Urban Transport Policies and the Environment: Evidence from Italy

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Summary

The paper reviews urban transport policies in Italian cities and their impact on the concentration of NO2 and PM10. Using parametric and non-parametric techniques, it finds no significant effect of the policy actions currently implemented. Further, it finds evidence of a weak positive impact of plans adoption. These results are interpreted as evidence of positive externalities among actions. Finally, by also discussing case studies, the paper points out the absence of economic instruments and argues that significant welfare gains would derive from their adoption.

Keywords: Urban Transport Policies, Traffic Externalities, Pollution Abatement

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1. Introduction

In recent years, sustainable development has become a building block of economic policy at local, national and international level. The urban environment is currently high on policy makers' agendas both because of its importance in determining the quality of life in cities (Blomquist et al., 1988) and because of the central role played by urban governments in shaping environmental policies (Nijkamp and Pepping, 1998). In this context, the sustainability of transport activities is one of the main objectives pursued by the European Commission to improve environmental quality in the European Union.

In the past decade, freight transport volumes and passengers have grown by 34% and 30% respectively. However, during the same period, greenhouse gas emissions have grown by 24%, whilst particulate matter has diminished by 30-40% (EEA, 2006). Despite this evidence of a relative *de-coupling* between transport growth and environmental quality, urban environment is still a source of concern for policy makers. This concern is driven by the fact that in the past decade, both NO_2 and PM_{10} have shown an increasing trend in concentration levels and, more disappointingly, annual average observations show that the concentrations of those substances are well above the European limits. In particular, in 2003, NO_2 and PM_{10} had an average concentration in the European cities of 57 $\mu g/m^3$ and 42 $\mu g/m^3$ respectively, while the limit will be set in 2010 at 40 $\mu g/m^3$ (EEA, 2006).

In order to deal with the risks deriving from the high level of pollution in the cities, the European Commission has funded several projects aimed at studying and managing the transport/environment link (EC, 2001a; 2001b). One of the main goals of these projects is to identify best practices and appropriate policies to enhance sustainable transportation. However, different policies vary enormously in their effectiveness in achieving a reduction of pollution, and the time spans of the effects differ as well. In this regard, the Transportation Research Board (1997) has considered several actions to reduce global greenhouse gas emissions, stressing that:

- aggressive demand management and land use planning strategies will result in a 6% reduction by 2020, 15% by 2040;
- a 1.5% annual increase in average new vehicle fuel efficiency will generate a 15–20% reduction by 2020, 35% by 2040;
- a 20% reduction by 2020 and 40% by 2040 will derive from higher fuel prices on the assumption of a 3% increase per year;
- the introduction of new low-emission vehicles (5% of the fleet by 2020, 35% by 2040) will not induce any significant change by 2020, but a 30% reduction by 2040.

The concern over sustainable transport is greater in the case of Italy, where the high density of population and economic activity makes transport market failures and the need for public interventions even more important. As recently reported by APAT (2006), between 1993 and 2005, the quality of the environment in Italian cities dramatically deteriorated in terms of PM_{10} and NO_2 concentrations. Because of transport intensity, both pollutant matters constantly exceed the limit for almost three quarters of Italian cities with more than 150,000 inhabitants. From an economic point of view, the costs associated with transport externalities amounted, in 1999, to 48,948 million euros (table 1), almost 5% of the total GDP. More than one third of this amount was due to greenhouse gas emissions and atmospheric pollution.

In recent years, a number of interventions have been undertaken by local governments. However, all these policy actions have been of the "command-and-control" type, whose economic efficiency is highly questionable (Fisher, 2000; Percoco, 2001).

This paper reviews urban transport policies in Italian cities and points out their failures in terms of pollution control. It argues that the lack of economic instruments has resulted in poor performance by current public policies. It stresses that substantial improvement is required in parking policies and road pricing schemes, as well as in the use of incentives for public transport.

The paper is organized as follows. The second section briefly introduces the main policy instruments and plans used in Italian cities to manage traffic. The effectiveness of these interventions is addressed in section 3, while concluding remarks are set out in section 4.

[Table 1]

2. Policies for sustainable transport in the cities of Italy

The economic literature has convincingly demonstrated that efficient transport pricing results in the internalization of external costs. In accordance with these findings, urban governments have introduced various economic instruments for traffic control. Among them, the most widely used are fuel taxes (Harrington and McConnell, 2003; Parry et al., 2006), car taxes (Fullerton and West, 2002) and, in some cases, road pricing (Rouwendal and Verhoef, 2006),[1]

[1] In recent years, however, tradable permits have begun to be considered in the case of transport as well, besides that of greenhouse gas emissions (Raux, 2004; Verhoef et al., 1997).

In Italy, fuel and car property taxes are set at central level,[2] so that they cannot be properly treated as urban transport policy instruments because of their lack of spatial variability (Rietveld, 2001).[3] Given this legal constraint/, urban governments have long addressed transport issues by means of infrastructure and public transport planning. However, in the past two decades, transport policy in Italian cities has consisted mainly in imposing standards and land use regulation measures, such as the definition of limited access or pedestrian areas, and in some sporadic cases, the construction of bicycle lanes (especially in Northern cities). Since the 1990s, and because of the increasing concern over environmental quality, urban governments have continued to rely on parking policies and traffic-free Saturdays or Sundays.

As regards parking, parking charges are very common in almost all cities, both because of their effectiveness (Feitelson and Rotem, 2004; Rietveld, 2006) and because of their positive effect on municipal budgets.[4] On the other hand, traffic-free weekends, although very common, even in small cities, have recently been much criticized by environmentalists because of their supposed ineffectiveness. Although a comprehensive study on their effects is not yet available, Galeotti (2005) has recently proposed (as a rule-of-thumb estimate) a 10% reduction in the annual average concentration of pollutant emissions for 54 days of halted traffic, which indicates that traffic stoppages have only a modest effect on environmental quality.

Besides specific parking plans, urban transport policy actions in Italian cities are largely considered in two types of urban plan:

- Piano Urbano del Traffico (henceforth PUT);

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[2] Regional governments can modify the tax on car ownership only within a very narrow range.
[3] The economic literature has not yet reached consensus on the overall impact of environmental federalism. For a good survey of the literature on this point see Millimet (2003).

- Piano Urbano della Mobilità (henceforth PUM).

The former type, PUT, is a classic urban transportation plan and is mainly devoted to managing city transport demand and supply issues, such as public transit, parking policies, and road safety measures. According to Italian law (Law Decree/D.Lgs. 285/92), only cities with more than 30,000 inhabitants must define and adopt a PUT, whilst for smaller ones, the approval of a PUT is optional. In this regard, Isfort (2006) has estimated that almost 25.5% of cities with more than 100,000 inhabitants, or provincial capitals, do not yet have a PUT. As table 2 shows, the situation is comparatively worse in the South, whilst the North has a broader coverage of plans.[5]

[Tables 2, 3]

The second type of plan, the PUM, is specifically designed to define sustainable transportation policies (Law/Legge 340/2000). A PUM may envisage a variety of actions, such as:

a) pollution and noise abatement measures;
b) road safety standards;
c) car-use reduction actions;
d) measures to encourage car pooling and car sharing;
e) actions to reduce congestion;
f) appointment of city mobility managers.

In 2006, only 14 cities had adopted a PUM. They were: Ancona, Brindisi, Como, Cremona, Foggia, Grosseto, Lecce, Livorno, Macerata, Milano, Padova, Pescara, Prato,

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[4] Note that in some cities, such as Bologna, Milan, and Rome, charged parking lots almost decupled between 2001 and 2003 (AIPARK, 2003).

Torino. In principle, the PUM may contain measures that can be considered as novelties for Italy, given that they are clearly economic instruments. However, as table 3 shows, the implementation of transport pricing measures is very limited, with the sole exception of Milan, where road pricing is at the very early stage of planning. In Padua, the newly-introduced transport pricing measure is simply the definition of new fares for public transport.

In addition to PUM and PUT, several cities have adopted city and firm mobility management plans in in the past decade. These plans aim at rationalizing transport flows from home to workplace (or the university, in the case of students) and at providing incentives for sustainable transport modes (such as car sharing or pooling, biking, etc.). Table 4 reports the presence of mobility managers in a sample of cities surveyed by the APAT (the Italian environmental and territorial protection agency).

[Table 4]

In this case, too, the difference between Northern and Southern cities is evident.

Thus far, I have briefly presented the instruments and plans used in Italian cities to manage transport. In the next section I address the issue of their effectiveness in terms of pollution control.

3. Some evidence on the effectiveness of transport policies

3.1 Cross section estimates

[5] See Appendix 1 for the geographical distribution of cities and regions.

The assessment of policy measures is particularly difficult in the case of urban transport, mainly because of the heterogeneity of interventions. From an economic viewpoint, Proost and van Dender (2001) address the issue in terms of the economic efficiency of different actions. Using numerical methods, they conclude that transport pricing policies yield substantial welfare gains.[6] In the same vein, Marshall and Banister (2000) have found that poor policy performance is often associated with poor planning in terms of a lack of clear objectives and strategy.

The analysis reported in this paper took a different approach and estimated the following model:

(1) log(pollution) = constant + $\alpha *$Urban Policies&Plans + $\beta *$socio-economic controls + e

where pollution is the concentration of a given pollutant in the atmosphere (in our case, both PM_{10} and NO_2 concentrations). Vectors α, β are vectors of parameters to be estimated. Urban policies and plans indicate specific instruments or plans adopted in a given city, whilst socio-economic controls denote a set of socio-economic variables respectively. Finally, *e* is an error term.

The dataset assembled contained information on 80 provincial capitals for 2005[7]. The following variables were considered for urban plans: PUT, which was a dummy variable taking value 1 if the city had adopted a PUT; PUM, which indicated whether or not the city had adopted a PUM. As for policy variables, I used PEDES and LAA, indicating the percentage of pedestrian and limited access areas respectively on total

[6] For a cost-effectiveness analysis of different economic instruments, see Fullerton and Gan (2005).

city area, while BROUTES was the length of bicycle lanes. Finally, PT indicated public transportation use in terms of passenger/km*vehicles, while MOBILITY indicated whether or not a city mobility manager had been appointed.

As for control variables, I used value added per employee in the manufacturing sector (VA), the number of volunteers per 1,000 inhabitants (VOLUNTEERS) to indicate "civicness" and concern for public goods (Putnam, 1993), and the density of total population (DENSITY). When data were available, I used 2000-2005 averages of explanatory variables in order to take possible time lag effects into account.[8]

I expected a negative coefficient in regression (1) for all policies and plans variables. As far as the control variables were concerned, I expected that VA and DENSITY would be positively correlated with the concentration of pollution, given that they wre meant to measure the intensity in the use of the urban territory. I also conceived VOLUNTEERS as a variable negatively correlated with the level of PM_{10} and NO_2, because I assumed that the more people are concerned with social welfare, the more they are likely to behave in an environmentally friendly way.

The reason for my inclusion of instruments and plans in the same regression was that, following Marshall and Banister (2000), I hypothesised that the adoption of a given plan stimulates synergies among measures. In other words, I presumed that the adoption of a PUT and/or a PUM had some sort of value added in terms of PM_{10} and NO_2 concentration.

Table 5 reports the summary statistics for selected variables. Table 6 gives the results of OLS estimates on the determinants of NO_2 concentration. As expected, pollution concentration is positively correlated with the (log) *per capita* value added, as well as

[7] Unfortunately, because of the lack of data panel estimation results were highly unsatisfying, even in the case of a small unbalanced panel.

with the size of the city as measured by the density of total population. Interestingly, the higher the social capital (as proxied by the number of volunteers), the lower the amount of pollution. In regard to urban transport policies, I found that the use of the public transit system, as well as the presence of a PUT in the city, had a positive impact on the level of NO_2 concentration (i.e. the corresponding coefficients are negative). However, to be noted is that the estimated coefficient for PUT is never significant.

As regards other policies – that is the presence of bicycle lanes, limited traffic and pedestrian areas – I found no significant effect on the concentration of NO_2, which suggests that such policies are substantially ineffective. Finally, the last column in table 6 checks for a possible beneficial effect of the presence of PUM. Neither in this case, despite the negative coefficient, is there a statistically significant effect.

[Tables 5, 6, 7]

Table 7 reports the results for the determinants of PM_{10} concentration, both as part of the empirical evidence and as sensitivity checks for the estimates obtained for NO_2 concentration. In general, all the results are confirmed, although the goodness of fit, as measured by the R-squared, of all models is always lower.

At this point, it should be stated that results presented in tables 6 and 7 may be affected by a selection bias, because the adoption of a PUT or of a PUM may have been driven by a high concentration of pollutant matter in the city concerned.[9] In order to avoid

[8] Appendix 2 contains descriptions of the variables.

[9] In principle, the same bias may affect other policy variables as well. In order to avoid this problem, these are discarded in the following analysis. This choice is also prompted by the fact that they were found to have little explanatory power in terms of statistical significance.

problems of endogeneity, I used an instrumental variables approach. To this end, I defined the propensity score as:

(2) $$P(\mathbf{Y}_i) = \Pr\left[PUM / PUT = 1 \middle| \mathbf{Y}_i\right]$$

where $\mathbf{Y}_i$ is the matrix of variables influencing the propensity of a city to adopt a PUM or a PUT. The fitted value of equation (2), $\hat{P}$, was then used to estimate the following equation

(3) $$\log(\text{pollution}) = \text{constant} + \alpha * \hat{P} + \beta * \text{socio-economic controls} + e$$

In other words, I used a two step procedure in which, in the first step, (2) was estimated by means of a logit model, and in the second step, $\hat{P}$ was used to estimate (3).

As explanatory variables for the adoption of a PUT or a PUM, I used MOBILITY, the number of firms with ISO 14001 environmental certification (ISO) and an index that synthetically measured the diffusion of clean technology (ECOMGMT). In addition, I used two geographical dummy variables (CENTER and SOUTH). The results for the first step regressions are set out in the first two columns of table 8. All the variables have the expected sign and are statistically significant, with the sole exception of the dummies.

Turning to the second stage regression, both PUT and PUM adoptions have a negative sign and, interestingly, the coefficient for the PUT is also significant.

According to my econometric analysis, the instruments adopted by Italian municipalities have no effect in terms of pollution control, whilst the adoption of transport plans seems to produce minor effects at most. This puzzling finding may be interpreted in the sense that "the sum of instruments" has no significant effect on NO_2 and PM_{10} concentration unless policies are coordinated by a plan. This shortcoming may be also due to the assumption of the linear form imposed by standard regression techniques. For this reason, in the next sub-section I report the use of a semi-parametric estimator that estimated the impact of policies independently of the functional form of the environment/policies relationship.

[Table 8]

3.2 Matching estimates

As said, the results reported in the previous section may have been affected by two methodological problems. The first concerns the fact that the use of simple regression techniques entails the imposition of a linear relation between pollution concentration and its determinants. The second methodological issue is that some plans may contain specific measures that are not coded in the variables that I have selected. In this sub-section I address the former issue, while in the following sub-section I discuss the latter.

In order to relax the assumption of linearity as well as all other assumptions of parametric functional forms, I used a semi-parametric technique: that is, I used the matching estimator. In particular, I maintained the assumption of endogeneity of PUM and PUT adoption, or conditional independence as defined in the literature on the treatment effect (Cameron and Trivedi, 2005).

As a first step I regressed PUT and PUM on a set of control variables like the ones reported in Table 8 (i.e. all explanatory variables for PUT/PUM adoption as well as the determinants of PM_{10}/NO_2 concentration). The estimation method was the standard logit. I next computed the propensity score as defined in (2) for every city in my sample. This fitted probability measures the likelihood of a city receiving the treatment as defined by the adoption of a PUT or a PUM. As a final step, I estimated the effect of PUM/PUT adoption on pollution concentration by comparing the values of NO_2 and PM_{10} for cities having adopted a plan or otherwise, but giving more weight to comparison of cities with similar propensity scores. Table 9 reports the estimated coefficients for three alternative weighting methods:

a) the stratification method, which divides the range of variation of the propensity score into intervals such that within each interval treated and control cities have similar propensity scores;
b) the nearest neighbour with random draw method, in which the same stratification procedure as the one mentioned above is applied, but observations in blocks where controls are absent are dropped;
c) the nearest neighbour with equal weights method, which allows one to match treated units only with controls with nearest neighbours with a propensity score falling in a predefined range.

The results confirm the positive impact of both types of plans, and they report higher significance values with respect to linear regression analysis. This may be due to the fact that the relationship between pollution and its determinants is not likely to be represented by simple linear regression. Note, in fact, that we do not need to make any functional assumption on the impact of plan adoption on pollution concentration.

[Table 9]

3.3 Discussion

The evidence reported in the previous sub-sections highlights the ineffectiveness of the instruments adopted to date by Italian municipalities, and it seems to show a weak, though promising, incidence of plans.

Although reasonable, my econometric results may suffer from the fact that transport plans, such as PUM and PUT, in different cities may contain different urban transport policy measures. However, to corroborate my argument on the ineffectiveness of such policies due to the absence of market-based instruments, I considered the cases of four large cities: Milan, Naples, Rome, and Turin.

The cities in question account for 1/170 of the total national surface, but they comprise 10% of the Italian population (i.e. 5,750,738 inhabitants in 2001). Table 10 reports environmental quality and policy variables for the cities under scrutiny. All of them present above-limits concentrations of NO_2, while PM_{10} does not seem to be problematic in the case of Naples. Interestingly, Milan has a much more widespread public transport system, although demand for it is relatively low, given that the utilisation factor (as defined by the ratio between passengers and km*vehicles) is 4.9, whilst it is 6.25 in Naples and 6.95 in Rome. As regards other policy variables, to be noted is that Milan, although its situation is worrying in terms of pollutants concentration, has very low indicators of pedestrian areas, limited access areas, and bicycle lanes length. Turin has the worst concentration of NO_2 and PM_{10}, although its policy indicators are relatively high, especially the bicycle lanes length.

[Tables 10,11,12]

All the cities have adopted a PUT and a parking plan, and they have appointed a city mobility manager (Table 11). Moreover, with the sole exception of Turin, price discounts on public transport for workers and students are available. Road pricing is under scrutiny only in Milan and Rome,[10] while car sharing or bicycle-use incentives are being considered only in Milan and Turin.

As mentioned above, parking policies are very common in Italian cities. Table 12 shows that between 2001 and 2003, considerable increases in the number of parking lots occurred in the cities considered, with the sole exception of Turin, where the number of charged lots was already very high.

To sum up, the previous tables seem to confirm the thesis that:

a) the cities surveyed have adopted a broad set of (ineffective, given the concentration of pollutant matters) regulatory instruments, while transport pricing as an efficient solution to externalities is widely lacking;
b) parking charges, although widespread, are considerably below the European average whilst there is no reason to believe that external costs are comparatively lower in Italian cities;
c) public transport has good growth potential, mainly driven by pricing policies, in addition to accessibility improvement.

The items of evidence provided by the discussion of the above cases and by the econometric analysis confirm that the effectiveness of urban transport policies can be

[10] On the application of road pricing schemes in Italy see Fiorio and Percoco (2007) and Ieromonachou et al. (2006).

improved by efficient pricing; and that, as they are at present, they perform poorly in terms of pollution abatement. In particular, the elasticities of the policy variables in tables 6 and 7 are not statistically different from zero, whilst the adoption of a given plan generates a reduction in the (log) concentration of NO_2 and PM_{10} amounting to 1.10-1.16 μg/m^3 (table 9). Note that, for the metropolitan area of London, Prud'homme and Bocarejo (2005) have estimated a reduction of 34-35% in total pollution after a congestion charge was introduced in the city center. As a benchmark result, if the same measure had been applied in Italian cities, and if we consider the average NO_2 and PM_{10} concentrations in table 10, reductions of 20.13 μg/m^3 and 15.07 μg/m^3 for NO_2 and PM_{10} respectively would have occurred.

But why have Italian municipalities not implemented more effective policies Perhaps, the main reason is the substantial lack of public support for economic policy measures, as in the case of a second-best tax.

In 1999, the Eurobarometer conducted a survey to determine the opinions of Europeans on, amongst other things, the perceived effectiveness of various policies to solve environmental problems due to traffic in towns (EC, 1999). Figure 1 shows that the public acceptability of an hypothetical toll in Italy is very weak (12%) and well below the EU average, which is in its turn very low.

[Figure 1]

4. Concluding remarks

The quality of urban environment, and in particular the concentration of air pollution, is becoming a source of major concern for European policy makers. This paper has considered the case of Italian cities, where levels of PM_{10} and NO_2 are increasingly problematic.

In regard to the determinants of pollutants concentration, the paper has attempted to evaluate, at least in terms of short run impacts, the effect of existing policy measures. Both parametric and non-parametric analyses, as well as a discussion of case studies, have shown that the measures adopted are largely ineffective in reducing pollution. However, the paper has also found a weak, though promising, effect of plans adoption, which suggests that effective value added derives from coordinated policy actions.

My analysis has pointed out the ineffectiveness of non-economic instruments of local transport policy, and it claims that, in light of the experiences of other countries (such as the UK), substantial gains can be yielded by introducing measures which provide economic incentives to use public transport, as well as by efficient parking and road pricing.

In recent years, a number of large cities, such as Bologna, Milan and Rome, have started to discuss or experiment with road pricing schemes. Local authorities are currently debating the desirability of such a policy, and they face the very well known problem of a lack of public support. The common and surprising feature shared by these cities is the fact that decisions or opinions on road pricing are not shaped by careful reviews of other cities' experiences or by the estimated outcomes of integrated models, but only by political convenience. As a consequence, although some cities have adopted second-best instruments on the transport policy agenda, their implementation is highly problematic, and is not driven by any welfare analysis.

A final word on social capital. My econometric analysis found that the higher the "civicness", the lower the concentration of pollutants in the atmosphere. From a policy perspective, this result should be interpreted as evidence for the crucial role of actions intended to increase public concern over environmental quality, and to reduce, through better information and education, free riding.

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Appendix 1
Geographical repartition of regions and cities

Northern regions: Piemonte, Valle d'Aosta, Liguria, Lombardia, Veneto, Trentino-Alto Adige, Fiuli Venezia-Giulia, Emilia Romagna.

Central regions: Toscana, Umbria, Marche, Lazio.

Southern regions, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria Sicilia, Sardegna.

Northern cities: Alessandria, Aosta. Asti, Belluno, Bergamo, Biella, Bologna, Bolzano, Brescia, Como, Cremona, Cuneo, Ferrara, Forlì, Genova, Gorizia, La Spezia, Lecco, Lodi, Mantova, Milano, Modena, Novara, Padova, Parma, Pavia, Piacenza, Pordenone, Ravenna, Reggio Emilia, Rimini, Rovigo, Savona, Sondrio, Torino, Trento, Treviso, Trieste, Udine, Varese, Venezia, Verbania, Vercelli, Verona, Vicenza.

Central cities: Ancona, Arezzo, Firenze, Frosinone, Grosseto, Latina, Livorno, Lucca, Perugia, Pesaro, Pisa, Pistoia, Prato, Roma, Siena, Terni, Viterbo.

Southern cities: Avellino, Bari, Benevento, Brindisi, Cagliari, Caltanissetta, Caserta, Catania, Lecce, Napoli, Nuoro, Palermo, Pescara, Potenza, Reggio Calabria, Salerno, Siracusa, Vibo Valentia.

Appendix 2

Description of variables

Variable	Description
BROUTES	Cycle lanes (m/100 ab.; average 2000-2005; Source: Istituto di Ricerca Ambiente Italia and Legambiente, Ecosistema Urbano)
DENSITY	Population density (Source: Istat, *Conti territoriali*, average 2000-2003)
ECOMGMT	Synthetic index measuring environmental concern and measures in the city. For a thorough description, see Legambiente (2006).
ISO	ISO Certification (N. of ISO 140001/1000 firms; Source: INFOCAMERE; data at provincial level)
LAA	Limited access areas (sq.m/ab.; average 2000-2005; Source: Istituto di Ricerca Ambiente Italia and Legambiente, Ecosistema Urbano)
MOBILITY	Presence of mobility managers (dummy variable. Mobility=1 if presence of firm or area mobility managers detected; Source: Bertuccio and Cafarelli, 2005)
NO_2	Average concentration (µg/mc); Source: Istituto di Ricerche Ambiente Italia and Legambiente, Ecosistema Urbano
PEDES	Pedestrian area (sqm/ab.; average 2000-2005; Source: Istituto di Ricerca Ambiente Italia and Legambiente, Ecosistema Urbano)
PM_{10}	Average concentration (µg/mc; Source: Istituto di Ricerche Ambiente Italia and Legambiente, Ecosistema Urbano)
PT	Public Transit Supply (km*vehicles/passengers; average over 2000-2005; Source: Istituto di Ricerche Ambiente Italia and Legambiente, Ecosistema Urbano)
PUT	Dummy variable indicating the presence of a PUT (PUT_Dum=1 it a PUT was approved before 2005)
VA	Value Added *per employee* (Source: il Sole 24 ore and Prometeia)
VOLUNTEERS	Number of volunteers per 1,000 inhabitants (data at provincial level for 2003; Source: Istat, *Censimento del nonprofit*)

Note: All variables are measured in 2005 where not indicated differently.

Table 1: External costs of urban mobility in Italy (million euros, 1999)

	Greenhouse gases	Atmospheric pollution	Noise	Accidents	Congestion	**Total**
Passenger transport	2,231	9,196	4,841	10,109	8,136	**34,514**
Car	*2,129*	*8,170*	*4,640*	*10,005*	*7,807*	***32,752***
Public transport	*102*	*1,027*	*201*	*104*	*329*	***1,763***
Freight transport	555	7,967	1,704	742	3,465	**14,434**
Total	**2,786**	**17,164**	**6,545**	**10,852**	**11,601**	**48,948**

Source: From the website of "Amici della Terra" (www.amicidellaterra.org).

Table 2: PUT adoption in Italian regions (% of municipalities adopting a PUT; 2005)

Region	PUT adoption (%)
Abruzzo	25
Basilicata	100
Calabria	60
Campania	85.7
Emilia Romagna	62.5
Friuli Venezia Giulia	100
Lazio	50
Liguria	100
Lombardia	75
Marche	100
Molise	0
Piemonte	100
Puglia	83.8
Sardegna	0
Sicilia	44.4
Toscana	80
Trentino	100
Umbria	100
Valle d'Aosta	100
Veneto	85.7
Italy	25.5

Source: Isfort (2006)

Table 3: Transport policy measures in a sample of PUMs

	Public transport and railways investment	Biking and car pooling/sharing incentives	Parking	Freight transport planning	Transport pricing policies
Ancona	x		x		
Cremona	x		x		
Milano	x	x	x	x	x
Padova	x		x	x	x
Prato	x	x	x	x	
Pistoia	x	x	x		
Torino	x		x		

Note: Information have been taken from official documents, as posted on municipalities' website.

Table 4: Diffusion of mobility managers

City	**Number of firm mobility managers**	**% of firms with mobility manager**
Bari	2	3.7
Bologna	37	88
Brescia	10	66.6
Firenze	27	47.3
Foggia	6	6
Genova	25	75.7
Milano	78	52
Modena	9	64.2
Napoli	9	9
Padova	13	52
Palermo	23	41.8
Parma	23	100
Roma	187	100
Torino	41	58.5
Trieste	9	60
Verona	19	63.3

Note: * indicates data at provincial level. City mobility managers have been appointed in all cities reported in the table. They are not considered in the second column.
Source: Bertuccio and Cafarelli (2006)

Table 5: Summary statistics for selected variables

	Mean	Median	Maximum	Minimum	Std. Dev.
NO_2	41.943	41.400	69.000	7.500	10.774
PM_{10}	37.426	36.000	59.000	15.900	9.563
PT	3.273	2.357	7.427	0	6.390
PEDES	0	0	4.660	0.000	0
LAA	4.578	3.270	45.610	0.000	6.868
BROUTES	7.502	4.560	32.010	0.000	7.725
ISO	1.593	1.540	5.090	0	0
ECOMGMT	63.959	63.000	100.000	0.000	23.841
GAS	532.195	542.670	1.144.280	20.070	245.566
VA	23,412	24,558	34,270	13,625	4,529
VOLUNTEERS	18.174	15.370	168.870	2.470	19.780

Table 6: Determinants of NO_2 concentration (Dependent variable: log(NO_2); OLS estimates)

	Models				
	1	2	3	4	5
VA	0.744	0.605	0.548	0.465	0.783
	(3.470)***	(2.664)***	(2.368)**	(2.556)***	(3.576)***
DENSITY	0.090	0.087	0.072	0.085	0.097
	(1.720)*	(1.920)*	(1.233)	(1.138)	(1.647)*
VOLUNTEERS	-0.153	-0.159	-0.188	-0.160	-0.148
	(-2.349)**	(2.121)**	(-2.664)***	(-2.408)***	(-2.186)**
PT	-0.108	-0.152	-0.170	-0.169	-0.114
	(-1.667)*	(-4.669)***	(-2.541)***	(-4.525)***	(1.738)*
PUT		-0.445	-0.597	-0.501	-0.556
		(-0.696)	(-1.137)	(-0.756)	(-0.610)
LAA			0.040		
			(0.278)		
PEDES			-0.021		
			(0.716)		
BROUTES			-0.014		
			(0.918)		
PUM				-0.231	-0.110
				(-1.032)	(1.146)
MOBILITY					-0.028
					(-0.358)
R^2	0.57	0.59	0.62	0.58	0.61
N. Obs.	80	80	80	80	80

Note: All variables are in logs, with the exception of PUT, PUM and MOBILITY. t-statistics are in parentheses. Levels of significance: ***: $p<0.01$; **: $p<0.05$; *: $p<0.1$. A constant is always included, though not reported.

Table 7: Determinants of PM_{10} concentration (Dependent variable: $\log(PM_{10})$; OLS estimates)

	Models				
	1	2	3	4	5
VA	0.617	0.612	0.657	0.627	0.607
	(3.398)***	(3.360)***	(1.816)*	(2.116)**	(3.599)***
DENSITY	0.018	0.021	0.019	0.022	0.019
	(0.403)	(0.467)	(0.314)	(0.489)	(0.376)
VOLUNTEERS	-0.151	-0.145	-0.228	-0.147	-0.207
	(-2.637)***	(-2.499)***	(-2.347)***	(-2.792)***	(-2.162)**
PT	-0.119	-0.115	-0.114	-0.105	-0.147
	(-2.348)**	(-2.034)*	(-2.053)*	(-2.005)*	(-2.167)**
PUT		-0.254	0.201	-0.251	-0.253
		(-0.716)	(-0.814)	(-0.689)	(-0.704)
LAA			0.017		
			(0.590)		
PEDES			0.019		
			(0.444)		
BROUTES			0.014		
			(0.333)		
PUM				0.111	-0.110
				(1.500)	(-1.490)
MOBILITY					0.018
					(0.314)
R^2	0.36	0.44	0.44	0.46	0.47
N. Obs.	80	80	80	80	80

Note: All variables are in logs, with the exception of PUT, PUM and MOBILITY. t-statistics are in parentheses. Levels of significance: ***: $p<0.01$; **: $p<0.05$; *: $p<0.1$. A constant is always included, though not reported.

Table 8: Model estimates with propensity scores

	Models			
	1 (Dep. Var.: PUT)	2 (Dep. Var.: PUM)	3 (Dep. Var.: NO_2)	4 (Dep. Var.: PM_{10})
VA	-2.389	-0.776	0.603	0.648
	(-0.632)	(-0.188)	(2.519)***	(2.907)***
DENSITY	0.571	0.396	0.059	0.046
	(0.935)	(1.749)*	(0.975)	(0.861)
VOLUNTEERS	0.116	0.131	-0.201	-0.182
	(1.803)*	(2.179)**	(-2.781)***	(-2.795)***
PT	-0.649	-0.080	-0.181	-0.167
	(-1.706)*	(2.132)**	(-2.752)***	(-2.098)**
Cond_PUT			-0.625	-0.129
			(-2.218)**	(-1.724)*
Cond_PUM			-0.302	-0.493
			(0.855)	(-1.555)
MOBILITY	2.073	2.223		
	(1.920)*	(1.816)*		
ISO	0.988	0.575		
	(1.769)*	(1.913)**		
ECOMGMT	0.023	0.028		
	(2.131)**	(1.765)*		
CENTER	-0.923	0.884		
	(-1.260)	(1.125)		
SOUTH	-0.640	0.536		
	(-0.968)	(0.593)		
R^2	0.23	0.29	0.55	0.43
N. Obs.	80	80	80	80

Note: All variables are in logs, with the exception of Cond_PUT, Cond_PUM, CENTER, SOUTH. Models 1 and 2 are logit models, while models 3 and 4 are 2SLS estimates. z- (models 1 and 2) or t- (models 3 and 4) statistics are in parentheses. Levels of significance: ***: p<0.01; **: p<0.05; *: p<0.1. R^2 for models 1 and 2 is a McFadden-R^2. A constant is always included in models 3 and 4, though not reported.

Table 9: Matching estimates

Propensity score matching method	PUT		PUM	
	NO_2	PM_{10}	NO_2	PM_{10}
Nearest neighbour matching method (random draw version)	-0.112 (-1.745)*	-0.102 (-1.201)	-0.118 (-2.231)**	-0.102 (-1.956)**
Nearest neighbour matching method (equal weights version)	-0.154 (-1.541)	-0.117 (-1.669)*	-0.109 (-1.856)*	-0.116 (1.545)
Stratification method	-0.122 (-1.855)*	-0.135 (-1.102)	-0.102 (-2.245)**	-0.107 (-1.688)*

Table 10: Description of cities

	NO_2	PM_{10}	PT	Pedes	ZTL	BRoutes
Milan	54.90	52.50	4.90	0.09	0.15	1.83
Naples	41.00	28.10	6.29	0.31	3.49	0.00
Rome	63.90	39.90	6.95	0.14	2.44	1.55
Turin	69.00	56.80	3.00	0.34	1.23	3.61

Table 11: Transport policies and plans in the cities

	Milan	Naples	Rome	Turin
PUT	x	x	x	x
PUM	x			
Parking plan	x	x	x	x
City mobility manager	x	x	x	x
Public transport cost incentives	x	x	x	
Road pricing planning or experimentation	x		x	
Bike and car sharing incentives	x			x

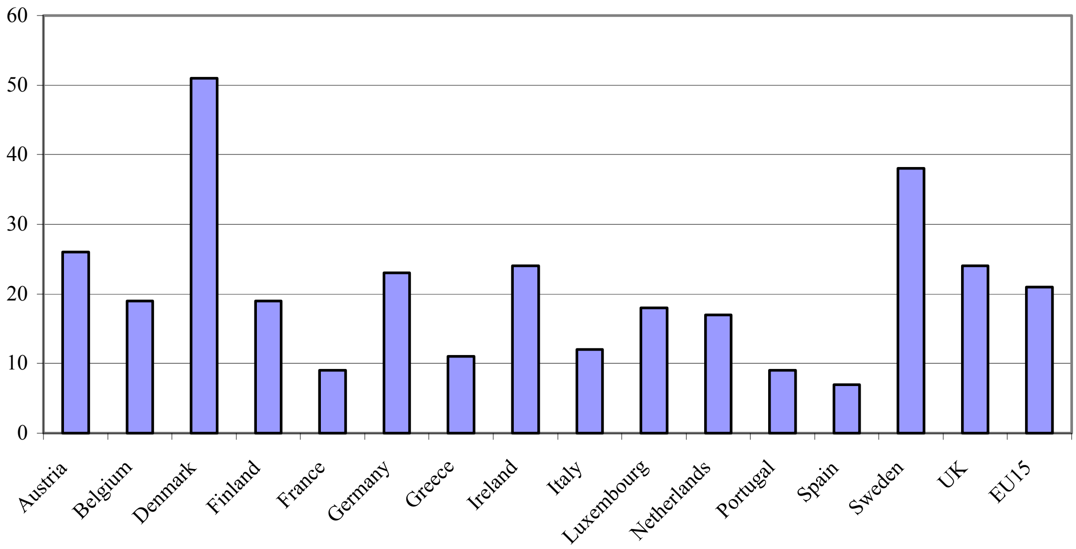
Source: ISTAT, Isfort (2005), and our own elaboration.

Table 12: Parking policies

	Charged parking lots			Price index (EU average=100)
	2001	2003	% var.	
Milan	3,030	31,225	931%	50
Naples	n.a.	n.a.	n.a.	112
Rome	4,540	18,900	316%	40
Turin	60,327	61,573	2%	86

Source: AIPARK (2003) and our own calculations from websites.

Figure 1: Percentage of respondents identifying tolls for city centers as effective means to solve environmental problems linked to traffic in towns (1999; in %)



Source: Eurobarometer 51.1

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