THE ROLE OF TRANSPORT AND LOGISTICS QUALITY IN EXPORTS: THE CASE OF CONTAINERIZED PRODUCTS FROM EMERGING COUNTRIES

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ABSTRACT
The objective of this paper is to evaluate the impact of transport infrastructure indicators on the volume of exports of emerging countries. The main hypothesis assumes that an improvement in hard and soft transport infrastructure has a positive effect on exports competitiveness, which is higher in the cases of goods that are closely integrated into global value chains. The results are twofold. First, given the high number of logistics indexes in the model, a principal component approach is implemented to reduce the number of variables. The results show evidence that all indexes are highly correlated, which implies that only one principal component shows a large share of the overall variance. Second, a panel data estimation indicates that exports respond to transport infrastructure improvements in the cases of meat and car parts. Therefore, better soft and hard transport infrastructure indicators tend to lead to an increase in exports competitiveness of products with more value added.

RESUMO
O objetivo desse artigo é avaliar o impacto dos indicadores de infraestrutura de transportes no volume de exportações de países emergentes. Na principal hipótese assume-se que uma melhora na infraestrutura *hard* e *soft* tem um efeito positivo na competitividade das exportações, o qual é maior nos casos de bens que são mais integrados a cadeias globais de valor. Os resultados derivam-se da aplicação de duas metodologias. Primeiro, dado o grande número de índices logísticos no modelo, uma abordagem de componentes principais é implementada para reduzir o número de variáveis. Os resultados evidenciam que todos os índices são fortemente correlacionados, o que implica que somente um componente principal exibe uma parcela majoritária da variância. Segundo, uma estimativa de modelo painel indica que exportações respondem a melhorias na infraestrutura de transportes no caso de carnes e autopeças. Portanto, ganhos de infraestrutura de transporte *hard* e *soft* tendem a aumentar a competitividade de exportações de produtos com maior valor agregado.

1. INTRODUCTION

Transport infrastructure – which is a non-tradable input that facilitates or makes exports more expensive – is still a structural characteristic that differentiates emerging countries from each other. Indeed, both the extension of transport facilities – e.g. road and railway networks – and the quality of these services stand as competitive advantages since they consist of the main costs of transport, from the production site to the exporting port.

The information on the extension and quality of transport services in the context of emerging countries is scarce and not compatible for cross-country comparisons. However, the World Bank (WB) provides an indirect means – based on a survey with stakeholders – to assess the logistics friendliness regarding infrastructure amplitude and quality of these services for 160 countries. The Logistics Performance Index (LPI) covers six different aspects measuring the challenges and opportunities these countries face in their performance on trade logistics.

Hence, the objective of this paper is to identify the extent to which differences in transport infrastructure services impact emerging countries' exports competitiveness. The study focuses on trade performance of containerized goods sold from emerging countries to more advanced economies. Besides, it is assumed that hard and soft transport infrastructure have distinct effects on exports competitiveness. Goods that are produced locally as part of a global value chain system are more demanding in terms of logistics quality and of delivery times.

The next section deals with a brief theoretical survey on the relationship between infrastructure and competitiveness. Section three shows preliminary evidence concerning the logistics profiles in the developing countries in the sample. Section four describes the panel origin-destination model and the main results. Finally, section five is dedicated to concluding remarks.

2. TRANSPORT, LOGISTICS FACILITIES AND EXPORTS COMPETITIVENESS

Transport infrastructure plays a key role on trade facilitation. Nonetheless, based on recent successful cases of exporting emerging countries, other aspects also trigger trade, such as logistics improvements – e.g., gains in customs clearance efficiency – trade agreements with key partners and growth at destination countries. These two latter issues are, to a large extent, beyond the control of a developing country's policy maker. On other hand, transport and logistics investment, although costly and inherently subject to significant sunk costs, rely on domestic decisions taken by local government and/or private sector.

Although relevant for overall competitiveness, efficient logistics and transport services are more decisive for products that are connected to just-in-time production systems and are more integrated in global value chains. In fact, countries and regions where poor logistics services prevail are less prone to engage in intra-regional and intra-industry trade. De La Torre et al. (2005) find out that one of the reasons that explain the lower rate of growth in Latin America in comparison to Asian countries is the small degree of local industry integration to international value chains. Besides, as pointed out by Korinek and Sourdin (2011), since developed nations have increased their demand of industrial inputs from emerging countries – as a consequence of a higher exposure to international vertical specialization – high quality logistics services in developing countries become a crucial differential aspect in the process choosing a trading partner.

As a preliminary methodological step, it is crucial to define and distinguish logistics and transport services. In a broad context, logistics can be regarded as a set of activities within a value chain that deals with plans, actions and controls related to achieving an efficient flow of goods, services and information from origin to destination (De Souza et al., 2007). As for a transport definition, first, it plays a crucial role as part of a logistics process – that is, transport is a function or a task within the range of logistics activities – and, second, it specifically consists of physical movement of people and goods by appropriate means. Besides enabling the exchange of goods, efficient transport adds valuable services such as loading, unloading and storage (Grabara, Kolcun, Kot, 2014).

Applied works that investigate the role of infrastructure to regional development have emphasized the differences between hard and soft infrastructure assets. Ismail and Mahyideen (2015) examine the effect of infrastructure investment in trade facilitation among developing countries. In that context, they distinguish the impacts of hard and soft infrastructure. The

former refers mainly to physical infrastructure such as ports, airports and road and railway networks. The latter deals with less tangible assets, including quality and efficiency measures, such as indicators related to travel time and transportation costs.

As for this study, the intuitive classification of logistics and transport services into hard and soft infrastructure is also adopted. Unlike with Ismail and Mahyideen (2015), the definition in the present study is limited to logistics and transport indicators and they are distinguished based on extension and quality of infrastructure. Therefore, this paper identifies hard transport infrastructure as mostly related to physical transport facilities. In this case, for variables that condition exports competitiveness, the model considers the extension of all transport means networks and also storage, customs facilities and handling equipment. Limão and Venables (2001) confirm the importance of infrastructure deterioration in emerging markets to the increase of transport costs that hinder the perspectives of bilateral trade in developing countries. Conversely, in this paper soft transport infrastructure refers mainly to logistics quality indicators which include export procedures efficiency, trade regulatory environment,delivery time, cargo tracking transparency and bribery threats. As an example of an empirical study that investigates the effect of infrastructure quality to trade, François and Manchin (2013) confirm the hypothesis that goods exports are significantly affected by institutional quality, which can be interpreted as a measure of soft infrastructure.

In sum, the main hypothesis of this study is that not only soft transport infrastructure but also hard transport infrastructure increase exports competitiveness of containerized goods from emerging countries to developed nations. The underlying intuition is that, in the context of developing nations, exports still face infrastructure bottlenecks that indicate that there is large room for improving competitiveness by means of an extended transport network.

3. LOGISTICS PERFORMANCE IN EMERGING COUNTRIES

Since the LPI poses as a reliable source for the logistics quality at country level, it is worth describing its different dimensions particularly with respect to the sub-indexes that are more relevant to capture transport quality indicators. Figure 1 provides a brief definition of each LPI dimension as well as whether they fall into the definition/category of soft or hard transport infrastructure presented.

Table 1 – LPI Dimensions: Definition and Correspondence to Transport Infrastructure

Dimension	Definition - Relevant Aspects	Correspondence to Transport Infrastructure
Customs	Customs declarations are processed electronically; Regulation updates; No delays in trade dispatchment; Assessment strongly values clearance time and bribery;	Soft
Infrastructure	Deals with physical transport conditions; Accessibility between actors of a supply chain;	Hard
Logistics quality and competence	Services provided by customs brokers and companies responsible for border procedures;	Soft
Timeliness	Delivery delays, lack of shipment and of information technology resources lower the ability to be on schedule.	Soft
Tracking and tracing	Deals with transparency related to the ability to track a cargo and to efficiently solve unexpected problems;	Soft

International shipments	Facilities in arranging international shipments regarding price and service quality; Ability to organize shipment efficiently;	Soft

Source: Authors own elaboration. Raw data: LPI (2018)

Out of the six LPI dimensions, infrastructure is the only one that is clearly highly related to quality and extension of transport services. The infrastructure dimension focuses on the physical availability of transport capacity for both passengers and cargo movements. For the sake of this paper, the other five LPI variables are regarded as logistics indexes.

Taking into account that the emphasis in the present study is on exports of emerging countries, the logistics performance of the selected countries is examined in Figure 1. The charts below describe the results for the six LPI dimensions for each product and each of the four largest exporters (among emerging countries). Three products are analysed: a basic commodity, coffee; and two products with more value added, meat and car parts.

Figure 1a: Coffee Exporters

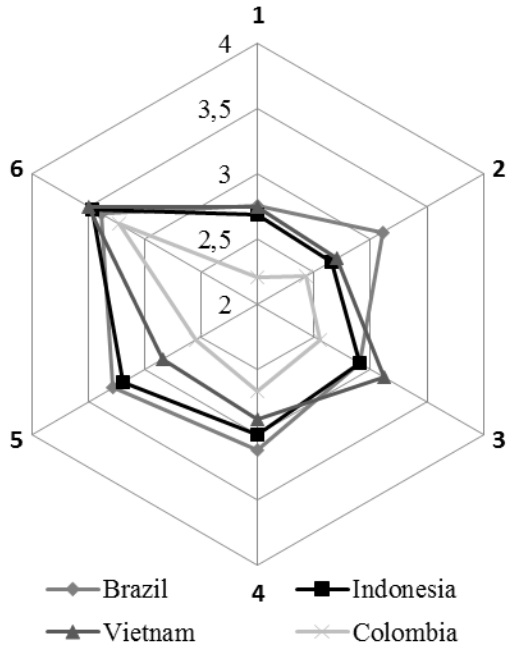


Figure 1b: Meat Exporters

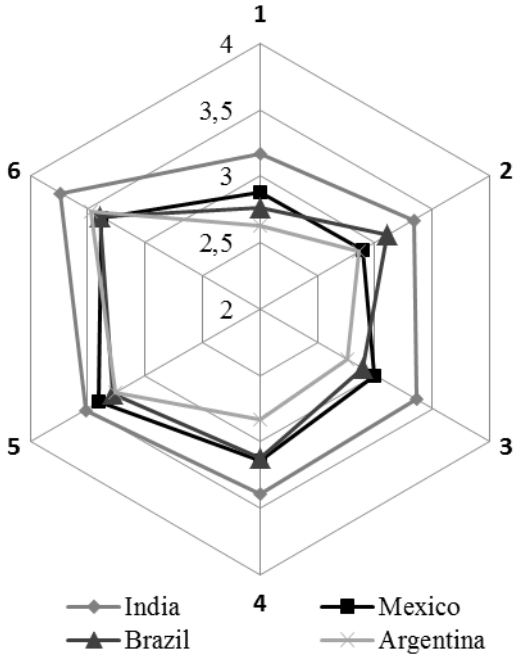
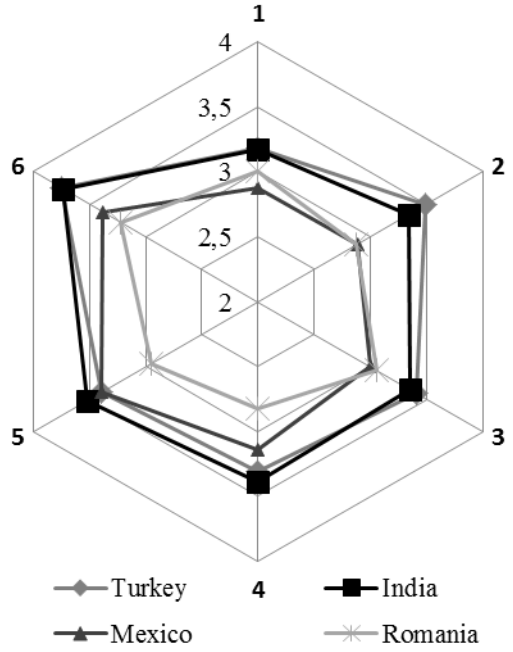


Figure 1c: Car Parts Exporters



Legend:
1 – Customs
2 – Infrastructure
3 – International Shipments
4 – Logistics Competence
5 – Tracking & Tracing
6 – Timeliness

Figure 1: Logistics Performance Index, Main emerging country exporters – Coffee, Meat and Car Parts – 2016
Source: Authors own elaboration. Raw data: LPI (2018)

Regarding the LPI results for the main coffee exporting countries (Figure 1a), it is worth mentioning Brazil's comparative positive outcome regarding infrastructure. Furthermore, all countries registered a low assessment related to customs indicators. Lastly, all LPI dimensions show unfavorable results in the case of Colombia. Regarding meat (Figure 1b), a striking result is the superior performance of India, not only in the relevant dimension in the context of transport services (the infrastructure sub-index), but also in all the other LPI variables. For the other meat exporters, the logistics conditions in Brazil and Mexico indicate a similar position; while Argentina exhibits a lower LPI performance. Finally, the results for car parts exporters (Figure 1c) indicate a superior performance for India and Turkey for most of the LPI sub-indexes. Mexico and Romania, on the other hand, reported lower results for all LPI indicators.

Despite the preliminary evidence above showing a relatively diverse logistics performance among developing countries, it also indicates that top exporters in goods with more added value account for a higher LPI performance. The four largest emerging countries in coffee exports achieved an overall LPI index of 2.91 and a mark of 2.72 for infrastructure. For the case of meat exporters, the scores are 3.14 and 3.04; while for car parts, they are 3.23 and 3.15. Therefore, that preliminary evidence demonstrates that logistics and particularly transport infrastructure indicators are relevant to transport conditions and export competitiveness in a developing country environment.

The Liner Shipping Connectivity index – also considered as logistics and infrastructure measure variable – intends to, according to the World Bank database definition (2018), "capture how well countries are connected to global shipping networks". It is developed through the analyses of five components related to the maritime infrastructure: number of

ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports. (World Bank, 2018)

4. ECONOMETRIC ESTIMATION AND RESULTS

The empirical analysis is twofold. First, because there are many different variables to capture logistics and transport indicators, the principal component approach was implemented to reduce the number of relevant variables. Second, these principal components are plugged in the model along with control variables in order to estimate the main determinants of exports performance of containerized goods from emerging countries.

As for the data outline, the variable of interest is bilateral exports from an emerging country to a developed nation. "Developed nations" follow the definition proposed by the World Bank (2017) for high income countries, while "emerging countries" includes all that do not fit the description. For origin countries, the four largest exporters among emerging countries were selected and destination countries comprise of the three main consumers among developed nations. The choice to constrain the empirical analyses to the four largest exporters – and not a longer list of sellers – can be justified by the fact that focus is given on LPI conditions on the countries that hold the highest market share in world supply of each of the selected products. The period of analysis is restricted by the data availability of the LPI index, which is estimated in 2007, 2010, 2012, 2014 and 2016. All the results are obtained for the three products referred above: coffee, meat and car parts.

Principal Component (PC) analysis – the first step of the empirical methodology – is a multivariate approach that explains the variance structure of a data set through a linear combination of variables (the principal components), that allows a reduction from many variables to fewer components. The objective of this technique is to achieve a high level of similarity between the (lower number of) PCs and the original data set. For a didactic reference on the PC analysis, see Abdi and Williams (2010). In the context of transport analysis, examples of principal components application are: Adler and Golany (2001), who employ a PC approach to reduce the excessive number of inputs and outputs, which are aggregated into a clustered set of components in order to examine the efficiency of airline networks.

The principal component (PC) analysis was carried out based on the set of the six LPI dimensions and the Liner Shipping Connectivity Index (described below). The PC approach estimates the significant component for each exporter country. Therefore, we implicitly claim that logistics and transport infrastructure conditions at the origin country matter to export competitiveness. In practical terms, if most of the variance of the logistics and transport variables can be attributed to the first or few most relevant components, then they can replace the original set of variables without a large loss of information. Suppose the original logistics and transport indexes are expressed by a random vector: $X = [X_1, X_2, \dots, X_7]$ and that the covariance matrix is given by V with eigenvalues $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$ and (normalized) eigenvectors $v_1, v_2, \dots v_p$. The principal components, extracted from the original logistics and transport variables, are given as weighted averages as follows:

$$pc_m = v_m X = v_1 X_1 + v_2 X_2 + \cdots + v_7 X_7$$
$$Cov(pc_m, pc_{m+q}) = v'_m V v_m = \sigma_m \ \ when \ \ q = 0 \ \ \ and = 0 \ \ when \ \ q \neq 0 \qquad (1)$$
$$with \ m = 1 \ldots 7$$

Therefore, as expressed in equation (1) above, principal components pc_m are uncorrelated with each other and they are ranked in a descending order according to their variances. Notice that the maximum number of PCs is equal to the number of logistics and transport variables included in the model (7).

The second step of the methodology is the estimation of panel data equations for each exporting product from emerging countries. It is worth mentioning that our underlying model is a basic gravity trade equation where bilateral exports from country *i* to country *j* are a function of GDP masses at origin and destination and distance between them. Furthermore, the variables concerning the main hypothesis are the most relevant PCs, extracted from the original logistics and transport set of indicators. Finally, some control variables are included. The equation to be estimated can be described as follows:

$$\log(exp)^k_{ijt} = \alpha_{0,ij} + \alpha_1 \log(gdp)_{it} + \alpha_2 \log(gdp)_{jt} + \alpha_3 \log(dist)_{ij} + \sum_{m=1}^{7} \alpha_{3m} pc_{mi} \qquad (2)$$
$$+ \sum_{n=1}^{5} \alpha_{4n} cv_{ijn} + e_{ijt}$$

where exp^k_{ijt} is the volume of exports (tons) of product *k* from country *i* to country *j* at time *t*; $gdp_{it,} gdp_{jt}$ are Gross Domestic Products (in 2010 US$) of country *i* and country *j*; $dist_{ij}$ is the maritime distance (in nautical miles) from the main container port in country *i* to the main container port in country *j*; pc_{mi} is the m-th principal component calculated based on the seven logistics variables available in origin country *i*. cv_{ijn} is the n-th control variable, which includes dummy variables to capture common language, former colony and trade agreements between countries *i* and *j*. Besides, changes in the exchange rates – measured in domestic currency per US$ – and container throughput in country *i* are also considered as control variables. Finally e_{ijt} is a stochastic term. Country *i* refers to origin (emerging) country and country *j* to destination (developed) country.

Table 2: Principal components, its cumulative variance and correlation to the variables

Products (exporters)	Principal components	Cumulative variance	Variables						
			v1	v2	v3	v4	v5	v6	v7
Coffee (Brazil, Colombia, Indonesia, Vietnam)	PC1	0.54	-	0.87	0.75	0.85	0.89	0.72	-
	PC2	0.69	-0.64	-	-	-	-	-	
	PC3	0.83	-	-	-	-	-	-	0.79
Meat (Argentina, Brazil, India, Mexico)	PC1	0.52	0.71	0.85	-	0.83	0.79	-	-
	PC2	0.71	-	-	-	-	-	0.75	-0.65
Car Parts (India, Mexico, Romania, Turkey)	PC1	0.62	0.88	0.93	-	0.94	0.89	-	0.82
	PC2	0.14	-	-	0.58	-	-	0.63	-

In which:
v1 = Customs
v2 = Infrastructure
v3 = International shipments
v4 = Logistics Competence
v5 = Tracking and tracing
v6 = Timeliness
v7 = Liner shipping connectivity index

Source: Authors own elaboration. Raw data: LPI (2018) and World Bank (2018)

The first set of empirical results is owing to the estimation of PCs for the seven logistics and transport variable considered in the present study. Table 2 provides the main PCs for the seven variables regarding the four largest exporters of each product. As for the case of coffee, for example, the three main components account for 83% of the total variance of the seven PCs. Notice the overall result indicates that the main PC explains, at least, 52% of the total variance. Further, taking into account our emphasis on transport infrastructure indicators, the above results shows that the hard infrastructure variable – called "Infrastructure" in the LPI index (v2) – is present in the PC1s for all the three products.

Once the PCs were extracted from the original data set, the second step of the empirical procedure was carried out, namely the estimation of exports determinants. The data set is organized as a panel data model where cross-section units refer to an origin-destination pair, with *i* (origin) varying from 1 to 4 (emerging countries) and with *j* (destination) varying from 1 to 3 (developed country). Since time span is five years, the number of total observations for each equation is sixty. Given the explanatory variables that are time invariant – e.g. distance, former colony and common language – a random effects approach was employed to estimate all panel data equations. Table 3 depicts the estimation results of equation 1 for each of the three products of interest. Notice that, for the case of coffee, two models are reported since Model 1 shows the non-significant impact of PC1 and Model 2 reports the result without this variable.

Table 3: Estimation Results – Dependent Variable is Bilateral Exports of Product *k* (from Country *i* to Country *j*): $log(exp_{ijt}^{k})$

Independent Variable	**Coffee**				**Meat**		**Car parts**	
	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.	Coeff.	Prob.
Constant	0.787	0.488	-0.723	0.936	-15.555	0.113	-23.953	0.000
$Pc1_i$	-0.019	0.766	-	-	0.113	0.018	0.080	0.008
$\log(cont)_{it}$	0.386	0.000	0.508	0.002	-	-	-	-
$\log(gdp)_{jt}$	0.414	0.000	0.409	0.189	1.172	0.001	1.319	0.000
$\log(exrate)_{ijt}$	-	-	-	-	-	-	0.700	0.000
$\log(avprice)_{ijt}$	-0.470	0.039	-0.730	0.001	-	-	-	-
$\log(tradeagr)_{ijt}$	-	-	-	-	-	-	3.228	0.000
McFadden R²	0.238		0.178		0.226		0.684	
NxT	60		60		60		60	

Source: Authors own elaboration (2018).

The main hypothesis concerns the impact of transport and logistics variables that are basically captured by PC1. Including other principal components was also attempted, however – given their lower explanation of the total variance – they were systematically not significant. The estimated coefficients for PC1 are statistically significant and positive for the cases of meat and car parts. On the other hand, PC1 was found to have a non-significant impact on the exports performance in the case of coffee. One possible reason is the stricter logistics and transport requirements for exporting meat and car parts. For instance, meat requires refrigerated containers and car parts are heavily integrated to a just-in-time global value chain.

Coffee exports, in turn, require a more standard logistics and are compatible with simple storage facilities. In addition, the lower effect of logistics and transport conditions in the coffee equation can be reasoned by the fact that the poor quality of logistics services is partially compensated by higher volatility – and, hence, higher profitability – of international coffee prices. In fact, the coefficient of variation of exports prices, for the origin countries in the sample, calculated between 2007 and 2014, is 14.4% for car parts, 10.9% for meat and 18.7% for coffee.

As for the traditional gravity variables, GDP at destination was found statistically significant and with a positive impact on exports in all equations. In other words, emerging country's exports are demand-driven especially when demand comes from high-income countries. The coefficient of GDP at the origin was found to have no significant impact on bilateral exports of emerging country *i* to developed country *j*. Maritime distances were also estimated to have no significant impact on exports. Previous empirical works on trade facilitation and logistics in the context of developing countries also support this finding. Korinek and Sourdin (2011), for example, found that the effect of a certain commodity spending an extra day at the border has a greater adverse impact on exports than an extra day spent in the container course, from origin to destination. Therefore, the results obtained in the present study corroborate that gains in transport infrastructure and logistics quality owe a more robust impact in emerging countries than a geographic advantage.

With respect to the other control variables, total volume of containers traded in the origin country was found to exert a positive impact on exports in the case of coffee. Recall that this variable captures the extension of infrastructure facilities and, therefore, provides a measure of different scale of infrastructure – despite logistics and transport quality indexes being estimated to be non-significant in the case of coffee. Given that coffee is a relatively homogeneous commodity, the average price was also added as an explanatory variable. The coefficient is significant and negative, which indicates that bilateral exports increase when the average price is lower. A dummy variable for trade agreement was found to be relevant for the case of car parts, showing that the existence of a preferential agreement between the emerging country at the origin and the developed country at the destination increases exports in the case of automotive components. Besides, the results indicate that an increase in exchange rate leads to a higher volume of car parts exports, which means that a devalued domestic currency raises car industry competitiveness. Among the variables that do not significantly affect exports of emerging countries in the sample are the two dummy variables to control common language and former colony.

5. CONCLUDING REMARKS

In this paper, the hypothesis that higher logistics quality and the presence of a more extensive transport network yield a positive effect to exports competitiveness in emerging countries was tested. In practical terms, distinct levels of added-value goods were taken into account by estimating different models for three exporting products.

Some methodological aspects are worth mentioning. First, due to differences in the nature of logistics and transport indexes, a classification of hard and soft transport infrastructure was implemented. Second, since the empirical model considers seven different transport infrastructure variables and the number of degrees of freedom is limited, a principal component approach was implemented. Third, a panel data model was used to estimate an

export equation and to assess the effect of transport infrastructure measures for the three products in the sample. It is also worth mentioning that, since the data sample is restricted to the four larger exporters of each product, the results obtained should be understood as valid for those representative sellers rather than the all exporting countries.

There are two main results. Concerning the PC approach, the results provide evidence that all seven indexes are highly correlated, which implies that only one PC shows a large share of the overall variance. Concerning the estimation of the panel equation, the results provide support for the main hypothesis – i.e., that exports competitiveness responds to transport infrastructure improvements – in the case of meat and car parts exports. The PC variable for coffee was estimated as a non-significant determinant. Therefore, an enrichment of transport infrastructure conditions, in the context of emerging countries, tends to lead to an increase in exports competitiveness of products with more value added. Furthermore, the model results emphasize the role of hard transport infrastructure along with soft transport infrastructure – which captures logistics quality – as key determinants of exports of containerized products from emerging countries. Hence, the results of the present study confirm the traditional positive effects of logistics improvements to exports competitiveness, but they also stress that there is still room for a direct impact of investment in increasing capacity of infrastructure facilities – such as airports, ports, railways and roads networks – to enhance exports performance in developing countries.

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