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Economic effects of transport sectors on Croatian economy: an input–output approach

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ABSTRACT

Multiplier effects play a major role in determining importance of a sector of interest to the national economy. In order to determine the significance of Croatian transport sectors, in this paper input-output analysis was applied. A comparative analysis of type I and type II output, gross value added and employment multipliers based on input-output tables for Croatian economy for the year 2010 and 2015 was performed. Type I multipliers were calculated based on the open IO model. Closed IO model was used in type II multipliers determination. Results indicate that sector code H49—Land transport services and transport services via pipelines and sector code H50—Water transport services in the year 2015 recorded lower type I and type II output, gross value added and employment multipliers compared to the year 2010. For sector code H51—Air transport services, significant growth in terms of all three economic indicators was detected, especially when interest is focused on type I and type II employment multipliers. Results presented in this paper could be valuable for academia and general public because they reflect multipliers estimation of transport sectors in Republic of Croatia for the first time based on sound macroeconomic analysis tool.

1. Introduction
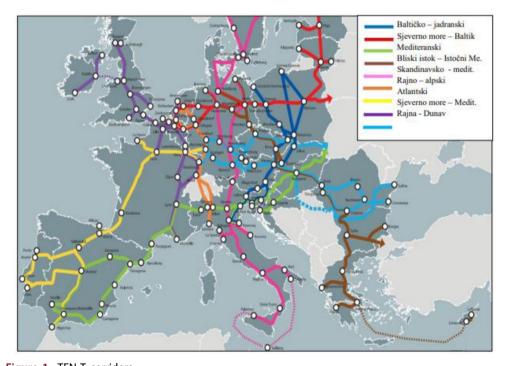
With its geo-traffic position, the Republic of Croatia has imposed itself as an important crossroads of the main European transport corridors. The branches of the 5th Pan-European Corridor, which connects the north and south of Europe, and the 10th Pan-European Corridor, which connects Central Europe and the Middle East, intersect here. These corridors are made up of road and railway infrastructure. It is necessary to add 7th Pan-European Corridor, which forms the Danube River with its tributaries.

Two TEN-T core network corridors also pass through the Republic of Croatia. Each TEN-T corridor must contain three types of transport infrastructure, pass through three member states and two border crossings. The Mediterranean corridor

connects the south of Europe with the north and, in addition to the road and rail, includes the Spanish seaports and inland waterways of the Italian Po River, as well as a large number of international airports. Rhine—Danube corridor, the main features of which are the inland waterways of the Rhine and Danube, with access roads, railways, and airports along the corridor (Figure 1).

Since the independence of the Republic of Croatia until today, the largest investments in the transport sector have been in the development of road infrastructure, and thus neglected, primarily, railway infrastructure. This is most evident from the statistics, according to which the number of kilometers of railways stagnated or decreased in that period, while the number of kilometers of built motorways increased from 394 km (1996) to 1310 km (2018) (Croatian Bureau of Statistics, 2019). This situation in railway transport has caused a drop in the number of transported passengers and freight.

According to Eurostat, in EU28 freight is mostly transported by road (76.7%), then by rail (17.3%) and inland waterways (6%). For Republic of Croatia these percentages are 73.6 for roads, 20.1 for railways and 6.3 inland waterways (Eurostat, 2019a). On the other hand, passenger transport for EU28 is split in the following way: 82.9% passenger cars, 7.7% trains and 9.4% for motor coaches, buses and trolley buses. For Republic of Croatia these percentages are 85% passenger cars, 2.7% trains and 12.3% for motor coaches, buses and trolley buses (Eurostat, 2019a).

According to the statistical indicators of EU countries, Table 1 presents data with some indicators of the competitiveness and sustainability of the transport system of

Figure 1. TEN-T corridors.
Source: https://ec.europa.eu/transport/themes/infrastructure_en).

Table 1. Comparative indicators of EU and Croatian transport systems for 2017.

	Republic of Croatia	EU	EU RANK
Road transport			
Quality of roads	5.49	4.78	8/28
Completion of TEN-T Road Core Network	60%	77%	19/28
Road fatalities per million inhabitants	80	49	26/28
Hours spent in road congestion annually	23.7	30.15	8/27
Rail transport			
Efficiency of train services (max 7)	2.66	4.33	26/26
Completion of TEN-T Conventional Rail Core Network	5%	60%	23/26
Electrified railway lines	37.2%	53.7%	18/26
Rail fatalities per million train-km	0.73	0.26	19/26
Consumer satisfaction with rail transport	70.80	76.80	22/26
Maritime transport			
Efficiency of seaport services (max.7)	4.47	5.00	19/23
Inland Waterways			
Completion of TEN-T Inland Waterways Core Network	33%	88%	18/19
Air transport			
Efficiency of air transport services (max.7)	4.60	5.17	24/28
Consumer satisfaction with air transport	80.9	82.2	25/28
Other			
Share of renewable energy in transport fuel consumption	1.3%	7.1%	27/28
Market share of electric passenger cars (BEV I PHEV)	0.05%	1.44%	28/28
Electric vehicle changing points per 100,000 urban inhabitants	54.25	52.10	13/28
Consumer satisfaction with urban transport	72.40	78.30	25/28

Source: Authors, according to https://ec.europa.eu/transport/factsfundings/scoreboard/countries/croatia/people_en.

the Republic of Croatia vis-à-vis the EU. With respect to the quality of road infrastructure, Republic of Croatia is performing below the EU average, while most indicators (road accidents, rail service efficiency, TEN-T inland waterway, and sustainability alone) are convincingly at the back.

Different economic approaches and econometric methods have been developed and applied to evaluate economic effects of transport sectors on the overall economy. However, the most common method that allows direct, indirect and induced effects of transport sectors estimation is IO analysis. There are many research using IO analyses and its implementation to investigate intersectoral relation using numerous economic indicators. However, the number of studies focused on the impact of transport on the Croatian economy is lagging behind its importance. The aim of this paper is to quantify multiplier effects of transport sectors in the Republic of Croatia in the terms of output, gross value added and employment based on the IO model. According to the Miller and Blair (2009), those three indicators are the most common indicators which result from the IO analyses. The comparison of output, gross value added and employment multipliers of transport sectors was based on IO tables for Croatian economy for the year 2010 and 2015. The contribution of this research is reflected in the first such calculation of the type I and type II multipliers of transport sectors in the Republic of Croatia.

The paper is structured as follows: after Introduction, there is an overview of the relevant literature analysing importance of transport sectors by using IO method. Research methodology is described in Sec. 3. Empirical results of type I and type II multipliers of transport sectors in Republic of Croatia are presented and discussed in Sec. 4. Finally, the conclusion presents policy implications and recommendations for further research.

2. Literature review

Economic effects of transport on the national economy can be estimated by various economic and econometric approaches, but the most common approach that quantifies direct, indirect and induced effects of transport sectors on the national economy is IO analysis. Papers dealing with importance of transport sectors for the national economies for the last decade based on a powerful analytical tool, IO analysis, are given below.

An extensive overview of IO models on modelling transportation-economic linkages was provided in Yu (2018). Author pointed out that in future research special attention should be focused on the assumptions of the IO model, especially when static IO model is observed and on transport sectors aggregation, as well as on household sector specification.

Based on the transport-oriented IO model, the impact of alternative investments in road, rail, water and air transport infrastructure in Australia was studied in Wang and Charles (2010). Authors concluded that new investments in transport would mainly affected the production of service sectors. The total output of the finance insurance and business and trade service sectors would increase significantly. Despite some IO model disadvantages, authors propose IO model for strategic transport infrastructure planning and better understanding of cross-sectoral linkages industries affected by transport infrastructure investments. Investments and improving transport infrastructure provides economic benefits to the region and increase the economic growth of that region. To assess the potential economic benefits in transport investments in the regional economy of Bandung district, IO analysis was applied (Anas et al., 2015). Investments in transport reduced logistic cost of the production sectors and decreased their marginal costs, which in turn has the effect of output increasing of the economic sectors influencing the development of the regional economy. The presented results of economic benefits in regions with transport investments can be significant for stakeholders involved in the development of Indonesian transport infrastructure. Lavee (2019) analysed effects of transport infrastructure investment in Israel in terms of employment. The direct short-term effect resulting from the establishment and operation of the project were analysed based on the IO tables, while long-term effects arising from transport development were examined through econometrics models. Author concluded that long-term effects of transport infrastructure investment are more important for the Israeli economy than investments in short-term.

Demand-driven model, supply-driven model, interindustry linkage effect analysis and Leontief price model was used in exploring the importance of transportation sector in Taiwan (Chiu & Lin, 2012). Authors analyzed effects of six transportation services: railway, road, water, air transportation sector, warehouse sector and other transportation service. The highest effects on other economic sectors in the national economy had road, rail and air transportation sectors. The role of rail, road, water, and air transportations sectors was analyzed in Lee and Yoo (2016) for Korean economy based on Korean IO tables. Results of the IO analysis indicate that rail and road had higher effects on Korean economy that other transport sectors. Indonesian transport sector recorded higher backward linkage and lower forward linkage indicating

that transport sector has greater impact in developing the upstream sector than downstream sector (Muryani & Swastika, 2018).

Chang et al. (2014) analyzed the impact of port sector on South African economy by using IO analysis. The estimated results of forward and backward linkage effect indicate that port sector in South African does not use other economic sectors much in its production. Direct and indirect effects in terms of output and employment of port industry on China's economy was analysed in Wang and Wang (2019). Based on the IO model, authors analysed industry linkage, production-inducing, sectoral supply shortage and employment-inducing effects. IO methodology was applied in socio-economic impacts estimation of air transport in Dimitrios and Maria (2018). Results of the conducted analysis showed that air transport is crucial for Greece economy and that there is a significant link between tourism and air transport. In order to explain the development of the volume of road freight transport, Alises and Vassallo (2016) applied extended IO model and data of the transport at the macro level in Spain and the UK. Based on the developed model authors concluded that in road freight transport volumes explaining significant role have economic restructuring processes including technological, logistic and modal factors. Also, economies that are more focused on services imply much lower transport needs, as for example UK.

To determine the link between the two industries relevant to the economy, tourism and transport, Nguyen and Shimizu (2017) conducted a survey to compile IO table with transportation and tourism industries presented explicitly. Multiplier effect analysis showed that transportation strongly encourages the development of tourism and act as a key factor in promotion domestic and outbound tourism. On the other hand, inbound tourism is considered as industry that strongly encourages production of domestic sectors, especially transport industry. Contribution of inbound tourism to transportation in terms of total output and value added is two times higher than domestic tourism.

3. Research methodology

3.1. IO model

IO analysis has been adopted around the world as a practical method for analyzing significance of the certain economic sector of interest and for analyzing the interdependence among economic sectors of national economy (Miller & Blair, 2009; ten Raa, 2005). As a powerful analytical tool, IO analysis is used for monitoring trends and changes of economic structure. IO analysis serves in evaluation both short-term policy measures and long-term strategies to improve overall productivity and growth of the national economy. The prerequisite for the IO analysis application is IO table. In IO table, cross-sectoral linkages among different economic sectors that ensure unhindered production flows in the economy of a country are described. Within IO table, whole national economy is divided into certain number of economic sectors, while each economic sector is defined by the homogeneity of goods and services produced and technology applied. Each row in the IO table shows the allocation of a certain sector production to the intermediate consumption of other sectors and to final

demand. Each column presents the value structure of the output of a certain sector. Value of output is separated into intermediate consumption of products delivered by other sectors and to gross value added. According to the European Union Regulation (European Union, 2013) every European Union member is obligatory to compile IO table in five years intervals. IO tables are compiled by national statistical offices according to the methodology of the European system of national and regional accounts, ESA 2010 (Eurostat, 2013).

The fundamental equation in the IO model showing the dependency of flows between sectors on total production of each sector is:

$$X_i = \sum_{j=1}^{n} X_{ij} + Y_i \tag{1}$$

where X_i is the total output of sector i, X_{ij} output of sector i which is used as the intermediate input in sector j and Y_i is the final consumption of sector i. Technical coefficient $a_{ij} = \frac{X_{ij}}{X_j}$ indicate a part of the product of sector i which is necessary for sector j for the production of one unit of that product, $i, j = 1, \ldots, n$.

The solution to the system of Eq. (1) in matrix form can be written as:

$$X = (I - A)^{-1} Y \tag{2}$$

where X is the column vector of total production, A is the matrix of technical coefficients, and Y is the column vector of final consumption. The matrix $(I - A)^{-1}$ is called Leontief inverse matrix or multiplier matrix.

By using IO model, direct, indirect and induced effects of an economic sector of interest to the national economy can be quantified. Those effects are mainly estimated in terms of output, gross value added (GVA) and employment. The direct effect in terms of output that direct supplier of goods or services achieves is equal to the value received from the final consumer. The difference between the direct output and the value of intermediate inputs that are directly used in the production process is called direct GVA. The direct employment equals to the number of employees involved by direct supplies to produce a given product. The indirect effects of particular sector of interest in terms of output, GVA and employment describe output, GVA and employment generated by all supplier sectors included in the production chain of observed sector. Supplier sectors produce intermediate goods and services and deliver them to the observed sector. By increasing deliveries of goods and services of the observed sector, the demand for output of supplier sectors included in the production chain increases affecting the increase in their output, GVA and employment. An effect of production growth of all sectors involved in the production chain of goods and services for final consumption of households induced by personal consumption growth is called induced effect.

3.2. Type I and type II multipliers

Direct, indirect and induced effects are determined via indicators called multipliers (Miller & Blair, 2009). Type I and type II multipliers are considered depending on the open and closed type of IO model. In open IO model final consumption is treated as an exogenous variable. Whole economy is separated into economic sectors where production of one sector depends on the production of all other sectors, and non-economic sectors which are holders of the final consumption. By open IO model type I multipliers, defined as the ratio of total (sum of direct and indirect effects) and an initial effect related to the change of final demand, can be calculated. In closed IO model some components of final consumption, mainly personal consumption of households, are endogenous, i.e., dependent on other model variables (Burrows & Botha, 2013; McLennan, 2006; Miller & Blair, 2009). Type II multipliers, defined as the ratio of total effects (direct, indirect and induced effects) and initial effect, are calculated by using closed IO model.

Type I multipliers calculation is based on the Leontief inverse matrix $L = (I-A)^{-1}$. Elements α_{ij}, $i,j = 1, \ldots, n$ of Leontief inverse matrix L, where n is the number of observed sectors, represent direct and indirect output of sector i per one unit of final demand for goods and services produced by sector j. On the other side, type II multipliers calculation is based on the matrix $\overline{L} = (I-\overline{A})^{-1} = \begin{bmatrix} \overline{L_{11}} & \overline{L_{12}} \\ \overline{L_{21}} & \overline{L_{22}} \end{bmatrix}$ where matrix $\overline{A}$ is expanded matrix of technical coefficients A with one more row representing compensation of employees coefficients and one more column representing household consumption coefficients. If one is interested for induced effects of n observed sectors calculation then matrix $\overline{L_{11}}$ is used (McLennan, 2006; Miller & Blair, 2009). Elements $\overline{\alpha_{ij}}$ of matrix $\overline{L_{11}}$ represent direct, indirect and induced effects on the increase in sector's i production as a result of the unit growth of final demand by the sector j. More of the above-mentioned matrices reader can find in ten Raa (2005), Miller and Blair (2009) and Mikulić (2018).

Type I output multiplier for sector j can be calculated according to the formula

$$m(o)_j = \sum_{i=1}^{n} \alpha_{ij}, \ j = 1, \ \ldots, \ n \tag{3}$$

while type II output multiplier for sector j can be calculated according to the formula

$$\overline{m}(o)_j = \sum_{i=1}^{n} \overline{\alpha_{ij}}, \ j = 1, \ \ldots, \ n \tag{4}$$

Furthermore, let coefficients $\widetilde{v}_j = \frac{v_j}{X_j}$, $j = 1, \ \ldots n$, represent the share of GVA in output of sector j, $j = 1, \ \ldots, \ n$. Then, formula for the type I GVA multiplier for sector j calculation is

$$m(v)_j = \frac{\sum_{i=1}^n \widetilde{v}_i \alpha_{ij}}{\widetilde{v}_j}, \ j = 1, \ \ldots, \ n \tag{5}$$

and for type II GVA multiplier for sector j is

$$\overline{m}(v)_j = \frac{\sum_{i=1}^n \widetilde{v}_i \overline{\alpha_{ij}}}{\widetilde{v}_j}, \ j = 1, \ \ldots, \ n \tag{6}$$

Let coefficients $\widetilde{e}_j = \frac{e_j}{X_j}$, $j = 1, \ \ldots n$, represent the share of the number of employees of sector j in its output. Type I employment multipliers for sector j is defined as

$$m(e)_j = \frac{\sum_{i=1}^n \widetilde{e}_i \alpha_{ij}}{\widetilde{e}_j}, \ j = 1, \ \ldots, \ n \tag{7}$$

and type II employment multiplier for sector j as

$$\overline{m}(e)_j = \frac{\sum_{i=1}^n \widetilde{e}_i \overline{\alpha_{ij}}}{\widetilde{e}_j}, \ j = 1, \ \ldots, \ n \tag{8}$$

3.3. Data sources

Main data sources that describe sectoral interdependence within the economy used for the purposes of this research were IO tables for Croatian economy for the domestic production for the year 2010 and 2015 (Croatian Bureau of Statistics, 2019; Eurostat, 2019b). IO tables for Croatian economy are made on the basis of 65 economic sectors which are linked to the National Classification of Activities 2007 classification sections. As empirical data for sector code U—Services provided by extraterritorial organisations and bodies are not available, sector code U was excluded from further analysis. Therefore, all calculations were based on the cross-sectoral values of the remaining 64 economic sectors.

Eurostat National accounts aggregates by industry (nama_10_a64) (Eurostat, 2019c) and Eurostat National accounts employment data by industry (nama_10_a64_e) (Eurostat, 2019d) were the additional data sources used in this analysis to estimate type I and type II GVA and employment multipliers. Data required for GVA and employment multipliers quantification downloaded from the Eurostat National accounts database per activities were converted on the same data per products to be comparable with official IO tables for Croatian economy. Since Croatian Bureau of Statistics in IO tables compilation uses B model of transformation, GVA per sectors and number of employees per sectors were converted according to the same methodology (Eurostat, 2008a).

Based on the Statistical classification of economic activities in the European Community, NACE Rev. 2 transport belongs to the section H—Transportation and Storage which 'includes the provision of passenger or freight transport, whether scheduled or not, by rail, pipeline, road, water or air and associated activities such as terminal and parking facilities, cargo handling, storage etc. Included in this section is the renting of transport equipment with driver or operator. Also included are postal and courier activities' (Eurostat, 2008b, p. 235). Sectors of the IO table that cover transport are given by code and description as follows:

- H49—Land transport services and transport services via pipelines.

This sector includes the transport of passengers and freight via road and rail, as well as freight transport via pipelines.

- H50—Water transport services

Sector code H50 includes the transport of passengers or freight over water, whether scheduled or not. The operation of towing or pushing boats, excursion, cruises or sightseeing boats, ferries, water taxis etc. are included.

- H51—Air transport services

This sector includes the transport of passengers or freight by air or via space.

4. Research results

Based on the IO tables for the year 2010 and 2015, in Table 2 the most important descriptive indicators for the analysed Croatian transport sectors are shown.

Total output for all transport sectors expressed in basic prices for 2010 approximately amounted to 24.21 billion HRK and for 2015 18.70 billion HRK. In 2010, total GVA amounted to almost 10 billion HRK, and in 2015 was slightly higher than 8 billion HRK. A total of 66,348 people were employed in transport sectors in 2010, and in 2015 the number of employees decreased by 7200. The highest share of output in total Croatian output was detected for land transport. It amounted to 2.70% in 2010 and 2.50% in 2015. For land transport, the highest shares were also observed in terms of GVA and employment.
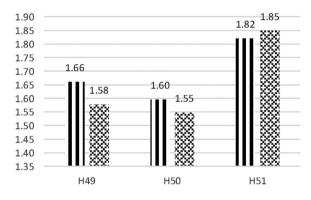
Table 2. Descriptive indicators for Croatian transport sectors.

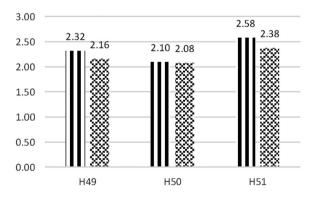|	2010			2015		
Sector code	H49	H50	H51	H49	H50	H51
Output, billion HRK	15.06	6.49	2.66	14.24	2.77	1.69
GVA, billion HRK	6.38	2.35	0.83	6.41	1.24	0.39
Employment	45,253	16,067	5028	42,057	16,478	615
Share of output in Croatian output (%)	2.70	1.16	0.48	2.50	0.49	0.30
Share of GVA in Croatian GVA (%)	2.27	0.84	0.29	2.28	0.44	0.14
Share of employment in Croatian employment (%)	2.66	0.95	0.30	2.67	1.03	0.04

Source: Authors' calculation.

In the continuation of this this section, results of type I and type II output, GVA and employment multipliers for Croatian transport sectors are provided. Multipliers determination is based on the IO tables for the year 2010 and 2015 and Eurostat National accounts data. According to the formulas (3) and (4) type I and type II output multipliers are calculated. Formulas (5) and (6) are used in type I and type II GVA multipliers calculation. Type I and type II employment multipliers are calculated according to the formulas (7) and (8).

Of all observed transport sectors, sector code H51 recorded the highest type I and type II output multipliers in 2010 and in 2015 (Figures 2 and 3). In 2010, type I output multiplier for sector code H51 amounted to 1.82 which means that if final demand for goods and services of air transport sector increases by 1 HRK, the total output in the Croatian economy is increased by 1.82 HRK. With induced consumption included, type II output multiplier for observed sector equals to 2.58 HRK. Compared to 2010, in 2015 sector code H49 and sector code H50 recorded lower type I and type II output multipliers, but it should be noted that calculated values did not differ significantly.

Figure 2. Type I output multipliers.
Source: Authors' calculation.

Figure 3. Type II output multipliers.
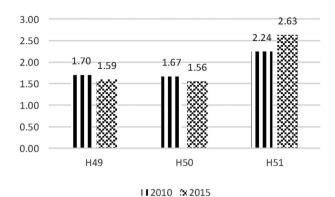Source: Authors' calculation.

Table 3. GVA total effects.

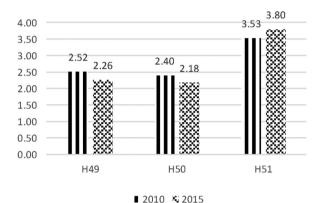| Sector code	2010			2015		
	H49	*H50*	*H51*	*H49*	*H50*	*H51*
Direct effects	0.42	0.36	0.31	0.45	0.45	0.24
Total effects I	0.72	0.60	0.70	0.72	0.70	0.62
Total effects II	1.06	0.87	1.10	1.02	0.97	0.89

Source: Authors' calculation.

Total effects in terms of GVA of a certain economic sector represent the increase of GVA in the overall economy as the result of 1 unit increase in the output of that economic sector. GVA multiplicative effects indicate the increase of GVA (output net of intermediate consumption) for 1 unit in the total economy as the result of unit increase in final demand of observed sector.

Table 3 presents direct effects, sum of direct and indirect effects, called total effects I and sum of direct, indirect and induced effects, called total effects II of transport sectors in terms of GVA. Total effects I are calculated based on open IO model and total effects II according to the closed IO model. Sector code H51 recorded the lowest direct effects in observed period suggesting following. An increase in final demand for goods and services of sector code H51 for 1 HRK directly affects the increase in GVA of sector code H51 for 31 lipa in 2010, and 24 lipa in 2015 (direct effects). Furthermore, final demand for goods and services of sector code H51 increased by 1 HRK directly and indirectly increases the GVA in total economy by 70 lipa in 2010 and 62 lipa in 2015 (total effects I). With included induced consumption increase in final demand contributed the increase of GVA in total economy of 1.10 HRK in 2010 and 89 lipa in 2015 (total effects II). It could be noted that in the case of air and water transport total GVA in Croatian economy is lower than initial change in final demand. It is due to the high direct and indirect import content, primarily related to imported fuel. In addition, both mentioned sectors operate in highly competitive global market which does not allow transferring of growth in prices of intermediate inputs to final prices of their services. Table 3 indicates that in sector air transport direct GVA amount to less than quarter of the value charged to final consumers.

Type I GVA multiplier is defined as the ratio of the total increase of GVA in the total economy as a result of the increase in the final demand for goods and services of observed sector (total effects I) and the share of GVA of observed sector (direct effects). Sector code H51 recorded the highest type I GVA multiplier in 2010 (2.24) and the highest in 2015 (2.63) (Figure 4). The ratio of total growth of GVA in the total economy as a result of the increase in the final demand for goods and services of sector code H51 (total effects II) and the GVA share in production of sector code H51 (direct effects), so called type II GVA multiplier, equals to 3.53 in 2010 and 3.80 in 2015 (Figure 5). The least additional HRK of the GVA in the total economy, regarding increase in output for 1 HRK, are realized in sector code H50, for which the lowest type I and type II GVA multipliers in observed period are detected. When high multiplier for air transport sector is interpreted one should be aware that it is primarily the result of a low denominator (direct GVA as shown in Table 3). The economic benefits related with air transport are distributed to the benefit of domestic producers involved in the value added of the transport industry.

Figure 4. Type I GVA multipliers.
Source: Authors' calculation.

Figure 5. Type II GVA multipliers.
Source: Authors' calculation.

Table 4. Employment total effects, number of full-time employees induced by 1 million HRK final demand.

	2010			2015		
Sector code	*H49*	*H50*	*H51*	*H49*	*H50*	*H51*
Direct effects	3.00	2.48	1.89	2.95	5.96	0.36
Total effects I	4.66	3.74	3.99	4.41	7.43	2.57
Total effects II	6.71	5.31	6.36	5.92	8.81	3.95

Source: Authors' calculation.

According to the values presented in Table 4. it can be noticed that if direct deliveries of goods and services of sector code *H51* are increased by 1 million HRK, then in production of the sector code *H51* for the deliveries amounting to million HRK number of employees is increased by 1.89 in 2010 and by 0.36 in 2015 (direct effect). When indirect effects of the sector code *H51* are included, the number of employees in the entire economy increases by 3.99 in 2010 and by 2.57 in 2015 (total effects I) Including induced consumption, number of employees in the total economy increases by 6.36 persons in 2010 and by 3.95 in 2015 (total effects II). The lowest number of full-time employees induced by final demand of 1 million of HRK is recorded for air transport because of comparative higher productivity in comparison to other transport sectors.
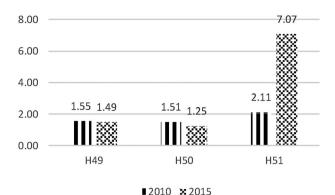
Figure 6. Type I employment multipliers.
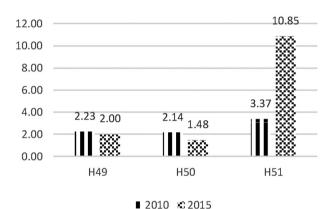Source: Authors' calculation.

Figure 7. Type II employment multipliers.
Source: Authors' calculation.

Type I employment multiplier is defined as the ratio of direct and indirect employment growth (total effects I) in the total economy and direct employment growth, i.e., ratio of employment and output of a certain economic sector (direct effects). Type II employment multiplier is defined as the ratio of direct indirect and induced employment growth (total effects II) in the total economy and direct employment growth, i.e., ratio of employment and output of a certain economic sector (direct effects). Sector code *H51* recorded highest type I and type II employment multiplier in observed period (Figures 6 and 7). If the number of employees in sector code *H51* increases by 1 then the total number of employees in the total economy increases by 2.11 persons in 2010 and by 7.07 in 2015 (type I employment multiplier), while with induced consumption it will increase by 3.37 persons in 2010 and by 10.85 in 2015 (type II employment multiplier). The lowest type I and type II employment multipliers are recorded for the sector code *H50*.

5. Conclusion

Transport plays an important role in the economic development of many countries and is a crucial factor for the well-being of the society. Therefore, the aim of this

paper was to conduct a comparative analysis of type I and type II output, gross value added and employment multipliers of transport sectors on Croatian economic growth and development by using the input-output method. Research conducted for the Republic of Croatia, as an example of the small open economy, confirms that in transport sectors value chains play a vital role in connecting domestic and foreign economies and in spreading modern technologies. The transport value chain is important for the variety of companies involved in it which includes not only transport firms but many supporting industries and the range of partners which deliver intermediate inputs. Also, the research confirms that transport sectors induce strong spill over effects and its operation is also the key for the performance of other economic sectors. Due to indirect effects, transport can lead to higher income and employment in the overall economy.

The results of the analysis indicate that Croatian land and water transport sectors recorded lower multipliers in 2015 compared to 2010. Lower indirect and induced effects in the more recent period are result of more intense international integration after Republic of Croatia joined EU. It is most pronounced for the road transport where domestic transporters are more engaged in the international transport than inland transport of freight and persons. When transport operation is conducted abroad, a proportion of indirect effects related to buying of intermediate inputs, like oil derivatives or specialised services, are not effective in the domestic economy but are spilling over to other economies. Despite decreasing trend, multiplicative effects of land and water transport are still significant and are estimated to be over 2 in 2015. Given numbers indicate that indirect and induced GVA and employment effects, along value chain, are higher than direct effects recorded by transport industry.

Unfortunately, official IO data do not provide disaggregation of land transport to road and rail transport which could enable separation of indirect and induced effects for that two different transport modes. Market structure, specific modes of operations and development of infrastructure could result in significantly different types of value chain and intensity of integration of domestic producers. Namely, in the last thirty years, since the independence of the Republic of Croatia, investments in the development of road transport were at the most. That led to the neglect of other branches of transport, primarily rail. Road infrastructure in terms of quantity and quality is therefore above the European average, while rail infrastructure is significantly below, or among the worst in the EU. Furthermore, the average completion of the TEN-T railway network in the EU is 60%, while in the Republic of Croatia this percentage is around 5%. This, of course, leads to higher traffic loads on the roads, and thus to an increase in external costs and negative environmental impacts. To improve modal split for passenger transport, intensive investment in railway infrastructure is required. Regarding Croatian water transport, statistics show that total ship traffic and total passenger traffic in Croatian seaports have an upward trend, with domination of domestic traffic. Overall goods traffic has a downward trend, primarily due to outdated port infrastructure that cannot cope with modern European ports. Because of the more complex technology applied, the highest multipliers have been found for air transport. Operation of air transporters requires engagement of

suppliers of technologically advanced products required for regular maintenance of airplanes, but also many supporting industries included in logistics of air transport. While direct employment requirements of air transport are not high due to engagement of highly skilled and productive labour, indirect and induced effects on employment are more pronounced and based on type II multiplier. It could be concluded each job in air transport indirectly induce 10 jobs in other industries. With the entry of low budget airlines into the air traffic of the Republic of Croatia intensive investments in air infrastructure are recorded. Especially at the Zagreb, Dubrovnik and Split airports, which account for more than three quarters of the total passenger traffic. This is largely attributable to tourism, which has influenced the better performance of these companies in air transport and the spread of multiplier effects to the other economic sectors.

Conducting research of transport sectors is of great benefit especially for economic policy makers who could, based on the broad analytical basis, formulate economic policy measures to stimulate certain transport sector that points to relative lag, which may have a negative impact on the overall productivity of the national economy.

In the future research, a comparative analysis of multiplicative effects of transport sectors, conducted for EU economies, could reveal in which extent are trends found for Croatian economy similar to trends in other countries. It is expected that indirect effects of the transport industry in the Republic of Croatia could be more similar to effects in EU new member states than in more developed old EU countries.

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