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Facilitating the extraction of extended insights on logistics performance from the logistics performance index dataset: A two-stage methodological framework and its application

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ABSTRACT

The Logistics Performance Index (LPI) developed by the World Bank provides a comparative assessment logistics performance in trade logistics for several countries. Given the lack of studies bringing insights on logistics performance in the backdrop of trade logistics from the perspective of nation as a whole—this paper recognizes the LPI dataset as an account of rich country-level data with harbored insights on logistics performance. It further suggests that upon linking the dataset with appropriate variable(s) of interest, extended insights on logistics performance can be extracted. Therefore, a two-stage methodological framework is suggested for the mining of LPI dataset towards extended insights. The first stage involves the clustering of LPI dataset into finite clusters using K-means data mining algorithm. Subsequently, in the second stage, the suitability of multivariate adaptive regression spline (MARS) based regression is outlined for capturing the complex non-linear relationship between the variables under investigation. Thereby, the application of the proposed two-stage methodological framework is demonstrated with an example by linking the six LPI dimensions with an important macro-economic variable. In addition to discussing the critical implications from the example towards extended insights on logistics performance, and its further implications towards the utility of the proposed methodological framework—the findings suggest that the extraction of extended insights from the LPI dataset is governed by the selection of appropriate variable(s) which can be linked with LPI dimensions, criteria of clustering in the first stage, and development of MARS models for the clusters and the overall data.

1. Introduction

Logistics performance, in the context of trade logistics, is an important aspect which determines the competence of a country in facilitating domestic and international trade (Anderson & Villa, 2015). In this context, logistics performance reflects the efficiency and effectiveness in the accomplishment of logistics activities (Fugate, Mentzer, & Stank, 2010). These activities typically encompass freight transportation, warehousing, payment system, border clearance, etc.—and therefore are a complex sequence of coordinated activities. A superior logistics performance reflects a faster, safer, and cost-efficient movement of goods within a country. In addition, it also indicates favorable conditions in a country towards international trade (Havenga, 2011; Havenga, Simpson, & Goedhals-gerber, 2016).

Extant research on logistics performance in trade logistics either focuses on the cost and benefits of trade facilitation (Banomyong, Cook, & Kent, 2008; Hausman, Lee, & Subramanian, 2005; Hoekman & Nicita, 2011; Rodrigues, Bowersox, & Calantone, 2005), or is largely inclined towards the evaluation of inherent challenges (Chow, Choy, Lee, & Chan, 2005; Gupta, Goh, Desouza, & Garg, 2011; Wang, Caron, Vanthienen, Huang, & Guo, 2014). However, there exists a lack of studies which bring insights on logistics performance in trade logistics from the perspective of nation as a whole (c.f. Önsel Ekici, Kabak, & Ülengin, 2016). Possibly, this might be due to the difficulty inherent in acquiring country level data surrounding various trade logistics activities.

In order to address this concern, the World Bank has come up with the comparative assessment logistics performance for about 160 countries (Arvis et al., 2014; Arvis, Mustra, Ojala, Shepherd, & Saslavsky, 2010, 2012; Arvis, Mustra, Panzer, Ojala, & Naula, 2007). Specifically, based on the country-level and worldwide surveys, it quantifies the logistics performance of a country on the key dimensions of trade logistics. These dimensions are Customs, Infrastructure, International shipments, Logistics quality and competence, Tracking and tracing, and Timeliness. Thereby, it generates an aggregate index, known as Logistics Performance Index (LPI), for reflecting the state of logistics

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performance in a country.

Recognizing the value of LPI dataset, in this paper, we suggest that LPI is an account of rich country-level data with harbored insights on logistics performance. Further, the dataset can be linked with appropriate variable(s) for extracting extended and meaningful insights on logistics performance in trade logistics. Our argument well aligns with—the few existing studies—which have employed LPI dataset for addressing their research objective. For example, Önsel Ekici et al. (2016) links about several indicators from the Global Competitiveness Index (WEF, 2014) with LPI dimensions. The authors thereby outline important global competitiveness indicators with respect to individual LPI dimensions for extending trade logistics implications towards Turkey. While we discuss the various aspects of the few LPI oriented studies in the literature section of this paper, we further suggest that the extraction of extended insights from the LPI dataset is methodology driven—for explicating the LPI dataset with appropriate variable(s) of interest. Therefore, in this paper, we intend to augment this perspective by devising a methodological framework for mining the LPI dataset towards extended insights.

In doing so, we recognize the heterogeneity inherent in the LPI dataset due to its holistic coverage to diverse countries in terms of economy, region, politics, and income group. Therefore, the dataset can be mined in two ways, i.e. at the level of overall data (including all countries) or at the level of cluster (involving selected countries with similar properties). Furthermore, the dataset comprises of rich country-specific data across the seven dimensions, i.e. the total LPI Score and its six dimensions. Therefore, linking of the dataset with appropriate variable(s) of interest towards extended insights can further happen both ways. As such, either multiple variables can be linked to the total LPI score for understanding the influence of these variables on logistics performance, or, conversely, the six LPI dimensions can be linked with an appropriate variable for understanding the influence of logistics performance on the variable. In addition, given the heterogeneity inherent in the LPI dataset, the linkage must be capable of capturing any non-linearity existing in the relationship between the variables under consideration. Furthermore, the drawn relationship must also be capable of reflecting the relative importance of the variables in affecting the outcome variable.

Therefore, in this paper, our objective is to outline a methodological framework for explicating the LPI dataset towards extended insights. Further, the framework must be capable of addressing the discussed critical aspects surrounding the mining of LPI data. We also demonstrate the application of this framework with an appropriate example by mining the LPI dataset in the backdrop of an interesting macroeconomic variable. Thereby, we discuss the findings from this example towards extended insights on logistics performance, and its further implication towards the utility of the proposed two-stage methodological framework.

The next section reviews the existing research surrounding the applicability of LPI dataset. Thereafter, we present our methodological framework for explicating the LPI dataset towards extended insights on logistics performance. Subsequently, we apply the methodological framework in an interesting example. We amend a discussion on the relevance and applicability of extended insights through LPI data in the backdrop of the proposed methodological framework and the example.

2. Literature review

2.1. Logistics performance and LPI

The efficiency of trade logistics primarily depends upon the efficiency of transportation capabilities of the countries involved (Acciaro & Wilmsmeier, 2015). Capabilities here typically comprise of logistics activities such as warehousing, freight transportation, etc. (Rodrigues et al., 2005). When trading among countries, efficiency in logistics ensures a fast and a safer mobility of products along with the reductions in cost (Havenga et al., 2016; Marti, Puertas, & García, 2014b). The involvement of government actors here plays a significant role in affecting the transaction costs (Grainger, 2007). National and regional logistics policy further plays an important role in addressing such issues for ensuring logistics performance (Banomyong et al., 2008).

Scholars' have dealt with the issue of improving logistics performance in the context of global trade. Rodrigues et al. (2005) estimate the logistics expenditures for the global economy and present implications regarding the improvement of the logistics performance. Hoekman and Nicita (2011) further analyze the sources of trade costs. Hausman et al. (2005) link the trade facilitation with supply chain performance and outline the importance of improvement in logistics performance for a country's economic growth and competitiveness. Banomyong et al. (2008) and Mann (2012) highlight the importance of policy formulation in this regard. Saslavsky and Shepherd (2014) suggest the importance of logistics performance for facilitating international production networks.

Ensuring a superior logistics performance also requires an understanding of the trade logistics challenges (Chow et al., 2005; Gupta et al., 2011; Wang et al., 2014). Shepherd and Hamanaka (2015) report Asia-Pacific experiences for overcoming many such challenges. Thereby, the authors outline the addressing of key challenges as a prerequisite towards superior logistics performance. Aligning with the notion, the World Bank's Logistics Performance Index (LPI) intends to assist a country to identify the challenges and the opportunities for improving its logistics performance (Arvis et al., 2014). The worldwide surveys quantify the state of logistics performance for a country based on the six unique dimensions of trade logistics. Since 2007, it has been releasing the LPI data for every two years. The first dimension of ‘Customs’ reveals the effectiveness and the efficiency of the dispatch procedure of the customs. The focus is to evaluate the speed, predictability, and simplicity of the customs agencies. The second dimension of ‘Infrastructure’ is concerned with the country's telecommunication and transport infrastructure. The third dimension of ‘Logistics quality and competence’ measures the quality of the service between the organizations and the consumers involved. The fourth dimension of ‘International shipments’ measures the ease of arranging the shipments at competitive prices. The fifth dimension of ‘Tracking and tracing’ concerns with the traceability of the shipments. It consists of aspects such as identification of the exact location, route, etc. The sixth dimension of ‘Timeliness’ revolves around the promptness of shipment delivery times and characterizes competition in the business environment.

Therefore, LPI can be understood as an index which informs the country-specific logistics performance in trade logistics based upon six unique dimensions. The index is reported on a one to five scale for each dimension, where one stands for lower and five stands for superior performance. Further, the Overall LPI Score is generated as the weighted aggregate of the individual dimensional scores.

2.2. LPI based studies

There exist only a handful of studies which derive insights on logistics performance using the LPI dataset. We analyze the research focus inherent in these articles and thereby focus on their methodology for gaining further insights regarding the suitable data mining approach for the LPI dataset. Korinek and Sourdin (2011) focus on examining the role of logistics performance in influencing the value and volume of international trade. This article is based on the LPI dataset and employs gravity model for linking the LPI data with bilateral trade (measured by international trade data obtained from United Nations Commodity Trade Statistics Database). The authors also evaluate the differentiated impacts among the variables by considering a distinction among low, middle, and higher-income countries.

Furthermore, in the same vein, based on the gravity model, Marti, Puertas, and García (2014a) similarly analyze bilateral trade in the