

# Contactability measures for assessing urban competitiveness

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Transport, being an indispensable support for economic and social interaction, has a major role to play in the structuring of urban regions all over Europe. Accessibility is one of the basic factors of competitiveness, but also of access to services, while at the same time it is one of the major sources of pollution and of energy consumption.

Accessibility is one of the major factors of city development. Accessibility constitutes a necessary condition for the economic and spatial development, and accessibility is one of the key sectors where public action plays a major role in infrastructure as well as in service provision in interaction with the transport operators. Developing tools that are able to assess the quality of the accessibility is then a major stake for decision help dedicated to urban stakeholders.

In addition accessibility represents a necessary condition for the development of exchanges between cities and between cities and their hinterlands. Measuring accessibility constitutes a step in the study and the identification the potential for development of cities; it also allows for identifying those links that already permit the development of cooperation between cities and those links that lack the minimum service provision to support polycentric development. The analysis of transport services across Europe will give much importance to the air mode as the privileged long distance mean to link cities. If we consider that the intensity of the links decreases with distance, we observe that proximity OD pairs are of major importance to city development, and to polycentric organisation. On these shorter distance high-speed rail, and to a lesser extent conventional rail, can play a prominent role.

Most of the recent and dramatic development of the air mode in Europe has to be credited to the rise of the low-cost airline model. Recent literature shows that the low cost airline model seems to benefit to medium or small size airports serving intermediate cities. This hypothesis will be investigated through the analysis of the contribution of the low-cost airlines to the present accessibility.

## ***Metropolises and communication: the role of high speeds***

Besoin d'allers-retours quotidiens entre métropoles

The spatial option of polycentrism chosen in the ESDP involves the two objectives of any spatial planning strategy, which are supporting the economic development and supporting a territorial cohesion by spreading the potential for development. For several centres to emerge the strategy relies on the development of strong urban centres all over Europe. Metropolitan European Growth Areas are those urban centres that should be considered as the basic structure for urban polycentrism in Europe. Metropolises are urban entities that communicate with other metropolises in long distance networks (Sassen 1991).

The development of communications between metropolises, which correspond to a fundamental need for any metropolis, has major spatial and territorial implications. If metropolises can be defined as urban entities that communicate on a global scale, the air mode constitutes the major passenger transport system associated with globalisation (Sassen 1991). Concretely one could wish to support metropolitanization processes through the development of international long distance, by privileging inter-continental transport air mode. The importance of schedule convenience in choosing specific flights for business travels has led airlines over the years to increase both the number of non-stop service and the frequency of service to key destinations (Park et Ha 2006).

Nevertheless, the density of metropolises in Europe constitutes an opportunity for territorial development, in that it allows for the development of intra-European transport networks dedicated to the metropolises development but that could also serve spatial cohesion purposes. In that sense the assessment the quality of links in the European urban system corresponds to two objectives, the support for economic development in metropolises and the support of spatial cohesion at the scale of the urban network.

We want to analyse the quality of the communication system between European metropolises corresponding to the needs of the metropolises economic functioning (Taylor 2004). We will focus on the needs of metropolitan superior urban economic functions of firm headquarters, superior service and financial firms and research and development centres. This groups partially corresponds to the “symbolic analysts” (Beaverstock et al. 2010), or the “creative class” (Florida 2003), as the social group corresponding to the metropolitan economic dynamic.

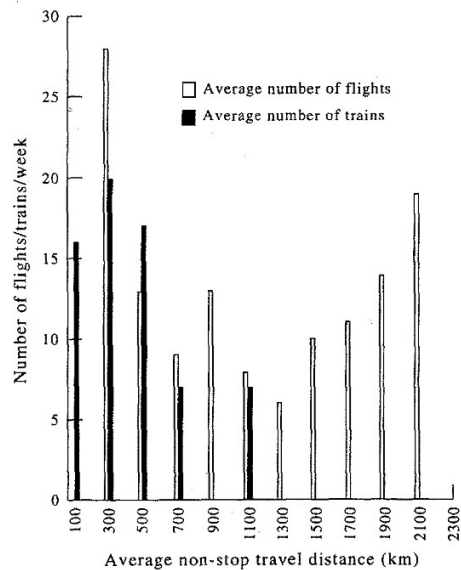
For a long time now sociology researchers have highlighted the importance of weak ties, i.e. relations with acquaintances as opposed to relations with friends and relatives, in the processes of evolution of individuals (Granovetter 1983). Recently, after theoretical developments made in the domain of networks analysis, these approaches have been diffusing in the field of geography (Rozenblat et Mélançon 2009). This direction of researches indicates that in order to understand the territorial dynamics, the study of major flows highlighting the hierarchical relations, should not prevent from considering the minor relations, sometimes on longer distances, since they can constitute the support for thematic cooperation between distant cities. Hence our analysis will not focus on major existing transport flows but rather develop an accessibility approach.

### ***Analysing air and rail networks in Europe***

Accessibility through fast transport systems, a key feature of the metropolitan fact, is all but independent of the sustainability issues. A particular focus can be put on sustainability by studying the respective roles of road, train, high-speed train and planes in their contribution to metropolitan accessibility. The introduction of high-speed inter-city rail has reportedly led to a significant decline in air travellers on certain city pairs (Park et Ha 2006). In addition, recent researches have shown the key role that can be played by the high-speed rail and air association to develop city accessibility (Bozzani 2005). To which extent the rail mode can substitute to less sustainable modes road and air remains an open question that we propose to investigate in the light of European urban development.

Janic studied the quality of service in the European railway network, highlighting the speed of relations, the frequencies and the delays according to the hierarchical level in the network (Janic 1996). This analysis focussed on the quality of the transport service.

Janic studied the two networks air and rail in Europe, comparing the distances of relevance of each mode (Janic 1997). In this paper he considered trains between locations and flights. Since most long distance trains and flight link major cities, this dataset can be considered as relevant in the analysis of the accessibility of (major) cities at the European scale. The number of existing trains on origin-destination (OD) pairs is maximal for distances of 300 km, which is also the case for air. For shorter distances one can find more trains than flights, while beyond 500 km, air becomes the dominant mode.



Cattan (Cattan 1995) has shown that the analysis of flows in the air and rail networks in Europe reveal privileged relations between cities potential support for territorial cooperation, and also helps identifying the barriers that a voluntarist transport policy could aim at overcoming.

### ***A timetable database***

Concerning the collective transport systems –rail and air– the main data considered is the timetable information. The assumption is made that short travel times and high frequencies are necessary but not sufficient to guarantee the daily accessibility level, and that an adequacy of timetables to mobility rhythms must be tested.

The data necessary to compute these indicators are timetables for the air transport system and for the rail transports system.

Concerning air transport we have used the OAG database of flights operated in the winter 2009.

Concerning the rail system an automatic query of the major cities and major rail nodes has been executed on the Deutsche Bahn website<sup>1</sup>. It covers all direct trains between cities in Europe for a typical weekday of the winter 2009. The base of the urban grid is constituted by the Urban Audit list of cities. Currently further investigations are conducted to assess the possibility to complete the database to include smaller cities, in order to develop a detailed analysis at the scale of city-hinterland relationships. The territorial base includes all countries of the ESPON space up to Moscow.

Extra data is used to connect transport nodes –station and airports– to cities, in order to attain a door-to-door approach. In addition several nodes where air to rail transfer is possible have been introduced. The criteria to introduce such possibility rely on the presence of long distance trains inside airports. Therefore, we have not introduced dedicated airport-city rail link in the analysis.

### ***Time geography and the concept of contactability***

The time-geography framework refers to the works conducted around the geographer Hägerstrand (Hägerstrand 1970). The question raised in this domain of research is the necessity of considering time when one wants to analyse space (Chardonnel 2001). This framework is relevant when one wants to analyse “the interrelationships between activities in

<sup>1</sup> The website : <http://www.bahn.de/>

space and time, and the role of transportation and communication technologies in facilitating and constraining these relationships” (Miller 2004).

Contactability is defined by Haggett (Haggett 2001) as the possibility to contact people in a distant city. The contractibility is considered, in a regional scale by Swedish geographers Hägerstrand and Tornqvist when it is possible to meet for 4 hours during a normal weekday. This indicator refers to an idea of spatial cohesion inside a territory.

Contactability analysis in a regional space was studied with specific indicators allowing for daily journey-to-work between majors cities (L'Hostis, Menerault, et Decoupigny 2004).

In the ESPON project on transport and territorial cohesion contactability indexes were developed under the aspect of daily accessibility. These indicators have been reused in several contexts including the definition of global integration zones as proposed in the ESPON atlas (ESPON et BBR 2006). This illustrates the potential of such indicators to help propose a spatial support for territorial cohesion concepts.

We will now propose a series of indicators to assess the relations between cities, based on the measure of contactability.

### ***Indicator of daily accessibility from a city: contactability***

According to the time-geography theoretical framework initiated by Hagerstrand, and the concept of contactability, the quality of the link between two poles can be assessed through the possibility to go from the pole A to the pole B, to have enough time for an activity related to work, education or other purposes, and to come back to pole A in a single day. Reciprocally, one can assess the possibility for a city to foster an event gathering people from remote metropolises. The same criteria are used but inversely, to allow for people from city A to get to city B, and to hold a meeting there. The indicator expresses the attractiveness of city B to organize a conference, an event with several persons.

A high level on this indicator will be necessary to develop a congress activity of a city.

This direction of the relation is also useful for universities, research centres, firm's headquarters and superior service and financial firms that need to gather persons from several remote cities, for seminars, colloquium and board of administration.

Consequently, and following the approach adopted in earlier works (Mathis et al. 2004), we propose to evaluate the possibility of single day business trip with 6 hours available at destination and within the time windows 6h-22h and 5h-23h, in a door to door approach and detailed as follows.

#### Structure of the return trips:



First take-off: 6h30

First arrival: 6h40 on Bruxelles-London (without considering GMT)

First departure back: 6h40 + 8h30 = 15h10

Last possible departure flight (in case of a ten minutes flight): 21h50

#### Structure of the rail return trips:



For the case of trains:

First departure: 5h45 (45 minutes + security time to the station)

Must stay 6 hours plus 2 x 45 minutes = 7h30 between times of arrival and departure

First departure back: 5h45 + 7h30 = 13h15

Maximum time of arrival of the returning train: 22h15

These criteria can be used to define a minimum service provision for the functioning of city networks and applies on the links in the network.

This family of indicators deals with intermodality by allowing to compare modal accessibilities (rail, air, road), and intermodal accessibility (air-rail), but also by taking into account the initial and terminal parts of the trips.

The indicator of contactability is displayed on the following map.

***Cf Map A1: City network contactability by rail, air or a combination of rail and air between MEGAs Return trips between 5h and 23h***

In this map, between any two cities, the modal combination that leaves the most time available at destination is chosen.

The map displays lines when a reciprocal relation is possible, i.e. when A to B and B to A relations are possible through the network. Unidirectional relations are not displayed for reasons of visual simplification.

Several key elements can be seen on this map. We can discuss the spatial distribution of the links and the transport mode distribution throughout Europe.

First element the very high importance given to rail, especially when we consider that links appearing on the map express the best spatio-temporal performance; this means that rail is able to compete with air for a large set of proximity relations. The high level of the role of rail in the inter-metropolitan relations is remarkable. One must notice though, that the national logic is very present as can be seen in the Italian case; the high-speed rail line opened recently between Naples and Milan allows for strong integration of the national city network with rail. Nevertheless Italian cross border links rely mostly on the air mode.

The second element is the high level of integration of most of the European space. The Iberic peninsula is strongly linked to the Pentagon, and the relations towards eastern countries like Poland or Hungary are clearly shown, even if their intensity is much lower than what can be seen inside the Pentagon. The integration of the Eastern Balkans proves more difficult; in this part of the territory the peripheral character and a lower density of MEGAs lead to a much less intense level of potential relations.

Thirdly the combination of rail and air plays a decisive role in the integration of the network. In order to better discuss this point we proposed to measure in each MEGA the number of other reachable MEGAs by each modal chain

***Cf Map A2: Number of MEGAs contactable by rail and/or air, return trips between 5h and 23h***

The role of each modal chain in each cities give indications on the transport modes determinants of cities accessibility. For a metropolis air is the privileged transport mode for inter-metropolises linkages. For those metropolises that do not posses an international strong airport, accessibility level is not necessarily poor as in the case of the couple

Copenhagen/Malmoe. Copenhagen is a city equipped with a large airport and air counts for more than a half of its 43 possible inter-metropolitan links. From Malmoe 24 MEGAs can be reached almost all through a rail-air combination that takes benefit of the proximity with the Copenhagen airport linkd with the rail Belt bridge.

Several intermediate MEGAs like Lille, Den Haag, German Ruhr and Rhein cities benefit of high levels of accessibility by the combination of high-speed and classical rail and efficient connection to airports. It is clearly an opportunity to build high levels of intermetropolitan accessibility without relying only on airport equipment. The indicator clearly demonstrates the potential of rail for this type of cities. Successful cases supposes to consider the position regarding the high performance rail network, the efficiency of the rail/air exchange poles.

***The hierarchy of MEGAs according to potential emission and reception factor***

The return trips can be used to determine the number of other MEGAs than can be reached from an existing city. When counting the number of reachable MEGAs potential emission and reception indexes can be build.

The potential emission and potential reception indices express the possibility to emit return-trips and receive return daily travels. The emission index expresses the possibility for travellers residing in the MEGA to reach other MEGAs for a business day trip between 6h and 22h. Reciprocally the reception factors express the possibility to hold a meeting inside a MEGA with people arriving from as many distant MEGAs.

The table shows the hierarchy of air platforms but also the imbalances between emission and reception functions. Large cities tend to have better emission than reception index.

The following map expresses the indicators of emission and reception indicators in the case of 5h to 23 hours return trips between MEGAs.

***Cf Map A3: Emission and reception potentials for city network contactability by rail or air between a proposed list of MEGA between 5h and 23h***

The tendency to see larger cities having a stronger reception potential than emission potential is here confirmed, despite notable exceptions like Francfort.

### ***Rail for inter-metropolitan links***

If air is the privileged transport mode for inter-metropolitan links, the return trips analysis shows that this type of business trips represents an opportunity for high-speed rail.

Indeed the mode combination leaving the longest available time at destination give a high importance to the rail mode, which competes with rail on distances ranging to 300 km or more in the case of high speed rail. To deepen the analysis of the potential of rail in inter-metropolitan links we produced a map of rail only relations. Between MEGAs one can find 1075 relations where rail make it possible to realise a return trip between 5h and 23h leaving 6 hours available for a meeting at destination. If we consider the number of 807 relations by rail that are better than the use of air or intermodality, we see that the potential for the use of rail is not overestimated by the global measure; it is even possible to envisage more rail for inter-metropolitan links, a tendency that is likely to evolve positively with the development of the high-speed rail network.

#### ***Cf map: A4 City network contactability by rail only between a proposed list of MEGA between 5h and 23h***

The map shows a high level of rail connection in the pentagon, with notably cross-alps relations possible, a better integration of the Spanish city network. As on the multimodal map, the national integration of the city networks is high in different situations:

- Dense city network and dense rail network: United-Kingdom, Benelux
- Dispersed city network and high-speed rail: France, Spain, Italy

It is worth noticing that crossborder relations are not as well deserved as intranational ones due to a combination of factors: longer distances, physical obstacles like Alps and Pyrenees, missing links in the high-speed rail network as between France and Spain or Spain and Portugal. This map can be interpreted as in support of the development of the Tran-European railway network, which, with well positioned services, will allow for a better integration of the European city network.

### ***Relating TEN-T rail corridors projects and missing rail contactability links between metropolises***

Several present missing links can be identified by examining the map A4 representing rail only return trips between metropolises.

Crossing of the Pyrenees could turn to rail when completion of the high-speed rail links between Perpignan and Barcelona in the East and Bordeaux-San-Sebastian in the West are completed and relevant service is set up.

Crossing of the Alps by rail for inter-metropolises contactability need probably waiting for the opening of the base tunnel to allow for high-speed rail between Lyon and Turin, and Milano beyond and the completion of the first TEN-T corridor, the Berlin-Palermo railway axis.

The Nordic triangle should most probably benefit from higher-speed rail in order for rail to surpass air transport for the daily relations between Oslo, Malmoe, Stockholm

In central Europe, many state borders remain visible on map A5. Rail is present in intra national inter-metropolises daily relations, but is much less present in international relations, even in case of relative close proximity in kilometre distances. This situation concerns the Polish Silesia cities and their Czech republic neighbour Ostrava. The polish system is clearly organized around its capital with a major role given to rail. Ostrava is linked by rail with Praha, but despite relative proximity with Silesia, no daily international relation is possible by air or rail. The TEN-T corridor 23 of the railway axis Gdansk–Warsaw–Brno/Bratislava–Vienna would contribute to fill this gap.

This case of marked international borders concerns also the Berlin to Szczecin relation. The city of Szczecin benefits from only one reciprocal return trips relations with the Polish capital. The weakness of its airport does not allow for contactability with international cities. Another illustration is provided by the lack of rail connection between Hamburg and Copenhagen. Here the TEN-T corridor of the Fehmarn belt railway bridge could provide the support for improved relations.

The borders are also visible between Brno in Czech Republic and Wien and Bratislava. Here again, the development of international rail infrastructure and services would be needed to support a better modal performance from rail over air.

These missing links by rail are all international. This shows the case for European transport policy in favour of cohesion of the European territory on the one hand and in favour of a more sustainable transport mode on the other hand.

### ***The potential of rail-air intermodality for secondary cities linked to large airports***

The map A5 is an extract of the global multimodal contactability map representing only the 37 intermodal reciprocal return trips between metropolises. This map shows the six European intermodal air-rail systems.

#### ***Map A5: City network contactability by a combination of rail and air between MEGAs cities, return trips between 5h and 23h, the European Intermodal systems***

The most comprehensive intermodal system can be seen around the major Frankfurt airport with cities of Karlsruhe, Saarbruck, Stuttgart and Bonn. This last city, representative of the accessibility of the Ruhr urban area benefits significantly from the airport of Frankfurt, by means of a very efficient and direct high-speed rail link to this major international airport.

The other case where high-speed rail and air intermodality plays a significant role in metropolis accessibility is Lille. The northern French city benefits from a contactability to 9 European cities with this intermodal system with the Parisian airport of Charles de Gaulle out of a total of 23 contactable cities.

In the Netherlands Tilburg can access to the Amsterdam Schiphol airport and benefits from a significant long distance accessibility.

In the United-Kingdom, Leeds gains a significant accessibility by using train to Manchester airport. And Bournemouth benefits from its rail connection with the Southampton airport.

Some European metropolises do not benefit from strong international airport but can access to large airports belonging to a neighbouring larger metropolis. The necessary conditions for this to occur are the existence of a long distance railway station located inside a major international airport. In addition the presence of high speed rail is susceptible to allow for a spatial extension of the accessibility provided by a major airport as can be seen in the case of the couples Frankfurt\_Ruhr and Paris-CDG-Lille.

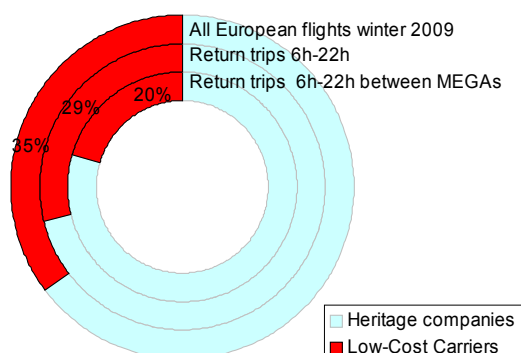
This result invites to support the connection of the upper level airport system and the high-speed rail network. This could allow for cities that do not possess a strong international airport to build an accessibility level equivalent to that of a much larger metropolis. The message here is that the possession of an international airport is not the unique way to build an international accessibility.

### ***The role of low cost airlines***

Low cost airlines are a strongly emerging new actor in the European air industry landscape (Dobruszques 2005). They represent 35 % of all flights scheduled in the winter 2009 in the OAG database.



In inter-metropolitan accessibility, low cost airlines play a particular role. It is widely accepted that low cost airlines are more present on smaller airports than on major platforms where heritage airlines have build dominant positions. In addition, most low cost airlines focus on leisure market, leaving heritage airlines dominate the business travel. Consequently, the inter-MEGAs relationships should stay in majority under the influence of major airlines. Nevertheless, with the strong emergence of low cost model, especially in intra continental links, challenging the historical players, what is the importance of theses new actors? To determine low-cost and heritage airlines we used reference works by Dobruszkes (Dobruszques 2005), and reference websites specialised in low cost ticket sales<sup>2</sup>.



**Illustration 1: Percentage of low-cost flights and return trips between airports and MEGAs**

The preceding illustration indicates the percentage of flights operated by low-cost carriers in the data base and among the flights selected for realising the return flights between all airports and finally between MEGAs operating the flights used in the return trips between 6 and 22 hours. Basically the analysis confirms the major characteristics of the supply of the low cost carriers. They are becoming major actors in the European airline industry but, so far, they are not the major actors for the business inter-metropolitan relationships. This segment of the market is mainly operated by heritage airlines with strong positions on major airports associated with the largest and most accessible metropolises in Europe.

### ***The contactability by air and rail among Urban Audit cities***

We propose to deepen the analysis by extending the contactability indicator towards the cities of the Urban Audit<sup>3</sup>. As in the previous analysis we have studied the possibility to realise daily return trips by means of trains and/or planes between cities. It must be noticed that we have not considered cars, despite its relevance for this type of trips especially between neighbouring cities when long distance modes, air and high speed trains, are not relevant. This shortcoming of the indicator in terms of realism is balanced by the identification of the potential for rail mode a substitute for road in the perspective of the greening of transport modes.

The following map shows the return trips accessibility, from 5 to 23 hours, considering air, rail and the combination of both. If we refer to the equivalent MEGA map we can observe a greater density of links all over Europe. Nevertheless, because of the too large number of

<sup>2</sup> Belvedair.com, bravofly.com and flyc.com, flylowcostairlines.org.

<sup>3</sup> The 362 cities of the Urban Audit were considered with the exceptions given in the table below:

LarisaGR BalikesirTR KocaeliTR Saint DenisFR GozoMT VolosGR BursaTR ManisaTR Pointe-a-PitreFR Ioannina-GR EdirneTR SiirtTR Fort-de-FranceFR KavalaGR HatayTR ZonguldakTR CayenneFR KalamataGR KastamonuTR- WirralUK L'Hospitalet de LlobregatES

links, this cartography technique shows shortcomings in terms of analysis, and we will use the summary map.

***Map A6: City network contactability by rail, air or a combination of rail and air between Urban Audit cities, return trips between 5h and 23h***

The following map indicates for each city of the Urban Audit list the number of distant cities reachable for a business trip and shows the respective parts of each transport chains. The map shows clearly that the dominant mode among Urban Audit cities is rail. Second rank cities like Le Mans, Ancona, Katowice or Middlesbrough often benefit of poor air services as compared to first rank cities like Frankfurt, Vienna or Copenhagen. But they can rely on the rail system to build contactability levels of relatively high importance.

***Map A7: Number of Urban Audit cities contactable by rail and/or air, return trips between 5h and 23h***

The map highlights those European regions were second rank cities, well connected by rail and separated by relatively short distances or separated by longer distances but served by an efficient high speed rail service can develop high contactability levels. This can be seen in England, in the Benelux and Ruhr, in Central Germany, in Northern Italy, in Western France and in Southern Poland. The rail system provides the support for daily communications between these cities at the local or regional scale.

The second observation that the map provides, confirms the analysis already developed regarding the articulation of the rail and air modes. Several major air hubs, like Paris, Frankfurt, Birmingham, Amsterdam, Copenhagen are able to, thanks to a good quality interconnection with classical rail or high-speed rail, contribute significantly to the accessibility of secondary centres located in the environment but not belonging to the functional area.

The indicator shows how rail can efficiently diffuse the long distance accessibility levels that the air system can provide. The rail system can benefit to secondary cities that can not pretend to develop a major air hub, in contributing to a significant level of contactability.

## **Conclusion**

Accessibility, analysed through the prism of contactability is a key component of city economic functioning. The indicators developed in this contribution highlight the possibility given to metropolites to reach distant metropolises through high speed transport. The indicator can be interpreted both ways, according to the emission or reception functions. Both are important to support the functioning of economic activities in cities.

Investigations have focused on two directions, a discussion on the cohesion of the territorial city network, and a discussion on the role of types and modes of transport.

The main messages given by the map is that of an extremely strong integration of the urban network in the centre part of Europe and to a lesser extent to some privileged peripheral spaces like the Iberic peninsula or the Nordic space. On the other hand some eastern countries and the Balkans appear not so well connected. This is due to a lower density of metropolises and to poorer connections by fast transport modes.

Regarding modes and types of transport the analysis let two points emerging. Firstly we confirm a fact already documented in the literature, that low cost airlines model, which is gaining influence all over Europe tend to be less present in the inter-metropolises segments than in the overall transport supply. Inter-metropolises contactability by air is mainly provided by heritage airlines. Secondly, and more surprisingly, we observe the very high importance of railways in the structuring of the European metropolises network. Rail, and particularly high-speed rail, competes successfully with air on a very significant number of origin-destination pairs. Rail is also very important in intermodal chains, combining the two modes. This third message expresses the possibility given by intermodality to provide high levels of

accessibility to cities like Lille, Malmoe, Den Haag, German Ruhr and Rhein that do not possess strong international airport but get access to it through rail. We measure here the fact that airport equipment is not the only way to support metropolis accessibility.

The great care given in the building of the indicator to allow for equitable comparison between air, rail and intermodal chains permits to show that the potential for inter-metropolitan contactability with rail in Europe is very high and likely to grow with the foreseen development of the European high-speed rail network.

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