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Master Thesis

Integration of production and transport: Empirical macro evidence

In-depth analysis of the relationship between production and transport and evolution of this relationship within the European Union between 2003 and 2007.

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I Preferences and acknowledgements

The purpose of this thesis is to investigate the relationship between production and transport. The relationship used to be dominated by production operations, of which the transport demand could be derived from. Due to logistical developments such as just-in-time production and pull-logistics, expected is that the operations of production and transport integrate into each other until it is difficult to tell them apart. The aim of this thesis is to evaluate the degree of integration of production and transport within the European Union and thereby adding to the general knowledge of the relationship between production and transport.

I would like to thank my supervisor drs. G. Mingardo for motivating me. Further I would like to thank my family, friends and fellow students for their support.

Integration of production and transport: Empirical macro evidence

II Abstract

The demand for transport is considered to be derived from the demand for produced goods. The amount of goods produced and sold determines the amount of goods transported. Attempts have been made to integrate production and transport activities to create a more efficient cooperation between both activities. Developments such as globalization, pull-logistics, logistic integrators, distribution centers and application of the just-in-time concept create a stronger integration of production and transport. The goal has become to minimize inventories in supply chains and to make goods pass through supply chains so fast that production companies can respond rapidly to increasing or decreasing market demand (Baker, 2004). The following research question was formulated:

Research question: How strong is the degree of integration between production and transport within the European Union?

Research within the European Union in the years 2003-2007 leads to the conclusion that the degree of integration between production and transport is weak. Transport volume is only explained for 37% by production volume and for 63% by other factors. Transport demand cannot yet be characterized as an integrated demand: Production volume would have to explain over 75% of transport volume and presence of logistical developments should be high. In the EU, the integration of production and transport has even weakened from 2003 to 2007.

Integration between production and transport appears to be strong in specific production sectors. Transport demand can be characterized as an integrated demand in production sectors Machinery and Food, due to the strong presence of logistical developments in these production sectors. Integration is also strong in production sectors Metal, Chemicals and Mineral despite their weakly developed logistical chains. Integration is weak in production sectors Mining and Fuel since these sectors produce mostly raw materials, and surprisingly weak in the Clothing industry since clothing are retail products.

Integration between production and transport is stronger in a country with excellent logistic performance where it is easy to move goods through the country. A country with excellent logistic performance has a solid infrastructure, efficient customs procedures, relatively low logistic costs etc. EU15 countries perform logistically strong; countries outside the EU make use of these logistical possibilities within the EU15. Integration of production and transport within EU15 is therefore weaker compared to the new EU member states, despite their weak logistical performance.

Despite having to overcome several limitations within this research, it has become clear that production and transport have not integrated in to each other yet in the EU, with the exception of production sectors Machinery and Food thanks to their application of concepts just-in-time production and pull logistics. This thesis proves that the integration of production and transport is weak in the EU and cannot yet be characterized as an integrated demand.

Keywords: Derived demand; Integrated demand; Integration production transport; Pull logistics; Just-In-Time Concept

Integration of production and transport: Empirical macro evidence

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1Introduction

The demand for transport is considered to be derived from the demand for produced goods. The amount of goods produced and sold determines the amount of goods transported. Demand for transport is therefore considered a derived demand. Example on micro level: A car manufacturer produces 100 cars, of which 90 cars are sold and transported. 10 cars have not been sold and transported due to lack of demand. Transport volume is derived from production volume, 90% of production volume is transported.

Logistical developments have been attempting to integrate production and transport activities, until it has become difficult to tell them apart (Rodrigue, 2006). The goal has become to minimize inventories in supply chains and to make goods pass through supply chains so fast that production companies can respond rapidly to increasing or decreasing market demand (Baker, 2004). Due to these logistical developments, it should become possible for the car production company to produce cars when customers order cars. The car manufacturer ultimately has to produce 90 cars and transport 90 cars. Transport volume is integrated with production volume since 100% of production volume is transported.

Transport demand was characterized as a derived demand. An increased degree of integration of production and transport could lead to a characterization of transport demand as an integrated demand. This leads to the following research question:

- Research question: How strong is the degree of integration between production and transport within the European Union?

A strong degree of integration between production and transport within the European Union would mean that transport demand can be characterized as an integrated demand (Hesse, 2004). The research is executed with the following purpose:

- The purpose of this thesis is to analyze the relationship between production and transport, to analyze developments of this relationship and to present a useful addition to existing literature on the relationship between production and transport

Production volume and transport volume are measured in the European Union in the years 2003-2007. Data has been retrieved from Eurostat(2010), the statistical office of the European Union. Each member state of the European Union collects national data and reports them to Eurostat. A short introduction to the used dataset:

- **Production volume:** Volume trends of added value of all production sectors as reported to Eurostat. Increases in added value are therefore corrected for price movements: Price level has no influence on this volume trend. Data is based on aggregations of sample surveys which are executed by the reporting countries.
- **Transport Volume:** Volume of ton-kilometers within the transport sector. A ton-kilometer is equal to 1 ton of freight moved 1 kilometer. The transport sector in this thesis consists of the transport modes of road, rail, barge and pipeline. Transport modes aviation and shipping have been excluded due to insufficient data. Data is based on mandatory data collection, which has to be completed by all public or private transport companies within the reporting countries.
- **European Union:** Data of the EU-27 is used for this thesis.

- **2003-2007:** The years of 2003, 2004, 2005, 2006 and 2007 have been used for this thesis. Years before 2003 could not have been used due to lack of sufficient transport volume data. Years after 2007 could not be used due to a new classification of transport data within Eurostat.

Overview of the entire dataset is visualized in figure 1:

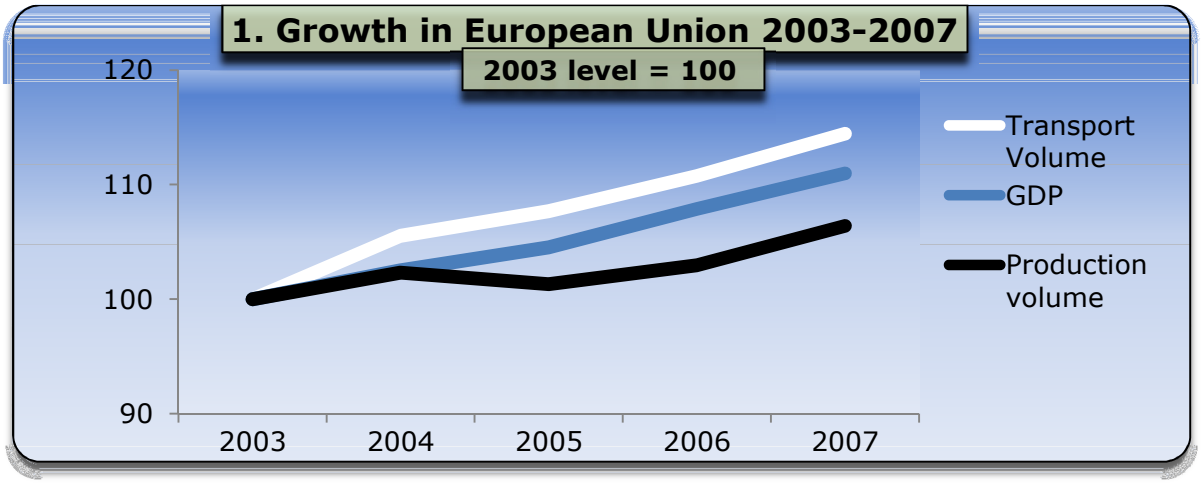


Figure 1: Developments of GDP, production and transport volume of 2003-2007 EU (Eurostat, 2010)

Figure 1 shows the general concept of this thesis. It shows that transport volume has significantly outgrown production volume. It does not appear that production volume is integrated with production volume. Question is how it is possible that extra volume is transported but not produced. Several explanations are possible:

- Production and transport have not been optimally integrated;
  - produced volume is being transported more than once
  - produced volume is being transported for longer distances
- Production from outside the EU is being transported within the EU

The level of integration between production and transport volume will also be measured per year, per production sectors, per country and per group of countries. Chapter 2 will present a literature review on the relationship between production and transport. Chapter 3 will present the methodology, limitations and the datasets of production volume and transport volume. In chapter 4 the results of the research of the integration of production and transport will be presented. Chapter 5 will present the conclusion and a discussion.

Data is unavailable on the exact production volume in tons and the exact transport volume in tons. Availability of this data would make it easier to analyze both the production and transport sector. By using these variables an attempt has been made to come as close as possible to this missing data. The used dataset comes as close as possible to actual production and transport volumes.

2Literature review

2.1Introduction

The relation between production and transportation is typically characterized in literature transportation being dependent on production (Danielis, 1999). Demand for transport is characterized as a derived demand. Derived demand is a term in economics where demand for a good or service occurs as a result of demand for another good or service. Only when products are purchased, the services of a transport company are demanded, in order to physically deliver the products. The demand for a product's transportation is derived from the product's demand at another location. The demand for produced goods determines the demand for transport of the produced goods. Transportation is a derived demand. Because of its derived character, one would expect a one-on-one relationship between production volume and transport volume. The relationship is researched using the entire dataset and further specified per year, per production sector, per country and per group of countries. Each subchapter starts with literature and ends with formulating the hypothesis. A summary of these hypothesizes follows in chapter 2.7.

2.2Overall analysis

With transport being a derived demand, one would expect a very strong relationship between production volume and transport volume within the European Union. However, existing literature sometimes denies the strong relationship. Cambridge (1995) denies the strength of integration on macro level, Chikan (2001) denies the strength of integration on micro level.

2.2.1Strenght of integration on macro level

According to Cambridge (1995), a number of factors besides production volume have a significant influence on transport volume, as visualized in table 1:

Transport volume is explained by two groups of factors:	
Basic influence	**Other direct and indirect influences**
• **Production volume**	• **Transport costs** • **Globalization** • **Development different types of goods** • **Logistic integrators** • **Centralized warehousing** • **Just-in-time concept** • **Packaging materials** • **Recycling**

Table 1: Factors explaining transport volume (Cambridge, 1995)

Basic influence: Production volume

According to Cambridge (1995) the basic influence of freight transportation demand is volume of goods produced and consumed. Expansion in national or regional economy results in increases in overall freight demand, contractions in economy result in reductions in freight demand. GDP is one of the most significant determinants in freight demand is as the more active an economy is, the more freight in circulation due to manufacturing and consumer demands.

Other direct and indirect factors of influence

- Transport costs: Transport costs directly influence the demand for transport, while transport costs in their turn are influenced by several other factors, such as:
    - Economic Regulation and Deregulation
    - International agreements
    - Government Subsidization
    - Environmental Policies
    - Fuel Prices
    - Infrastructure
    - Congestion
    - Technological Advances
- Globalization: Many companies manage worldwide production and distribution systems, national economies are increasingly integrated into a global economy. Globalization leads to spatial distribution of economic activity with production facilities placed all around the globe, which has a positive influence on transport distances. (Rauch, 1985). Chapter 2.4.1 further analyzes globalization.
- Development different types of goods: production of larger products requires more transportation, smaller products require less transportation
- Logistics integrators such as freight forwarders decide whether a shipment is made and which mode and route it will take. Freight forwarders therefore control the transport chain, not the production companies. Chapter 2.4.3 further analyzes logistic integrators.
- Centralized warehousing: More use of third-party logistics providers: increase in demand for transportation, reduction in inventory costs. Chapter 2.4.4 further analyzes central warehouses and distribution centers.
- Just-in-Time concept (JIT): Inventories can be kept at minimum levels by coordinating input deliveries with production schedules; JIT firms increase frequency of shipments while size of shipments is decreased. Chapter 2.4.5 further analyzes the JIT concept.
- Packaging Materials: Reduction in average density of shipment
- Recycling: Recycling leads to a growing importance of reverse logistics and leads to products being transported more than once.

2.2.2Strength of integration on micro level

According to the results of a study of Chikan (2001) there doesn't exist a fundamental conflict between the functions of production and transport on micro level but both show different behavior. Harmony or conflict between the performance measures of both functions on micro level may be a good indicator of the integration of production and logistics. Opportunistic behavior within each of the functions leads to several conflicts. These conflicts are caused by the several inconsistencies between both functions as presented in table 2:

Comparison production and transport functions on micro level	
Consistencies	
• **Must be operational at the end of the day** • **Dependent on short-term feedback** • **Have a measurable contribution to the profitability of the company**	
Inconsistencies	
Production	**Transport**
1. **Adds use-value**	1. **Adds place-value and time-value**
2. **Advances quality**	2. **Generates costs**
3. **Central function within company**	3. **Sub-function within company**
4. **Manager high position**	4. **Manager no high position**
5. **Managers prioritize quality, delivery speed and sales**	5. **Managers prioritize costs and reliable delivery**
6. **Influenced by marketing**	6. **Influenced by production**

Table 2: Comparison production and transport functions on micro level (Chikan, 2001)

The degree of integration between production and logistics appears to be much lower than expected. Business literature exaggerates the appearance of integration in practice. The actual integration of production and logistics in business practice is less frequent and less deep compared to expectations shaped by literature (Chikan, 2001).

Literature as discussed in 2.2.1 and 2.2.2 leads to the formulation of hypothesis 2.2 which is based on the research question of this thesis:

Hypothesis 2.2: The degree of integration between production and transport is not strong.

Integration of production and transport will be characterized as strong when production volume explains over 75% of the variations within transport volume.

2.3Analysis per year

As longer as production companies are cooperating with transport companies, one might expect production operations to be more adjusted to transport operations. According to Rodrigue(2006) production and transport have integrated in to each other so far, that is has become difficult to tell them apart. The integration has been caused by recent developments in logistic and supply chain management as discussed in chapter 2.4. Due to these developments, Hesse (2004) argues that the paradigm should shift from transport being a derived demand, to transport being an integrated demand. Integrated demand would imply a one-on-one relationship of production volume and transport volume. Each ton of production should have to be transported. This perfect level of integration will be hard to reach, however one may expect production and transport to grow towards each other. The degree of integration may not be strong as hypothesis 2.2 describes, but may be expected to grow stronger as formulated in hypothesis 2.3:

Hypothesis 2.3: The degree of integration between production and transport has strengthened over the years.

2.4Analysis per production sector

According to Cambridge (1995) it is important to distinguish between commodities when comparing production with transportation. The degree of integration between production and transport will be different per type of commodity and therefore per production sector. The degree of integration between production and transport has increased due to the following logistical developments (Rodrigue, 2006):

2.4.1 Globalization: Increasing scale of distribution
2.4.2 From push logistics to pull logistics
2.4.3 Functional integration along supply chains
2.4.4 Emergence of distribution centers (DCs)
2.4.5 Implementation of just-in time concept

2.4.1Globalization: Increasing scale of distribution

Globalization has led to the emergence of global supply chains. The scale of distribution has grown significantly due to globalization. The process of globalization within freight distribution identifies four cyclic phases:

A. Introduction: A freight transport system serves a specific local opportunity
B. Expansion and interconnection: The distribution system is adopted in new locations. Independently developed distribution systems connect with each other leading to the emergence of regional hubs.
C. Standardization and integration: A fully developed distribution system services national markets. Through intermodal integration, mergers and acquisitions the market expands to the continental level.
D. Integrated demand: A global distribution system answers predicted and unpredicted freight mobility needs. The distribution capabilities are tuned to the demand in an interdependent system.

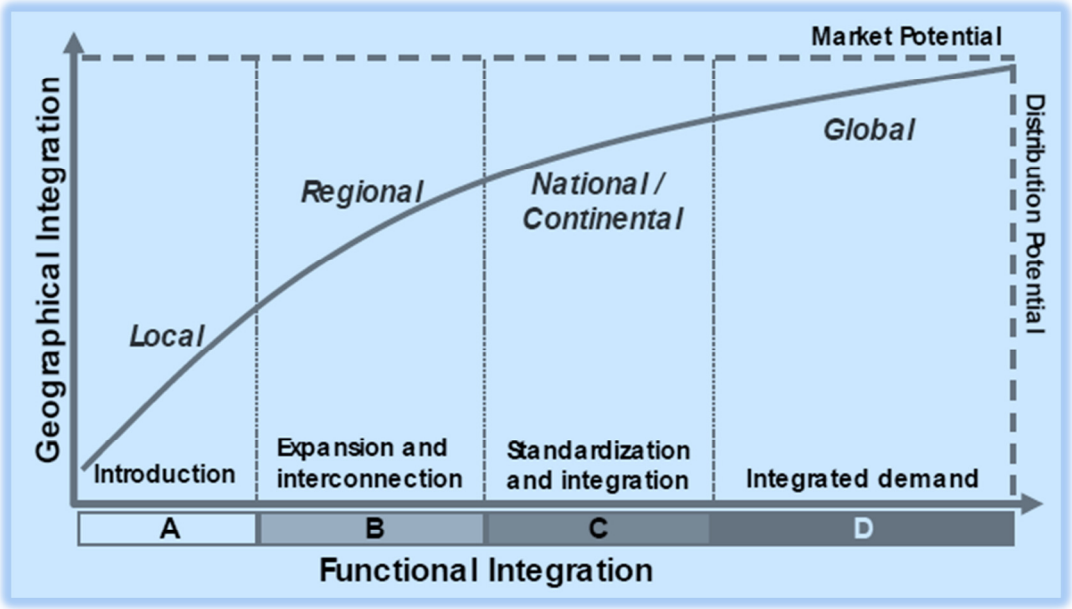


Figure 2: 4 cyclic phases of globalization (Rodrigue, 2006)

The geographical scope extends per stage. The 1st stage takes place at a local level, the 2nd stage at a regional level, the 3rd stage at a national/continental level and the 4th stage at a global level. Intermediate locations attract and regulate large flows and are therefore more powerful then origins and destinations. The more extensive the operational scale of distribution, the more globally oriented, the less derived demand applies (Rodrigue, 2006).

2.4.2Push – Pull logistics

The relationship between supply and demand of freight distribution has gone through significant changes, identified as the shift from push logistics to pull logistics. Both concepts show different characteristics on the following 5 areas:

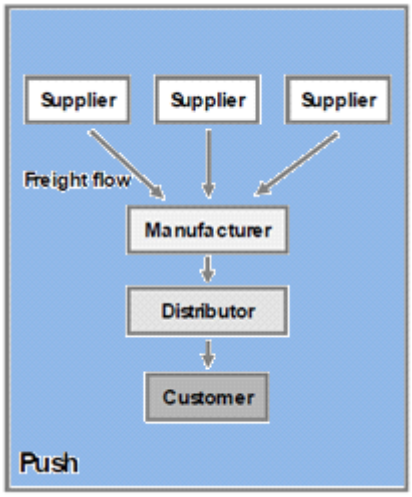
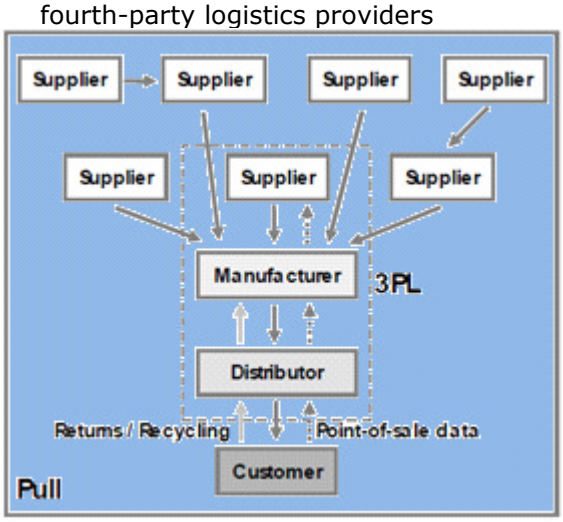
Push logistics	Pull logistics
1. Supply-driven 2. Manufacture-to-supply 3. Inventory-based 4. Maintaining inventories aimed at approximately satisfying the demand 5. Limited level of integration between suppliers, manufacturers and distributors	1. Demand-driven 2. Manufacture-to-order 3. Replenishment-based 4. On-demand transport: matching supply with demand using data collection systems 5. Integration between transport modes and inventory control due to third and fourth-party logistics providers
	

Table 3: Comparison Push and Pull Logistics concepts (Rodrigue, 2006)

Due to the shift to pull-logistics, the relative importance of inventories is reduced while the importance of transport increases. Specific logistical functions as inventory management, intermediate activities (packaging, bundling) and information systems have grown in relative importance as well. Transportation is no longer perceived as an exogenous cost but has been internalized within supply chains. The logistics industry is dominated by integrators which aim to synchronize distribution with production; therefore transportation cannot be considered a derived activity. The more demand-driven a freight distribution system, the more pull logistics are applied**,** the less the concept of derived demand applies (Rodrigue, 2006).

2.4.3Logistic integrators

In the push-logistics context, strong regulations led to a highly fragmented freight distribution sector. The regulations prevented multimodal ownership, the supply chain involved several different entities. Moving freight through the supply chain required several steps leading to additional costs and delays.

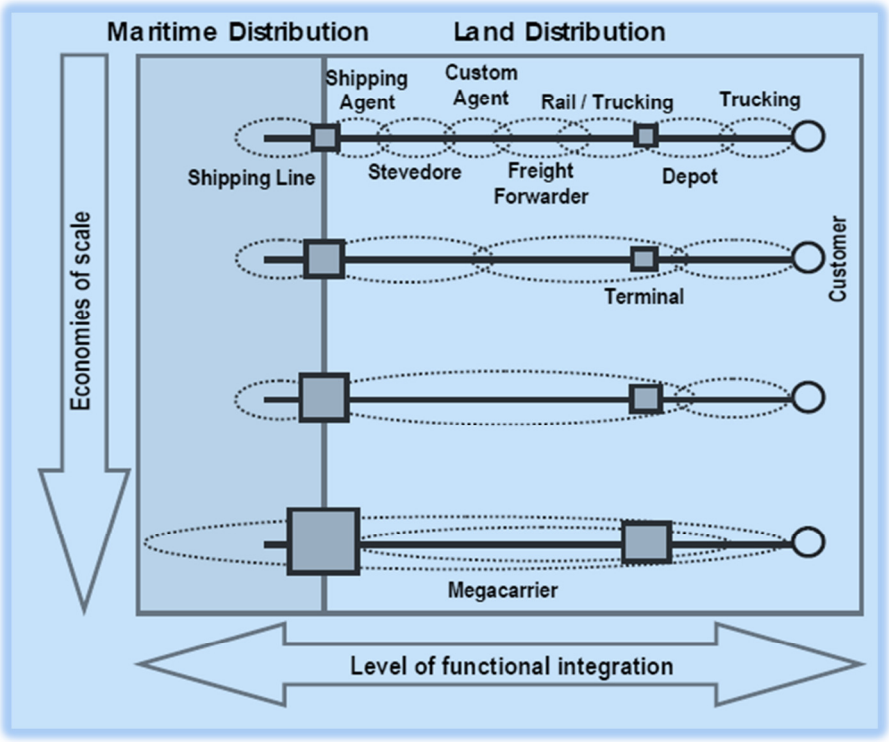


Figure 3: Influence of logistic integrators to the fragmented transport sector (Rodrigue, 2006)

Mergers and acquisitions have permitted the emergence of large logistics operators (3PL operators) which were able to remove intermediate steps in the supply chain and integrate the modalities. Information technology enabled an improved control of the supply chain. Large logistics integrators anticipate and regulate freight flows. Integrators control their respective supply chain and do not react to a derived demand, but choose a different strategy instead. According to Rodrigue(2006), integrators answer and shape its customer's needs, and shape the time sequence of customer service. Logistic integrators do not react to a derived demand but instead are able to control the supply chain. The stronger the presence of logistic integrators in a production sector, the stronger the integration of production and transport.

2.4.4Distribution centers (DCs)

Distribution centers have become the fundamental link between production and consumption. The original role as warehouse close to the final market has been expanded to a DC performing numerous value-added activities such as warehousing, packaging, labeling, final assembly and taking returns. DC's have become more efficient through automation, inventory control and cross-docking transfer capabilities. DC's provide an excellent link between industries and retail by specializing in distribution and provide a crucial link to customers (Rodrigue, 2006).

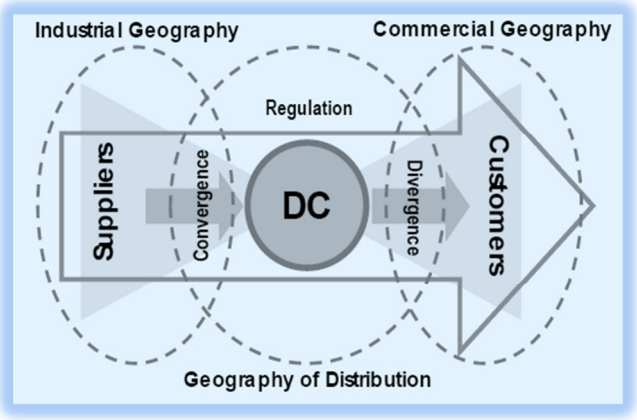


Figure 4: Supplier, DC and customer (Rodrigue, 2006)

2.4.5Just-in time concept (JIT)

In short, the just-in-time concept focuses on having the right material, at the right time, at the right place, and in the exact amount, without the safety net of inventory (Lean Deployment, 2010).

The value of time has increased due to decreases of transport costs and inventory levels. Supply chains are more synchronized with most of the inventory in circulation. Time has become the factor where a logistical operator can gain a competitive advantage; delays therefore are of more significance. A delay creates a domino effect through the entire supply chain. All linked manufacturing and retailing activities will be affecting and ultimately shut down. The higher the value of the commodity, the larger the role time plays. The lower the transport costs, the higher the value of time. Time has become a factor and has moved from a derived component to an integrated component (Rodrigue, 2006).

2.4.6Integrated demand

One would expect that a production sector with high globalization, pull logistics, high usage of logistic integrators and DC's and the application of the JIT concept can consider its transport demand to be an integrated demand. This leads to formulation of hypothesis 2.4:

Hypothesis 2.4: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport.

2.5Analysis per country

It will be relatively easy to move goods through the Netherlands due to the excellent physical infrastructure and massive supply of logistic services. When it is easier to transport all produced goods through the Netherlands, one would expect production and transport to be closely integrated in the Netherlands, more closely integrated compared to a country with worse logistical performance.

The World Bank (2007) measures the logistic performance of each world country with the Logistic Performance Index (LPI). The LPI is an index which evaluates the quality of logistics within a country. Quality of logistics means presence of high quality infrastructure, efficient custom procedures, low logistic costs etc. Table 4 shows the LPI scores of the European countries, their world rank and the year they joined the EU.

Country	LPI score (scale 0-5)	World Rank	Joined EU
Netherlands	4,18	2	1958
Germany	4,10	3	1958
Sweden	4,08	4	1995
Austria	4,06	5	1995
United Kingdom	3,99	9	1973
Ireland	3,91	11	1973
Belgium	3,89	12	1958
Denmark	3,86	13	1973
Finland	3,82	15	1995
France	3,76	18	1958
Italy	3,58	22	1958
Luxembourg	3,54	23	1958
Spain	3,52	26	1986
Portugal	3,38	28	1986
Hungary	3,15	35	2004
Slovenia	3,14	37	2004
Czech Republic	3,13	38	2004
Poland	3,04	40	2004
Latvia	3,02	42	2004
Estonia	2,95	47	2004
Cyprus	2,92	49	2004
Slovakia	2,92	50	2004
Romania	2,91	51	2007
Bulgaria	2,87	55	2007
Lithuania	2,78	58	2004

Table 4: LPI score of all EU27 countries 2007 (World Bank, 2007)

On basis of table 4, the following hypothesis can be formulated:

Hypothesis 2.5: Degree of integration between production and transport is stronger in a country with a stronger logistic performance.

2.6 Analysis per group of countries

Table 4 implies a possible relationship between the year when the country joined the EU and its LPI score. The 14 highest LPI scoring countries joined the EU in the 20th century; the 11 lowest LPI scoring countries joined the EU in the 21st century. The group of countries which joined the EU in the 20th century will be referred to as the EU15; the group of countries which joined the EU in the 21st century will be referred to as the new EU member states.
A relationship between the year of joining the EU and the LPI score on one hand; a relationship with integration of production and transport and the LPI score on the other hand leads to formulation of the following hypothesis:

Hypothesis 2.6: Degree of integration production and transport is stronger in EU15 compared to new EU member states.

2.7 Overview hypothesizes

As conclusion of chapter 2 follows an overview of all hypothesizes:

- Hypothesis 2.2: The degree of integration between production and transport is not strong.
- Hypothesis 2.3: The degree of integration between production and transport has strengthened over the years.
- Hypothesis 2.4: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport.
- Hypothesis 2.5: Degree of integration between production and transport is stronger in a country with a stronger logistic performance.
- Hypothesis 2.6: Degree of integration production and transport is stronger in EU15 compared to new EU member states.

Chapter 4 will test and either accept or reject these hypothesizes.

3Methodology and limitations

3.1Methodology and limitations

3.1.1Production volume

Production volume is measured by using the variable 'Value added at factor costs'. Definition of this variable is, as supplied by Eurostat (2010): 'Value added at factor costs is the gross income from operating activities after adjusting for operating subsidies and indirect taxes'. Factor costs are defined as the total costs of all factors of production used in producing a good. Correcting added value for inflation leaves only a volume trend of added value, which comes close to the exact produced volume. An increase in produced tons leads to an increase in added value and vice versa, despite eventual price changes. The production sector is divided into the following 10 subcategories:

MINING	Stone, sand, salt, crude petroleum, gravel, coal, lignite, natural gas, ores, uranium
FOOD	Meat, fish, fruit, vegetables, dairy products, grain, beverages, tobacco
CLOTHING	Textiles, wearing apparel, fur, leather
WOOD	Paper, wood, pulp, wood and cork products, printed matter, recorded media
FUEL	Solid fuels, refined/gaseous/liquefied/compressed petroleum products
CHEMICALS	Rubber, plastic, pharmaceuticals, mineral and organic chemical products, nuclear fuels
MINERALS	Glass, porcelain, cement, lime, plaster
METAL	Iron, steel, tubes, pipes, boilers, hardware, weapons
MACHINERY	Computers, cars, other transport equipment, medical instruments, office/household/electric/agricultural machinery
OTHER	All other production not fitting into the other subcategories

Production volume within the Food sector is therefore defined as the costs of labor, capital, land and entrepreneurship in all food producing companies within a certain period and a certain country at a fixed costs level. The level of these costs is expected to increase or decrease together with produced number of tons. The production sector 'Other' is excluded from statistical research since it is unclear which produced goods are compared with which transported goods. Missing data is replaced with the average level of the production sector in the EU, or with the average taken from the previous and the following year.

Limitations:

- Using added value as variable may lead to misleading results: Added value of a ton of jewelry is significantly higher than added value of a ton bricks, while their weight is equal. Both commodities however require an identical number of trucks to transport the ton in weight. Production volume appears to be different per commodity due to their value; however in reality the production volume in produced tons is equal.
- The level of added value at factor costs is assumed to increase or decrease together with produced number of tons.

3.1.2Transport Volume

Transport volume is measured as the volume of ton-kilometers within the transport sector. A ton-kilometer is equal to 1 ton of freight moved 1 kilometer. The volume of ton-kilometers is measured differently per transport mode.

Definition of measurement of road transport according to Eurostat (2010): 'Road freight transport statistics are reported by Member States for vehicles registered in their country. Each reporting country reports all activities of a road motor vehicle inside and outside its national territory. There is thus no risk of double counting at European level. Data is based on aggregations of sample surveys which are executed by the reporting countries'.
Definition of measurement of rail, barge and pipeline transport according to Eurostat (2010): 'Measurements are based on movements on national territory ('territoriality principle'), regardless of the nationality of the vehicle or vessel. The "territoriality principle" means that each country reports the loading/embarkation, unloading/disembarkation and movements of goods and passengers that take place in its national territory. For this reason, "ton-kilometer" or "passenger-kilometer" are the best measure for comparing transport modes and countries, because the use of tons or passengers entails a high risk of double counting, particularly in international transport'.
Missing data is replaced with the average level of the production sector in the EU, or with the average taken from the previous and the following year. Data is based on mandatory data collection, which has to be completed by all public or private undertakings within the reporting countries.

Limitations

- Using ton-kilometers as variable may be misleading: An increase of transport volume may be caused by an increase of kilometers instead of an increase of transported tons.

3.1.3Integration of production and transport

Limitations:

- Comparing production and transport volumes on country level may lead to distortions: A production company in Germany may outsource road transport to a Dutch company with trucks registered in the Netherlands. Hence, an increase in German production leads to an increase in Dutch transport, however in this thesis the German production is only linked to German transport.
- An import from Asia to Europe leads to ton-kilometers from for example the port of Rotterdam to Germany. Production has been performed in Asia, but still leads to ton-kilometers in Europe. Cases like these above mentioned may distort the connection between production and transport within a country.
- Due to lack of data transport modes shipping and aviation have not been included in research, produced goods transported using these modes have not been recorded and therefore the comparison of production and transport may be distorted.
- In order to compare production and consumption growth figures are used. It is impossible to transport more tons than have been produced. When transport volumes outgrow production volumes, this implies that a higher percentage of production is being transported and production and transport have increasingly integrated into each other. However it gives no indication on the actual level of integration between production and transport, but only shows an increase in the level of integration between both sectors.
- In principle it is impossible to transport more tons than have been produced. When transport volumes outgrow production volumes (as is the case in this thesis), this implies that a higher percentage of production is being transported and production and transport have increasingly integrated into each other. An indication is shown of the

level of integration between both sectors. It is however impossible with the available data to present the exact proportion of production which is also transported. The only possible conclusion to be drawn from this thesis is to indicate whether the integration of production and transport is growing or declining.

3.1.4Range of dataset

Countries

The European Union consists per 2007 of 27 European countries and is therefore shortened as the EU27. Greece and Malta are missing within analysis due to lack of data. Greece in particular has presented unreliable figures which were hiding their budget deficit (Telegraaf, 2010). Eurostat therefore is exploring methods to double-check the figures presented by the member states, to prevent member states from presenting incorrect figures. The 27 countries can be subdivided into the following two groups:
EU15: 15 European countries which all joined or founded the European Union in the 20th century: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
EU new member states: 12 countries which joined the EU in the 21st century, mostly Eastern European countries: Bulgaria, Cyprus, Czech Republic, Estonia, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia and Hungary.

Years

The years of 2003, 2004, 2005, 2006 and 2007 have been used. Data from before 2003 appeared unavailable for a number of transport modes. Production data from 2008 and 2009 was differently categorized and therefore not usable.

3.1.5Other used variables:

GDP

Official description as supplied by Eurostat (2010): 'Gross domestic product (GDP) is a measure of the economic activity, defined as the value of all goods and services produced less the value of any goods or services used in their creation. For measuring the growth rate of GDP in terms of volumes, the GDP at current prices are valued in the prices of the previous year and the thus computed volume changes are imposed on the level of a reference year; a chain-linked series'. Accordingly, price movements will not inflate the growth rate.

LPI

LPI is the logistics performance index indicating the logistic performance per country. Official description as supplied by World Bank (2010): 'The Logistics Performance Index is based on a worldwide survey of operators on the ground (global freight forwarders and express carriers), providing feedback on the logistics "friendliness" of the countries in which they operate and those with which they trade. They combine in-depth knowledge of the countries in which they operate with informed qualitative assessments of other countries with which they trade, and experience of global logistics environment'

Companies

The official description as supplied by Eurostat (2010): 'A count of the number of companies active during at least a part of the reference period'

3.2Dataset: Production volume

Added value of the entire production sector within the European Union has seen a significant increase of almost 20% between the years of 2003 and 2007. Figure 5 shows the division of the entire production sector over these subcategories:

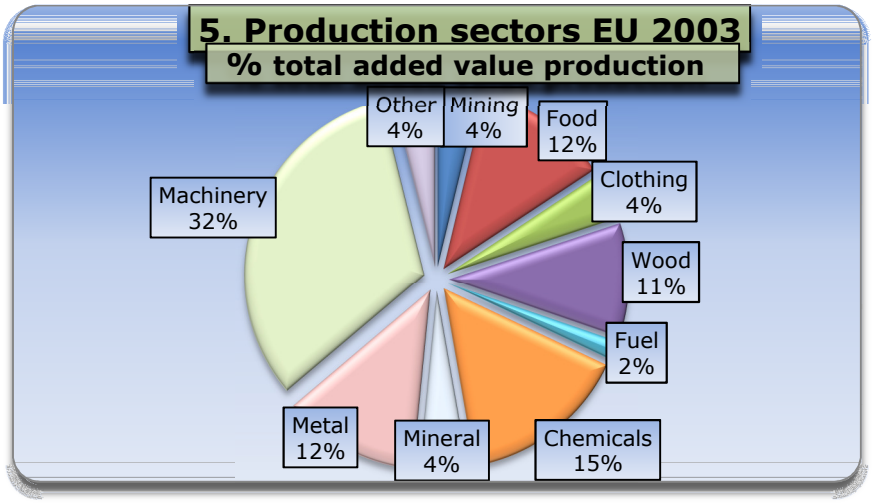


Figure 5: Overview of the production sectors and their proportion of total production EU 2007 (Eurostat, 2010)

Based on added value of production, figure 5 presents the share in production of 10 production sectors. The machinery sector is the largest production sector with a share of over 30% of the total added value of production within the European Union in 2003.
Figure 6 shows the growth or decline per production sector:

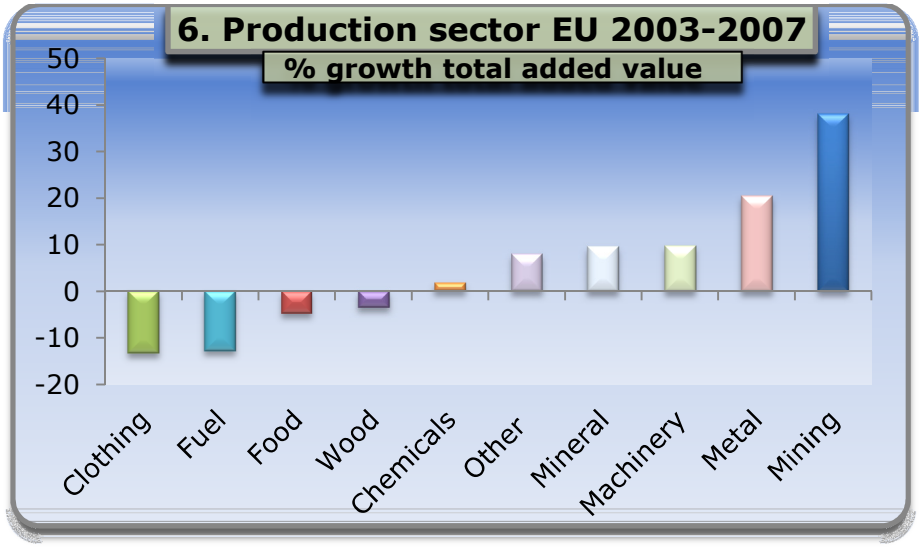


Figure 6: Growth in added value per individual production sector in the EU 2003-2007 (Eurostat, 2010)

The Mining and Metal production sectors have seen a significant growth in the added value of their production, whilst the Clothing and Fuel industry have seen a decrease in added value. One might expect transport volumes to decrease as well in the Clothing and Fuel sectors, and transport volume to increase in the Mining and Metal sectors.

3.3Dataset: Transport volume

The transport sector has been researched by distinguishing the following 4 transport modes:

- Rail
- Road
- Barge
- Pipeline.

The transport modes of shipping and aviation have not been used. The shipping industry is unable to present data on transport per type of good, despite the fact that short sea shipping is a popular mode for transport within the European Union. The aviation industry transports mainly high-value goods but, just as the shipping industry, is unable to present accurate data on transport per type of good.
In terms of transport volume, based on ton-kilometers, the transport sector is divided across the transport modes as presented in figure 7. Road transport is by far the most popular transport mode within the European Union with a share of over 70% of the modal split.

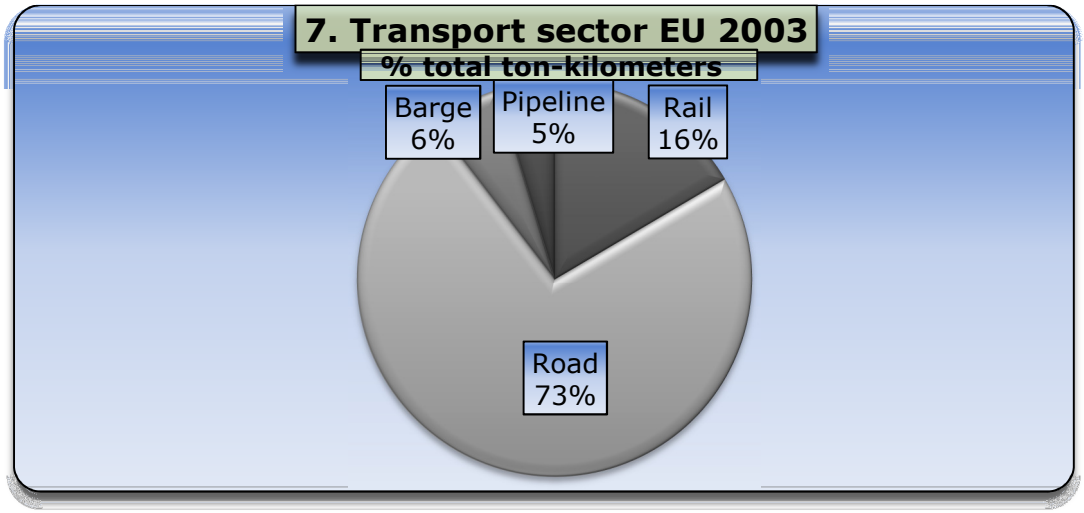


Figure 7: Proportion of total ton-kilometers per transport mode EU 2003 (Eurostat, 2010)

Figure 8 shows that transport volume of pipe transport has decreased despite the fact that is a relatively new transport mode. Road, barge and rail all show a significant increase in ton-kilometers of 10-20%.

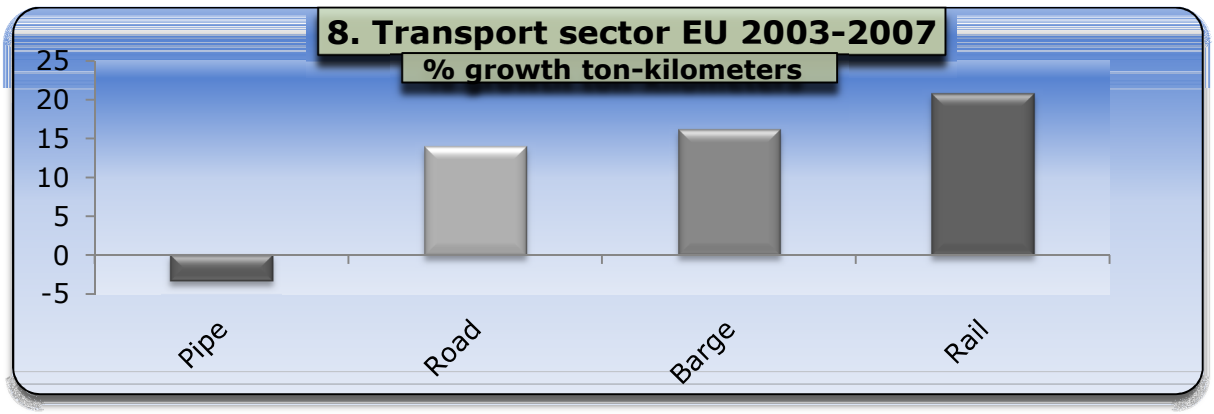


Figure 8: Development per transport mode 2003-2007 European Union (Eurostat, 2010)

Figure 9 shows the division of the transport sector into the 10 production categories:

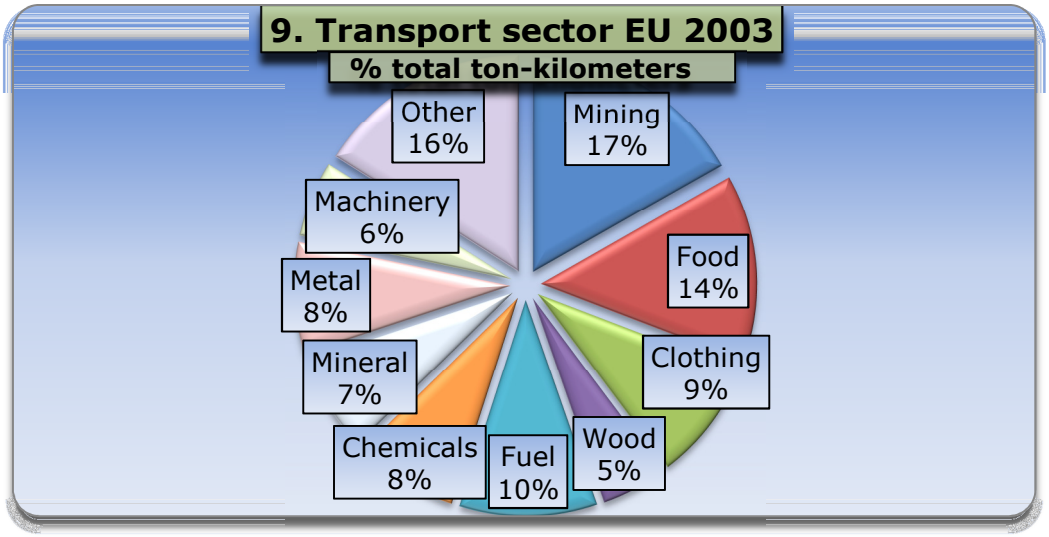


Figure 9: Transport per type of good in 2003 within European Union (Eurostat, 2010)

Figure 9 shows the division of the transport sector into the 10 production categories. It is already interesting to see the difference with production per type of good. The share of machinery within production is more than 30% as seen in figure 5, whilst the share of machinery within transport is surprisingly small.

The development of transport per each specific type of good is visualized in figure 10:

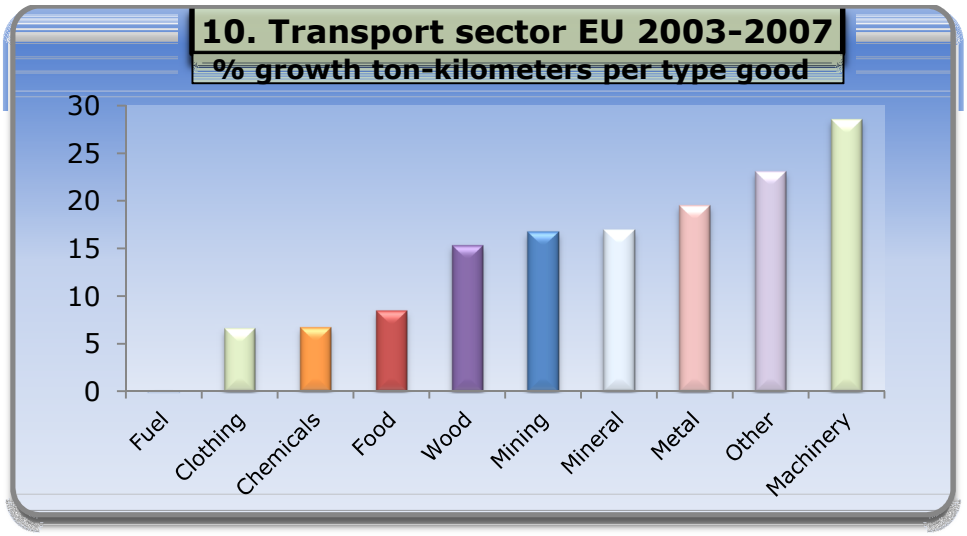


Figure 10: Development of transport per type of good 2003-2007 EU (Eurostat, 2010)

Interesting is that the two categories with a decrease in added value of production being Fuel and Clothing (as seen in figure 6 in chapter 3), also emerge as the two categories with the lowest growth in ton-kilometers. This can be seen as an indication of a strong relationship between production and transport.

4Results: Integration of production and transport

4.1Introduction

Overall analysis has been executed using a total of 1125 observations of production volume and 1125 observations of transport volume. These observations together form 1125 pairs of production and transport volume data. These 1125 pairs are spread across 25 nations of the EU27 (Greece and Malta are excluded due to severe lack of data). The 25 nations each provide 45 pairs of observations which are divided across the 9 production sectors. Each production sector within a country therefore provides 5 pairs of observations for the years of 2003, 2004, 2005, 2006 and 2007. To illustrate by using the example of production sector machinery within Germany:

year	production volume	%	transport volume	%
2005	199.751	100	29.997	100
2006	217.670	109	32.229	107

Table 5: Growth production and transport volume Germany 2005-2006

Production volume had increased with 9% compared to 2006 whilst transport volume had increased with 7%. Production and Transport are moving closely together in the same direction. Production has the ability to predict a change in transport volume. How strong the relationship is will be presented in the following order.

4.2Evaluation overall analysis

With transport being a derived demand, one would expect a very strong relationship between production volume and transport volume within the European Union. Literature as reviewed in chapter 2.2 from Cambridge (1995) and Chikan (2001) however already questioned the strength of the degree of integration of production and transport, which led to the formulation of the following hypothesis:

Hypothesis 2.2: The degree of integration between production and transport is not strong.

Research of the integration between production and transport using all 1125 paired observations of production volume and transport volume leads to the following outcome:

Regression		Paired T-test
R Square	**Coefficient**	**Correlation**
0,37	0,65*	0,61*

Table 6: Statistical influence production volume on transport volume EU 2003-2007

- R Square: Variance of the level of transport volume is for 37% explained by the level of production volume.
- Regression coefficient: A production volume increase of 1 million ton leads to an increase in transport volume increases by 650.000 ton-kilometers. The level of transport volume is significantly derived from the level of production volume.
- * significant for 0.000

- Correlation: If production volume increases by 1%, transport volume increases by 0.61%. If transport volume increases by 1%, production volume increases by 0.61%.

The relatively low R Square indicates that production and transport are not closely integrated. Transport volume is for 37% explained by its basic influence production volume, and for 63% by other factors of direct and indirect influence which were presented in chapter 2.2.1. These research results confirm the conclusions of Cambridge (1995) and Chikan (2001). The degree of integration of production and transport is relatively low; transport volume is still dependent on several other factors. Due to these other factors, it is impossible for production volume and transport volume to be constantly equal. Hypothesis 2.2 can be accepted and conclusion 5.2 can be formulated:

Conclusion 4.2: The degree of integration between production and transport is not strong. Transport volume is only explained for 37% by production volume and for 63% by other factors.

Results may however vary per year, per production sector, per country and per country group, as discussed respectively in chapter 4.3, chapter 4.4, chapter 4.5, and chapter 4.6.

4.3Evaluation analysis per year

Literature as reviewed in chapter 2.3 from Rodrigue (2006) and Hesse(2004) indicated that production and transport were integrating in to each other so far that is has become difficult to tell them apart. The paradigm should therefore shift to transport demand being an integrated demand. This led to the formulation of the following hypothesis:

Hypothesis 2.3: The degree of integration between production and transport has strengthened over the years.

Research to test this hypothesis used 225 paired observations of transport and production per year within a regression and paired T-test, and leads to the following results:

	Regression		Paired T-test
Year	R Square	Coefficient	Correlation
2003	0,40	0,71*	0,63*
2004	0,39	0,69*	0,62*
2005	0,37	0,64*	0,61*
2006	0,36	0,63*	0,60*
2007	0,34	0,60*	0,58*

Table 7: Statistical influence production volume on transport volume per year 2003-2007 EU

- R square: Over the years, production volume has lost some of its ability to explain transport volume with an R-square moving from 0.40 to 0.34.
- Regression coefficient: An increase of production volume by 1 million ton led to an increase of 710.000 ton-kilometers in 2003, but only to an increase of 600.000 ton-kilometers in 2007.
- Correlation: Production has started to move less closely together with correlation dropping from 0.63 to 0.58.

These results all move in the same direction: The influence of production volume on transport is diminishing per year. In 2003 production volume explained 40% of the variations of transport volume, in 2007 only 34% of the variations. These results show the opposite picture of hypothesis 2.3. Hypothesis 2.3 has to be rejected and the following conclusion can be formulated:

Conclusion 4.3: The degree of integration between production and transport has weakened per year in the period of 2003-2007 within the EU.

Conclusion 4.3 indicates that the concept of integrated demand of Hesse(2004) does not apply within the European Union in the period of 2003-2007. Chapter 4.4 however shows that the concept of integrated demand does apply within some production sectors.

4.4Evaluation analysis per production sector

According to Rodrigue(2006), the degree of integration between production and transport has increased due to several logistical developments. The degree of integration between production and transport will be different per type of commodity and therefore per production sector. One would expect that a production sector with high globalization, pull logistics, high usage of logistic integrators and DC's and the application of the JIT concept can consider its transport demand to be an integrated demand. This led to formulation of hypothesis 2.4:

Hypothesis 2.4: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport.

Hypothesis 2.4 will be tested in this chapter in two parts. In chapter 4.4.1 will be researched in which production sectors presence of the logistical development is strong; in chapter 4.4.2 the strength of the degree of integration of production and transport will be researched. Conclusions follow in chapter 4.4.3.

4.4.1Strength of presence of logistical developments

Per logistical development is discussed in which production sectors the developments are most applied, which indicates in which sectors transport demand can be considered an integrated demand according to Rodrigue(2006).

Globalization: Increasing scale of distribution

As stated in chapter 2.4.1: The more extensive the operational scale of distribution, the more globally oriented, the less derived demand applies (Rodrigue, 2006).

Globalism occurs in each production sector, within each production foreign direct investments are placed in other continents. It is however impossible to assume that all production sectors have reached stage D of Rodrigue (2006) of global integrated demand. According to OECD (2010) the production sectors of Clothing shows a small relative activity of multinationals in 2005 which might indicate minimal integration of production and transport in the Clothing sector. Production sectors Machinery and Food show a relative large activity of multinationals which might indicate strong integration of production and transport in these sectors. Production sectors Mining and Fuel are unable to globalize since they are very dependent on the physical presence of raw materials. The variable activity multinationals as presented in table 8 comes down to the total % of total output within a production sector performed by foreign multinationals.

Sector	Regression R Square	Activity Multinationals
Food	0,93	38%
Clothing	0,30	12%
Wood	0,54	27%
Chemicals	0,79	27%
Mineral	0,93	31%
Metal	0,93	19%
Machinery	0,77	62%

Table 8: Activity mulitinationals per production sector EU 2005 (OECD, 2010)

Conclusion is that a global oriented production sector with active multinationals is able to integrate its production and transport activities.

Push – Pull logistics

As stated in chapter 2.4.2, the more demand-driven a freight distribution system, the more pull logistics are applied, the less the concept of derived demand applies (Rodrigue, 2006).

The nature of the production sector will determine whether push or pull logistics are applied in the sector. According to LogisticsIT (2010), the customer is the beginning instead of the end of the supply chain. Companies have to differentiate their products and offer personalized solutions to their customers. This trend should therefore be visible in all production sectors which are dealing with final customers which are the Clothing, Food and Machinery sector. According to Rodrigue (2006), in these sectors the demand-driven character applying pull logistics should indicate a strong integration of production and transport.

Logistic integrators

According to Rodrigue(2006), logistic integrators do not react to a derived demand but instead are able to control the supply chain. The stronger the presence of logistic integrators in a production sector, the stronger the integration of production and transport.

According to SupplyChainBrain(2010), logistic integrators extract revenue from the following production sectors:

Sector	% revenue logistic integrators
Machinery	52%
Food	14%
Clothing	11%
Fuel	9%
Chemicals	6%
Other, Mining, Wood	5%
Mineral, Metal	3%

Table 9: Proportion of revenue logistic integrators per production sector in 2006 (SupplyChainBrain, 2010)

Logistic integrators extract a large share of their revenue from the machinery sector, mainly due to the automotive and electronic segments. Retail sectors Food and Clothing account for respectively 14% and 11%. One would expect the stronger the presence of logistic integrators in a production sector, the stronger the integration of production and transport. Based on table 9, integration will be high in the Machinery, Food and Clothing production sectors. Integration should be low in the Metal and Mineral industries which hardly use the services of logistics integrators but still show a strong integration of production and transport.

Distribution centers (DCs)
DC's provide an excellent link between industries and retail by specializing in distribution and provide a crucial link to final customers (Rodrigue, 2006).

Not each production sector makes use of DC's. DC's are installed in production sectors which sell retail products. Distribution centers handle retail products like food, cars, electronic products, clothing, mail, paper, office supplies, flowers etc. The production sectors Food, Machinery, Wood and Clothing are dominant users of distribution centers, whilst the other sectors Fuel, Chemicals, Mining, Mineral and Metal make minimal use of distribution centers (Tenessee Government, 2010).

Just-in time concept (JIT)
In short, the just-in-time concept focuses on having the right material, at the right time, at the right place, and in the exact amount, without the safety net of inventory (Lean Deployment, 2010). Application of the JIT concept within a production sector should lead to shorter supply chains and in the end a stronger integration of production and transport.

The just-in-time concept was originally introduced by Toyota in the Machinery production sector and has been adopted by the Wood, Clothing and Food industry (Buzzle, 2010). Accordingly attempts have been made to introduce the concept in all other production sectors. So far it has proven to be impossible to introduce the concept in producing sectors producing raw materials, such as Mining. The Mining production sector therefore still carries large finished goods stocks which are decoupled from any supply chains. This also influences the production sectors Metal, Mineral and Chemicals (Liker, 2003). For example, manufacturing steel is not yet connected to an order for a particular car, but may in the future be when the just-in-time concept is expanded from the retailer part to the raw material part of the supply chain. The fuel industry has proven unable to adopt the JIT-concept, storage capacities have decreased but not drastically (Energy Information Administration, 2010).

Presence of logistical developments
Based on these analyses per logistical development a conclusion can be drawn per production sector. The Machinery production sector appears to show high globalization, use of pull logistics, high usage of logistic integrators and DC's and the application of the JIT concept. Expectation is that transport demand within the Machinery and the Food sector is an integrated demand. Mining production sector shows no presence of logistical developments and, therefore transport demand will probably be characterized as a derived demand.

	Presence of logistical developments
Mining	no
Fuel	no
Metal	no
Chemicals	low
Mineral	low
Clothing	average
Wood	average
Food	high
Machinery	very high

Table 10: Presence of logistical developments per production sector

4.4.2Strength of the degree of integration of production and transport

Figure 11 shows the different shares per production sector in both production and transport:

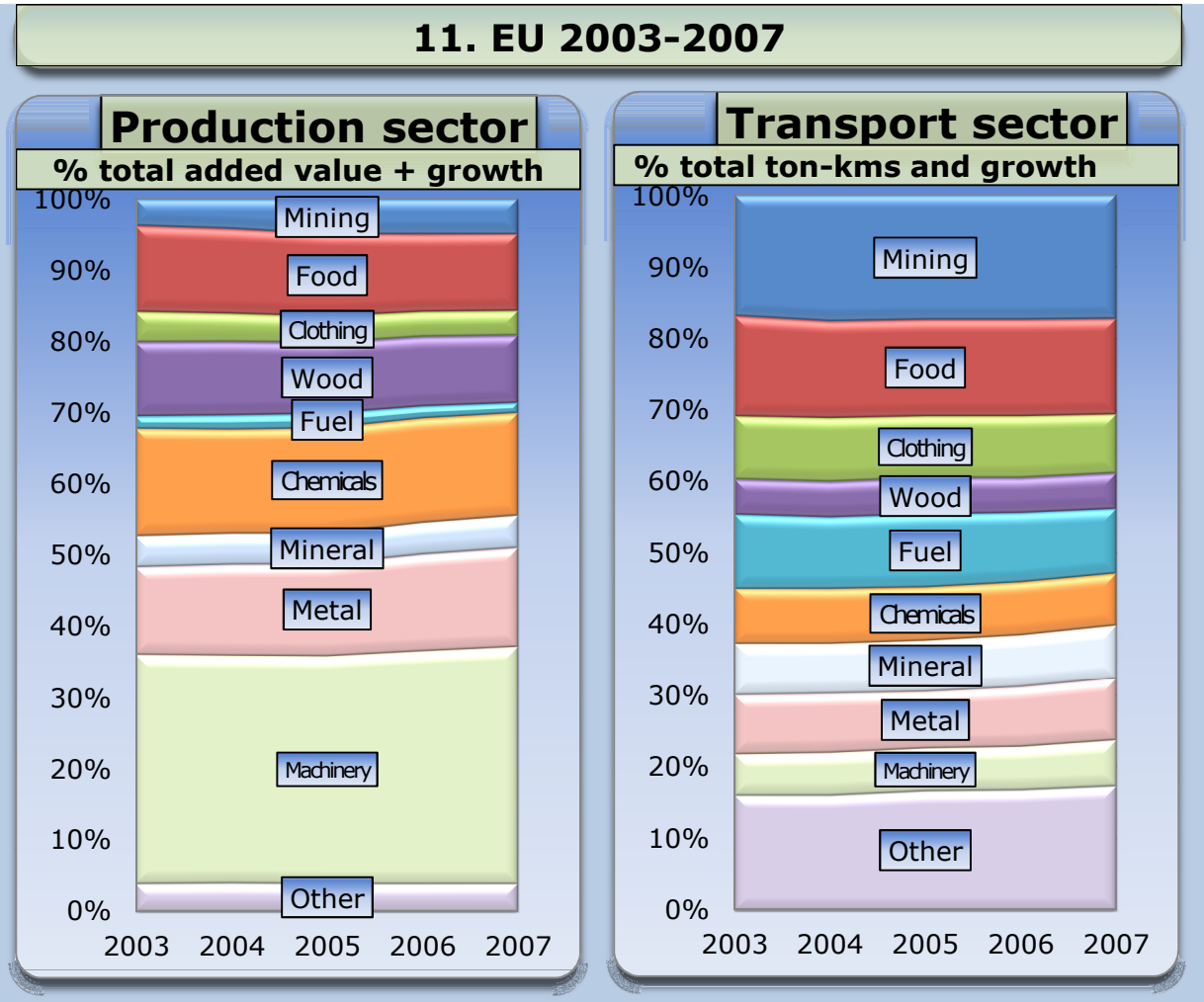


Figure 11: Comparison relations within production and transport sector (Eurostat, 2010)

Some remarkable differences appear when production and transport sectors are compared as in figure 11, such as the difference in sizes of the machinery, mining and fuel production sectors. It is however hard to compare added value and ton-kilometers with each other in terms of absolute volume. More interesting is to see whether production volume and transport volume move in the same direction, which would indicate a strong relationship between production and transport. Figure 12 shows the differences in growth per production sector in both production and transport.

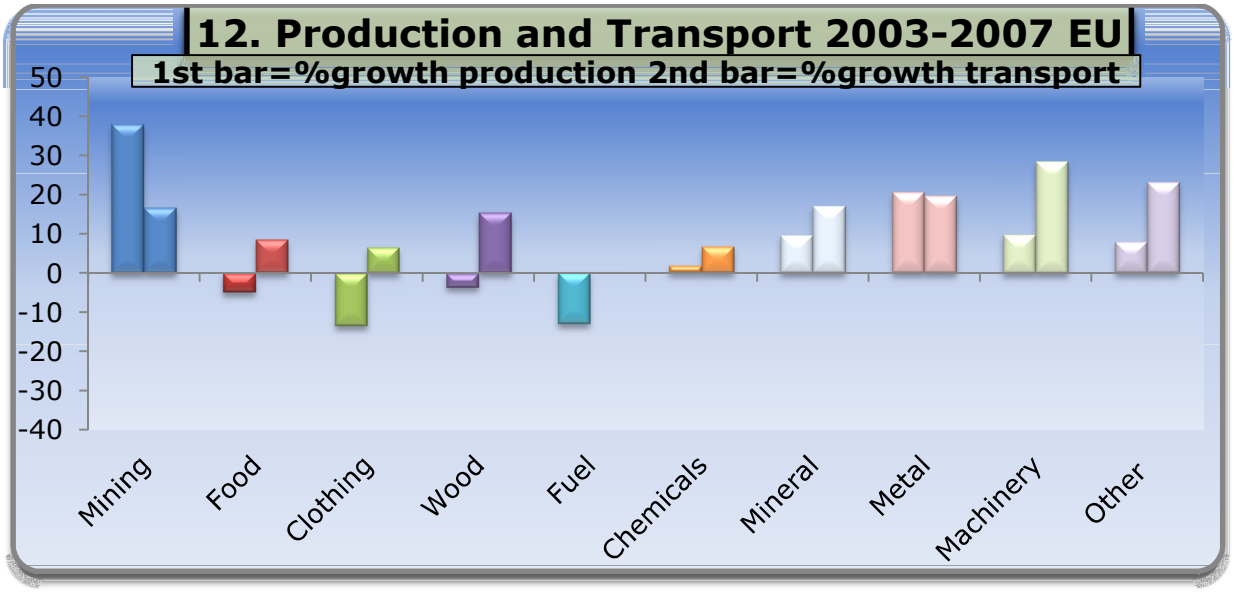


Figure 12: Growth production and transport volume per type of good 2003-2007 (Eurostat, 2010)

Figure 12 shows several production sectors with huge differences in their developments in both production and transport, such as Mining, Clothing, Wood or Machinery. Other production sectors show a similar growth in both production and transport, such as Mineral and Metal. These differences may be an indication: the larger the difference in growth, the weaker the integration of production and transport. Integration of production and transport is however best measured using statistical research, as presented in table 11:

	Regression		Paired T-test
Sector	**R Square**	**Coefficient**	**Correlation**
Mining	0,15	0,45*	0,38*
Food	0,93	1,45*	0,96*
Clothing	0,30	2,14*	0,54*
Wood	0,54	0,52*	0,74*
Fuel	0,58	3,01*	0,76*
Chemicals	0,79	0,54*	0,89*
Mineral	0,93	0,77*	0,97*
Metal	0,93	1,63*	0,96*
Machinery	0,77	0,44*	0,88*

Table 11: Statistical influence production on transport volume per sector EU 2003-2007

A high R Square implies production volume to be the main determinant of variations within transport volume. The high R Square will lead to a high correlation, which implies production volume to move together with transport volume. A high R Square and high correlation therefore indicate a strong integration of production and transport.
Level of integration in this thesis is characterized as:

- Weak: R Square of 0,00-0,50
- Average: R Square of 0,50-0,75
- Strong: R Square of 0,75-0,90
- Very strong: R Square of 0,90-1,00

Based on table 11, the level of integration per production sector is presented in table 12:

Level of integration production and transport	Production sector
weak	Mining
	Clothing
average	Wood
	Fuel
strong	Chemicals
	Machinery
very strong	Food
	Mineral
	Metal

Table 12: Levels of integration production and transport per production sector EU 2003-2007

Possible explanations of level of integration production and transport:

Mining: Weak due to its dependency on nature to extract raw materials and no constant level of demand from clients

Clothing: Surprisingly weak since clothing are retail products, probably distorted due to a high level of import volumes from Asia

Wood, Fuel: Average due to dependency on nature, despite a constant level of demand from clients

Chemicals: Strong since chemicals are often used in producing retail products

Machinery: Strong since most machinery are retail products.

Food: Very strong since food are retail expiring products, some with expiration dates.

Mineral, Metal: Surprisingly very strong, despite only being used in producing retail products.

4.4.3Integrated transport demand

Whether transport demand can be characterized as an integrated demand differs per each production sector. Integrated demand would imply all produced goods to be transported therefore minimizing inventory levels (JIT concept). In order to achieve equal production and transport volumes, the supply chain should contain a minimal amount of steps due to the cooperation with a logistic integrator and the use of distribution centers which combines production and transport activities. With a fast, short supply chain, a customer should be able to pull its products out of the production sector, instead of the products being pushed towards the customer. The more globally oriented a production sector is, the more it is able to control its production and transport volume and create equal volumes.

A production sector with high globalization, pull logistics, high usage of logistic integrators and DC's and the application of the JIT concept can consider its transport demand to be an integrated demand. Based on the discussions per each of the logistical developments can be concluded that as closer the sector is to the final customer thereby producing and selling final products, the stronger presence of the logistical developments.

Based on the discussion per each of the 5 logistical developments of Rodrigue (2006) in chapter 4.2.1 and on the statistics as visualized in chapter 4.2.2 conclusions can be drawn per production sector. Transport demand will be characterized when level of integration is strong or very strong (R Square above 0,75) and presence of logistical developments is high or very high. Conclusions per production sector are visualized in table 13:

	Level of integration production and transport	Presence of logistical developments(globalized business, push or pull logistics, use of logistic integrators, DC's and JIT)	Integrated Demand?
Mining	weak	no	no
Fuel	average	no	no
Metal	very strong	no	no
Chemicals	strong	low	no
Mineral	very strong	low	no
Clothing	weak	average	no
Wood	average	average	no
Food	very strong	high	yes
Machinery	strong	very high	yes

Table 13: Analysis of transport demand per production sector

A number of conclusions can be drawn based on table 13:

- Clothing sector shows a weak level of integration despite producing mostly final products and an average presence of logistical developments.
- Metal, Chemicals and Mineral sectors all show a strong level of integration despite a low or total absence of logistical developments
- Wood sector should be able with an increased usage of logistical integrators and pull logistics be able to reach the level of integrated demand.
- Mining and Fuel sectors produce mostly raw materials; their transport demand can be characterized as a derived demand.
- Food and Machinery sectors show high levels of integration and presence of logistical developments; transport demand can be characterized as integrated demand.

Due to the surprising results in the Clothing, Metal, Chemicals and Mineral can be concluded that there is not a strong relationship between the level of integration between production and transport volumes and the presence of logistical developments. The relationship does however apply in the Mining, Fuel, Food and Machinery sectors. Hypothesis 2.4 can only be partly rejected and partly accepted; the following two conclusions can be formulated:

Conclusion 4.4.1: There is no significant relationship between presence of logistical developments and degree of integration production and transport in production sectors Clothing, Metal, Chemicals and Mineral.

Conclusion 4.4.2: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport in production sectors Mining, Fuel, Wood, Food and Machinery production sectors.

4.5Evaluation analysis per country

In a country with a high LPI score one might expect it to be relatively easy to move goods through the country. Therefore it should be easier to transport all produced goods through the Netherlands, which would imply production and transport to be closely integrated in the Netherlands. The following hypothesis was formulated:

Hypothesis 2.5: Degree of integration between production and transport is stronger in a country with a stronger logistic performance.

Comparing the percentage growth of production volume and transport volume leads to figure 13. Figure 13 shows the differences in growth percentages between production and transport per country, which may be the first indication of the degree of integration between production and transport per country.

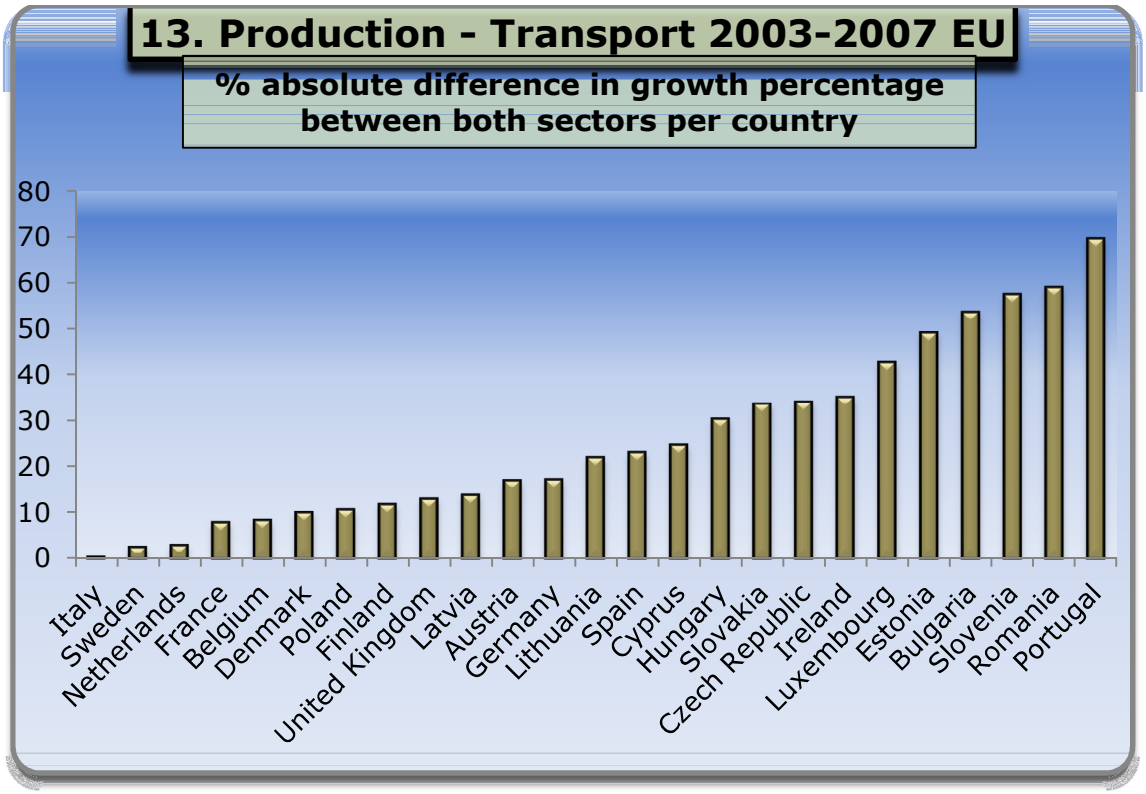


Figure 13: Absolute difference in growth % production and transport per country (Eurostat, 2010)

To clarify what is visualized in figure 13 a short example: The absolute difference in growth percentage between production and transport in Bulgaria is 53% as seen in figure 13. This is the result of a growth in added value of production within Bulgaria of 100%, while the growth in ton-kilometers has been 153% between the years 2003 and 2007. Interesting is that the transport sector has significantly outgrown the production sector within Bulgaria. Differences can be explained by welfare within a country: welfare is significantly higher in the original EU countries compared to the newly joined countries. Other explanations for the differences are the logistical performance of each country. Optimal integration of production and transport activities will only be possible in an accessible country with a strong logistical performance, which implies high quality of infrastructure, efficient custom procedures, low logistic costs etc.

Integration of production and transport: Empirical macro evidence

Significant differences in growth percentages of production and transport volumes as visualized in figure 13 may indicate a weak integration of production and transport. The weak integration of production and transport may be caused by a weak logistical performance of the country's logistical sector. As mentioned in chapter 2.5, logistical performance per country is measured by World Bank (2007) using the Logistic performance index

In chapter 2.5 was discussed that presence of logistical developments within a production sector could lead to strong integration of production and transport within a production sector. In the same sense, a strong logistical performance within a country could therefore lead to a strong integration of production and transport within a country. This relationship is studied and the results presented in table 14:

	Regression			Paired T-test	
Country	**R Square**	**Coefficient**	**Significance**	**Correlation**	**Significance2**
All	0,296	-23,89*	0,005	-0,54*	0,005

Table 14: Statistical influence LPI on absolute difference production and transport

The regression coefficient indicates that a higher LPI score leads to a significant decrease in the absolute growth difference between production and transport within a country. High quality infrastructure, efficient custom procedures and low logistic costs, shortly put: Strong logistic performance within a country is a necessary condition for a strong integration of production and transport within a country. Hypothesis 2.5 can be accepted and the following conclusion can be formulated:

Conclusion 4.5: Integration between production and transport is stronger within a country with a stronger logistic performance.

4.6Evaluation analysis per group of countries

Table 4 within chapter 2.5 showed that the 14 highest LPI (Logistic Performance Index) scoring countries joined the EU in the 20th century; the 11 lowest LPI scoring countries joined the EU in the 21st century. This led in chapter 2.6 to the formulation of hypothesis 2.6:

Hypothesis 2.6: Degree of integration production and transport is stronger in EU15 compared to new EU member states.

Analyzing figure 14 shows that the largest differences between production volume and transport volume occur in countries that have recently joined the EU. For further analysis, the EU27 can be subdivided into two groups:

- EU15: 15 European countries which all joined or founded the European Union in the 20th century: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.
- New EU member states: 12 countries which joined the EU in the 21st century, mostly Eastern European countries: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

Figure 13 already indicated that there are strong differences between the EU15 group and the new EU group. Significant differences mostly occurred in the new EU member states, only small differences occurred in the EU15 group. When figure 13 is presented per group of countries, this leads to figure 14.

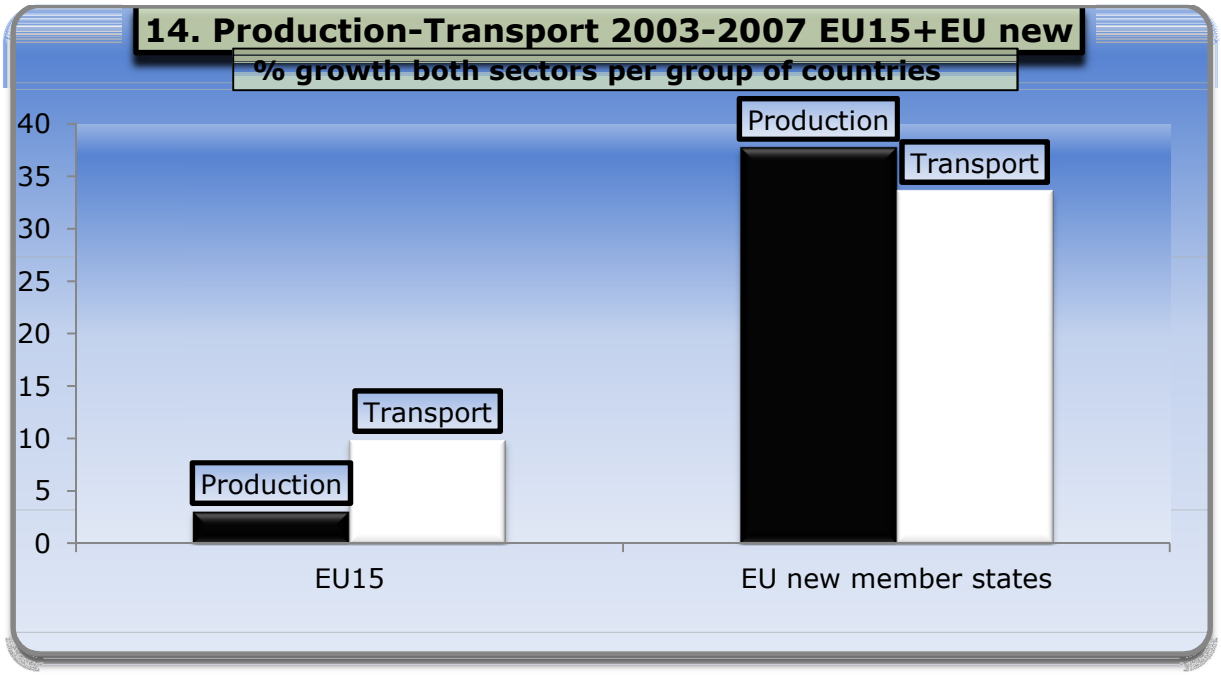


Figure 14: Growth of production and transport sector per group of countries EU 2003-2007 (Eurostat, 2010)

Transport volume significantly outgrows production volume in the EU15, whilst production volume outgrows transport volume in the EU new member states. Differences within the EU15 are significantly larger compared to the EU new member states which is the opposite picture of figure 13 of chapter 4.5. This is mainly caused by the economically strong Germany which saw an increase of 22% in transport volume. An increase of 22% transport volume in

Germany has a significant stronger effect compared to an increase of 22% transport volume of a small country such as Lithuania.
Developments in the EU new member states have been relatively explosive compared to developments in the EU15. The same picture shows when the growth in number of production companies of all production sectors is analyzed per group of countries, as visualized in table 15:

TOTAL	EU15	Eunew
2003 nr of production companies	1.687.344	554.079
2007 nr of production companies	1.677.391	567.004
% growth	99,4%	102,3%

Table 15: Growth number of production companies per group countries EU 2003-2007 (Eurostat, 2010)

Results of globalization are visualized in Table 15 since production companies are moving away from the EU15 and more production companies are locating in the EU new member states. The growth of production locations in the EU new member states has probably had a positive influence on the increase of transport kilometers within the EU and therefore has its influence on the increase in ton-kilometers.

When the overall analysis of chapter 4.2 is divided into two groups of countries, this leads to the outcome as visualized in table 16:

	Regression		Paired T-test
Country group	**R Square**	**Coefficient**	**Correlation**
EU15	0,31	0,57*	0,56*
EU new member states	0,62	2,38*	0,79*

Table 16: Statistical influence production on transport volume per group EU 2003-2007

Within the new European countries production volume is accountable for 62% of all variations within transport volume. The percentage is significantly smaller in the EU15 with an R Square of only 31%. This is a surprising result, since was expected the logistic performance of the EU15 countries to be higher than the EU new member states, and therefore was expected production and transport to be more closely integrated in the EU15 group compared to the EU new member states. A possible explanation for the weak integration in EU15 is the fact that all countries outside the EU15 make use of the EU15 logistical possibilities. As shown in table 4, countries in the EU15 score a significant higher LPI score, compared to the EU new member states. The excellent logistic performance in the EU15 invites other countries, such as EU new member states or Asian countries to move their produced goods through the EU15, which distorts the R Square of EU15 group as seen in table 16. EU new member states import minimal amounts from other continents which is why their transport volumes have not been distorted.
Hypothesis 2.6 can be rejected; the following conclusion can be formulated:

Conclusion 4.6: Degree of integration production and transport is stronger in EU new member states compared to EU15.

4.7 Overview hypothesizes and conclusions

Chapter 2 presented a number of hypothesizes which were either accepted or rejected in chapter 4:

Overall analysis:

- Hypothesis 2.2: The degree of integration between production and transport is not strong.
- Accepted by conclusion 4.2:
- Conclusion 4.2: The degree of integration between production and transport is not strong. Transport volume is only explained for 37% by production volume and for 63% by other factors.

Analysis per year:

- Hypothesis 2.3: The degree of integration between production and transport has strengthened over the years.
- Rejected by conclusion 4.3:
- Conclusion 4.3: The degree of integration between production and transport has weakened per year in the period of 2003-2007 within the EU.

Analysis per production sector:

- Hypothesis 2.4: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport.

- Rejected by conclusion 4.4.1:
- Conclusion 4.4.1: There is no significant relationship between presence of logistical developments and degree of integration production and transport in production sectors Clothing, Metal, Chemicals and Mineral.

- Accepted by conclusion 4.4.2:
- Conclusion 4.4.2: The stronger the presence of logistical developments, the stronger the degree of integration of production and transport in production sectors Mining, Fuel, Wood, Food and Machinery production sectors.

Analysis per country:

- Hypothesis 2.5: Degree of integration between production and transport is stronger in a country with a stronger logistic performance.
- Accepted by conclusion 4.5:
- Conclusion 4.5: Integration between production and transport is stronger within a country with a stronger logistic performance.

Analysis per group of countries:

- Hypothesis 2.6: Degree of integration production and transport is stronger in EU15 compared to new EU member states.
- Rejected by conclusion 4.6:
- Conclusion 4.6: Degree of integration production and transport is stronger in EU new member states compared to EU15.

Chapter 5 will present the final conclusion based on these hypothesizes and conclusions.

5Conclusion

5.1Conclusion

The demand for transport is considered to be derived from the demand for produced goods. The amount of goods produced and sold determines the amount of goods transported. Attempts have been made to integrate production and transport activities to create a more efficient cooperation between both activities. Developments such as globalization, pull-logistics, logistic integrators, distribution centers and application of the just-in-time concept create a stronger integration of production and transport. The goal has become to minimize inventories in supply chains and to make goods pass through supply chains so fast that production companies can respond rapidly to increasing or decreasing market demand (Baker, 2004). The following research question was formulated:

Research question: How strong is the degree of integration between production and transport within the European Union?

Research within the European Union in the years 2003-2007 leads to the conclusion that the degree of integration between production and transport is weak. Transport volume is only explained for 37% by production volume and for 63% by other factors. Transport demand cannot yet be characterized as an integrated demand: Production volume would have to explain over 75% of transport volume and presence of logistical developments should be high. In the EU, the integration of production and transport has even weakened from 2003 to 2007.

Integration between production and transport appears to be strong in specific production sectors. Transport demand can be characterized as an integrated demand in production sectors Machinery and Food, due to the strong presence of logistical developments in these production sectors. Integration is also strong in production sectors Metal, Chemicals and Mineral despite their weakly developed logistical chains. Integration is weak in production sectors Mining and Fuel since these sectors produce mostly raw materials, and surprisingly weak in the Clothing industry since clothing are retail products.

Integration between production and transport is stronger in a country with excellent logistic performance where it is easy to move goods through the country. A country with excellent logistic performance has a solid infrastructure, efficient customs procedures, relatively low logistic costs etc. EU15 countries perform logistically strong; countries outside the EU make use of these logistical possibilities within the EU15. Integration of production and transport within EU15 is therefore weaker compared to the new EU member states, despite their weak logistical performance.

Despite having to overcome several limitations within this research, it has become clear that production and transport have not integrated in to each other yet in the EU, with the exception of production sectors Machinery and Food thanks to their application of concepts just-in-time production and pull logistics. This thesis proves that the integration of production and transport is weak in the EU and cannot yet be characterized as an integrated demand.

5.2Discussion

This thesis has evaluated the level of integration between production and transport within the EU on several levels and has led to a number of clear conclusions. Results of this thesis will add up to general knowledge on the relationship between production and transport. It has become clear that production and transport have far from integrated into each other; characterizing transport demand as an integrated demand is not yet realistic.

However what has remained unclear is the following question: Is integration between production and transport actually a good thing? Should a production sector, a company within a production sector or the government of a country focus on integrating production activities with transport activities?

When the level of integration per production sector is compared to the growth in added value per production sector, this leads to a number of interesting conclusions. Despite a very low level of integration in the Mining sector, added value of production within EU between 2003 and 2007 has increased with almost 40%. In the Food sector, level of integration is very strong but added value has decreased with 5%. On the other hand, the Clothing sector shows weak integration and a decrease in added value of 12%, while the Machinery sector shows strong integration and a steady decrease in added value of 10%.

Researching the relationship between a production sector's integration between production and transport is outside the scope of this thesis, but may for sure lead to interesting conclusions. Concepts such as just-in-time and pull logistics have grown significantly in popularity and are widely applied. On micro level, these concepts will probably lead to significantly improved results for a company and enable a company to integrate its production and transport activities. However on macro level, application of these logistical concepts such as just-in-time and pull logistics has no significant visible impact. Production and transport are closely integrated in a number or production sectors but has not yet led to a visible positive impact on the growth of these production sectors. This asks for a further in-depth research to the relationship between the integration of production and logistics per production sector, and the growth of the production sector in production, turnover or net results.

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