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# THE EFFECT OF CHANGES IN PRODUCTIVITY ON THE DEVELOPMENT OF LOGISTICS SERVICES IN EUROPEAN COUNTRIES

Case  
Study

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Road freight;  
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River, sea freight;  
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## Abstract

*The development and international competitiveness of Hungary's international relations depend on several factors. Nowadays, new production technologies have accelerated the ability of companies to produce. Thus, the delivery of goods in terms of tonnes per kilometre has also significantly increased. In recent years, instead of a labour-based economy, knowledge-based competitiveness has come to the fore. Some companies engage in intense international procurement but produce and sell on the local market, while other companies buy and produce in the country but sell on the international market. This study intends to analyse the data related to the transportation of goods and the strategic development of production networks for foreign and Hungarian companies. The main question is how the improvement in each country affects the national and international transport of production companies. This article focuses on the period 2010-2017. The goals are to see how fast production companies have changed in relation to Hungarian and international freight goods transport and how productivity has changed. There are several ways of transport: by water (rivers and sea) and land (road and rails). The analysis of relations used data from the Organization for Economic Cooperation and Development (OECD) from ten members of the European Union: Austria, Denmark, Estonia, Finland, France, Luxembourg, Hungary, Portugal, Sweden, and Slovakia. The relationships between the data were analysed using different descriptive statistical methods. The result of the research may have an impact on the development of international relations between production companies and the re-thinking of their production strategies.*

## INTRODUCTION

The global economic crisis of 2008 also affected international freight transport, and thus reduced international trade and also significantly reduced foreign investment (Mester and Tóth, 2016). The crisis caused major problems in Hungary, as Hungary was not able to handle such a change (Karmazin et al., 2013). One of the engines of recovery from the crisis was the growth of production and services, and the development of logistics and international trade (Chikán, 2013; Slusarczyk and Golnik, 2015).

Logistics has a significant impact on Hungary's international competitiveness as more and more production companies join the international trade market. Nearly 8% of domestic enterprises and about 24% of foreign companies had export income, according to data for 2014 (Vakhal, 2016). One of the decisive factors of production resources is the proper development of the supply chain, which acts as an independent industry in the economy and accounts for more than 6% of the national economy (Egri, 2017), as well as the networks of companies cooperating with each other (Sroka and Hittmar, 2013, 2015).

As logistics is one of the key determinants of competitiveness, it is a relevant research question to examine how changes in productivity affect the development of domestic and international logistics networks (Tóth and Kozma, 2016) and the spread of the three main types of supply chain (road, rail, and river and sea). Coordinated implementation of logistics processes is essential for the smooth operation of the procurement and sales activities of production companies (Horváth and Karmazin, 2014; Draskovic, 2019; Kot and Pigon, 2014; Kot et al., 2018).

The goal is to examine how the improvement in production performance affects the national and international transport of production companies. There are very large differences between the different regions in the quantity of goods delivered per tonne. The Statistical Database of the Organization for Economic Co-operation and Development (OECD) was used to identify the relationships. Ten European Union Member States were selected for the period 2010-2017. The relationships between the data were analysed using different descriptive statistical methods.

The result of the research may have an impact on boosting the international relations of production companies and rethinking their production and logistics strategies.

## LITERATURE REVIEW

The definition of an international business is a business that deals with transactions involving

services, products, and resources between two or more nations (Drotski and Okanga, 2016; Johanson and Vahlne, 2009; Meyer, 2018). This international cooperation does not mean that production companies should set up an establishment abroad, but that they establish links with cross-border companies through their export activities. Export and import activities have an impact on innovation activity and increase competitiveness and business performance, as supported by numerous studies (e.g. Lööf and Heshmati, 2002; Kemp et al., 2003; Halpern and Muraközy, 2010; Hashi and Stojcic, 2013).

It seems that manufacturing companies prefer to build international relationships for certain reasons: they either want new challenges, because they don't have the opportunity on the domestic market, or they simply open cross-border companies in order to survive (Hitt et al. 2006).

The EU has one advantage over its competitors and that is the macroeconomic environment created by the adherence to the Maastricht criteria. In terms of market size, innovation and business complexity it lags far behind the US and Japan, and European R&D activity is also weaker (Vakhal, 2016).

## PERFORMANCE OF FREIGHT TRANSPORT

Freight transport is the physical process of transporting goods, serving certain social needs. The delivery of the same quantity of products may be different depending on the distance the given passenger or freight volume needs to be carried, i.e. the performance also depends on the quantity and distance, which is the basis for the tonne/kilometre performance of the delivery. The performance basis determines the freight price, which is the same regardless of the sector. The following variables are considered when measuring performance (Szegedi and Gerhard, 1985):

Q: weight of freight volume (usually expressed in tonnes),

L: number of passengers (persons),

S: transport distance

T:  $Q \cdot S$ , tonne-kilometres,

U:  $L \cdot S$ , passenger-kilometre.

This research examines the performance of freight tonne/kilometres between countries based on three transport modes: road, rail, river and sea. The size of the shipment and the frequency of delivery affect the choice between the freight sectors.

**Road freight transport** is becoming more and more important in Hungary, as it is the most popular type of transportation and affects both its economy and international competitiveness. Cooperation is especially important for European countries so good infrastructure and transport

conditions are of significant importance (Karmazin and Tóth, 2016; Meyer and Meyer, 2016).

In recent years, there have been acquisitions and mergers in the road transport market. Several freight forwarding companies use hiring or leasing contracts to finance freight equipment, which is financed by income from freight services (Oláh et al., 2018).

In Hungary, the demand for road freight transport is constantly increasing, with nearly 70% of deliveries completed in this way. This may be due to the fact that road transport provides the greatest freedom of movement. Nowadays, the transportation of goods all over the world has been simplified by the appearance of containers, so more than 70% of transportation takes place with the help of containers (Nagy and Forgó, 2017).

One of the biggest advantages of road freight transport is that it is faster than rail, river and sea freight; carriage is door-to-door, so it is possible to deliver the goods directly to the buyer without transfer. The most significant drawback is pollution of the environment by vehicles. Delivery time of goods is influenced by traffic restrictions and congestion at border stations so calculating the exact time of delivery is not always possible (Pasaoglu et al., 2016).

Over the past ten years, Hungary's road network has undergone continuous investment and development, and in recent years, the modernization of railway lines has also begun. The volume of goods transported on the road is constantly increasing, while in the case of rail transport this proportion is almost unchanged.

In Europe, Hungary has one of the most extensive **rail freight networks** in terms of population and territory. Currently, the length of the railway infrastructure is 8,000 km, which is characterized by rather low quality parameters (Oláh et al., 2017a). Nearly 50% of the rail network is subject to speed limits, and multiple track crossings are required in many sections.

The competitiveness of rail freight transport is severely undermined by the high usage fee, which exceeds total costs by more than 30%. This ratio is below 10% for road freight. Additional costs include access charges at the storage location, the railway station and the access fees at border stations (Indóház Extra, 2015).

In the case of rail transport, it is possible to transport heavy and bulky goods in a more environmentally friendly way than road transport. However, the route is predetermined so there is no door-to-door delivery and it is uneconomical over a short distance. The price calculation is inflexible and a track or branch line near the dispatch point is required (Oláh et al., 2017b).

Unfortunately, over the years, we have not paid attention to the deterioration of the state of the railway track and other complementary

infrastructure (such as station buildings), so we are in the lower quartile of the EU ranking in terms of rail development (Galambos, 2010).

**River and sea freight transport** primarily enables goods to be transported over long distances between different continents. It is advisable to use it when the delivery time of the goods can be relatively long. Taking into account the mass of goods transported and the transport distance, the most popular transport branch is maritime shipping. In 1955, the Danube shipping companies signed the Bratislava Convention, which agreed on the terms of water freight transport. Apart from Hungary, the Convention was signed by shipping companies from Austria, the Czech Republic, Bulgaria, the Federal Republic of Germany, the Soviet Union and Yugoslavia. The international agreement was redrafted in 2000 in order to harmonize the river and sea freight law across Europe and to determine freight rates between ports (Bányai, 2014).

Of the three modes of transport examined, the specific energy demand of river and sea transport and the environmentally damaging effects are the lowest, so this mode of transport can be considered relatively inexpensive and environmentally friendly. Its tariffs are flexible and water freight can be used to transport all types of goods. One of the drawbacks of the service is the long delivery time of the products; other hindering factors can include too high or low water levels, ice drifts and freezing in the winter. It is not suitable for direct delivery between consignor and consignee since multiple reloading of goods is required (Hollik, 2017; Ngouapegne and Chinomona, 2018).

## PRODUCTIVITY

The new millennium has brought technological advances (robotics, information technology, cyber-physical systems, biotechnology) that have changed production strategies so that it is impossible to engage in production without the expertise of the so-called fourth industrial revolution (Erdei et al., 2018).

There are several different definitions of productivity in international literature but in practice they all share the same elements, i.e. added value per unit of labour, time, cost, and investment, etc. Such variables may give insights into how efficient a given enterprise or economy is on average. The more values you can create at a given cost, the better the competitiveness of the company is. Competitiveness is, of course, not only a function of technology (Sadaf et al., 2018), since in that case all companies, regardless of environmental conditions, would be able to operate with the same efficiency, as technology can be obtained at any time, and procedures can be

learned. Productivity depends on the country in which the production companies operate, and on what micro and macro environment they operate in. Different territories have completely different economic and social environments; different countries have different investments, labour markets and different advantages and disadvantages (Meyer et al., 2016; Nagy et al., 2018). Unfortunately, most economic indicators cannot measure production companies and there are no statistics available that would allow international comparison. Accurate information about the economy is needed to measure competitiveness. According to findings from research on academic publications competitiveness, logistics, production and Industry 4.0 will remain the focus of interest in the future (Nagy et al., 2018). It is important that the theoretical and practical development of these areas continues.

## MATERIAL AND METHOD

The aim of the research is to reveal changes in freight delivery and productivity in a Hungarian and international (EU member states) context. The study covers 10 countries in the period 2010-2017. The analysis examined the changes in the volume of products launched on the market by production companies in a quarterly breakdown; it also discovered how the improvement in production performance affects three types of goods transport (road, rail and river, sea) on a national and international scale. The development of the transportation of goods in Hungary and internationally is also studied in production companies as well as the changes that have occurred in the productivity of the examined countries over the last 8 years.

Data was taken from the OECD Statistical Database, which gives more accurate insights into the domestic and international logistic relationships among production companies and the changes made in productivity. Variables have been selected from a database which was set up decades ago and has since been updated yearly (Table 1).

The relationships between the data were analysed using different descriptive statistical methods. The analysis of the data collected for 8 years illustrates how the productivity of the production companies influences the quantity of goods in tonnes per shipment and the development of Hungarian and international logistics connections.

## FINDINGS EXAMINING INTERNATIONAL TONNE- KILOMETRE PERFORMANCE

This research examines the performance of three different types of freight (road, rail and river, sea) in the following 10 EU countries: Austria, Denmark, Estonia, Finland, France, Luxembourg, Hungary, Portugal, Slovakia and Sweden.

Due to the economic and financial crisis in Hungary in 2009, the total quantity delivered (in terms of tonne-kilometre performance) decreased continuously to 2012. Subsequently, the importance of freight transport increased as the economic environment changed and the number of investments and the developments related to Industry 4.0 increased.

The OECD statistical database was used in studying the volume of goods transported by the three most common modes of transport per tonne.

The performance of tonne-kilometres of road freight was analysed both nationally and internationally. In terms of **international road freight transport**, initially (2010) Sweden and then Finland transported the least amount of goods internationally. In the period 2015-2017, Slovakia's international freight transport registered the highest value in the data series, with a peak performance of 29,071 million tonnes in 2017 (Figure 1). Slovakia's international freight transport has increased by 31% over the past 8 years, the highest growth in percentage. The biggest decline (62.34%) was registered by Finland's international transport. Out of the 10 countries, only 4 countries (Hungary, Slovakia, Estonia, Portugal) have increased freight tonne/kilometre performance.

In 2010, Portugal was ranked first in international road freight transport (22,602 million tonne-kilometres), but its place was taken by Slovakia in 2011 and then Hungary in 2012 with 24,545 million tonne/kilometres. During the years under review, Portugal's international road freight transport decreased by around 4%. Each year, Hungary, Slovakia and Portugal always performed above average, and France, Denmark, Estonia, Finland, Luxembourg and Sweden were always below average.

Hungary saw an increase in tonne-kilometre performance in international road freight, except for 2017, when it fell by 620 million tonne-kilometres compared to the previous year. The above findings reflect the performance of international road haulage. Volumes in some countries decreased, while elsewhere, they increased by more than 30%, reflecting the impact of favourable developments in the real economy.

In Hungary in 2017, 30% of the volume of goods transported by road was moved domestically within the country. This proportion is still typical in Estonia and Portugal of the surveyed countries. In

France and Finland, about 95% of the products are delivered to users by domestic transport, while in Denmark and Austria the proportion is 80% and 63% respectively. In contrast to international freight transport, the four countries focus on domestic freight.

In terms of **domestic road haulage**, Luxembourg has the lowest tonne-kilometre performance, while France ranks first each year. Domestic road haulage, with the exception of two countries (France, Portugal), increased compared to 2010, showing that countries are striving to support their economies by boosting domestic commodity transport.

As for the average domestic tonne/kilometre performance for the surveyed countries, only France and Sweden are above average each year for the 2010-2017 period. This means that domestic transport in both countries has a significant weight compared to other countries. In 2017, the figure for France was 156,434 million tonne-kilometres, and for Sweden 38,553 million tonne-kilometres.

Luxembourg comes last in terms of **international rail freight** tonne-kilometre performance (Figure 2). The rail network is not properly built up in this country, so the use of this freight option is negligible. Analysing international rail freight, Austria is ranked first among the surveyed countries. In this country, the opportunities offered by railways are fully exploited, and have been steadily increasing in recent years. Austria's tonne-kilometre performance of national rail freight in 2017 (17,672 million tonne-kilometres) is also well ahead of international road freight (9,174 million tonne-kilometres).

In the past 8 years, national rail freight has decreased in Estonia, Luxembourg and Slovakia, and has risen most in Portugal. Portugal has outstanding performance in international road and rail freight. In France, the utilization of the international rail network is higher (12,836 million tonne-kilometres) than the road (6677 million tonne-kilometres) for 2017.

Hungary's international rail freight transport has grown by 25% since 2010, with a 22% increase in road use. The performance of international river and sea freight transport in Hungary has decreased by approximately 17%. In terms of the utilization of the **national rail network**, and freight tonne-kilometre performance on rail tracks France ranks first each year. Austria ranked 3rd of the ten countries (4584 million tonne-kilometres) in 2017 (Figure 3).

Slovakia is characterized by international transport of goods by rail rather than by domestic rail freight, while **domestic river and sea freight** is the lowest in this country. Its value in 2017 was only 1.4 million tonne-kilometres.

The OECD database provided information on river and sea freight transport only for the following countries out of the ten surveyed ones: Austria, France, Hungary, Slovakia, Finland, Luxembourg.

In France, Austria and Slovakia, the tonne/kilometre performance of **international river and sea freight** has declined, but their domestic performance has risen over the past 8 years. Slovakia has focused less on river and sea freight in recent years, and its international use has declined by around 20% since 2010.

In Hungary, international river and sea freight transport has increased in recent years and domestic transport has declined. Its domestic river freight transport was the most prominent in 2014 (13.6 million tonne-kilometres) but it now barely reaches 6.4 million tonne-kilometres.

At present, the share of road freight transport is the largest but compared to the first quarter of 2017, the international performance in tonne-kilometres in all countries decreased in the first quarter of 2018. Rail transport accounts for only 21% of the total transport while road transport accounts for about 75%.

Examining the three types of goods transport in 2017, a total of 340 152,7 tonne-kilometres were transported nationally while internationally 336,306 million tons were transported by the ten countries, which marks an increase of about 8% compared to 2010. The seasonality of freight transport can be well observed in each time series, which indicates that the 3rd quarter of each year is the strongest in terms of freight tonne-kilometres.

#### PERCENTAGE CHANGES IN PRODUCTIVITY

Analysing the productivity of production companies in the 2010-2017 period, Estonia recorded nearly 40% growth (Figure 4). With productivity growth in Estonia, the international road freight tonne-kilometre performance rose in approximately the same proportion as national road freight. While productivity in the country rose to a large extent and road transport increased by around 18% (576 million tonne-kilometres), in national and international terms, the performance of international rail freight decreased by 72% (4310 million tonne-kilometres) in the previous 8 years.

Analysing productivity growth, Slovakia came second with a 30% increase between 2010 and 2017. Increasing productivity in Slovakia was accompanied by an increase of around 30% in the performance of national and international freight kilometres, which means a performance of 7950 million tonnes of freight. This increase only applies to road freight transport, as national and international rail performance dropped by 4% (361 million tonne-kilometres) and river and sea

performance by 21% internationally and 65% nationally over the past 8 years, totalling 256 million tonne-kilometres. This means that the growth of road haulage can be influenced by productivity growth and also by the decrease in rail and river and sea freight. Since the decline in rail and river and sea freight transport was much lower than the increase in freight tonne-kilometre in road freight transport, productivity can be said to have had a positive impact on freight transport.

A more than 25% increase is also typical in Hungary, which can affect the growth of road, rail and river and sea freight in national and international terms. In Hungary, along with productivity, international road freight transport increased by 5095 million tons over 8 years, while domestic road freight by only 870 million tons of freight. In Hungary, the volume performance of international rail freight (1878 million) and national (657 million) also increased. This shows that productivity in Hungary has clearly increased the performance of international freight tonne kilometres.

Among the surveyed countries, Sweden's productivity increased least, by just 1.3%, affecting the unchanging volume of goods transported. Sweden's international road tonne-kilometre performance dropped by 241 tonnes in 8 years but its domestic freight performance increased by 5815 tonnes. In spite of the increase in the proportion of domestic road freight, rail freight decreased by 1,626 tons. If we consider the last 8 years, then a similar economic situation is typical for Portugal and Finland.

It can be concluded from the above analysis that a change in productivity affects the change in tonne-kilometre performance but we do not know to what extent as the types of goods transport interact with each other at the same time. This means that when rail freight changes (for example, decreases) road freight can also change (grow). The change in productivity alone does not determine changes in the types of goods transport (road, rail and river).

## CONCLUSIONS AND RECOMMENDATIONS

Production companies need to keep in touch with companies not only nationally but also internationally as they can improve their business performance and maintain their long-term competitiveness by initiating and developing international freight.

The research examined changes in productivity and freight transport among domestic and EU production companies. The analysis was conducted for production companies from ten countries in the period 2010-2017. During the analysis, the spread of freight (road, rail and river,

sea) was examined to measure the performance of tonne/kilometre.

Productivity has risen by nearly 40% in Estonia, which may have a positive impact on road transport, with a tonne-kilometre performance increase of approximately 18% in national and international terms over the past 8 years. However, the performance of rail freight has decreased by 4310 million tonnes of freight.

In Hungary, with a 25% increase in productivity, the performance of international road and rail freight transport has significantly increased compared to the domestic tonne/kilometre performance, which shows that in Hungary the change has clearly increased international performance.

When examining the total turnover of goods the findings show that the change in productivity has a positive effect on the transport of goods. The growth of road freight transport can be influenced by productivity growth and a decrease in rail and river and sea freight. For this reason, the change in productivity influences the change in tonne-kilometre performance but we do not know to what extent each type of freight (road, rail and river, sea) has an impact because the types of goods transport interact with each other at the same time. The analysis also shows that the productivity changes may have a positive or negative relationship with the development of rail freight, which also confirms that the development of certain modes of transport does not depend only on productivity.

The seasonality of freight transport can be well observed in each time series, which indicates that the 3rd quarter of each year is the strongest in terms of freight tonne-kilometres.

Examining the three ways of transport used by production companies, it can be said that road haulage utilization is the highest in both Hungary and the European Union countries on the basis of tonne-kilometre performance. This may be due to the fact that road transport provides the greatest freedom of movement.

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**TABLES & FIGURES**

Table no 1  
**Presentation of a database, description of variables.**

Country	Change in productivity (%)	Freight delivery on a national and international level (million tonnes)
Austria Denmark Estonia Finland France Luxembourg Hungary Portugal Sweden Slovakia	manufacture, base year=2015	Public road delivery  Rail delivery  River, sea delivery

*Source: Author's own editing, 2019.*

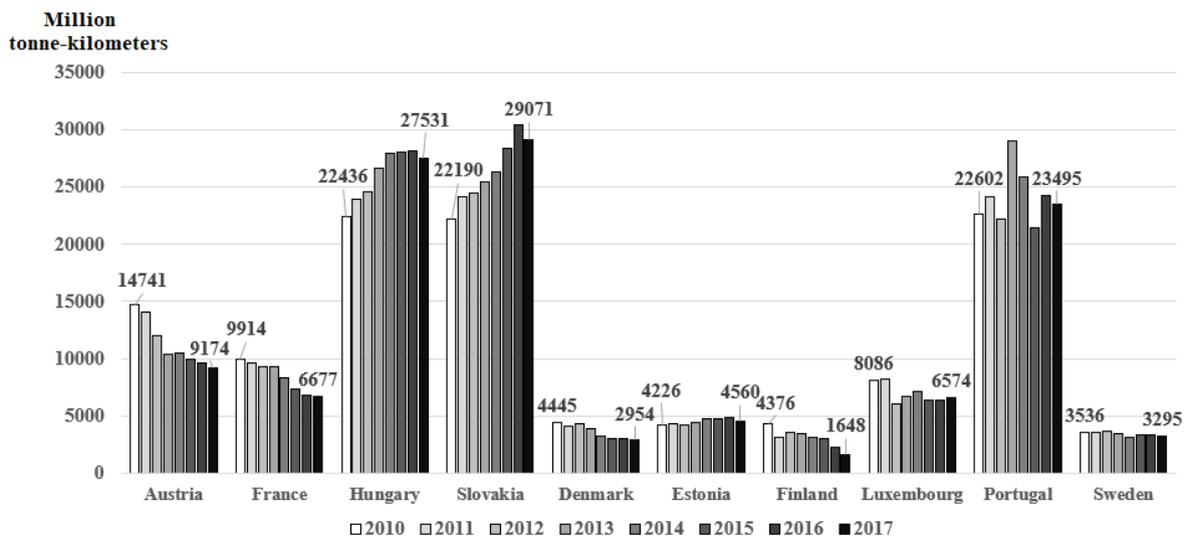


Figure no. 1  
**International road freight delivery performance in tonne-kilometres, 2010-2017.**

*Source: Author's own editing, based on OECD, 2019.*

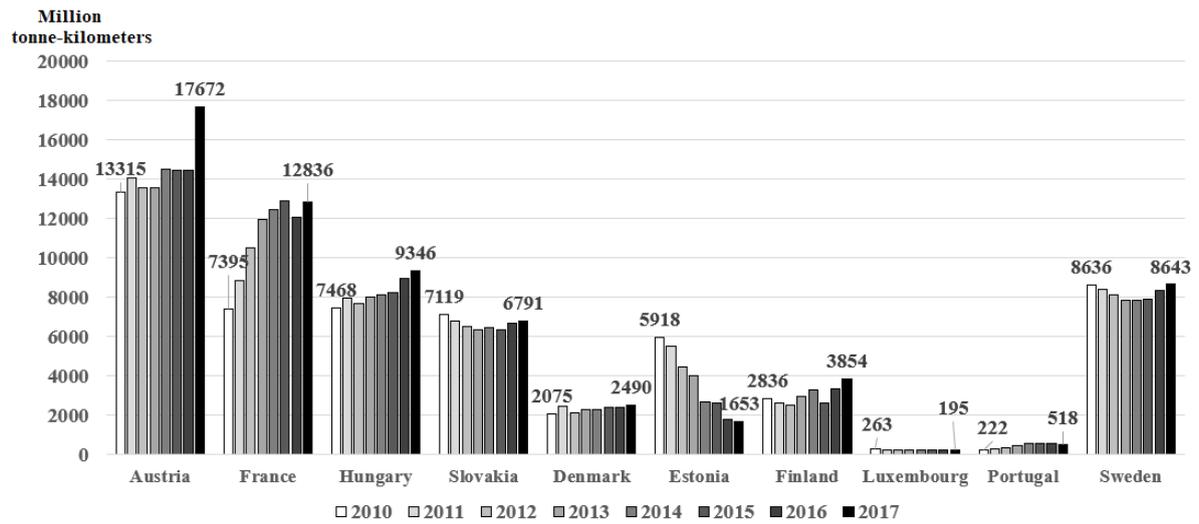


Figure no. 2  
**International rail freight performance in million tonne-kilometres, 2010-2017.**  
 Source: Author's own editing, based on OECD, 2019.

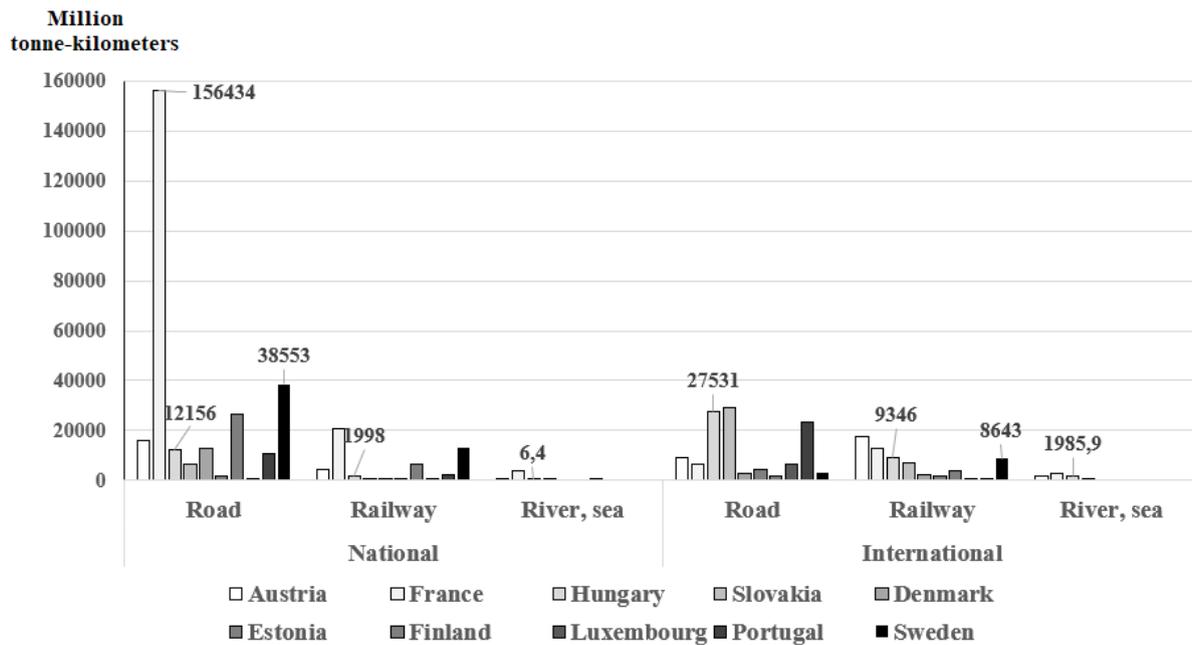


Figure no. 3  
**National and international freight in million tonne-kilometers, in 2017 in the examined countries.**  
 Source: Author's own editing, based on OECD, 2019.

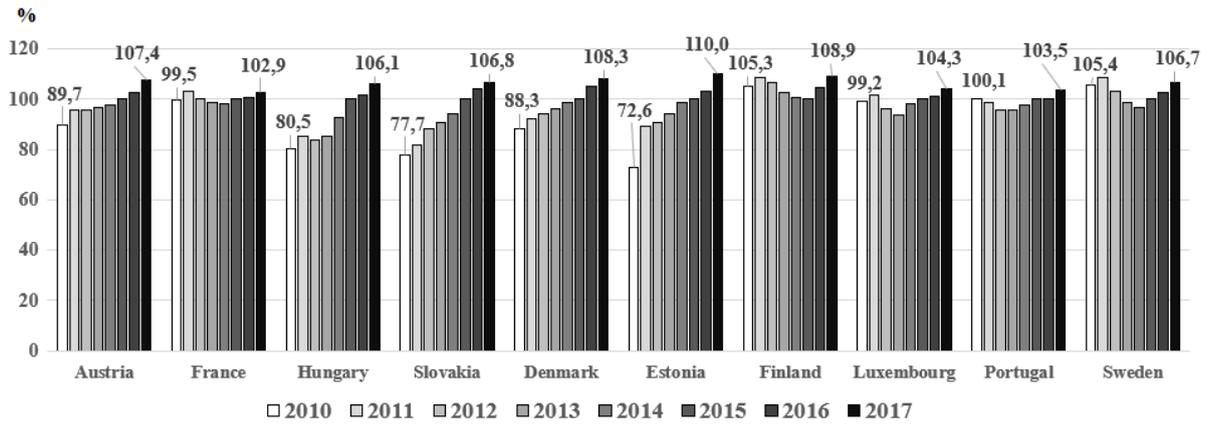


Figure no. 4  
**Changes in productivity in the ten examined countries. Base year = 2015.**  
*Source: Author's own editing, based on OECD, 2019.*