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## Article

# Development trends and the importance of paper industry for the Slovak economy

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## Development Trends and the Importance of Paper Industry for the Slovak Economy<sup>1</sup>

Richard KALIŠ – Martin LÁBAJ – Mikuláš LUPTÁČIK – Karol MORVAY – Erika STRACOVÁ\*

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### Abstract

*In this paper, we examine the dynamics of paper industry, its productivity, the capital-labour ratio, as well as the connections between the development of employment, labour costs and its competitiveness. An extended Leontief model with induced effects is used. We show that the Slovak paper industry grew faster than in most of the European countries. However, compared to the manufacturing sector or the whole Slovak economy, it experienced a slower growth. The final demand for the products of the paper industry generated in 2013 more than 18 thousand jobs and more than EUR 650 million of value added. The final use of paper for EUR 1 million generates value added in the Slovak economy directly and indirectly for EUR 630 thousand. One employee in the production of paper generates 3.6 jobs in the remaining industries.*

**Keywords:** paper industry, Slovak economy, input-output analysis, Leontief model

**JEL Classification:** C67, O14

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### Introduction

Based on several macro-economic indicators and international classifications, the paper industry in Slovakia belongs to smaller industries. However, compared to other countries as well as other industries in Slovakia, it is defined by a number of interesting and significant characteristics examined in this paper. During

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the last few years and thanks to important investments, the manufacture of paper, which is a significant part of the paper industry, has experienced technological changes in production that greatly reduced the environmental burden of this industry. However, the emphasis on the environmental aspects of its development has been too great and it has led to the fact that analyses of the functioning of this industry in Slovakia exclude a number of economic aspects.

Therefore, the aim of this paper is to examine the development trends and the economic links of the paper industry in Slovakia. Our definition of the industry is based on international classification of industries. It includes the manufacture of pulp, the manufacture of paper, and the manufacture of articles of paper. As far as development trends are concerned, we examine the development dynamics of the paper industry in Slovakia and abroad. Moreover, we compare the level of productivity, capital-labour ratio and investments in relation to foreign countries and the countries of the Central and East European region, as well as in relation to other industries in Slovakia. The analysis of the development of employment, wages and labour costs is performed to evaluate the competitiveness of the industry as well. Economic links of the paper industry are examined on the basis of the so-called input-output model. This approach allows us to transparently examine its direct, indirect and induced effects in Slovakia. The economic importance of the paper industry is evaluated based on its effects on production, value added and employment.

Background literature can be divided into two categories: (i) studies dealing with the examined industry, and (ii) studies using similar methodology in different industries. First, studies on the pulp and paper industry are mainly focused on the environmental aspects of the production of paper. González (2005) investigates the internal as well as external factors of clean technology adoption in the paper and pulp industry. According to the survey of 46 Spanish paper producers, the most preferred reason to adopt greener technology is to improve the corporate image.

However, the regulatory requirements seem important as well (González, 2005). Despite of increased energy efficiency within the industry, some studies indicate that cost efficiency is falling behind. In the case of the Swedish paper industry, the barriers seem to be market-related, as well as firm-specific. The lack of time or even low staff awareness play their role in the gap between cost and energy efficiency (Thollander and Ottosson, 2008). Furthermore, according to a Canadian study, the source of pressure on managers for higher environmental standards is mainly connected to the government or the public and not to the financial sector or consumers as would be expected (Doonan, Lanoie and Laplane, 2005).

Second, from the methodological point of view, similar studies have been done in different sectors. Dissaggregated Irish marine sector revealed important economic linkages. Notably, maritime transportation and construction plays a key role within the Irish economy (Morrisey and O'Donoghue, 2013). The input-output approach was also used to examine the mining industry on the European level. The study identified three industries as the most important: mining of coal and lignite in Germany, metal ore in Sweden and mining in Denmark, Austria and Spain. These have the highest impact in terms of investment expenditures on the national economy compared to other industries within the economies (Cristóbal and Biezma, 2006). The final consumption of forestry in Finland surpassed the pulp and paper industry in the direct and indirect effects on the economy (Rimmler et al., 2000). A similar methodology was used to investigate the role of the four Korean electric power industries (hydro, fossil, nuclear and non-utility). Han et al. (2004) not only explained the importance of the electric industry for the Korean economy, but also identified that the non-utility electric sector has the highest impact on the economy according to calculated multipliers.

The paper is structured as follows: The first section deals with the development trends of the paper industry in Slovakia. Specifically, it deals with its dynamics, productivity development, capital flows, as well as employment and the associated labour costs in this industry with implications for its competitiveness. The second section develops an economic model used in the analysis of the importance of the paper industry in the Slovak Republic. Here, we explain the methodology, which innovatively extends the basic Leontief model to include an analysis of induced effects simultaneously by commodities and industries. The third section presents the main economic effects of the paper industry on production, value added and employment. The conclusion summarises the most important results of the analyses performed in this paper.

## **1. Development Trends of the Paper Industry in Slovakia**

For simplification, we use the term “paper industry” to describe economic activities included in international classifications and the Eurostat databases in the category: “Manufacture of paper and paper products” (NACE code: C 17). This industry includes the following activities: Manufacture of pulp (17.11), Manufacture of paper (17.12) and Manufacture of articles of paper (17.2).

The size of this industry in the Slovak economy is displayed in Table 1 (roughly 2% of the manufacturing sector and 0.5% of the whole economy – according to the selected parameter). In some places, we will compare the paper

industry parameters with the parameters of the whole manufacturing sector. Sometimes, however, we will also use a comparison with the parameters of the whole economy.<sup>2</sup> These comparisons are used especially in the first part of this paper. In the later parts of the paper, we also use the above-mentioned division of the paper industry into its three sub-industries.

Table 1

**Basic Parameters of the Size of the Slovak Paper Industry (2015 data)**

Parameter	Value in absolute terms	Share on Slovakia's manufacturing (%)	Share on the whole economy of Slovakia (%)
Gross output in current prices	EUR 1,329.5 million	1.8	0.7
Value added in current prices	EUR 356.8 million	2.3	0.5
Number of employed persons (national accounts methodology)	6.91 thousand persons	1.4	0.3
Compensation of employees (Volume of compensation paid per year)	EUR 124.5 million	1.8	0.5

Source: Eurostat (2016a; 2016d) and authors' calculations.

First, we deal with the analysis and evaluation of development trends in the paper industry including comparisons between industries and countries. We focus our attention on 4 areas:

- Dynamics of the paper industry in Slovakia and abroad. (Is the paper industry a growing sector?)
- Productivity level. (What is the productivity of labour in the paper industry in Slovakia compared to other industries or other countries?)
- Capital-labour ratio, investments and capital flows. (The industry of the Slovak Republic has been negatively influenced by under-capitalisation. How did the paper industry cope with it?)
- Employment, wages and labour costs. (Do the labour costs support competitiveness?)

**1.1. Dynamics of the Paper Industry: Is It a Growing Sector?**

To answer the question whether the paper industry is a growing sector, we use data about changes in value added calculated by means of the so-called chain-linked volumes. This way, the changes of real volumes can be observed without the influence of price increase. Table 2 compares the growth rates of the whole economy, the manufacturing sector and the paper industry. It follows from the table that:

<sup>2</sup> CEPI (2016) looks at European-wide comparisons and tendencies.

- In the EU-28 and EU-15 groups, the paper industry grew faster than the whole manufacturing sector. Manufacturing grew relatively slowly (in EU-15, it grew by only 4% between 2004 and 2014), slower than the whole economy. This is one of the demonstrations of deindustrialisation (a decrease in the importance of industrial activities in economy, cf. e.g. Dadush, 2015). The paper industry has been influenced by deindustrialisation less than the whole manufacturing sector.

- The trends in Slovakia were different: the growth rate in the paper industry was lower than the growth rate of the whole economy and of the manufacturing sector. One of the reasons is that in the Slovak economy, an extraordinarily strong expansion has been experienced by a different industrial sector – the automotive industry (that is why the growth of manufacturing in Slovakia was much stronger than the growth of the whole economy, which is opposite to EU-wide data). In the data for Slovakia, the aforementioned process of deindustrialisation cannot be observed. On the contrary.

The growth rate of the paper industry in Slovakia is several times higher than in the EU. Generally, it can be said that the growth in the states of Central and Eastern Europe (hereinafter CEE) was considerably stronger than in the more developed EU countries. This can be seen on the fact that the growth in EU-28 is significantly higher than in EU-15 (CEE countries are a part of EU-28 but not of EU-15). We also included EU-15 in the overview, although the EU with 15 members only existed until 2004 (but it is still statistically observed). Even despite that, such an insight is necessary. The EU-15 group is composed of the economically more developed part of the EU (before extending the EU and including the economically weaker states of the Central and Eastern Europe). Thus, EU-15 is a group of economies the CEE states want to catch up with in terms of performance.

Table 2

**A Change in Value Added during Ten Years in %** (a change in value added, calculated using the chain-linked volumes, years 2004 – 2014, change 2014/2004)

	EU-28	EU-15	Slovakia
Economy total	10.4	9.0	<b>48.0</b>
Manufacturing	7.7	4.0	<b>94.6</b>
Manufacture of paper and articles of paper	8.9	5.9	<b>29.5</b>

Source: Authors' calculations based on Eurostat (2016a) data.

The development of the paper industry in individual European economies was largely heterogeneous. In the 2004 – 2014 period, around half of the examined countries (14) experienced a decrease in the performance of the paper industry,

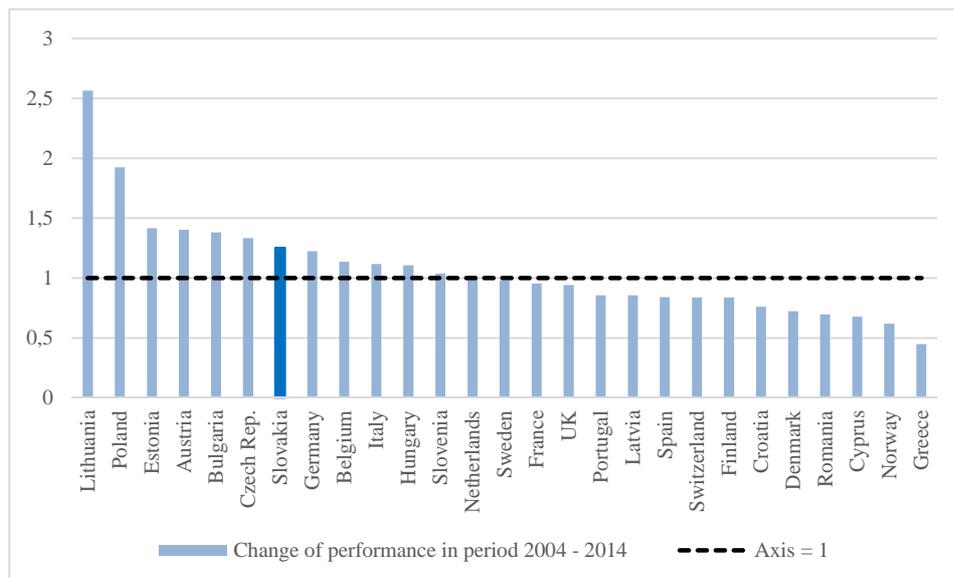
and the remaining countries (13) experienced a growth. Slovakia's development belongs to the positive group (Figure 1).

The Slovak paper industry reached its bottom in 1999. Its development was very unstable with stages of sharp decline as well as sharp growth. Compared to 1995, the level of the real value added generated in 2015 was higher by 35%. Since its lowest point in 1999, the real value added increased threefold until 2015.

It can be stated that the paper industry in the Slovak economy is a growing sector. In Slovakia, this industry grew faster than in most of the European countries. However, compared to the manufacturing sector or the whole Slovak economy, it experienced a slower growth. The more favourable numbers are based on the international comparison, the less favourable numbers are based on a comparison within the national economy.

Figure 1

**Changes in the Volume of Value Added during the 2004 – 2014 Period**  
(volume in 2004 = 1)



Source: Authors' calculations based on Eurostat (2016a) data.

## 1.2. Productivity Level in the International Comparison

Here, the labour productivity is expressed as value added per worker. We find the following interesting facts:

1. The productivity in the paper industry in European countries is between EUR 12 thousand per worker (Bulgaria) and EUR 150 thousand per worker (Finland, 2014 data). The Slovak Republic has the highest productivity among

the countries of Central and Eastern Europe (CEE). The productivity parameter of the Slovak paper industry (with EUR 52 thousand per worker in 2014) thus forms a threshold between the developed Western European economies and the CEE economies.

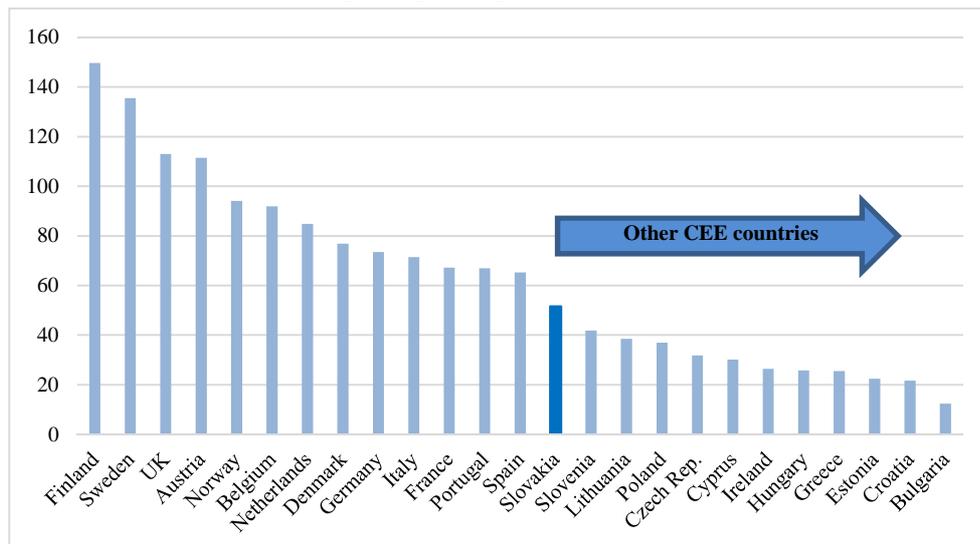
2. We compared the productivity in paper industry with the productivity in the whole manufacturing sector. In a set of four countries (Slovakia, Poland, Finland and Portugal), the productivity in the paper industry exceeds the average productivity of manufacturing. In these countries, the paper industry is one of the leading sectors in the growth of productivity in industry. The productivity in the paper industry in Slovakia is higher by roughly 60% than the average productivity in the manufacturing sector.

3. In the paper industry, the so-called productivity gap between Slovakia and other more developed countries is shrinking significantly (for the issues of the productivity gap between Slovakia and the more developed economies, cf. e.g. Biea, 2015). It can be stated that the paper industry in Slovakia is rapidly catching up with the productivity level in the EU-28 countries, Germany or Austria. While in 2000, the productivity in the Slovak paper industry reached 30% of the EU-28 average, in 2013 the percentage was already around 66%. As far as catching up with the productivity level of the most advanced economies is concerned, Slovakia was more successful than other CEE countries.

Figure 2

### Productivity in the Paper Industry

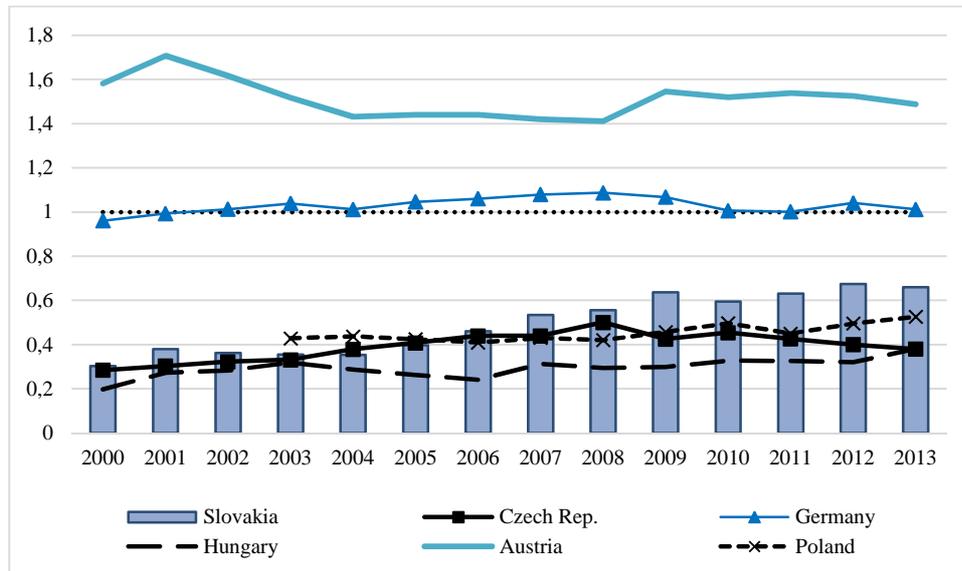
(value added in EUR thousand per employed person, 2014)



Source: Authors' calculations based on Eurostat (2016a; 2016d) data.

Figure 3

**Catching Up with the Productivity Level of More Advanced Economies: Productivity in the Paper Industry** (value added per employed person, the value for EU-28 = 1)



Source: Authors' calculations based on Eurostat (2016a; 2016d) data.

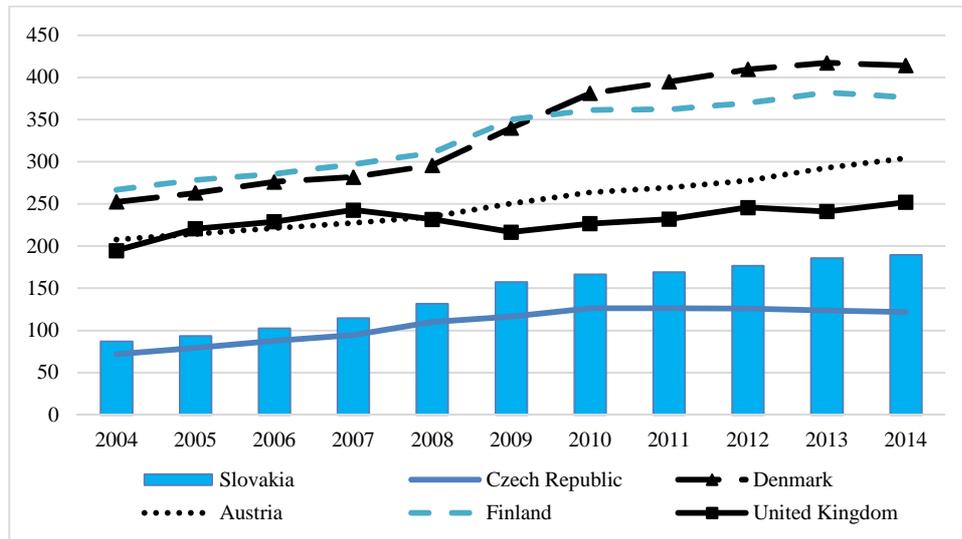
### 1.3. Capital-labour Ratio, Investments and Capital Flows

One of the characteristic features of the former transition economies was that they lagged behind in terms of the capital-labour ratio. This so-called under-capitalisation was perceived as a barrier to a higher performance of former transition economies in the Central and Eastern Europe (for more details cf. e.g. Morvay, 2017). To express this issue, we use the value of fixed assets divided by the number of workers. This shows us how the labour force is equipped with fixed capital. The amount of capital per worker calculated in this way is usually much higher in developed economies than in Slovakia (Figure 4 demonstrates this on the manufacturing sector data).

The aforementioned lagging behind in terms of the capital-labour ratio is being gradually mitigated but this is largely differentiated among industries. It is remarkable if in a certain period of time, this is the other way around, i.e. if the capital-labour ratio is higher in Slovakia than in more developed economies. This is the case in the sector of paper industry (Figure 5).

It can be assumed that the capital-labour ratio is a significant determinant of the performance level. Thus, with a growing capital-labour ratio, the output or productivity level should grow as well (cf. Dombi, 2013).

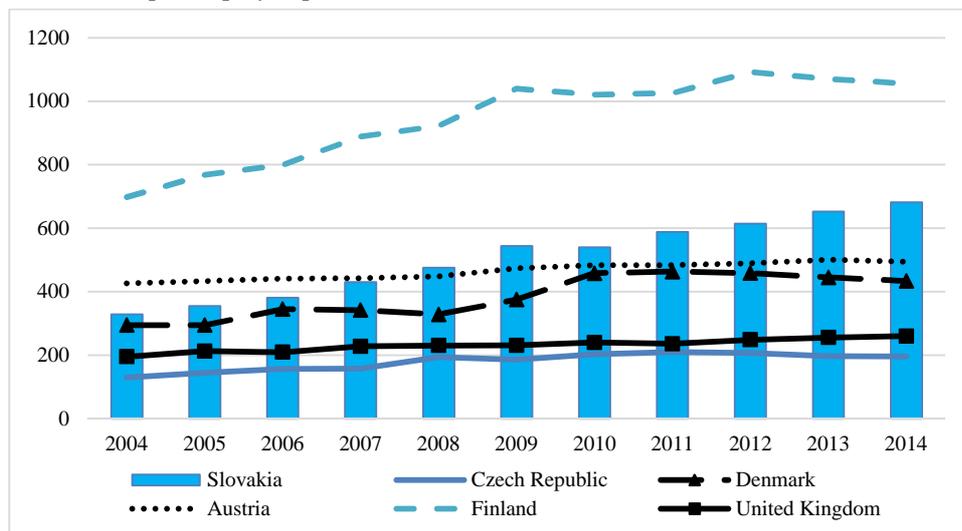
Figure 4  
**Capital-labour Ratio in the Whole Manufacturing Sector**  
 (fixed assets per employed person, in EUR thousand)



Note: The figure shows us the “normal” picture: the capital-labour ratio is much higher in the most advanced economies compared to the former transition economies.

Source: Authors’ calculations based on Eurostat (2016b; 2016d) data.

Figure 5  
**Capital-labour Ratio in the Paper Industry**  
 (fixed assets per employed person, in EUR thousand)



Note: The rare picture: the capital-labour ratio in the Slovak paper industry is higher than in some of the most advanced economies.

Source: Authors’ calculations based on Eurostat (2016b; 2016d) data.

It is interesting to note that there are cases which do not follow this logic. In Austria, the productivity level is higher than in Slovakia, although the capital-labour ratio is already higher in Slovakia. This means that the investments into the paper industry were more effective in Austria (meaning they enabled a greater increase in productivity). This can be at least partially explained by the fact that the investments in Slovakia (which increased the capital-labour ratio) had a primarily ecological impact and their main goal was not to expand production.

The ratio of capital to a unit of labour (fixed assets per worker) has more than doubled in the Slovak paper industry between the years 2004 and 2014. The average growth rate of this indicator was around 7.5%, while this growth was primarily (70%) caused by a change in the fixed capital (average growth rate of 5.2%) and secondarily by a decrease in the number of workers (the average year-on-year decrease was 2.3%).

To evaluate the investment flow in the industry, we use the gross fixed capital formation (GFCF) indicator from the national accounts system. It is a flow value expressing the volume of capital formation in a given year. The paper industry GFCF has a markedly uneven development in time. If we compare capital formation and the volume of generated value added (this way we calculate the so-called level of investment expressing what part of generated value is used by the industry to form new capital or replace the older capital), we find extraordinarily high values in Slovakia.<sup>3</sup> Countries which lag behind in economic terms and need to catch up with more advanced economies should have a higher level of investment compared to the economies they need to catch up with. The level of investment in the Slovak paper industry is indeed exceptionally high, much higher than in the more advanced economies we need to catch up with. However, it is also higher than in other CEE countries (namely in the Czech Republic and Hungary, Figure 6). In the long-term average, the GFCF in the Slovak paper industry reached 58% of the value added generated in the industry. This value is between twice and three times as high as in more developed countries like Denmark, Austria, Germany or Finland.

The above-mentioned massive investing is accompanied by an exceptionally high share of depreciation on the value of production. This “depreciation intensity” in the Slovak paper industry is truly very high. It is more than twice as high compared to the manufacturing sector in Slovakia and it is by far the highest in the set of the examined countries. The production in the value of EUR 100 in the Slovak paper industry uses up fixed capital (= depreciation is created) in the

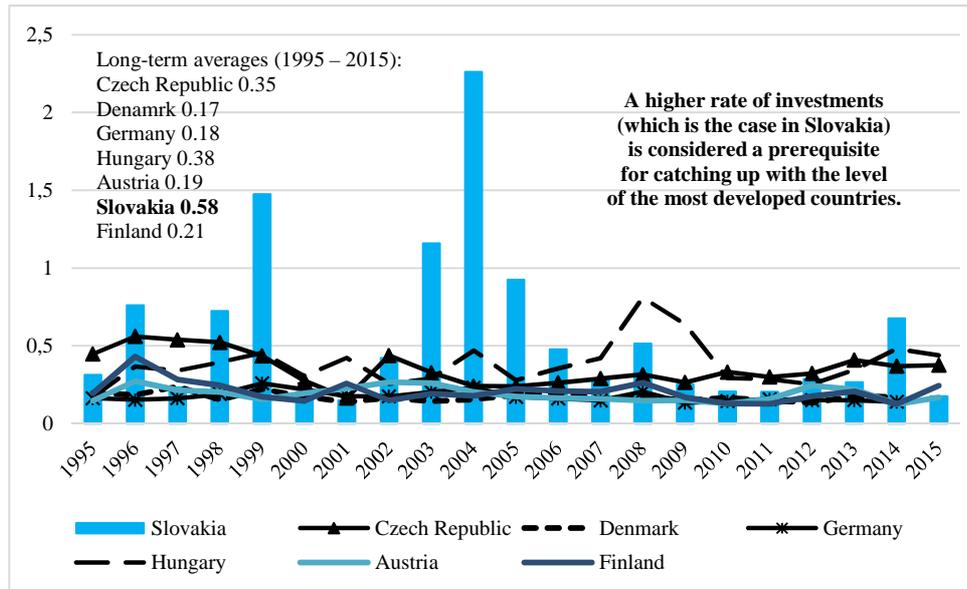
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<sup>3</sup> The above mentioned high values are partly caused by state investment incentives. They were already provided in the period 2001 – 2007 (MH SR, 2008); the last major state aid for the paper industry was approved by the European Commission in 2017.

value of EUR 12.40. The average for the Slovak manufacturing sector would be less than half (EUR 5.20).

Figure 6

**Level of Investment in the Paper Industry** (gross fixed capital formation/value added)



Source: Authors' calculations based on Eurostat (2016a; 2016c) data.

#### 1.4. Employment, Wages and Labour Costs: In Line with the Needs of Competitiveness?

Already Table 1 showed that this industry is a relatively small employer. Its share on the employment in Slovakia (0.3%) is lower than its share on value added (0.5%).

This is caused by a high labour productivity. In the years 2004 – 2014, the employment in the Slovak paper industry decreased by 20% (1,700 persons). In recent years, the decrease of employment in the paper industry has been a frequent phenomenon across Europe. This was probably a necessity resulting from a rapid increase of productivity and maintaining competitiveness.

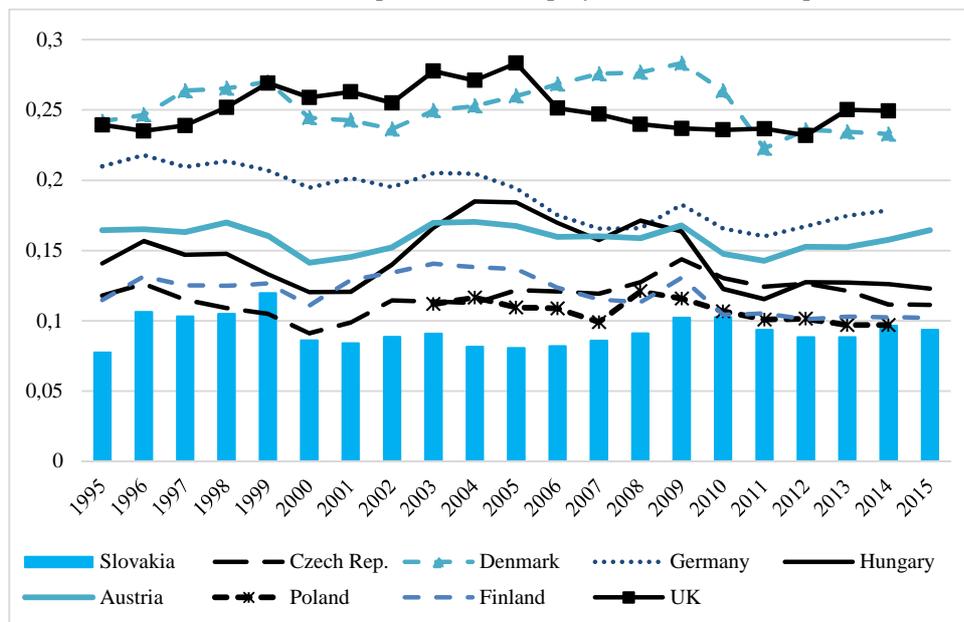
To evaluate the wage level, we use the relative wage indicator (the ratio of wages in a given industry to wages in the whole economy). The average wage in the paper industry in 2015 was 8% higher than the average wage in the manufacturing sector and 10% higher than the average wage in the economy of Slovakia (for this purpose, we used the wage data converted to the so-called full time equivalent – FTE, Table 3).

Table 3  
Wages and Relative Wages

	2011	2013	2015
Average wage in the <b>paper industry</b> (EUR per month, converted to FTE)	971	1,036	1,119
Average wage in the <b>manufacturing sector</b> (EUR per month, converted to FTE)	872	957	1,033
Average wage in the <b>whole economy</b> (EUR per month, converted to FTE)	875	939	1,019
Ratio of wage in the paper industry to the wage in the whole manufacturing sector	1.11	1.08	1.08
Ratio of wage in the paper industry to the wage in the whole economy	1.11	1.10	1.10

Source: ŠÚ SR (2017) (the Slovstat database) and authors' calculations.

Figure 7  
Unit Labour Costs (share of compensation of employees on the value of production)



Source: Authors' calculations based on Eurostat (2016a) data.

For assessing the relation between wages (or labour costs) and industry competitiveness, the so-called unit labour costs indicator is useful. Unit labour costs in this case are expressed as the share of compensation of employees<sup>4</sup> on the value of production. The data show that the unit labour costs in the paper industry in Slovakia were maintained on a lower level compared to more advanced

<sup>4</sup> The compensation of employees includes gross wages and social contributions (levies) paid by the employer. They can be regarded as labour costs.

economies as well as other CEE countries. EUR 100 of production generated in Slovakia required less than EUR 9.40 of compensation paid to employees. The lower level of unit labour costs supports the cost competitiveness of the industry. This lower level of unit labour costs provides a good outlook for maintaining competitiveness even in the case of increased wage level.

Besides economic development, it is important to highlight the positive development of the paper industry with respect to environment. The production and income generated by the Slovak paper industry gradually became “greener”; they were getting less and less burdened with harmful substances. For illustration: While in 1995, EUR 1 million of paid wages was connected to 567 tonnes of released emissions, in 2013 it was only 25 tonnes (the value is a sum of the volumes of solid substances, sulphur and nitrogen oxides, and carbon monoxide). This shift happened thanks to technological changes: a lower emission intensity of production. Elsewhere, we have mentioned that massive investments in this industry were of ecological nature (they secured sustainability and competitiveness of the production and their main goal was not to expand production).

## **2. Importance of the Paper Industry in the Slovak Economy: Methodology**

The economic importance of industries and individual activities in economy is not given by the direct indicators of performance or productivity, but especially by complex linkages with other industries and effects arising from these connections for the total generated production, value added or employment. The main reason for such an approach is the fact that current economies are characterised by a high degree of division of labour within the domestic economy as well as in relation to foreign countries. In this part of the paper, we deal with the analysis of these relations not visible on the first sight. Except for the directly observed indicators, we also model the indirect effects arising from the supplier-customer linkages in the whole chain of production and the induced effects arising from increased income and consumption of employees and self-employed persons.

A useful tool for revealing and quantifying these linkages is the so-called input-output analysis based on the extended Leontief model. By performing the input-output analysis of the interdependencies between industries, we can reveal the direct, indirect and induced effects of the paper industry in Slovakia and thus get the foundation to assess its economic importance. A similar methodological basis was used in studies dealing with the importance of the automotive and manufacturing industry in Slovakia (Luptáčík et al., 2013; 2016).

The analysis of the economic effects of using the commodities from the paper industry is based on the Leontief input-output model (1936) extended to include the household sector in the commodity  $x$  industry structure. Thus, we can take not only the direct and indirect effects in the supply chain into account but also the so-called induced effect arising from the consumption of households with income from working in the whole supply chain. A detailed description of the input-output analysis can be found in Miller and Blair (2009) and the method for composing input-output tables can be found in Hajnovičová (2005) or Timmer et al. (2012). The effective use of data from the input-output tables can be found in Timmer et al. (2015). Usually, the input-output analysis is based on data with a symmetrical structure, i.e. industry  $x$  industry or commodity  $x$  commodity. The original data obtained and processed by the Statistical Office of the Slovak Republic is in the commodity  $x$  industry structure and can be found in the supply and use tables. The explicit model formation from data in the commodity  $x$  industry structure enables us to analyse the effects on industries and commodities separately. When analysing the effects of the paper industry, this distinction is important because, for instance, the production in the manufacture of paper sector includes not only paper production itself (the main activity of the industry) but also a significant number of other products (e.g. pulp and energy).

For the purpose of the empirical analysis of economic effects, the commodity  $x$  industry tables of supply and use for 2013 were used together with their conversion to symmetrical input-output tables within the model. The industry and commodity NACE/CPA 17 – Manufacture of paper and paper products/Paper and paper products has been classified in the tables as follows:<sup>5</sup>

NACE/CPA:	17.11 – Manufacture of pulp/Pulp
NACE/CPA:	17.12 – Manufacture of paper and paperboard/Paper and paperboard
NACE/CPA:	17.2 – Manufacture of articles of paper and paperboard/Articles of paper and paperboard

At the same time, the data about the number of employed persons were added, separately for employees and self-employed persons.

This made it possible to get an overview of the flows of production and intermediate consumption within the paper industry, where, for instance, pulp serves as an input for the manufacture of paper and paper is then an intermediary for the manufacture of articles of paper. The results of the models show the effects generated by the final use of the individual commodities for the production

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<sup>5</sup> The commodity  $x$  industry tables of supply and use with detailed classification of the paper industry (products of the paper industry) was created by the Statistical Office of the Slovak Republic based on a special request for the needs of a detailed analysis of the paper industry in Slovakia.

of other commodities in the whole national economy. These effects differ from those on generated production, value added and employment of industries, as they produce, except for their main activity, also other goods and services. Where useful, we calculated the effects of the final demand for goods and services on the generated production, value added and employment of industries. A difference in the structure of production and use of commodities and industries is dealt with separately in the next part.

### 2.1. Commodity $x$ Industry Model with Induced Effects

To elaborate the commodity  $x$  industry model (based on industry technology assumption), we start from two basic balance equations for individual commodities and industries in the following form:

$$\begin{aligned}\mathbf{B}\mathbf{g} + \mathbf{y} &= \mathbf{q} \\ \mathbf{D}\mathbf{q} &= \mathbf{g}\end{aligned}\tag{1}$$

where  $\mathbf{B}$  represents a technical coefficients matrix from the domestic intermediate consumption table with the commodity  $x$  industry dimension, i.e. the intermediate consumption of the commodity  $i$  per one unit of the industry's production  $j$ . The vector of the total production of individual industries is marked with  $\mathbf{g}$ . The  $\mathbf{y}$  symbol represents the vector of final demand by individual commodities and  $\mathbf{q}$  is a vector of the total commodity production. Matrix  $\mathbf{D}$ , in literature also called the market share matrix, includes the calculated shares of production of individual industries on the total production of a given commodity. Its elements express the share of industry  $i$  on the production of commodity  $j$ . The sum of the elements in the individual columns of this matrix by definition equals 1. The first balance equation captures the use of commodities in the domestic economy either in the intermediate consumption of individual industries or for satisfying one of the categories of final demand (final consumption of households, gross capital formation, final government consumption, export), The second balance equation in (1) indicates the production of individual commodities in the corresponding industries.

We base our quantification of the economic effects of the paper industry on the exogenously given volume of exports  $\mathbf{y}_{ex}$ . The model includes the induced effects that arise from the final consumption of households generated endogenously  $\mathbf{y}_{c(ex)}$ . The corresponding production of individual commodities generated by export  $\mathbf{y}_{ex}$  can be expressed as follows

$$\mathbf{q} = \mathbf{B}\mathbf{g} + \mathbf{y}_{ex} + \mathbf{y}_{c(ex)}\tag{2}$$

Because the only exogenously given variable in the model is final demand  $\mathbf{y}_{ex}$ , we can define the model for calculating the direct, indirect and induced effects as follows:

$$\begin{array}{rccccccc}
 \mathbf{q} & -\mathbf{B}\mathbf{g} & -\mathbf{y}_{c(ex)} & & & & = & \mathbf{y}_{ex} \\
 \mathbf{D}\mathbf{q} & -\mathbf{g} & & & & & = & \mathbf{0} \\
 \hat{\mathbf{A}}_1\mathbf{g} & & & -\mathbf{l}_1 & & & = & \mathbf{0} \\
 \hat{\mathbf{A}}_2\mathbf{g} & & & & -\mathbf{l}_2 & & = & \mathbf{0} \\
 \hat{\mathbf{A}}_w\mathbf{g} & & & & & -\mathbf{w} & = & \mathbf{0} \\
 & & \mathbf{y}_{c(ex)} & & & & -c_d\mathbf{h}b & = & \mathbf{0} \\
 & & & \mathbf{m}'_1\mathbf{l}_1 & +\mathbf{m}'_2\mathbf{l}_2 & & -b & = & 0
 \end{array} \quad (3)$$

The first equation in the model says that the production of commodities  $\mathbf{q}$  is divided into intermediate consumption in the production process  $\mathbf{B}\mathbf{g}$ , the endogenously created (induced) final consumption  $\mathbf{y}_{c(ex)}$ , and the exogenously given final consumption  $\mathbf{y}_{ex}$ . The second equation in the model indicates the conversion of the production of commodities to the production of industries through the market share matrix  $\mathbf{D}$ . The third equation in the model expresses that the total number of employees is equal to the product of the direct labour intensity of industries  $\mathbf{A}_1$  and the production of individual industries  $\mathbf{g}$ . The fourth equation describes an analogous relationship in the case of self-employed persons, where the total number of self-employed persons by industries  $\mathbf{l}_2$  is equal to the product of the direct labour intensity of industries  $\hat{\mathbf{A}}_2$  and production  $\mathbf{g}$ . The fifth equation expresses the value added  $\mathbf{w}$  as a product of the direct value-added intensity of production  $\hat{\mathbf{A}}_w$  and the production of industries. When we express the number of employees, self-employed persons and the value added in the intensive form as a function of the production of industries, these variables react to changes in the total production. In the sixth equation, the endogenously given (induced) final consumption of households  $\mathbf{y}_{c(ex)}$  is a function of the generated incomes  $b$  and the vector of shares of consumption expenditures by commodities of domestic production  $\mathbf{h}$  (the consumption of imported products does not increase the level of production in the Slovak economy). Coefficient  $c_d$  represents the share of the income of households spent in the Slovak Republic to purchase goods produced in the domestic economy (the rest is composed of net savings and the purchase of imported goods). It is the product of the share of consumption expenditures on the net disposable income and the share of domestic goods in the basket of goods. The last equation is a balance equation where the total income

of households  $b$  equals to the sum of income from dependent employment  $\mathbf{m}'_1\mathbf{l}_1$  and the income from self-employment  $\mathbf{m}'_2\mathbf{l}_2$ . Vectors  $\mathbf{m}'_1$  and  $\mathbf{m}'_2$  represent the annual net compensation of employees (compensation of personnel based on national accounts less the paid levies and income tax) or self-employed persons.

The variables in the model are internally linked and thanks to an increased production, any change in the exogenous demand causes effects on the remaining variables, e.g. Employment, value added or the total level of income. The model variables are linearly dependent. The Leontief model assumes setting fixed ratios of individual inputs – the so-called Leontief production functions. The net income of self-employed persons was set on the level of the net compensation of personnel in the individual industries. The share of consumption expenditures on the net disposable income was set diversely by individual years, while we used the national accounts as a guide. In the examined period, the share had a narrow range between 0.97 and 1.00. During the whole examined period, the share of domestic goods in the basket of goods was maintained on the level of 0,72 taken from the input-output table. The share of net wage (net compensation of personnel) on annual compensation was also maintained on the same level during the whole period, and the value was 0.60. This was estimated based on the data from national accounts and the tax and levy rates set in legislation.

After converting the set of equations into the form of a matrix and inverting the extended input coefficients matrix, we can express all endogenous variables in the model as a function of the exogenously given final demand  $\mathbf{y}_{ex}$ .

$$\begin{bmatrix} \mathbf{q} \\ \mathbf{g} \\ \mathbf{y}_{c(ex)} \\ \mathbf{l}_1 \\ \mathbf{l}_2 \\ \mathbf{w} \\ b \end{bmatrix} = \begin{bmatrix} \mathbf{R} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \end{bmatrix}_{(6n+1) \times (6n+1)} \times \begin{bmatrix} \mathbf{y}_{ex} \\ \mathbf{0} \\ \mathbf{0} \\ \mathbf{0} \\ \mathbf{0} \\ \mathbf{0} \\ 0 \end{bmatrix} \quad (4)$$

Matrix  $\mathbf{R}$  has a dimension of  $(6n + 1)$  rows by  $(6n + 1)$  columns corresponding to the number of individual equations in the model, while  $n$  is the number of commodities (industries) in the model. This is an extended Leontief inverse matrix, which includes an array of important multipliers describing the relationships between individual economic variables. It is composed of individual sub-matrices expressing interdependencies among endogenous variables. For instance, an element of matrix  $\mathbf{R}_{qq}$  expresses the total production of commodity  $i$  in the whole chain of production (including induced effects) needed to supply one unit

of commodity  $j$  into final use. The sums of the columns of this matrix  $\sum_{i=1}^n \mathbf{R}_{qq,ij}$  represent the multipliers of domestic production for individual commodities  $j$  (also including induced effects). Matrix  $\mathbf{R}_{gq}$  indicates the effects of the final use of individual commodities on the production of industries (including induced effects). Its elements express the direct, indirect and induced production of industry  $i$  generated by the final use of commodity  $j$ . In the model, we can find the effects of the final demand for commodities on the production of commodities in the whole national economy, as well as the effects on the production of individual industries. Usually, either effects by commodities or the effects on industries are analysed separately. Thus, our approach provides more general results that are quite rare in the input-output literature. Moreover, it also indicates the effects of the final use of commodities on the creation of employment and value added.

## 2.2. Description of the Data Entering the Model

The total production in the three examined industries in 2013 accounted for more than EUR 1.3 billion, while the the sector of manufacture of paper and paperboard had the highest share on the total production, reaching 56.5%. Manufacture of articles of paper and paperboard followed with 38.4% and the manufacture of pulp had the smallest share on the shared production. Because the production is not entirely homogeneous even within these industries, let us have a look at its structure.

The production within the sectors of manufacture of pulp and manufacture of articles of paper and paperboard can be considered homogeneous. There, the dominant good with a share exceeding 90% is a good inherent to the given industry. A different phenomenon can be observed in the sector of manufacture of paper and paperboard, where the dominant commodity is paper and paperboard with a 63% share on the total production, but the sector is much more diversified.

The second most important commodity produced in this sector is represented by articles of paper followed by pulp with a 10% share as the main intermediary for further production. Because of the size of this industry, more pulp is produced in the manufacture of paper and paperboard industry than in the manufacture of pulp industry itself.

The dominant final use of the examined commodities is export with a total production value of EUR 1 billion, i.e. roughly three quarters of the total production of all three industries. The decisive role is played by the manufacture of paper and paperboard again. The main commodity of this sector, i.e. paper and paperboard, is almost exclusively directed at foreign markets. Pulp is the only commodity with a more significant share in further production with 37% of the

total pulp production going into the intermediate consumption and being used for further production, naturally mainly of paper and paperboard. However, majority of the output is exported in this case as well. The last commodity of the examined chain of production are articles of paper and paperboard. A part of the domestic production is also used in domestic consumption, more specifically in the final use of households. It is clear that almost the whole domestic production is directed at export or into further production. This, however, does not mean that there is no domestic demand for these commodities. In 2013, the domestic demand (final as well as intermediate) for all three types of commodities amounted to EUR 1.1 million, out of which 80% was imported and only 20% produced by Slovakia's domestic producers.

### **3. Empirical Results**

In this section, we present the empirical results of the analysis of the importance of the paper industry for the Slovak economy. First, we describe the effects on production. Then, we focus on direct and indirect effects on value added and imports. Finally, we present the final demand effects (including induced effects) at aggregate level, as well as in a detailed analysis by industries for generated employment.

#### **3.1. Effects on Production**

The manufacture of products for satisfying final demand requires many inputs – intermediates produced on different levels of the production chain. A high division of labour and the complexity of final products lead to the fact that products are produced from a range of other commodities and intermediates, and thus they generate an array of indirect effects on the industries through the supplier-client relationships. The value of production generated by the final use of a given commodity in the whole chain of production can be recorded using the so-called production multipliers. The final use of a commodity for EUR 1 million can be matched with the value of production (sales) created on all levels of production. The input-output tables include a detailed classification of the use of intermediates from the domestic and imported production, so we can calculate the production multipliers separately for the domestic economy, as well as including the effects on production generated abroad.

Supplying pulp for EUR 1 million into the final use generates production in the Slovak economy of EUR 2.1 million (EUR 2.93 million when including imported goods). In Slovakia, the final use of pulp and paper creates the highest effects on domestic production among all manufacturing sectors.

**Table 4**  
**Manufacturing Products with the Highest Production Multipliers, 2013\***

Code	Name	Production multiplier (domestic)	Production multiplier (domestic + imports)
17.11	Pulp	2.11	2.93
17.12	Paper and paperboard	1.91	2.82
10	Food products	1.76	2.58
11	Beverages	1.73	2.56
16	Wood and products of wood, except furniture	1.73	2.16
23	Other non-metallic mineral products	1.72	2.54
31	Furniture	1.68	2.65
17.2	Articles of paper and paperboard	1.63	2.92
33	Repair and installation services of machinery and equipment	1.60	2.40
29	Motor vehicles, trailers and semi-trailers	1.60	3.88

*Note:* \* The multipliers are based on standard Leontief model without induced effects. Domestic multipliers are based on intermediate consumption matrix in a Version B (without imports), while production multipliers that include imports are based on intermediate consumption matrix in a Version A.

*Source:* Authors' calculations based on the input-output model for paper industry products.

**Table 5**  
**The Effects Generated by the Final Consumption of Paper Industry Products on Production of other Industries, 2013 (EUR million)**

Code	Name	Generated production, EUR million
35	Electricity, gas, steam and air conditioning supply	194.9
02	Forestry and logging	141.3
46 – 47	Trade	131.5
49	Land transport and transport via pipelines	64.1
52	Warehousing and support activities for transportation	26.0
68	Real estate activities	22.1
18	Printing and reproduction of recorded media	20.3
33	Repair and installation of machinery and equipment	17.8
43	Specialised construction activities	16.6

*Source:* Authors' calculations based on the input-output model for paper industry products.

Paper industry products generate significant indirect effects on the production of electricity and steam and forestry, logging, and related services but also on trade, land transport, warehousing and support activities for transportation, or real estate activities.

### 3.2. Effects on Value Added and Imports

From the point of view of the national economy, the effects generated by the final use of certain products on value added in the whole national economy are often more important than those on the gross production of other industries. The final use of EUR 1 million corresponds to EUR 1 million of value added created across the chain of production either in the domestic economy or abroad. These

effects can be captured using the value added and import multipliers. While the direct value-added coefficients measure the share of value added in a given industry on the total production, value added and import multipliers measure value added (or imports) generated by EUR 1 million of the final use of individual commodities.

Table 6

**Manufacturing Products with the Highest Indirect Effects on Value Added Creation, 2013\***

Code	Name	Direct value added coefficients	Value added multipliers	Import multipliers
17.11	Pulp	<b>0.19</b>	<b>0.64</b>	<b>0.36</b>
17.12	Paper and paperboard	<b>0.25</b>	<b>0.63</b>	<b>0.37</b>
16	Wood and products of wood and cork, except furniture	0.43	0.80	0.20
10	Food products	0.30	0.65	0.35
11	Beverages	0.31	0.64	0.36
31	Furniture	0.32	0.63	0.37
23	Other non-metallic mineral products	0.34	0.64	0.36
33	Repair and installation services of machinery and equipment	0.43	0.70	0.30
17.2	Articles of paper and paperboard	<b>0.25</b>	<b>0.51</b>	<b>0.49</b>
29	Motor vehicles, bodies and parts for motor vehicles	0.12	0.32	0.68

*Note:* \* The multipliers are based on standard Leontief model without induced effects. Value added multipliers are based on intermediate consumption matrix in a Version B (without imports). Import multipliers are calculated with an extension of the standard Leontief model for a vector of imports to intermediate consumption. For more details see Miller and Blair (2009).

*Source:* Authors' calculations based on the input-output model for paper industry products.

Manufacture of pulp and paper generates high indirect effects on value added creation in Slovakia. The final use of paper for EUR 1 million generates, directly and indirectly, value added of EUR 630 thousand. Although the manufacture of pulp and paper has low direct value-added coefficients, they generate significant indirect effects on value added in other industries.

### 3.3. Effects of Final Demand Including Induced Effects

As has been mentioned elsewhere, the importance of individual industries for the national economy is based not only on the value added they create directly or on the number of employees they employ but also what effects are generated by the final use (final demand) of their products. The following table lists effects of the final demand for all commodities of the paper industry, i.e. pulp, paper, and articles of paper.

The final use of paper industry products for EUR 1,065 million generated a direct, indirect and induced production of EUR 1,971 million. In 2013, the paper industry in Slovakia generated 16,371 jobs directly and indirectly, while

directly, it employed a little over 7,000 persons. Moreover, it generated additional jobs in an induced way, i.e. through consumption arising from the income from its effects in the whole production chain. After taking the induced effects into consideration, it generated more than 18 thousand jobs. Value added created in the paper industry in 2013 amounted to almost EUR 300 million, but the total value added generated by the paper industry products exceeded EUR 650 million, out of which EUR 611 million was generated directly and indirectly and the remaining EUR 40 million was generated in an induced way.

Table 7

**Effects of the Final Demand for the Paper Industry Products**  
(17.11 Pulp + 17.12 Paper + 17.2 Articles of paper), 2013

	Total effects (including induced effects)	Out of which: direct and indirect effects	Direct effects
Effects on production, EUR million	1,971	1,913	1,065
Effects on employment, number of persons	18,111	16,371	7,044
Effects on value added, EUR million	651	611	299

Source: Authors' calculations based on the input-output model for paper industry products.

### 3.4. Effects on Employment

This part includes an analysis of the effects of paper industry on employment. We point out significant indirect and induced effects of the final demand for its products on one hand and the varied nature of the effects within the production of individual commodities included in this industry on the other.

Table 8

**Direct and Indirect Effects of the Final Consumption of Paper Industry Products on Employment, 2013\***

	Total	17.11 Pulp	17.12 Paper	17.2 Articles of paper
Direct employment	7,044	669	1,787	4,588
Direct and indirect employment	16,371	1,641	7,118	7,612
Indirect employment generated by one employee	1.32	1.45	2.98	0.66

Source: Authors' calculations based on the input-output model for paper industry products.

Within the paper industry, more than half of the people are employed in the manufacture of articles of paper and only 1,787 employees work in the manufacture of paper. The remaining 669 jobs are created in the manufacture of pulp. However, after taking the indirect effects of the final demand for these individual commodities into account, the picture of the generated employment is somewhat different. While the direct employment in the manufacture of articles of paper was significantly higher than the direct employment in the manufacture of paper,

the direct and indirect effects of the production of both commodities on employment are comparable. Articles of paper generate a little over 7,600 jobs, while the manufacture of paper generates 7,118 jobs. On average, one worker in the paper industry generates 1.3 jobs in other industries. A detailed look at the individual commodities, however, shows that these indirect effects are decreased by the manufacture of articles of paper, where one employee indirectly generated less than one worker. In contrast, one worker in the manufacture of paper generates 3 more employees in other industries directly and indirectly. This fact is based on the high productivity in the manufacture of paper and a higher labour intensity of its main suppliers and other firms in the chain of production, e.g. in forestry or transport.

The effects of the paper industry on employment are even more pronounced after taking the induced effects into account. Because the manufacture of paper generates higher direct and indirect effects on the income of workers than the manufacture of articles of paper, it also has higher impacts on employment after taking induced effects into consideration. Thus, the number of direct, indirect and induced jobs in this industry exceeds 8,200, while in the case of the manufacture of articles of paper, this number is less than 7,900.

Table 9

**Total Effects of the Final use of the Paper Industry Products on Employment**  
(including induced effects), 2013\*

	Total	17.11 Pulp	17.12 Paper	17.2 Articles of paper
Total generated employment (including induced effects)	<b>18,111</b>	<b>1,956</b>	<b>8,255</b>	<b>7,899</b>
Direct labour intensity coefficients	–	4.7	3.5	8.0
Employment multipliers	–	18.24	14.76	15.46
Total employment generated by one employee (indirect and induced)	<b>1.57</b>	<b>1.92</b>	<b>3.62</b>	<b>0.72</b>

Source: Authors' calculations based on the input-output model for paper industry products.

Differences in the labour intensity coefficients document the differences in labour productivity, which is defined as their reciprocal. The lowest labour intensity coefficients are in the manufacture of paper, where 3.5 employees are assigned to EUR 1 million of production. Manufacture of pulp has somewhat higher coefficients (4.7). Significantly higher labour intensity coefficients are in the manufacture of articles of paper, where 8 employees are assigned to EUR 1 million of production. These facts bear witness to the high labour productivity in the manufacture of paper and partly explain why one employee in the manufacture of paper generates as much as 3 jobs in other industries, while this number is 3.6 if it includes induced effects as well. These high indirect and induced effects

are reflected in employment multipliers with much lower differences than in the case of direct employment coefficients. The supply of paper for EUR 1 million into final use generates almost 15 jobs directly and indirectly. The effects are a bit higher for articles of paper (15.46 jobs). The supply of pulp for EUR 1 million into final use generates as many as 18 jobs. The following table includes an overview of the indirectly generated jobs by industry.

Table 10

**The Effects Generated by the Final Consumption of Paper Industry Products on Employment of other Industries, 2013**

Code	Name	Generated employment
02	Forestry and logging	3,006
46 – 47	Trade	2,373
49	Land transport and transport via pipelines	922
35	Electricity, gas, steam and air conditioning supply	393
52	Warehousing and support activities for transportation	312
43	Specialised construction activities	292
33	Repair and installation of machinery and equipment	256
16	Manufacture of wood and products of wood and cork, except furniture	197
68	Real estate activities	182
69	Legal and accounting activities	156

Source: Authors' calculations based on the input-output model for paper industry products.

The highest effects on employment are generated by the manufacture of paper industry products in forestry, logging and related services, trade, land transport and energy production. Moreover, it also generates significant effects on the sectors of warehousing and support services for transportation; specialised construction works; repair and installation services of machinery and equipment; and the manufacture of wood and of products of wood and cork, except furniture.

## Conclusions and Summary

In Slovakia, the paper industry is a relatively small sector of economy. However, its output can be and is widely used in various manufacturing activities, as well as in the final consumption. It is also a sector in which several interesting tendencies can be identified. The main favourable characteristics of the Slovak paper industry (from the macroeconomic viewpoint) are the following:

- In Slovakia, the industry is a growing one but the development of the paper industry outside of Slovakia (25 European Union countries based on data availability plus Norway and Switzerland) was considerably heterogeneous (this sector was growing in approximately half of the countries and experienced a decrease in the other half).

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- The Slovak paper industry has reached a relatively high labour productivity. It is the highest among the countries of Central and Eastern Europe. It is also significantly higher than the average productivity of the whole manufacturing sector. The productivity gap between Slovakia and the most developed countries has been reduced significantly.

- The industry experienced a massive influx of investments. The level of investment (capital formation in relation to the generated value added) was particularly high, which resulted in a substantial improvement of the capital-labour ratio. Undercapitalisation in the paper industry – a problem shared by the industries in former transitive economies – has been eliminated to such an extent that the capital equipment in Slovakia exceeded the values of some of the most developed economies.

- The relatively high average wage was still associated with low unit labour costs (compensation of employees/production), which contributed to cost competitiveness. Wages paid in the paper industry have become ‘greener’, i.e. they are not so environmentally burdened. There has been a major decline in the ratio of emissions to a unit of paid wages. This is caused by a decline in the emission intensity of production.

The economic effects of the paper industry in Slovakia:

- In Slovakia, one unit of final use of pulp and paper generates the highest direct and indirect effects on domestic production among all manufacturing products.

- Final use of pulp and paper for EUR 1 million has above-average total effects on the value added created in the national economy of Slovakia with significant indirect effects on the creation of the value added in other industries.

- The final demand for the products of the paper industry generates more than 18 thousand jobs and more than EUR 650 million of value added per year in total including induced effects.

- The export of paper for EUR 1 million generates EUR 1.91 million of production directly and indirectly in the whole Slovak economy.

- The final use of paper for EUR 1 million generates value added in the Slovak economy directly and indirectly for EUR 630 thousand.

- One employee in the production of paper generates 3 jobs in the remaining industries in the Slovak economy (3.6 jobs including induced effects).

Room for improvement, open questions for further research and challenges for a new industrial and economic policy can be identified in the following:

- The relationship between fixed capital formation (investments) and the dynamics of value added. The extensive investments were not followed by a massive growth of value added in the following years. This may be explained, at least to some extent, by the fact that the investments made in the last fifteen

years have rather strengthened environmental sustainability and have not led to an expansion of production.

- In some countries, the productivity of paper industry is higher than in Slovakia, even though the capital equipment in Slovakia is higher (this can be seen on the comparison of Slovakia and Austria). This problem is related to the previous one and it may be a subject for further studies.

- In the last two decades, a continual decline in the employment can be detected both in the paper industry and the whole manufacturing sector. This was a consequence of a major increase in the labour productivity and the resulting increase of competitiveness. It can be assumed that future investments will not have such a major impact on the issue of environment (since it has been completely changed), but instead it will positively influence value added and employment. Compared to services, the share of direct employment and value added in the whole manufacturing sector has been declining (at present, this leads to discussions about deindustrialisation). This is the consequence of a higher growth of labour productivity. However, as a result of the high division of labour, a question arises: what is the share of employment that is generated by the demand for industrial (paper-industry) products? This question may be the subject for further studies as well, and the answer may be found in the circular context of the national economy.

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