METHODS FOR CROSS-NATIONAL PERFORMANCE EVALUATION IN LOGISTICS

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Abstract: The efficient movement of freight across countries is the backbone of world global trade. To keep track of gaps between national logistic systems, different approaches for comparison are developing. In this chapter, we provide a review of various monitoring tools with the focus to the Logistic Performance Index (LPI) developed by the World Bank, as the most known national measure. The need and possibility to improve an index-based approach for cross-national performance comparison is analyzed. We emphasize the functionality of LPI as a benchmarking tool and argue that in order to learn from more successful peers, comparability and similarity of countries needs to be entailed. Accordingly, we analyze the usability of two conceptually different approaches, one drawn from multi-criteria decision analysis and other grounded in statistics. Using a sample of OECD (Organization for Economic Cooperation and Development) countries, we explore the performance evaluation outputs of ELECTRE (ELimination Et Choix Traduisant la REalité; Elimination and Choice Corresponding to Reality) multi-level outranking (ELECTRE MLO) benchmarking approach and hierarchical clustering on the basis of Ward’s method. The results are discussed in relation to LPI ranking scores to show that alternative approaches can supplement to LPI results by giving more insight to policy-makers on how countries stand relative to each other.

Keywords: cross-national performance evaluation, benchmarking, logistic performance index, ELECTRE MLO, hierarchical clustering, OECD countries

1. INTRODUCTION

Logistic industry is proven to be the most important ‘trade facilitator’ bringing significant growth in trade flows at national level (Marti et al., 2014; Puertas et al., 2014). In the era of intensified global flows of freight and capital it is nearly unattainable to trade internationally unless logistic companies monitor their performances in a flow of functions i.e. in macro level context (Brar et al., 2010; Çakir, 2017). This invoked researchers to give more attention to the international dimensions of logistics and research logistic performance in cross-national context. Still, majority of evaluation approaches in logistics are focusing on micro (firm) level while the literature aiming to
benchmark the logistics performances of countries worldwide is rather scarce (Cakir, 2017; Rashidi and Cullinane, 2019).

From methodological point of view, composite indicators (CIs) or indexes are far the most exploited. In the centre is Logistic Performance Index (LPI) devised by World Bank, along with other logistic indexes built up around some specific topics of interest, as for example Green Logistic Performance Index (GLPI) constructed by Hung Lau (2011) or index of sustainable operational logistics performance (SOLP) introduced in Rashidi and Cullinane (2019). All indexes are referred as benchmarking tools but with rather modest justification. Namely, as it is generally the case with benchmarking on the basis of CIs, comparing is a central issue with little or no consideration of ‘cross-national learning’ and tracking relevant best practice exemplars as the principal aim of international benchmarking. Benchmarking is envisioned as powerful policy tool, set to support exchanging knowledge and experience in contrast to regulatory posed pressures associated with sharing the same policy goals.

In this chapter we argue that some alternative approaches to cross-national performance evaluation should be revisited to make macro level logistic assessment more about learning than comparing. Following some fresh ideas of international benchmarking for policy, we demonstrate the importance of similarity among compared peers as well as the notion of incomparability. We propose to rely on an outranking approach and hierarchical levels of performance, instead of ranking them without sufficient knowledge of the arguments for which someone was declared better. Accordingly, we emphasize the feature of corresponding benchmarks, which allows to reveal an appropriate peers to learn from.

Among numerous issues that scrutinize Composite indicators (see Jeremić et al., 2016) is the collinearity of variables underlying particular CI which might generate biased CI (Fusco, 2015; de Freitas et al., 2019). Also, issues such as weighting scheme and aggregation methods still raise a concern among researchers (Jeremić et al., 2011; Dobrota et al., 2012; Dobrota et al., 2016; Milenković et al., 2016; Maričić et al., 2019). In line with learning from the similar within benchmarking framework, applications of hierarchical clustering (HC) can also offer an added value. HC represents an exploratory technique, aiming at creating groups of similar countries, and in following steps merging the clusters according to level of similarity (Seddon and Currie, 2017). It is often used when evaluating various CIs (Đurović et al., 2016; Kostoska and Hristoski, 2017; Roszko-Wójtowicz and Białek, 2018; Akande et al., 2019).

To be able to highlight the added value of proposed alternatives against mainstream index approach, we rely on the data used to construct LPI for 34 OECD countries.

The chapter is organized in the following manner. In section 2, we first elaborate existing approaches for cross-national performance evaluation in logistics. Afterwards we expose arguments in support to the need for alternatives to index approach. The fundamentals of the proposed methods are presented in section 3. Empirical examples which are illustrating the added value of the proposed LPI complements are presented in section 4. Chapter ends with summary of findings along with limitations and future research directions.
2. CROSS-NATIONAL STUDIES IN LOGISTICS - WHY AND HOW

2.1. The need for macro level analysis in logistics

Organised and synchronised international transport flows are the key factor of effective global trade. World Bank reports that on average logistics costs make up some 13 percent of GDP but with distinct variations among countries - ranging from around 8 percent in United States and the Netherlands to even 25 percent in least efficient countries (World Bank, 2017). Besides providing low costs in more competitive imports and exports, logistics enables better using of national transportation assets and increases the employment opportunities (Hayaloglu, 2015).

Logistics is associated with the ‘trade facilitation’ concept, introduced by World Trade Organisation (WTO) entailing “simplification and harmonisation of international trade procedures” (Hollweg and Wong, 2009; Puertas et al., 2014; Marti et al., 2014). Guner and Coskun (2012) offer a comprehensive review of facilitating impact of logistics on international trade flow and argue that logistics is one of the most important elements of national competitiveness. In the core is the ability to move goods expeditiously, reliably and at low cost. This is highly dependable on country’s logistics capacity and gains importance with globalization and growth of international trade volume. Poor infrastructure, complex customs procedures, excessive bureaucracy are just some of the factors leading to varying level of logistics performance from country to country that hinders the efficient movement of goods across borders and brings the assessment of trade facilitation measures to the forefront (Marti et al., 2014). To come up with so-called trade facilitation measures, researchers and practitioners are in search for adequate tools that will enable tracking performance of each link (country) in international trade chain. These measures refer to both policy and also trade and logistics procedures with high impact on trade competitiveness.

Recognizing the cross-cutting nature of logistics and the need to facilitate countries worldwide in framing their own policies, in 2007 World Bank began to be involved in a process of constructing a measure of country-specific logistic performance. The result was global index of logistic performance – LPI, devised to motivate consistent approaches to intervention and reforms at the national level (World Bank, 2018). It was a breakthrough that also invoked researchers and scholars to engage more in cross-national studies in logistics.

2.2. LPI and beyond - A review of methods for cross-national performance evaluation in logistics

As previously pointed out, macro level studies in logistics are relatively scarce compared to micro level analysis. In cross-national performance evaluation context, Logistic Performance Index (LPI) is the most known national measure. It is published by World Bank every two years ever since 2007 year. LPI is built up around six categories of enquiring: customs, infrastructure, international shipments, logistics competence, tracking and tracing and timeliness (Figure 1).
LPI underlying data are gathered using standardized online questionnaire, which contains two parts – first used to collect data for international LPI, and second for domestic LPI. The latest edition of LPI (from 2018) covers 160 countries in case of international LPI, and 100 countries for domestic LPI, entailing nearly 6,000 country assessments. In the case of domestic LPI, respondents (logistic professionals) provide opinions and data on the logistics environment in the country where they work using values from 1 to 5 that indicate worst and best performance respectively. Different is for international LPI where each respondent is asked to evaluate eight countries i.e. trading partners on each of the six dimensions of LPI also using five-step qualitative scale. Countries to be evaluated are selected on the basis of data on most important export and import partners of the country where the respondent is located, or from neighbouring land-bridge countries in the case of landlocked respondents. Starting from 2012, respondents are selected following the predefined sampling procedure - Uniform Sampling Randomized (USR) to avoid under-representing countries with lower trade volumes (World Bank, 2018).

To come up with a single aggregated score of international LPI, first z-scores procedure is used to normalize data followed by Principal Component Analysis (PCA). Kaiser Criterion and eigenvalue screen plot results are used to indicate that the single principal component value encapsulates all six LPI dimensions (with 92 percent of the variation in the six components for data from 2018 as well as from 2016). Normalized data for six dimensions are multiplied by component loadings obtained by PCA and summed to obtain international LPI. Component loadings are in fact weights of six LPI indicators and calculations from previous years indicate that they remain steady over years and with close values for each of six components. It implies that LPI dimensions are close to equal weighting. This allows to compare results over years and also to come up with an aggregated LPI which is a new feature first published in 2018 report. It is calculated in a way that scores from years 2012, 2014, 2016 and 2018 are aggregated with different weights for each year, giving higher weights to more recent data. The novelty of 2018 LPI report is insight on cyber security threats in logistics and the use of electronic trading platforms by shippers.

It is undoubtedly that LPI represents a comprehensive national logistic measure and broad database that allows cross-national performance evaluation in logistics. As pointed out in a recent study by Rezaei et al. (2018), LPI is the only available tool to measure worldwide logistics performance and it is respected everywhere. However there are several concerns raised by scholars. Rashidi and Cullinane (2019) elaborate the lack of insights on operational level, i.e. lack on guidelines for countries with
acceptable level of infrastructure and on how to improve their operational outcome. Rezaei et al. (2018) questioned the reliability of data gathered from poorer countries as they rely on traditional smaller operators with specific characteristics. The other concern they highlight and that is also addressed by Petrović et al. (2017) is about landlocked countries. As they are dependable on the infrastructure and customs of neighbouring countries their rating may be not adequately presented in terms of international trade.

Regardless the concerns, LPI gave an impetus to macro level studies in logistics which are drawing attention over last years (from 2011). Some of representative macro level studies in logistics are listed in Table 1. We can see that many of them are built up around LPI (Burmaoglu and Sen, 2011; Hung Lau, 2011; Guner and Coskun, 2012; Jane and Laih, 2012; Martí et al., 2014; Puertas et al., 2014; Popescu and Sipos, 2014; Yildiz, 2014; Hayaloglu, 2015; Civelek et al., 2015; d’Aleo, 2015; Uca et al., 2016; Yu and Hsiao, 2016; Çakır, 2017; Petrović et al., 2017; Rezaei et al., 2018; Sezer and Abasiz, 2017, Rashidi and Cullinane, 2019).

Besides leaning on LPI as information base, several other conclusions can be drawn on the basis of presented macro level studies in logistics.

The relationship between logistic performance and other aspects (social, economic, environmental) is in the focus of majority of macro level studies (Guner and Coskun, 2012; Popescu and Sipos, 2014; Yildiz, 2014; Martí et al., 2014; Puertas et al., 2014; Hayaloglu, 2015; Civelek et al., 2015; d’Aleo, 2015; Uca et al., 2016; Çakır, 2017; Sezer and Abasiz, 2017). Guner and Coskun (2012) performed correlation analysis to analyse social and economic factors of logistics performance in OECD countries measured by LPI and ended up with results in favour of social influences (reflected by index measures as Human Development Index - HDI and Democracy Index - DMC). The relationship between economic and logistic performance was also studied by Popescu and Sipos (2014) who found positive correlation between two measures (GDP and LPI) for analysed EU countries. Similar, but more thorough research was done by Yildiz (2014) who besides GDP and LPI also included World Bank’s “doing business” scores which were as well as GDP found to be highly positive correlated with LPI dimensions. They have also created world maps distinguishing countries by their logistics performance. Martí et al. (2014) relied on 5-year LPI data and a gravity model and found out that each LPI component has a significant impact on trade flows in developing countries especially those from Africa, South America and Eastern Europe. The same analysis was performed by this group of authors using EU countries as a case study (Puertas et al., 2014). Research of Hayaloglu (2015) follows this stream and uses eight different models for panel data analysis to study the relation between economic growth and developments in logistic sector measured by predefined proxy indicators. Three studies (Civelek et al., 2015; d’Aleo, 2015 and Uca et al., 2016) used hierarchical regression analysis to deal with a so called mediator role of LPI and examined how is LPI related to GDP as well as some other global measures as Global Competitiveness Index (Civelek et al., 2015; d’Aleo, 2015), Corruption Perception Index (CPI) and Foreign Trade Volume (FTV) (Uca et al., 2016). The LPI was used as a mediator criterion to examine its effects on other indexes. Not all studies dealing with impact of logistics development on economic growth use LPI. For example, Sezer and Abasiz (2017) exploited various WBs logistics variables of transportation and communications.
Another study worth mentioning is done by Jhawar et al. (2014). Although not about cross-national performance evaluation (and thus not included in Table 1) it is about LPI. The authors analysed the impact of development of skilled work force on logistic performance in India, measured by LPI. The variables around HR and skills
developments are termed as enablers and within system dynamics model their influence on results reflected by six LPI aspects is analysed. The result was in a form of Causal loop diagram.

We now proceed with conclusions from methodological point of view. Above mentioned studies dealing with relationship between logistics and social and economic aspects mostly rely on different statistical approaches like Correlation analysis (Guner and Coskun, 2012), Regression models (Popescu and Sipos, 2014; Civelek et al., 2015; d’Aleo, 2015 and Uca et al., 2016), Panel Data Analysis (Hayaloglu, 2015; Sezer and Abasiz, 2017) or Gravity model (Martí et al., 2014; Puertas et al., 2014).

If we move to cross-national analysis, i.e. comparing performance of countries, various approaches are evident. Majority of them rely on a new index derived from LPI data. Yu and Hsiao (2016) offered an alternative to LPI on the basis of Meta-Frontier Data Envelopment Analysis with Assurance Regions. Using a sample of OECD countries they compare World Bank LPI and proposed DEA-based LPI rankings and highlight that their approach is more useful in revealing the directions of improvement. A hybrid approach (including CRITIC, SAW and Peters’ fuzzy regression methods) was used by Çakir (2017) to rank OECD countries on the basis of LPI data. The results were compared with LPI rankings and other Multi-Criteria Decision Making (MCDM) approaches with conclusion that variations in the rankings are evident and come as a consequence of distinct mathematical foundations of different methods. A specific study is done by Hung Lau (2011) aimed at international benchmarking of green logistics using composite indicator. Based on the concept of LPI (questionnaire for logistics companies, 5-point scale, PCA analysis) they have developed Green Logistics Performance Index (GLPI) and demonstrated its development process and usage for two countries China and Japan. New cross-national measure was also proposed by Rashidi and Cullinane (2019). It is named sustainable operational logistics performance (SOLP) score. The authors proposed to merge it with LPI and come up with a new index for ranking countries - SLPI. It was created on the basis of Data Envelopment Analysis and LPI data and calculated for OECD countries. Rezaei et al. (2018) and Petrović et al. (2017) dealt with methodological issues of LPI in terms of weights and presented alternatives to PCA used to construct LPI. The first study exploited Best Worst Method (BWM) while the later used I-distance. Both studies report matching rankings with LPI (with small differences), but highlight that offered solutions better encapsulate LPI dimensions. Another research about methodological construct of LPI is done by Jane and Laih (2012), who used a specific algorithm to devise new logistic performance index.

Some authors present their indexes as the alternative to LPI (Jane and Laih, 2012; Yu and Hsiao, 2016; Petrović et al., 2017; Rezaei et al., 2018) while others see them as the complementary measures. Rashidi and Cullinane (2019) compared their SOLP and LPI and argued that, due to different criteria included, two indices should be seen as complementary measures rather than alternatives. Also, regardless the name (GLPI) and underlying building procedure similar to LPI, index proposed by Hung Lau (2011) is not seen as an alternative to World’s Bank index, because it solely includes environmental variables (15 in total, in three categories green purchasing, green packaging and green transportation) and relies exclusively on self-assessment.

Although ranking countries is prevailing there are examples of clustering approach. Such is work done by Burmaoglu and Sesen (2011) who performed hierarchical clustering analysis to distinguish between low and high competitive countries in logistics. They...
further moved to discriminant analysis to track the most effective discriminatory variables and found that infrastructure and ICT (tracking and tracing) to be the most influential in separating country into groups.

We want also to highlight that LPI is a global measure and although main stream informational base, a great deal of studies tend to focus on specific country groups - mostly OECD countries due to large data sets available for researchers.

2.3. Moving from comparing to learning - The motivation and the scope of the study

Composite indicators are far the most used tool for international comparison and benchmarking. This includes logistics to. By being able to accommodate various aspects and accompanying indicators, they provide a practical measure of development, which is easy to interpret and addresses rising public awareness. There are two basic approaches in the context of macro level analysis - global indices developed by relevant international organizations and indexes proposed by scholars. The first ones are more popular, reachable for a wider audience, but also sometimes poor in their construct as a result of a so-called ‘trade-off between breadth and depth in the selection of indicators’ (Vicente and Lopez, 2006). Namely in order to cover as many countries, proxy indicators need to be included, as in case for example with ITUs 2010 version of Information and communication technology development index - IDI (Petrović et al., 2012). On the other hand, scholarly devised indexes are more sophisticated in methodological terms but often covering limited set of countries. Examples are above discussed logistic indexes - GLPI and SOLP.

Opting for an average/aggregated score also referred as “super criterion” is logical, having that there is no entity (organization or country) that is a best performer in all aspects analysed (Laise, 2004). The outcomes are rankings or league tables that distinguish leaders from laggards. The natural question that has been previously elaborated (see for e.g. Laise, 2004 or Petrović et al, 2012, 2013, 2018a, 2018b) is - what can CIs base approach offer to decision/policy makers?

If we recall macro level studies presented in the section above, we can argue that majority of them is about comparing countries' performance with lack of insight on learning from leading peers. As argued by Cakir (2017), the performance metrics should be designed as a system to allow countries to complement and support one another. LPI itself is promoted as a benchmarking tool but it fails to fulfil the principal aim of benchmarking i.e. tracking relevant best practice exemplars to support cross-national learning (see also Yu and Hsiao, 2016 for discussion). Moreover, although devised as a tool for international benchmarking, GLPI lacks of insights on how can laggards use it to emulate performance of the more successful counterparts. Namely, it is all about comparing instead of learning because the question of a relevant or corresponding benchmark is neglected. The feature of corresponding benchmark is well accommodated by Data Envelopment Analyses. In its principal formalization, DEA provides a “reference set” which pinpoints to the similar (in terms of its inputs and outputs) but more successful units. They are labelled as corresponding benchmarks and form the frontier (see Petrović et al., 2018c for more thorough discussion). Simply, to become efficient, a laggard needs to reach the performance of its corresponding benchmark. Rashidi and Cullinane (2019) exploited DEA to come up with a new macro level measure in logistics
and addressed the issue of benchmarks - they proposed 'development matrix' (Diagrammatic representation of SOLP rankings vs. LPI) as a tool for tracking benchmarks for lagging logistic industries. However, it is not in a spirit of corresponding benchmark because it rather groups countries by performance than to directly relate laggards to relevant benchmarks. Detecting directions for improvements on the basis of DEA approach is also offered by Yu and Hsiao (2016). The authors address the issue of benchmarking on the basis of their DEA-based LPI, arguing that the income effects on the logistics production frontier of countries with similar characteristics must be included to move from ranking/comparing to benchmarking. In line, they benchmark countries against peers that operate under similar technologies and relative to the frontier that is drawn from the groups of OECD countries formed on the basis of income level. This allowed them to come up with efficiency differences within each group, technology gap between groups as well as the global logistics frontier, which than led to suitable managerial implications for each country. However, although comprehensive in background calculations, similar to the diagrammatic representation offered by Rashidi and Cullinane (2019), the model ends up with a 2D grid that classifies OECD countries in four group without direct linking those failing behind to the ones to look up to.

Following the idea of moving from comparing to learning, we propose to use ELECTRE based benchmarking tool (introduced in Petrović et al., 2012) for cross-national performance evaluation in logistics. Beside resolving the above elaborated issue of corresponding benchmark, this approach has additional advantage over DEA. Namely, it has broader scope of application since it does not require input/output typology of performance indicators as is the case with DEA based efficiency measuring. Rashidi and Cullinane (2019) see the input-output structure of the DEA methodology as an issue in logistics performance evaluation because the size of units under evaluation is excluded from the performance evaluation process.

What is also in favour of the ELECTRE MLO is the outcome in a form of hierarchical levels of performance instead of index based ranking. Opting for classifying countries into the level of performance is more reasonable as its accommodates decision makers appraisal of superior performance as well as the notion of incomparability - i.e. sharing the same level of performance if there is not enough argument to declare that someone is better (Petrović et al., 2012, 2014, 2018a, 2018b). It is important to stress that due to compensatory effect posed by CIs, incomparability may be neglected, leading to 'mechanical' ranking of incomparable units.

To place this approach under scrutiny we have also explored another way to hierarchically classify countries according to their performance. Clustering is conceptually in line with hierarchical grouping of countries on the basis of ELECTRE MLO. It is also about similarity of cases which is maximized within the cluster while at the same time the resemblance to folders outside of the group is minimized. We opted for hierarchical clustering on the basis of Ward’s method. Cluster analysis for cross-national evaluation in logistics was exploited by Burmaoglu and Senen (2011) as well as in Yildiz (2014). Burmaoglu and Senen (2011) ended up with two clusters which they further analysed in terms of factors discriminating countries into these two groups. Yildiz (2014) used k-means (partitioning clustering) to cluster countries according to all six dimensions of LPI as well as overall LPI score. Hierarchical clustering, proposed in our paper, is superior to partitioning clustering in terms of coherence of clustering (Bindra et al., 2018). Also, the hierarchical relationship among clusters is easily detected,
and it provides relatively high scalability (Xu and Tian, 2015). Moreover, hierarchical clustering approaches produce clusters of higher quality (Bouguettaya et al., 2015).

3. METHODOLOGY

3.1. Benchmarking with ELECTRE MLO

ELECTRE MLO is a relatively new idea envisaged in support of the international benchmarking. As argued by the authors who devised it, the aim is twofold. First is to classify countries into hierarchical levels of performance instead of ranking them. This kind of grouping countries offers more perceptible output, than ranking according quantitative performance gaps whose magnitude may be less explicable. Second, it enables to go beyond searching for a 'mythical' best practice and to discover the relevant practice exemplars which could help for achieving countries’ own distinct objectives. In this way, benchmarking procedure is closer to the desired nature of benchmarking - tool for learning.

The procedure entails classification of countries into performance groups and arranging them in hierarchical levels, visualized in the form of specific output labelled as 'relation tree'. It is an easy to follow output where countries are graphically interpreted as nodes and organized in a descending manner (the first level consists of the best performing countries). The countries from adjacent levels are connected by arrows. An arrow directed towards a country shows that this country is outperformed by the one from upper adjacent level. The better performing country is than seen as a corresponding benchmark for the one bellow. It is termed 'corresponding' since it is from a nearby performance level and with the smallest performance gap compared to the outperformed one. The alternatives at the same hierarchical level are seen as mutually incomparable.

In detail explanation of mathematical formalisation of ELECTRE MLO, can be found in Petrović et al. (2012) and Stamenković et al. (2016). Here we will present in short the main postulations. Some basic notations typical for ELECTRE are listed below:

1. \( A = \{a_1, a_2, ..., a_n\} \) is the set of \( m \) alternatives.
2. \( G = \{g_1, g_2, ..., g_n\} \) is the coherent set of criteria used to evaluate alternatives with their corresponding weights \( \omega_1, \omega_2, ..., \omega_n \).
3. \( I_1, I_2, ..., I_n \) are the sets of scores for each of the criteria. Every set of scores has a finite number of elements, and let \( |I_1|, |I_2|, ..., |I_n| \) denote diameter of these set of scores, i.e. \( |I_k| = \max I_k - \min I_k \).
4. sets \( G_{ij}^+, G_{ij}^- \) and \( G_{ij}^= \) represent all the criteria where the performance score of alternative \( a_i \) is higher \( (G_{ij}^+) \), lower \( (G_{ij}^-) \) or equal \( (G_{ij}^=) \) to the performance score of the alternative \( a_j \).
5. \( g_k(a_i) \) \( I_k \) is the score of alternative \( a_i \) with respect to criterion \( g_k \) for all alternatives \( a_i \in A \) and all criteria \( g_k \in G \), which creates the performance matrix \( M_{m \times n} \).

ELECTRE MLO is grounded in modified ELECTRE I, a well known MCDM technique that classifies alternatives in core and non-core, where the first ones are those that are not outranked by any of the later. It relies on the computation of two indexes - Concordance and Discordance, used to apprise the dominance relations. Namely, if for two
alternatives \((a_i \text{ and } a_j)\) Concordance index is above and at the same time the Discordance is below the thresholds set by decision maker \((p \text{ and } q)\), the \(a_i\) is outperforming \(a_j\).

ELECTRE MLO entails specific iterative procedure including repeated identification of preferable alternatives (i.e. core alternatives). The modification comes from the fact that ELECTRE MLO uses the cutting level of the modified Concordance index (Equation 1) above the so called Absolute Significance Threshold (AST) to create a hierarchical order for each step of the procedure.

\[
C_{ij}^* = \frac{\sum_{k \in S} \omega_k c_{ij}^k}{\sum_{k \in S} \omega_k c_{ij}^k + \omega_k c_{ij}^*}
\]

(1)

In this way cycles are omitted, meaning that it will not allow the core subset of alternatives to be empty in each step of iterative procedure. This is known as problem of intransitivity in outranking relation resulting in so called cycles - a situation when: an alternative \(a_1\) outranks alternative \(a_2\) alternative \(a_2\) outranks alternative \(a_3\), ..., alternative \(a_{k-1}\) outranks alternative \(a_k\) and alternative \(a_k\) outranks alternative \(a_1\). More about modified concordance index and AST can be found in Anić and Larichev (1996) and Bojković et al. (2010) while application in ELECTRE MLO (i.e. omitting cycles in relation graph) is in detail explained in Stamenković et al. (2016).

As stated above, the creation of hierarchical levels entails specific iterative procedure for creating hierarchical levels of performance. First, core alternatives are selected and placed at the first level. The same procedure is applied for the remaining alternatives, i.e. a new core is created. These alternatives will be the second-level alternatives, and they are outperformed only by some of alternatives from the first level. The procedure proceeds until all alternatives are exhausted. Generally, the alternative \(a_i\) that is outside the core belongs to the hierarchical level \(L_k\) \((k \geq 2)\) when the condition from the Eq. 2 is satisfied:

\[
\max \{ t | (\exists a_j \in L_t) a_j > a_i \} = k - 1.
\]

(2)

The computation is performed using a designed software solution and output entails relation graph (relation tree) as well as concordance and discordance matrices.

### 3.2. Hierarchical clustering with Ward’s method

Ward hierarchical clustering method is one of the agglomerative clustering methods that is based on a classical sum-of-squares criterion. The method is interesting because it looks for clusters in multivariate Euclidean space (Murtagh and Legendre, 2014). It essentially starts with the \(n\) clusters (each with the size of 1 entity) and eventually group all the observations into one cluster. Results of the hierarchical clustering are depicted as a tree or dendrogram. Ward’s method forms the distance between two clusters, \(M\) and \(N\), and calculates how much the sum of squares will increase when we merge those clusters following Eq. 3.

\[
\Delta(M, N) = \sum_{i \in M \cup N} ||\bar{x}_i - \bar{m}_{M\cup N}||^2 - \sum_{i \in M} ||\bar{x}_i - \bar{m}_M||^2 - \sum_{i \in N} ||\bar{x}_i - \bar{m}_N||^2
\]

(3)
Where \( m_j \) is the centre of cluster \( j \), and \( n_j \) is the number of entities in it. Initially, sum of squares equal zero and grows as the merging of clusters occur. Idea of the Ward’s method is to keep the growth of sum of squares as small as possible (Strauss and von Maltitz, 2017).

4. EMPIRICAL EXAMPLE

4.1. Data set

To illustrate the added value of ELECTRE MLO and hierarchical clustering on the basis of Ward’s method we have evaluated the performance of 34 OECD countries on the basis of their LPI results from 2018 (available at World Bank internet site). In ELECTRE MLO procedure, countries are considered as alternatives and six LPI dimensions are the criteria, while in Ward’s method we group countries by considering how similar they are in terms of six LPI dimensions. First of all, we decided on this data set because LPI is a comprehensive data base and OECD countries have been exploited in a number of studies. Second and more important, LPI data was chosen for comparison purposes i.e. to make a distinctions between of ELECTRE MLO and hierarchical clustering on the basis of Ward’s method on one side and CIs based approach on the other. OECD countries are chosen in respect to the one of the premises of using benchmarking as a policy tool - the selection of benchmarking partners (here countries that are to be benchmarked). As elaborated by several authors (e.g. Ros 1991, Dolowitz and Marsh, 2000; Petrović et al., 2012, 2013, 2018c; Evans, 2017) policy transfer based on cross-national learning is a questionable issue and it cannot be assured that benchmarking will lead to policy transfer - as it can go from inspiration to coping. Moreover, if it is expected that countries steer their agendas according to benchmarking results, it is important that there is an institutional support for this - an organization which gathers these countries and can serve as a facilitator in exchanging knowledge and practice.

4.2. Benchmarking OECD countries with ELECTRE MLO

Following ELECTRE MLO procedure, in the first step scores are assigned to performance indicators for each country. We decided on nine step scale as to offer finer differentiation in performance (see Bojković et al., 2010 and Petrović et al., 2012 for additional discussion). As all of the observed countries are far from the theoretical benchmark (five for LPI dimensions) maximum value in the sample is associated with the highest score. Criteria and alternatives with associated scores are presented in Table 2.

The weights are drawn from PCA loadings in LPI construct.
Table 2. Criteria and alternatives with associated scores

|        | w | Customs | Infrastructure | International shipments | Logistics competence | Tracking and tracing | Timeliness |
|--------|---|---------|----------------|------------------------|----------------------|----------------------|------------|
| w     |   | 17      | 17             | 16                     | 17                   | 17                   | 17         |
| Ik    |   | 1-9     | 1-9            | 1-9                    | 1-9                  | 1-9                  | 1-9        |
| |l|k|   |   | 9        | 9               | 9                      | 9                   | 9             | 9          |
| w*    |   | 0,16832 | 0,16832        | 0,15842                | 0,16832              | 0,16832              | 0,16832    |

| Country | | | | | |
|---------|---|---------|----------------|------------------------|----------------------|----------------------|------------|
| Australia | AUS | 8 | 7 | 4 | 5 | 6 | 6 |
| Austria | AUT | 7 | 8 | 9 | 8 | 8 | 8 |
| Belgium | BEL | 7 | 7 | 9 | 8 | 8 | 8 |
| Canada | CAN | 6 | 6 | 5 | 7 | 6 | 6 |
| Chile | CHL | 4 | 3 | 4 | 1 | 2 | 5 |
| Czech Republic | CZE | 4 | 4 | 8 | 5 | 5 | 5 |
| Denmark | DNK | 8 | 7 | 6 | 7 | 9 | 9 |
| Estonia | EST | 4 | 2 | 4 | 1 | 2 | 5 |
| Finland | FIN | 8 | 7 | 6 | 7 | 9 | 9 |
| France | FRA | 6 | 7 | 6 | 6 | 7 | 8 |
| Germany | DEU | 9 | 9 | 9 | 9 | 9 | 9 |
| Greece | GRC | 1 | 2 | 4 | 1 | 2 | 4 |
| Hungary | HUN | 5 | 3 | 4 | 2 | 5 | 2 |
| Iceland | ISL | 4 | 3 | 1 | 5 | 3 | 4 |
| Ireland | IRL | 5 | 3 | 5 | 5 | 5 | 5 |
| Israel | ISR | 4 | 3 | 1 | 3 | 4 | 4 |
| Italy | ITA | 5 | 6 | 6 | 5 | 6 | 8 |
| Japan | JPN | 9 | 9 | 7 | 8 | 8 | 8 |
| Korea, Rep. | KOR | 5 | 6 | 5 | 4 | 6 | 6 |
| Luxembourg | LUX | 6 | 5 | 5 | 6 | 5 | 6 |
| Mexico | MEX | 1 | 1 | 3 | 1 | 1 | 3 |
| Netherlands | NLD | 8 | 9 | 7 | 8 | 7 | 8 |
| New Zealand | NZL | 7 | 7 | 5 | 7 | 7 | 8 |
| Norway | NOR | 6 | 5 | 5 | 5 | 7 | 6 |
| Poland | POL | 4 | 3 | 7 | 4 | 4 | 6 |
| Portugal | PRT | 4 | 3 | 8 | 5 | 5 | 8 |
| Slovak Republic | SVK | 1 | 1 | 3 | 1 | 1 | 1 |
| Slovenia | SLO | 5 | 3 | 4 | 1 | 2 | 4 |
| Spain | ESP | 6 | 6 | 8 | 6 | 6 | 7 |
| Sweden | SWE | 9 | 9 | 9 | 7 | 7 | 9 |
| Switzerland | CHE | 7 | 7 | 6 | 7 | 8 | 8 |
| Turkey | TUR | 1 | 3 | 3 | 1 | 2 | 4 |
| United Kingdom | GBR | 7 | 7 | 7 | 8 | 8 | 9 |
| United States | USA | 7 | 8 | 6 | 6 | 8 | 7 |

The concordance ($p$) and discordance ($q$) threshold are set to 0.80 and 0.30 respectively. The first threshold is the sum of the criteria weights and in this case if it is greater than 80% of the total weight of all criteria, the dominance can be declared. In choosing $p$ we followed recommendation drawn from AST value. If the lower values are chosen, it would mean that decision-maker is less strict when asserting that a country’s performance is preferable. The tolerance of inferior performance (discordance threshold) is set to 0.3 meaning that country will not be considered as ‘better performing’ if, under any criteria where a country’s performance level is worse, the
difference in scores is three or more. Based on the Concordance and Discordance indices (see Appendix A) as well as the above defined threshold values, and following the level construction procedure (described in Section 3.1.), the relation tree is obtained and presented in Fig. 2.

As seen from relation tree (Fig. 2) 34 OECD countries are classified into 13 levels (groups) of performance. First level occupies best performing country, Germany in this case. It dominates all countries from the second level – which is illustrated by arrows connecting Germany and second-level countries. Looking at second and third level we can observe that not all countries from these adjacent levels are connected. Four countries from the second level (Austria, Sweden, Finland and Denmark), although better performing, and thus placed on higher level, are not dominating Netherlands and Great Britain (third-level countries in relation tree and with lower rank according to LPI as well). This implies that these countries are incomparable and therefore they are eliminated as potential benchmarks for Netherlands and Great Britain. The same can be found among other performance levels, for example Korea and Portugal relative to Ireland. This is why ELECTRE MLO provides a more sophisticated ranking scheme.
compared to index based rankings where every better ranked country is a potential benchmark for lower ranked ones.

If we move to comparing ELECTRE MLO results with LPI rankings (Fig. 2) we can see that in general, considerable level of correspondence exists between hierarchical status and LPI rankings. However there are some differences - cases when LPI levels do not match performance level obtained by ELECTRE MLO. For example, Netherlands is classified at lower level than Denmark and Finland although with higher rank according to LPI. This is the consequence of a kind of unbalanced performance of Netherlands that is masked due to compensatory effect posed by CIs approach. Although Netherlands achieves a good performance on majority of criteria, it falls behind in 'Tracking and tracing' and 'Timeliness' (e.g. compared to Denmark). Unlike in CIs based approach pairwise comparison accommodated by ELECTRE MLO allows this kind of observation. It is also important to stress that Denmark and Finlnd are recognized by ELECTRE MLO as with rather specific performance and thus excluded as potential benchmarks for Netherlands. Relation tree pinpoints to Japan to be a corresponding benchmark for Netherlands. This means that Japan is better by sufficient number of criteria (according to pre-defined threshold) and among second level countries has the smallest performance gap compared to Netherlands (hence the term 'corresponding').

Also it can be observed that some countries have more than one corresponding benchmark (e.g. Czech Republic may chose between Spain and France). In this case it is up to decision maker to make the final decision following some additional criteria. Regarding development paths a country may also opt for more ambitious strategy i.e. instead of adjacent level countries to focus on those from upper levels (and skip some intermediate goals). As discussed in Petrović et al. (2012) this entails choosing a 'revolutionary' over 'evolutionary' development path. Namely although ELECTRE MLO favours gradual development paths ('climbing up the relation tree' in a stepwise manner as explained in Petrović et al. (2014, 2018)) using concordance and discordance matrices decision maker may track benchmarks with higher performance gain.

4.3. Hierarchical clustering of OECD countries with Ward's method

Method generated five clusters presented on Figure 3: A (Denmark, United Kingdom, Finland, France, Switzerland, United States, New Zealand, Austria, Belgium, Japan, Netherlands, Sweden and Germany), B (Canada, Luxembourg, South Korea, Norway, Italy, Australia, Spain), C (Czech Republic, Portugal, Ireland, Poland), D (Chile, Estonia, Slovenia, Hungary, Israel) and E (Greece, Turkey, Mexico, Slovak Republic, Iceland). Clusters D and E are far from the rest of the field, and they are joined with other clusters in the final stage. Cluster A represents the best performing countries and they are joined in second stage with cluster B and C (which are joined together before this stage). Added value of hierarchical clustering is possibility to visualize not only the cluster membership, but relationship with similar clusters and the stages in which similar clusters are aggregated.

The advantage over LPI ranking is that countries are grouped by similarity in their performance implying that corresponding more successful peers i.e. the ones to ‘look up to’ can be tracked more easily in twofold manner. First the most similar (by performance) counterparts can be tracked within the same cluster, similar to opting for “evolutional” development strategy on the basis of ELECTRE-MLO results. Secondly, due
to the hierarchical relationship between clusters, decision maker may opt for more ambitious goals and chose a relevant benchmark from a set of better performers within the cluster connected with the one containing the country under observation. For instance, some of the countries which are represented by the cluster C (Portugal and Czech Republic) might strive to meet the performance of Norway or Canada.

![Dendrogram of Cluster Membership](image)

Figure 3. Cluster membership of countries represented via dendrogram

Relating clustering results with LPI rankings (Table 3.) we can observe that there is a significant degree of matching (i.e. clusters “follow” LPI rankings). The only difference can be observed in the case of clusters B and C. Some of the countries in the cluster C (Portugal and Czech Republic) have better LPI rank than some countries from cluster B (South Korea and Luxembourg). One of the issues that composite indicators (such as LPI) suffer from, is the compensability among the variables, meaning the possibility to offset certain poor performance of particular variable with strong performance from the other one(s) (Munda and Nardo, 2009; Mazziotta and Pareto, 2016). As the consequence, certain country might be propelled to better rank while being more similar to lower ranked countries based on all remaining variables (which is in this case being presented in the results of Ward’s method). As authors (Otoiu et al., 2014) pointed out, cluster analysis helps overcome problems that may occur due to the distribution of variables and therefore, validation results achieved through cluster analysis are more robust and help to achieve a good check of the validity of the composite indicators.
Table 3. Clusters and LPI rankings

| Cluster | Country         | LPI rank |
|---------|-----------------|----------|
| A       | Germany         | 1        |
|         | Sweden          | 2        |
|         | Belgium         | 3        |
|         | Austria         | 4        |
|         | Japan           | 5        |
|         | Netherlands     | 6        |
|         | Denmark         | 8        |
|         | United Kingdom  | 9        |
|         | Finland         | 10       |
|         | Switzerland     | 13       |
|         | United States   | 14       |
|         | New Zealand     | 15       |
|         | France          | 16       |
| B       | Spain           | 17       |
|         | Australia       | 18       |
|         | Italy           | 19       |
|         | Canada          | 20       |
|         | Norway          | 21       |
|         | Luxembourg      | 24       |
|         | South Korea     | 25       |
| C       | Czech Republic  | 22       |
|         | Portugal        | 23       |
|         | Poland          | 28       |
|         | Ireland         | 29       |
| D       | Hungary         | 31       |
|         | Chile           | 34       |
|         | Slovenia        | 35       |
|         | Estonia         | 36       |
|         | Israel          | 37       |
| E       | Iceland         | 40       |
|         | Greece          | 42       |
|         | Turkey          | 47       |
|         | Mexico          | 51       |
|         | Slovak Republic | 53       |
Quantitative Methods in Logistics

5. CONCLUSION

This chapter reviews existing approaches for cross-national evaluation in logistics and highlights the advantages of grouping countries (to levels or clusters) according to their performance instead of ranking them on the basis of index value. Two conceptually different methods are explored: benchmarking with ELECTRE-MLO and hierarchical clustering with Ward's method. To illustrate the added value of these potential methodological substitutes we relied on data included in the most known national measure in logistics, Logistic Performance Index (LPI) for 34 OECD countries.

The advantage of ELECTRE MLO approach is in addressing the comparability between countries along with the selection of suitable benchmark countries for the outperformed ones. Compared to CIs approach, ELECTRE MLO gives more respect to the essence of benchmarking - discovering the 'relevant practice to follow' in reaching own specific objectives. Also the visualisation of results in a form of 'relation tree' provides decision makers with an easy to follow output. As showed in empirical example, both ELECTRE MLO and Ward's method revealed a fair level of correspondence with LPI results making these approaches valid options for cross-national performance evaluation in logistics. However, we argue that they are more complements than alternatives to LPI. As for ELECTRE MLO, there are two limitations. Firstly, it is not to be exploited as a global performance evaluation tool (like is LPI) because if a large number of countries is included, the outcome i.e. 'relation tree' may be blurry and unreadable. Secondly, the 'relation tree' is in fact a network of benchmarking partners implying that it includes countries with a kind of institutional support for sharing knowledge and practice (e.g. members of cooperation organizations like OECD or EBRD which will facilitate eventual policy transfer). On the subject of future applications of this tool in logistics we propose to move to stepwise benchmarking, tracking set of intermediate benchmarks that a country can follow on the road to the top performer (ultimate benchmark). Methodological foundations can be drawn from Petrović et al. (2014, 2018a) but additional research is needed to make it more suitable for cross-national performance evaluation in logistics.

Regarding hierarchical clustering on the basis of Ward's method we have demonstrated how to obtain clusters by similarity of performance and the procedure to aggregate them. It can serve as a valuable input for decision making process, since countries can observe peers of similar LPI performance and peers who can serve as the benchmark. In future research, applications of k-medoids (such as partitioning around medoids) might bring additional value (Patel and Thakral, 2016) to the research since the particular countries are being defined as the cluster centre (best representative of the group).

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### Table A1: Concordance Matrix

| Country   | AUS | BEL | CAN | CZE | DNK | EST | FIN | FRA | GBR | IRE | ITA | LUX | NLD | NOR | POL | POR | SWE | SLO |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AUS       | 1.0 | 0.7 | 0.5 | 0.3 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| BEL       | 0.7 | 1.0 | 0.8 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| CAN       | 0.5 | 0.8 | 1.0 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| CZE       | 0.3 | 0.6 | 0.8 | 1.0 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| DNK       | 0.2 | 0.5 | 0.7 | 0.8 | 1.0 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| EST       | 0.1 | 0.4 | 0.6 | 0.7 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| FIN       | 0.0 | 0.3 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| FRA       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| GBR       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| IRE       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| ITA       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| LUX       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| NLD       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| NOR       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| POL       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.8 |
| POR       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 | 0.8 |
| SWE       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 | 0.8 |
| SLO       | 0.0 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1.0 | 0.8 |

Quantitative Methods in Logistics
Table A2: Discordance Matrix

|       | AUS | BEL | CAN | CZE | DEU | DKK | EST | FIN | FRA | ITA | JPN | LUX | MEX | NLD | NOR | PRT | POL | FIN | RUS | SWE | TUR | USA |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| AUS   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| BEL   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CAN   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CZE   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| DEU   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| DKK   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| EST   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FIN   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FRA   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ITA   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| JPN   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LUX   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MEX   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NLD   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NOR   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PRT   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| POL   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FIN   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| RUS   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| SWE   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TUR   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| USA   | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

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