46	6.56	7.17	10.06
Italy	3.72	0.66	28.84	3.10	8.51	18.63	10.44	10.04	7.37	8.68
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.44	4.36	21.21	2.35	8.10	20.01	9.65	11.05	7.13	12.70
Norway	1.34	28.87	13.29	3.20	6.47	11.52	10.03	7.08	6.19	12.01
Poland	6.01	3.28	24.26	4.49	9.40	24.88	8.51	7.98	6.27	4.94
Slovakia	5.56	0.88	30.22	5.79	9.83	18.64	11.16	8.81	4.53	4.59
Slovenia	3.96	0.79	33.19	3.87	9.14	16.53	9.41	8.36	7.68	7.08
Spain	5.05	0.53	24.23	3.54	13.30	17.16	9.74	12.22	6.64	7.58
Sweden	2.74	0.67	28.65	4.01	7.29	15.70	10.33	7.41	7.96	15.22
Min	1.09	0.18	13.29	2.23	6.41	11.52	7.46	6.56	4.53	4.59
Average	3.67	2.67	27.10	3.60	8.87	17.38	10.55	9.40	7.28	9.48
Median	3.71	0.67	28.64	3.40	8.72	17.16	10.33	8.81	7.17	9.84
Max	7.07	28.87	38.92	5.79	13.30	24.88	15.82	12.88	10.05	15.65

[12] We make use of the following abbreviations in Appendix B: Agriculture (A), Mining (Mi), Manufacturing (Ma), Electricity, Gas and Water (EGW), Construction (C), Wholesale (W), Transport (T), Public Administration (PA), Education (E), and Health (H).

Table B.2: Weights for the scale ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	5.23	0.88	29.41	4.02	8.95	17.24	10.10	7.44	7.15	9.56
Belgium	1.60	0.21	26.63	3.72	7.69	17.71	11.17	10.42	9.46	11.40
Czech Republic	3.13	2.17	33.11	5.34	10.57	16.56	10.58	6.86	6.03	5.66
Denmark	2.77	3.30	27.47	2.94	6.75	17.03	10.07	7.00	8.70	13.98
Estonia	4.98	2.11	36.60	5.50	8.66	17.27	12.28	5.13	4.71	2.76
Finland	4.66	1.54	33.82	3.75	7.55	12.45	9.11	8.33	7.54	11.26
France	3.64	0.49	22.94	2.96	8.99	16.80	9.27	12.73	8.81	13.38
Germany	2.17	0.56	34.89	3.35	7.38	16.04	8.24	9.66	6.92	10.79
Hungary	4.82	0.41	36.33	3.45	8.62	15.20	9.56	9.87	7.17	4.58
Ireland	5.21	3.29	32.26	4.17	8.08	16.61	8.97	5.52	7.35	8.54
Italy	3.84	1.09	31.00	2.84	9.47	18.40	9.57	9.14	6.74	7.91
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.25	3.85	21.20	2.41	7.89	20.26	9.18	9.72	6.93	15.30
Norway	2.08	24.01	18.01	2.67	6.06	10.07	9.57	7.38	6.74	13.41
Poland	5.69	2.12	24.06	4.19	11.16	22.05	7.26	7.81	9.73	5.92
Slovakia	3.02	0.84	41.11	7.58	6.87	14.15	9.53	8.00	4.12	4.79
Slovenia	11.61	0.54	22.27	9.71	9.88	17.28	10.18	7.86	5.39	5.28
Spain	4.22	0.87	21.69	3.48	12.53	21.30	10.70	12.05	6.51	6.67
Sweden	2.41	2.08	28.50	3.99	7.24	14.76	10.18	7.74	9.60	13.49
Min	1.09	0.21	18.01	2.24	6.06	10.07	7.26	5.13	4.12	2.76
Average	3.97	2.66	28.40	4.12	8.76	16.95	10.07	8.63	7.25	9.18
Median	3.64	1.09	28.50	3.72	8.62	17.03	9.57	8.00	7.15	9.56
Max	11.61	24.01	41.11	9.71	12.53	22.05	15.82	12.73	9.73	15.30

Appendix C[13]

[13]We make use of the following abbreviations in Appendix C: Agriculture (A), Mining (Mi), Manufacturing (Ma), Electricity, Gas and Water (EGW), Construction (C), Wholesale (W), Transport (T), Public Administration (PA), Education (E), and Health (H).

Table B.3: Weights for the congestion ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	5.30	0.89	29.42	4.06	9.08	17.48	10.12	7.54	7.01	9.10
Belgium	1.63	0.21	26.06	3.81	7.51	18.10	11.33	10.66	9.68	11.00
Czech Republic	3.23	2.05	31.27	5.42	10.88	17.19	10.99	7.00	6.10	5.86
Denmark	2.73	3.24	27.19	2.94	6.81	17.26	10.12	7.10	8.56	14.07
Estonia	5.64	2.11	36.81	4.83	8.90	14.79	12.39	5.81	5.58	3.14
Finland	4.74	1.55	33.47	3.80	7.69	12.68	9.28	8.49	6.84	11.46
France	3.69	0.48	21.97	2.95	9.13	17.04	9.41	12.81	8.94	13.59
Germany	2.16	0.51	34.91	3.35	7.39	16.05	8.24	9.66	6.93	10.80
Hungary	5.92	0.57	32.09	3.10	10.82	13.63	9.75	11.48	7.70	4.92
Ireland	5.43	3.40	33.69	3.85	8.47	15.86	7.08	5.75	7.58	8.89
Italy	3.77	1.09	30.96	2.91	9.42	17.55	9.83	9.39	6.93	8.13
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.21	3.88	21.31	2.33	7.92	20.41	9.25	9.80	6.48	15.41
Norway	2.11	24.40	17.37	2.72	6.12	10.13	9.74	7.50	6.26	13.64
Poland	4.26	2.41	18.62	3.27	13.67	27.93	6.88	7.83	10.26	4.86
Slovakia	3.37	0.90	39.60	8.18	7.09	12.64	10.39	8.89	3.68	5.26
Slovenia	3.38	0.63	22.61	8.23	11.29	20.14	12.03	9.16	6.37	6.17
Spain	4.61	0.89	22.89	3.43	12.23	18.89	10.20	13.01	6.70	7.14
Sweden	2.48	2.12	27.06	3.94	7.37	15.21	10.25	7.97	9.86	13.74
Min	1.09	0.21	17.37	2.24	6.12	10.13	6.88	5.75	3.68	3.14
Average	3.62	2.71	27.66	3.97	9.15	17.05	10.16	9.01	7.35	9.32
Median	3.38	1.09	27.19	3.43	8.90	17.19	10.12	8.89	6.93	9.10
Max	5.92	24.40	39.60	8.23	13.67	27.93	15.82	13.01	10.26	15.41

Table B.4: Changes for the technical ratio weights

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.01	0.00	0.02	-0.01	-0.01	0.01	-0.02	-0.01	0.01	0.03
Belgium	-0.01	0.00	-0.07	-0.01	0.02	0.02	-0.03	0.03	0.02	0.03
Czech Republic	-0.03	-0.02	0.07	-0.01	-0.01	0.00	-0.05	0.02	0.01	0.02
Denmark	-0.02	0.02	-0.03	0.00	0.00	0.00	-0.02	-0.01	0.02	0.03
Estonia	-0.02	0.00	-0.04	0.01	0.01	0.02	-0.02	0.03	-0.01	0.01
Finland	-0.01	0.00	-0.08	0.00	0.03	0.02	-0.04	0.03	0.02	0.04
France	-0.02	0.00	-0.06	0.00	0.02	0.01	-0.02	0.02	0.00	0.04
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	0.00	0.01	0.03
Hungary	-0.04	0.00	0.05	-0.01	0.00	0.01	-0.01	0.01	0.00	0.00
Ireland	-0.06	0.00	-0.04	0.02	-0.02	0.04	0.00	-0.01	0.03	0.05
Italy	-0.01	0.00	-0.05	0.00	0.01	-0.01	-0.01	0.03	0.00	0.04
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.06
Netherlands	-0.02	0.01	-0.06	-0.01	-0.01	0.03	-0.02	0.01	0.02	0.05
Norway	-0.02	0.13	-0.06	-0.01	0.02	-0.04	-0.05	0.00	0.00	0.03
Poland	-0.05	-0.02	-0.01	0.00	0.02	0.03	0.00	-0.01	0.01	0.02
Slovakia	-0.01	-0.01	-0.05	-0.02	0.05	0.04	-0.04	0.02	0.01	0.01
Slovenia	-0.03	-0.01	-0.01	0.01	0.00	0.01	0.00	0.02	0.01	0.00
Spain	-0.02	0.00	-0.04	0.00	-0.02	0.04	-0.04	-0.08	0.08	0.08
Sweden	-0.02	0.00	-0.06	-0.01	0.03	0.02	-0.02	0.00	0.02	0.04
Min	-0.06	-0.02	-0.13	-0.02	-0.03	-0.04	-0.06	-0.08	-0.01	0.00
Mean	-0.02	0.01	-0.03	0.00	0.01	0.02	-0.02	0.01	0.01	0.03
Median	-0.02	0.00	-0.04	0.00	0.01	0.02	-0.02	0.01	0.01	0.03
Max	-0.01	0.13	0.07	0.02	0.05	0.08	0.00	0.04	0.08	0.08

Table B.5: Changes for the scale ratio weights

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.03	0.00	0.05	-0.01	-0.01	0.01	-0.03	-0.01	0.01	0.03
Belgium	-0.01	0.00	-0.04	-0.01	0.01	0.01	-0.04	0.02	0.01	0.04
Czech Republic	-0.02	-0.01	0.01	-0.02	0.00	0.00	0.00	0.02	0.01	0.00
Denmark	-0.02	0.00	0.00	-0.01	0.00	-0.01	-0.04	0.00	0.02	0.05
Estonia	0.00	0.01	0.08	0.10	0.00	-0.04	-0.04	-0.02	-0.06	-0.03
Finland	-0.04	0.01	-0.04	0.00	0.02	0.02	-0.05	0.03	0.00	0.05
France	-0.02	0.00	-0.05	0.00	0.02	0.01	-0.02	0.02	0.00	0.04
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	0.00	0.01	0.03
Hungary	-0.02	0.00	0.08	-0.04	-0.02	0.03	-0.01	0.09	-0.05	-0.04
Ireland	-0.04	0.01	-0.03	0.01	-0.01	0.04	-0.02	-0.01	0.01	0.04
Italy	-0.01	0.00	-0.02	0.00	0.02	-0.02	-0.01	0.02	0.00	0.03
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.06
Netherlands	-0.01	0.01	-0.04	-0.01	0.00	-0.01	-0.03	0.01	0.02	0.06
Norway	-0.02	0.13	-0.03	-0.01	0.03	-0.02	-0.06	-0.01	-0.01	0.01
Poland	-0.01	-0.01	-0.02	-0.01	-0.01	0.04	0.01	0.05	-0.02	-0.02
Slovakia	-0.02	-0.02	0.08	0.00	-0.04	-0.01	0.01	0.01	-0.01	0.01
Slovenia	0.08	0.00	-0.13	0.10	0.01	-0.07	0.00	0.02	-0.01	0.00
Spain	-0.01	0.00	-0.08	0.02	-0.02	0.07	-0.03	-0.09	0.08	0.07
Sweden	-0.01	0.02	-0.05	0.00	0.03	0.01	-0.03	-0.01	-0.01	0.03
Min	-0.04	-0.02	-0.13	-0.04	-0.04	-0.07	-0.06	-0.09	-0.06	-0.04
Mean	-0.01	0.01	-0.02	0.00	0.00	0.01	-0.02	0.01	0.00	0.02
Median	-0.01	0.00	-0.03	0.00	0.00	0.01	-0.03	0.01	0.00	0.03
Max	0.08	0.13	0.08	0.10	0.03	0.08	0.01	0.09	0.08	0.07

Table B.6: Changes for the congestion ratio weights

	A	Mi	Ma	EGW	C	W	T	PA	E	H
Austria	-0.03	0.00	0.05	-0.01	-0.01	0.01	-0.03	-0.01	0.01	0.02
Belgium	-0.01	0.00	-0.04	-0.01	0.02	0.02	-0.04	0.03	0.02	0.02
Czech Republic	-0.02	-0.01	0.00	-0.02	0.00	0.00	0.00	0.02	0.01	0.00
Denmark	-0.02	0.00	0.01	-0.01	0.00	-0.02	-0.04	0.00	0.01	0.06
Estonia	-0.01	0.01	0.12	0.11	0.00	-0.04	-0.05	-0.03	-0.07	-0.03
Finland	-0.04	0.01	-0.04	0.00	0.02	0.02	-0.05	0.03	-0.01	0.06
France	-0.02	0.00	-0.06	0.00	0.02	0.01	-0.02	0.02	0.00	0.04
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	0.00	0.01	0.03
Hungary	-0.02	0.00	0.22	-0.01	-0.06	-0.04	0.01	0.00	-0.04	-0.06
Ireland	-0.04	0.01	-0.03	0.01	-0.01	0.04	-0.03	-0.01	0.01	0.04
Italy	-0.01	0.00	-0.02	0.00	0.02	-0.02	-0.01	0.02	0.00	0.03
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.06
Netherlands	-0.01	0.01	-0.03	-0.01	0.00	-0.01	-0.03	0.01	0.01	0.06
Norway	-0.02	0.12	-0.01	-0.01	0.03	-0.03	-0.07	-0.01	-0.02	0.01
Poland	-0.03	-0.01	0.04	0.01	-0.06	0.07	0.02	0.01	-0.07	0.01
Slovakia	-0.02	-0.03	0.18	0.00	-0.06	-0.07	0.00	-0.01	0.00	0.00
Slovenia	-0.06	-0.01	0.02	0.14	-0.03	-0.09	0.00	0.04	-0.01	-0.01
Spain	-0.02	0.00	-0.04	0.00	-0.02	0.06	-0.04	-0.11	0.09	0.07
Sweden	-0.01	0.02	-0.06	0.00	0.03	0.01	-0.03	-0.01	-0.01	0.06
Min	-0.06	-0.03	-0.13	-0.02	-0.06	-0.09	-0.07	-0.11	-0.07	-0.06
Mean	-0.02	0.01	0.01	0.01	-0.01	0.00	-0.02	0.00	0.00	0.02
Median	-0.02	0.00	-0.01	0.00	0.00	0.00	-0.03	0.00	0.00	0.03
Max	-0.01	0.12	0.22	0.14	0.03	0.08	0.02	0.04	0.09	0.07

Table B.7: Country-level technical efficiency ratios

	Indicator	**Lower bound**	**Upper bound**	**Standard error**
Austria	1.18	0.91	1.45	0.04
Belgium	1.06	0.79	1.33	0.19
Czech Republic	2.12	2.09	2.15	0.08
Denmark	1.34	1.18	1.50	0.29
Estonia	2.00	1.71	2.29	0.05
Finland	1.23	0.94	1.52	0.29
France	1.02	0.87	1.17	0.24
Germany	1.01	0.97	1.05	0.13
Hungary	2.28	2.01	2.55	0.24
Ireland	1.21	0.92	1.50	0.20
Italy	1.10	1.09	1.11	0.25
Luxembourg	1.00	0.72	1.28	0.20
Netherlands	1.14	0.91	1.37	0.22
Norway	1.22	1.10	1.34	0.20
Poland	2.02	1.97	2.07	0.21
Slovakia	2.21	2.20	2.22	0.08
Slovenia	1.82	1.81	1.83	0.03
Spain	1.20	0.95	1.45	0.21
Sweden	1.15	1.05	1.25	0.29
Min	1.00	0.72	1.05	
Average	1.44	1.27	1.60	
Median	1.21	1.05	1.45	
Max	2.28	2.20	2.55	
# Eff	1	9	0	

Table B.8: Technical efficiency ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	2.27	1.66	1.21	1.40	1.00	1.07	1.23	1.00	1.05	1.29
Belgium	1.09	1.24	1.11	1.19	1.05	1.00	1.06	1.00	1.00	1.16
Czech Republic	1.59	2.57	2.08	2.09	2.57	2.27	1.89	1.86	2.31	2.34
Denmark	1.49	1.29	1.73	1.23	1.24	1.28	1.30	1.03	1.38	1.19
Estonia	1.82	2.16	2.96	2.28	1.77	1.90	1.62	1.17	1.41	1.21
Finland	1.32	2.12	1.33	1.48	1.07	1.11	1.03	1.36	1.30	1.13
France	1.00	2.06	1.06	1.13	1.00	1.00	1.00	1.01	1.00	1.00
Germany	1.40	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hungary	1.53	2.64	2.64	1.81	3.07	2.31	2.09	1.89	2.31	1.66
Ireland	2.01	1.80	1.00	2.47	1.22	1.39	1.45	1.01	1.29	1.03
Italy	1.13	1.90	1.19	1.00	1.22	1.08	1.00	1.00	1.00	1.00
Luxembourg	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Netherlands	1.08	1.00	1.14	1.18	1.11	1.16	1.08	1.00	1.11	1.37
Norway	2.06	1.00	1.67	1.02	1.14	1.07	1.15	1.26	1.33	1.37
Poland	1.99	1.30	2.01	1.91	2.39	1.79	1.74	1.97	3.15	2.48
Slovakia	1.19	2.06	3.02	3.12	1.60	1.68	1.91	1.99	2.04	2.30
Slovenia	1.18	1.16	1.20	1.50	1.98	1.93	1.98	1.71	1.28	1.34
Spain	1.00	1.96	1.07	1.15	1.15	1.48	1.32	1.21	1.17	1.05
Sweden	1.02	2.12	1.14	1.14	1.14	1.08	1.13	1.20	1.39	1.02
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.43	1.71	1.56	1.53	1.46	1.40	1.37	1.30	1.45	1.36
Median	1.32	1.80	1.20	1.23	1.15	1.16	1.23	1.17	1.29	1.19
Max	2.27	2.64	3.02	3.12	3.07	2.31	2.09	1.99	3.15	2.48
# Eff	3	3	3	2	3	3	3	2	4	3

Table B.9: Technical efficiency ratio changes per year (%)

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	0.11	-0.04	1.73	0.64	2.60	0.08	0.14	-0.68	0.00	0.38	0.20
Belgium	0.24	1.02	3.07	1.01	1.75	-0.03	-0.14	-0.26	0.00	0.00	0.56
Czech Republic	-0.74	0.51	6.01	-1.45	1.29	0.04	-0.46	2.37	3.72	0.61	-1.64
Denmark	-0.25	2.24	-3.80	0.62	-0.55	0.26	-0.56	-0.99	0.40	-0.49	0.96
Estonia	-2.44	4.45	4.03	1.78	12.17	9.20	0.34	8.83	-4.06	1.35	-4.24
Finland	0.53	-1.51	12.30	1.47	3.12	0.12	0.77	-0.56	1.13	-0.65	1.33
France	0.12	0.00	12.99	0.56	0.26	0.00	0.00	0.06	0.12	0.00	0.00
Germany	-0.01	1.03	3.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hungary	2.00	6.08	7.48	2.62	0.04	2.78	4.80	3.54	9.55	4.33	2.20
Ireland	-0.04	4.91	11.40	0.00	1.10	2.16	0.09	-1.20	0.05	-0.97	0.13
Italy	0.41	0.14	2.83	1.18	0.00	0.84	0.20	0.00	-0.03	0.00	0.04
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	-0.28	0.28	0.00	0.28	-0.70	0.28	-1.26	-0.79	0.00	-0.07	-0.10
Norway	-0.40	3.14	0.00	1.92	0.49	0.44	0.16	-0.76	-1.04	-1.61	-1.16
Poland	-0.12	4.30	1.70	-0.18	-1.83	-1.55	0.23	1.75	5.88	-1.28	-2.71
Slovakia	0.22	3.90	15.99	3.42	12.50	0.47	-0.14	8.97	-5.47	6.82	7.09
Slovenia	-0.47	2.58	3.50	-1.16	7.32	0.75	-2.72	4.85	0.95	2.39	4.62
Spain	-0.15	0.00	4.43	-0.96	1.84	-0.04	0.58	0.49	-0.27	0.06	0.09
Sweden	-0.91	0.33	11.32	-0.73	0.68	-0.63	-1.19	-0.89	-1.21	-2.39	-1.07
Min	-2.44	-1.51	-3.80	-1.45	-1.83	-1.55	-2.72	-1.20	-4.06	-2.39	-4.24
Average	-0.11	1.76	5.19	0.58	2.21	0.80	0.05	1.30	1.19	0.97	0.86
Median	-0.04	1.02	3.68	0.56	0.68	0.12	0.00	0.00	0.00	0.00	0.04
Max	2.00	6.08	15.99	3.42	12.50	9.20	4.80	8.97	9.55	6.82	7.09
# Imp	11	2	2	5	4	5	8	10	6	11	6

Table B.10: Spearman correlation coefficients for technical efficiency ratios

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
coefficient	-0.16	-0.15	-0.25	-0.12	-0.20	-0.19	-0.12	-0.23	-0.32	-0.24	-0.27
$p-value$	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00

Table B.11: Country-level scale ratios

	Indicator	**Lower bound**	**Upper bound**	**Standard error**
Austria	1.13	1.12	1.14	0.13
Belgium	1.11	1.00	1.22	0.23
Czech Republic	1.26	1.02	1.50	0.06
Denmark	1.07	0.92	1.22	0.13
Estonia	1.68	1.49	1.87	0.21
Finland	1.09	0.86	1.32	0.08
France	1.21	1.01	1.41	0.20
Germany	1.35	1.30	1.40	0.04
Hungary	1.22	1.07	1.37	0.29
Ireland	1.03	0.93	1.13	0.18
Italy	1.31	1.24	1.38	0.23
Luxembourg	1.16	1.08	1.24	0.15
Netherlands	1.15	0.94	1.36	0.27
Norway	1.19	0.90	1.48	0.16
Poland	1.31	1.27	1.35	0.04
Slovakia	1.16	1.08	1.24	0.25
Slovenia	1.12	1.04	1.20	0.24
Spain	1.30	1.23	1.37	0.28
Sweden	1.13	1.03	1.23	0.06
Min	1.03	0.86	1.13	
Average	1.21	1.08	1.34	
Median	1.16	1.04	1.35	
Max	1.68	1.49	1.87	
# Eff	0	6	0	

Table B.12: Scale ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	1.03	1.09	1.30	1.08	1.00	1.08	1.11	1.03	1.08	1.03
Belgium	1.03	1.04	1.29	1.05	1.00	1.06	1.10	1.04	1.01	1.03
Czech Republic	1.04	1.10	1.66	1.14	1.01	1.04	1.11	1.04	1.02	1.02
Denmark	1.02	1.02	1.12	1.02	1.02	1.04	1.10	1.03	1.08	1.02
Estonia	1.59	1.08	1.34	2.41	1.88	1.50	1.68	2.13	1.22	2.14
Finland	1.01	1.03	1.17	1.02	1.02	1.04	1.04	1.04	1.17	1.02
France	1.05	1.15	1.56	1.46	1.01	1.04	1.14	1.16	1.16	1.09
Germany	1.08	1.24	1.61	1.29	1.10	1.14	1.31	1.15	1.31	1.34
Hungary	1.09	1.08	1.44	1.17	1.05	1.04	1.08	1.06	1.32	1.15
Ireland	1.02	1.01	1.00	1.02	1.04	1.07	1.11	1.04	1.03	1.03
Italy	1.17	1.14	1.79	1.39	1.09	1.11	1.11	1.08	1.03	1.04
Luxembourg	1.74	1.47	1.72	1.76	1.13	1.00	1.07	1.00	1.00	1.00
Netherlands	1.03	1.04	1.41	1.10	1.01	1.06	1.11	1.10	1.22	1.03
Norway	1.02	1.64	1.02	1.01	1.01	1.01	1.08	1.05	1.18	1.02
Poland	1.06	1.17	1.96	1.26	1.06	1.09	1.29	1.21	1.04	1.03
Slovakia	1.11	1.07	1.23	1.04	1.07	1.05	1.07	1.11	1.83	1.15
Slovenia	1.03	1.01	1.02	1.05	1.07	1.08	1.23	1.24	1.76	1.41
Spain	1.02	1.10	1.87	1.32	1.21	1.11	1.17	1.11	1.22	1.03
Sweden	1.00	1.05	1.33	1.11	1.01	1.09	1.11	1.05	1.02	1.01
Min	1.00	1.01	1.00	1.01	1.00	1.00	1.04	1.00	1.00	1.00
Average	1.11	1.13	1.41	1.25	1.09	1.09	1.16	1.14	1.19	1.14
Median	1.03	1.08	1.34	1.11	1.04	1.06	1.11	1.06	1.16	1.03
Max	1.74	1.64	1.96	2.41	1.88	1.50	1.68	2.13	1.83	2.14
# Eff	0	0	1	0	0	1	0	1	1	0

Table B.13: Scale ratio changes per year (%)

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
Austria	0.44	-0.26	1.99	0.66	0.79	0.02	1.52	0.52	-0.36	-0.30	0.05
Belgium	0.31	0.20	0.45	0.86	0.39	-0.02	1.15	0.51	-0.77	0.01	0.06
Czech Republic	0.91	-0.50	1.39	2.24	-0.14	0.12	0.77	0.54	-0.24	0.03	0.06
Denmark	0.12	0.07	-0.18	-0.03	-0.04	-0.01	0.76	0.38	-0.16	0.40	-0.04
Estonia	3.61	5.12	1.09	1.74	10.59	13.32	12.73	12.71	16.78	21.77	23.01
Finland	0.17	0.05	0.36	0.44	0.05	-0.13	0.86	0.79	-0.39	0.12	-0.01
France	0.38	0.55	2.06	1.54	1.93	0.03	1.18	1.35	-0.06	-1.36	0.31
Germany	0.34	-0.79	1.94	1.57	-1.07	-0.74	1.00	1.20	-1.11	-0.60	0.36
Hungary	0.97	1.07	0.16	1.90	-0.24	1.02	-0.29	2.66	0.51	2.53	0.87
Ireland	0.25	0.08	0.02	0.00	-0.21	0.03	1.24	0.48	0.69	-0.10	-0.23
Italy	0.86	-0.22	1.55	2.16	0.11	-0.25	1.56	0.75	-0.58	-0.25	0.38
Luxembourg	0.72	4.90	6.35	6.08	4.68	-0.43	0.00	1.61	0.00	0.00	0.02
Netherlands	0.32	0.07	0.92	0.94	0.97	0.03	1.11	1.13	-0.10	-0.44	0.15
Norway	0.95	0.07	2.86	0.45	0.04	0.06	0.07	0.48	-0.17	0.28	0.01
Poland	1.59	1.98	3.23	3.75	0.95	1.55	1.01	5.09	0.05	-0.39	-0.09
Slovakia	0.69	0.21	1.24	1.28	7.46	1.56	0.27	0.64	0.10	5.45	2.00
Slovenia	0.85	-0.19	0.07	-0.52	-0.45	0.00	3.69	2.32	3.17	7.31	5.00
Spain	0.72	-0.17	0.92	2.45	2.74	0.13	1.78	0.17	-0.76	-1.44	0.09
Sweden	0.32	0.02	0.45	0.83	1.12	-0.03	1.52	0.46	-0.34	-0.55	-0.08
Min	0.12	-0.79	-0.18	-0.52	-1.07	-0.74	-0.29	0.17	-1.11	-1.44	-0.23
Average	0.76	0.65	1.41	1.49	1.56	0.86	1.68	1.78	0.86	1.71	1.68
Median	0.69	0.07	1.09	1.28	0.39	0.03	1.11	0.75	-0.16	0.00	0.06
Max	3.61	5.12	6.35	6.08	10.59	13.32	12.73	12.71	16.78	21.77	23.01
# Imp	0	6	1	3	6	7	2	0	13	9	5

Table B.14: Spearman correlation coefficients for scale ratio

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
coefficient	-0.19	-0.20	-0.45	-0.17	-0.12	-0.19	-0.28	-0.37	-0.30	-0.21	-0.25
p−value	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Table B.15: Country-level congestion ratios

	Indicator	Lower bound	Upper bound	Standard error
Austria	1.01	0.93	1.09	0.18
Belgium	1.02	0.88	1.16	0.11
Czech Republic	1.04	0.79	1.29	0.18
Denmark	1.01	0.85	1.17	0.28
Estonia	1.17	1.08	1.26	0.23
Finland	1.02	0.79	1.25	0.11
France	1.01	0.84	1.18	0.02
Germany	1.00	0.98	1.02	0.16
Hungary	1.67	1.44	1.90	0.28
Ireland	1.04	1.00	1.08	0.17
Italy	1.03	0.89	1.17	0.00
Luxembourg	1.00	0.90	1.10	0.05
Netherlands	1.01	0.77	1.25	0.09
Norway	1.02	0.86	1.18	0.05
Poland	1.40	1.22	1.58	0.08
Slovakia	1.14	0.94	1.34	0.21
Slovenia	1.18	0.96	1.40	0.14
Spain	1.09	1.06	1.12	0.07
Sweden	1.03	0.76	1.30	0.05
Min	1.00	0.76	1.02	
Average	1.10	0.94	1.25	
Median	1.03	0.90	1.18	
Max	1.67	1.44	1.90	
# Eff	1	14	0	

Table B.16: Congestion ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	1.00	1.01	1.01	1.00	1.00	1.00	1.01	1.00	1.04	1.07
Belgium	1.00	1.02	1.05	1.00	1.05	1.00	1.01	1.00	1.00	1.06
Czech Republic	1.00	1.11	1.11	1.04	1.01	1.00	1.00	1.02	1.05	1.00
Denmark	1.03	1.05	1.02	1.01	1.00	1.00	1.01	1.00	1.03	1.01
Estonia	1.06	1.21	1.27	1.47	1.16	1.48	1.20	1.00	1.00	1.00
Finland	1.00	1.02	1.03	1.01	1.00	1.00	1.00	1.00	1.14	1.00
France	1.00	1.02	1.06	1.02	1.00	1.00	1.00	1.01	1.00	1.00
Germany	1.00	1.08	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hungary	1.36	1.46	1.99	1.81	1.66	2.01	1.73	1.56	1.72	1.56
Ireland	1.00	1.01	1.00	1.21	1.00	1.13	1.35	1.00	1.01	1.00
Italy	1.05	1.02	1.03	1.00	1.04	1.08	1.00	1.00	1.00	1.00
Luxembourg	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Netherlands	1.02	1.00	1.00	1.05	1.00	1.00	1.00	1.00	1.08	1.00
Norway	1.00	1.00	1.06	1.00	1.01	1.01	1.00	1.00	1.10	1.00
Poland	1.99	1.30	1.87	1.91	1.18	1.13	1.49	1.45	1.53	1.81
Slovakia	1.03	1.08	1.22	1.09	1.16	1.34	1.07	1.03	1.42	1.06
Slovenia	1.67	1.00	1.14	2.05	1.05	1.02	1.00	1.02	1.00	1.01
Spain	1.00	1.07	1.03	1.08	1.13	1.25	1.15	1.02	1.08	1.01
Sweden	1.00	1.01	1.09	1.05	1.01	1.00	1.02	1.00	1.00	1.02
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.12	1.08	1.16	1.20	1.08	1.13	1.11	1.06	1.12	1.08
Median	1.00	1.02	1.05	1.04	1.01	1.00	1.01	1.00	1.03	1.00
Max	1.99	1.46	1.99	2.05	1.66	2.01	1.73	1.56	1.72	1.81
# Eff	6	3	3	3	4	5	6	9	6	5

Table B.17: Congestion ratio changes per year (%)

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	0.12	0.00	0.02	0.09	0.01	0.00	-0.03	0.04	0.00	0.24	0.86
Belgium	0.15	0.00	0.05	0.17	0.00	-0.03	-0.14	0.01	0.00	0.00	1.51
Czech Republic	0.14	0.00	0.47	0.89	0.11	0.09	0.02	-0.01	0.16	0.97	0.21
Denmark	-0.12	0.42	-1.33	-0.20	0.03	-0.09	-0.01	0.01	0.00	0.50	-0.51
Estonia	0.65	0.58	3.37	3.51	8.51	9.37	5.91	11.80	0.00	0.00	0.00
Finland	0.04	0.00	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.90	-0.10
France	0.11	0.00	0.02	0.56	0.19	0.00	0.00	0.00	0.12	0.00	0.00
Germany	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hungary	2.24	3.23	9.74	0.84	0.04	16.25	9.29	5.24	12.90	10.54	8.86
Ireland	0.06	0.00	0.01	0.00	6.77	0.00	0.81	0.90	0.00	-0.02	0.00
Italy	-0.03	0.06	0.01	-0.03	0.00	-0.41	0.20	0.00	-0.03	0.00	0.01
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.04	0.09	0.00	0.02	1.25	0.01	0.00	0.00	0.00	0.33	0.01
Norway	-0.08	0.00	0.00	-0.55	0.00	0.01	0.03	0.00	0.00	0.75	0.00
Poland	0.83	4.30	1.70	0.29	-1.83	3.83	0.84	1.03	4.37	8.13	0.77
Slovakia	-0.38	0.09	0.72	-1.62	1.28	5.02	5.00	0.79	0.50	9.81	0.87
Slovenia	-0.05	7.94	0.00	-2.21	15.38	2.16	0.71	0.01	-1.49	-0.07	0.06
Spain	-0.17	0.00	0.15	-1.05	1.51	0.14	0.82	1.30	0.27	-0.91	0.03
Sweden	-0.06	0.01	0.01	0.36	0.50	0.05	0.00	0.05	0.00	-0.05	-1.07
Min	-0.38	0.00	-1.33	-2.21	-1.83	-0.41	-0.14	-0.01	-1.49	-0.91	-1.07
Average	0.18	0.88	0.80	0.06	1.78	1.92	1.23	1.11	0.88	1.64	0.61
Median	0.04	0.00	0.02	0.02	0.04	0.01	0.02	0.01	0.00	0.00	0.01
Max	2.24	7.94	9.74	3.51	15.38	16.25	9.29	11.80	12.90	10.54	8.86
# Imp	8	2	2	7	2	5	5	3	10	9	4

Table B.18: Spearman correlation coefficients for congestion ratio

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
coefficient	-0.17	-0.28	-0.42	-0.19	-0.37	-0.30	-0.22	-0.30	-0.56	-0.22	-0.39
p−value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table B.19: Spearman correlation coefficients

Level	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
Technical Eff.	0.01	0.07	-0.06	-0.02	-0.09	0.17	0.09	0.13	0.08	0.00	0.00
v.s. Scale	0.84	0.17	0.24	0.69	0.07	0.00	0.08	0.01	0.14	0.93	0.93
Technical Eff.	0.68	0.40	0.51	0.55	0.57	0.39	0.49	0.52	0.33	0.52	0.51
v.s.Congestion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Congestion	0.10	0.14	0.05	0.07	-0.01	0.16	0.13	0.17	0.12	0.26	0.13
v.s. Scale	0.06	0.01	0.31	0.18	0.86	0.00	0.01	0.00	0.02	0.00	0.01
Change	**Country**	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Technical Eff.	-0.16	-0.20	-0.13	0.10	-0.03	-0.17	-0.30	-0.15	-0.20	-0.28	-0.22
v.s. Scale	0.00	0.08	-0.18	-0.11	0.01	0.02	-0.03	0.03	0.01	0.07	0.00
Technical Eff.	0.14	0.31	0.23	0.10	0.27	0.24	0.18	0.13	0.19	0.36	0.16
v.s.Congestion	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Congestion	-0.04	0.08	-0.18	-0.11	0.01	0.02	-0.03	0.03	0.01	0.07	0.00
v.s. Scale	0.50	0.15	0.00	0.04	0.86	0.68	0.52	0.57	0.92	0.21	1.00

Table C.1: Weights for the technical efficiency ratios

	A	Mi	Ma	EGW	C	W	T	PA	E	H
Austria	2.69	0.63	28.64	3.43	10.51	18.98	9.63	8.74	8.00	8.75
Belgium	1.57	0.18	25.61	3.40	7.80	18.79	11.15	11.07	10.05	10.39
Czech Republic	4.18	1.83	33.83	5.48	8.72	15.51	11.98	7.79	5.51	5.17
Denmark	2.69	3.88	21.37	3.23	7.33	17.92	10.35	9.09	8.49	15.65
Estonia	5.42	1.82	24.32	4.76	9.43	18.43	15.65	8.65	6.93	4.60
Finland	4.32	0.48	31.54	3.17	8.69	13.82	10.86	7.63	7.23	12.26
France	3.71	0.24	22.09	2.68	9.18	17.14	9.45	12.88	8.98	13.66
Germany	1.56	0.40	35.17	3.38	7.44	16.16	8.31	9.73	6.98	10.87
Hungary	7.07	0.37	31.25	4.13	6.41	15.04	10.51	12.09	6.98	6.14
Ireland	3.60	0.69	38.92	2.23	8.83	14.46	7.46	6.56	7.17	10.06
Italy	3.72	0.66	28.84	3.10	8.51	18.63	10.44	10.04	7.37	8.68
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.44	4.36	21.21	2.35	8.10	20.01	9.65	11.05	7.13	12.70
Norway	1.34	28.87	13.29	3.20	6.47	11.52	10.03	7.08	6.19	12.01
Poland	6.01	3.28	24.26	4.49	9.40	24.88	8.51	7.98	6.27	4.94
Slovakia	5.56	0.88	30.22	5.79	9.83	18.64	11.16	8.81	4.53	4.59
Slovenia	3.96	0.79	33.19	3.87	9.14	16.53	9.41	8.36	7.68	7.08
Spain	5.05	0.53	24.23	3.54	13.30	17.16	9.74	12.22	6.64	7.58
Sweden	2.74	0.67	28.65	4.01	7.29	15.70	10.33	7.41	7.96	15.22
Min	1.09	0.18	13.29	2.23	6.41	11.52	7.46	6.56	4.53	4.59
Average	3.67	2.67	27.10	3.60	8.87	17.38	10.55	9.40	7.28	9.48
Median	3.71	0.67	28.64	3.40	8.72	17.16	10.33	8.81	7.17	9.84
Max	7.07	28.87	38.92	5.79	13.30	24.88	15.82	12.88	10.05	15.65

Table C.2: Weights for the scale ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	5.27	0.91	28.00	3.99	9.18	17.54	10.48	7.63	7.06	9.94
Belgium	1.57	0.20	25.50	3.60	7.95	17.87	11.67	10.26	9.31	12.06
Czech Republic	3.18	2.07	31.51	5.15	10.75	16.92	10.91	7.21	6.44	5.87
Denmark	2.78	3.31	26.52	2.88	6.89	17.57	10.55	7.09	8.82	13.58
Estonia	4.97	2.06	36.81	5.43	8.95	17.11	12.27	5.03	4.65	2.72
Finland	4.69	1.58	32.81	3.62	7.78	12.66	9.35	8.69	7.71	11.12
France	3.69	0.50	22.02	2.92	9.13	17.04	9.40	12.80	8.93	13.58
Germany	2.26	0.56	34.86	3.35	7.38	16.02	8.23	9.65	6.92	10.78
Hungary	4.81	0.41	36.26	3.44	8.67	15.17	9.54	9.90	7.22	4.58
Ireland	5.35	3.18	31.13	4.04	7.83	17.30	9.86	5.43	7.51	8.38
Italy	3.92	1.12	30.14	2.89	9.42	18.43	9.77	9.35	6.89	8.07
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.30	3.69	20.33	2.38	8.06	20.60	9.27	9.91	7.00	15.47
Norway	2.17	22.69	17.34	2.55	6.60	9.72	9.93	8.14	7.37	13.48
Poland	5.69	2.12	24.05	4.19	11.12	21.97	7.27	7.78	9.92	5.91
Slovakia	2.98	0.82	40.47	7.50	6.90	14.60	9.62	8.22	4.08	4.80
Slovenia	11.78	0.52	21.40	9.52	10.21	17.83	10.28	7.89	5.37	5.20
Spain	4.25	0.87	21.51	3.42	12.41	21.15	11.00	12.21	6.43	6.73
Sweden	2.34	1.98	27.77	3.94	7.58	14.99	10.74	8.03	9.90	12.73
Min	1.09	0.20	17.34	2.24	6.60	9.72	7.27	5.03	4.08	2.72
Average	4.00	2.57	27.72	4.06	8.89	17.13	10.31	8.77	7.35	9.20
Median	3.69	1.12	27.77	3.60	8.67	17.30	9.93	8.22	7.22	9.84
Max	11.78	22.69	40.47	9.52	12.41	21.97	15.82	12.80	9.92	15.47

Table C.3: Weights for the congestion ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	5.34	0.91	28.07	4.04	9.32	17.81	10.42	7.75	7.11	9.23
Belgium	1.61	0.20	25.19	3.69	7.59	17.97	11.86	10.52	9.56	11.81
Czech Republic	3.40	2.00	27.66	5.36	11.07	18.09	11.74	7.61	6.76	6.31
Denmark	2.75	3.23	26.05	2.91	6.99	17.87	10.66	7.22	8.60	13.73
Estonia	5.61	2.06	37.44	4.79	9.34	14.28	12.08	5.74	5.55	3.11
Finland	4.80	1.60	32.22	3.67	7.99	12.98	9.59	8.93	6.81	11.41
France	3.69	0.48	21.99	2.87	9.14	17.06	9.41	12.82	8.94	13.60
Germany	2.23	0.51	34.89	3.35	7.38	16.04	8.24	9.65	6.92	10.79
Hungary	5.93	0.58	31.65	3.21	11.38	14.16	9.03	11.53	7.40	5.12
Ireland	5.59	3.29	32.57	3.90	8.19	17.05	7.16	5.67	7.82	8.76
Italy	3.76	1.11	30.45	2.94	9.30	17.86	9.92	9.49	6.99	8.19
Luxembourg	1.09	0.23	18.26	2.24	12.11	20.89	15.82	11.39	8.14	9.84
Netherlands	3.28	3.75	20.64	2.28	8.17	20.90	9.40	9.52	6.39	15.68
Norway	2.21	23.04	16.69	2.59	6.68	9.74	10.09	8.25	7.06	13.64
Poland	4.11	2.32	18.48	3.17	13.94	27.71	6.83	7.94	9.92	5.58
Slovakia	3.32	0.90	38.15	8.12	7.19	13.86	10.43	9.10	3.62	5.32
Slovenia	3.21	0.60	21.27	9.55	11.48	20.55	11.92	9.13	6.27	6.01
Spain	4.61	0.89	22.62	3.40	12.15	19.22	10.42	13.02	6.58	7.10
Sweden	2.41	2.01	26.13	3.99	7.72	15.44	10.86	8.27	10.21	12.96
Min	1.09	0.20	16.69	2.24	6.68	9.74	6.83	5.67	3.62	3.11
Average	3.63	2.62	26.86	4.00	9.32	17.34	10.31	9.13	7.40	9.38
Median	3.40	1.11	26.13	3.40	9.14	17.81	10.42	9.10	7.06	9.23
Max	5.93	23.04	38.15	9.55	13.94	27.71	15.82	13.02	10.21	15.68

Table C.4: Changes for the technical ratio weights

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.01	0.00	0.02	-0.01	-0.01	0.01	-0.02	-0.01	0.01	0.03
Belgium	-0.01	0.00	-0.07	-0.01	0.02	0.02	-0.03	0.03	0.02	0.03
Czech Republic	-0.03	-0.02	0.07	-0.01	-0.01	0.00	-0.05	0.02	0.01	0.02
Denmark	-0.02	0.02	-0.03	0.00	0.00	0.00	-0.02	-0.01	0.02	0.03
Estonia	-0.02	0.00	-0.04	0.01	0.01	0.02	-0.02	0.03	-0.01	0.01
Finland	-0.01	0.00	-0.08	0.00	0.03	0.02	-0.04	0.03	0.02	0.04
France	-0.02	0.00	-0.06	0.00	0.02	0.01	-0.02	0.02	0.00	0.04
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	0.00	0.01	0.03
Hungary	-0.04	0.00	0.05	-0.01	0.00	0.01	-0.01	0.01	0.00	0.00
Ireland	-0.06	0.00	-0.04	0.02	-0.02	0.04	0.00	-0.01	0.03	0.05
Italy	-0.01	0.00	-0.05	0.00	0.01	-0.01	-0.01	0.03	0.00	0.04
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.06
Netherlands	-0.02	0.01	-0.06	-0.01	-0.01	0.03	-0.02	0.01	0.02	0.05
Norway	-0.02	0.13	-0.06	-0.01	0.02	-0.04	-0.05	0.00	0.00	0.03
Poland	-0.05	-0.02	-0.01	0.00	0.02	0.03	0.00	-0.01	0.01	0.02
Slovakia	-0.01	-0.01	-0.05	-0.02	0.05	0.04	-0.04	0.02	0.01	0.01
Slovenia	-0.03	-0.01	-0.01	0.01	0.00	0.01	0.00	0.02	0.01	0.00
Spain	-0.02	0.00	-0.04	0.00	-0.02	0.04	-0.04	-0.08	0.08	0.08
Sweden	-0.02	0.00	-0.06	-0.01	0.03	0.02	-0.02	0.00	0.02	0.04
Min	-0.06	-0.02	-0.13	-0.02	-0.03	-0.04	-0.06	-0.08	-0.01	0.00
Average	-0.02	0.01	-0.03	0.00	0.01	0.02	-0.02	0.01	0.01	0.03
Median	-0.02	0.00	-0.04	0.00	0.01	0.02	-0.02	0.01	0.01	0.03
Max	-0.01	0.13	0.07	0.02	0.05	0.08	0.00	0.04	0.08	0.08

Table C.5: Changes for the scale ratio weights

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.03	0.00	0.04	-0.01	0.00	0.00	-0.03	-0	0.01	0.026
Belgium	-0.01	0.00	-0.04	-0.01	0.01	0.00	-0.04	0.03	0.02	0.039
Czech Republic	-0.02	-0.01	0.02	-0.02	0.00	-0.01	0.00	0.02	0.02	-0
Denmark	-0.02	0.00	0.01	-0.01	0.00	-0.02	-0.04	0.01	0.02	0.056
Estonia	0.00	0.01	0.10	0.10	-0.01	-0.06	-0.03	-0	-0.1	-0.03
Finland	-0.03	0.01	-0.04	0.00	0.02	0.03	-0.06	0.03	-0	0.05
France	-0.02	0.00	-0.06	0.00	0.02	0.01	-0.02	0.02	0	0.041
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	-0	0.01	0.028
Hungary	-0.02	0.00	0.08	-0.04	-0.02	0.03	-0.01	0.09	-0.1	-0.04
Ireland	-0.05	0.01	-0.03	0.01	-0.01	0.04	-0.02	-0	0.01	0.041
Italy	-0.01	0.00	-0.01	0.00	0.01	-0.02	-0.01	0.02	-0	0.029
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.064
Netherlands	-0.02	0.01	-0.04	-0.01	0.00	0.00	-0.02	0.01	0.02	0.051
Norway	-0.02	0.12	-0.03	-0.01	0.03	-0.03	-0.06	-0	-0	0.018
Poland	-0.01	-0.01	-0.02	-0.01	-0.01	0.04	0.01	0.05	-0	-0.02
Slovakia	-0.01	-0.02	0.09	0.00	-0.06	-0.02	0.02	0.01	-0	0.007
Slovenia	0.09	0.00	-0.11	0.10	-0.01	-0.08	0.01	0.01	-0	-0
Spain	-0.02	0.00	-0.07	0.01	-0.02	0.06	-0.02	-0.1	0.08	0.065
Sweden	-0.01	0.02	-0.06	0.01	0.03	0.01	-0.02	-0	-0	0.036
Min	-0.05	-0.02	-0.13	-0.04	-0.06	-0.08	-0.06	-0.09	-0.07	-0.04
Average	-0.01	0.01	-0.02	0.00	0.00	0.00	-0.02	0.01	0.00	0.02
Median	-0.02	0.00	-0.03	0.00	0.00	0.00	-0.02	0.01	0.00	0.03
Max	0.09	0.12	0.10	0.10	0.03	0.08	0.02	0.09	0.08	0.06

Table C.6: Changes for the congestion ratio weights

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.03	0.00	0.04	0.00	0.00	0.01	-0.03	-0	0.01	0.011
Belgium	-0.01	0.00	-0.04	-0.01	0.02	0.01	-0.04	0.03	0.02	0.014
Czech Republic	-0.02	-0.01	0.00	-0.03	0.05	-0.02	0.00	0.02	0.01	-0.01
Denmark	-0.02	0.01	0.00	-0.01	0.00	-0.03	-0.04	0.01	-0	0.071
Estonia	0.00	0.01	0.14	0.11	-0.01	-0.06	-0.04	-0	-0.1	-0.03
Finland	-0.03	0.01	-0.04	0.00	0.02	0.03	-0.06	0.03	-0	0.054
France	-0.02	0.00	-0.06	0.00	0.02	0.01	-0.02	0.02	0	0.041
Germany	-0.01	-0.01	0.03	0.00	-0.03	-0.01	-0.01	-0	0.01	0.028
Hungary	-0.03	0.00	0.28	-0.01	-0.06	-0.03	-0.07	0.01	-0	-0.06
Ireland	-0.05	0.01	-0.02	0.01	-0.01	0.04	-0.03	-0	0.02	0.043
Italy	-0.01	0.00	-0.01	0.00	0.02	-0.02	-0.01	0.02	-0	0.029
Luxembourg	-0.01	0.00	-0.13	-0.02	0.02	0.08	-0.06	0.04	0.03	0.064
Netherlands	-0.02	0.01	-0.04	-0.01	0.00	0.00	-0.02	0.02	0.01	0.054
Norway	-0.02	0.11	-0.01	-0.01	0.03	-0.03	-0.06	-0	-0	0.024
Poland	-0.03	-0.01	0.05	0.01	-0.05	0.08	0.02	0.01	-0.1	-0.01
Slovakia	-0.02	-0.03	0.22	0.00	-0.08	-0.08	0.01	-0	0	0.002
Slovenia	-0.05	0.00	0.03	0.13	-0.05	-0.10	0.01	0.04	-0	-0
Spain	-0.02	0.00	-0.04	0.00	-0.02	0.05	-0.04	-0.1	0.09	0.073
Sweden	-0.01	0.02	-0.08	0.01	0.03	0.00	-0.02	-0	-0	0.06
Min	-0.05	-0.03	-0.13	-0.03	-0.08	-0.10	-0.07	-0.11	-0.07	-0.06
Average	-0.02	0.01	0.02	0.01	0.00	0.00	-0.03	0.00	0.00	0.02
Median	-0.02	0.00	-0.01	0.00	0.00	0.00	-0.03	0.01	0.00	0.03
Max	0.00	0.11	0.28	0.13	0.05	0.08	0.02	0.04	0.09	0.07

Table C.7: Country-level technical efficiency ratios

	Indicator	**Lower bound**	**Upper bound**	**Standard error**
Austria	1.15	1.02	1.28	0.16
Belgium	1.08	0.88	1.28	0.02
Czech Republic	2.23	2.25	2.21	0.03
Denmark	1.34	1.16	1.52	0.00
Estonia	2.04	1.93	2.15	0.25
Finland	1.21	1.06	1.36	0.03
France	1.01	1.05	0.97	0.08
Germany	1.01	0.89	1.13	0.13
Hungary	2.28	2.12	2.44	0.05
Ireland	1.25	1.34	1.16	0.04
Italy	1.07	1.22	0.92	0.26
Luxembourg	1.00	0.97	1.03	0.16
Netherlands	1.19	1.33	1.05	0.26
Norway	1.29	1.24	1.34	0.11
Poland	2.02	2.01	2.03	0.12
Slovakia	2.24	2.41	2.07	0.07
Slovenia	1.90	2.05	1.75	0.06
Spain	1.19	1.29	1.09	0.13
Sweden	1.22	1.40	1.04	0.27
Min	1.00	0.88	0.92	
Average	1.46	1.45	1.46	
Median	1.22	1.29	1.28	
Max	2.28	2.41	2.44	
# Eff	1	3	2	

Table C.8: Technical efficiency ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	2.23	1.66	1.12	1.35	1.00	1.06	1.24	1.00	1.01	1.31
Belgium	1.10	1.24	1.08	1.17	1.11	1.03	1.12	1.00	1.00	1.26
Czech Republic	1.70	2.58	2.08	2.11	2.76	2.45	2.05	2.05	2.60	2.56
Denmark	1.48	1.27	1.67	1.20	1.26	1.32	1.36	1.04	1.40	1.15
Estonia	1.84	2.16	3.02	2.29	1.87	1.93	1.65	1.17	1.43	1.22
Finland	1.30	3.73	1.26	1.39	1.08	1.11	1.03	1.39	1.30	1.09
France	1.00	2.06	1.00	1.10	1.00	1.00	1.00	1.00	1.00	1.00
Germany	1.47	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hungary	1.53	2.64	2.64	1.81	3.10	2.31	2.09	1.90	2.33	1.67
Ireland	2.13	6.15	1.00	2.50	1.23	1.50	1.65	1.04	1.37	1.05
Italy	1.13	1.90	1.13	1.00	1.19	1.06	1.00	1.00	1.00	1.00
Luxembourg	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Netherlands	1.15	1.00	1.14	1.22	1.19	1.23	1.15	1.07	1.17	1.45
Norway	2.26	1.00	1.70	1.03	1.32	1.09	1.26	1.47	1.54	1.45
Poland	1.99	1.30	2.01	1.91	2.38	1.78	1.74	1.96	3.22	2.48
Slovakia	1.20	2.07	3.02	3.15	1.64	1.78	1.96	2.08	2.05	2.35
Slovenia	6.20	1.16	1.20	4.56	2.13	2.08	2.09	1.78	1.32	1.37
Spain	1.00	1.96	1.05	1.13	1.13	1.46	1.35	1.23	1.13	1.05
Sweden	1.06	3.32	1.18	1.20	1.27	1.17	1.26	1.32	1.53	1.02
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.72	2.09	1.54	1.69	1.51	1.44	1.42	1.34	1.49	1.39
Median	1.47	1.90	1.18	1.22	1.23	1.23	1.26	1.17	1.32	1.22
Max	6.20	6.15	3.02	4.56	3.10	2.45	2.09	2.08	3.22	2.56
# Eff	2	3	3	3	4	3	3	5	5	4

Table C.9: Technical efficiency ratio changes per year (%)

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	-0.23	-0.33	1.77	0.19	2.12	0.00	-0.33	-0.70	0.00	0.06	-0.28
Belgium	-0.02	0.89	3.12	0.74	1.74	-0.34	-0.73	-0.25	0.00	0.00	-0.01
Czech Republic	-0.82	1.26	5.86	-1.47	1.05	0.66	-0.04	2.66	4.46	1.08	-1.47
Denmark	-0.60	1.71	-3.77	0.31	-1.03	-0.17	-1.21	-1.13	0.43	-0.84	0.63
Estonia	-2.47	5.38	4.03	1.91	12.01	9.96	-0.04	9.49	-4.07	1.38	-4.27
Finland	0.51	-1.41	12.34	1.46	2.85	0.17	0.97	-0.57	1.36	-0.92	1.08
France	0.01	0.00	13.04	0.00	0.24	0.00	0.00	0.06	0.00	0.00	0.00
Germany	0.00	1.28	3.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hungary	1.98	6.08	47.49	2.62	0.04	2.73	4.80	3.54	9.80	4.92	2.11
Ireland	-0.10	4.91	11.33	0.00	1.16	2.11	-0.16	-0.88	0.19	-0.75	0.27
Italy	0.40	0.14	2.84	1.25	0.00	0.54	0.19	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	-0.48	0.02	0.00	-0.17	-0.46	0.14	-1.22	-0.55	0.02	-0.40	-0.66
Norway	-0.26	3.14	0.00	1.85	0.68	1.62	0.36	-0.23	-0.74	-1.67	-0.67
Poland	-0.19	4.30	1.70	-0.18	-1.83	-1.79	0.24	1.75	5.80	-1.46	-2.71
Slovakia	0.12	4.62	16.28	3.42	13.27	0.41	0.08	10.05	8.94	17.15	18.66
Slovenia	-0.60	11.60	3.50	-1.16	7.64	0.12	-3.06	5.08	0.56	3.70	5.15
Spain	0.06	0.00	4.47	-0.71	1.64	0.17	0.70	0.95	0.21	0.50	0.11
Sweden	-1.05	0.77	11.31	-1.10	1.25	-0.88	-1.54	-0.49	-1.18	-2.36	-1.07
Min	-2.47	-1.41	-3.77	-1.47	-1.83	-1.79	-3.06	-1.13	-4.07	-2.36	-4.27
Average	-0.20	2.33	7.32	0.47	2.23	0.81	-0.05	1.51	1.36	1.07	0.89
Median	-0.10	1.26	3.68	0.00	1.05	0.14	0.00	0.00	0.02	0.00	0.00
Max	1.98	11.60	47.49	3.42	13.27	9.96	4.80	10.05	9.80	17.15	18.66
# Imp	12	2	2	8	3	6	10	9	3	9	8

Table C.10: Spearman correlation coefficients for technical efficiency ratios

	Country	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
coefficient	-0.17	-0.12	-0.27	-0.11	-0.28	-0.13	-0.13	-0.25	-0.29	-0.22	-0.27
p−value	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00

Table C.11: Country-level scale ratios

	Indicator	**Lower bound**	**Upper bound**	**Standard error**
Austria	1.10	0.92	1.28	0.15
Belgium	1.09	1.09	1.09	0.10
Czech Republic	1.26	1.10	1.42	0.11
Denmark	1.05	1.21	0.89	0.23
Estonia	1.70	1.74	1.66	0.07
Finland	1.07	1.11	1.03	0.03
France	1.18	1.33	1.03	0.28
Germany	1.40	1.22	1.58	0.17
Hungary	1.22	1.40	1.04	0.07
Ireland	1.04	1.10	0.98	0.25
Italy	1.22	1.41	1.03	0.01
Luxembourg	1.13	1.26	1.00	0.19
Netherlands	1.13	1.04	1.22	0.19
Norway	1.20	1.22	1.18	0.16
Poland	1.29	1.37	1.21	0.22
Slovakia	1.16	1.28	1.04	0.21
Slovenia	1.14	1.27	1.01	0.11
Spain	1.25	1.20	1.30	0.23
Sweden	1.12	1.29	0.95	0.28
Min	1.04	0.92	0.89	
Average	1.20	1.24	1.15	
Median	1.16	1.22	1.04	
Max	1.70	1.74	1.66	
# Eff	0	1	4	

Table C.12: Scale ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	1.02	1.08	1.24	1.07	1.00	1.07	1.08	1.01	1.08	1.01
Belgium	1.03	1.04	1.23	1.05	1.00	1.08	1.08	1.04	1.01	1.01
Czech Republic	1.04	1.09	1.69	1.16	1.03	1.03	1.11	1.04	1.02	1.02
Denmark	1.02	1.01	1.09	1.02	1.02	1.03	1.08	1.03	1.07	1.02
Estonia	1.66	1.08	1.32	2.41	1.91	1.53	1.69	3.25	4.76	3.96
Finland	1.01	1.03	1.12	1.02	1.02	1.05	1.04	1.04	1.17	1.02
France	1.03	1.14	1.48	1.42	1.01	1.03	1.13	1.16	1.12	1.09
Germany	1.07	1.23	1.63	1.29	1.12	1.14	1.37	1.22	1.38	1.50
Hungary	1.09	1.08	1.44	1.17	1.05	1.03	1.08	1.06	1.32	1.14
Ireland	1.02	1.01	1.00	1.01	1.04	1.09	1.09	1.09	1.03	1.04
Italy	1.09	1.14	1.58	1.21	1.07	1.09	1.07	1.03	1.02	1.01
Luxembourg	1.65	1.46	1.58	1.63	1.14	1.01	1.07	1.00	1.00	1.01
Netherlands	1.01	1.05	1.37	1.06	1.01	1.04	1.10	1.10	1.20	1.03
Norway	1.03	1.72	1.03	1.01	1.02	1.01	1.08	1.02	1.12	1.02
Poland	1.06	1.16	1.90	1.26	1.05	1.07	1.29	1.21	1.03	1.03
Slovakia	1.11	1.07	1.23	1.04	1.07	1.05	1.07	1.10	1.86	1.17
Slovenia	1.03	1.01	1.02	1.05	1.07	1.09	1.25	1.32	1.90	1.48
Spain	1.01	1.09	1.74	1.23	1.21	1.09	1.12	1.07	1.21	1.01
Sweden	1.01	1.05	1.28	1.07	1.01	1.11	1.08	1.03	1.02	1.02
Min	1.01	1.01	1.00	1.01	1.00	1.01	1.04	1.00	1.00	1.01
Average	1.10	1.13	1.37	1.22	1.10	1.09	1.15	1.20	1.39	1.24
Median	1.03	1.08	1.32	1.07	1.04	1.07	1.08	1.06	1.12	1.02
Max	1.66	1.72	1.90	2.41	1.91	1.53	1.69	3.25	4.76	3.96
# Eff	0	0	1	0	1	0	0	1	1	0

Table C.13: Scale ratio changes per year (%)

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
Austria	0.63	-0.46	1.96	1.06	1.02	0.00	1.63	0.29	0.06	0.13	0.00
Belgium	0.49	0.19	0.46	1.21	0.36	-0.01	1.33	0.37	-0.42	0.03	0.04
Czech Republic	1.02	-0.40	1.40	2.31	0.04	0.53	0.72	1.14	0.00	0.12	0.00
Denmark	0.14	0.08	-0.20	-0.20	-0.04	0.16	0.71	0.39	0.22	0.67	-0.02
Estonia	3.63	4.84	1.09	1.58	10.82	13.74	13.20	13.02	17.22	22.77	21.15
Finland	0.27	0.00	0.36	0.65	0.02	-0.08	0.77	0.79	-0.29	0.53	0.05
France	0.74	0.48	2.22	2.23	1.77	0.14	1.08	1.51	0.83	-1.03	0.23
Germany	0.64	-0.78	2.02	1.76	-0.84	-0.26	1.13	1.74	-0.35	-0.12	0.49
Hungary	0.99	1.07	0.14	1.90	-0.24	1.06	-0.21	2.66	0.43	2.26	0.94
Ireland	0.30	0.05	0.03	0.00	-0.24	0.46	1.41	0.17	1.10	-0.22	-0.28
Italy	0.89	-0.32	1.55	2.29	-0.67	0.10	1.38	0.47	0.07	-0.30	0.08
Luxembourg	0.61	4.16	6.33	6.29	3.47	-0.61	-0.48	1.66	0.00	0.00	-0.52
Netherlands	0.40	0.01	1.01	1.36	0.09	0.10	0.82	1.02	0.30	-0.21	0.14
Norway	0.93	0.04	2.83	0.52	0.21	0.04	0.07	0.77	0.21	0.47	0.01
Poland	1.50	1.98	3.19	3.44	0.95	1.58	0.79	5.06	-0.06	-0.13	-0.09
Slovakia	0.67	0.22	1.19	1.28	35.35	1.56	0.26	0.71	0.06	4.64	1.94
Slovenia	0.75	-0.20	0.05	-0.52	-0.61	-0.03	3.43	2.20	3.76	7.45	3.63
Spain	1.11	-0.52	0.89	3.36	1.84	0.35	1.71	0.37	-0.04	-1.18	0.04
Sweden	0.59	0.02	0.49	1.37	0.31	-0.06	1.96	0.36	0.20	-0.35	-0.11
Min	0.14	-0.78	-0.20	-0.52	-0.84	-0.61	-0.48	0.17	-0.42	-1.18	-0.52
Average	0.86	0.55	1.42	1.68	2.82	0.99	1.67	1.83	1.23	1.87	1.46
Median	0.67	0.04	1.09	1.37	0.21	0.10	1.08	0.79	0.07	0.03	0.04
Max	3.63	4.84	6.33	6.29	35.35	13.74	13.20	13.02	17.22	22.77	21.15
# Imp	0	6	1	2	6	6	2	0	6	8	6

Table C.14: Spearman correlation coefficients for scale ratio

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
coefficient	-0.21	-0.22	-0.39	-0.19	-0.15	-0.21	-0.27	-0.35	-0.28	-0.22	-0.25
$p-value$	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Table C.15: Country-level congestion ratios

	Indicator	**Lower bound**	**Upper bound**	**Standard error**
Austria	1.02	0.91	1.13	0.15
Belgium	1.03	1.06	1.00	0.13
Czech Republic	1.08	1.16	1.00	0.15
Denmark	1.02	1.02	1.02	0.25
Estonia	1.18	1.06	1.30	0.19
Finland	1.03	1.08	0.98	0.24
France	1.00	0.99	1.01	0.11
Germany	1.00	0.82	1.18	0.26
Hungary	1.74	1.72	1.76	0.19
Ireland	1.05	1.02	1.08	0.06
Italy	1.02	1.10	0.94	0.14
Luxembourg	1.00	1.11	0.89	0.25
Netherlands	1.02	1.14	0.90	0.07
Norway	1.02	1.15	0.89	0.07
Poland	1.35	1.38	1.32	0.09
Slovakia	1.15	0.98	1.32	0.13
Slovenia	1.17	1.30	1.04	0.27
Spain	1.08	0.89	1.27	0.13
Sweden	1.03	1.19	0.87	0.08
Min	1.00	0.82	0.87	
Average	1.10	1.11	1.10	
Median	1.03	1.08	1.02	
Max	1.74	1.72	1.76	
# Eff	1	5	6	

Table C.16: Congestion ratios

	A	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Austria	1.00	1.01	1.01	1.00	1.00	1.00	1.02	1.00	1.01	1.10
Belgium	1.00	1.02	1.04	1.00	1.08	1.02	1.01	1.00	1.00	1.05
Czech Republic	1.01	1.14	1.26	1.06	1.08	1.02	1.01	1.03	1.07	1.01
Denmark	1.03	1.09	1.04	1.01	1.00	1.00	1.00	1.00	1.04	1.01
Estonia	1.07	1.22	1.26	1.48	1.15	1.53	1.28	1.00	1.00	1.00
Finland	1.00	1.02	1.05	1.01	1.00	1.00	1.00	1.00	1.18	1.00
France	1.00	1.02	1.00	1.02	1.00	1.00	1.00	1.00	1.00	1.00
Germany	1.01	1.09	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hungary	1.41	1.52	2.10	1.81	1.66	2.01	1.93	1.59	1.88	1.56
Ireland	1.00	1.01	1.00	1.17	1.01	1.10	1.51	1.00	1.00	1.00
Italy	1.06	1.02	1.00	1.00	1.04	1.05	1.00	1.00	1.00	1.00
Luxembourg	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Netherlands	1.02	1.00	1.00	1.06	1.00	1.00	1.00	1.06	1.12	1.00
Norway	1.00	1.00	1.06	1.00	1.00	1.02	1.00	1.00	1.07	1.01
Poland	1.99	1.30	1.80	1.89	1.10	1.09	1.45	1.37	1.55	1.53
Slovakia	1.04	1.09	1.27	1.10	1.17	1.29	1.09	1.05	1.43	1.06
Slovenia	5.97	1.00	1.16	1.37	1.06	1.02	1.00	1.01	1.00	1.01
Spain	1.00	1.07	1.02	1.07	1.11	1.21	1.15	1.02	1.06	1.02
Sweden	1.00	1.01	1.10	1.02	1.01	1.00	1.02	1.00	1.00	1.02
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Average	1.35	1.09	1.17	1.16	1.08	1.12	1.13	1.06	1.13	1.07
Median	1.01	1.02	1.04	1.02	1.01	1.02	1.01	1.00	1.01	1.01
Max	5.97	1.52	2.10	1.89	1.66	2.01	1.93	1.59	1.88	1.56
# Eff	7	3	3	4	4	4	3	8	6	6

Table C.17: Congestion ratio changes per year (%)

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
Austria	0.12	0.00	0.01	0.09	0.00	0.00	-0.03	0.09	0.00	0.06	1.51
Belgium	0.13	0.00	0.05	0.19	0.00	-0.24	-0.27	0.20	0.00	0.00	1.47
Czech Republic	-0.17	0.03	0.77	1.26	0.12	-2.53	0.19	0.05	0.38	1.43	0.38
Denmark	-0.02	0.37	-2.12	0.10	0.03	-0.22	0.00	0.01	0.00	1.31	-0.58
Estonia	1.03	0.81	3.55	3.85	8.47	9.48	7.14	17.12	0.00	0.00	0.00
Finland	0.07	0.00	0.04	0.14	0.19	0.00	0.00	0.00	0.00	1.10	-0.10
France	0.00	0.00	0.02	0.00	0.13	0.00	0.00	0.01	0.00	0.00	0.00
Germany	0.00	-0.01	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hungary	2.77	4.33	61.98	0.39	0.04	16.58	9.54	9.98	12.12	18.73	8.72
Ireland	0.13	0.00	0.01	0.00	9.10	0.00	1.26	2.13	0.00	-0.11	0.00
Italy	0.00	0.11	0.01	0.01	0.00	-0.30	0.20	0.00	0.00	0.00	0.00
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.06	0.43	0.00	0.00	2.14	0.00	-0.07	0.00	0.02	0.83	0.00
Norway	-0.10	0.00	0.00	-0.63	0.09	0.01	0.05	0.00	0.18	0.97	-0.30
Poland	0.77	4.30	1.70	0.16	-1.86	2.74	0.18	1.19	4.01	7.84	5.49
Slovakia	-0.48	0.12	0.79	-2.36	1.04	5.16	2.66	0.89	1.58	9.83	0.89
Slovenia	0.09	32.34	0.00	-1.95	10.11	2.47	0.71	0.02	-1.15	-0.15	0.09
Spain	0.00	0.00	0.15	-0.79	1.45	0.29	1.10	2.26	0.27	-0.58	0.19
Sweden	-0.03	0.00	0.01	0.46	0.21	0.06	0.00	0.34	0.00	0.00	-1.07
Min	-0.48	-0.01	-2.12	-2.36	-1.86	-2.53	-0.27	0.00	-1.15	-0.58	-1.07
Average	0.23	2.25	3.54	0.05	1.64	1.76	1.19	1.81	0.92	2.17	0.88
Median	0.00	0.00	0.02	0.01	0.12	0.00	0.05	0.05	0.00	0.00	0.00
Max	2.77	32.34	61.98	3.85	10.11	16.58	9.54	17.12	12.12	18.73	8.72
# Imp	9	2	2	7	2	6	5	3	5	5	5

Table C.18: Spearman correlation coefficients for congestion ratio

	Country	A	Mi	Ma	EGW	C	W	T	PA	E	H
coefficient	-0.17	-0.28	-0.42	-0.19	-0.37	-0.30	-0.22	-0.30	-0.56	-0.22	-0.39
$p-value$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table C.19: Spearman correlation coefficients

Level	**Country**	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Technical Eff.	0.03	0.08	-0.05	-0.05	-0.12	0.21	0.12	0.15	0.10	0.01	0.00
v.s. Scale	0.86	0.15	0.32	0.69	0.06	0.00	0.05	0.00	0.10	0.93	0.93
Technical Eff.	0.69	0.42	0.53	0.54	0.55	0.37	0.51	0.55	0.34	0.53	0.53
v.s.Congestion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Congestion	0.16	0.16	0.07	0.08	-0.02	0.18	0.16	0.19	0.15	0.26	0.17
v.s. Scale	0.04	0.01	0.28	0.18	0.84	0.00	0.00	0.00	0.00	0.00	0.00
Change	**Country**	**A**	**Mi**	**Ma**	**EGW**	**C**	**W**	**T**	**PA**	**E**	**H**
Technical Eff.	-0.19	-0.23	-0.15	0.09	-0.04	-0.18	-0.33	-0.18	-0.25	-0.29	-0.26
v.s. Scale	0.00	0.06	-0.14	-0.12	0.01	0.02	-0.01	0.02	0.00	0.08	0.00
Technical Eff.	0.17	0.33	0.21	0.15	0.29	0.27	0.21	0.15	0.25	0.32	0.17
v.s.Congestion	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Congestion	-0.03	0.07	-0.16	-0.10	0.01	0.02	-0.02	0.01	0.00	0.05	0.00
v.s. Scale	0.52	0.17	0.01	0.05	0.88	0.69	0.53	0.59	0.95	0.23	1.00