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The impact of transport investments on competitiveness

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Abstract

At different policy levels, from local to European, the concept of competitiveness is used to stimulate or promote a region. Often it is assumed that regions can compete with each other on aspects such as labour market, education, investments or human capital. This is also true for investments in transport infrastructure. Investments in transport infrastructure are assumed to have a positive impact on the competitiveness of regions. The question is whether this assumption is true and how it can be measured.

This article starts discussing the concept of spatial competitiveness and the way it can be measured using indicators. Improving the accessibility of a region by means of investments is often seen as a precondition to improve the competitiveness of a region. We therefore describe both the transport system and the use of accessibility as one of the supporting indicators. Finally, we consider the link between investments in the transport system and competitiveness.

We conclude that competitiveness is a vague term that is hard to operationalise and to measure. It is often used as a marketing concept for regions. Comparison of regions is the goal of using the concept. In that sense, attention must be paid to use the right indicators. Accessibility is one of these indicators. Accessibility can be linked to improvements in transport infrastructure. There is evidence that transport infrastructure investments improve accessibility of regions and cities, but how this affects competitiveness remains unclear. Attempts have been made to quantify the wider economic impacts, which also needs to be included when considering competitiveness. Research into indicators that support competitiveness is therefore recommended.

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Keywords: Competitiveness; Transport Investments; Impacts; Region; Transport System

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1. Introduction

The European Union turned a new page with the start of the 'Europe 2020 Strategy'. By replacing the previous Lisbon Strategy (2000 – 2010), the transition process between the two strategy plans coincides with the EU's hardest economic crisis since its formation. The objective of getting out of the crisis, in the context of fiercer competition on the global market with the new emerging economies, has turned Europe's competitiveness and economic performance into fundamental issues.

In line with the 'Europe 2020 Strategy' flagship initiatives, the Transport White Paper (EC, 2011) summarizes the main objectives of the European transport strategy. The objectives help to establish a transport system that underpins European economic progress and offers high quality mobility services, while using resources more efficiently. It is therefore essential to clarify the relationship between the transport sector, economic growth and competitiveness.

I-C-EU is a project that explores the relationship between transport infrastructure investment and its wider economic impacts, in particular competitiveness and economic growth. The project explores the state-of-the-art of the assessment tools, analyses the current and future situation of European economy and competitiveness, and takes into account the current European strategy to improve its economic performance and competitiveness. This concept allows the I-C-EU project to provide recommendations to the European Commission on making political interventions in order to enhance the competitiveness of Europe in relation to the rest of the world as well as between its member countries and regions. Departing from this concept, the project has four objectives:

- To understand the relationship between transport infrastructure, competitiveness and growth.
- To contribute to the development of a methodology to quantify the impacts of the different investments in transport infrastructure on competitiveness and economic growth.
- To include the impacts on competitiveness and economic growth in the assessment methodologies.
- To make recommendations on the assessment of EU policy regarding competitiveness and growth.

In this article we concentrate on the difficulties in defining and measuring competitiveness in a spatial context, as well as the relation between the transport system and competitiveness. Especially, the way competitiveness can be seen as an outcome of the use of transport and economic models receives attention. Literature has been explored to get more insights in competitiveness, accessibility and the relation between changes in the transport system and wider economic impacts, especially competitiveness. The ultimate goal is to further develop assessment methodologies of transport infrastructure investments.

This article is organised as follows. Chapter 2 discusses the concept of competitiveness at a spatial level, such as a region or a nation. Also indicators to measure competitiveness are described. Chapter 3 provides an overview of the transport system and accessibility as a key concept for measuring competitiveness. Chapter 4 links the transport system, transport investments and competitiveness. Chapter 5 concludes and recommends about the use and interpretation of model results with the assessment of effects of transport infrastructure investments.

2. Spatial competitiveness

2.1. Introduction

Studying the impact of transport investments on spatial competitiveness, implies that the concepts used should be clear. Spatial competitiveness has raised increasing awareness over the past two decades, due to limitations and challenges posed by globalization. Different attempts have been made to define, measure and use the concept at a spatial level such as a city, region or nation. This chapter looks at the definition of spatial competitiveness, its complications and possible indicators to measure competitiveness.

2.2. Defining spatial competitiveness

The literature distinguishes between competitiveness at firm level and at spatial level:

- Competitiveness at firm level relates to the competitiveness between firms in different sectors like agriculture or industry. The objective is to increase the productivity of a firm.
- Spatial competitiveness refers to competitiveness at a geographical level like a city, region or nation. The aim is often to increase the productivity of a region.

Concerning spatial competitiveness different definitions are available, such as:

- European Union (2012) defines spatial competitiveness in the context of the European Union: *'When identifying economic impacts, particular attention should be paid to factors that are widely considered as being important to productivity, and hence to the competitiveness of the EU. Competitiveness is a measure of an economy's ability to provide its population with high and rising standards of living and high rates of employment on a sustainable basis. Vigorous competition in a supportive business environment is a key driver of productivity growth and competitiveness.'*
- Smit (2013), who defines competitiveness as: *Competitiveness is the extent to which firms in a particular region can compete with those elsewhere. Critical factors for competitiveness are those that determine the level of productivity in a region in relation to other regions.*
- World Economic Forum (2012a): *Competitiveness is the set of institutions, policies, and factors that determine the level of productivity of a country*.

Each of the definitions relate to a spatial context. The European Union refers to the entire EU, Smit to regions and WEF to a country. In all definitions, the assumption is made that regions can compete with each other. However, competitiveness between nations or regions is not without criticism. Krugman (1994) argues that competitiveness is a meaningless word when applied to national economies (and thus local or regional economies). Krugman states that defining competitiveness for a nation is more problematic than defining it at a firm level. Firms, who perform badly, will go out of business. But countries do not go out of business whether they are happy or unhappy about their economic performance[†].

Berger (2008) explored different definitions of national competitiveness. Berger argues that national competitiveness can have a meaning if it is seen as a relative concept as a basis for comparisons and benchmarking. In this sense competition is more or less a container for concepts such as labour rate, gross national product and productivity. This makes competitiveness in a sense comparable to concepts such as 'attraction'.

2.3. Measuring competitiveness

As a consequence of the discussion on the concept of spatial competitiveness, over the years more attention was paid to the measurement of competitiveness. Dunn (1994) argues that the methodological and empirical difficulties of competitiveness do call for the development of better measurement of competitiveness. Measurement of competitiveness by looking at different factors or indicators is a way of trying to get more grip on the concept.

Thompson (2003) shows in an exploratory article that, despite the debates, worldwide competitiveness is chartered in different countries annually by different indicators. However, what these indicators measure is uncertain as the concept of competitiveness has no clear or agreed definition. Regarding the factors that contribute to national (and thus regional) competitiveness even less consensus is available. Cambridge Econometrics (2003) performed a study on the influencing factors of regional competitiveness. The study concludes that the causes of competitiveness are usually attributed to the effects of an aggregate of factors rather than the impact of any individual factor. Isolating effects is however limited.

[†] The article of Krugman led to a vivid debate on competitiveness, see for example Thurow (1994) and Prestowitz (1994)

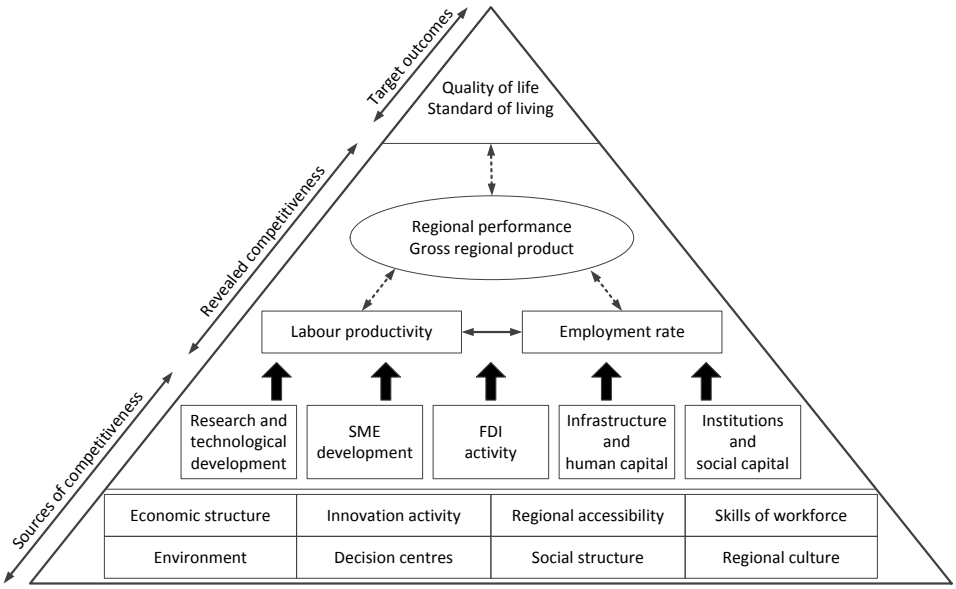

Fig. 1. Pyramid model for regional competitiveness (Lengyel (2003) and Gardiner (2004)).

Lengyel (2003) constructed a 'Pyramid Model' of competitiveness, which was enhanced by Gardiner et al (2004). Lengyel distinguishes direct and indirect components concerning factors that influence regional competitiveness. Economic output, profitability, labour productivity and employment rates are important factors. But also success determinants with an indirect impact need to be taken into account such as social, economic, cultural and environmental processes.

With regard to the objective of regional development programming and the various characteristics and factors influencing competitiveness, Lengyel distinguishes three levels:

- Basic categories which measure competitiveness, such as income, labour productivity, employment and openness.
- Development factors which concern factors that have an immediate impact upon the basis categories.
- Success determinants, which comprise social and environmental conditions. These have an indirect impact on the basic categories and development factors.

Lengyel places the characteristics that determine competitiveness on a chart, which form a pyramid. Fig. 1 provides an overview of this conceptual model. The development factors in this model provide an indication for the regional competitiveness. Infrastructure is regarded as one of the factors to serve competitiveness rather than improve competitiveness, by catering the needs of local sectors and clusters.

While infrastructure is seen as a development factor for being a competitive region, regional accessibility is listed as one of the success determinants that contribute to the (regional) competitiveness. The accessibility, transport infrastructure and geographical location of successful regions seem to be more advantageous than that of other regions. This raises the question to what extent infrastructure or accessibility contribute to competitiveness. What indicators are available? In the next chapter we will turn to the transport system and accessibility to shed some light on this question.

Summarizing the concept of spatial competitiveness it can be concluded that the definition is still under discussion. Berger (2008) concludes that the concept is best used for comparisons and benchmarking between countries. But this makes spatial competitiveness more like a city/region marketing concept, helping policy makers to promote their region or to monitor progress of certain indicators that support competitiveness. Using it this way, we still need indicators that help to benchmark or monitor regions. The Pyramid Model developed by Lengyel and

Gardiner is used in different studies to measure and benchmark competitiveness. In the model regional performance is measured by looking at regional gross product, labour productivity and employment rate. These are compared to or benchmarked with other regions or nations.

A drawback of the pyramid model is that besides the output indicators, no specific input indicators are given. For example, accessibility is seen as one of the preconditions, but not further explained. In the next section we will look at the consequences. The section explores the relation between the transport system, transport policy and spatial competitiveness.

3. The transport system and accessibility

Large-scale investments in transport infrastructure have an impact upon spatial competitiveness and thus the economic growth of an urban area, a region or a nation. To underpin the infrastructure investments, both transport models and economic models are used. Transport models are able to capture the direct effects such as changes in travel costs or changes in volume of passengers and goods. Economic models are used to incorporate the indirect effects of infrastructure investments, such as employment or economic growth.

However, to what extent are the models precisely able to provide input for studies that incorporate changes in the transport system, as well as impacts from the macro-environment upon the transport system and the other way round? In order to answer this question, a conceptual model of the transport system and its macro-environment is provided. It helps to clarify the relations between (infrastructure) investments in the transport system and the macro environment. Section 3.2 provides this conceptual model of the transport system.

Having a conceptual overview of the transport system, it leads us to the question how changes in the transport system affect the macro-environment and more specifically competitiveness, employment and economic growth. This will be the core of section 3.3, in which a relation between the transport system, competitiveness and economic growth is made, within the context of usage in a transport and/or macro-economic model.

3.1. A conceptual model of the transport system

Every introductory textbook on transport economics states that the essence of transport is derived demand. In order to satisfy needs or activities, people, goods and information travel or move between geographical different locations. As Button (2003:4) puts it: '*Possibly the most important characteristic of transport is that it is not really demanded in its own right. (...) The derived nature of demand for transport is often forgotten in everyday debate but it underlies all economics of transport*'. This essence implies that the drivers for transport lie outside the transport system, in the macro-environment. Therefore, the developments in the transport system cannot be understood without a good knowledge of the developments in the macro-environment.

In our conceptual model, the transport system consists of different elements that can be assigned to transport demand and transport supply. The demand side of the transport system comprises trip patterns, transport patterns and traffic patterns. The supply side comprises transport means and services, and infrastructure and its attributes as well as the perceptions (such as for comfort and reliability). The conceptual framework is based upon the conceptual models by Van de Riet & Egeter (1998) and Kiel et al (2012). Van de Riet & Egeter regard travel and transport as a set of markets with a dynamic interaction between demand and supply. In this interaction choices are made on both the demand and supply side of the markets.

Three different markets are distinguished, the trip market, the transport market and the traffic market (see fig. 2):

- The trip market consists of activities to be performed, whose location and time are as yet unknown. The supply side consists of the spatial and temporal distribution of the locations where the activities could be performed and the trips associated with them, as well as how this distribution is perceived. The output of this market consists of a set of trip patterns, an allocation of the activities to locations and times. The result, the trip patterns, become the demand side of the transport market. In modeling terms these comprise the production and attraction.
- The transport market consists of trip patterns, which demand for vehicles to transport people and freight. The supply side consists of vehicles and services to make the trips. The output of this market is an allocation of

trips to vehicles and services, the transport patterns. The transport patterns form the demand side for the traffic market. In transport models this is about the origin-destination matrices.

- The traffic market comprises the transport patterns, which demand for infrastructure to accommodate the vehicles and services. The supply side consists of infrastructure and all its attributes such as traffic control systems or timetables. The output is a traffic pattern (see OECD, 2002). In modelling terms these comprise the routing and loaded networks.

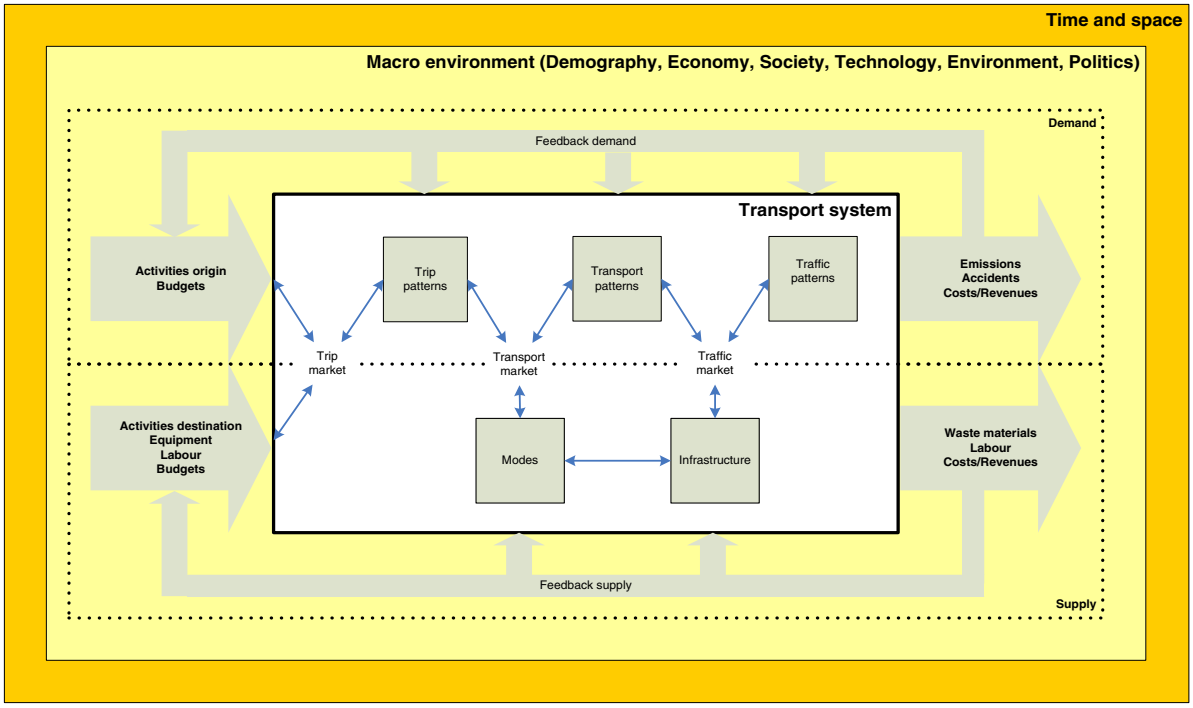

Fig. 2. Conceptual framework of the transport system.

In each of the markets, the balance between demand and supply is affected by changes in volume of freight and passengers, distance, time, costs, capacity and perceptions. These can be regarded as the key variables in the transport system. Except for perception, the variables can be directly measured. Perception consists of a qualitative view on different elements in the transport system such as comfort and reliability in public transport. For example, if a new road is built to reduce congestion, this leads to an increase in capacity and a reduction in travel time and travel costs. Also, the perception using car improves. The changes in the key variables lead to a different balance between demand and supply and thus to changes in the transport system and its output.

To keep the transport system running, different input is needed. These inputs can be distinguished into input for the demand side and input for the supply side. Concerning the demand side, the input consists of volume of passengers, freight and information, and budgets of households and businesses. On the supply side the input consists of energy for different modes, budgets of governments, operators and providers, manpower for governments, operators and providers (inflow of personnel), equipment such as vehicles, information, education and construction material to build infrastructure. Changes in any of these input have an impact on the functioning of the transport system.

The transport system also produces output. On the demand side one needs to think of different output such as volumes of freight and passengers, travel time, travel distances, costs (variable, fixed, energy, external) and revenues, emissions and noise, and victims of accidents. On the supply side output can be found like costs and revenues (for example from pricing), outflow of manpower (think of retirement), waste and damages.

The input and output of the transport system have a relation to the macro-environment. The input is affected by

the macro-environment, while the output affects the macro-environment. Therefore, it is essential to understand the impacts of changes in the input on the key variables on one hand. On the other hand it is important to understand the impacts of the key variables on the output of the transport system. The output of the transport system may have significant impacts on society, economy and environment.

In order to change the output of the transport system as well as to keep the transport system running smoothly, transport policies are implemented. Transport policies of any kind, such as supporting cleaner vehicles, improvement of transport networks, pricing measures and legal measure. All these can be seen as a form of feedback for the transport system. Knowledge of the key variables is therefore essential to understand how to influence the transport system. It helps to understand how the output of the transport system will change.

The input of the transport system is constantly affected by external drivers. As Goodwin (2002) states: *to understand the developments in the transport system it is important to identify the fundamental drivers that affect the system. The drivers are beyond the control or influence of the organisations in the transport system. The drivers are not directly subject to transport policy control. On the other hand it is important to be aware of the drivers for carrying out different activities, such as the development of transport policy measures*. In other words, it is important to analyse the macro-environment of the transport system in order to understand the functioning of the transport system.

The drivers of the transport system can be categorised into Demography, Economy, Society, Technology Environment and Politics (DESTEP). This is in line with management and organisation theory, where the analysis of the macro-environment of an organisation follows similar categories (see for example Paul, 2010)‡. It helps organisations to think about their environment and the opportunities and threats that lie within it. It incorporates the different perspectives and provides a logical structure for further discussions and proactive decision making. It is as a strategic starting point in thinking about what the drivers mean and how they affect an organisation or the transport system. The categorisation helps thinking about the different drivers and trends that affect the transport system.

The drivers in the macro-environment affect the transport system in one way or another on a continuous base. These have different implications for the transport system. Some affect the demand side in the first place, such as changes in Demography. Some will affect the supply side, such as Technology and some affect both. It is important to show where the implication occurs in the transport system, as this eases to make a link between the transport system and its macro-environment.

As an example, it is expected that ageing of the European population (Demography) will have an implication for the demand side of the transport system. Elderly people will perform different activities, such as more leisure and less work. This will have a further implication for the transport and traffic patterns. Also, more elderly people imply fewer youngsters. This may have an implication for the use of modes such as public transport to school.

Another example concerns extreme weather events. As a consequence of climate change (Environment), some parts of Europe may envisage more extreme weather in the future. This may have an impact on the critical infrastructure in the transport system. Measures to prevent critical infrastructure from malfunctioning need to be taken. This is a supply measure in the infrastructure, which help to ensure traffic patterns in the future (key variable perception/reliability) and thus a smooth working transport system, despite extreme weather events.

The conceptual model on the transport system helps to make a link to the macro-environment. More specific it helps to think about a link towards competitiveness and potential indicators to measure competitiveness, following the recommendations of Berger (2008). The first step is to define accessibility, thus making a link towards the conceptual model of Lengyel (2003).

3.2. The concept of accessibility

In chapter 2 we have seen that the measurement of competitiveness is linked to –regional– accessibility according

‡ Several categories exist like PEST or STEP. The only difference with DESTEP is the combination of drivers. In PEST, demography and society are combined.

Lengyel (2003). Accessibility is an essential concept in transport studies. However, as with the concept of 'competitiveness', defining 'accessibility' is not without discussion as several definitions exist. As Peter Gould (1969) states it: '*Accessibility is a slippery notion…one of those common terms that everyone uses until faced with the problem of defining and measuring it!*'. This section provides some thoughts about the term 'accessibility' and how to measure it in relation to competitiveness.

Litman (2012) provides a comprehensive overview of literature on the concept of 'accessibility'. According Litman, accessibility can be evaluated from many perspectives that need to be taken into account when performing an analysis on accessibility: *Accessibility refers to people's ability to reach goods, services, activities and destinations (opportunities), which is the ultimate goal of most transport activity. Many factors affect accessibility, including mobility (physical movement), the quality and affordability of transport options, transport system connectivity, mobility substitutes, and land use patterns. Accessibility can be evaluated from various perspectives, including a particular group, mode, location or activity. Conventional planning tends to overlook and undervalue some of these factors and perspectives. More comprehensive analysis of accessibility in planning expands the scope of potential solutions to transport problems.*

Litman found different factors that affect accessibility. These comprise transportation demand, mobility, transportation options, user information, integration of the transport system, affordability, mobility substitutes, land use factors, transport network connectivity, roadway design and management, prioritization and inaccessibility. Litman concludes that there is no single indicator to capture accessibility. All these fit in our conceptual model of the transport system. For accessibility, it depends on the goal of a study how accessibility should be measured.

Geurs & Van Wee (2013) reviewed different concepts of accessibility as well. They define accessibility as: *The extent to which land- use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s) at various times of the day (perspective of persons), and the extent to which land- use and transport systems enable companies, facilities and other activity places to receive people, goods and information at various times of the day (perspective of locations of activities).*

Given the definition, Geurs and van Wee (2013) describe two different perspectives for accessibility. Concerning the perspectives, they distinguish accessibility seen from the origin (what activities can I reach or do I have access to) and accessibility seen from the destination (catchment area in which people or goods are located to reach me within a certain amount of time or costs). Related to the transport system, these perspectives are related to the demand and supply side (see fig. 1). For both perspectives, different characteristics play a role such as income category, car ownership, type of industry, modes, or geographical scale.

Concerning the indicators of accessibility, Geurs and van Wee (2013) make a distinction between infrastructure-based accessibility measures, location-based accessibility measures, person-based accessibility measures and utility-based accessibility measures. Infrastructure-based measures are related to analysing the transport system itself, such as length of networks, level of congestion or speed. The location-based measures analyse the accessibility of locations at a macro level. The person-based measures relate to the accessibility at an individual level. Utility-based measures analyse the benefit that people derive from access to spatially distributed activities (see de Jong et al, 2005).

Another overview of accessibility measures is provided by Scheurer et al (2007). Scheurer also concludes that there is no agreement about an accessibility index that is most suitable for the assessment of urban and regional land use and transport system. Every measure has its drawbacks and weaknesses. The choice of an accessibility indicator depends upon the objective of the study.

Based upon the reviewed literature, there are a few criteria for the choice of a suitable accessibility measure in relation to spatial competitiveness:

- The measure needs to include a spatial level (location, region, nation)
- The measure needs to include both the supply and demand side of a location
- The measure should include both freight and passenger transport
- The measure should contain the economic value in order to ease the link to economic variables such as GDP
- The measure should be fit for use in forecasts.

Based upon these criteria, some accessibility measures can be dropped, such as transport system measures (such as distance, network length). Both location-based measures and utility-based measures seem potentially interesting to link with the concept of competitiveness. The reason for this is that both measures can be used at a spatial macro

level. They also include both the supply and demand side of a location. However, utility-based measures are difficult to express in money terms. They are also difficult to explain to practitioners and therefore less used, despite the increasing academic interest (see de Jong et al, 2005).

In the National Policy Strategy for Infrastructure and Spatial Planning (2011), the Dutch Ministry of Infrastructure and the Environment proposes one single accessibility measure based upon generalised transport costs. The measure can be differentiated into different characteristics such as regions, freight and passenger transport, purposes, commodities or time-of-day. As generalised transport costs are used, it is also possible to include aspects like perception, comfort or reliability. The measure has been further improved since the Policy Strategy was published (see Hoogendoorn-Lanser et al, 2012). The accessibility indicator was improved among other things to provide information for a region as well as for freight and passenger transport. This indicator in fact helps to compare or benchmark regions on their accessibility with just one indicator.

From the point of view of our conceptual framework, the accessibility measure should include the key variables to measure accessibility at a spatial level. This comprises volume (of passengers and freight), costs, time, distance and preferably perception (comfort, reliability, etc.). Both the location based measures and utility based measures are able to use these variables to show changes in accessibility. This way changes in the functioning of a transport system are taken well into account. The changes in the key variables can be computed by most transport models.

4. The relation between the transport system and competitiveness

Large-scale investments in transport infrastructure have been traditionally evaluated assuming the equivalence between direct and indirect economic effects (Jara-Diaz, 1986), which is only correct under -generally non-guaranteed- perfect competition assumptions. Despite this common practice, there is still no consensus amongst economists as to how the benefits and costs of large infrastructure projects should be determined. The discussions regarding the desirability of, for instance the Betuwe railway line, illustrates this. The focus has been, in particular, on the magnitude of 'indirect' and 'strategic' effects. Effects on parties other than the direct users of the infrastructure (indirect effects) and those factors that have a favourable effect on the long-term development of the (regional) economy, such as effects relating to firm location (strategic effects).

The link between the transport system and the rest of the economy has been recently discussed extensively in the economics literature for a number of reasons. Two are worth mentioning when the welfare effects of transport infrastructure improvements at an aggregate level are compared to those arising in the transport system itself.

On one hand, an intense debate at an empirical level was initiated by Aschauer (1989) in a study on the elasticity of aggregate output with respect to public capital. A key role is given in this literature to "core-infrastructure", of which roads, ports and railways are major components. Once elasticities are used to calculate public capital social rates of return, an excess with respect to private capital returns is found and usually explained as reflecting aggregate general equilibrium effects not accounted for in traditional cost-benefit analysis (CBA).

On the other hand, and coincidentally at the same time, developments towards a more formal spatial economic theory started with Krugman (1991). Krugman gave transport costs a central role in determining the configuration of the economy through the influence on workers and firm's location decisions, trade flows and regional incomes. Some recent papers have used these theoretical developments, usually dubbed as new economic geography (NEG), to construct and calibrate models addressing the economy-wide benefits arising from improvements in transport infrastructure, to compare them later with benefit estimations arising from a conventional CBA exercise. Venables & Gasiorek (1999) and Bröcker (1998) are representative cases, finding quite different orders of magnitude in these comparisons (Hvidt & Jensen, 2004).

The consequences of transport infrastructure improvements have been analysed with spatial general equilibrium models and in particular with two rather conventional types of NEG models. The interesting implication for transportation literature arising from this kind of models is to give transport costs a more sophisticated role in the economy, as compared to the traditional competition protection role already present in spatial price equilibrium models of the Enke-Samuelson tradition. Those models emphasized production specialization and were widely used

in earlier literature of the topic addressed here and in transportation networks modelling in general (Jara-Diaz and Triez, 1982; Lakshmanan et. al, 2001, Takayama and Judge, 1971).

In spatial general equilibrium models (like RAEM see Ivanova 2007) besides transport, the labour market and the housing market are included. Production, consumption (households) and transport are modelled to assess consequences of infrastructure. Models can be different in geographical scope (number of regions) and the number of sectors that are included. These models usually show effects on the prices of goods and income levels.

Turning to fig. 2, it can be seen that the transport system is dependent upon and embedded in a macro-environment, containing demography, economy, society, technology, environment and politics. The transport system is both affected by these drivers and has an impact upon (some of) these drivers. Investments in the transport system are made on the supply side, in both modes and infrastructure. These investments may concern different elements, such as renewal of a vehicle fleet, improvement of logistic services or new railway lines. All these investments are supposed to have an impact in the first place upon the trip, transport and traffic markets. Through changes in the key variables of these markets, a new equilibrium is established. Changes in one of these key variables lead to a change in output of the transport system.

As we have seen in the previous chapter, accessibility can be seen as one of the key outputs of the transport system. So, the transport models should at least be able to provide accessibility as an output, or results with which accessibility can be calculated. However, this is not sufficient output. Accessibility preferably needs to be linked to competitiveness. Looking at the pyramid model by Gardiner and Lengyel (see Fig. 1), the authors used the term 'accessibility' without defining it. The impact of accessibility upon competitiveness shows a gap if it comes to a causal link. Both accessibility and competitiveness do not have one definition. Concerning accessibility, there are different perspectives, geographical scales, users and indicators. This is also the case for competitiveness. Concluding, there are different ways to link accessibility to competitiveness. There is not one path that can be followed to connect accessibility to competitiveness.

The economic models (spatial general equilibrium models or LUTI models) are able to address the issue to connect transport investments to economic growth. There exists a large amount of literature with a consensus on the mechanisms on how changes in the transport infrastructure affect economic and productivity growth. A reduction of transport costs may cause a change in costs for the private sector. Furthermore, it may increase specialization and labour division. Also, it may lead to changes in factor markets and firm location decisions (see Schade, 2006).

Concluding, the transport investments have an impact on the economy and labour market given different assumptions. There are models that can be used to connect changes in accessibility and indicators that comprise competitiveness such as changes in production and consumption. The fact that transport investments are assumed to have an impact on economy does however not imply a causal relation. This is a reason not to try to make a firm link between changes in accessibility and changes in competitiveness. Referring to the work of Lengyel (2003) and Berger (2008), the link between accessibility and competitiveness is an assumed link: good accessibility contributes to a stronger position of a region compared to other regions.

5. Conclusions and recommendations

The concept of competitiveness in a spatial context has been used widely by policy makers to either promote their region or nation or to compare it to other regions. Providing a definition for spatial competitiveness is difficult. Different definitions on spatial competitiveness exist and these are not without debate. Berger (2008) concludes that spatial competitiveness is best used to compare regions. In that sense, spatial competitiveness is a city or region marketing concept that consists of from different indicators. The pyramid model by Lengyel/Gardiner provides a visual overview of the way one could address competitiveness through indicators. Changes in employment and GDP play an important role and these two indicators were chosen for the review of the models.

Lengyel/Gardiner state that changes in both employment and GDP are driven by different factors. Among these drivers they mention accessibility. Changes in the accessibility have an impact upon changes in employment and GDP. Two remarks have to be made in this context. First, both authors do not describe how changes in accessibility change employment and GDP. Second, they do not define accessibility, which is also crucial.

For accessibility different definitions are available for the calculation of this indicator. As with competitiveness we concluded that it is difficult to provide a good definition. Instead we defined some criteria for a good

accessibility indicator. Accessibility should be measured at a spatial level and include both the supply and demand side of a region, it should include passenger and freight transport in order to be complete, it should contain some economic value in order to ease the link with economic variables and it should be fit for use in forecasts.

Accessibility can be seen as an indicator that helps to get an idea of changes in the transport system. Following the conceptual model in fig. 2, key variables as costs, distance, volume, time and perception (comfort/reliability) should be part of the accessibility indicator.

Having described both competitiveness and accessibility, we paid attention to the link between the two. The conclusion is that there is an assumed link between accessibility and competitiveness. However, whether the link is strong or weak (is there a large or small impact) cannot be retrieved from the literature. The literature acknowledges the link, but revealed evidence is not available. Instead economic modelling exercises do exist that try to capture the indirect economic impacts (which indicates that besides the direct accessibility impacts also wider benefits may exists that also contribute to competitiveness). Our conclusion is that the link between transport investments and their impact upon competitiveness does exist, but it is a weak link as revealed evidence or a causal relation is hard to find.

Our recommendation is not to put too much effort in defining spatial competitiveness if this is used as a regional marketing concept. It would be better to pay attention to the measurement of competitiveness using indicators that support comparisons or benchmarking between regions. Accessibility is one of the indicators. For the quality of the transport system this could even be the only one. Also, economic indicators such as GDP or labour rate could be used. The I-C-EU project will recommend further indicators that support the spatial competitiveness.

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