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EVALUATION OF TRANSPORT INFRASTRUCTURE PROJECTS BEYOND COST-BENEFIT ANALYSIS. AN APPLICATION TO BARCELONA'S 4th RING ROAD(*)

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Abstract: The paper carries out an economic evaluation of Barcelona's fourth ring road with a combination of two types of analyses: a cost-benefit evaluation and an estimation of the macroeconomic effects due to the construction and operation of the infrastructure. This allows us to complement the use of CBA techniques with the quantification of the effects that, both regional and nationally, the new road can be expected to generate. Our results show that the social rate or return of the investment is below the usual 6% benchmark, although they are relatively sensitive to changes in the monetary value assigned to travel time savings. As regards the economic impact on other variables, the investment has a relatively important effect on GDP and employment, particularly in the tertiary sector, without significatively crowding out private investment.
(JEL classification) R15, R42

1. INTRODUCTION

Due to a growing demand for transport infrastructures and the scarcity of public resources to match it, the public sector has been in all countries under growing pressure to establish priorities among the different projects. In order to do it, the method most used is cost-benefit analysis (CBA). This technique has the feature of quantifying in monetary terms the dif-

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ferent advantages and disadvantages generated by the project. It thus makes it possible to discuss the way in which its results depend on the assumptions made in order to turn each concept into monetary units.

However, CBA by itself cannot take into account the whole set of economic effects which can be generated as a result of the infrastructure investment. In the UK, the awareness about this limitation lead to the discussion of project evaluation techniques by the Leitch committee, whose main conclusions this committee referred to the need of complementing CBA with other types of analysis which take into account other kinds of impacts, such as environmental effects. In this way, a broader framework of analysis would be provided (Glaister, 1999). As a result of such conclusions, evaluation of road infrastructure projects in the UK require an environmental impact report, as well as a discussion of the effects on local and regional economic growth (1). Although applying CBA to public investment in transport projects has become common practice, they are rarely complemented with an evaluation of their consequences on the regional or national economy. Even though these effects are not captured by CBA, they provide valuable information which should make it possible to carry out a more complete evaluation of the different projects.

The aim of this paper is to evaluate the effects of a new transport infrastructure complementing traditional CBA with a quantification of the short and long run economic effects derived from the project. Besides accounting for social costs and benefits in the usual way, we quantify the impact that the project would have on economic growth, investment and employment, both in the region where it is located and in the rest of the nation.

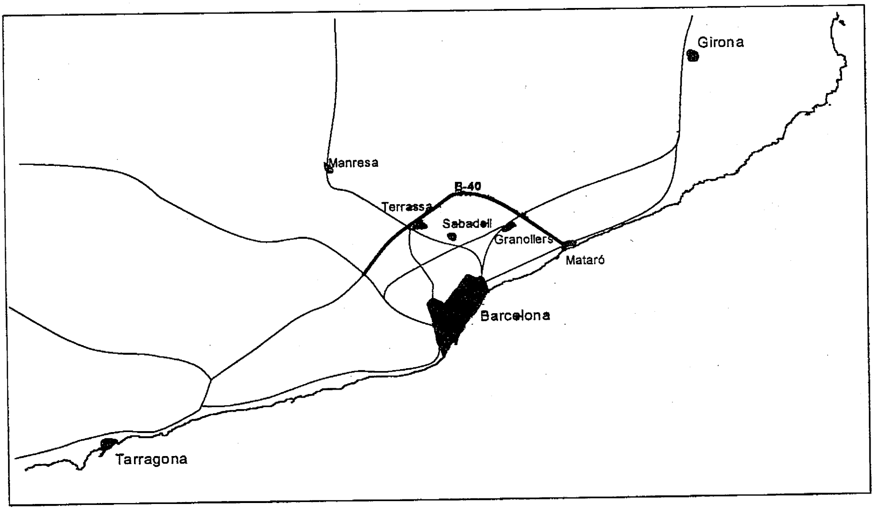
The analysed project is Barcelona's projected 4th ring road. This important piece of transport infrastructure consists of a double carriage road orbiting Barcelona's metropolitan area and providing an alternative to heave transversal traffic now using the A-2 motorway. Although it was initially planned in the mid sixties, the ring road still does not have a definitively approved route. Both its construction, characteristics and route have been subject to deep political and social discussion. The route considered in this paper is the one proposed by Catalonia's Road Plan : starting from Mataró, a coastal city 30 km northeast of Barcelona, the 4th ring road connects with Granollers, Sabadell, Terrassa and Abrera, in the west of the metropolitan area (see map 1). The connection between Mataró and Granollers has already been built and is open to the traffic, while the

(1) This methodology has been recently revised in order to complement it with a set of indicators (Price 1999, Glaister 1999, DETR 1998).

rest of the project is either being planned or under construction. The total length of the ring road is 65 km.

Evaluation exercises similar to the one carried out here have been applied to Spanish infrastructures. Riera (1993) and Romero (1999) have applied CBA to ring roads in Barcelona and Las Palmas de Gran Canaria, respectively, while Artís *et al.* (2000) did it to a tunnel in the Pyrenees. Pérez Touriño *et al.* (1997) evaluated the effects of the Atlantic Motorway, in Galicia, while Riera *et al.* (1997) took into account both social and economic effects of a tunnel providing a new motorway access to Barcelona.

After this introduction, the second section presents and discusses the CBA of Barcelona's 4th ring road. Economic effects are evaluated in the third section. Those effects include the ones due to the construction of the infrastructure, which are calculated with Input-Output methodology, as well as the ones generated when the road is open to the traffic. The latter are measured using the results of a previously estimated dynamic econometric model for the Spanish economy.



Map 1: Location of the 4th ring road in the Metropolitan Area of Barcelona

2. COST-BENEFIT ANALYSIS

In this section we present the methodology employed and the results obtained when evaluating the social costs and benefits derived from the construction of the 4th ring road. Such analysis requires making certain assumptions which may have an important influence on the final results. Since this necessarily implies a certain degree of arbitrariness, we not only need to make them explicit at the outset, but also to carry out a sensitivity analysis which will tell the degree up to which they may be influencing our results.

The quantification of the present value of the flows of costs and benefits generated by the project requires the previous determination of both its useful life and the discount rate which is used to convert future values into present ones. We have considered a period of 30 years and a discount rate of 6%. Both values are the usual ones in CBA of transport infrastructures in Spain, although in some cases different values have been employed (Pérez Touriño *et al.* 1997). Another assumption refers to the geographical area in which changes in the traffic conditions are to be considered. We have defined the area of influence of the 4th ring road as Barcelona's Metropolitan Region (RMB), a set of 163 municipalities which, although lacking administrative or political representation as a whole, represent the area usually employed to define the metropolitan area in broad economic terms.

The benefits due to the construction of the new infrastructure greatly depend on the future evolution of transport demand in the area. We obtain demand forecasts for such with the help of the transport model built by Barcelona's Metropolitan Plan (Ulied *et al.* 2000). The model divides the RMB in 301 zones and simulates the load of private traffic in all roads using 1996 data for calibration. By modifying the number of trips generated and attracted by each area, it is possible to simulate changes in average daily intensities for each route, both with and without new infrastructures such as the 4th ring road. We assume yearly increases in transport demand of 2.5% for all zones. After obtaining from the model the yearly data for private traffic we have assumed an extra load of 10% of heavy vehicles for each route (2).

Although a complete CBA should take into account external costs and

(2) This percentage results from the data supplied by the traffic count stations in the RMB area (Ministerio de Fomento, 1997).

benefits, the difficulties involved with obtaining reliable information justify that in most applied exercises such issues are not included in the evaluation. In cost terms, the main issue refers to the environmental effects, noise, or what is known as 'barrier effect' provoked in certain urban areas as a consequence of the breaking of economic or social relationships because of the physical separation imposed by the new infrastructure.

The following paragraphs present the results of computing costs and benefits due to the construction of the new infrastructure. All quantities are considered as 1997 Pta. net of indirect taxes.

2.1. Costs

Costs related to the 4th ring road can be divided in two types: construction and maintenance costs. Given that some sections have already been built, while others are being projected or under study, different sources of information have been used to quantify the costs in each one. The section Mataró-La Roca (16 km.), already built, had construction costs of 15,000 million pesetas (MPta). The section Terrassa-Abrera (15 km), already projected but not yet built, would have a cost of 22.000 MPta, according to the informative study of the Ministry of Public Works (Ministerio de Fomento 1998). Using these data and taking into account the length and topographical conditions of the remaining sections under study, the costs of connecting La Roca-Granollers (9 km) and Granollers-Terrassa (25 km) have been taken as 7.000 and 23,500 MPtas, respectively. The total cost for the whole 65 km would therefore be of approximately 67,500 MPta. Maintenance costs have been estimated using the recommendations of the Spanish Ministry of Public Works for a dual carriageway with freeway characteristics.

TABLE 2.1

Project's costs. (All values in 1997 million Peseta)

Section	*Construction costs*	*Maintenance costs*
Mataró - La Roca	15,000	1,683
La Roca - Granollers	7,000	697
Granollers - Terrassa	23,500	1,967
Terrassa - Abrera	22,000	1,621
Total	**67,500**	**5,968**

Source: Own calculations.

2.2. *Benefits*

Three types of benefits are taken into account: those due to changes in the vehicles' operation costs, those due to changes in accidents' costs and those due to travel time savings.

a) Changes in operation costs.
Operation costs include a) maintenance, repairs and spare parts; b) tyres' wear and tear; and c) unexpected costs. Changes in those costs provoked by the existence of the 4th ring road are calculated as a function of changes in number of km travelled and, in the case of petrol consumption, also of travelling speed. Those variables are obtained from the PTMB model, both under the assumption that the ring road is wholly completed in 1996 and the alternative case in which it is not built at all. Costs that depend only on travelled distance are computed using the coefficients in Table 2.2. These values are obtained by subtracting indirect taxes from the values used by MECSA and TEMA (1990) and updating them to 1997 Pta.

TABLE 2.2

Coefficients used to convert travelled Km into operating costs

1. Maintenances, repairs and spare parts	⇒ 2.793 Ptas. / Km.
2. Tyres' repairs and wear and tear	⇒ 0.976 Ptas. / Km.
3. Unexpected costs	⇒ 1.331 Ptas. / Km.

Source: MECSA and TEMA (1990) and own calculations.

Petrol consumption is calculated as a function of petrol prices (taking free of tax average prices for available kinds according to their market share), distances travelled and travelling speed. Average consumption per km. at each speed is calculated on the basis of the coefficients in table 2.3.

TABLE 2.3

Petrol consumption per vehicle

Average speed	10	20	30	40	50	60	70	80	90	100-135
Consumption	10	9.25	7.05	6.65	6.50	6.25	6.35	6.50	6.80	7.25

** Petrol consumption, in litres per 100 Km.*
Source: MECSA and TEMA (1990)

Table 2.4 shows the present value of changes in all operating costs which arise as a consequence of the existence of the 4th ring road. In all cases changes are negative, which implies that due to the opening of the new road operating costs actually increase. This fact is mainly due to the increase in the travelled distances. The new ring road would provide a new link between peripheral localities in Barcelona's region that in most cases merely substitutes previously existing local roads. The model's simulations show that most users of the new road would be previous users of parallel roads who would opt for the ring road even though it implies driving larger distances, but at higher speeds. Given that all maintenance costs directly depend on travelled distances, it is normal that they increase as a result of the opening of the ring road. In the case of petrol, not only distances rise, but so do travelling speeds, which also implies increased consumption in the case of the most usual present average speeds.

TABLE 2.4

Changes in operation costs

In Million 1997 Peseta

	Total	Maint.,.repairs, spares	Unexpected	Tyres	Petrol
Total	**- 3,426**	**- 1,101**	**- 384**	**- 524**	**- 1,417**

Source: Own calculations.

b) <u>Changes in accidents' costs.</u>
Similarly to operation costs, accidents' costs with and without the 4th ring road are computed as a function of total travelled distance. In order to obtain the expected number of car accidents, deaths and injured persons, we use the coefficients per 100,000 km travelled recommended by the Spanish Ministry of Public Works referred to the province of Barcelona. To compute the values without the 4th ring road, we use average values for all roads, while for the new road we use the freeway coefficients. Once we have computed the differences in the number of accidents and casualties, we translate them into monetary quantities using the following values: 30.3 MPta/death, 4 MPta/injured, and 0.21 MPta/car accident. The first two are the values recommended by the Spanish Ministry of Public Works, while the last one has been updated from the value calculated by Riera (1993). Table 2.5 shows the resulting present values of changes in accidents' costs due to the 4th ring road existence.

Results in Table 2.5 show apparently contradictory signs. They can be explained by the fact that the construction of the new ring road, although reducing the number of accidents which would take place, would increase average driving speeds, thus increasing the probability of death in each accident.

TABLE 2.5

Benefits in accidents' costs terms

In Million 1997 Peseta

	car repairs	deaths	injured	Total
Total	**16**	**- 173**	**542**	**385**

Source: Own calculations.

c) Changes in travel times.
Changes in travel times are directly obtained from the PTMB model. The results show that the opening of the 4th ring road generates travel time savings equivalent to 0.52% of total time spent travelling in the RMB. In the year 2026 this percentage rises to 1.55%. When converting those absolute time values into monetary units a value for travel time savings needs to be chosen. This is not an easy choice, as the literature on this issue shows (Wardman 1998, Calfee and Winston 1998, Hensher, 1997). We have decided to employ the value recommended by the Spanish Ministry of Public Works, updating it to 1997 values with the CPI. The result is a value of 1,751 Pta/hour in the case of private vehicles and 3,021 Pta/hour for heavy ones. Given the share of traffic among the two types, an average value of 1,878 results. The present value of travel time savings during the 30 years considered in the analysis amounts to 64,490. However, given the discussion about the values recommended by the Spanish Ministry (De Rus and Moreno 1995), we have decided to carry out a sensitivity analysis based on the use of slightly larger values. This analysis is reported in section 2.4.

2.3. Project's analysis: Net Present Value and Internal Rate of Return.

Table 2.6 shows the results of the cost-benefit analysis in the form of the Net Present Value (NPV) of the project, using a 6% discount rate. As can be seen, a negative result of 12,020 MPtas is obtained. Therefore, according to the valuation of the different concepts which has been carried out and the discount rate employed, the project would not yield a positive social return.

The Internal Rate of Return (IRR) has also been computed. The IRR is that which, if used as a discount rate to convert all quantities into present value ones, would result in a net present value of zero. The IRR of the project is 4.30%. This value can be interpreted as an indication that society would obtain 4.30 pta for each 100 invested in the project, during a period of 30 years.

TABLE 2.6

4th ring road costs and benefits

In Million 1997 Peseta

	Costs		Benefits			Total Net
	Construction and maintenance	Operation costs	Accidents	Time	Total Benefits	
1996	67,500,000	-76,678	34,083	3,636,215	3,593,620	-63,906,380
1997	151,060	-87,042	31,020	3,469,386	3,413,363	3,262,303
1998	145,068	-95,988	28,194	3,309,792	3,241,999	3,096,930
1999	139,271	-103,641	25,589	3,157,149	3,079,097	2,939,827
2000	133,665	-110,121	23,189	3,011,183	2,924,250	2,790,586
2001	128,247	-115,536	20,978	2,871,625	2,777,068	2,648,821
2002	123,014	-119,984	18,944	2,738,219	2,637,178	2,514,164
2003	117,963	-123,559	17,072	2,610,714	2,504,228	2,386,264
2004	1,377,326	-126,344	15,352	2,488,871	2,377,878	1,000,553
2005	110,092	-128,419	13,771	2,372,457	2,257,809	2,147,718
2006	107,071	-129,853	12,321	2,261,247	2,143,714	2,036,644
2007	104,039	-126,569	12,048	2,192,696	2,078,174	1,974,135
2008	101,007	-123,240	11,766	2,124,660	2,013,186	1,912,178
2009	97,986	-119,883	11,478	2,057,301	1,948,896	1,850,910
2010	94,982	-116,511	11,185	1,990,760	1,885,434	1,790,451
2011	92,005	-113,136	10,888	1,925,160	1,822,912	1,730,906
2012	884,521	-109,770	10,589	1,860,608	1,761,427	876,905
2013	90,425	-106,423	10,288	1,797,196	1,701,062	1,610,636
2014	89,336	-103,103	9,988	1,735,002	1,641,887	1,552,551
2015	88,080	-99,818	9,689	1,674,090	1,583,961	1,495,881
2016	86,680	-96,574	9,392	1,614,514	1,527,332	1,440,653
2017	85,156	-100,921	8,055	1,566,716	1,473,850	1,388,694
2018	83,527	-104,467	6,840	1,519,155	1,421,529	1,338,002
2019	84,820	-107,287	5,736	1,471,960	1,370,408	1,285,588
2020	583,361	-109,454	4,735	1,425,239	1,320,521	737,160
2021	86,207	-111,032	3,830	1,379,092	1,271,890	1,185,683
2022	86,383	-112,080	3,011	1,333,602	1,224,533	1,138,151
2023	86,262	-112,654	2,273	1,288,844	1,178,463	1,092,201

(continued)

2024	85,879	-112,804	1,609	1,244,879	1,133,685	1,047,806
2025	85,262	-112,576	1,013	1,201,763	1,090,200	1,004,938
2026	439,277	-112,012	479	1,159,539	1,048,006	608,729
NPV	73,467,971	-3,427,478	385,403	64,489,633	61,447,559	-12,020,413

Source: Own calculations

2.4. Sensitivity analysis

As has been previously stated, the results obtained from a CBA can be very sensitive to some of the assumptions employed in the monetary quantification of the benefits derived from the project. Because of this, our results need to be complemented with a discussion of the changes that would take place if some of the assumptions were modified. More precisely, we evaluate the degree to which they change if higher values for travel of time savings are employed. Table 2.7 summarises the CBA results when those values are increased to 2,000 and 2,200 Pta/hour, from the previous 1,878. As expected, higher values of travel time savings results in an increase in the project's benefits. However, not even in the most favourable case do total benefits outweigh total costs. With values slightly higher than 2,200 (and maintaining a discount rate of 6%) a positive net value for the project would result.

TABLE 2.7

CBA results with different travel time savings

Value of travel time (Ptas)	Benefits	Costs (Million Ptas)	NPV	IRR (%)
1,878	61,448	73,468	-12,020	4.30
2,000	65,637	73,468	-7,831	4.91
2,200	72,504	73,468	- 963	5.87

Source: Own calculations.

3. ECONOMIC IMPACT ANALYSIS

In this section we estimate both the short and long run economic impacts due to the construction and operation of the 4th ring road. Economic effects of transport infrastructures can be divided in two types. On the one hand, those generated by the construction process, which take place in the short run. On the other hand, the ones that take place once the infrastructure has been built and is being used. The later are clearly noticed over a longer time period. Herce and Sosvilla (1996) use the term 'demand effects' for the first ones, and 'supply effects' for the second. We use that distinction in the rest of this paper. In section 3.1 we deal with demand effects, while in 3.2 we calculate the supply ones.

3.1. Demand effects due to the construction of the 4th ring road.

We estimate the economic impact resulting from the construction of Barcelona's 4th ring road on both the national and regional economies. In this analysis, Catalonia is considered the regional economy, while the rest of Spain is the national one. No effects on other countries are taken into account. In order to carry out that estimation, we employ the methodology of Leontieff's Input-Output (IO) tables (3). The use of that methodology is standard practice when evaluating the impact of the construction of large infrastructures. Álvarez and Herce (1993) used it to measure the sectorial effects of the construction of new high-speed train tracks in Spain. They compared their results for the Barcelona-Madrid line with an equivalent investment in road building. The Spanish Ministry of Public Works carried out a similar analysis in its medium-term infrastructural plan (MOPTMA 1994). In a slightly different setting, the Spanish Ministry of Economy (Ministerio de Economía, 1995) and Herce (1995) evaluate the effects that regional subsidies from the EU had on objective 1 regions during the period 1989-1993. Both studies distinguish between demand and supply effects using IO tables to estimate the first ones. Other researchers have carried out similar analyses on regional economies, using IO tables specifically calibrated for those areas (4).

The building of roads requires substantial investments, which result in demand increases for certain Catalan industries. Demand increases for a specific industry are in turn converted into a rise in the demand made on its suppliers, and so on. The input-output methodology is used in this paper to calculate the effects on final demand as a result of the initial investment increase. Prior to the estimation of the demand effects due to the construction of the 4th ring road, it is necessary to quantify the construction costs involved, as well as making an assumption about the time

(4) See Matas *et al.* (1994), Blanco *et al.* (1995) and Roca (1997).

period over which construction takes place. In this research we have assumed that all investment related to the construction of the ring road takes place during one year. As regards the costs involved, in the previous section we have been able to estimate them at 67,500 MPtas of 1997, using information on both the completed and projected road sections.

Taking into account the location of the project, the geographical area most suitable to measure its economic effects is the whole region of Catalonia. We will therefore employ Catalonia's 1987 IO table (5) (from now onwards, TIOC87), which is the most recent one. The TIOC87 provides information about each industry's economic trade both with other Catalan industries and with the rest of Spain. It will, therefore, allow us to measure the increase in production that will take place in the rest of Spain in order to build the 4th ring road.

The TIOC87 considers 73 different sectors. We allocate the total construction costs among them using the information of two large road projects recently built in Catalonia: Barcelona's Tunnels of Vallvidrera (Riera *et al.* 1997) and the Transversal Axis (GISA, 1997). In this way, we obtain the following share of constructions costs among 4 of the 73 economic sectors:

- 95.4 % for installations and public works: 64,395 MPtas
- 3.8 % for studies, projects and work guidance: 2,565 MPtas
- 0.6 % for insurance related expenses: 405 MPtas
- 0.2 % for buying of vehicles: 135 MPtas

Applying those quantities to the TIOC87 makes it possible to obtain, for each economic sector, the total economic impact due to demand increases in those four industries, both for Spain and the rest of Spain. Those economic effects can be measured in terms of new output, gross value added (GVA) and employment.

The main economic impact takes place on the Catalan economy, but they are also significant in the rest of Spain and even abroad. We do not take into account effects taking place on imports from the rest of the world, but we do quantify Catalan imports from the rest of Spain. It has to be noted that in order to measure total impact on the Spanish economy, we need to quantify effects which take place within that economy as a result of the new exports to Catalonia. In order to measure those effects we have used the 1989 Spanish IO table. Table 3.1 summarises all the measured effects, aggregating all industries in six main groups.

(5) Parellada, M. (1992).

TABLE 3.1

Effects on Gross Added Value and Employment

In million 1997 Peseta and number of jobs created

	Investment	Effects on Gross Added Value			New Employment		
Sectors		Catalonia	Rest of Spain	Total	Catalonia	Rest of Spain	Total
Agriculture	0	25	41	66	14	26	40
Energy	0	1,217	747	1,964	75	63	138
Manufacturing	135	8,594	4,181	12,775	2,204	1,046	3,250
Construction	64,395	32,287	60	32,347	10,846	18	10,864
Tradeable Services	2,970	10,550	2,781	13,331	2,838	601	3,439
Untradeable Services	0	0	0	0	0	0	0
Total	**67,500**	**52,672**	**7,810**	**60,483**	**15,977**	**1,754**	**17,731**

* Effects generated by Catalonia through imports consumed by the rest of Spain.
Source: Own calculations

Therefore, total investment linked to the construction of the 4th ring road would result in an increase of Gross Value Added for the Catalan economy of 52,700 MPta (at 1997 values), and for the whole Spanish economy of 60,500 MPta. More than half of that increase would take place in the construction sector. As regards employment, our results point out that the building of the ring road generates around 17,700 workplaces during one year, of which around 90% would be in Catalonia. Almost two thirds of the created employment would take place in the construction sector.

3.2. Supply effects derived from the opening of the 4th ring road.

Economic effects, which take place on the supply side over the long run due to the services provided by the new infrastructure, have been estimated with the help of a dynamic econometric model of autoregressive vectors (VAR) (6). More precisely, we have quantified the effect of a shock in the growth rate of public capital (transport infrastructures) over variables such as Gross Domestic Product (GDP), private capital and employment. We have measured how these variables react in the long run to a change in growth rate of investment in public infrastructures. In order

(6) Davidson and Mc Kinnon (1993, 684-686) and Hamilton (1994,257-259) provide a clear and brief explanation of vector autoregressive models.

to do it, we use the results of an econometric sectorial model for the Spanish economy which permits the identification of the sectors that are more and less influenced by investment in transport infrastructures. The model's results are those of Roca and Pereira (1998), who use VAR techniques to estimate the economic impact provoked by investment in transport infrastructures over the medium and long run. Using an aggregate VAR model and four sectorial ones they estimate, for the whole Spanish economy and its four sectors (agriculture, manufacturing, construction and services), which are the effects due to the opening of new infrastructures. In this paper we have applied the results obtained by those authors in order to estimate the supply effects due to the investment related to the 4th ring road. Those results refer to the impact of transport infrastructures in terms of GDP, employment and private investment elasticities aggregated over the 20 years after the investment takes place. If we focus on the most recent years of the sample used by Roca and Pereira (1970 to 1991), an increase of public investment in infrastructures of 67,500 MPtas1997 equals a change in public investment from 7.7% of GDP to 8.2%, in 1991 values. If we assume that the construction of the 4th ring road had taken place that year, leading to a 0.5% increase in the growth rate of public capital, the generated supply effects would have been the following:

* For the whole Spanish economy, GDP shows an aggregate elasticity with respect to transport investment of 0.74. Thus, total GDP increase over the next twenty years would equal 0.37% of its 1991 value. In 1997 terms, that value equals 241,500 Mpta.

* Employment shows an aggregate elasticity of 0.33, which implies that as a result of the new investment, total employment would increase by 0.165%. This value equals 20,700 new workplaces during one year. It has to be noted that this value refers to a cumulated increase, that is, the total amount of generated workplaces with an equivalent duration of one year.

* The cumulated elasticity for private capital is -0.01. This value has to be interpreted as proof that in the long run there is no crowding out effect between public and private investment. Private investment, thus, would not be significantly influenced by the construction of the 4th ring road.

Roca and Pereria's results on the sectorial models make it possible to estimate how those effects are shared among the four economic sectors. The services sector is the main beneficiary of the existence of the new road, as it accounts for 63% of the GDP effects and 46% of new employment. Given that the Spanish economy is substantially a services' economy, it should come as no surprise that tertiary activities are those that most benefit from an improvement in the transport infrastructure. The building sector also experiences a significantly positive impact, since it captures one fourth of the GDP increase and 41% of the new employment. This can be explained by the fact that improvements in transport infrastructures increase accessibility to new areas and increase investment in residential building. Although manufacturing activities account for one fourth of GDP and employment in the Spanish economy, they would only absorb 12% and 10% of the medium and long run effects on GDP and employment, respectively. Table 3.2 shows the results for each sector, both in terms of GDP and employment.

TABLE 3.2

Long term economic effects per sectors

In 1997 Million Peseta and number of jobs created

	Agriculture	Manufacturing	Construction	Services	TOTAL
Effects on GDP	800	28,700	60,000	152,000	**241,500**
New Employment	700	2,000	8,500	9,500	**20,700**

Source: Own calculations

4. CONCLUSIONS

The research reported here has consisted of an evaluation of a new transport infrastructure combining different analysis techniques. Firstly, a cost-benefit analysis has been applied. The result has been negative in terms of the present net value of the flow of social benefits. However, as the sensitivity analysis has shown, such result greatly depends on the value employed to convert time savings into monetary flows.

The quantification of the short and long run economic effects derived from the building and operation of the infrastructure shows, on the contrary, clearly positive effects. The main shocks take place in terms of GDP growth and employment, without crowding out effects on private investment. Services and construction are the most beneficed economic sectors.

It has to be pointed out that our evaluation exercise has not taken into account environmental effects. Including such elements in the analysis would be a more controversial task, both because of the need to define them and of converting them to monetary values.

5. REFERENCES

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