Impact of transport and storage sector on sustainable development: evaluation using input-output model

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ABSTRACT

Transport and storage sector has high importance in any economy as it serves to all major economic agents – companies (supply of materials and deliveries of final goods), households (getting to planned destinations, supply of goods etc.), government. Nowadays the production of commodities demand components from all over the world and the production supply process diversifies more and more, the evaluation of the importance of transport is relevant issue to be researched and investigated. The research is devoted to the assessment and evaluation of impact of transport and storage sector on economy (monetary impact) and in respect to the sustainability in the European Union (EU). As the research method the input-output model is selected as it illustrated the sectoral interlinkages – both direct linkages and also indirect interlinkages. In the research, a special attention is paid to the EU member states with highest share of transport and storage sector in the economy, the case of Latvia is analyzed in more detail. Alternatives are to apply hybrid (monetary and physical) methods. The paper does not examine emission issues.

Keywords: Transport, Logistics, Input-Output Analysis, Sustainable Development, Macroeconomic Modelling.

1. INTRODUCTION

Transport and storage sector is defined and analyzed on the basis of NACE Rev.2. classification applied to all the EU countries –Transportation and storage (H); that is subdivide into the following five subsections (classification codes are given in the parenthesis): Land transport and transport via pipelines (H49); Water transport (H50); Air transport (H51); Warehousing and support activities for transportation (H52); and Postal and courier activities (H53).

The aim of the research is to evaluate the effect of transport and storage sectors on the national economy and economic sustainability, using input-output approach.

The research focusses on European Union (EU) and in more detail the case of Latvia is selected and analyzed as Latvia's transport and storage sector has the largest share of output in national economy amid all the EU countries. The selected method, computed and evaluated results can be applied to other countries with appropriate alterations.

Transportation and storage sector in the EU on average account for 5% of the economic activity (value added), however the share significantly varies amid the memberstates – the transport forms the largest share in the national economies in Lithuania (12.1%), Latvia (9.5%), and Estonia (7.6%) due to the geographical location and existing transit transport channels.

The importance of transport (measured as a share in the economy (value added)) is significantly higher in countries where transit channels are located and transport and logistic centers or hubs are located (as in Lithuania, Latvia and Estonia (see Table 1)).

Table 1
List of TOP 10 EU member states by largest share of Transport and storage sector in the national economy in 2017 by various indicators (%)

Country	Value added, gross	Output	Intermediate consumption	Compensation of employees
LT	12.1%	11.7%	11.2%	9.5%
LV	9.5%	13.4%	16.7%	9.3%
EE	7.6%	10.1%	12.1%	6.7%
CY	7.3%	12.7%	17.6%	5.0%
RO	7.3%	7.9%	8.4%	6.5%
SK	7.1%	6.1%	5.5%	6.2%
EL	7.0%	8.7%	10.8%	5.4%
PL	6.6%	7.0%	7.4%	6.0%
MT	6.6%	6.7%	6.8%	6.5%
SI	6.4%	7.2%	8.0%	5.8%

Data source: [1]; : no data

Nevertheless, the transport and storage services are also important as input for other industries to produce goods and services (Cyprus economy is specific due to geographical formation (island) and location and legislation issues and, in a result, 17.6% of intermediate costs of other industries (or inputs) are associated with transport and storage sector that also indicated the dependence on transport activity and sustainability).

Transport and storage sector serves the economy, if economy is transit specialized (significantly large flows of goods are transported (probably stored for short time period or repacked etc.) through the country – imported and re-exported etc.), the transport sector (number and size of companies, specialization, type of employees etc.) is different from the countries where the transport serves only the domestic economy business,

government and population needs. Transport and storage sector, despite impressive capital investments in modernization and automatization in past decades, still is relatively labor-intensive sector and hence a notable employer. The sector demands both low-skilled manual workers in loading etc.manually operated processes, as well as high-skilled highly-remunerated professionals in supply-chain management and planning.
In Lithuania and Latvia transport sectors are significantly more important employers (respectively 9.5% and 9.3% of all labor costs in economy are paid to employees in transport sector) than in Ireland (3.8%) or Spain (4.6%).

Table 2
The rest of 10 EU member states by share of Transport and storage sector in the national economy in 2017 by various indicators (%)

Country	Value added, gross	Output	Intermediate consumption	Compensation of employees
HU	6.3%	5.8%	5.4%	6.7%
CZ	5.7%	5.8%	5.8%	6.2%
DK	5.7%	9.9%	14.2%	5.2%
AT	5.6%	5.2%	4.9%	5.5%
IT	5.6%	6.0%	6.4%	5.8%
BG	5.5%	7.6%	9.2%	6.3%
BE	5.4%	6.3%	6.9%	6.2%
SE	5.2%	:	:	5.0%
PT	4.9%	6.1%	7.2%	5.3%
FI	4.8%	5.8%	6.7%	5.4%
NL	4.8%	5.6%	6.2%	5.2%
DE	4.6%	5.6%	6.7%	4.6%
FR	4.6%	5.2%	5.9%	5.2%
ES	4.5%	5.4%	6.3%	4.6%
LU	4.4%	2.7%	2.2%	6.2%
UK*	4.3%	5.1%	6.0%	5.3%
IE	2.7%	3.0%	3.3%	3.8%

Data source: [1]; : no data; * data of 2016

The EU economies with the lowest share of transport and storage sector in the economy are Ireland, the United Kingdom and Luxembourg (See Table 2).

The comparison of countries based on the indicators presented in Table 2, indirectly reveals also the efficiency of technologies applied in the sector. For example, In Denmark the services of transport and storage sector are significant inputs in other industries (14.2% of all intermediate consumption costs are related to transport and storage costs in the economy), but meanwhile only 5.5% of all labor costs are paid to employees in transports and storage sector. It may be concluded that Denmark's transport and storage sector have on average higher labor productivity and operates more efficiently than on the average in the EU. A contrasting example is the case of Luxembourg, where only 2.2% of all intermediate consumption costs are related to transport and storage costs in the economy, but 6.2% of all labor costs in the economy are paid to employees in transports and storage sector.

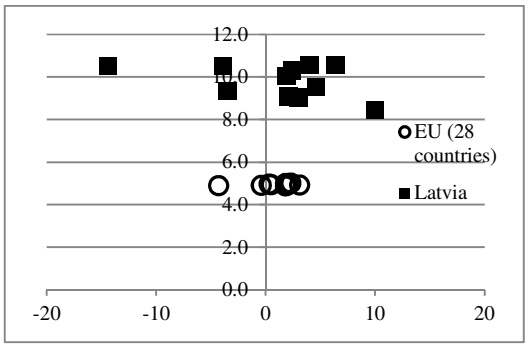

Fig. 1. Real GDP growth rate (%) and share of transport and storage sector in the economy (%) in Latvia in 2007-2017

Figure 1 illustrates and confirms the exiting correlation between economic activity and transport services in small open economies – when the economic activity is high, the share of transport in the economy even increases, but during economic crisis (the period of negative real GDP growth rates) the demand for transport significantly and very sharply plummets. But there are weak or no correlation within the economic unions as the EU economy is more stable and fluctuates with lower growth rates (real GDP growth rates), meanwhile the share of transport is stable. The EU forms a common market and companies can offer transport services both nationally and in other EU countries.

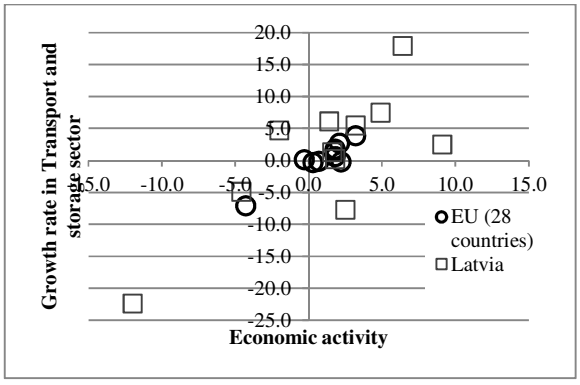

Fig. 2. Real value added growth rate (%) representing economic activity and real value added growth rate in transport and storage sector in the economy (%) in Latvia in 2007-2017

However, real value added growth rate as economic activity measure and real value added growth rate in transport and storage sector analysis indicates strong correlation in national economies (the case of Latvia is represent in Figure 2), but considerably weaker correlation are observed and estimated in larger economies and economic unions as the EU.

2. METHOD

Input-output analysis is a traditional method that is frequently used in evaluations and estimations of various economic scenarios and developments; depending to the research goals and scope different input-output models are developed and applied (for example, statistic, comparative static, dynamic etc.).

In recent years input-output and derivative approaches and approaches that include input-output principles experience a renaissance and are widely applied to environmental, CO_2 emissions, consumption-based emissions [3], carbon footprint, pollution, economic importance of rare metals and scares resources etc. issues that cannot be tackled by other methods. Some authors combine input-output approach with other approaches. Resent trend is approaches that have traditionally competed, for example Duarte et.al [4] combines multiregional input-output (MRIO) model and gravity model to exploit their synergy in assessing factors that drives embodied carbon in international trade.
If a country is not an oil producing country, then the transport and storage sector is highly dependent on imported oil products. It creates additional risks regarding sustainability and future costs. The research focuses on evaluation of import importance in the respect to the sustainability of the economic activity.
Transport and storage industry is more linked to and serving to the national economic activity; however, according to Reich [5] nowadays we live within an interconnected set of national economies rather than in one 'global economy'. Each economy has its specifics due to historical, technological, economic, social etc. factors.

In the European Union Input-output tables are elaborated within the framework of ESA 2010, National Accounts and sectoral accounts statistics, thus the same economic activity classification and product classifications are applied – NACE classification Rev.2 and CPA. However, symmetric input-output table is can be elaborated either product-by-product or industry-by-industry [6]. More common selection of national statistical offices is product-by-product option (according to Eurostat [7] 23 EU countries applied product-by-product; 8 EU countries applied industry-by-industry); some national statistics offices elaborate in both practices (the Czech Republic, Italy and Hungary).
Latvia is amid countries that elaborate product-by-product symmetric input-output tables according to CPA classification.

Transport and storage sector is analyzed and evaluated by input-output model.

Input-output model includes the basic identities that ensure the equilibrium in the economy:

$$x = Ax + y, \qquad (1)$$

Where x – output (vector),
Ax – intermediate consumption (matrix).
y – final demand (vector).

As Latvia is amid countries that elaborate product-by-product symmetric input-output tables according to CPA classification.

A is a matrix of technical coefficients, each element a_{ij} corresponds to the volume of intermediate input of product i products to produce a unit of output of product j. technical coefficients represent the direct cost structure of production of product j.

$$x = By, \qquad (2)$$

Where B – Leontief inverse (matrix), computed by equation (3):

$$B = (I - A)^{-1}, \qquad (3)$$

where I – identity matrix.

Use of primary factors depends (F) on the technology (technical coefficients of primary factors, showing the quantity of primary factors required per unit of output; L) and output of industry x (see Equation (4)):

$$F = Lx. \qquad (4)$$

Value added (VA) indicates the deference between output and intermediate consumption of commodities (goods and services of industries). Nowadays, quite a high attention is paid to high value added industries and activities and hence the value added multipliers are applied (see Equation (5)):

$$VA = va\, x \qquad (5)$$

As the higher value added and in result gross domestic product is one of the key goals of all modern economies, hence technology, representing how much which factors are required to produce unit of output, and output gives ground to evaluated the impact of certain scenario on economic development and sustainability.

It is worth to stress that none of technological coefficients is stable in long term, in other words, technologies and resources available (commodities and primary factors) changes over the time, changes the productivity, for example, primary factors productivity as labor productivity.
Additional ratio is applied in the research to estimate the relative impact and dependence on imported inputs in the sector analyzed (See Equation (6)):

$$im\_c = \frac{IM}{x} \qquad (6)$$

The import share relatively to the domestic output illustrates the reliance on imported products or services; however, it is clear that the service sector industries (as transport and storage) rely mainly on imported intermediate consumption inputs, but less imported are final goods (transport and storage services) imported due to the nature of service specifics rather than economic reasons. At the same time, it is worth to stress that high specialization in certain production internationally leads to sustainability issue and forthcoming ecological, social etc.problems.

Econometric multi-sectoral input-output models are developed and regularly updated for many countries [8]; these models can be created by various software and approaches; multi-sectoral input-output models are wide set of models with large lever of variance – some are INFORUM models [8], some combine Computable General Equilibrium with a Multi-Regional Input-Output model [9] etc.
Many authors, as Yu [10], argue that multi-sectoral input–output modelling, as a standard economic analysis tool, has advantages as they illustrate industrial interdependencies in an economy. The input-output modelling allows adopting and extending the method application according to the research goals, as a bi-regional input-output model can was built with a special disaggregation of the more than ten port-related sectors in one certain Italian region researched [11] etc.
Regarding the case of Latvia the studies involving input-output approach are on evaluation of competitiveness of industries [12], regional allocation of high-technologies industries [13]

and productivity [14] and etc. that illustrating the national expertness in this field.

In this research, as the impact and the so-called what-if scenarios are evaluated in short term and medium term hence technological coefficients are constant. The what-if scenarios allow to estimate the quantitative effect of a certain (or given) change in the economy. As any application and approach is has its limitations and drawback, however in economic analysis and especially in economic policy analysis it is a very powerful tool.

3. RESULTS AND DISCUSSION

The results are computed on the basis of symmetric input-output table and corresponding domestic and import input-output tables of Latvia; in the research the latest available tables are used – the set of tables of 2010. Latvia's input-output tables are product-by-product tables according to CPA classification issued by Central Statistical bureau of Latvia.

The results argue that transport and storage industries in Latvia are greatly interlinked – consumes services of the same industry or other transport services (See Table 3). Warehousing and support services for transportation (CPA Code: H52), are specialized in certain activity or sphere and hence are extremely interrelated and consuming a lot of services (products) of the same sector (from other companies in the economy) - in order to produce an output of one euro, 0.45 euros are spend on inputs of the same products.

Table 3
Technical coefficients in Transport and storage sector of major inputs in Latvia

CPA Code	Product\ Product	H49	H50	H51	H52	H53
H49	Land transport services and transport services via pipelines	0.0737	0.0000	0.0000	0.1367	0.0621
H50	Water transport services	0.0037	0.0117	0.0000	0.0000	0.0000
H51	Air transport services	0.0002	0.0002	0.0851	0.0002	0.0069
H52	Warehousing and support services for transportation	0.2046	0.1393	0.2293	0.4453	0.0005
H53	Postal and courier services	0.0003	0.0007	0.0000	0.0004	0.0002

At the same time, Warehousing and support services for transportation services are important inputs in also other transport service as well. The products are being produced or imported and warehousing and support services for transportation services have an essential role in supply-chain. Air transport services (H51) and Land transport services (H49) consume proportionally a lot of Warehousing and support services for transportation services – respectively technical coefficients are 0.2293 and 0.2046.

Detailed analysis of technical input-output coefficients reveals that transport and storage sector uses inputs of various products and transport and storage sector has definitely not unified technical coefficients (See Table 4, where cells of technical coefficients above 0.05 are with grey fill). For example, Postal and courier services (H53) use Printing and recording services (C18), but for the rest of transport industries (H49-H52) Printing and recording services have no importance or tiny inputs.

As the research is focused on sustainably, the demand for energy inputs (for example, fossil fuels) is examined. The results show that petroleum products (C19) accounts for 2.0% to 13.6% in costs structure. The highest technical coefficients value for petroleum products are in Air transport services (0.1361) and Land transport services and transport services via pipelines (0.1050). Any price increases both by tax policy changes and by resource global prices have a significant impact on output of the two abovementioned transport industries.

In case of Air transport services, the companies operating in the industry are more flexible as mainly international air transportation services are offered, the domestic (meaning inland) flights are rare and air transportation is not a usual passengers and cargo transportation scheme inland in Latvia.

Table 4
Technical coefficients of Transport and storage sector of other major inputs in Latvia

CPA Code	Product\ Product	H49	H50	H51	H52	H53
C18	Printing and recording services	0.0002	0.0001	0.0000	0.0000	0.0559
C19	Coke and refined petroleum products	0.1050	0.0204	0.1361	0.0095	0.0323
C20	Chemicals and chemical products	0.0058	0.0143	0.0520	0.0014	0.0031
C33	Repair and installation services of machinery and equipment	0.0090	0.0970	0.0625	0.0043	0.0020
G46	Wholesale trade services, except of motor vehicles and motorcycles	0.0291	0.0108	0.0533	0.0033	0.0077
N77	Rental and leasing services	0.0358	0.1303	0.1289	0.0014	0.0329

*grey fill if cell's value above 0.05.

Nowadays, many companies outsourcing numerous activities and buy them as services from other business agents in the market. Water transport services and Air transport services rely on Rental and leasing services (N77) – respectively 0.1303 and 0.1289; other transport and storage industries do not use relatively so much Rental and leasing services per unit produced.

The analysis of technical coefficients of primary factors indicates that even despite technologies and automatization (and other labor replacing processes) transport and storage sector industries still are more labour-intensive rather than capital-intensive (See Table 5).

Table 5
Technical coefficients of primary factors of Transport and storage sector in Latvia

Factor\ Product	H49	H50	H51	H52	H53
Compensation of employees	0.1571	0.3045	0.1229	0.1432	0.3842
Consumption of fixed capital	0.1107	0.3429	0.0280	0.0538	0.0988

Exports are have an upmost significance in economies with relatively small domestic market and are anticipated as one of the driving force of the economy. Extra final demand generates increase of domestic production (larger output of products); extra production demands additional resources and transport sector rely on almost completely imported products (as C19 Petroleum products). Another recent but growing trend is waste-reduction thinking and people (individuals and households as well) rethink their consumption patterns and change in order to be so-believed more eco-friendly or less waste generating and thus move towards sustainable economy.

Two comparative-static scenarios are estimated taking into account the above-mentioned sustainability trends in the economy:
1) 10% increase of exports of Land transport services and transport services via pipelines (H49) as companies in other EU are outsourcing carbon-intensive activities outside the country;
2) 10% decrease of households final demand expenditures on Air transport services (H51) due to environmental and waste reduction idea and relocate the saved expenditures (absolute value in money terms) to travel more by Land transport services (H49).

The results of the first scenarios estimated by input-output model claim that impact on the economy is not as high as it might be due to the fact that a large proportion of imported products are used in the economy.

Table 6
Results of estimated impact of increase of export of Land transport service by input-output model

CPA Code	Product	Output change (%)
H49	Land transport services and transport services via pipelines	4.1%
H52	Warehousing and support services for transportation	1.4%
C30	Other transport equipment	1.0%
C22	Rubber and plastics products	0.9%
N77	Rental and leasing services	0.7%
C20	Chemicals and chemical products	0.6%
C33	Repair and installation services of machinery and equipment	0.5%
R45	Wholesale and retail trade and repair services of motor vehicles and motorcycles	0.4%
C29	Motor vehicles, trailers and semi-trailers	0.4%
N79	Travel agency, tour operator and other reservation services and related services	0.4%

The results argue that the largest impact is detected in Warehousing and support services for transportation (output increased by 1.4% in comparison with the base), manufactured other transport equipment (1.0%) and manufactured rubber and plastics products (0.9%) (See Table 6).

The results of the second scenarios estimated by input-output model claim that households despite the considerable change (10% of expenditure spent on air travel services are located to less waste generating transport services as land transport) relatively by small extend can influence the economy (See Table 7). Only few industries in the economy have been affected by this change in the behavior of households. Regarding the case of Latvia, the households do not spend so much on air travel services and even 10% expenditure decrease results only in air travel services' final demand decrease of 3.2% and hence the effects on the output of other products are so weak. Only outputs of two products have been influenced by more than 0.1% in this scenario.

Table 7
Results of estimated impact of households' decision of replacing Air transport services with Land transport service by input-output model

CPA Code	Product	Output change (%)
H49	Land transport services and transport services via pipelines	0.4%
C22	Rubber and plastics products	0.1%
N79	Travel agency, tour operator and other reservation services and related services	0.04%
H50	Water transport services	0.02%
C29	Motor vehicles, trailers and semi-trailers	0.02%

In addition, the imports effect in the economy is examined by ratio of import to sectoral output computed on the basis of input-output data. The more products and services are produced nationally (locally), the more evenly the production and waste is distributed globally in condition of equivalent technologies are available. Even in a relatively small EU economy (as Latvia), the imported transport and storage services form relatively small share in respect to corresponding sectoral output (see Table 8), at the same time the national average of this ratio is 0.2552, several times higher than in the transport and storage sector analyzed.

Table 8
Ratios of import to sectoral output in Transport and storage sector in Latvia

Code	Economic activity	Ratio
H49	Land transport services and transport services via pipelines	0.0800
H50	Water transport services	0.0188
H51	Air transport services	0.1458
H52	Warehousing and support services for transportation	0.0603
H53	Postal and courier services	0.0410

The highest values are in air transport services (0.1458) as this service specific determines relatively high international

integration and large multi-national companies operate world widely in this sector. Majority of the imports are intra EU imports, mainly from the neighboring, at that moment, non-members of the euro area.

4. CONCLUSIONS

The results lead to conclusions that:

- Input-output model is a valuable tool to research and estimate intersectoral linkages regarding the transport and storage sector's impact on the economy; it gives notable results impossible to obtain by other models and approaches.
- Some transport and storage sector economic activities (as Warehousing and support services for transportation) are specialized in certain activity or sphere and hence are extremely interrelated and consuming a lot of services (products) of the same sector (from other companies in the economy) - in order to produce an output of one euro, 0.45 euros are spend on inputs of the same products.
- Applied input-output model involves the scenario analysis computing comparative-static results. Two scenarios are evaluated in the framework of the research.
- The results of the first scenario estimated by input-output model claim that impact on the economy is not as high as it might be due to the fact that a large proportion of imported products are used in the economy.
- The results of the second scenario estimated by input-output model claim that households despite the considerable expenditure change relatively by small extend can influence the economy; the households do not spent so much on air travel services and even 10% expenditures decrease results only in minor air travel services' final demand decrease and hence the effects on the output of other products are so weak.
- The imported transport and storage services form relatively small share in respect to corresponding sectoral output; national average of this ratio is several times higher than in the transport and storage sector analyzed.
- The input-output model is data demanding analytic and modelling tool hence the input data topicality and reliability are the keys to valuable and applicable results.

REFERENCES

[1] Eurostat (2018). National accounts aggregates by industry (up to NACE A*64). https://ec.europa.eu/ eurostat/data/database

[2] A. Beylot, J.Villeneuve, "Assessing the national economic importance of metals: An Input-Output approach to the case of copper in France", **Resources Policy**, Vol. 44, 2015, pp. 161-165.

[3] K.S. Wiebe, "The impact of renewable energy diffusion on European consumption-based emissions", **Economic Systems Research**, Vol. 28 no.2, 2016, pp. 133-150.

[4] R. Duarte, V. Pinilla & A. Serrano, "Factors driving embodied carbon in international trade: a multiregional input–output gravity model", **Economic Systems Research**, Vol. 30, No. 4, 2018, pp. 545-566.

[5] U.-P. Reich, "Accounting for international trade in value added: a comment on the OECD–WTO project", **Economic Systems Research**, Vol. 30, No. 4, 2018, pp. 462-477.

[6] Eurostat, **Eurostat Manual of Supply, Use and Input-Output Tables**, Luxembourg: Office for Official Publications of the European Communities, 2008.

[7] Eurostat, Supply, use and Input-output tables, 2018 https://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/data/database

[8] D.S. Meade, V. Ozoliņa, Applied Macroeconomic Multisectoral Modeling. Riga: RTU Press, 2018. 208 p. ISBN 978-9934-22-118-7. e-ISBN 978-9934-22-119-4. Available from: doi:10.7250/9789934221194

[9] S. Nabernegg, B. Bednar-Friedl, P.Muñoz, M. Titz, J Vogel, "National Policies for Global Emission Reductions: Effectiveness of Carbon Emission Reductions in International Supply Chains", **Ecological Economics**, Vol. 158, 2019, pp. 146-157.

[10] H. Yu, "A review of input–output models on multisectoral modelling of transportation–economic linkages", **Transport Reviews,** Vol.38 (5), 2018, pp. 654-677.

[11] R. Danielis, T., Gregori, "An input-output-based methodology to estimate the economic role of a port: The case of the port system of the Friuli Venezia Giulia Region, Italy", **Maritime Economics and Logistics**, Vol. 15 (2), 2013, pp. 222-255.

[12] A. Auziņa-Emsiņa, V. Ozoliņa, "Evaluation of Competitiveness of Industries in Regions and Global Market", Proceedings of the International Scientific Conference "Economic Science for Rural Development 2018, Latvia, Jelgava, 9-11 May, 2018. Jelgava: 2018, pp.17-25. e-ISBN 978-9984-48-293-4. ISSN 1691-3078. e-ISSN 2255-9930. Available from: doi:10.22616/ESRD.2018.064

[13] A. Auziņa-Emsiņa, V. Ozoliņa, "High-Technology Industries Competitiveness and Regional Allocation by Nuts 3 Regions in Latvia", Research for Rural Development 2017: Annual 23rd International Scientific Conference: Proceedings. Vol.2, Latvia, Jelgava, 17-19 May, 2017. Jelgava: 2017, pp.241-248. ISSN 1691-4031. e-ISSN 2255-923X. Available from: doi:10.22616/rrd.23.2017.074

[14] A. Auziņa-Emsiņa, "Labour Productivity, Economic Growth and Global Competitiveness in Post-Crisis Period", **Procedia - Social and Behavioral Sciences**, Vol.156, 2014, pp.317-321. ISSN 1877-0428. Available from: doi:10.1016/j.sbspro.2014.11.195