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Low Emission Areas vs. Urban Congestion Taxes

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In most European cities, urban transport is responsible for the majority of energy consumption, the emission of pollutants into the air, traffic congestion and noise, and in the last century we have faced an increase in urban mobility and a growing tendency to use private, as opposed to public transport, and an increase in the number of vehicles. The strictly private economic rationality of citizens explains this trend and the market will regulate it, albeit with largely avoidable social costs of congestion. Supply policies, that is, more and more extensive routes, are those that have been carried out almost exclusively traditionally, but these have been insufficient and, paradoxically, have even caused effects contrary to those intended, in the light of the state of empirical experiences, not to mention the waste of public resources that may be destined for more socially profitable alternative uses. As a consequence, where there is the greatest room for manoeuvre for urban transport policy is found in demand, that is, in the use of available means of urban transport. In recent decades, a good number of partial demand measures have been tried in European cities, such as subsidies for buses and subways, ecological fuels, car-sharing, smart cards, road-pricing, park-pricing, one day without a car, distribution of departure times at the end of the working day, etc. This paper focuses on Road Pricing, pointing out the experiences of the cities in which it has been put into practice but, mainly, examining its economic foundation and the design that should inspire collaboration in terms of achieving a more efficient and socially equitable urban mobility model.

Keywords: Taxes; Automobiles; Highways; Payments; Urban congestion; Polluters.

Introduction: Automobiles, Pollution and Urban Congestion

It is generally known that the growing urban traffic of people and goods generates congestion, accidents and other problems relating to environmental quality in cities and that, however, most trips are made in private cars. In contrast, public transport represents a very small proportion of urban traffic and is, consequently, bares little responsibility for this state of affairs[1].

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[1]No studies currently exist with a proven methodology on the possible effects of developments in electronic communications on traffic in the coming years. In any case, some of the national projections that have appeared that ensure a significant reduction in urban automobile traffic lack empirical support. The use of electronic communications that compete with the physical movement of people is today limited to a small number of professionals in the area of services; furthermore, however, it seems that the driving effect that electronic communications have on physical movements is greater than the substitute. In reality, the increase in leisure time that some people

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The main reason for the preference shown by city dwellers for private vehicles, to the detriment of public transport, is mainly related to the time cost of each system, without completely ignoring other factors such as privacy, comfort, autonomy and freedom of movement and even in some cases the manifestation of high social status, etc. although of seemingly less importance.

Indeed, in the absence of congestion and segregation of roads, the private vehicle is faster than public transport, both from the perspective of speed reached when traveling and in the waiting times necessary for use, with such advantages apparently far outweighing the higher private cost involved in car use in view of the choice made by a very significant proportion of citizens.

These advantages associated with the private vehicle over public transport have increased among citizens of southern European countries. In recent decades there has been a suburbanisation or emigration from the centre cities to the outskirts and nearby rural areas, emulating the Anglo-Saxon model and opting for the private car as the main form of transportation.

The period of time dedicated to journeys, generally from the home to other locations such as place of work, study, leisure, etc. has traditionally been a decisive argument in favour of the use of individual and private vehicles to the detriment of collective and public transport. For citizens, journeys are considered a waste of free time and, in the case of business owners, as an increase in production costs. However, some technological innovations, such as mobile phones, which can be used during journeys on public collective transport, but not in private vehicles, produce changes in social behaviours, lifestyles and ways of relating with other people, such as walking, cycling on roads and pedestrian areas... and can contribute to the existence of friendlier cities that do not inevitably require very high speeds in the movements of citizens.

On the other hand, erratic infrastructure construction policies, almost the only formula for improving citizen mobility, have actually worsened the situation of urban traffic on many occasions, since they have been revealed as offers that create their own demand. In other words, citizens who, in the absence of a certain infrastructure, had a preference for collective and public transport, now paradoxically opt for the private vehicle due to the transitory advantages provided by this infrastructure. In addition, the increasing construction of extensive roads, in addition to the high public and environmental cost they demand, has a regressive effect, as in the case of Spain, for example, they are funded with broad-based taxes such as Value Added Tax (VAT) or personal income tax, as well as the reduction in spending of a distributive nature on elements such as basic education, healthcare and other social policies.

But the comparison of the results obtained from the application of the cost-benefit analysis in social terms to both modes of urban transport yields different conclusions. To the strictly private costs generated by the private vehicle, mainly related to purchase, maintenance and general use, we must add the incremental private and social costs generated with respect to the alternative of collective transport.

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enjoy due to electronic communications is used for the development of various activities that require urban mobility.

Thus, the private car causes costs associated with the construction and maintenance of necessary infrastructures to increase. It also entails additional costs of congestion and other types of urban pollution; that is, private transport occupies more space within cities than public transport and, furthermore, complicates traffic for both private vehicles and public transport, causing loss of time (congestion), greater fuel consumption and, consequently, more urban pollution. For example, an average bus occupies approximately three times more effective space (five times more theoretical space) and uses three times more fuel than the private car, but carries forty times more passengers. Finally, traffic accidents are the leading cause of unnatural death in Spain, as well as handicaps and disabilities in the population. Urban accidents represent 17% of the total and, of these, 73% were suffered by people who were users of private vehicles (18% pedestrians and 9% users of collective and/or freight transport).

The conclusion for the purposes of municipal management is clear and immediate: there would be much less congestion on urban roads, less fuel consumption[2], less air pollution and deterioration of the health of citizens[3], fewer deaths and disabilities caused by traffic accidents etc.; in general, there would be fewer environmental quality problems (collective social welfare) if the use of public and collective transport, such as the bus, the surface tramway, the underground railway, etc., were increased [4]to the detriment of private vehicle use.

The origins of these approaches in economic science can be found in Ronald Coase, Nobel Prize in Economics, especially in his article "The Problem of Social Cost" [5]although also in other equally relevant ones such as "The Nature of the firm".[6]

Nevertheless, the pioneering work is "The Economics of Welfare" by Athur Pigou, published in 1920, in which he argues that the existence of negative externalities justifies government intervention by introducing a tax that internalises the social costs generated by the producer.

A marginal analysis of this situation would show that the private cost borne by the driver of a private vehicle using urban roads is less than the marginal social

[2]From a more strictly economic perspective, saving fuel acquires special relevance for the effects of social welfare in urban life, since it must be taken into account that 99% of this energy is imported, and 40% consumed in urban areas.

[3]Paradoxically, some of the least studied consequences of urban pollution are those that directly affect the health of city dwellers. A report prepared by the Barcelona Public Health Agency (ASPB) "Assessment of air quality in the city of Barcelona", reveals that in 2018 there were 350 premature deaths in the city attributable to urban air pollution.

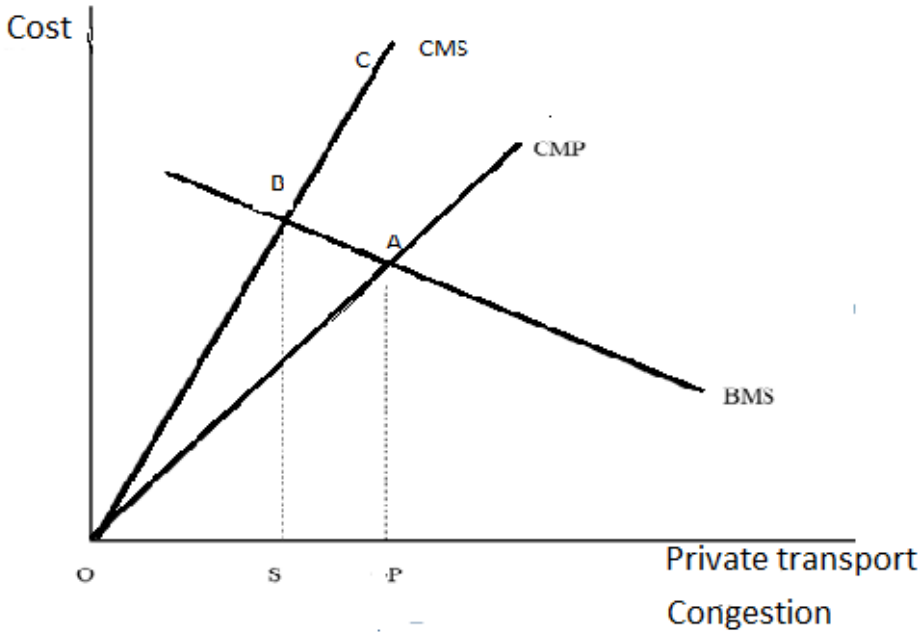
[4]In the London experience the results were: a 35% reduction in average vehicle-kilometre (veh - km) as a measure of traffic flow, determined by multiplying the number of vehicles circulating or remaining in a given area by the average duration of its permanence measured in kilometres, reduction of congestion, on average 30%, improvement of the speed of the urban bus service, reduction of the victims of accidents of traffic between 40-70 per year, reduction of polluting gas emissions in the city by 13% NOx and 16% PM10. See Santos (2008) and Santos & Caranzo (2022).

[5]Coase (1960).

[6]Coase (1937).

cost of using them. This is the main reason why many people prefer private transport to collective and public transport[7]

Graphic 1. *Excess Traffic and Loss of Social Welfare*



Source: Own creation.

An analysis of the private marginal costs (PMC), social marginal costs (SMC) and the demand for urban transport serve to illustrate the preference shown by many people for the private vehicle to the detriment of collective transport.

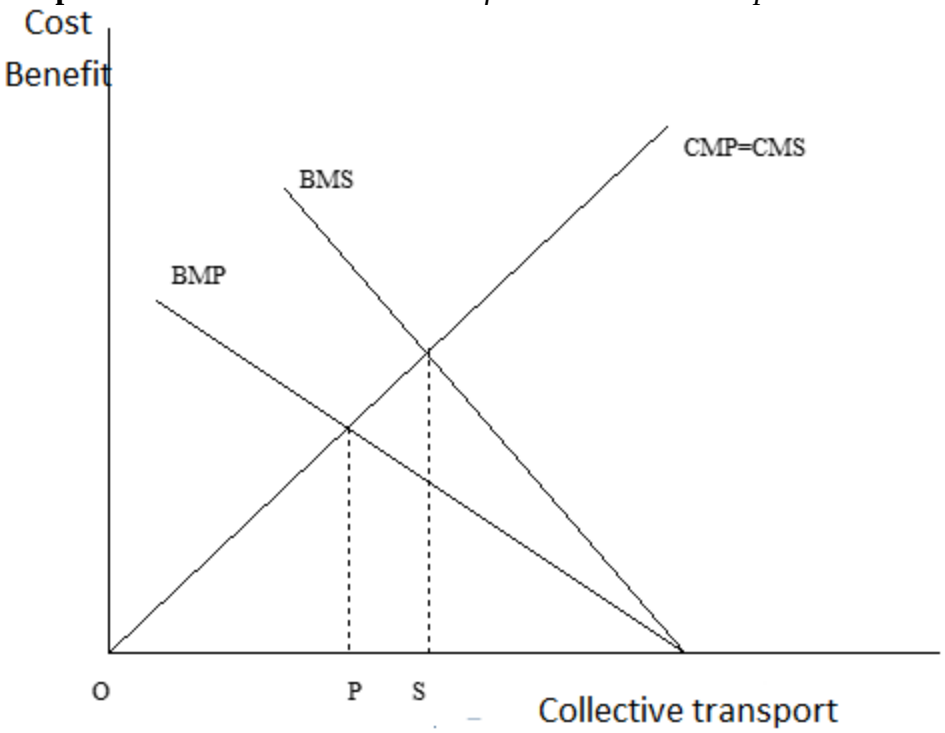
The effective level of urban traffic and, with it, of congestion would be lower private vehicle users considered all the costs generated by their choice (OS), instead of considering only the private costs (OP).

If area S-P is excess traffic, the level of traffic P is higher than the socially desirable level and would therefore generate a loss of social welfare delimited by the triangle ABC.

However, when choosing the mode of urban transport, it is necessary to consider all the income generated by collective transport.

[7]The fundamentals and a broad discussion on the negative externalities caused by private vehicles and positive ones coming from urban public transport can be seen in Castillo Lopez, J.M. (1999), particularly p 68-80 and 214-227)

Graphic 2. *Social and Private Income from Collective Transportation*



Source: Own creation.

The marginal social benefit (MSB) of collective transport is greater than the private marginal benefit (BMP) generated for the users of this mode, insofar as it also has benefits for private transport users in terms of less congestion, time displacement, number of accidents, atmospheric congestion, fuel imports, etc.

The most intransigent neoliberal positions, in the framework of the reaction, shows above all what the intervention of the State means in defence of public interests, it being argued that the congestion of urban roads constitutes the most powerful instrument for self-regulation of urban mobility.

It is evident that traffic congestion generally leads to a decrease in demand for urban mobility and, consequently, in private car use, which strongly influences decisions related to mode of transport. However, the existence of urban congestion is a clear manifestation of social inefficiency, which ultimately has a pernicious effect on the quality of life of city dwellers.

Urban transport policy must be able to face the challenge of reconciling the development of economic activities and, in general, the rights of citizens to mobility with respect for the quality of life of all urban centre inhabitants, in the knowledge that this model entails higher private costs than the prevailing conventional model, particularly in the short term.

One of the results of the conventional model of urban mobility is a continual decrease in private car traffic speed in large cities. In other words, the achievement of very *important* technological innovations applied to modern cars, such as the turbo, 16 valves, power steering, four-wheel drive, speeds of 280 km/h, etc., have converted the car not into a means of transportation, but an end in itself, an

indicator of the social status of its owners. Paradoxically, the *old clunkers* from the beginning of the 20th century reached higher speeds through city streets.

With the conventional model of urban transport, traffic congestion is inevitable in cities. The war against traffic jams using only urban measures (bypasses, widening or connecting streets, etc.) is lost before it has even begun. The wider the roads that are built, the more the use of private cars will be encouraged.

The urban transport system is a clear example of supply that creates its own demand. In other words, as the transport system becomes cheaper or better in real terms (faster, safer and more comfortable roads, increase in the real income of citizens, etc.), the number and length of journeys demanded by citizens will increase.

However, in addition, the particular case of large roads built on the outskirts of cities has an influence on the fluidity of urban traffic that is less positive than that attributed by official propaganda. In reality, with greater weighting than desired, these constructions are motivated more by the prospect of certain politicians appearing in the inauguration photo than by the real improvement they will bring about in urban traffic.

As in fluid dynamics, speed is limited by the narrowest section of the tubes through which it runs. In the case of vehicles, their real speed will be conditioned by the most conflictive intersection, by the most congested street, etc., through which they are obliged to pass.

That is, the destination of the traffic is the centre of cities and the current inadequacy of their streets for the simultaneous circulation of a large number of vehicles (narrowness, intersections, double parking, etc.) are the main causes of urban congestion.

But, on the other hand, it would be tremendously difficult to reform our current cities and articulate our urban mobility model around streets that serve both for pedestrians to walk or for children to play that have a pleasant appearance, etc, and, in addition, that facilitate fast road traffic.

In conclusion, at present the only socially viable way of having a significant effect on reducing congestion caused by vehicular traffic is to encourage (positively and/or negatively) citizens to use fewer private cars when travelling in the centre of cities. In other words, a sustainable transport policy in the urban environment requires initiatives aimed at changing social habits, transferring users from private vehicles to collective transport, by penalising the use of private vehicles and, in addition, supporting the means of more energetically and socially efficient collective transport.

‘Road Pricing’

Along with solutions based on direct regulations, above all, the prohibition of unauthorised private vehicle traffic in certain areas or the mandatory use of catalytic converters, silencers, etc., measures have also been suggested that encourage changes in certain social habits, in particular the staggered entry and exit times of company employees, shared cars, location of activities, etc. In the

same way, a good number of economic-financial instruments have been proposed, which discourage the use of the private automobile.

In 1992, the European Commissioner for the Environment promoted the beginning of an intense debate about the problems caused by urban vehicle traffic and, consequently, to seek solutions to them. *The Network of Car-Free Cities* is framed in this context

The first Car-Free Cities Conference was held in Amsterdam in 1994 and the second in Granada in 1995.

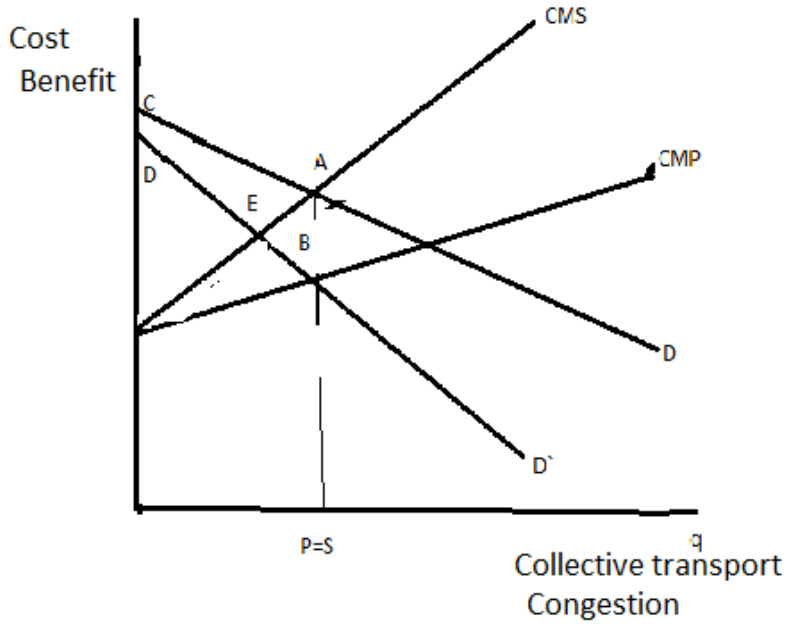
In these and other European cities, innumerable practical projects are being carried out aimed at promoting sustainable mobility in an ecological context favoured by a reduction in individual and private car use.

At present, many large cities are testing instruments and numerous other projects including cycle lanes, bus subsidies, ecological fuels, pedestrian zones, *car - sharing, smart cards, road-pricing, park-pricing, bus-taxi lane, a day without a car*, environmental suitability inspection, surcharge and/or rebates on fuels, catalytic converters and mufflers, incentives for the use of electric cars, distribution of departure times at the end of the working day, and information panels on the traffic situation, centralised control of traffic light regulations, and not only by periods of time, reservation of lanes and other incentives for the use of shared cars, alternatively managing car access to city centres depending on the even or odd nature of the license plate, including an absolute prohibition on circulation in certain areas, information panels on the traffic situation, laptop installations in vehicles that could indicate the route less congested to carry out a certain journey at each moment, etc..

Traffic restriction measures in certain areas, for example, through the lowering of emissions by reducing the number of vehicles that can access daily, or the prohibition of those that are more polluting, suffer in the short term from economic inefficiency because they fail to consider differences in evaluating the access needs of different groups of drivers, but also in the medium term as license plate restrictions are circumvented by purchasing other vehicles that, being even older, are more polluting. Low emission zones also lose efficiency in terms of spatial traffic congestion, although they gain in terms of reducing atmospheric pollution. On the other hand, they provide a dose of regression to the system because only the wealthiest people have the economic capacity to replace traditional vehicles with less polluting ones.

The alternatives in terms of the use of economic-financial instruments are based on the fact that although quality of service is a very significant variable in the modal distribution of transport, the monetary costs perceived by private vehicle users (fuel, tolls, parking fees, etc.) can also contribute to modifying the demand for the different types of urban transport available.

Graphic 3. *The Alternative of the Contraction of the Demand*



Source: Own creation

A demand restriction policy could achieve socially optimum vehicle circulation by eliminating excess traffic (P=S), as can occur with the use of Road Pricing, which is shown in Graphic no. 2. This option eliminates the loss of social welfare caused by Road Pricing (ABE area) but generates another loss of welfare measured by the area (AEDC area) caused by the different assessment that drivers have of access to the restricted area. Therefore, the pricing system is more efficient than that of access or demand restrictions.

The possibility of discouraging private vehicle use has been suggested, above all, through higher fuel prices, with which some drivers would probably change their means of transport. But the convenience of rationally managing scarce resources is evident, including of course, the precious time of citizens. But more specifically, the marginal social cost of the automobile in terms of air pollution and, above all, congestion, is variable throughout the day and it would be tremendously difficult, and it is indeed currently impossible, to carry out a parallel graduation of the price of fuel used at every moment.

There are simple fare systems such as payment for the mere ownership of a resident vehicle in a population modulated according to its characteristics, the single payment for registration, the purchase of cards or badges that permit driving and parking in a certain area, etc. which all have a collection effect but a negligible influence on congestion and air pollution, since these payments do not depend on the length of time the vehicle remains in the area or the distances travelled.

In Spain, the use of articulated standardised environmental charges, for example, in relation to what are generically referred to as use bonuses or annual single payments, such as our current Tax on Mechanical Traction Vehicles (based on the capacity and power of the vehicle), or the Tax on Certain Means of

Transport (former registration tax), is insufficient for drivers to internalise the full social cost generated, that is, where, when and how the vehicle was used.

Other urban toll systems, such as those established in London, Stockholm and Oslo, mandate fixed rates so that cars can access certain areas of the cities, and cameras are used to link vehicle registration plates with their corresponding owners, who are fined where they fail to pay the corresponding rate, do not discourage private vehicle use either.

These drawbacks can be avoided, at least in part, with an economic-financial instrument that is extraordinarily flexible, selective, in short, efficient and suggested some time ago, but only the recent developments of *ad hoc telematic systems* are making its application possible. It consists, in general, in the use of a tariff system that penalises the use of the automobile in proportion to the social damage it causes.

Together with type of car, driving mode, etc., the social damage caused by urban road traffic congestion is a case of possible congestion, that is, the external cost is practically zero when urban roads are quiet, but when they are congested the negative externalities are manifest.

With circulation in very clear streets we are in the presence of a pure public good. There are no externalities and, therefore, charging prices for driving on the streets would be inefficient. But once congestion occurs, if there are negative externalities for the vehicles that join traffic it would be socially efficient to charge drivers who circulate in that period of time, that is, during rush hours.

The price mechanism can encourage drivers of private vehicles to behave more ecologically, by rationalising use, taking into account the existing levels of congestion in each place and period, redistributing the demand for public space in the different areas, cities and over time, through due payment for the negative externalities they produce, that is, for the additional congestion they cause.

Road Pricing management requires the installation in private cars of transmitting devices, along with receivers strategically placed throughout the urban network. Receiving devices could show where and for how long each car drove. Periodic checking of these devices would allow motorists to be charged the exact price for the social cost incurred at each time the car was used.

The three types of technology tested for electronic tolls have been microwave and infrared in some cities of Andalusia and the United Kingdom, GSM (Global System for Mobile Communication) and GSP (Global Positioning System, tested in Switzerland).

There has also been the proposal, without knowing its empirical evidence, of a fixed emission calculator installed in the vehicle, that will also estimate emissions caused depending on model, driving mode and time.

Recent technological innovations substantially facilitate the relatively easy establishment of new urban toll systems, in particular, through satellite positioning coupled with the development of C-V2X1 communications.

C-V2X1 (Cellular-Vehicle-to-Everything) is a communications system capable of connecting vehicles to each other and institutions in their environment. This technology, accompanied by the development of the 5G network supported by satellite positioning, will allow direct communication in real time between

connected. In this way, vehicles and public institutions will have the ability to send and receive information instantly, including the identification of vehicles, their location and due and corresponding payments.

Although it is already technologically possible and economically efficient to establish *Road-Pricing* in the urban area, numerous issues, such as the system of exemptions, bonuses, treatment of vehicles belonging to citizens who do not live in a certain city and, even more so, in the case of foreigners, the presumed double taxation generated by inventories of other figures that tax use by automobiles of urban roads, etc., must be resolved before proceeding to the demand with the rigor that its indisputable legitimacy and social justification requires.

In some countries, such as Spain, there are taxes that are levied on mere ownership of the car or the act of its registration, which is why some people allege possible double taxation. No. Road Pricing does not record these taxable facts, but ranks the damage caused by the use of the car through its characteristics.

In order for Road Pricing to be efficient, the rate structure must consist of at least two sections:

One fixed for each car, which depends on:

a) Type of energy used.
b) Physical characteristics of vehicle (age, size, power, etc.)
c) Adequate maintenance and technological adaptations that reduce the different manifestations of pollution (catalysts, silencers, etc.).

Another variable that affects the effective use of the car, depending on:

a) Busy urban areas.
b) Hours of the day.
c) Distances travelled and parking time.

A system of this type allows citizens to rationalise the use of the private car by internalising the social costs generated by its use and, with it, a reduction in the global social cost caused by air pollution and congestion on urban roads.

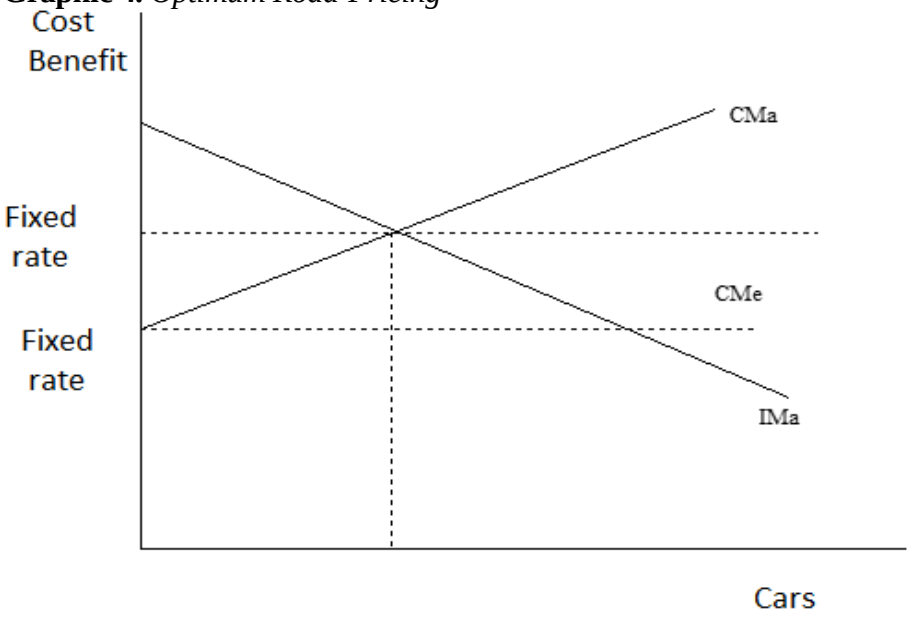
The double rate structure of Road-Pricing proposal will allow users of private cars in urban areas to be charged the total social cost caused by this type of traffic; that is, both the cost of infrastructure, maintenance and operation and the cost of congestion and pollution.

The fixed rate, variable depending on vehicle characteristics, will be calculated as an average of the total monetary cost indicated divided by the number of users (standardised units).

Given that infrastructure costs and, to a lesser extent, maintenance and operational costs do not depend on degree of use, it may be that a marginal cost pricing system, although contributing to efficiency in its use, is insufficient to fully cover them. For this reason, in this case, the fixed rate per type of vehicle calculated at average cost guarantees financial sufficiency.

The variable section of the rate must serve to compensate for the excess of the marginal cost over the average cost, that is, that which corresponds to the marginal social costs caused by congestion and pollution.

Graphic 4. *Optimum Road-Pricing*



Source: Own creation

As congestion and contamination of a certain capacity and/or infrastructure can cause very significant oscillations in both time and space, changes in the average level of the rate do not guarantee the achievement of the objectives pursued and, can even cause inefficiency and distortions in the yields obtained from the different modes of transport and/or types of private vehicles. Therefore, an efficient and effective tariff requires adequate temporal and spatial modulation.

There are some who uphold that the application of Road Pricing in urban areas can cause regressive distributional effects[8]. More often than not, the *polluter pays* principle becomes *whoever pays has the right to pollute.*

The result of Road Pricing is clearly regressive for drivers of private vehicles, but the effect on all road users is not predetermined, since it will favour users of collective public transport. Therefore, in order to obtain a correct evaluation of this public action, it is necessary to examine it case by case and type by type and, in addition, also analyse the distributive effect of the public expenditure that is financed, where appropriate, with the collection obtained by the establishment of this levy without forgetting, of course, the effects on former car users who will be transferred to collective public transport.

[8]The fairness of establishing traffic tolls in the urban environment has been investigated by many authors, including Richardson (1974); Izquierdo & Vassallo (2001); Villegas (2001); Ferrari (2005); Franklin (2007); Schweitzer & Taylor (2008); Zhicai, Qingyu, Zhongning & Hongfei (2008); Lauridsen (2011); Ortega Hortelano (2014); Muñoz Miguel & Anguita Rodríguez (2019); Santos & Caranzo (2022).

In fact, there will be a segregation of traffic by quality levels: a payment network, with less vehicle traffic and its consequences, among which the shorter time needed to move from one point to another in the delimited area particularly stands out. On the other hand, there is the a free secondary network with lower effective circulation speed and longer journey time to go from one point to another of this delimitation.

But the indisputable negative consequences on equity caused by the implementation of this type of economic-financial instrument should not serve as the only pretext to disqualify its probable implementation. This presumed detrimental effect should only alert us to the necessity of accompanying its implementation with complementary measures (greater public subsidies for collective transport, greater housing subsidies for people with low level incomes, subsidies for the installation of measures to surround homes located in certain areas, etc.). In summary, with the collection obtained through Road-Pricing, the competent Public Administration can obtain extraordinary financing with which to attempt to mitigate the pernicious effects the circulation of vehicles on urban roads causes to citizens, including those produced on the drivers themselves.

Complementary Measures to Road Pricing

In summary, the aforementioned institutional possibility as well as, by its very nature, the frequent mobility between municipalities of private vehicles, advise the creation of a new regional or local tax, subject to the appropriate agreements for the management thereof and, above all, the necessary compensation in order that municipalities do not see their sources of financing diminished.

The repeatedly manifested growth of social awareness of city dwellers as regards urban ecological problems and, consequently, the willingness to voluntarily accept individual sacrifices and some immediate inconveniences for the sake of the quality of collective life and a sustainable urban development model should not serve as a stimulus or justification to public managers for the adoption of unconnected or fragmented, and therefore ineffective, measures, which would in reality only serve to undermine the invaluable capital afforded to urban policy by existing social awareness and predisposition.

For example, the mandatory use of cleaner energies, catalytic converters, other installations and/or devices in automobiles, etc., may lead to substantial improvements in the state of air pollution, but would not mean any progress in other aspects of urban pollution such as noise, visual obstacles to the movements of citizens, accidents, in short, in the invasion of vital space.

Likewise, for example, the entry into operation of urban buses that are comfortable, modern, clean, fast, etc will have a very limited effect if measures are not simultaneously adopted on private transport that prevent it from hindering the development of this collective transport.

The delimitation of public pedestrian or residential areas without cars, in order for them to continue fulfilling their traditional functions, in particular, places of rest, meeting and market, however, must be complemented with the urban design

of access roads to those that are equally necessary, such as a system of dissuasive car parks, properly managed and located on the outskirts, with public transport shuttle lines, etc.

International Experiences

Tax Figures Established in the World

Although the theoretical background and first attempts of primary figures of urban tolls on the circulation of private vehicles are older, the first experience of the establishment of a measure similar to Road Pricing took place in Singapore in 1975.

It consisted of the payment of a congestion charge for those vehicles that wanted to access the city centre between 7:30 and 9:30 in the morning.

Similar figures have also subsequently been established:

In Hong Kong between 1983-1985. Electronically controlled road pricing, Cancelled.
In 1986 in Norway the "Toll ring" of Bergen. Manual system for circulation in a delimited area between 9 and 10 in the morning.
In 1989 in the Italian city of Rome.
In 1990 in the Swedish city of Oslo, entrance toll, and in 1992 in Trondhein, toll at peak hours.
In 1994 in Stuttgart.
In 1997 in Leon toll for driving in certain areas, variable at peak hours.
In 1997 in Norway in the city of Kristiansand.
In 1999 in Santiago de Chile.
In 2000 in New Jersey. Electronic system with variable rate in the hours of the day.
In 2001 in New York, Variable loads in bridges and tunnels.
In 2001 in Stavanger, a city in Norway.
In 2002 in the city of Durham, in the United Kingdom.
In 2003 in London. Daily payments for access to certain zones.
In 2006 in Stockholm, through a referendum.
In 2007 in La Velletta (Malta).
In 2008 in Milan (Italy). Payments for access to a certain zone.
In 2009 in Mexico City.
In 2013 in Gothenburg (Sweden).
In 2019 in New York.
In 2020 in San Francisco (USA).

Most of the evidence examined shows that the objectives achieved by urban congestion tolls and Road Pricing in particular have been and currently are the reduction of circulatory congestion and the environmental problems associated

therewith and, finally, the improvement of collective, mainly public, transport services and the frequency of their use by citizens.[9]

Thus, the available empirical evidence globally shows an initial resistance to the establishment of Road Pricing by some business groups and residents, but in the medium and long term this decreases substantially, given the obvious environmental improvements and reduction in congestion it entails. This resistance is more persistent over time in those groups that have their usual origins, destinations or transits in the area, without the possibility of altering them. On the other hand, its social acceptance increases substantially if the collection of public funds provided by road-pricing is finalist in nature and used to improve the public transport system, which must inevitably be in deficit from a financial point of view.

Public acceptance towards its implementation is not easy, but experience shows that, in the medium and long term, it is achieved thanks to the environmental and congestion improvements generated. In any case, for said acceptance it is essential that the income generated by the urban toll be dedicated expressly and with the appropriate public information to the improvement of the collective and public transport system.

In some of the experiences examined, cars are charged based on the time they spend within the delimited area and in others a fixed rate is even paid independently of that period of time, which favours and simplifies management but substantially reduces its positive effects on congestion and associated environmental problems.

This simple system can improve its efficiency if the rate for time spent is modulated according to the exact hours of the day and also by establishing different rates depending on the day of the week.

The Institutional Framework in Europe

The first reference on the need to implement urban toll systems, as a decisive management instrument to address the problem of congestion and poor environmental quality in large cities around the European Union (EU) is clearly stated through the White Paper of the Commission of the European Community: "European transport policy for 2010. The moment of truth 2001", p. 94.

Later, through the EC Green Book of 2007 "Towards a new culture of urban mobility", there was a development of the urban toll system through the study of available technologies for its application, methodologies for calculating rates that internalise the external costs caused by vehicles, levels and clauses for social acceptance, effectiveness of these instruments, etc. which materialised through a set of European projects financed by the European Community that sought to explore technical, financial, political and social aspects related to the execution and implementation of this type of system, some examples being: Europrice, Progress, Cupid and Curacao.

One such policy aimed at reducing the volume of emissions caused by vehicle traffic and currently implemented in more than 220 European cities in 14 countries

[9]Rotaris, Daniel, Marcucci & Massiani (2010); OCDE (2022).

is the delimitation of low emission zones (LEZs), which generally consist of prohibiting the movement in certain urban areas of vehicles that do not meet technical characteristics that guarantee that a maximum level of emissions is not reached as a whole[10].

In summary, the procedure of the proposal consists in the fact that in order to drive through a low emission zone, vehicles are obliged to display a "green" badge, otherwise drivers will be penalised.

To date, low emission zones have been established in 60 European cities in Spain, Germany, Belgium, France, Italy, the United Kingdom, Denmark, Finland, the Netherlands, Norway, Portugal, Sweden, Latvia, Hungary, Romania, Bulgaria and Ireland.

For the establishment of Road Pricing, it is essential to previously delimit the low emission zones, which would technologically justify them and also serve as a spatial framework for their application.

Experiences in Spain: Low Emission Zones and Urban Tolls for Private Vehicles

In Spain, low emission zones have been established in Barcelona and Madrid.

A) **Barcelona**

The Rondas de Barcelona low emission zone encompasses the municipalities of Barcelona (except for the Industrial Free Zone and the Vallvidrera, Tibidabo i les Planes neighbourhood), l'Hospitalet de Llobregat, Sant Adrià del Besòs i parts d'Esplugues de Llobregat and Cornellà de Llobregat.

As of January 1, 2020, the movement of vehicles that do not display a green badge provided by the General Direction of Traffic (DGT) is prohibited, from Monday to Friday and from 7 a.m. to 10 p.m.

However, the most polluting vehicles can request daily circulation authorisations and others that require longer periods can do the same, such as those for people with reduced mobility, public services (firefighters, police, refuse collection, etc.),

The Metropolitan Registry is a service of the Barcelona Metropolitan Area (AMB) that allows the registration of the most polluting vehicles to request daily circulation authorisations, as well as enjoying other exceptions and authorisations. Registered vehicles will be able to circulate in any low emission zone in the metropolis of Barcelona with a simple procedure

The Metropolitan Council of the Metropolitan Area of Barcelona definitively approved the modification of the Fiscal Ordinance regulating the Fee for the metropolitan management of Low Emission Zones and its entry into force on January 1, 2022, in accordance with the provisions of article 17.3 and 17.4 of Royal Legislative Decree 2/2004, of March 5, which approves the consolidated text of the Law Regulating Local Treasuries,

[10]Croci (2016).

A significant number of citizen and environmental organisations have presented a proposal for an urban toll for Barcelona this month. The suggestion is very specific: four euros to be able to circulate (with exceptions) and a period of two years to initiate it.

The project has been promoted by several business, citizen and environmental institutions of Barcelona, among others, by the Platform for Air Quality, Transport Promotion Públic , Ecologistes en Acció, Eixample Respira, the Bicicleta Club de Catalunya, the Xarxa per la Justícia Climate and the Prevention Association d'Accidents de Trànsit, and the Polytechnic University of Catalonia (UPC) has been entrusted to carry out the cost and benefit calculation models.

The Barcelona 2022 urban toll project for the city of the same name, in summary, is a proposal that contemplates a daily rate of 4 euros to drive through low emission areas from 7 a.m. to 10 p.m., Monday to Sunday, , with the exception of those vehicles that circulate with 3 or more occupants. It is not controlled through the installation of entry and exit barriers in the low emission zones but through cameras, and collection is destined towards improving public transport and healthcare.

This rate would apply to both residents and non-resident drivers in Barcelona.

According to the study by the Polytechnic University, the application of this toll would reduce traffic in Barcelona by 25.1. In addition, it would translate into 370 million euros of net income that should be used, according to the proposal, to "improve collective public transport and the public health system."

The results of a survey carried out by the Office of Social Studies and Public Opinion (GESOP) at the request of environmental entities, show that 51% of the citizens of the metropolitan area would be in favour of applying the urban toll.

In summary, this project is a hybrid system between direct regulation supported by the determination of low emission zones with prohibitions and entry control and taxes. In general, the regulations on circulation permits and prohibitions are effective because they are simple to apply, but once the established amount has been paid, it does not encourage less use of vehicles as taxes, that is, the payment based on the actual car use in a certain area constitutes a constant incentive, since the amount to be paid will be lower the less the vehicle circulates.

B) **Madrid**

Madrid ZBE is a Low Emissions Zone that seeks the progressive restriction of access and circulation to all vehicles with an A environmental classification, according to their polluting potential (which cannot obtain an environmental badge), throughout the municipal area.

The sustainable mobility ordinance that regulates Madrid ZBE was approved on September 22, 2021 with a transitional regime, by which it is applied progressively from January 1, 2022 to December 31, 2024. The Agents of the authority monitor and penalise improper access to the interior of the M30 motorway and circulation through Madrid ZBE from January 1, 2022. The photo-network devices located on roads inside the M-30 will denounce improper access

to Madrid ZBE from January 1. May 2022. Madrid City Council plans to install a camera system on the access roads to the part of the city located inside the M-30.

Unauthorised access to the Madrid Low Emission Zone (ZBE) constitutes a traffic offense that is penalised with a fine of between 90 and 200 euros.

The New Institutional Framework for the Establishment of Road Pricing in Spain

The publication of The Law on climate change and energy transition and the draft of the Sustainable Mobility Law represent a new institutional framework for the establishment of low emission zones and taxes on urban traffic congestion.

Law on Climate Change and Energy Transition and the Draft of the Sustainable Mobility Law

Law 7/2021, of May 20, on climate change and energy transition, in its article 14, Promotion of Mobility without Emissions, establishes, among other points, that municipalities with more than 50,000 inhabitants and island territories will before 2023 implement sustainable urban mobility plans through the introduction of mitigation measures, that is, preventive actions that reduce the emissions caused by vehicles, which include low emission zones.

The Law understands low emission zone as the area delimited by a public administration, within its territory and within the scope of its powers, the establishment of restrictions on access, circulation and parking of vehicles in order to reduce greenhouse gas emissions, and thereby improve air quality.

This Programme is financed in part by the European Union, Next Generation EU EDN within the framework of the Recovery, Transformation and Resilience Plan, approved by the European Commission on June 16, 2021 and by the Spanish Government on July 13, 2021.

In Spain there are 149 municipalities with over 50,000 inhabitants, and as of October 31, 2022, only a few of which have their ZBE regulated and active, and according to the Spanish Federation of Municipalities (FEM) forecasts, fewer than 20 population centres will have their ZBE active by January 1, 2023.

In fact, together with the cited cases of Madrid and Barcelona, only Valencia, Bilbao, Seville and Valladolid have their ZBE active.

For the first time, the draft of the Sustainable Mobility Law enables municipalities of towns with more than 50,000 inhabitants to “introduce a fee for the circulation of private vehicles in low emission zones.

Although the norm will be state-wide, within its powers, it allows municipalities to delimit tax elements, such as bonuses, tax rates, exemptions, etc.

On the other hand, with the avowed purpose of reducing the emissions produced by motor vehicles, Additional Provision 7 creates the rate for Special Use of Low Emission Zones, and Final Provision 2 modifies Royal Legislative Decree 2/2004, of March 5, which approves the Consolidated Text of the Local Treasury Law.

The Question of the Tax on Mechanically Drawn Vehicles and the Tax on Certain Means of Transportation (ivtm)

The taxes configured by the state law of compulsory levy must necessarily be required. However, local entities have the capacity to modulate the volume of tax resources by regulating specific aspects of local taxes, both voluntary levy and mandatory levy, under the terms and conditions established by state law. Thus, they may set the type of tax or establish some tax benefits, within the limits of the law.

The Tax on Certain Means of Transportation

The Special Tax on Certain Means of Transportation is a state tax of an indirect nature, regulated in Title II of Law 38/1992, of December 28, on Special Taxes (hereinafter LIE).

Since its creation, the IEDMT (Tax on Certain Media of Transport) has undergone a series of modifications. But the regulatory regulations of the IEDMT have been undergoing transformations in such a way that this Tax currently no longer only records the economic capacity of the holders, but also attends to environmental considerations, depending on potential CO_2 emissions, based on vehicle characteristics.

Among the modifications are the so-called *Renove* and *Prever* plans that have constituted tax incentives for the purchase of new vehicles and the scrapping of old ones, by reducing the fee for this tax, for which they have had a favourable impact on the environment.

The Tax on Mechanically Drawn Vehicles

The Tax on the Value of Mechanical Traction Vehicles (IVTM) is a local tax, which with its current name was created by Law 39/1988, of December 28, Regulating Local Treasuries, and began to be required from 1990, substituting the old Municipal Tax of Circulation of Vehicles. It is a direct tax that taxes the ownership of vehicles of this nature, suitable for driving on public roads, whatever their class and category.

Regarding the allegations of possible incompatibilities or double taxation with the Mechanical Traction Vehicle Tax, obviously it does not occur while the taxable event of this tax is constituted by the mere ownership of mechanical traction vehicles suitable for circulation on public roads, whatever their class and category.

The Commission of Experts appointed by Agreement of the Spanish government of July 5, 2013 for the reform of the tax system carried out a comprehensive analysis of said system. Regarding the IEDMT and the IVTM, it advised reform according to the following criteria: explore the future introduction of a tax on the use of vehicles that can replace most of the taxes, and that takes into account the distance travelled and discriminates by type of vehicle, place and time of use.

In other words, replacement of the IEDMT and IVTM taxes by a tax with two sections, a fixed variety, depending on the characteristics of the type of vehicle (power, size, fuel, etc.) and another variable depending on the pollution caused, measured by the time of circulation and parking of the vehicle through the Low Emission Zones (ZBE), hours of the day and day of the week, that is, with the general characteristics of Road Pricing mentioned above.

Conclusions

The problem of quality of life due to the urban traffic system is multifaceted (social). Therefore, the policy on the mobility of citizens in this area, if it is to be effective, must combine: urban design measures that put the health of citizens first; the adoption and installation of the advances that new technologies can bring to urban traffic management; actions aimed at improving knowledge and the consequent social awareness of the consequences of the deterioration of the quality of urban life; positive incentives (tax relief, forgiveness of municipal pecuniary obligations) and negative incentives (fines, taxes, etc.) in order to take advantage of the economic rationality of the inhabitants of the cities, and, finally, in those cases in which the effects could be extraordinarily harmful, irreversible or whose solution would require very expensive investments, mandatory regulations (catalysts, cleaner energies, etc.), zones and hours prohibited to traffic, etc., of course, with an adequate control and sanctioning apparatus thereon.

It is foreseeable that Road Pricing, such as that set out above, will presumably contribute to a reduction in traffic, an increase in the speed of circulation, with the consequent reductions in spatial occupation, accidents and both acoustic and atmospheric pollution; in short, it will contribute a higher degree of social efficiency to urban mobility.

In addition, this tax will also provide the urban mobility system with a dose of equity since collection, if it is configured as final, can be used to finance collective transport that has still been financially deficient, if it is intended that it be ecological, fast, safe, with convenient periodicity, etc.

These forecasts have been confirmed, at least, in those places where they have been put into practice, including Singapore[11], Stockholm[12], Gothenburg[13], London[14] and Milan, and even the forecasts produced by the mathematical models elaborated on the hypothesis of their establishment for the Madrid case[15].

In short, they involve urban design measures that facilitate the transition from favourable attitudes to positive actions In this process, the coordination of the greater efficiency presented by economic-financial instruments and the advantages in the control function offered by the city would play a prominent role in terms of direct regulation, especially in extreme situations.

[11]Christainsen (2006).
[12]Eliasson, Hhultkrantz, Nerhagen & Rosqvist (2006).
[13]Börjesson & Kristoffersson (2015).
[14]Buckingham, Doherty, Hawkett & Vitouladiti (2010) and Santos (2008).
[15]Muñoz Miguel (2012).

The only intention behind partial measures is to justify and exhibit an extremely recent self-assigned environmentalist vocation of some Administrations, but which, in reality, will only serve to undermine and waste the capital that the current and positive social attitude in this regard supposes.

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