Accessibility and Development in Peripheral Regions.
The Case for Beira Interior

Abstract

Beira Interior is a Portuguese region located at the centre of Portugal, close to the Spanish border, and traditionally seen as a strongly peripheral region. In the last years the decrease in population and weaknesses of the industrial park have been justified on basis of shortness and/or lack of quality in transport infrastructure.

In order to evaluate whether there is in fact a case in favour of infrastructure shortage we have developed a methodology that would allow us to identify the accessibility gains in the recent past, the ones foreseeable in the usually adopted planning periods and the ones possible in a asymptotic scenario of strong generalised accessibility, enabling this way to make explicit identification of the gains already achieved and the ones still possible.

The evolution of values of the studied region was compared with the corresponding values in the region Litoral Centro – the region that was also used as benchmark in a previous consultation process to industrial key informants operating in Beira Interior.

This thematic is extremely important for the region and for the country since the conclusions obtained will enable a better supported discussion on additional investment in transport infrastructure.

Key – words

Infrastructure, Transport, Accessibility, Development, Region, Periphery

1 Introduction

The space distribution of activities is the result of opportunities and strategies of localization in function of specific objectives. However if we take in mind that a lot of human activities involve the use and allotment of limited resources easily we evidence that the decision processes are complex and involve important economic components.

The theme of regional development mainly the one of peripheral regions generally appears connected with strong investments of capital, application of sophisticated technical and scientific tools to the productive systems, and a deep remodelling of the economy. That is to say development of such spaces means an important public investment to help the private capital to become more productive expecting in consequence the increment of social/economic nets and productive systems allows, on one hand that companies may operate at lower costs and get better performances, and on the other that inherent profits of productivity may contribute to regional economic activity increment.

Beira Interior (Figure 1) is an inner region located in the Portugal centre near Spain border. Most of the local stakeholders look at this territory as a peripheral one, in accented decrease of population, with a weak enterprise dynamics and endowed with a set of transport infrastructures generally pointed as *inadequate to the real necessities of development*. Since a long time Beira Interior demographic evolution and enterprises dynamic are justified in the basis of scarcity and/or lack of quality of transport infrastructures.

So we decided to estimate the real weight of this problem applying a methodology that allowed us even without forget the inherent effects of the past *eliminate* them in the present and explore (eventual) opportunities of development that would be placed to the region facing a scenario of high generalized accessibility. That is to say thinking about the foreseen most significant transport infrastructures investments, not only in the region but also in the Iberian Peninsula, we estimated the inherent (eventual) profits of regional accessibility in 3 temporal scenarios - 1992, 2006 and 2020, and in an asymptotic framework of high generalized accessibility.

Figure 1 - Beira Interior Region in the Context of Portugal

Source: TIS, pt[1]

We started for applying a longitudinal reading to the most populous cities of Beira Interior urban axle: Guarda, Covilhã and Castelo Branco (Figure 2). Later we repeated this procedure for 5 cities located in the Litoral Centro region, near the coast and close the main road axle Oporto/Lisbon with a neighbourhood population identical to that of Guarda, Covilhã and Castelo Castelo: Paços de Ferreira, Ovar, Águeda, Caldas da Rainha and Santarém. The city of Leiria even inserted in a more populous region was also included in this set for representing an important development pole. Finally we overlapped the estimations of the temporal evolution of the accessibility pointers in each set of cities for a transversal analysis between regions.

2 Accessibilities Estimation

2.1 Methodological Aspects

Thus our work consisted in the analysis of the real and potential accessibility of Beira Interior and Litoral Centro regions based on 1992[2] and 2006[3] iberian road nets, 2020[4]

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[1] TIS, pt – Consultants in Transports, Innovation and Systems.

iberian road and High Velocity Train railway nets, and an ideal (Asymptotic) scenario in the scope of which it was possible any displacements for any destinations at an average speed of 100 km/h.

Figure 2 - Beira Interior and Litoral Centro Main Cities

Source: TIS, pt

The specialized literature distinguishes among several Accessibility Pointers the Topological ones, those of Aggregate Weight and the Bilateral ones. The Topological ones allow to identify the areas inside of a certain territory more and less favoured for some transports net; those of Aggregate Weight allow to identify the destinations (opportunities) possible to reach from any point of the net, that is to say to estimate the potential of mobility of each origin; and the Bilateral ones estimate simultaneously the eventual *weight* of a destination and the hypothetical number of those persons interested in such a displacement.

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[2] 1992 – after the construction of the main road axle Oporto - Lisbon.
[3] 2006 – in the context of the transport infrastructures investment foresees into the sixth Framework Programme of the European Community for Regional Development.
[4] 2020 – after to be in practice not only the actual portuguese National Road Plan but also the Transport Trans-European Networks (TEN's); in this scenario we considered the announced iberian railway net of High Velocity Train (HVT) too.

Among the Aggregate Weight Pointers those of General Aggregation were the closest to our purposes: to each origin (O) - city/region corresponds a set of destinations (D) - cities/regions, function of economics and/or geographics criterions, and thus each O-D pair is function of displacement utility and cost. The General Aggregation is the sum of all O-D pairs accessibilities. In rule destinations utility is estimated using socio-economic variables, that is to say through the GDP for goods transport and the Population for passengers one.

So in each scenario and according with road and railway nets characteristics we looked at so far it was possible to travel between 1 and 5 hours[5] of displacement from Guarda, Covilhã and Castelo Branco - in Beira Interior, and from Leiria - in Litoral Centro. In each threshold of displacement time importance/utility of the cities accessibility was estimated as the population[6] sum reached throughout all routes. In 2020 scenario whenever used the High Velocity Train railway for specific linkages was considered for that sum only the local population concerning origin and destination train stations.

Meanwhile REFER[7] announced the intention for the construction of an High Velocity Train linkage between Aveiro and Salamanca (Spain) that would allow, not only to connect Oporto and Madrid in less than 3 hours of displacement but also to establish a new route of passengers and goods between the North of Portugal and the North/Centre of Europe - by Irún, and the North of Portugal and the Mediterranean Europe - by Port-Bou (Silva, 2004). Although portuguese national authorities had not still defined its tracing with rigor probably it can benefit the city of Viseu in the centre of the country. Simultaneously some transport researchers (Viegas, 2002) defended over all the initial plans not only the construction of more stations but also the circulation of more convoys to catch even more local traffics[8].

Thus Table 1 evidences stations and daily services of convoys we admitted for each High Velocity Train line.

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[5] Each hour divided into 15 minutes steps.
[6] The demographic data concerning local portuguese (*concelhos*) and spanish (*províncias*) territories is that published by its national authorities in 2001 and 2003, respectively.
[7] REFER – portuguese National Railway Authority.
[8] Each railway station would not be the stoppage of all the convoys on the line but only of a few ones in a frequency to be weighed for several external factors.

Table 1 - Stations and Daily Services in HVT Lines

HVT Lines	Stations	Daily Services (Total)
Lisbon - Oporto	Lisbon	20
	Santarém	4
	Leiria	4
	Coimbra	6
	Aveiro	4
	Vila Nova de Gaia	8
	Porto	20
Lisbon - Madrid	Lisbon	20
	Pragal	4
	Évora	4
	Elvas/Badajoz	8
	Cáceres	8
	Madrid	20
Lisbon - Faro	Lisbon	6
	Pragal	2
	Évora	2
	Beja	2
	Faro	6
Oporto – Vigo	Porto	10
	Braga	4
	Vigo	10
Oporto - Madrid	Porto	6
	Vila Nova de Gaia	6
	Aveiro	2
	Viseu	2
	Guarda	2
	Salamanca	2
	Valladolid	2
	Madrid	6

Source: TIS, pt

Whenever in each route it was necessary to change transportation mode (road-rail and/or rail-road) we took in account a delay time. Firstly and always 20 minutes, a time considered necessary to enter/leave the city and/or to enter/leave the railway station.

Secondly a time (TUe$_i$ - Equation 1) to access the transport service in any railway station (i) served by a single line[9], function of its number of daily services (Sd$_i$) as proposed by J. M. Viegas Consultores (2000); or, if the station was served by two or more lines[10], a time (TVe$_i$ - Equation 2) to access the transport service estimated through the quotient between, the sum of maximum of population between cities pairs which stations were located in each line extremities (j, k) weighed for its TUe$_i$, and the sum of maximum of population between cities pairs inherents to those stations[11].

$$TUe_i = 20 + 169.38 \ e^{\ -0.1947 Sd_i}$$ (Eq. 1)

$$TVe_i = \frac{\sum MaxPop(j,k) * TUe_i(j,k)}{\sum MaxPop(j,k)}$$ (Eq. 2)

To estimate road and rail accessibilities we used Arc View, Arc Info and Access databases, and the Intergraph Corporation GeoMedia Transportation Manager Program, version 5.2.

2.2 The Case for Covilhã and Leiria

In the 1992 scenario up to 90 minutes of displacement from Covilhã (Figure 3) the population reached (0,346 million inhabitants) was quite the same of that of Beira Interior an *isolation* that could be explained by the regional deficit of accessibility infrastructures of quality. Just after 90 minutes of displacement Covilhã could experiment a smooth amount of population, that is to say 0,524 million inhabitants reached in 2 hours, 2,067 million in 3 hours, 6,366 million in 4 hours and 18,042 million in 5 hours.

This situation changes in 2006 mainly because important roads like IP.5/A.25 (in the North), A.23 (crossing North-South the region) and IC.6 (in the South, acting as a direct linkage to Coimbra and therefore to all Litoral Centro) are still open to traffic. However

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[9] Santarém, Leiria, Coimbra, Elvas/Badajoz, Cáceres, Beja, Faro, Braga, Vigo, Viseu, Guarda, Salamanca and Valladolid.
[10] Lisbon, Aveiro, Vila Nova de Gaia, Oporto, Pragal, Évora and Madrid.
[11] If the station of origin would be served for more than one line indices *j* and *i* are concurrents.

Figure 3 - Portugal and Spain Contributions for Covilhã Accessibility

in 1992, 2006 and 2020, (in inhabitants)
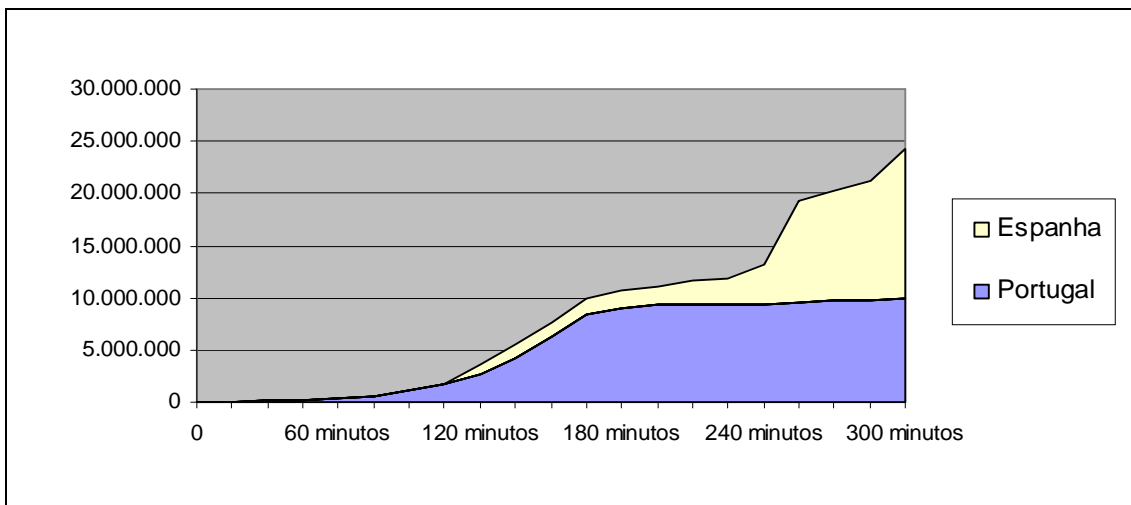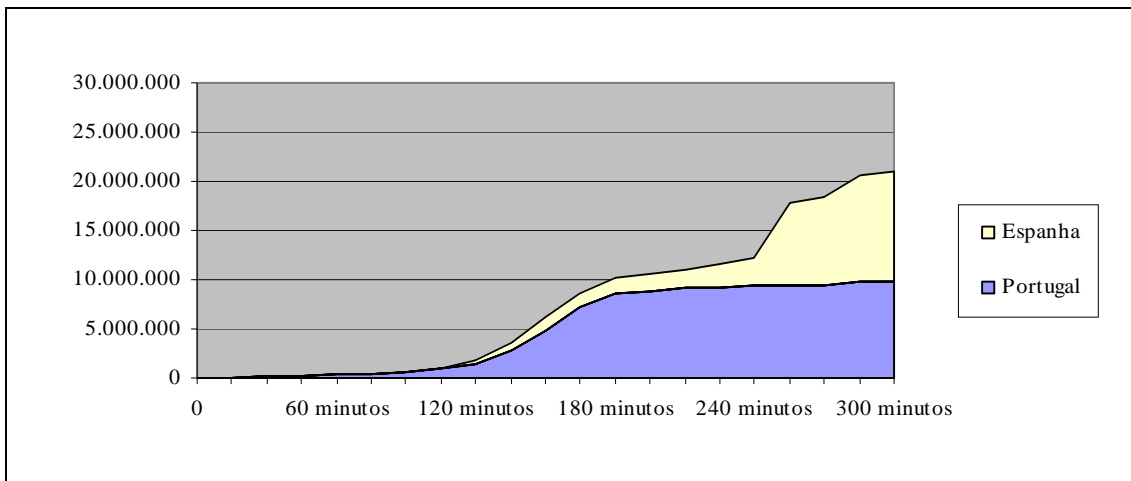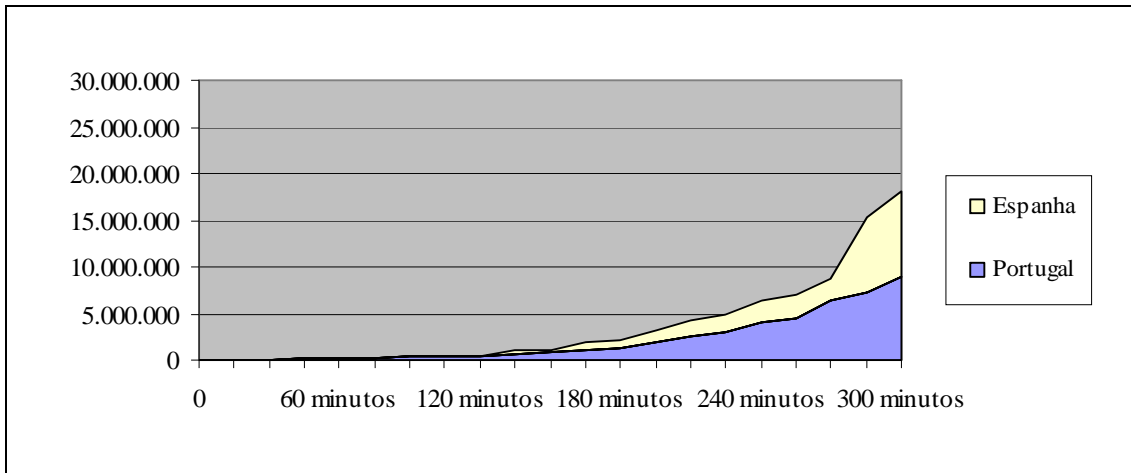
time required to reach a population equivalent to that one of Beira Interior just falls less than 30 minutes which means now at about 1 hour of displacement. Besides it's just after 1 hour of displacement from Covilhã that begins accessibility increment especially remarkable at 3 hours (Figure 4): in the 1992 scenario 3 hours of displacement allowed to reach 2,067 million inhabitants and in the 2006 scenario 3 hours allow to reach 10,130 million. Also the geographical position of Covilhã face to Spain (IP.5/A.25) induces the city to choose contacts inside the portuguese territory.

Figure 4 – Covilhã Accessibility for 3 hours of Displacement
in 1992 and 2006 Scenarios
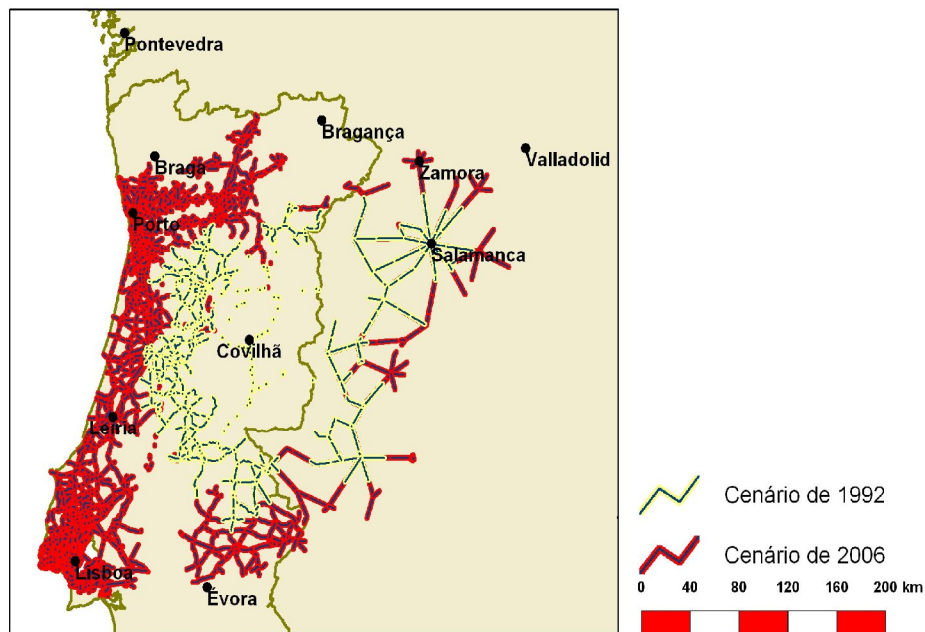
Source: Accessibilities Estimation

In 1992 it was necessary 3 hours of displacement from Covilhã to reach quite the same population (2,067 million inhabitants) than in 2 hours in 2006 (1,835 million) but in 2006 3 hours of displacement means the possibility to reach much more population (10,130 million) than in 4 hours in 1992 (6,366 million). In the transition from 3 to 4 hours of displacement Covilhã doesn't experiment in 2006 a significant accessibility increment mainly because already gets access to quite all the portuguese territory without any *necessity* to earn space in Spain. The situation is reversed in the transition from 4 to 5 hours with Covilhã reaching 20,983 million inhabitants, more 2,941 million than in the 1992 scenario.

In the transition from 2006 to 2020 it's remarkable that time Covilhã would require to reach a population equivalent to that one of Beira Interior just would fall slightly from 1 hour (allowing to reach at about 0,373 million inhabitants). In the 2020 scenario it would be possible to reach 3,698 million inhabitants with 2 hours of displacement, the double of population as in 2 hours in the 2006 scenario (1,835 million). Also for 5 hours of displacement the scenario of 2020 would take an advantage of 3,344 millions of inhabitants over the 2006 one mainly on account of the High Velocity Train station foreseeable for the city of Guarda. Besides differences in general both scenarios remain quite similar showing that after 2006 the accessibility of Covilhã will remain almost unchangeable.

Time Covilhã requires to reach a population equivalent to that of Beira Interior doesn't fall significantly from 60 minutes in any of the scenarios. In fact with the main roads (IP.5/A.25, A.23 and IC.6) open to traffic what seems to be source of regional peripherality is the lack of *weight* in population substance. Even thus in the 2006 and 2020 scenarios quite all the portuguese territory is reached just after 3 hours of displacement exactly when it starts the significance of the spanish population *weight* to Covilhã mainly with 4 and 5 hours of displacement.

Figure 5 compares 2020 and Asymptotic scenarios. In the Asymptotic one with 3 hours of displacement it would be possible to reach almost all the portuguese territory, Galiza and the Centre of Spain. In 4 hours it would be possible to reach all the portuguese territory, Madrid, Burgos and Ciudad Real. However even with 5 hours of displacement it would not be possible to reach the border of Spain with France. So we can support that for 3 and 4 hours of displacement in the 2020 scenario the city of Covilhã would get an accessibility of 100% and 80% of the ideal one, respectively.

In the longitudinal analysis we used Leiria (Figure 6) to benchmark Guarda, Covilhã and Castelo Branco. In the 1992 scenario Leiria only required 15 minutes to reach a population equivalent to its own vicinity a framework rather different of that of Beira Interior cities on account of fewer constraints concerning accessibility infrastructures. Besides since low thresholds of displacement time Leiria earned amounts of population: with 1 hour Leiria reached 1,043 million inhabitants, with 2 hours 5,968 million, with 3 hours 8,049 million and with 4 hours quite all the portuguese territory was already

reached (9,044 million) to which it still was added a small portion of the spanish one (a total at about 10,656 million inhabitants). In this same (1992) scenario to reach 1 million of inhabitants Guarda/Castelo Branco and Covilhã needed 1/1,5 hours more of displacement than Leiria, respectively. All the 4 cities needed more than 4 hours of displacement to reach 10 million inhabitants but for those of Beira Interior such a value was reached only with the contribution of the spanish population in the vicinity. Precisely the vicinity with Spain is the main reason why with 5 hours of displacement each of the Beira Interior cities (18 millions) reached much more inhabitants than Leiria (10,656 million).

Figure 5 – Covilhã Accessibility in 2020 and Asymptotic Scenarios
up to 5 hours of Displacement
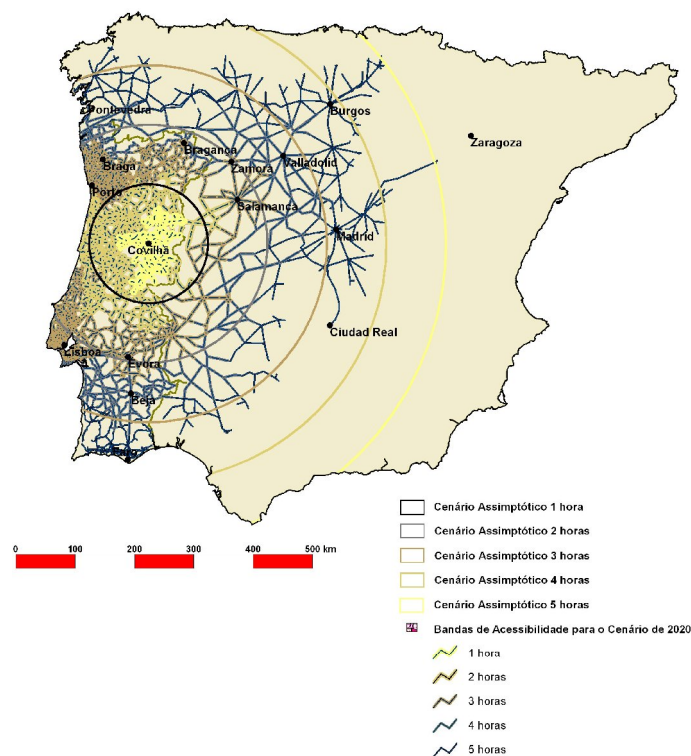
Source: Accessibilities Estimation

This situation changes significantly in 2006 just after 2 hours of displacement with Leiria reaching 7,738 million inhabitants almost the same population as in 3 hours in the 1992 scenario. With 3 hours of displacement it's possible to reach now all the portuguese territory (at about 9,182 million inhabitants) and since than Leiria starts to earn even more spanish one reaching a total of 14,849 million inhabitants with 5 hours

Figure 6 - Portugal and Spain Contributions for Leiria Accessibility
in 1992, 2006 and 2020, (in inhabitants)
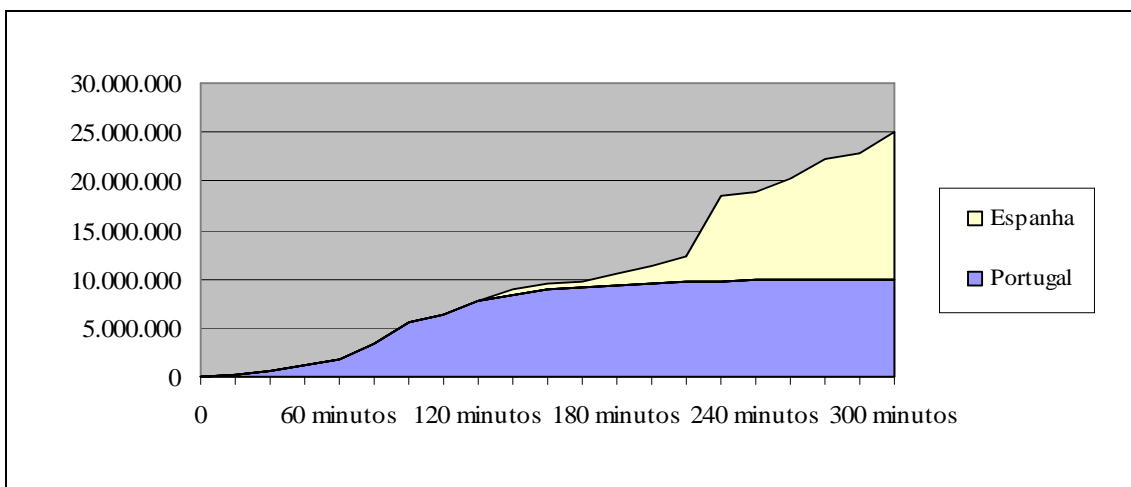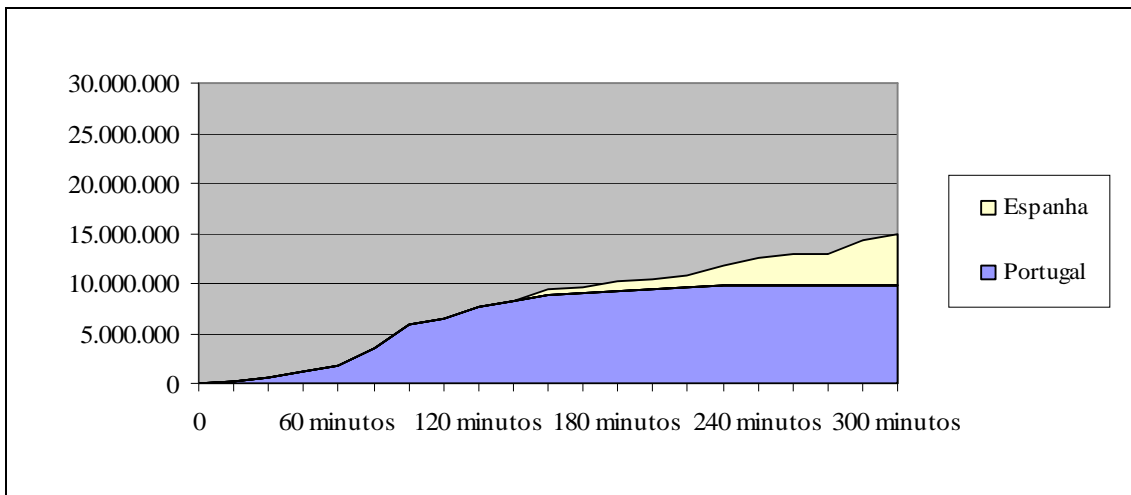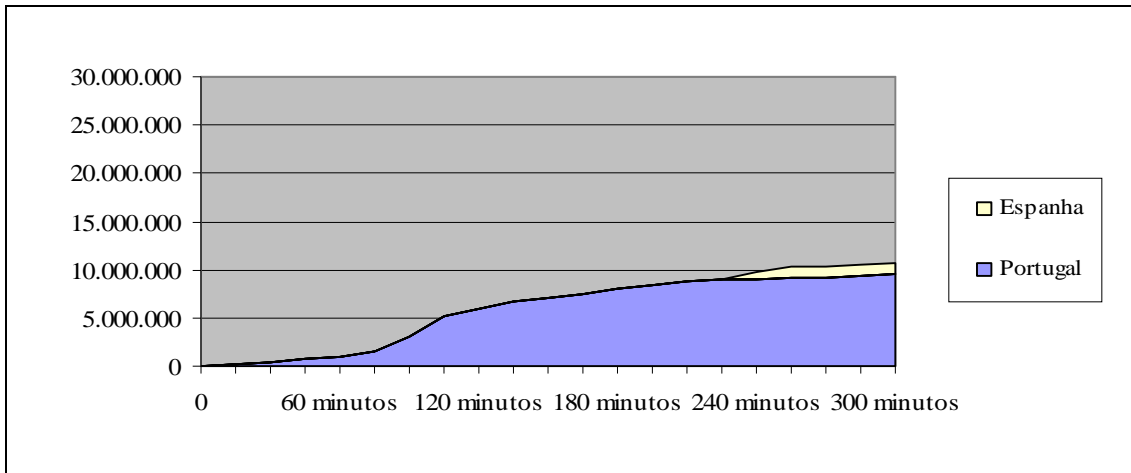
Source: Accessibilities Estimation

of displacement. These marks evidence the new framework of transport infrastructures in Portugal, not only in the Leiria vicinity but also along the national territory main axes. In Beira Interior region it's also possible to access 10 million inhabitants in about 3 hours of displacement but only with the contribution of the spanish population. That's the reason why any one of Beira Interior cities reaches more than 20 million inhabitants with 5 hours of displacement, against 14,849 million of Leiria.

In the transition from 2006 to 2020 scenarios taking into account the High Velocity Train net in all the Iberian Peninsula too we verify that the accessibility only would change significantly just after 4 hours of displacement (18,895 million inhabitants) by the strong increment of the spanish population. Besides concerning the portuguese territory the behaviour of Leiria is very similar in both scenarios.

In the 2020 scenario with 3,5 hours of displacement Leiria would reach 15 million inhabitants as with 5 hours in the 2006 scenario. With 5 hours of displacement Leiria would access in 2020 at about 25,113 million inhabitants – so as Covilhã and Castelo Branco but quite less than Guarda (27,295 million) mainly because it always would be easy for Guarda earn population in the North of Salamanca where Leiria can't access directly even with the High Velocity Train.

Figure 7 compares the 2020 and the Asymptotic scenarios for Leiria. In the Asymptotic one with 3 hours of displacement it would be possible to Leiria reach not only all the portuguese territory but also quite all the iberian central boundary including Salamanca. With 4 hours it would be possible to reach all the most important cities of Galiza, Zamora and Valladolid. With 5 hours it would be possible to reach Madrid, Burgos and Ciudad Real. So we can support that for 3 and 4 hours of displacement in the 2020 scenario the city of Leiria would get an accessibility of 100% and 80% of the ideal one, respectively.

With all the achieved data we constructed Figure 8 which gives a comparative framework of the collected ideal (asymptotic) accessibility of both Interior and Litoral regions between 1 and 5 hours of displacement. Intentionally we distinguished the city of Leiria always used as benchmark in the longitudinal analysis. We decided to include the remaining mentioned Litoral cities localized along the main road axle Oporto –

Lisbon too: Águeda, Caldas da Rainha, Ovar, Paços de Ferreira and Santarém. However to make more perceivable the accessibility comparison between regions instead of using the case for each one of the Litoral cities face to those of the Interior we substituted the *real* cities of the Litoral for two *virtual* ones correspondents to the supreme (maximum) and the undermost (minimum) among them graphically represented for two involving upper/lower lines, respectively.

Figure 7 - Leiria Accessibility in 2020 and Asymptotic Scenarios
up to 5 hours of Displacement

Source: Accessibilities Estimation

In an ideal scenario, that is to say in the scope of which transport infrastructures can't be pointed as a barrier to mobility the cities of Guarda, Covilhã and Castelo Branco have always an accessibility score worst than the undermost of those of the Litoral until at about 2 hours of displacement. Not only better transport infrastructures in the vicinity but mainly highest population density transform Litoral accessibility pointer better than the Interior one during the first 2 hours of displacement. In the transition from 2 to 3 hours of displacement the accessibility framework keeps balanced between Interior and Litoral. This is an expectable framework even after the Interior break all the transport

Figure 8 - Longitudinal Analysis of the Collected Ideal (Asymptotic) Accessibility
of Litoral Centro and Beira Interior Cities
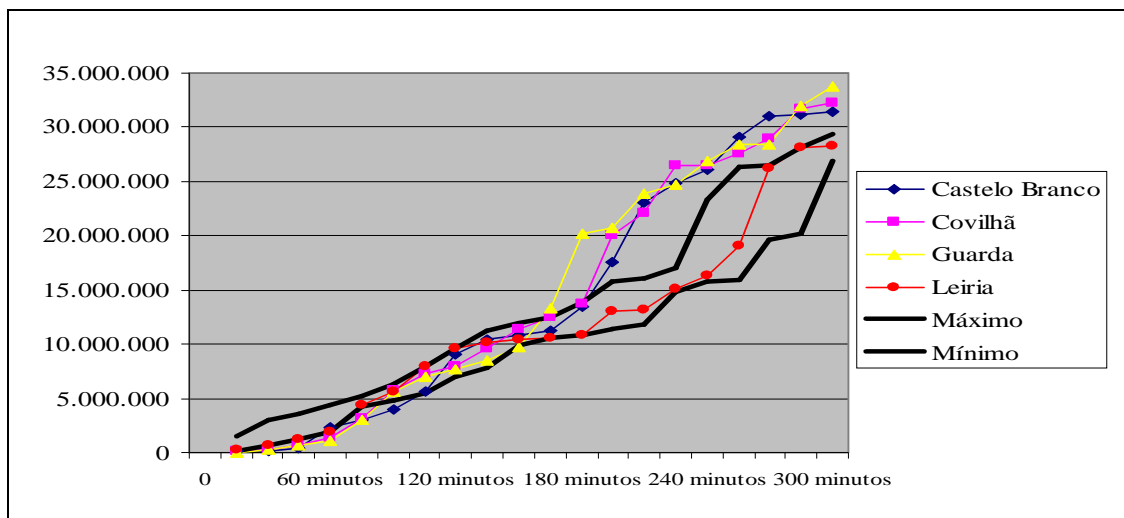
Source: Accessibilities Estimation

barriers that ever hinder its quicker approach with Litoral and/or the interior of the
spanish territory. Obviously for Litoral cities it's easier to reach portuguese territory
than earn spanish one while for those of the Interior the spanish territory is always more
accessible. From 3 hours of displacement accessibility pointer starts to favour Interior
cities. Litoral just finished to reach almost all portuguese territory and only remains the
far from spanish territory to reach even more population. Interior cities that
simultaneously earn territory in both countries only need to continue earning territory in
the neighbourhood country to accumulate advantage face those of the Litoral.

3 Conclusion

In Beira Interior such as in any other region development concept is present as a set of
potential initiatives. However to materialize these initiatives it's necessary, on one hand
to mitigate all infrastructural barriers, and on the other that involved regulation
frameworks are steady enough so that drivers of such initiatives can evaluate and feel
the existence of conditions to get the expected success.

All references underline the importance of good accessibilities to enable regions
development even nowadays becomes evident that accessibilities themselves aren't the

main neither the critical factor. With this aim there are several methods to estimate regional accessibility but all of them try to quantify contact opportunities among regions in a limited time period. Thus these contacts lead to models/styles of relationships rather different of those that are possible to establish naturally with more stability for a scale of displacements times significantly distincts. That's the main reason we estimated the accessibility pointers in steps from 1 to 5 hours of displacement.

Temporal evolution analysis of Beira Interior main cities accessibility evidence important profits in recent past and a small edge of remaining profits in future. Thus what really seems to matter more than to improve road linkages at local level is to centralize efforts to the attainment of development by other factors than accessibility infrastructures. The hypothesis of the High Velocity Train opens new accessibility insights to the region since simultaneously there are adequate road linkages to the cities where national authorities think about to construct railway stations mainly those located trough lines crossing the region to Salamanca and Badajoz.

From transversal analysis to compare accessibility endowments of Beira Interior main cities with accessibility endowments of Litoral Centro main cities it seems evident that Interior is worse positioned up to 2 hours and better positioned after 3 hours of displacement than Litoral. This is to say it's possible to find situations of comparative advantage of the Interior over the Litoral but even so it's also necessary to search the right models/styles of investments to warm up reciprocal economic advantage activities with regions localized after 3 hours of displacement from Beira Interior.

This methodology allows to show:

- in which accessibility domains it's still desirable that Beira Interior can get improvements and in which accessibility domains still possible small profits can be conquered only at very high costs;
- which are the geographic *directions* and where are the partners regions of Beira Interior to get significant contributions for the accessibility profits in such more deficit stages;

- in which accessibility domains Beira Interior has a comparative advantage with the Litoral Centro allowing opportunities for searching new economics sectors and activities that can fix in the region in high competitiveness conditions.

In fact this methodology allows to get a wide scenario of the contribution already conquered and still possible to reach of accessibilities improvement to Beira Interior cities as an instrument for regional development.

Facing these results and in comparison with more rich and prosperous regions we suggest that Beira Interior must carefully weight competitive advantages foreseen on account of the accessibility increment. Those Beira Interior advantages are based on Globalization phenomena too: the region can't only look at its trajectory and specific goals but also to those models/styles of relationships resultants of opportunities *windows* that can be opened precisely after 2 hours of displacement and that in really may influence and condition its own development.

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