

# THE DEVELOPMENT OF ECONOMIC STRUCTURE AND INTER-INDUSTRY LINKAGES IN THE BALTIC COUNTRIES

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**Abstract.** *The article presents an analysis of the production and trade structure in three Baltic countries. Both exports and imports were emphasized, pointing out the importance of regional shifts and specialization patterns. The research was performed using the input–output model to determine the relative importance of respective production changes over time and the key differences among the Baltic countries. The paper also analyses the backward and forward inter-industry linkages of manufacturing and service industries. The results have indicated that during the period under analysis the share of sectors creating a lower value added has decreased, and a deeper economic integration was observed in the majority of industrial sectors of the Baltic countries with manifesting stronger forward linkages.*

**Key words:** *inter-industry linkages, economic structure, the Baltic countries*

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## Introduction

The European economic integration has substantially changed economic relations, positively affected the volumes of trade and the mobility of factors of production among the European regions. Interregional competition and the division of labour should receive further support; however, there is no explicit answer whether such changes are equally useful for all European countries. The key issue remains to be whether, due to an increase in regional integration, the cohesion and prosperity will increase or, vice versa, decline. Today, this issue becomes even more important for the new European Union (EU) members which use the economic integration process to achieve a higher level of economic development reached by the old member states, to increase productivity and gain a foothold in the higher value added production chain of goods and services. This is a complex task for the Baltic countries as the old EU member states tend to develop economic relations with the neighbouring countries rather than with the peripherally located Baltic countries.

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The question of economic integration while accessing the EU was widely discussed. However, the economic integration of the Baltic States has rarely been examined by evaluating the international interdependence with the EU countries and their economic sectors which, even in similar economic structures, may vary considerably depending on different multiplier effects.

The study was aimed to explore and compare the development of international economic integration of the Baltic countries and to determine what effect it had on the evolution of economic sectors in the period 1995–2009. The main hypothesis of the article is that the economic integration with the EU countries during this period has increased. To reveal the development and relations of the economic sectors of the Baltic countries, an interregional input–output model was applied, which was obtained by combining the national input–output tables with the international trade data. Unlike the conventional trade statistics, this method allows to determine reliably the interdependence of countries and economic sectors, whereas the consumption of goods and services can be broken down by using economic sectors and end users.

## **Literature review**

As a result of increased globalization, the international division of labour has also deepened in the recent decades. In this context, developed countries specialise in the production of capital-intensive goods while tending to import more and more necessary intermediate inputs and materials from less developed and lower-income countries. On the other hand, less developed countries attract foreign investment and also seek to gain a foothold in the higher value-added production chain due to cheaper factors of production, technology spillovers and other favourable conditions. Different interregional relations are established depending on the geographical situation, economic structures, political decisions, and the other reasons that affect the development and success of economic integration.

These and the related issues of economic integration of the EU countries have been analysed in a number of research papers. The results obtained are distinct due to the use of different methods, assumptions, and timescales. One of the most suitable instruments for this type of analysis is the Leontief input–output model as it allows the best assessment of the interregional flows of products among different countries as well as their economic sectors. For this reason, the input–output model has been chosen for this research. An input–output analysis enables to perform an investigation of different economic integration aspects depending on the model details. Analysis of trade flows is the most frequently used method, where flows can be subdivided into inter- and intra-industry trade.

According to Ricardo and Heckscher-Ohlin, the inter-industry trade is determined mainly by the differences in factor productivities or factor endowments among the coun-

tries. In contrast, intra-industry trade is the exchange of goods within the same industry. Trade within the sector may also be of a horizontal nature (trade in differentiated varieties of similar products manufactured with similar factor inputs) or a vertical nature (trade in similar products distinguished by quality and price). The latter is close to the traditional endowment-based model, whereas labour among sectors is assumed to be mobile. Thus, capital-intensive goods are vertically differentiated while labour-intensive goods are homogeneous. Such analysis using the input–output model allows defining changes in trade flows due to the economic integration. In general, researchers agree that the share of intra-industry trade in the Baltic countries has increased. A similar trend was discovered by Lithuanian researchers as a result of analysis based on traditional trade data (Bernatonyte, Normantiene, 2009). However, it does not reveal how deep the relations among countries and sectors are.

For a deeper analysis of economic integration, in addition to trade flows breakdown, the input–output model allows also the assessment of cross-sectorial inter-country relations indicating the extent of the integration of countries and sectors through direct and indirect spillovers (Miller, Blair, 2009). The direct effect occurs when an increase in demand for certain products in one country causes the increase in demand of required intermediate inputs (including imports) from other sectors. The indirect effect is an additional demand for products required to satisfy the additional demand determined by the direct effect. In this way, the dependence among the countries reflects an economic integration when changes in demand or supply in one country determine a change in the output in the same country as well as in other countries depending on the intensity of economic linkages. The dependence has a backward nature if the growth in one sector will result in the growth of its sectors-suppliers, and a forward nature if the growth in one sector will result in the growth of other sectors using the outputs of the first sector as intermediates (Hirschman, 1988). The forward dependence describes the supply side, while the backward dependence shows the demand side. The whole relations define the common dependence of one country or sector on other countries or sectors. The more changes demand or supply induce in the output in of other countries, the deeper the economic integration is.

Concerning the economic integration among the new EU countries, there are only a few researches in which the input–output model is used, whereas the structured data required for this model have not been systematically collected. The existing studies demonstrate the different status of old and new EU countries in the value-added chain.

The economic structure of the Eastern European countries (Czech Republic, Hungary, Poland, and Slovakia) were investigated by Černoša (2007, 2009) using the input–output model. He has found that the intra-industry specialization of these countries has a vertical nature and that they specialize mainly in producing lower-quality goods.

The studies indicate that the situation has changed slightly over time. In one of the recent studies, Zeddies (2011) analyses the nature of international trade in intermediary goods in the same Eastern European countries, i.e. in Czech Republic, Hungary, Poland, and Slovakia, as well as in more developed Western European countries. A comparison of flows between Western and Eastern European countries has demonstrated that exports from Western to Eastern Europe countries contain considerably more high-skilled factor services than imports to Western European countries from their Eastern European trading partners, whereas the trade data among Western European economies have indicated that the content of exports and imports differs only slightly. Cabral and others (2009) also draw attention to the fact that the composition of intermediary goods in the export and import flows among the countries with different levels of economic development differ significantly due to the skill-intensive manufactured goods.

Economic integration is taking place also among countries with a similar economic development, for example, among the OECD countries which have a higher level of economic development and are using similar factors of production and similar technologies. However, trade flows among such countries do not indicate any significant differences in their exports and imports (Nishioka, 2006). Some authors have noted a positive impact of the EU integration on the new Member States. Ito and Okubo (2011), who analysed trade flows during 1988–2007 in Eastern European countries, have found that trade flows within industry have a vertical nature, and the share of higher quality products has also increased.

Several studies carried out using the input–output model included also the Estonian case. In one of their recent studies, Backer and Miroudot (2012) while analysing the global value chains have found that the indicator of the Estonian participation in the global value chain is relatively high despite the long distances, although the country specializes in the production of inputs at the beginning of the global value chains.

There are also some researches based on the input–output model, which analyse inter-country cross-sectorial relations of the EU members, which cover a wider group of countries. The most comprehensive analysis is conducted by Yamano, Webb, Hewings (2012). They have found that all manufacturing sectors in the new EU member states have strong backward and forward linkages. However, the dependence of the Baltic countries was not specified, because the aim of the research was to reveal the global relations. The research has shown that among the Baltic countries Estonia has the strongest relationships in the global value chain.

In general, the results of the studies demonstrate a lack of in-depth analysis of the impact of economic integration on the development of economic sectors and international relations of the Baltic States. The purpose of the present study is to perform a deeper analysis of sectors of the Baltic countries.

## Methods

Based on the input–output model, it is possible to determine the share and destination of the exported products, the share and the origin of imported products as well as the differences among the Baltic countries and their changes during the period. The analysis focuses on the changes of economic structure of the Baltic countries as well as on international linkages. Two types of linkages have been investigated:

- backward: the total of direct and indirect purchasing inputs per sector (the ordinary production multipliers of the **Leontief inverse**  $(I - A)^{-1}$  minus the direct effect);
- forward: the total of direct and indirect processing outputs per sector (the production multipliers of the **Ghosh inverse**  $(I - \vec{A})^{-1}$  minus the direct effect).

While the Leontief inverse is based on the input requirement matrix  $A = [a_{ij}]$ , the Ghoshian inverse is based on the output allocation matrix  $\vec{A} = [\vec{a}_{ij}]$ . The elements of these matrices are computed in the following way:

$$a_{ij} = \frac{z_{ij}}{x_j}, \quad (1)$$

$$\vec{a}_{ij} = \frac{\tilde{z}_{ij}}{x_j}, \quad (2)$$

where  $z_{ij}$  is the input from  $i$  required in the production of  $j$ , and  $X$  is the total input or output.

Let  $(I - A)^{-1} = [b_{ij}]$  be the Leontief inverse matrix. The sector's backward linkage ( $BL_j$ ) and forward linkage ( $FL_i$ ) are defined as

$$BL_j = \frac{\frac{1}{n} \sum_{i=1}^n b_{ij}}{\frac{1}{n^2} \sum_{i,j=1}^n b_{ij}} = \frac{\frac{1}{n} \sum_{i=1}^n b_{ij}}{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n b_{ij}} = \frac{\sum_{i=1}^n b_{ij}}{\frac{1}{n} \sum_{i=1}^n \sum_{j=1}^n b_{ij}}, \quad (3)$$

$$FL_i = \frac{\frac{1}{n} \sum_{j=1}^n b_{ij}}{\frac{1}{n^2} \sum_{i,j=1}^n b_{ij}} = \frac{\frac{1}{n} \sum_{j=1}^n b_{ij}}{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n b_{ij}} = \frac{\sum_{j=1}^n b_{ij}}{\frac{1}{n} \sum_{i=1}^n \sum_{j=1}^n b_{ij}}. \quad (4)$$

The usual interpretation is to propose that, if  $BL_j > 1$ , a unit change in final demand in sector  $j$  will generate an above-average change in the activity of economy due to an additional demand of sector  $j$  for intermediate inputs. Similarly, for  $FL_i > 1$ , it is asserted that a unit change in the primary input of sector  $i$  would create an above-average production change in sectors using the output of the sector  $i$  as intermediate inputs. Thus, the key sector is identified as the one having both indices greater than 1. Such sectors show that some activities in an economy have the potential to generate a greater growth and, through their backward and forward linkages, spur the growth of the rest of the economy. In the article, in assessing relations among countries, and sectors a percentage expression of an indicator is applied.

## Analysis of sectors in the Baltic countries

An important challenge for each country is to ensure that economic sectors are competitive on the international market producing higher value added products, because such specialization generates a higher national income. Therefore, while analysing economic structures, it is important to draw attention to competitive and a greater value added creating sectors. For this purpose, the economic sectors of all Baltic countries have been divided according to their share in the country's economic structures and value added per working hour on the basis of the input–output model data in 1995 and 2009.

However, a greater share of value added created in a certain sector does not indicate its competitiveness in the international markets as the outputs of the sector may be dedicated more to meeting the domestic demand. Part of products may be unattractive to foreign markets because of relatively high transportation costs, different consumer priorities and for other reasons. A lower export is also typical of service sectors. For the purpose of a more detailed analysis, sectors exporting more than 30% of outputs abroad in Table 1 were marked in grey, and in bold if more than half of such sector's export is intended for the final consumption.

During the period under analysis, the economic structures of all three Baltic countries did not differ significantly (Table 1), and many common characteristics in structural changes of all Baltic countries can be observed as well. The value added share in the production of agriculture, hunting, forestry and fishing, food, beverages and tobacco, textiles and textile products in all three countries has decreased. In spite of significant structural changes, during the period, exports in Latvia and Estonia have remained mostly stable, Lithuania being an exception.

Exports in the total output<sup>1</sup> of economy in 1995 accounted for 21.1% in Latvia, 26.2% in Estonia, and 21.4% in Lithuania. In 2009, these figures in Latvia and Estonia were 19.0% and 26.6%, respectively, while in Lithuania they increased by 6.2 percentage points up to 27.6%. In Lithuania, in 1995, 12 economic sectors exported more than 30 per cent of the output, in Latvia 16, and in Estonia 15. In 2009, the number of such sectors increased to 20 in Lithuania, decreased to 14 in Latvia and grew to 17 in Estonia. The most significant structural changes in Lithuania were observed in the coke, refined petroleum, and nuclear fuel sectors, inland transport, other supporting and auxiliary transport activities, other manufacturing and wholesale trade sectors where both export share and the share of value added increased.

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<sup>1</sup> In order to determine the share of the output produced by a country or an economic sector, the ratio of export and the total output is used in this article rather than the usually used export and GDP ratio. The numerator of both indicators is the export, which includes the created value added as well as intermediate goods and services, which can also be imported from other countries. For this reason, the total output in the denominator was selected, which, unlike GDP, also includes not only created value added, but also intermediate goods and services.

The competitiveness of a country rises with a higher productivity, i.e. with the ability to create a higher value added per working hour. As we see in Table 1, the average value added per hour was similar in the Baltic States; however, quite significant differences among the sectors were observed. The real estate sector demonstrates the highest productivity; however, its export share is one of the smallest.

TABLE 1. Value added share in economic structure and value added per hour in 1995 and 2009

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
	Value added share in economic structure, %	Value added created per working hour, USD	Value added share in economic structure, %	Value added created per working hour, USD	Value added share in economic structure, %	Value added created per working hour, USD	Value added share in economic structure, %	Value added created per working hour, USD	Value added share in economic structure, %	Value added created per working hour, USD	Value added share in economic structure, %	Value added created per working hour, USD
Agriculture, Hunting, Forestry and Fishing	11.0	1.4	9.1	2.2	5.8	1.3	3.4	4.6	3.3	15.8	2.6	9.1
Public Admin. and Defence; Compulsory Social Security	10.0	4.2	7.0	2.9	5.4	2.7	7.5	14.7	8.3	17.7	7.7	18.5
Real Estate Activities	8.3	28.4	6.2	8.8	11.7	24.7	8.4	85.7	11.2	49.3	10.8	110.8
Retail Trade, except Motor Vehicles and Motorcycles; Repair of Household Goods	8.0	2.0	2.5	0.9	4.4	1.5	<b>6.9</b>	<b>8.7</b>	6.5	7.8	4.5	8.2
Construction	7.0	2.4	4.6	3.0	6.7	3.2	6.4	9.1	6.6	16.6	7.0	11.3
Wholesale Trade and Commission Trade, except Motor Vehicles and Motorcycles	6.3	5.4	6.1	5.1	6.2	5.0	7.6	20.4	6.9	17.9	6.5	38.3
Food, Beverages, and Tobacco	<b>5.9</b>	<b>2.8</b>	5.7	3.3	<b>5.5</b>	<b>3.1</b>	<b>4.0</b>	<b>14.6</b>	2.4	10.8	<b>2.2</b>	<b>12.7</b>
Electricity, Gas and Water Supply	5.0	3.7	5.0	6.9	3.4	3.9	3.9	26.8	3.6	38.7	3.9	39.7
Education	4.2	1.3	5.4	1.6	6.0	2.4	6.3	8.9	5.5	11.2	5.4	9.2
Inland Transport	3.8	2.2	3.9	2.1	3.9	2.2	6.8	17.6	4.6	18.5	3.8	13.9
Textiles and Textile Products	<b>2.9</b>	<b>1.7</b>	<b>2.3</b>	<b>2.0</b>	<b>2.8</b>	<b>1.7</b>	<b>1.2</b>	<b>5.5</b>	<b>0.5</b>	<b>5.2</b>	<b>1.0</b>	<b>7.5</b>
Other Community, Social and Personal Services	2.7	2.1	3.3	1.6	2.8	1.8	3.0	8.8	4.9	16.7	3.4	11.4
Health and Social Work	2.5	0.9	4.5	1.7	3.4	1.7	4.1	7.8	3.3	11.2	4.2	11.4
Financial Intermediation	2.1	3.5	5.0	8.4	2.2	5.7	2.3	17.9	6.1	40.9	3.4	30.0
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	1.9	7.5	5.4	6.9	2.6	2.3	3.8	39.0	3.4	18.0	4.0	20.7
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	1.8	1.4	1.3	3.0	1.8	2.1	2.4	9.2	1.8	9.9	1.9	10.4
Post and Telecommunications	1.7	2.6	5.0	9.3	2.9	4.7	2.8	28.7	2.6	30.5	2.7	33.7
Renting of M&Eq and Other Business Activities	1.6	1.4	3.8	4.2	4.8	3.7	5.9	12.4	8.7	17.9	10.5	24.7
Pulp, Paper, Paper, Printing and Publishing	1.5	4.8	1.8	3.9	1.6	4.5	1.0	13.8	0.9	13.9	1.2	15.1
Hotels and Restaurants	1.4	2.4	1.0	1.9	1.4	1.3	1.4	7.3	1.4	9.3	1.5	7.1

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
Chemicals and Chemical Products	1.4	5.2	0.6	3.9	1.8	5.7	1.7	24.7	0.6	20.9	0.7	23.2
Other Non-Metallic Mineral	1.1	1.9	0.6	2.2	1.0	2.3	0.5	7.4	0.5	13.2	0.8	17.4
Coke, Refined Petroleum and Nuclear Fuel	1.0	9.9	0.0	2.9	0.1	0.4	1.3	73.4	0.0	0.0	0.5	38.5
Electrical and Optical Equipment	0.9	1.1	<b>0.8</b>	<b>3.1</b>	1.1	2.6	0.8	16.3	0.6	16.6	1.9	12.2
Machinery, Nec	<b>0.9</b>	<b>1.3</b>	<b>0.8</b>	<b>2.2</b>	0.8	1.4	<b>0.5</b>	<b>8.7</b>	<b>0.3</b>	<b>8.9</b>	<b>0.7</b>	<b>13.0</b>
Wood and Products of Wood and Cork	0.9	1.7	4.0	2.6	1.7	1.5	1.2	8.3	1.9	12.4	1.8	11.8
Manufacturing, Nec; Recycling	0.9	2.4	<b>1.1</b>	<b>2.4</b>	<b>1.6</b>	<b>1.5</b>	<b>1.6</b>	<b>10.0</b>	0.6	8.5	<b>0.9</b>	<b>7.6</b>
Water Transport	0.7	5.8	0.1	5.2	1.7	5.2	0.4	35.9	0.1	49.8	0.5	16.8
Basic Metals and Fabricated Metal	0.5	1.8	2.0	4.1	1.2	3.6	0.7	12.3	1.0	11.4	1.5	11.4
Transport Equipment	0.5	1.7	<b>0.7</b>	<b>2.4</b>	1.2	2.7	<b>0.9</b>	<b>17.2</b>	<b>0.4</b>	<b>6.7</b>	<b>0.5</b>	<b>9.3</b>
Leather, Leather and Footwear	<b>0.4</b>	<b>1.8</b>	<b>0.0</b>	<b>0.8</b>	<b>0.3</b>	<b>1.8</b>	<b>0.0</b>	<b>4.2</b>	<b>0.0</b>	<b>5.7</b>	<b>0.1</b>	<b>5.6</b>
Mining and Quarrying	0.4	3.0	0.1	1.3	1.9	4.0	0.3	17.1	0.5	26.9	1.3	20.4
Air Transport	0.2	4.7	0.1	5.2	0.1	1.0	0.1	23.9	0.6	49.8	0.1	4.8
Rubber and Plastics	0.2	1.6	0.3	3.3	0.3	2.3	0.8	15.6	0.3	12.1	0.4	10.7
Private Households with Employed Persons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0	0.0	0.0	0.0

**Regular font** – sectors exporting more than 30 per cent of output for the intermediate consumption.

**Bold font** – sectors exporting more than 30 per cent of output for the final consumption.

Source: authors' calculations based on the WIOD database data.

At the end of the period, relatively more exporting and the highest added value per hour creating sectors in Lithuania and Estonia were the coke, refined petroleum and nuclear fuel sectors, in Lithuania wholesale trade and air transport, and in Latvia the mining and quarrying sector. In all three countries, other sectors also excelled (chemicals and chemical products, other supporting and auxiliary transport activities, and water transport sectors). During the period the share of most of these sectors has increased, though in a different scope.

Among the main exporting sectors in all three Baltic States, the lowest productivity was noted in the following sectors: leather, leather and footwear, textiles and textile products, other manufacturing and recycling. A considerable share of goods in these sectors are produced for final consumption. A significant part of output for the final consumption was exported to Russia and Germany, as well as to Finland and Sweden (in case of Estonia). However, export for the final consumption was dominated by relatively lower productivity products, while exports intended for intermediate consumption were dominated by relatively high productivity products in most of the sectors.

The proportion between intermediate and final consumption in the exports of goods from the Baltic countries during the period was very similar. A similar trend is observed in the advanced economies as well. This phenomenon is a result of output decomposi-



TABLE 2. **Backward linkages by countries, %**

	1995			2009		
	Lithuania	Latvia	Estonia	Lithuania	Latvia	Estonia
Lithuania	52.5	1.8	0.9	40.1	3.6	1.8
Latvia	0.7	52.7	0.8	1.5	66.9	1.8
Estonia	0.7	1.5	60.0	0.9	1.9	58.2
Russia	14.4	8.3	9.4	19.5	4.6	4.0
Germany	5.1	5.2	5.2	3.6	3.7	4.7
Finland	1.8	3.9	16.5	0.8	1.1	4.6
China	0.2	0.2	0.7	2.4	1.9	4.7
Sweden	1.2	2.8	4.5	1.1	1.3	2.8
Poland	1.7	0.9	0.4	3.9	2.7	2.0
Other NMS-12	1,4	1,7	1,2	1,4	1,4	1,4
Other ES-15	11,4	8,0	11,7	6,8	7,8	10,1
RoW	10,7	7,4	7,8	6,8	8,2	12,1
Total	101.7	94.3	119.2	88.5	105.2	108.4
Of them intercountry linkages	49.3	41.5	59.2	48.4	38.3	50.2

Source: authors' calculations based on the WIOD database data.

tion when production is fragmented into larger task sets many of which are carried out in different geographical locations. So, the value added in the production of final consumer goods not necessarily will be higher than in the production of intermediaries.

The research has also analysed sector linkages of the Baltic States with other countries. The identification of linkages facilitates a better understanding of the existing economic structures and their changes during the period.

In general, backward linkages indicate how much an increase in exogenous demand will change the endogenous output, which in turn further leads to changes in the demand for intermediate inputs. Causality runs from the demand for final (or higher value-added intermediate) products to the demand for raw materials, intermediary products, and primary inputs used in production process. In other words, it follows the respective production chains in the backward direction.

Table 2 demonstrates the percentage expression of estimated backward linkages revealing how much an output change in Estonia, Lithuania, and Latvia (direct effect) will further affect the change of output in the same and other countries (indirect effect). The more significant is the change in output, the stronger is the economic integration with the countries concerned. It should be noted that the results are partly influenced by the economic crisis in 2008; until then, both backward and forward linkages in all three countries had been somewhat stronger, however, the trend for all three countries remained the same.

Backward linkages in the Baltic States throughout the period indicate some different trends: the dependence of Lithuania and Estonia on the supply of intermediary products has decreased, while the dependence of Latvia, increased. In case of Latvia the increase of

backward linkages was influenced by the internal interdependence of the country's sectors in which the indicator of linkages has shown an increase by 14.2 percentage points. The internal interdependence of the Lithuanian sectors has decreased by 12.4 percentage points.

The dependence on foreign markets of the Baltic countries has changed slightly during the period. Internal interdependence in Estonia has changed only to some extent, although the relationship with foreign countries has decreased. The greatest reduction occurred in Finnish and Russian supplies of intermediary products. It should be noted that interdependence among sectors of the three Baltic countries has increased.

In the period under analysis, the Baltic States maintained strong economic relations with Russia and Germany. The backward linkages demonstrated an increased dependence of Lithuania and a decreased dependence of Latvia and Estonia on the Russian supply of intermediary products. The greater Lithuanian dependence on Russia was determined by coke, refined petroleum, and nuclear fuel sector's dependence. The dependence of the Baltic States on the supply of inputs from Germany has decreased, but the dependence on China, especially of Estonia, has increased. Lithuania's backward dependence on the other EU countries has declined, although Latvia's and Estonia's dependence remained relatively stable.

Forward linkages indicate how much the change of primary inputs in a country leads to changes of other sectors using products of the first country. In other words, it follows the respective production chains in the forward direction. This interpretation arises from the supply side of the input–output model, and it was criticized for some of its shortcomings (Dietzenbacher, 1997, Oosterhaven, 1996). However, it is not so important in determining the interdependence of countries and sectors, as in this case the structure at a given moment is analysed.

Forward linkages in Table 3 demonstrate an increased Latvian and Estonian and almost unchanged Lithuanian total dependence on the demand of its intermediate inputs.

TABLE 3. **Forward linkages by countries, %**

		Lithuania	Latvia	Estonia	Germany	Russia	Finland	Sweden	Denmark	Great Britain	Netherlands	China	Spain	Poland	Other NMS-12	Other ES-15	RoW	Total	Of them intercountry linkages
1995	Lithuania	52.5	1.2	0.6	3.8	5.5	0.4	1.9	1.6	2.4	1.6	0.2	0.7	0.9	0.7	5.3	8.6	<b>92.0</b>	39.6
	Latvia	1.0	52.7	0.7	3.4	4.2	1.2	3.6	1.3	3.7	1.2	0.4	0.3	0.3	0.1	3.9	2.5	<b>96.6</b>	43.9
	Estonia	1.1	1.7	60.0	3.8	4.4	8.9	5.2	3.7	3.3	3.3	0.2	0.8	0.8	0.7	3.8	2.6	<b>109.9</b>	49.9
2009	Lithuania	40.1	2.9	1.1	4.5	2.9	0.8	1.3	1.7	1.2	0.8	2.8	1.1	3.1	0.9	5.6	7.5	<b>91.7</b>	51.6
	Latvia	1.9	66.9	1.3	2.4	2.0	1.2	1.6	2.6	1.4	0.9	2.7	0.6	1.1	1.0	3.8	3.3	<b>109.9</b>	43.1
	Estonia	1.5	2.6	58.2	5.3	3.0	8.0	4.9	2.2	1.3	1.6	2.7	2.6	1.3	1.0	5.4	1.5	<b>116.9</b>	58.7

Source: authors' calculations based on the WIOD database data.

Dependence on foreign demand increased in Lithuania by 12.0 per cent points, in Estonia by 8.8 per cent points, while in Latvia changed only slightly. A. Strong forward dependence of the Baltic countries remains on Germany, slightly decreased on Russia, the Great Britain, but increased on China and Poland. Forward linkages demonstrate a stronger dependence than do backward linkages on a greater number of the EU countries.

Considerable information on interdependence is provided by the breakdown of backward and forward linkages by internal interdependence (Int) and external dependence (Ext). Intersectoral backward linkages indicate how much the growth of one sector will affect the growth of other sectors in satisfying the additional demand for inputs. Table 1 showed that some sectors exported relatively more, although generated a lower value added per working hour, for example, leather, leather and footwear, textiles and textile products, other manufacturing, recycling, wood and products of wood and cork sectors. Table 4 indicates that external linkages in these sectors have been strong and during the study period were not inclined to fall, except the leather and footwear sector.

The most significant increase in external dependence was observed in the Lithuanian sectors of coke, refined petroleum and nuclear fuel, chemicals and chemical products, and basic metals and fabricated metal sectors, in the Latvian sectors of other machinery, basic metals and fabricated metal, manufacturing, recycling, the post and telecommunications in the, Estonian sectors of rubber and plastics, chemicals and chemical products, transport equipment, and post and telecommunications. The major general backward linkages with foreign countries in all three Baltic States were observed in chemicals and chemical products and electrical and optical equipment sectors. In Latvia, more than in Lithuania or Estonia, backward linkages indicate the increased internal interdependence.

TABLE 4. **Backward linkages by sectors, %**

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext
Coke, Refined Petroleum and Nuclear Fuel	42.7	117.3	47.5	127.3	56.0	84.2	17.6	142.3	0.0	0.0	55.1	52.7
Chemicals and Chemical Products	34.4	94.5	33.6	85.5	64.2	85.6	13.8	111.7	44.3	91.2	55.3	95.1
Rubber and Plastics	36.3	101.4	42.1	90.6	46.7	96.9	31.5	95.2	56.2	101.2	53.2	108.7
Basic Metals and Fabricated Metal	55.5	70.6	55.6	79.9	50.0	99.7	41.1	90.7	43.5	123.3	59.6	106.7
Textiles and Textile Products	44.3	88.3	64.7	70.3	55.6	113.0	33.2	89.6	59.4	82.9	48.9	92.6
Electrical and Optical Equipment	54.9	86.4	34.6	75.4	37.7	137.5	41.4	81.7	44.8	77.1	41.8	118.2
Other Non-Metallic Mineral	59.0	71.2	42.9	74.6	61.3	81.6	38.7	73.8	72.8	71.5	64.3	65.8
Machinery, Nec	61.2	72.7	36.1	61.1	46.6	86.1	41.1	70.3	54.0	81.9	48.9	92.0
Air Transport	75.2	76.7	72.2	78.6	69.0	100.3	99.5	69.8	82.7	61.0	94.1	94.3

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext
Electricity, Gas and Water Supply	69.2	74.3	27.9	57.7	63.5	76.0	45.1	69.5	69.2	66.9	57.4	55.8
Transport Equipment	46.4	64.8	47.0	68.4	47.7	65.9	51.2	67.9	67.5	79.3	64.5	76.1
Food, Beverages and Tobacco	88.8	67.0	71.9	50.4	98.9	67.4	73.0	65.6	96.8	61.9	83.4	73.4
Leather, Leather and Footwear	63.9	80.4	57.3	81.2	58.6	101.9	58.5	64.5	57.7	42.7	50.7	84.0
Manufacturing, Nec; Recycling	63.4	66.7	66.9	55.1	58.9	86.7	52.3	63.3	81.8	74.4	75.0	86.2
Wood and Products of Wood and Cork	64.3	67.5	76.2	52.3	86.9	73.5	58.5	59.0	103.5	57.6	96.4	73.6
Agriculture, Hunting, Forestry and Fishing	72.4	56.6	67.7	48.4	85.9	63.1	72.2	58.7	75.9	60.5	68.5	63.8
Pulp, Paper, Paper , Printing and Publishing	49.0	64.4	40.9	55.4	64.6	63.0	47.3	56.3	65.7	61.7	71.9	72.0
Construction	51.3	61.0	57.9	65.1	51.3	87.3	48.1	49.1	101.7	68.9	62.0	69.4
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	48.8	48.7	65.9	53.4	87.0	79.2	49.1	41.3	69.5	39.2	120.6	78.4
Mining and Quarrying	51.5	41.7	40.6	56.2	46.4	59.0	43.2	37.9	58.8	50.0	38.9	53.9
Inland Transport	46.3	56.0	43.3	61.6	40.1	65.8	38.9	37.6	57.4	52.7	61.1	61.0
Water Transport	57.0	60.5	72.0	82.2	76.1	84.8	44.1	36.5	98.9	42.1	90.3	85.8
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	27.0	43.4	44.7	50.4	47.6	56.3	32.4	34.5	55.7	30.5	52.1	40.7
Health and Social Work	42.4	42.0	32.7	44.1	47.3	43.9	34.6	32.1	37.8	36.4	33.0	42.5
Other Community, Social and Personal Services	42.6	35.9	48.2	34.3	58.5	39.5	51.2	31.3	66.9	29.7	55.1	39.1
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	36.2	32.0	52.8	35.9	49.4	56.0	41.8	29.3	65.0	28.7	56.3	37.2
Financial Intermediation	48.1	22.5	42.8	17.9	59.7	36.3	62.4	24.8	44.2	16.0	58.1	26.6
Post and Telecommunications	36.7	32.4	24.8	11.4	44.6	30.8	27.4	23.2	76.9	27.5	62.3	40.3
Hotels and Restaurants	37.6	29.1	73.9	45.9	71.5	46.5	39.9	22.9	71.7	32.0	66.1	45.8
Public Admin and Defence; Compulsory Social Security	46.1	32.7	44.9	34.4	55.9	51.6	33.3	20.5	45.3	21.6	39.7	28.5
Renting of M&Eq and Other Business Activities	56.1	31.3	38.5	30.2	47.3	55.3	41.8	19.1	62.5	28.1	48.4	35.5
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	38.4	28.4	74.2	46.9	44.6	37.4	26.0	16.5	53.9	19.1	49.7	26.3
Real Estate Activities	19.8	11.7	24.8	15.6	21.4	14.7	29.9	16.2	77.8	22.4	31.1	18.4
Education	41.3	19.8	30.3	23.1	39.3	25.7	21.3	11.5	30.3	14.7	32.0	21.9

Source: authors' calculations based on the WIOD database data.

Intersectoral forward linkages indicate how much the growth of one sector will affect the growth of other sectors when using the output of the first sector as intermediate inputs to produce the sector's own products. Forward linkages are presented in Table 5.

The dependence of economic sectors of the Baltic countries on the foreign demand of intermediary products evolved unevenly. In some sectors, it was the internal dependence that has strengthened, while in others it was the external dependence. The dependence on foreign demand for supplies most significantly increased in the Lithuanian sectors of water transport, basic metals and fabricated metal, textiles and textile products, leather, leather and footwear, rubber and plastics, transport equipment, in the Estonian sectors of electrical and optical equipment, coke, refined petroleum and nuclear fuel, chemicals and chemical products, basic metals and fabricated metal, pulp, paper, paper, printing and publishing sectors, in the Latvian sectors of other supporting and auxiliary transport activities, the basic metals and fabricated metal, rubber and plastics, other manufacturing, recycling, transport equipment.

TABLE 5. Forward linkages by sectors, %

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext
Water Transport	83.5	102.4	0.7	151.8	32.4	136.2	10.2	145.8	0.1	157.8	92.0	154.4
Basic Metals and Fabricated Metal	9.9	82.5	96.2	102.7	66.3	107.6	20.2	133.5	39.6	182.2	53.1	136.8
Rubber and Plastics	4.4	42.4	60.5	50.0	23.6	129.8	28.6	129.8	72.9	102.5	12.5	155.0
Electrical and Optical Equipment	19.1	117.9	13.4	70.5	28.3	78.0	15.3	124.5	31.3	95.1	5.8	153.6
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	93.9	97.4	51.5	126.8	19.4	192.1	70.4	118.9	41.8	171.9	104.4	157.8
Coke, Refined Petroleum and Nuclear Fuel	21.6	111.8	23.9	49.1	92.9	69.0	16.9	116.5	0.0	0.0	13.8	132.3
Chemicals and Chemical Products	21.6	111.7	3.7	119.6	39.0	123.0	16.9	116.4	4.4	129.5	6.2	180.3
Inland Transport	55.1	85.6	50.8	90.5	83.3	55.4	34.2	107.8	62.2	87.5	79.3	67.8
Wood and Products of Wood and Cork	62.5	119.6	75.6	132.8	29.7	148.6	52.1	97.0	77.6	128.7	48.1	156.1
Pulp, Paper, Paper, Printing and Publishing	113.6	63.0	74.0	41.7	125.6	61.0	117.0	89.1	132.0	62.5	68.2	120.1
Leather, Leather and Footwear	30.0	45.9	5.1	68.7	6.8	26.6	77.2	86.6	62.7	43.2	5.8	41.7
Textiles and Textile Products	33.5	48.6	46.3	42.1	25.9	44.1	18.6	81.0	26.8	20.7	4.2	32.1
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	56.2	56.8	59.8	65.5	86.9	48.6	43.8	75.6	61.7	58.0	76.6	59.8

	1995						2009					
	Lithuania		Latvia		Estonia		Lithuania		Latvia		Estonia	
	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext	Int	Ext
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	50.3	46.0	87.8	50.0	111.2	48.1	41.1	58.7	71.8	45.3	94.5	47.2
Machinery, Nec	13.1	33.0	4.1	99.6	38.2	78.2	8.9	58.6	4.1	60.3	9.4	104.9
Renting of M&Eq and Other Business Activities	92.1	54.7	65.4	94.9	102.6	81.5	106.4	54.1	144.0	49.8	120.0	89.2
Other Non-metallic Mineral	58.0	42.2	102.9	60.4	54.9	103.0	47.4	53.2	127.6	71.0	53.5	117.3
Agriculture, Hunting, Forestry and Fishing	96.3	48.6	62.5	53.7	112.0	86.0	49.3	52.2	64.6	50.6	90.1	85.1
Transport Equipment	51.1	19.9	42.6	59.3	68.8	160.2	35.0	52.1	0.6	92.3	11.7	93.8
Air Transport	84.9	65.6	60.0	115.8	22.3	142.1	2.8	49.3	90.0	84.9	0.6	154.0
Post and Telecommunications	88.7	42.5	103.8	46.5	120.3	48.9	76.7	46.2	139.0	46.1	123.4	69.1
Manufacturing, Nec; Recycling	74.7	26.5	50.3	30.9	19.9	78.1	49.0	41.9	34.4	113.4	11.8	79.5
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	56.4	34.5	60.8	33.4	93.5	39.3	44.3	41.4	58.5	34.4	82.7	46.8
Financial Intermediation	135.1	37.0	70.2	38.4	141.9	65.5	107.7	38.5	86.9	34.4	97.1	76.2
Electricity, Gas and Water Supply	122.3	35.9	85.8	27.3	111.4	49.6	91.8	33.9	97.8	29.0	93.0	55.3
Other Community, Social and Personal Services	53.6	22.0	45.5	9.5	34.5	11.8	53.4	21.6	43.6	9.1	29.3	12.9
Food, Beverages and Tobacco	32.9	31.8	30.5	14.1	36.1	25.4	29.3	18.1	47.7	16.8	28.1	18.4
Real Estate Activities	59.1	15.0	84.1	25.0	53.8	17.2	41.5	17.0	97.1	20.9	63.4	24.5
Mining and Quarrying	2.5	0.9	142.5	142.2	129.9	58.1	48.9	15.0	102.5	112.6	148.7	68.9
Hotels and Restaurants	36.4	10.3	22.6	10.6	42.3	21.3	25.6	11.9	15.1	7.3	20.5	10.7
Construction	10.9	4.4	42.7	9.0	46.3	26.0	25.7	8.1	78.3	23.2	29.7	18.5
Education	12.5	2.1	5.0	1.4	10.5	2.9	8.5	2.2	14.0	3.8	8.7	3.0
Public Admin and Defence; Compulsory Social Security	3.4	1.4	1.8	1.2	11.4	7.5	1.6	1.7	1.3	6.9	7.4	6.2
Health and Social Work	16.3	3.2	9.1	3.7	13.9	3.0	3.5	1.4	8.8	2.2	7.6	2.5

Source: authors' calculations based on the WIOD database data.

The forward linkages with foreign countries in all three Baltic States were significant in the sectors of water transport, basic metals and fabricated metal, electrical and optical equipment, other supporting and auxiliary transport activities, chemicals and chemical products, wood and products of wood and cork. In general, a deeper integration of the Baltic countries is observed in industry sectors with stronger forward linkages.

Usually, as the key sector, the one having both forward and backward linkage indices greater than 100% is identified, regardless of which dependence, internal or external, is stronger. In the economic integration approach, the sectors where backward linkages (BL) and forward linkages (FL) with foreign countries are stronger can be described as key sectors, because their economic activities exert a greater impact on the economy of foreign countries. For this purpose, the sectors indicating the forward or backward dependence on foreign countries as more than 100% are listed in Table 6.

TABLE 6. **Key sectors of the Baltic countries in the approach of economic integration**

	1995			2009		
	Lithuania	Latvia	Estonia	Lithuania	Latvia	Estonia
Mining and Quarrying		FL			<b>FL</b>	
Textiles and Textile Products			BL			
Leather, Leather and Footwear			BL			
Wood and Products of Wood and Cork	FL	FL	FL		FL	FL
Pulp, Paper, Paper, Printing and Publishing						FL
Coke, Refined Petroleum and Nuclear Fuel	<b>BFL</b>	BL		<b>BFL</b>		FL
Chemicals and Chemical Products	FL	FL	FL	<b>BFL</b>	FL	FL
Rubber and Plastics	BL		FL	FL	<b>BFL</b>	<b>BFL</b>
Other Non-metallic Mineral			FL			FL
Basic Metals and Fabricated Metals		FL	FL	FL	<b>BFL</b>	BFL
Machinery, Nec						FL
Electrical and Optical Equipment	FL		BL	FL		<b>BFL</b>
Transport Equipment			FL			
Manufacturing, Nec; Recycling					FL	
Inland Transport				FL		
Water Transport	FL	FL	FL	FL	FL	FL
Air Transport		FL	<b>BFL</b>			FL
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies		FL	FL	FL	FL	FL

Source: authors' calculations based on the WIOD database data.

The backward and forward linkages are strongest in the Lithuanian sectors of coke, refined petroleum and nuclear fuel, chemicals and chemical products. These sectors have also generated a higher value added per working hour. The Latvian and Estonian key sectors of rubber and plastics, basic metals and fabricated metals, and the Estonian electrical and optical equipment sector are not high value added sectors; however, due to a deeper integration, they have a greater potential to grow and create higher value added products in future. Strong forward linkages are observed in all Baltic countries in wood and products of wood and cork, chemicals and chemical products, rubber and plastics,

basic metals and fabricated metals, water transport, and other supporting and auxiliary transport activities. This demonstrates a stronger dependence of these sectors on the foreign demand for supplies. As compared with the advanced EU economies, these sectors create a lower value added per hour, which reveals their specialization at the beginning of the value chain. However, these linkages should be taken into consideration in order to encourage exports, because these sectors have better prospects because of their stronger linkages.

## **Conclusion**

In the period under analysis, changes in the economic structure of the Baltic countries have taken place: the share of sectors creating a lower value added has decreased, but the export share in output during the period has increased only in Lithuania, whereas in Latvia and Estonia it has remained largely stable.

The export intended for the final consumption was dominated by products with the relatively lower productivity, while the exports intended for the intermediate consumption were dominated by relatively higher productivity products in most of the economic sectors. In the period under analysis, the proportion of the intermediate and final consumption in exports of goods and services from the Baltic countries was very similar. A similar trend is observed also in the advanced economies. This demonstrates that production is fragmented into larger task sets many of which are carried out in different geographical locations. This trend indicates that for the Baltic countries it would be useful to specialise in the production of higher value-added intermediary products.

This assumption is confirmed by the analysis of international relations of the Baltic countries, based on backward and forward linkages. The results show that in the period under analysis the Estonian and Lithuanian forward linkages with foreign countries have increased whereas the, Estonian backward linkages have decreased, and the Latvian linkages have changed only slightly.

A deeper integration was observed in most of industrial sectors manifesting stronger forward linkages. This indicates a greater dependence on foreign demand of intermediary products of these sectors. Strong forward linkages in all Baltic countries are observed in the sectors of water transport, wood and products of wood and cork, chemicals and chemical products, rubber and plastics, basic metals and fabricated metals, electrical and optical equipment, and other supporting and auxiliary transport activities.

Forward linkages have also indicated a stronger dependence of the Baltic States on a number of EU countries. In comparison with advanced EU economies, the sectors of Baltic countries create a lower value added per hour, which is revealed by a specialization at the beginning of the value chain. However, due to a deeper integration, these sectors have a greater potential to grow and produce higher value-added products in future.



This analysis contributes to the research of other authors on the subject of economic integration of the Baltic countries. The obtained results confirm the hypothesis that integration with the EU is increasing, and provide a useful stimulus to encourage exports and economic growth.

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