DELIVERABLE 3.1: Methodology proposal for the macro-economic influence of rail freight transport

FRANK TROCH, THIERRY VANELSLANDER & CHRISTA SYS
TPR-UNIVERSITY OF ANTWERP

Work package (WP) 3 aims at providing tools from the macro-economic research domain, in order to measure the impact of rail transport on the Belgian economy. This research includes rail transport as a part of the intermodal chain. The SWOT analysis in deliverable 1.1 – 1.2 has shown that both economic growth and transport growth share a strong connection, impacting on one another (Hilferink, 2003). Although transport demand is a derived demand, and therefore usually following the economic growth and industrial production, changes within the transport sector and decisions impacting on transport in general do have an impact on the economic growth of a country as well (Konings et al., 2008; UNCTAD, 2014). As such it is important to understand and measure the relationship between rail transport and the national economy or macro-economic level.

Within this deliverable, the main components of the proposed methodology will be explained. An overview will be given according to four sequential steps:

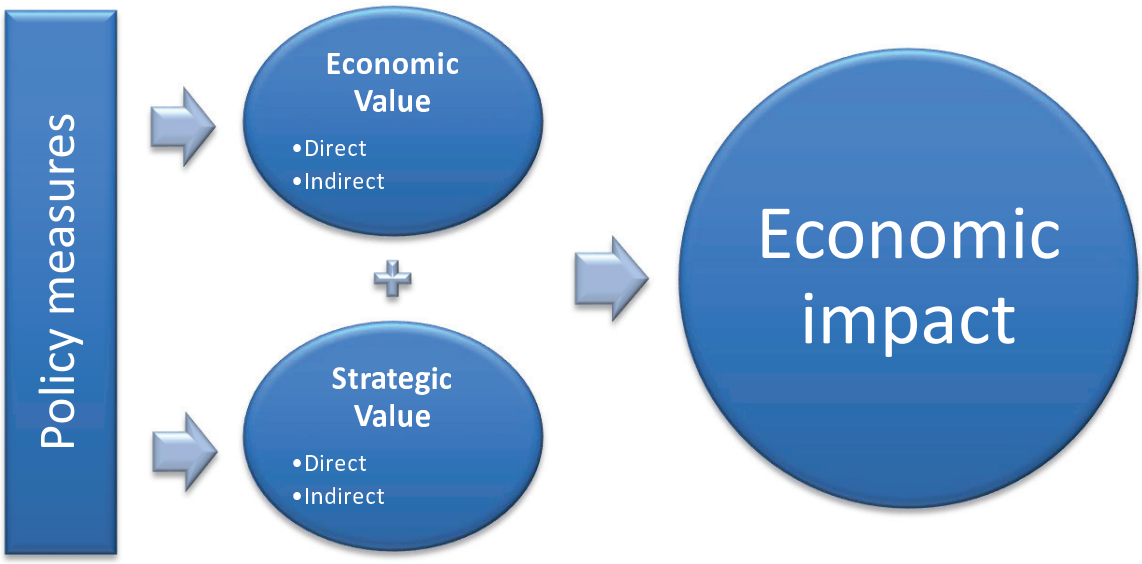
1. Problem identification: why measuring the macro-economic impact?
2. Methodology: input-output, multipliers and linkages
3. Risk analysis: data collection and validity of the results
4. Link with the scenarios: translation of tkm and a sensitivity analysis

In this WP, the analysis will be built in three steps. First the framework of an input-output model is applied to the sector of rail operations and the multipliers for the national economy are calculated. In a second step, the connections between the different sectors of the national economy and the actors involved in rail transport are investigated through linkages between the rail freight sector and other industries of the national economy. Both steps are explained in section 2. Section 3 highlights possible problems and risks for the analysis of the current state. This current state will then be further analysed in a third step, by linking the scenarios from WP 1 to the obtained results. This will be discussed in section 4.

1. PROBLEM IDENTIFICATION: WHY MEASURING THE MACRO-ECONOMIC IMPACT?

The SWOT analysis in WP 1 has shown the importance of high productivity, flexibility and a customer-oriented approach for rail transport and other related sectors, in order to obtain a competitive advantage and increase its attractiveness. Decisions and actions taken in the field of rail freight transport which aim at achieving these aspects also impact to a greater or lesser extent on the rest of the economy. As shown in figure 1, in order to quantify these effects, direct and indirect effects on the economic value should be taken into account, as well as direct and indirect effects on the strategic value (Kuipers et al., 2005; Coppens et al., 2005).

FIGURE 1 – ECONOMIC IMPACT OF MEASURES DIRECTED TO FREIGHT TRANSPORT



SOURCE: OWN COMPOSITION BASED ON KUIPERS ET AL. (2005) AND COPPENS ET AL. (2005)

Economic value is expressed by the physical and monetary effects of policy measures. Direct effects of transport decisions and investments are often calculated by a classical cost-benefit analysis approach. However, Mouter et al. (2012) and Beukers et al. (2012) indicate the weakness of such approach due to the absence or underestimation of the indirect economic effects. In addition to the social costs and benefits, also indirect effects should be taken into account, which exist because the economic sectors are interrelated due to which changes in demand and supply in one sector ignite a ripple effect throughout the rest of the economy (Coppens et al. 2005).

Strategic value is often for many businesses and sectors a reason to remain active in a particular region or country. However, this effect is not always calculated in the direct and indirect economic value of transport. As such, it is important to also quantify the direct and indirect effects of the strategic significance of freight transport to the rest of the economy (Kuipers et al., 2005).

The goal of this WP is to develop a methodology to quantify both the economic and strategic value of rail freight transport. Coppens et al. (2007) performed a similar research for the economic impact of port activity, by applying a disaggregate analysis for the case of Antwerp. Within their study, the input-output technology is used to identify the multipliers capturing all direct and indirect economic effects, measured by the change of two macro-economic parameters: employment and added value. This information is then used to define the strategic value. This is done by using the Markov-chain to identify the relationships or linkages between port actors and the rest of the economy, and how these relationships can change under the influence of certain policy measures impacting the port and its environment.

In the next section, the input-output methodology will be explained, as well as the use of corresponding multipliers and the Markov-chain theory to identify strategic linkages. This will be done in the next section by means of a simplified example and the results obtained from the study of the port sector.

2. METHODOLOGY: INPUT-OUTPUT, MULTIPLIERS AND LINKAGES

In order to capture the chain effect discussed in the previous section, the methodology of an input-output table is often used in similar studies. With this methodology, both the direct and indirect impact of modifications in the rail freight transport sector are captured by estimating the total effect on the national economy. However, whereas the port study by Coppens et al. (2007) used a regional input-output table, the study of economic impact of rail freight transport on the national economy requires using national input-output tables. The Federal Planning Office (2015) is publishing these national input-output tables every five years. The last version takes into account the input-output tables of 2010 and was published in December 2015.

2.1 General framework

The methodology of input-output analysis has been developed by the Russian economist Wissily Leontief (Miller & Blair, 2009). Table 1 gives a general overview of the structure of a national input-output table.

TABLE 1 – STRUCTURE OF A NATIONAL INPUT-OUTPUT TABLE

	1	2	…	N	X	F	C
1	c_{11}	c_{12}	…	c_{1n}	x_1	f_1	c_1
2	c_{21}	c_{22}	…	c_{2n}	x_2	f_2	c_2
…	…	…		…	…	…	…
N	c_{n1}	c_{n2}	…	c_{nn}	x_n	f_n	c_n
M	m_1	m_2	…	m_n		m_f	
VA	va_1	va_2	…	va_n			
C	c_1	c_2	…	c_n			

N = Number of industries in the economy
C_{ij} = Output of industry i delivered to industry j
C_n = total input / output of industry n
VA = Value added
M_j = Import
X_i = Export
F_i = Final demand

SOURCE: OWN COMPOSITION BASED ON COPPENS (2006) AND COPPENS ET AL. (2007)

In a national input-output model, the economy is split into n industries. According to the NACE classifications, active companies are divided amongst these n industries (Coppens, 2007). The output of an industry i can be delivered to a certain industry j, indicated by parameter C_{ij}. Other possibilities are that the output of an industry i is exported, indicated by parameter X_i, or is used by exogenous actors such as final consumption by families or investments by the government. This is the final demand, indicated by parameter F_i. As such, the total output of an industry i, indicated by parameter C_i can be calculated according to formula (1):

$$c_i = \sum_{j=1}^{n} c_{ij} + x_i + f_i \qquad (1)$$

The same logic can be applied to obtain the purchases or input of each industry j (Coppens, 2006). The input of each industry i to industry j is added to the input or import bought from outside of the national economy, indicated by parameter M_j. As the total input of a certain industry should be the same as the output of that industry ($c_i = c_j$), the difference can be calculated as the added value that this industry is generating (Miller & Blair, 2009). This is shown in formula (2) and (3):

$$VA_j = c_j - \sum_{i=1}^{n} c_{ij} - m_i \quad (2)$$

$$c_j = \sum_{i=1}^{n} c_{ij} + m_i + VA_j \quad (3)$$

2.2 Simplified example

How such an input-output table is calculated will be explained by using a simplified example based on Van Gastel (2015) and an illustration of input-output calculations by Miller and Blair (2009).

A first step is to collect the supply and demand tables from the national accounts. These tables are published every year by the National Bank of Belgium (NBB, 2015) and used every five years by the Federal Planning Office to calculate the national input-output table (Federal Planning Office, 2015). The supply and demand tables show the transactions between companies, indicating the structure of production costs, revenues generated from the production process, and transactions coming from import and export (NBB, 2015). The main difference between supply –and demand tables and an input-output table, is that the former identifies the relationship between products and industries, where the latter gives more insight in the mutual relationship between industries (Van Gastel, 2015).

Table 2 shows a simplified example of a possible supply table. Within this table, the output of each industry can be analysed.

For example, the chemicals industry is providing 100 units of PVC and 50 units of plastic. Cars are manufactured by the car manufacturing industry (200 units) and they are partially bought as an input from outside of the national economy (40). In this respect, import can be seen as an industry which is delivering an output of 40 units to the national economy.

TABLE 2 – SIMPLIFIED SUPPLY TABLE

	Chemicals	Plastic	Machines	Car man.	Energy prod.	Import
PVC	100	0	0	0	0	0
Plastic	50	200	0	0	0	0
Machines	0	0	410	0	0	0
Energy	0	0	0	0	815	0
Cars	0	0	0	200	0	40
TOTAL	**150**	**200**	**410**	**200**	**815**	**40**

SOURCE: OWN COMPOSITION BASED ON VAN GASTEL (2015)

Table 3 shows a simplified example of a possible demand table. Within this table, the input of each industry can be analysed.

For example, the chemicals industry is using 5 units of PVC, 50 units of machines and 30 unit of energy. Cars are used by the car manufacturing industry (20 units) and they are partially sold to buyers outside of the national economy (190). In this respect, export can be seen as an industry which is buying an input of 190 units from the national economy. Cars are also used outside of the defined industries and export, resulting in a final demand by families and the government of 30 units.

TABLE 3 – SIMPLIFIED DEMAND TABLE

	Chemicals	Plastic	Machines	Car man.	Energy prod.	Export	Final demand
PVC	5	20	0	0	0	75	0
Plastic	0	25	0	10	0	115	100
Machines	50	15	10	35	100	150	50
Energy	30	5	15	25	100	540	100
Cars	0	0	0	20	0	190	30
TOTAL	**85**	**65**	**25**	**90**	**200**	**1070**	**280**
Added Value	*65*	*135*	*385*	*110*	*615*		
TOTAL	**150**	**200**	**410**	**200**	**815**	**1070**	**280**

SOURCE: OWN COMPOSITION BASED ON VAN GASTEL (2015)

It should be noticed that the sum of each corresponding row in table 2 and 3 would equal the same amount. This can be explained by the earlier statement that, on the condition that import, export, final demand and added value are included in the calculation, the total input of an industry should be the same as the total output of that industry (Miller & Blair, 2009). As such, the total amount of products used or exported should also equal the total amount produced or imported from this product.

For example, 240 cars are produced as an output (200 by the car manufacturing industry within the national economy and 40 are imported), while 240 cars are also used as an input (20 going to the car manufacturing industry, 190 are requested from outside the national economy and 30 are used by families and the government).

As a consequence, the added value for each industry can also be calculated. This is obtained by calculating the difference between what is needed for the total production of an industry and what is supplied as an output by this industry in return of these inputs. The added value for each industry is shown in table 3.

For example, the chemicals industry is producing and supplying 150 units (100 PVC + 50 plastic). In order to be able to produce these units, a total of 85 units is required by this industry (5 PVC + 50 machines + 30 energy). As such, the added value of the chemicals industry can be calculated as 65 (150 outputs – 85 inputs).

In a second step, the data of the demand table has to be corrected. The reason for this is that the obtained supply table is created based on the basic prices, or the actual product value based on the cost of production, where the demand table is calculated based on the commercial or market prices, including taxes, subsidies, transport margins and handling margins (Van Gastel, 2015). Indeed, companies can adapt the price of a product they are selling according to national laws, subsidies and their obtained profit margin (Coppens, 2006). Therefore, the price paid by an industry demanding a certain product is different from the actual product value. Within this

example, it will be assumed that the demand table in table 3 is already adapted based on the remarks made in the previous paragraph.

In a third step, the actual merge of both tables can be executed. Thereby, the input-output table with a sector-sector comparison is obtained by calculating the ratio for each industry:

$$Input - Output\ coefficient\ between\ sector\ A\ and\ B = \sum_{i=1}^{n}(Output\ of\ product\ i\ by\ sector\ A * \frac{Input\ of\ product\ i\ by\ sector\ B}{Total\ input/output\ product\ i}) \quad (4)$$

As such, the input – output relation between two sectors can be calculated by multiplying the output of each product of the first sector with the relative use of the concerned product by the second sector, and finally summarising the results for all products.

For example:

Industry A = Chemicals industry
Industry B = Plastic industry

*- For the product "PVC": Output "PVC" by chemicals * (input "PVC" by plastic / Total I-O of "PVC").*
*- For the product "Plastic": Output "Plastic" by chemicals * (input "Plastic" by plastic / Total I/O of "PVC").*
- No other output is produced by the industry of chemicals.

Input-output relation between sector A and B =

*100 * (20 / 100) + 50 * (25 / 250) + 0 * (15 / 410) + 0 * (5 / 815) + 0 * (0 / 240) =*

20 + 5 + 0 + 0 + 0 = 25

TABLE 4 – INPUT-OUTPUT TABLE

	Chemicals	Plastic	Machines	Car man.	Energy prod.	Export	Final demand	TOTAL
Chemicals	5	25	0	2	0	98	20	**150**
Plastic	0	20	0	8	0	92	80	**200**
Machines	50	15	10	35	100	150	50	**410**
Car. Man.	0	0	0	17	0	158	25	**200**
Energy prod.	30	5	15	25	100	540	100	**815**
Import	0	0	0	3	0	32	5	**40**
TOTAL	**85**	**65**	**25**	**90**	**200**	**1070**	**280**	
Added Value	*65*	*135*	*385*	*110*	*615*			
TOTAL	**150**	**200**	**410**	**200**	**815**	**1070**	**280**	

SOURCE: OWN COMPOSITION BASED ON VAN GASTEL (2015)

When the input-output coefficient between sectors is calculated using equation 4 for each possible relation between two industries, the input-output table is obtained as shown in table 4. The red circle shows the result of the example previously explained. It should be noted that the inversed relationship, between the plastic industry and the chemicals industry, results to 0. This can be explained by the information that the plastic industry only has 200 outputs of plastic, while the chemicals industry is not using any plastic as input. As such,

the only relation between the plastics industry and the chemicals industry, is in the direction of chemicals providing inputs towards the plastic industry.

This also explains how the input-output table in table 4 can be read and interpreted. Reading it from left to right, the output relation between the row industry and the column industry can be analysed. The chemicals industry is indeed providing an output of 25 towards the plastic industry, whereas the plastic industry is not providing any output to the chemicals industry. Reading the table from top to bottom, the input relation is showing itself, by indicating what each column industry is using from a row industry. From the example, it is indeed clear that the plastic industry is using 25 inputs from the chemicals industry, whereas the chemicals industry is not using any input from the plastic industry.

2.3 Multipliers

An input-output table can be used to calculate technical coefficients for the national economy (Coppens, 2006; Miller & Blair, 2009). Then, these coefficients can be used to obtain multipliers that measure the impact of a change in input or output for one of the industries on the rest of the economy.

The **Leontief multiplier** measures the total effect on the output of the national economy by a change in final demand for one of the industries. It is expected that a change of one unit in final demand in industry i results in a total output change greater than the initial change of one unit. This is explained by the chain effect each change in final demand is invoking. In our example above, an increase in final demand from the plastic sector would not only result in a direct output increase for this sector. Instead, the plastic sector would require additional inputs from the sectors it is related to, in our example identified as the plastics industry, the chemicals industry, the machines industry and the energy industry. As such, the output from these industries would also increase, and in their turn these sectors would require additional inputs from the sectors they are related to. As such, a ripple effect would impact the total output of the national economy.

In order to calculate the Leontief multiplier for a sector, the technical input coefficients for the relationship between each industry needs to be obtained. This corresponds with the intermediate usage of products between industries. The following formulas can be used:

$$A = C * c^{-1} \tag{5}$$

Where C is a matrix with all intermediate deliveries c_{ij}, as shown in table 1 and table 4, and c^{-1} is an inverted diagonal matrix with the total inputs or outputs shown as c_i. According to our example above, this would result in the following matrices:

$$C = \begin{array}{l} \\ \text{chemicals} \\ \text{plastic} \\ \text{machines} \\ \text{car man.} \\ \text{energy prod.} \end{array} \begin{array}{c} \begin{array}{ccccc} \text{chemicals} & \text{plastic} & \text{machines} & \text{car man.} & \text{energy prod.} \end{array} \\ \begin{bmatrix} 5 & 25 & 0 & 2 & 0 \\ 0 & 20 & 0 & 8 & 0 \\ 50 & 15 & 10 & 35 & 100 \\ 0 & 0 & 0 & 17 & 0 \\ 30 & 5 & 15 & 25 & 100 \end{bmatrix} \end{array}$$

c^{-1} =

	chemicals	plastic	machines	car man.	energy prod.
chemicals	1/150	0	0	0	0
plastic	0	1/200	0	0	0
machines	0	0	1/410	0	0
car man.	0	0	0	1/200	0
energy prod.	0	0	0	0	1/815

A =

	chemicals	plastic	machines	car man.	energy prod.
chemicals	0,03	0,12	0,00	0,01	0,00
plastic	0,00	0,10	0,00	0,04	0,00
machines	0,33	0,08	0,02	0,18	0,12
car man.	0,00	0,00	0,00	0,08	0,00
energy prod.	0,20	0,02	0,04	0,12	0,12

These technical input coefficients can be interpreted as follows: for each euro output, the plastic industry needs 0.12 euro of purchases (input) from the chemicals industry, 0.10 euro of purchases from the own industry, … . The sum of the column for each industry is less than one, which can be explained by the absence of added value and import in this table (Coppens, 2006).

Based on the technical input coefficients from equation (5), the impact of a change in final demand on the national economy, taking into account the direct and indirect effects in the whole chain, can be calculated by:

$$L = (I - A)^{-1} \tag{6}$$

With I a corresponding identity matrix and L being the (inverted) Leontief matrix, containing the technical output coefficients for the national economy. According to our example above, this would result in the follow matrix:

L =

	chemicals	plastic	machines	car man.	energy prod.
chemicals	1,03	0,14	0,00	0,02	0,00
plastic	0,00	1,11	0,00	0,05	0,00
machines	0,38	0,14	1,03	0,23	0,14
car man.	0,00	0,00	0,00	1,09	0,00
energy prod.	0,25	0,06	0,05	0,16	1,14
LEONTIEF	**1,66**	**1,45**	**1,08**	**1,55**	**1,28**

The Leontief multiplier can be calculated by summarising all technical output coefficients of certain column industry. The result is called the Leontief multiplier for the corresponding industry and it can be interpreted as the total effect on the output of the national economy by a change of one unit in final demand for the concerned industry. In the example, each increase in final demand of the plastic industry by 1 euro, will result in a total output increase of 1.45 euro for the national economy of Belgium.

In addition, the Leontief multiplier can also be used to analyse the impact on the national employment by applying the same multiplier values to the corresponding employment data of each industry. In order to do this, the assumption that needs to be made is that the relation between output and employment remains unchanged when a shift in final demand is taking place (Coppens, 2006).

The **Gosh multiplier** is calculated similarly to the Leontief multiplier, but using the added value and import as an exogenous factor, instead of the final demand. This way, the Gosh multiplier is supply-driven, while the Leontief multiplier is demand-driven. The Gosh multiplier measures the total effect on the output of the national economy by an exogenous change in import or added value for one of the industries. A change of one unit in final demand in industry i results in a total output change expected to be greater than initial change of one unit (Coppens, 2006; Miller & Blair, 2009).

It should be noted that both models are using the assumption that the relations between the industries on one side, and final demand or import and added value on the other side are not changing when the demand or added value is increasing or decreasing (Coppens, 2006).

Finally, Oosterhaven and Stelder (2002) have applied a correction factor to the multipliers which makes it possible to multiply them with the total output without distortion. As such, the total share of generated effects on the total national economy of a whole industry can be calculated without any overestimations. This is the final version of the multipliers that has also been used in the study of economic impact from port activity (Coppens et al., 2007) and it is the multiplier that is proposed to be used in the analysis of this WP.

2.4 Interdependence or linkages of industries

In order to further analyse the relations between industries, three different indicators can be used based on the theory of the Markov-chain and its corresponding attributes: (i) Cai and Leung linkages, indicating the effect of an industry compared to its own output; (ii) decomposed linkages, indicating the effect of an industry compared to the output of the industry of concerned customers or suppliers and finally (iii) key sectors (Coppens, 2007). For the first two indicators, forward and backward linkages can be calculated. Forward linkages estimate the total effect of a certain industry on its customers. Backward linkages are showing the same relation, but for the suppliers of a certain industry. An overview of the formulas for these linkages is given in table 5. Within the formulas, l_{ij} refers to the Leontief technical output coefficients and g_{ij} refers to the Gosh technical output coefficients, which are explained in section 2.3.

These linkages can be calculated between the industries that are taken into account in the input-output analysis. Due to data limitations, which will be explained in section three, the most important relations from the available national input-output analysis will be the relation between the rail freight industry and multiple customers and suppliers. Moreover, intermodal relations with land transport (road freight and pipeline transport), water transport (maritime freight and inland shipping), air transport and storage and supporting activities will be further investigated. Further analysis will need to make clear how national companies are distributed within the national input-output analysis over the different industries that are available, in order to be able to give a correct interpretation and understanding on the different industries involved.

TABLE 5 – INPUT-OUTPUT INDICATORS REGARDING THE RELATIONS BETWEEN INDUSTRIES

Cai and Leung linkages (all levels)	backward	$BL_j = \frac{\sum_{i=1}^{n} l_{ij}}{l_{jj}}$	linkage of industry *j* to its suppliers	in relation to the output of industry *j*
	forward	$FL_i = \frac{\sum_{j=1}^{n} g_{ij}}{g_{ii}}$	linkage of industry *i* to its customers	in relation to the output of industry *i*
Decomposed linkages (all levels)	backward	$BDec_{ij} = \frac{g_{ij}}{g_{jj}}$	linkage of industry *j* to its supplier *i*	in relation to the output of industry *i*
	forward	$FDec_{ij} = \frac{l_{ij}}{l_{ii}}$	linkage of industry *i* to its customer *j*	in relation to the output of industry *j*
Key sectors	$\frac{\text{Leontief multiplier of j} \times \text{final demand of j}}{\text{output of j}} > 1$		sector *j* is more important for the other sectors than vice versa	

SOURCE: CAI & LEUNG (2004), COPPENS ET AL. (2007)

3. RISK ANALYSIS: DATA COLLECTION AND VALIDITY OF THE RESULTS

In the previous section, it is indicated that a national input-output table is dividing the economy into a certain number of industries (Coppens, 2007). The Federal Planning Office is using 64 industry clusters for the Belgian national input-output table of 2010, based on the revised NACEBEL codes from NAI (Federal Planning Office, 2015). As it was mentioned before, a time delay for this kind of data of approximately 5 years has to be taken into account (Federal Planning Office, 2015). Corresponding to our research on rail freight transport, the lowest level of details publicly available in this national input-output table is classification number 49, including all companies active in the field of land transport and pipes transport. This includes both freight and passenger transport. As such, no conclusions can be drawn from this national input-output table for the rail freight industry. In addition, the national input-output table is also limited in terms of comparison of linkages and relations between the different industries, as this could only be done between the included 64 clusters. As a consequence, interesting relations such as the linkage between rail freight transport and shipping agents, freight forwarders, terminals and others transport actors cannot be analysed.

Taking this into account, the main difference between the port study of Coppens et al. (2007) and the current analysis of the rail freight sector and its impact on the Belgian economy should be explained. Whereas the port study is a disaggregate analysis, it is more focussed on the micro-economic level of the port industry. Only companies active within a geographically bound area, being the port of Antwerp, and a limited number of cluster industries, being the port actors, were taken into account. This set of companies was re-clustered in a new set of industries defined by the researchers. Applying the same bottom-up approach to the current analysis would require disaggregate micro-level data about all companies related to rail activities that are active in Belgium, and re-cluster them into an own defined set of industries linked to the rail freight sector. This would be the same work that the Federal Planning Office is doing every five years, although with a different set of industries. The

end result would be more of a micro-level analysis of the rail freight sector, without having a full picture of the macro-economic impact on the Belgian economy, which is the main objective of the current research.

Therefore, it should be accomplished to split the rail freight sector from the national classification number 49. In this way, the rail freight industry can be compared with the main national industries of the Belgian economy. According to the methodology described in section 2, this can be done by departing from the original supply – and demand tables for the Belgian economy, and re-clustering companies active in the rail freight industry into a new industry. As such, the rail freight industry is pulled from the land transport and pipes transport industry and can be analysed separately.

In order to obtain this result, a partnership has been started with the National Bank of Belgium and relations have been set-up with B Logistics, the incumbent Belgian rail operator who is still holding a market share of above 80% and therefore representing the biggest part of the rail freight industry in Belgium (Deville & Verduyn, 2012). The objective of this cooperation is to retrieve the necessary data to calculate the input-output analysis and the corresponding multipliers and linkages for the rail freight industry in Belgium.

A last remark with respect to the data is the validity of the results. The national input-output table and the data that will be collected during the research will take into account rail freight operators and their corresponding activities that are registered in Belgium and active on the Belgian geographical territory. As such, rail actions performed by international companies without establishment in Belgium will not appear in the data and will not be taken into account. Although these international operations also have a clear influence on the Belgian economy, the output of the current research should be interpreted as the macro-economic effect of national operations by national companies on the national economy.

4. LINK WITH THE SCENARIOS: TRANSLATION OF TKM AND A SENSITIVITY ANALYSIS

The last published Leontief multiplier by the Federal Planning Office dates from May 2010, being calculated based on the input-output tables for Belgium for the year 2005. Although the input-output tables for Belgium for the year 2010 are also calculated and published in December 2015 (Federal Planning Office, 2015), the Leontief multipliers have not yet been calculated and analysed. As a first step towards the continuation of this research, this has been done as a start for further analysis and an exercise to learn the methodology described above. The results of this exercise can be found in table 6.

TABLE 6 – LEONTIEF MULTIPLIERS FOR TRANSPORT SECTORS (2005 AND 2010 COMPARISON)

Industry (cluster)	Multiplier 2005	Multiplier 2010
Land transport	1.73	1.66
Water transport	1.91	1.63
Air transport	1.82	1.72
Storage and transport services	1.73	1.67

SOURCE: FEDERAL PLANNING OFFICE (2010); OWN CALCULATIONS BASED ON FEDERAL PLANNING OFFICE (2015)

This means that the industry of land transport has an effect of 1.73 on the national economy of 2005 and 1.66 in 2010. As a consequence, each euro increase in final demand in the industry of land transport results in an increase by 1.73 euro and 1.66 euro for the national Belgian economy, for 2005 and 2010 respectively. The decrease can be linked to the economic crisis that started in 2008, lowering the relative contribution of the transport sector to the macro-economic level of a country.

The results for the land transport industry can be compared with other transport industries, such as water transport and air transport. Where air transport provided a higher economic impact in both years, water transport faced a greater drop by 2010 compared to the other transport industries. The industry of storage and transport services is delivering a similar impact to the national economy compared to land transport. It should be emphasised that the land transport sector is mainly represented by road freight and public transport. As such, no direct conclusion can be taken for the rail freight industry.

When comparing to other industries in the Belgian economy, it can be stressed that the construction industry has the greatest impact on the national economy. With a multiplier of 2.14 in 2005 and 2.06 in 2010, each euro increase in final demand for the construction industry is resulting in more than an additional euro worth of indirect effects. The industry with the lowest effect on the national economy is education, with a multiplier of 1.12 in 2005 and 1.14 in 2010.

Looking at the strongest and weakest links for the industry of land transport, a first analysis shows that strongest link exists with the industry of storage and transport services, as well as legal services, leasing and the production industry of cokes and oil. The weakest link of land transport in terms of indirect output effects exists with the pharmaceutical industry and agriculture. It should again be mentioned that this analysis is based on aggregated data for the land transport sector as a whole, and therefore no conclusions can be drawn yet for the industry of rail freight transport.

After the calculation of the macro-economic impact of the rail freight industry on the national economy, the results of WP 3 will be linked to the scenarios developed in WP 1. Within this first WP, three different scenarios have been defined based on a SWOT that was performed for the rail freight sector. These scenarios are created by a set of parameters, indicating a worst-case evolution, a medium-case evolution and a best-case evolution for rail freight transport by 2030. As the model to measure the macro-economic impact is demand-driven, the parameter indicating the realised amount of ton-kilometre (tkm) will be of main importance for WP 3.

Based on the evolution of the amount of rail tkm in the three scenarios, the impact on the national economy can be estimated by applying this new demand to the collected data that was found for the analysis of the current state of the rail freight sector in terms of impact on the national economy. For the best-case scenario, an increase of rail freight demand by 133% is estimated. For the medium-case and worst-case scenario, this is respectively set to 64% and 10%. Taking into account the set growth parameters for the national economy in the corresponding scenarios, the data of the national supply –and demand tables and the data of the rail freight industry can be adapted accordingly, and the impact on the multipliers and linkages between the industries can be analysed.

By applying these scenarios to the set of data, in a first stage, the assumption is made that the relations between the sectors will remain unchanged. Therefore, a sensitivity analysis can be performed, in which different conditions are released and tested, to measure the influence on the outcome of the model. For example, one parameter could be the impact of the capacity, which is excluded from the first analysis, but can be verified in a second stage as this might become a bottleneck when rail freight demand is increasing.

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