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ECONOMIC EFFECTS OF ROAD ACCESSIBILITY IN THE PYRENEES: USER PERSPECTIVE[1]

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Abstract:

At present, Spain faces one of the key moments in planning the future design of the infrastructure network. As a consequence of the critical role played by haulage in intra-European trade, the most important investments are those that guarantee that road haulage traffic can move freely at the borders. That is why it is necessary to make serious evaluations of the economic and social profitability of these investments. Normally the most significant social benefit of investment projects in transport infrastructure is time saving, which in turn changes traffic intensity. In this article we analyse the changes in the user excess caused by public investment in transport infrastructure planned by the Spanish government and which will be located on the border between Spain and France. In particular, we study the increase in network user surplus for HGV traffic in the Spanish and French border zones in the Pyrenees.

Key words: intra-European trade, time saving, user surplus, gravitational model
JEL Codes: C21, D12, R41.

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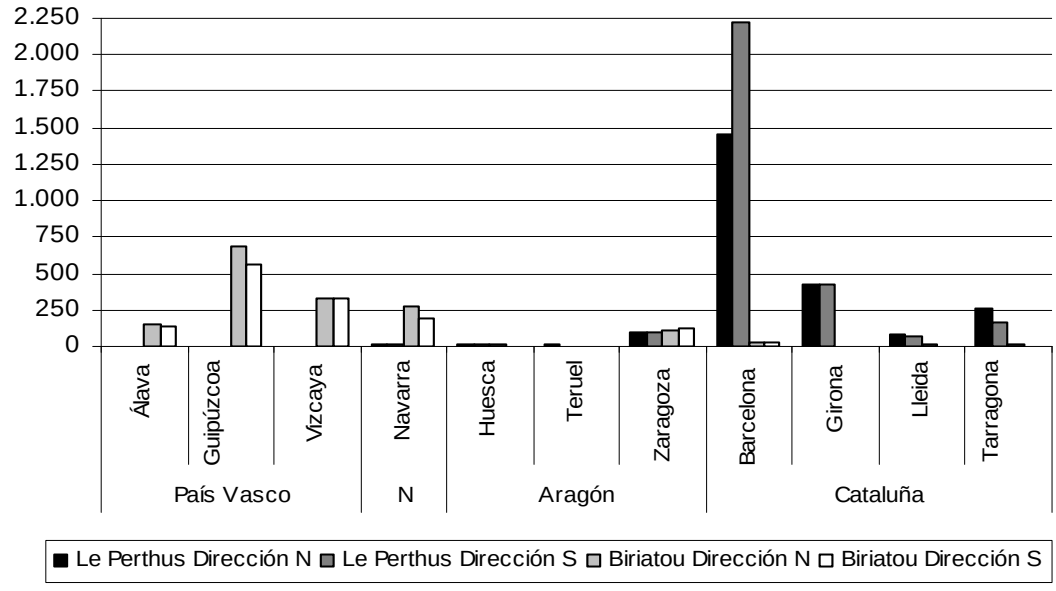
ECONOMIC EFFECTS OF ROAD ACCESSIBILITY IN THE PYRENEES: USER PERSPECTIVE

1. Expectations of the connection between Spain and France: the importance of time

The State Transport Infrastructure Plan for high capacity roads in the stretches that connect with the French border aims to correct the imbalance that currently occurs at the two crossing points. The movement of people and goods across the border is absorbed via Irun and La Jonquera due to insufficient access through the Pyrenees. The plans to open new roads through Navarre, Aragon and Catalonia aim to relieve this saturation on the only two road crossings of the Pyrenees (see graph 1).

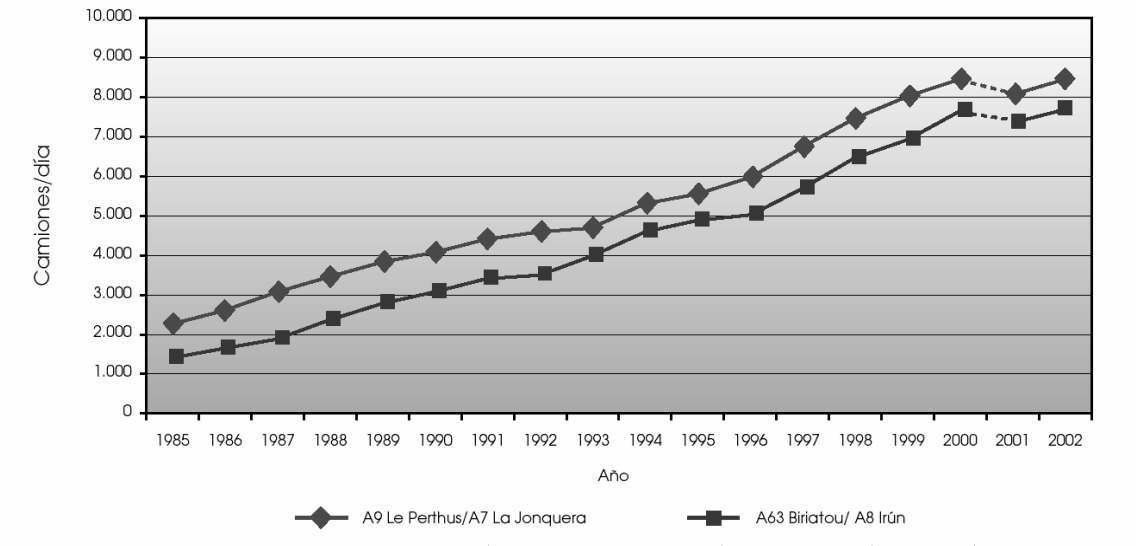
Graph 1. Distribution of the ADT of HGVs on the Pyrenees motorways according to province of origin/destination



Source: Drawn up using censuses, Transit 99 survey, Ministère de l'Équipement, des Transports

Graph 2 shows the evolution of the daily HGV transit through the border crossings at Perthus / La Jonquera in Catalonia, and Biriatou / Irun in the Basque Country. Since 1985, the number of HGVs crossing the French-Spanish border has been increasing gradually, influenced in good measure by Spain's entry into the EC and later the establishment of the Single European Market.

Graph 2. Evolution of the ADT of HGVs on the Pyrenees motorways in both directions



Source: Spanish/French Traffic Observatory in the Pyrenees (2003)

This high traffic intensity concentrated in the only two access points to France currently operating would be greatly reduced by opening alternative roads and consequently would offer great benefits, in terms of saving time, to the users of the connections between Spain and France. It is expected that the expansion of direct links with France will decongest the two existing access points and therefore guarantee greater flow. Thus, the new itineraries would have positive effects on the time needed by users for their journeys. Nevertheless, the time reduction also implies an increase in traffic on the network, that is, the new investments cause new users to incorporate into the network to take advantage of the time saving.

Therefore, the result in economic terms will translate into time savings, which will cause changes in the flow of traffic on the network. Both effects determine part of the user surplus and consequently the social benefit of the investment. This double effect is analysed together to assess the improvements in user surplus.

After this introduction, the second section presents the theoretical framework and method that allowed us to assess the time savings, the increase in traffic and the user surplus. The following

chapter evaluates the change in the user surplus expected due to the public investment planned by the government in the Spanish/French border area. In particular, we analysed the improvements in the user surplus on the network for HGV traffic between the Spanish and French border regions of the Pyrenees. The article closes with the main conclusions of the analysis.

2. Effects of new investment in transport infrastructures: network user perspective

2.1. The value of time in the generalised cost of the journey

The demand of transport is defined as consumers' willingness to pay to use a certain transport infrastructure or service. It may also be defined as the quantity of services and uses of the infrastructure they wish to purchase for each price. In transport, this relationship between price and quantity demanded is affected by monetary and non-monetary factors. Among other non-monetary factors[5], the role time plays in individual decisions stands out. Once multiplied by its unitary value, this time determines the cost that the user will bear, allowing us to establish a direct relationship between this and transport demand.

So one of the key elements in transport demand is the time of the users. De Rus et al. (2003) point out that the user moves between the points of origin and destination of a trip for another activity (work, leisure, etc.) and that, consequently, they wish to invest as little time as possible in the journey, as this travelling time is useless. Moreover, these authors point out that in the carriage of goods the time invested is also important, as the speed of delivery is inversely proportional to the cost of keeping a determined stock of goods.

The monetary and non-monetary variables on which transport demand depends is integrated into the concept of generalised cost. The general cost is the sum of the monetary value of all the transport demand determinants for an individual. This general cost (g)) is usually expressed as a linear combination of three elements.

$$g = p + vt + \theta \qquad (1)$$

[5] In the carriage of goods or transport of travellers, the user considers how much the journey will cost, the time it will take and the conditions in which they will make the journey (comfort, safety, etc.).

p are the monetary components of the trip, *vt* is the total value of time taken and θ is the monetary assessment of the rest of the qualitative elements involved in the decision. In particular, this article concentrates on studying the second component of the generalised cost, time. Therefore, this refers to the journey time between the Spanish and French regions adjacent to the Pyrenees, by means of the high capacity trans-Pyrenees roads. The objective was to determine the value of the time saved on the journey using the current network compared to that taken using the network stipulated in the Transport Infrastructures Plan.

Although this element does not necessarily translate to a monetary payment, it always constitutes a cost for the user. Its amount is obtained from the product of the total time invested in the transport and the value of every unit of this time. The total duration of the journey usually depends on the distance travelled and the speed of travel. In general, the unitary value of the time (*v*) will depend on the opportunity cost of this for each user.

2.2. Effects of time reduction on the volume of traffic: gravitational model

The most important social benefit of the investment projects for transport infrastructures is generally time saving, which, in turn, affects the volume of traffic. With a reduced travelling time, it is expected that a greater number of users make use of the infrastructure, that is, that the traffic increases.

In order to estimate these traffic increases, a gravitational model is drawn up, which explains the flow of traffic between two regions (Gil et al, 2004). This model is based on in the principle of interaction between the two regions (see table 1), in such a way that the strength of their economic relations varies according to the dimension (positively) and according to the distance that separates them (negatively).

Table 1. Matrix of interregional traffic

Destination, j / Origin, i	*Region j=1*	*Region j= 2*	.....	*Region j=n*
Region i=1	q_{11}	q_{12}		q_{1n}
Region 1=2	q_{21}	q_{22}		q_{2n}
.....				
Region 1=m	q_{m1}	q_{m1}		q_{mn}

From the gravitational model expressions that may be used, we opted for that which fits the so-called *generalised* gravitational model (Bergstrand, 1989; E. Helpman and P. Krugman, 1985). The simplest equation of the *generalised* gravitational model is expressed as follows:

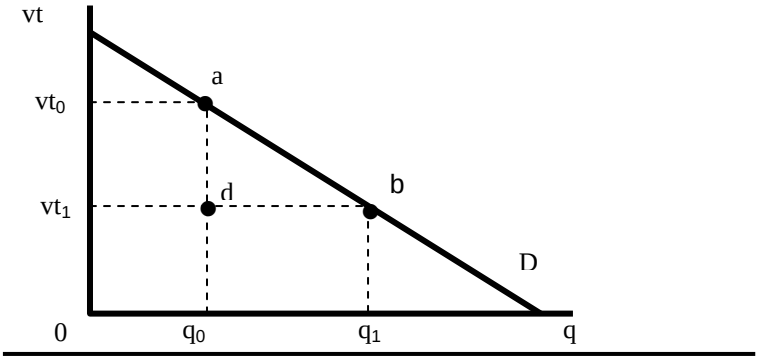
$$\ln q_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln t_{ij} + u_{ij} \qquad (2)$$

q_{ij} is the traffic between two regions; GDP_i y GDP_j is the GVA of the regions; t_{ij} is the distance measured according to the time it takes to travel the distance that separates the regions.

According to this model, the bilateral traffic between two regions is directly proportional to the size of their economies and inversely proportional to the geographic distance that separates them.

The estimation of the equation allowed us to estimate the effect of a decrease in the time taken for a determined journey on the volume of traffic. As shown in graph 3, if we know the time savings associated with new investment in transport infrastructure (t_1), the time elasticity of demand ascertained with the model (β_3) allowed us to predict the increase in traffic (q_1).

Graph 3. Effect of the reduction on the volume of traffic



Source: Drawn up using De Rus et al. (2003)

The prediction of the increase in traffic arising from a decrease in journey time allowed us to evaluate the change in the user surplus and therefore, the economic effects for the user of the infrastructure.

2.3. Effects on the user surplus: time savings, volume of traffic and evaluation of the associated benefit

The measurement based on the change in the social surplus tries to estimate the change in the surpluses produced by the reduction in the generalised cost. We analysed this reduction only for the non-monetary component, i.e., time. The increase in social well-being associated with the time savings is equal to the change in the user surplus.

The calculation of the social benefits expected forms part of the economic assessment of a new transport infrastructure. Graph 3 shows the demand according to the time, $D=t(q)$, where the value of the time to the infrastructure user in the initial situation is vt_0.

In the measurement based on the change in the social surplus, the calculation of the user benefit first requires an estimate of the change in the initial user surplus (q_0) and then that associated with the users that are incorporated into the market once the new infrastructure is in operation (q_1):

$$\Delta EC = (vt_0 - vt_1)q_0 + \frac{1}{2}(vt_0 - vt_1)(q_1 - q_0) \quad (3)$$

Or similarly:

$$\Delta EC = \frac{1}{2}(vt_0 - vt_1)(q_0 + q_1) \quad (4)$$

Graph 3 shows that opening the new road means a reduction in time for the users. For the existing users (q_0) there will be an improvement, as the value of the time reduction is the area vt_0advt_1. The new users (q_1-q_0) benefit from the area *abd* as they are willing to pay the area abq_1q_0 and pay dbq_0q_1 in time. The expression (4) reflects the sum of the surpluses of both types of user, area (vt_oabvt_1).

3. Effects of the new investment in high capacity trans-Pyrenees roads: HGV traffic

3.1. Framework of analysis: Spanish and French border regions

The object of the study was to analyse HGV traffic between the Spanish and French border regions (NUTS 3) and the benefits arising from time saved in travelling the distance that separates them. This time reduction is expected around the year 2020 after the investment stipulated in the Strategic Plan of Infrastructure and Transport of the Ministry of Development. Choosing both the Spanish and French border regions at NUTS 3 level (see table 2) allows us to limit the analysis to the area where there is expected to be the greatest effect from the new investment in the trans-Pyrenees network.

To do this, we compared the time taken using the current high capacity road network with the time it will take when the new sections stipulated in the Plan of Infrastructure and Transport are in operation.

The reference years for the HGV journey times were 2004 and 2020. The time references allowed us to compare the situation prior to the new investment in high capacity roads with the improvements that will be seen when they are operative in 2020. It was expected that the times would be reduced with the new stretches of high capacity trans-Pyrenees roads that connect Spain with the French border and that new user will enter the network.

Table 2. Spanish and French border regions (NUTS 3)

Spanish	French	
Alava	Dordogne	Tarn
Guipuzcoa	Gironde	Tarn-et-garonne
Vizcaya	Landes	Aude
Navarre	Lot-et-garonne	Gard
Huesca	Pyrenees-atlantiques	Herault
Teruel	Ariege	Lozere
Saragossa	Aveyron	Pyrenees-orientales
Barcelona	Haute-garonne	
Girona	Gers	
Lleida	Lot	
Tarragona	Hautes-pyrenees	

3.2. High capacity trans-Pyrenees and traffic between border regions: time reduction and traffic increase

The HGV traffic that crosses the Pyrenees with origin and/or destination in the Spanish and French border regions can be estimated using the data from the Spanish/French Traffic Observatory in the Pyrenees and the Transit Survey.

The data from the Observatory is available for 2003 and records the daily traffic intensity of HGVs crossing the border. For its part, the Survey gives the counts of HGVs that cross the border and the last record made was in 2000, corresponding to data from 1999. The Survey offers data broken down territorially in NUTS 3 and enables us to obtain the bidirectional traffic distribution between the regions. You can apply this distribution to the total Average Daily Traffic (ADT) that the Observatory provides and thus obtain an estimate of the bidirectional ADT per NUTS 3 region.

Therefore, to establish the bidirectional ADT between NUTS 3 regions, we applied the distribution coefficients deduced in the Survey. The results show that Spain's exchanges with France represent approximately 50% of the HGVs that pass through the Pyrenees, while those

with the rest of the European Union make up 45%. The Spanish and French border regions produce 40% of French/Spanish traffic and 20% of traffic that crosses the Pyrenees.

Table 3 shows the estimated bidirectional ADT of HGVs between the Spanish and French border regions for 2003. Therefore, it shows the traffic travelling both north and south between the Spanish and French border regions, i.e., traffic with their origin and/or destination in a Spanish region and origin and/or destination in a French region.

The French regions are more homogenous in the traffic distribution, but the Spanish regions concentrate a large part of the origin or destination flow in few regions. The French regions that attract or generate the most traffic are Pyrenees-Orientales, Pyrenees-atlantiques and Landes. On the Spanish side, the traffic is concentrated in three origin and/or destination regions: Guipuzcoa, Barcelona and Girona.

The time savings were estimated for the route between the capitals of the Spanish and French Pyrenees regions that in the time frame of 2020 will receive the investment stipulated in the Strategic Plan of Infrastructure and Transport of the Ministry of Development. Both the investment in high capacity roads made directly by the Ministry of Development and that made by the autonomous regions were included. When calculating the times, we used the distance to between the capitals of the NUTS 3 regions as reference and estimations of average speeds of 90 km/h, which do not seem far from reality according to the information available in the Mapa de Tráficos 2004 of the Ministry of Development. In addition, to estimate the route time, we took into account the compulsory rest stops that HGVs must take on long journeys according to current legislation.

This implies that the traffic of each region originates in the capital and is destined for the capital of the other region. This supposed simplification is not too serious. On one hand, the economic activity is greatly concentrated in the capital of the province and, on the other, the nearest destinations in the region are compensated by the farthest. Only in capitals that are not in the centre their territory –as occurs with capitals by the sea– can this error be considered important.

Table 4 shows the time savings forecast for the year 2020 between the pairs of Spanish and French regions and associated with the new infrastructure. The results show that Navarre, Lleida and Tarragona, compared to their current situation, are those that experience a greater improvement in accessibility to the French regions. On the French side, in Landes, Pyrenees-atlantiques and Arige there are greater time savings in the journey that links them to the Spanish regions.

The time savings would improve if the operations on the Spanish side up to the border were complemented by similar investment on the French side. Therefore, the establishment of good connections to between the two sides would serve to eliminate the natural barrier of the Pyrenees and would contribute to more efficient traffic distribution according to the relative advantage of the destination.

It is expected that these time savings will cause a change in the flow of HGV traffic and, to estimate this, we have drawn up a gravitational model that gives us the elasticity of the traffic with respect to time:

$$\ln x_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + Cont_i + Cont_j + u_{ij} \qquad (5)$$

x_{ij} is the HGV traffic between the Spanish and French NUTS-3 regions that belong to a NUTS-2 region border; GDP_i y GDP_j is the GVA of the Spanish and French NUTS-3 regions that belong to a NUTS-2 region border; and the Cont. variable is a dummy equal to 1 if it is traffic between the Spanish and French NUTS-3 border regions.

For HGVs crossing the border between Spain and France, using the procedure of ordinary least squares of the equation (5), it was estimated that the bilateral trade flow between the Spanish *i* and French *j* regions is related to the respective gross national products of both regions. Two dummy variables, $cont_i$ and $cont_j$, for the Spanish *i* and French *j* regions, which have the value 1 when they are on the border and 0 when they are not. Apart from the dummy variables, the rest of the variables are expressed in logarithms, which facilitates interpretation of the results.

Table 3. Bilateral ADT of HGVs (q_{ij}) in the year 2003 between the Spanish and French border regions (NUTS 3)*

q_{2003}	Dordogne-	Gironde	Landes	Lot-et-garonne	Pyrenees-atlantiques	Ariege	Aveyron	Haute-garonne	Gers	Lot
Alava	2	21	31	2	27	1	0	3	1	1
Guipuzcoa	4	87	254	14	356	0	1	20	3	0
Vizcaya	6	58	75	7	104	1	3	11	7	0
Navarre	0	19	95	7	56	2	0	7	4	1
Huesca	0	0	1	0	2	0	0	0	0	0
Teruel	0	0	0	0	0	0	0	1	0	0
Saragossa	1	8	23	3	12	0	1	2	0	0
Barcelona	11	23	23	9	15	11	10	80	5	1
Girona	1	3	3	3	0	7	3	82	4	0
Lleida	0	3	0	0	1	0	1	2	0	0
Tarragona	0	3	5	1	2	0	1	9	0	0
Total	25	226	511	47	576	24	21	217	25	4

* ADT of HGVs in 2003, Source: Fuente Ministère de l'Équipement, des Tranports. Distributed between NUTS-3. Source: Censuses, Transit 99 survey, Ministère de l'Équipement, des Transports

Table 3. Bilateral ADT of HGVs (q_{ij}) in the year 2003 between the Spanish and French border regions (NUTS 3) (continued)

q_{2003}	Hautes-pyrenees	Tarn	Tarn-et-garonne	Aude	Gard	Herault	Lozere	Pyrenees-orientales	Total
Alava	2	1	1	0	0	0	1	1	95
Guipuzcoa	7	3	5	1	4	1	0	1	760
Vizcaya	3	1	2	4	5	2	0	3	294
Navarre	3	1	3	1	1	2	0	2	205
Huesca	0	0	0	0	0	0	0	3	7
Teruel	0	0	0	0	0	1	0	0	2
Saragossa	0	2	2	2	5	11	1	18	91
Barcelona	2	28	11	52	34	97	2	701	1,117
Girona	1	16	5	95	11	37	0	302	575
Lleida	1	0	0	3	3	2	0	19	38
Tarragona	0	5	2	7	4	12	0	57	110
Total	20	58	30	167	67	165	5	1107	3,293

Table 4. Time savings in the journey between Spanish and French border regions (ΔT_{ij}) in 2020 compared to 2004 (minutes)

t_{2004}-t_{2020}	Dordogne-	Gironde	Landes	Lot-et-garonne	Pyrenees-atlantiques	Ariege	Aveyron	Haute-garonne	Gers	Lot
Alava	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**
Guipuzcoa	**13**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Vizcaya	**13**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Navarre	**18**	**5**	**18**	**18**	**18**	**18**	**18**	**18**	**18**	**18**
Huesca	**5**	**5**	**13**	**13**	**13**	**13**	**13**	**13**	**12**	**12**
Teruel	**8**	**8**	**28**	**28**	**28**	**28**	**28**	**28**	**5**	**5**
Saragossa	**5**	**5**	**5**	**13**	**14**	**22**	**22**	**22**	**14**	**22**
Barcelona	**5**	**5**	**18**	**5**	**18**	**12**	**5**	**5**	**5**	**5**
Girona	**5**	**5**	**18**	**5**	**18**	**12**	**5**	**5**	**5**	**5**
Lleida	**5**	**19**	**32**	**19**	**32**	**25**	**19**	**22**	**22**	**22**
Tarragona	**8**	**18**	**31**	**18**	**31**	**24**	**18**	**23**	**23**	**23**
Total	98	93	186	142	195	177	151	159	127	135

Table 4. Time savings in the journey between Spanish and French border regions (ΔT_{ij}) in 2020 compared to 2004 (minutes) (continued)

t_{2004}-t_{2020}	Hautes-pyrenees	Tarn	Tarn-et-garonne	Aude	Gard	Herault	Lozere	Pyrenees-orientales	Total
Alava	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**18**	239
Guipuzcoa	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	98
Vizcaya	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	98
Navarre	**18**	**18**	**18**	**18**	**18**	**18**	**18**	**21**	314
Huesca	**12**	**12**	**12**	**12**	**12**	**12**	**12**	18	214
Teruel	**5**	**5**	**5**	**5**	**5**	**5**	**5**	8	237
Saragossa	**13**	**23**	**21**	**16**	**14**	**14**	**14**	**14**	273
Barcelona	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	123
Girona	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	123
Lleida	**22**	**22**	**22**	**8**	**8**	**8**	**8**	**8**	323
Tarragona	**23**	**23**	**23**	**5**	**5**	**5**	**5**	**5**	311
Total	126	136	134	97	95	95	95	112	2,353

The goodness of fit of the estimate is acceptable, in light of the fact that the data used is a cross-section. So the corrected R^2 reached a high value that allowed us to conclude that the estimation reflects an important part of the variation in the endogenous variable. This result is corroborated by the verification of F, which refers to the global significance of the independent variables used to explain the variation in the endogenous variable.

In table 5 you can see that all the coefficients are significant and show the expected result: an increase in the domestic product within any of the regions analysed triggers an increase in the trade flow between both, this effect being greater for the Spanish region than for the French. So an increase of 1% of the domestic product of the Spanish region *i* causes an increase in HGV traffic of 2.28%, while the same increase in the domestic product in the French region *j* only causes an increase of 1.46% of the flow between both regions. With respect to the coefficients associated with the dummy variables, which include the border conditions of every region, we can see that the proximity to the border entails an increase in HGV traffic: the greater the proximity to the border, the higher the traffic in the Spanish and French regions. This result seems to indicate that the physical distance between the Spanish and French regions notably influences trade flow.

To go deeper into the relationship between the proximity of the regions and HGV traffic, in the estimation the *dummy* variables were replaced by the variable 'distance' expressed in logarithms. This variable describes the average time – measured in hours – that a vehicle needs to make the journey between the regions *i* and *j*. In this sense the variable t_{ij} reflects the proximity between the regions involved:

$$\ln x_{ij} = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + t_{ij} + u_{ij} \qquad (6)$$

t_{ij} is the time it takes to travel the distance that separates the Spanish and French regions. The *dummy* variables were not used in the estimation to avoid the problem of multicollinearity between the variables, given that both are interpreted as the distance between the regions. Nevertheless, the variable t_{ij} gives a more exact measurement of this distance. The results of the estimation with the 'distance' variable are shown in Table 6.

Table 5. Results of the HGV traffic estimations between the Spanish and French border regions (NUTS 3)

$$\ln x_{ij} = \hat{\beta}_0 + \hat{\beta}_1 \ln GDP_i + \hat{\beta}_2 \ln GDP_j + \hat{\beta}_3 cont_i + \hat{\beta}_4 cont_j$$

Coefficient	Estimated value	Statistic *t*
$\hat{\beta}_0$	-28.9107	-11.08
$\hat{\beta}_1$	2.2829	11.76
$\hat{\beta}_2$	1.4688	6.95
$\hat{\beta}_3$	0.5147	1.32
$\hat{\beta}_4$	0.7349	2.04
Observations = 198	F(4.193) = 48.06	R^2 corrected = 0.49

Table 6 shows that the goodness of fit has improved with respect to the previous estimation, with which the explanatory variables manage to explain much of the variation in the flow of traffic between the regions. Also, the test of the F shows a higher value than the previous estimation. This result is not unusual given that the variable entered t_{ij} is a very reliable indicator of the distance between the regions that only verifies whether the region is on the border or not.

The coefficients associated with the independent variables are significant, showing the expected results. In this estimation you can see that a reduction of 1% of the distance between the *i* and *j* regions, measured in time, increases the trade flow by 3.10%. In terms of the influence of the respective gross domestic products, these are again significant and positive, although their values decrease as to the previous estimation. So we can conclude that the distance between the regions explains a large part of the flow.

The projection of the HGV ADT was estimated using the coefficient associated with the time variable. Therefore, the increase in traffic between two regions will be according to the time savings value for the route that joins them[6]. Table 7 shows the estimations of HGV traffic travelling both north and south, derived from the reduction in journey time for each pair of regions. The total increase is marked, from 3,293 vehicles to 3,759, that is, 14.15%. The data reflects that Navarre, Lleida and Tarragona experience a greater increase in trade with the French regions, with percentages greater than 20%. And on the French side, Landes, Pyrenees-atlantiques and Arige have a greater increase in trade flow with the Spanish regions, with even higher increases than this percentage.

Table 6. Results of the estimations of HGV traffic between the Spanish and French regions (NUTS 3)

$$\ln x_{ij} = \hat{\beta}_0 + \hat{\beta}_1 \ln GDP_i + \hat{\beta}_2 \ln GDP_j + \hat{\beta}_3 \ln t_{ij}$$

Coefficient	Estimated value	Statistic *t*
$\hat{\beta}_0$	-16.8106	-6.45
$\hat{\beta}_1$	1.7806	10.36
$\hat{\beta}_2$	1.2886	6.93
$\hat{\beta}_3$	-3.1036	-8.01
Observations = 198	F(3.194) = 102.08	R^2 corrected = 0.61

[6] Nevertheless, note that the estimated time savings are exclusively derived from the changes in the itineraries made possible by the new infrastructure and not from a reduction in congestion. Therefore the estimates of the benefit are probably lower than the real figures.

Table 7. Projection of the bilateral ADT of HGVs (q_{ij}) between the Spanish and French regions for the time frame 2020

q_{i2020}	Dordogne-	Gironde	Landes	Lot-et-garonne	Pyrenees-atlantiques	Ariege	Aveyron	Haute-garonne	Gers	Lot
Alava	2	24	37	2	32	1	0	3	1	1
Guipuzcoa	4	95	285	15	406	0	1	22	3	0
Vizcaya	6	62	82	8	114	1	3	12	8	0
Navarre	0	20	126	8	76	2	0	8	5	1
Huesca	0	0	1	0	2	0	0	0	0	0
Teruel	0	0	0	0	0	0	0	1	0	0
Saragossa	1	9	24	3	15	0	1	2	0	0
Barcelona	12	24	26	9	18	13	10	85	5	1
Girona	1	3	4	3	1	9	3	89	4	0
Lleida	0	3	1	0	2	1	2	2	0	0
Tarragona	0	3	6	1	2	1	2	11	0	1
Total	26	243	601	52	705	28	22	249	27	4

Table 7. Projection of the bilateral ADT of HGVs (q_{ij}) between the Spanish and French regions for the time frame 2020 (continued)

q_{i2020}	Hautes-pyrenees	Tarn	Tarn-et-garonne	Aude	Gard	Herault	Lozere	Pyrenees-orientales	Total
Alava	2	1	1	1	0	0	1	1	105
Guipuzcoa	8	3	5	1	4	1	0	1	807
Vizcaya	4	1	2	4	5	2	0	3	309
Navarre	4	1	3	2	1	2	0	3	238
Huesca	0	1	0	0	1	1	0	3	7
Teruel	0	0	0	0	0	1	0	0	2
Saragossa	0	3	2	2	5	12	2	20	103
Barcelona	2	29	12	57	36	104	2	788	1,192
Girona	1	17	5	106	12	41	0	374	624
Lleida	1	1	0	3	3	3	0	21	44
Tarragona	0	6	3	8	4	12	0	62	126
Total	23	64	33	181	71	177	6	1,221	3,630

3.3. Economic effects: value of the time saved on the route that connects the border regions

In this section we evaluate the time savings with the object of estimating the change in the social surplus associated with the new infrastructure. The calculation of the benefits passed on to the network users required an estimate of the change caused in the existing user surplus and that of the induced traffic.

Knowing the initial traffic (q_{2004}), the traffic that is incorporated into network after the new infrastructure is opened (q_{2020}), the travelling time for each of them (*t*) and the value associated with the time (*v*) you can estimate the change in user surplus according to the following expression:

$$\Delta EC = (vt_{2004} - vt_{2020})q_{2004} + \frac{1}{2}(vt_{2004} - vt_{2020})(q_{2020} - q_{2004}) \qquad (7)$$

The first component of the equation represents the improvement in the surplus of current network users and the second is the part associated with users attracted by the new investment. The traffic and time were calculated in the preceding section and to evaluate the time savings it was necessary to assign a price (v) to the time taken that allows it to be converted into monetary terms. The UNITE (2001) study recommends the values associated with the time used in road transport (*v*). To evaluate the time for the transport of goods we used an estimate of 43 euros per vehicle-day for HGV transport. In addition, the application of a factor of 0.778 for Spain is recommended (transfer value). Following these parameters, in this article we used the unitary value of 43 euros (v) to evaluate the time taken for the journey between the Spanish and French regions and we applied a factor of 0.778.

So to specify the economic effects of the investment for the ADT of HGVs that cross the Pyrenees through the high capacity network, first we estimated the value of the time savings for the HGV journey. The value of the time needed to make the journey (*vt*) using the high capacity network was calculated by multiplying the time in days of the journey by its unitary value. Table 8 shows the value of the journey time of an HGV using the network of 2004 and the value of the time it would take in the year 2020 in light of the investment stipulated in the Plan of Transport Infrastructures. We obtained an average saving per vehicle of 3.32%.

The most important social benefit of the project of investment in transport infrastructures is generally the time saving. Road construction usually reaches 80% of the benefit (De Rus et al, 2003). The investment stipulated for the year 2020 to reduce the travelling time and increase the well-being of the users that cross the border each day is 180,027 euros, as you can see in Table

9. This table shows the improvement in the user surplus calculated for the accumulated ADT of HGVs that cross the border (both directions). The amount mentioned means a value of 65,709,855 euros per year, which does not seem to be very high, but corresponds to a saving of 3.32% over current transport times.

Table 8. Evaluation of the journey time for HGVs between the Spanish and French regions (NUTS 3) in the years 2004 and 2020* (euros)

	Vt_{2004}	Vt_{2020}
Alava	155	149
Guipuzcoa	115	113
Vizcaya	142	140
Navarre	137	130
Huesca	144	139
Teruel	280	275
Saragossa	157	151
Barcelona	133	130
Girona	103	101
Lleida	144	136
Tarragona	151	144
Total	1,658	1,603

* According to a unitary value of time of 43€ per day applying a factor of 0.778

On one side, we have calculated the improvement new users will experience (average of HGVs daily) attracted by the reduction in journey time. The amount of this saving derived from additional traffic is small, 9,202 euros per day. Adding this to that of current users gives an approximate value of the total benefit in terms of time savings that will positively affect HGV traffic daily, crossing the border origin and/or destination in the border regions with the Pyrenees. We estimated 189,229 euros per day, or 69,068,585 euros per year. Again, these figures do not seem very important, but they imply savings in transport costs of close to 3.5%. It seems very probable that in comparison with the investment expenditure, it would not produce very profitable results, but note that the new infrastructure will also offer costs savings to car users, aside from attracting many new users.

Table 9. Benefits (ΔEC) in terms of daily time savings in 2020 compared to 2004 for the bilateral ADT for HGVs (euros)

	ΔEC existing HGVs $(vt_{2004} - vt_{2020})q_{2004}$	**ΔEC induced HGVs** $\frac{1}{2}(vt_{2004} - vt_{2020})(q_{2020} - q_{2004})$	**Improvements in the user surplus ΔEC**
Alava	525	29	554
Guipuzcoa	1,731	53	1,784
Vizcaya	669	17	686
Navarre	1,492	123	1,616
Huesca	34	2	35
Teruel	10	0	11
Saragossa	580	36	616
Barcelona	3,193	106	3,299
Girona	1,643	70	1,713
Lleida	284	23	307
Tarragona	794	59	853
Total	180,027	9,202	189,229

4. Conclusions of the economic effects: user perspective

In this study, we have evaluated the benefits in terms of time savings for the ADT of HGVs that cross the border. The analysis has concentrated on the Pyrenees area, i.e., on the Spanish and French (NUTS 3) border regions. In spite of the limitations of the analysis, the approach enabled us to evaluate the most important social benefit of the projects of investment in transport infrastructures, time saving.

This HGV traffic between border regions is significant in the total that cross the Pyrenees. The results show that Spain's exchanges with France represent approximately 50% of the HGVs that pass through the Pyrenees, while those with the rest of the European Union make up 45%. The Spanish and French border regions produce 40% of French/Spanish traffic and 20% of traffic that crosses the Pyrenees.

The main results of the analysis reflect that the investment stipulated in the Strategic Plan of Infrastructure and Transport of the Ministry of Development for the year 2020, will produce

time savings for routes that join the Spanish and French regions in the Pyrenees area. In addition, these time savings will provoke a change in the flow of traffic due to the introduction of new users attracted by the reduction in journey time. Specifically, we have estimated increases in the volume of HGV traffic of 10.23%. The reduction in the travelling time will increase the well-being of the users (existing and new) improving the surplus. We estimated these benefits for the bidirectional ADT of HGVs between the Spanish and French border regions, i.e., both the northbound and southbound traffic between Spanish and French border regions.

The results obtained from the estimates indicate savings of the daily travelling time of 3.5% for HGVs that cross the border in the year 2020. A great part of this saving will benefit the current user of the high capacity network, but a small part will come from the new traffic linked to to the major trade encouraged by the improvement of the existing infrastructure, which will rise by 10%.

We have not undertaken the calculation of profitability for the new infrastructure for various reasons, such as the difficulty of isolating the cost of the infrastructures studied. We would also have to take in consideration other beneficial effects that have not been considered here, such as the reduction of congestion, but above all, we would have to take into account the gain in well-being derived from the many current and potential car users crossing the border.

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