An economic, environmental and transport evaluation of the Ecopass scheme in Milan: three years later

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Abstract

The paper provides an evaluation of the Ecopass scheme for the years 2008, 2009 and 2010. The term Ecopass conveys the stated political objective of the scheme: a PASS to improve the quality of the urban environment (ECO). The scheme has actually improved the air quality in Milan, although the recommended PM_{10} threshold is still exceeded for a larger number of days than that recommended by EU directives. This paper estimates the costs and benefits of the scheme three years after its implementation using the same methodology applied in Rotaris et al. (2010) for the year 2008. It results that the benefits still exceed the costs by an increasing amount, but at an annual decreasing rate of improvement. The Ecopass scheme has proved beneficial, but it seems to have exhausted its potential: little further gains in environmental quality could be obtained via a fiscal incentive to improve the abatement technology of the vehicles. The new administration, elected in June 2011, is faced with the task of deciding whether to dismiss, maintain or change the Ecopass scheme. The prevailing idea coming from the Ecopass Commission and from the advocacy groups is to extend both the area of application and the number of classes subject to the charge. A move from a pollution charge to a congestion charge, or at least a combination of a pollution and a congestion charge is envisaged.

1 Introduction

The aim of this paper is to provide an economic, environmental and transport evaluation of the Ecopass scheme implemented since January 2008 in Milan. The term conveys the stated political objective of the scheme: a PASS to improve the quality of the urban environment (ECO). Rotaris et al. (2010), based on 2008 evidence, concluded that the scheme had been effective in curbing not only pollution emissions but also congestion and that these results had been achieved with low implementation costs and without major political opposition. The cost–benefits analysis resulted in an overall net benefit for the society.
Building on this previous estimate, this paper aims at:

1. updating the estimates of the costs and benefits caused by this scheme comprising the impacts which took place during the years 2009 and 2010;
2. analyzing the existing evidence on traffic, environment, and social and economic activities taking place in the Ecopass area;
3. illustrating the political debate that has taken place within the local authorities and the public opinion, especially with regards to how to further improve the Ecopass policy.

The estimates reported in Rotaris et al. (2010) can be considered short term effects of the policy. Taking into account two more years allows us to consider the effects on travellers' behavior, mode choice, routing and vehicle ownership, allowing for a medium term evaluation.
With regards to the social impact, the effect of the policy is still controversial. It has not been clarified yet whether the policy actually produced an improvement and of which amount. The existence a three-years dataset can shed some light on the concentration of some leading air quality indicators such as PM_{10}, although there is also initial evidence on the effects on finer particles at street level (Ruprecht and Invernizzi, 2009). In parallel, a slight reduction of injury-causing accidents also occurred with large social gains.

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Locational effect in urban activities represents a further impact to be discussed both concerning commercial and residential activities.
Furthermore, the Ecopass scheme generated an interesting political debate. Some political parties supported it, some other contrasted the policy. Mayor Mrs. Letizia Moratti, who introduced the scheme, failed re-election. In a referendum 79.12% of the voters (49 % of the eligible voters casted their vote) voted in favor of extending the Ecopass. The new Mayor, Mr. Giuliano Pisapia, is faced with the decision of whether to enlarge both the charging the area and the number of vehicles subject to the fee. If the latter proposal is implemented, the Ecopass would turn from a pollution charge to a congestion charge. Some political groups as well as the Ecopass Committee (an expert group created by the local authorities in order to provide recommendations about the future of the system) are in favor of such a change.
The remaining of this paper is organized as follow. Section 2 illustrates the Ecopass scheme. Section 3 discusses the available evidence on the impact of the scheme on the environment, on traffic and on social and economic activities. Section 4 presents our estimates of the monetary costs and benefits of the scheme in the year 2008[2], 2009 and 2010. Section 5 illustrates the political debate and Section 6 concludes. For convenience, the details on the calculations performed are presented in the Appendices.

2 The Ecopass scheme

Milan is one of the largest Italian metropolitan areas. It comprises 3.7 million inhabitants (1.9 million within the city boundaries) and is the main centre of the polycentric Lombardy region of about 9.5 million inhabitants. Although the area is served by an important transport public network, Milan is one of the cities with the highest car concentration in the world: 0.6 cars per inhabitant (0.74 including all vehicles).
The high reliance on car use for travel in Milan together with adverse geoclimatic conditions of the Padania region result in very high pollution levels. Since the national legislation require Mayors to drastically intervene to curb pollution (even with a temporary ban of private vehicles' traffic) in order to improve the quality of the urban environment, the Milan city administration, with the Major Mrs. Letizia Moratti, decided to introduce, starting January 2008, a package of transport policies including Ecopass.
The Ecopass requires that the vehicles entering the 8 km²-wide area between 7:30 and 19:30 pay a charge. The charging area is relatively small compared to London (22 km² before 2005, and 40 km² after 2005) and Stockholm (30 km²), but is comparable to Singapore (7 km²). The choice of the location and of the dimension of the charging area has been based on the historic urban layout, rather than on theoretical transport planning considerations.
A crucial decision was made to set the charge according to the five Euro emission standard classes (Table 1). In contrast with theoretical prescriptions, no differentiation is made according to access time to the charging area, within the charging window (7:30-19:30). This is because the charge is mainly conceived and communicated as a pollution charge and not as a congestion charge.
The Ecopass scheme is, however, characterized by a relatively high level of charge differentiation based on emission standards. The maximum charge in Milan is €10, it applies only to a limited number of vehicles and is comparable to the £8 (about €11 using PPP conversion rates) charge used in London.
In contrast with the goals pursued in London (congestion charging), Trondheim (infrastructure financing), or Stockholm (congestion, accessibility, environment, public transport infrastructures financing), the objective stated by the Milan local authorities is to reduce air pollution. Congestion is mentioned only as a secondary-goal. This choice is motivated by the high air pollution levels in Milan, much higher than, for instance, in London or in Stockholm. Focusing on air pollution abatement not only signals the interest of the local authorities for environmental issues, but represents also a strategy to overcome the tax payers' reluctance to the introduction of yet another charge.

[2] For the year 2008 a revision of the estimates made by Rotaris et al. (2010) is presented.

Table 1 - Toll classes based on Euro emission standards

Toll classes	*Definition*
Class I	Liquid propane gas – methane – electric - hybrid.
Class II	Gasoline Euro III, IV or more recent
	Diesel Euro IV without Anti-Particulate Filter (up to 30/06/08)
	Cars and freight vehicles diesel Euro IV o more recent with anti particulate filter
Class III	Gasoline Euro I and II
Class IV	Gasoline Euro 0
	Diesel cars Euro I, II and III
	Diesel freight vehicles Euro III
	Diesel buses Euro IV and V
Class V	Diesel cars Euro 0
	Goods vehicles Euro 0, I and II
	Diesel buses Euro 0, I, II and III

Table 2 - Ecopass fees for cars

Toll classes	Daily charge	Discounted multiple entries (max 100 entries per year)		Yearly pass for residents
		50% rebate (first 50 entries)	40% rebate (successive 50 entries)	
Class I			Free	
Class II			Free	
Class III	€ 2	€ 50	€ 60	€ 50
Class IV	€ 5	€ 125	€ 150	€ 125
Class V	€ 10	€ 250	€ 300	€ 250

Charge differentiation is also obtained through discounts available for frequent users, also with the aim of increasing political acceptability. There is a 50% rebate for the first 50 entries per year and a 40% rebate for the subsequent 50 entries. There are no rebates for accesses exceeding 100-per-year. Discounts are also available for residents in the tolled area. A number of categories are exempted. These include motorcycles and scooters, public transport, vehicles for handicapped people, Army and Police (State and local) vehicles, vehicles used for public services, ambulances and, from 10 a.m. to 16 p.m., vehicles transporting exclusively perishable and refrigerated food products, provided a permit is purchased from the municipality.

Since in Milan the objective is mainly to curb pollution rather than congestion, it was decided to implement the Ecopass scheme via an automatic-number-plate-recognition (ANPR) technology, previously tested in London, and Stockholm, whereas Singapore implemented a more advanced electronic road pricing (ERP) technology allowing better differentiation according to the prevailing congestion level. The decision was also influenced by the fact that the area to be charged was already monitored via cameras for the enforcement of the Limited Traffic Zone.

The Ecopass scheme is part of a wider transport policy package including short-term policies such as traffic calming measures, new bus lanes, increased bus frequency, increase in parking restriction and fees, and medium-term policies such as park-and-ride facilities and underground network extensions.

3 The impact on the environment, on traffic and on social and economic activities

The impact on the environment

The impact on the environment is positive.
Considering the particulate matter with a diameter larger than 10 nanometers or less (PM_{10}), during the year 2010 the number of days whose average daily value exceeded the 50 $\mu g/m^3$ threshold has been equal to 86, much lower than the 2002 when it was equal to 166 (Figure 1) or of the 2007 value, the year before the introduction of Ecopass, when it was equal to 132. However, it should be noticed that the European Directive 2008/50/CE recommends a value lower than 35, hence, Milan has still a long way to go to be considered a city with a satisfactory air quality.

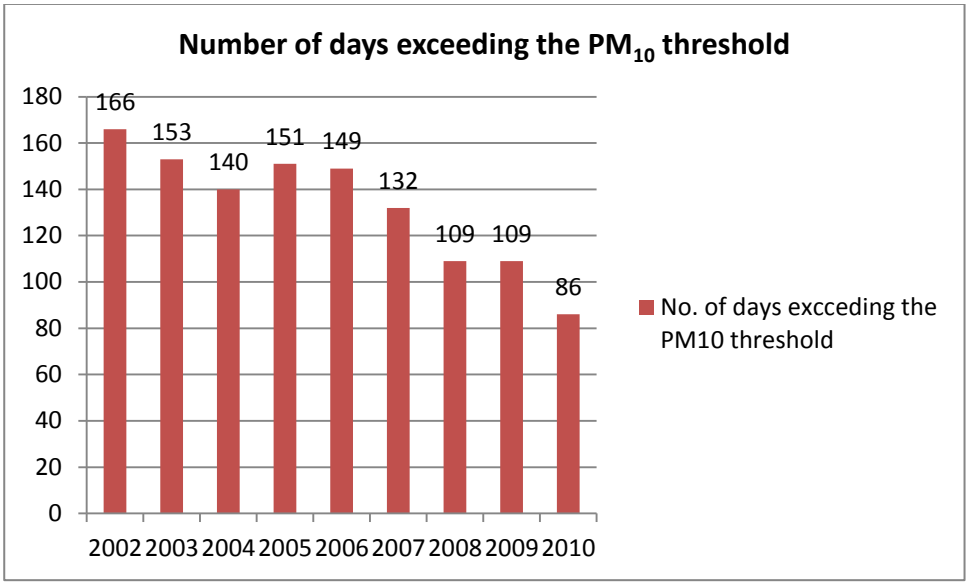

Figure 1 - No. of days exceeding the PM_{10} 50 $\mu g/m^3$ threshold. Source: Ecopass Commission (2010)

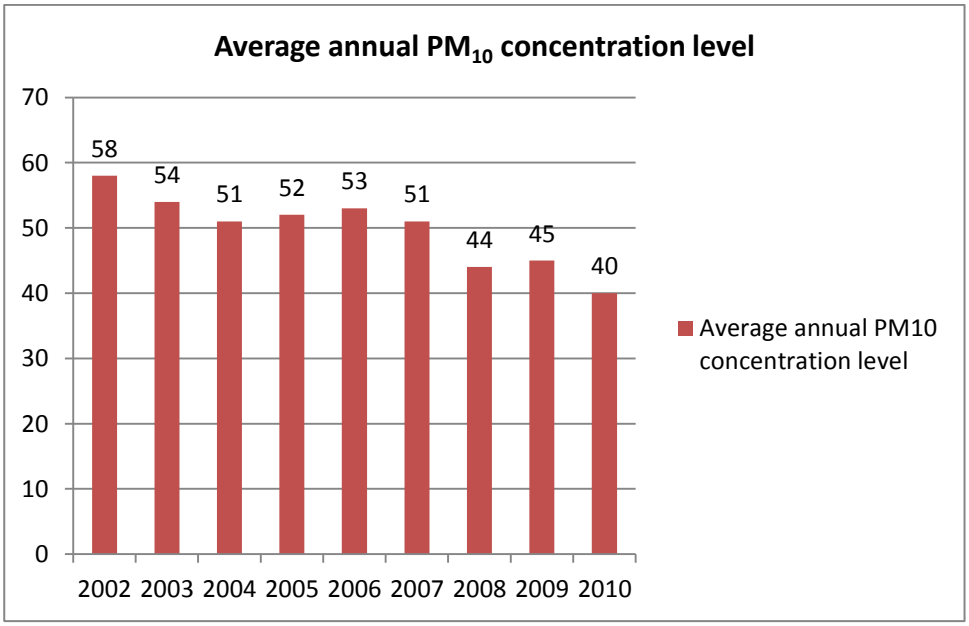

Figure 2 - Average annual PM_{10} concentration level. Source: Ecopass Commission (2010)

The average yearly PM_{10} concentration level in 2010 has been equal to 39,7 $\mu g/m^3$, slightly lower than 40 $\mu g/m^3$ goal set by the EU directive starting from January 1st, 2005 (Figure 2).

Considering the particulate matter with a diameter larger than 2.5 nanometers or less ($PM_{2.5}$), the 2010 value was equal to 25,1 μg/m^3, slightly higher than the 25 μg/m^3 goal set by the EU directive starting from January 1st, 2005.
With regard to the ambient concentration values of nitrogen dioxide (NO_2) and ozone (O_3), the empirical evidence is as follows. The hourly limit of 200 μg/m^3 was exceeded in 2010 only a single day, the lowest number of days in the last 9 years. The maximum average hourly concentration of 200 ug/m^3 in 2010 has been exceeded 12 days, a value equal to the year 2005 but lower than the previous years. As for the yearly average, the value is equal to 61 μg/m^3 in the year 2009, higher than the 42 μg/m^3 threshold recommended by the EU Directive 2008/50/CE.
As regards ozone, during the year 2010 the alarm threshold of 240 μg/m^3 as maximum average hourly threshold has never been exceeded, as in the year 2004. However, the information threshold of 180 ug/m^3 has been exceeded 13 days as in the year 2002.

The impact on traffic

The Ecopass scheme has decreased the number of vehicles entering daily the Ecopass area (see Table 3), from 90,580 in the year 2007 to 76,114 in the first half of the year 2010. The drop has been very relevant in the first year of application of the measure (-21%) but the number of vehicles actually increased in the years 2009 and 2010 relative to the year 2008.

Table 3- Average number of daily entries in the Ecopass area

	Vehicles paying the toll			*Vehicles not paying the toll*			*Total*		
	Goods	*Passenger*	*Total*	*Goods*	*Passenger*	*Total*	*Goods*	*Passenger*	*Total*
Before Ecopass	9,738	28,341	38,079	3,302	49,199	52,501	13,040	77,540	90,580
2008	5,116	11,206	16,322	4,493	50,914	55,407	9,609	62,120	71,729
2009	3,961	8,294	12,255	5,804	57,038	62,842	9,765	65,332	75,097
Jan-June 2010	3,749	7,820	11,569	5,772	58,773	64,545	9,521	66,593	76,114
Before Ecopass	100%	100%	100%	100%	100%	100%	100%	100%	100%
2008	53%	40%	43%	136%	103%	106%	74%	80%	79%
2009	41%	29%	32%	176%	116%	120%	75%	84%	83%
Jan-June 2010	38%	28%	30%	175%	119%	123%	73%	86%	84%

Source: AMMA (2010).

The Ecopass scheme changed drastically the composition of the vehicles daily entering the charging area. Compared with the pre-Ecopass composition, the number of vehicles belonging to the tolled classes, hence the most polluting vehicles, decreased from 38,070 in the year 2007 to 11,569 (-70%) in the first half of the year 2010. Such a drop is higher for passenger (-72%) than for freight vehicles (-62%). Possible explanations include that passenger vehicles have a higher rate of substitution (a passenger car costs less than a freight vehicle, families might also have more than one car, etc.) and that freight vehicles have a low chance to transfer the fee on the consumers. Note also that one third of the tolled vehicles are freight vehicles and two-thirds are passenger vehicles.
Conversely, the number of vehicles belonging to the exempted classes, hence the least polluting vehicles, increased from 52,501 in the year 2007 to 64,545 (+23%) in the first half of the year 2010. In this case, although the large majority of these vehicles are passenger vehicles, the number of exempted freight vehicles increased at a very fast rate and in the years 2009 and 2010 it exceeded the number of the paying freight vehicles.
To summarize:

- The total number of vehicles daily entering the Ecopass area initially decreased drastically but starting from the year 2009 shows a tendency to increase again. This had positive effects both on the environment and on congestion in the first year, but at least the effect on congestion might have stopped.
- The composition of the vehicles daily entering the Ecopass area has changed drastically, and, judging from the class they belong to, this means that the vehicles are becoming "cleaner"[3] and the environmental goals closer. In fact, the number of vehicles belonging to the tolled classes on the total entering vehicles drops from 42% in the year 2007, to 23% in the year 2008, to 16% in the year 2009 and to 15% in the first half of the year 2010.
- Within the vehicles paying the Ecopass charge, the percentage of freight vehicles went from 25,6% in the year 2007 to 32,4% in the year 2010. This is a very high percentage since freight vehicles represent about 13% of the vehicles entering the Ecopass area.
- The reduction of the number of paying vehicles, from 16,332 in the year 2008 to 11,569 in the year 2010, entails less revenues for the city administration.

Impact on social costs and benefits and on economic activities

An important side-impact of the Ecopass scheme is the increase of safety due to the reduction of the number of cars circulating in the charging area and to the reorganization of the traffic flows. The data show that the number of accidents decreased over the years and that in the year 2007, before the implementation of the Ecopass, it was equal to 1.345 (853 of which with injured people), in the year 2008 it was equal to 1.164 (750 of which with injured people), and in the year 2009 it was equal to 1.204 (738 of which with injured people, AMMA, 2010, p. 45). The available data for the first six months of the year 2010 report 518 accidents (298 of which with injured people).
A further side-effect is the impact on traffic outside the Ecopass area: the traffic index decreased by 3.4% in the year 2008, by 8% in the year 2009 and by 6.6% in the first six months of the year 2010 (AMMA, 2010b). How much of this decrease is due to Ecopass scheme is, however, difficult to be determined.
Although it is known that a pricing scheme induces relocation of economic activities (Eliasson and Mattsson, 2001), how much relocation has occurred in Milan is a matter of speculation since, so far, there is no collected data on this issue.

4 The monetary costs and benefits

Using the same methodology applied in Rotaris et al. (2010), the costs and benefits for the years 2009 and 2010 are estimated. Note also that the estimate for the year 2008 is slightly different from that presented in Rotaris et al. (2010) since new data are now available (the previous estimates were based on evidence only for the first 11 months of the year 2008) and some calculations have been refined. A detailed description of the new estimates is reported in the Appendix section. The new estimates, however, do not alter the conclusions previously drawn in Rotaris et al. (2010).
The estimates for the year 2009 are based on AMMA (2010), reporting data for the entire 2009 year, while the estimates for the year 2010 are based on AMMA (2010b), reporting data for the first six months of the year 2010. A detailed description of these estimates is reported in the Appendix section.
The results for the years 2008, 2009 and 2010 are reported in Tables 4, 5, and 6.

[3] There has been also an increase of the vehicles using "alternative fuels" or with "zero emission. The number of passenger vehicles entering the Ecopass area with these characteristics increased from a daily value of 1,002 in the pre-Ecopass year to 4,574 in June 2010. Freight vehicles with the same characteristics and in the same period increased from 92 to 1,089.

Table 4 - Costs and benefits of Milan Ecopass scheme estimated for the year 2008 relative to the pre-Ecopass year 2007 (at 2008 prices, million €)

Category	Sub-category	Travel time and reliability	Operating costs	Other costs and services	Financial impacts (excluding penalties)	Total
Car, freight vehicles, taxi	Passenger vehicles	11.4	0.5	-0.4	-8.3	3.2
	Freight vehicles	0.3	0.1	-0.2	-3.8	-3.6
Buses	Passenger transportation	4.9				4.9
Deterred trips	Passenger vehicles			-2.4		-2.4
	Freight vehicles			-0.5		-0.5
Social costs	Accidents			5.4		5.4
	CO2			0.05		0.0
	NOx and PM10			0.4		0.4
Administrations (City adminstr., Region, State)	Fuel duty				-2.2	-2.2
	VAT				-0.8	-0.8
	Tolls		-6.5		12.1	5.6
	Infrastructure			-0.6		-0.6
	Parking revenues				-1.4	-1.4
Private parking	Net revenues				-1.0	-1.0
Total		16.6	-6.0	1.7	-5.4	6.9

Table 5 - Costs and benefits of Milan Ecopass scheme estimated for the year 2009 relative to the pre-Ecopass year 2007 (at 2008 prices, million €)

Category	Sub-category	Travel time and reliability	Operating costs	Other costs and services	Financial impacts (excluding penalties)	Total
Car, freight vehicles, taxi	Passenger vehicles	11.6	1.1	-0.4	-6.5	5.9
	Freight vehicles	0.3	0.2	-0.2	-3.1	-2.9
Buses	Passenger transportation	4.9				4.9
Deterred trips	Passenger vehicles			-1.9		-1.9
	Freight vehicles			-0.5		-0.5
Social costs	Accidents			6.2		6.2
	CO2			0.1		0.1
	NOx and PM10			0.7		0.7
Administrations (City adminstr., Region, State)	Fuel duty				-2.2	-2.2
	VAT				-0.8	-0.8
	Tolls		-6.5		9.6	3.1
	Infrastructure			-0.6		-0.6
	Parking revenues				-1.2	-1.2
Private parking	Net revenues				-0.8	-0.8
Total		16.8	-5.2	3.4	-5.0	10.1

Table 6 - Costs and benefits of Milan Ecopass scheme estimated for the year 2010 relative to the pre-Ecopass year 2007 (at 2008 prices, million €)

Category	Sub-category	Travel time and reliability	Operating costs	Other costs and services	Financial impacts (excluding penalties)	Total
Car, freight vehicles, taxi	Passenger vehicles	11.6	1	-0.4	-6.8	5.5
	Freight vehicles	0.3	0.1	-0.2	-3.3	-3.1
Buses	Passenger transportation	5.8				5.8
Deterred trips	Passenger vehicles			-1.7		-1.7
	Freight vehicles			-0.5		-0.5
Social costs	Accidents			6.2		6.2
	CO2			0.1		0.1
	NOx and PM10			0.9		0.9
Administrations (City adminstr., Region, State)	Fuel duty				-2.0	-2.0
	VAT				-0.8	-0.8
	Tolls		-6.5		10.0	3.5
	Infrastructure			-0.6		-0.6
	Parking revenues				-1.1	-1.1
Private parking	Net revenues				-0.7	-0.7
Total		17.7	-5.3	3.8	-4.6	11.6

In order to make the comparison simpler, the main results are summarized in Table 7.

Table 7 - Summary indicators of cost and benefits (at 2008 prices, million €)

	2008	2009	2010	Difference 2009 - 2008	Difference 2010 - 2009
All transport users	1.5	5.5	6.0	4.0	0.5
- passengers	5.7	8.9	9.6	3.2	0.7
- freight	-4.2	-3.4	-3.6	0.8	-0.2
Social costs savings	5.8	7.0	7.2	1.2	0.2
Public finances	0.5	-1.7	-0.9	-2.2	0.7
Private parking	-1	-0.8	-0.7	0.2	0.1
Total net benefits	6.9	10.1	11.6	3.2	1.5

Transport users as a whole, comprising the users of passenger vehicles, freight vehicles, buses and trams, have a net gain in 2008 equal to €1.5 Million (= 3.2-3.6+4.9-2.4-0.5). The net gain increases in 2009 to M€5.5 and in 2010 to M€6.0. While it is encouraging that transport users' net benefits increase, it should also be noticed that the marginal increase is diminishing.

A striking result comparing the impact on passenger and freight vehicle users is that while passenger users have a net benefit, freight vehicle users consistently face a net loss in all three years. This confirms that the Ecopass scheme, as already stated in Rotaris et al. (2010), is penalizing freight while favoring passenger transport. And while passengers' benefits increase over the years, although at a diminishing rate, the users of the freight vehicles experience a loss, which decreases in 2009 and increases again in 2010.

The reason why passenger users gain and freight transporters loose is linked to: a) the higher travel time and reliability savings of passengers relative to freight vehicles as a consequence of the introduction of the Ecopass scheme (see Tables 4, 5, 6) and b) the relatively higher percentage of freight vehicles paying the fee relative to the passenger vehicles.

Bus and tram users have an increasing net benefit caused by the increasing speed of the surface public transport services over the three years, reported by AMMA (2010, p. 43), equal to 8.67 km/h in the year 2008, 9.25 km/h in the year 2008, 9.26 km/h in the year 2009 and 9.4 km/h in the first half year 2010 AMMA (2010b, p. 46). Such increase in speed is both due to the effect of the Ecopass scheme and to reserved-lane policies implemented by the city administration.

Table 8 - Summary of cost and benefits for passengers (at 2008 prices, million €)

	2008	2009	2010
Travel time and reliability	11.4	11.6	11.6
Operating costs	0.5	1.1	1.0
Other costs and services	-0.4	-0.4	-0.4
Financial impacts	-8.3	-6.5	-6.8
Subtotal	3.2	5.9	5.5
Deterred trips	-2.4	-1.9	-1.7
Buses	4.9	4.9	5.8
Total	5.7	8.9	9.6

More in detail (Table 8), the gains for passengers increase from M€5.7 in the year 2008 to M€9.6 in the year 2010. Hence, they increase but at a decreasing rate. This is the result of the following variations. The gains in travel time and reliability savings relative to the year 2007 are stable at M€11.4 – M€11.6, because congestion is substantially decreased in 2008 and remained constant in the following years. The charges paid by the users of passengers vehicles decreased relative to the year 2008 from the initial M€8.3. The value of the deterred trips decreased from M€2.4 to M€1.7, and the travel time savings of bus passengers increased from M€4.9 ti M€5.8.
The benefits in terms of social cost savings appears also to increase, but at a decreasing rate. As it can be seen in Tables 4, 5 and 6, the largest savings are due to the reduction of accidents with injured people in the Ecopass area and not to the air quality improvements, although this represents the stated political motivation of the policy. The increase of the benefits over the years is also due to the increase of the air quality, but it is mainly due to the improvement of traffic safety.
The impact on public finances - comprising fuel duty, VAT, tolls, operating costs, infrastructural cost and parking revenues - is positive, although small, in the year 2008 and negative in the subsequent years. That is mainly due to the decrease in toll revenues.
The loss of private parking revenues is small and decreasing.
As a result, the estimated annual total net benefits are positive and increasing in all three year, but at a decreasing rate.

5 The political debate

The Ecopass system was introduced by the Milan administration in 2008 as a temporary measure. The mayor was Mrs. Letizia Moratti, a politician of the center-right party, member of Forza Italia, the political party founded by Mr. Berlusconi. Mr. Edoardo Croci was the Assessore ai trasporti, i.e. the person in charge of the transport policy for the city administration.
Although the Ecopass policy was not supported by all political parties of the governing coalition - particularly the Northern League was against it since it perceived it as a tax on the poor people - Mayor Mrs. Letizia Moratti pushed the policy through as an experiment aimed at reducing the high pollution level in the metropolitan area of Milan. The geographical and meteorological conditions of the area, characterized by very little wind, cause very high concentration of air pollutants, which makes it necessary to occasionally impose partial traffic bans (usually on Sundays) especially during the winter period. Traffic, being a major emitter of air pollutants, was and still is seen as one of the main culprits. Environmental advocacy groups and also the center-left parties, requesting a shift from the mainly private car-based traffic to public transport were in favor of the Ecopass. A referendum was promised to confirm or cancel the policy.
As discussed in Rotaris et al. (2010), the policy was relatively easy and inexpensive to be implemented. The technology was already in place since the cameras were already used for the pre-existing traffic control measures. What apparently went out of proportion is the number of fines that were given because drivers did not pay the Ecopass ticket. Although an estimate of the fines levied is not reported in official accounts, press reports indicate very high values. The reasons are many, including unwillingness to pay the toll, lack of

information on policy details, lack of information about the area where the policy applied. Since the number of occasional drivers is high, it might be that the drivers needed a long time to be properly informed.
A high number of fines means complains, court trials and dissatisfaction from a number of very vocal citizens and citizen groups. Although some results in terms of traffic reduction and environmental improvements could be shown, Mayor Mrs. Letizia Moratti had to face substantial political opposition within her own coalition. The Assessore ai Trasporti, Mr. Edoardo Croci, an advocate of the policy, was substituted. The promised referendum turned into a Commissione di Saggi (Advisory Commission "of wise man", from now on, it will be called the Ecopass commission) in charge of examining the main impacts and making policy proposals. The Ecopass Commission carried out his mandate but, because the administrative elections were very close, their conclusions were not made public. During the election campaign Mrs. Letizia Moratti, in fear of losing political support, made promises of loosening up the Ecopass rules (lifting up some fines or reducing the fee). Nonetheless, Mrs. Letizia Moratti lost the election. How important was the Ecopass issue in leading to the electoral result cannot be estimated. The new center-left Mayor, Mr. Giuliano Pisapia, is not against the Ecopass. Furthermore, a referendum took place in Milan on 12-13 of June 2011, organized by the supporters of Ecopass and of more stringent policies to fight air pollution[4]. The actual wording of the question asked in the referendum, translated in English, was: "do you agree that the Comune of Milan would pass a plan to strengthen public transport and a cleaner alternative to the car, through the extension to all vehicles (excluding the zero emissions ones) and the widening of the Ecopass area up to the "rail circle", with the aim of reducing by 50% traffic and air emissions?". 49,08% of the electorate participated to the referendum and 79.12% voted in favor.
In order to understand what is going to happen next, a good starting point is the questions that the city administration asked to the Ecopass Commission. Four questions were asked:

1. Evaluate the impact of the Ecopass policy on the environment and on traffic.
2. Evaluate the possibility of extending the paying area: a) up to the city border, b) up to "Circonvallazione filoviaria".
3. Evaluate other policy alternatives such as: a) an even-odd plate number policy, b) a traffic ban within the Navigli area.
4. Evaluate what would happen in the coming years if the paying area is left as it is, and if some policy adjustments are implemented such as a toll simplification, a fee reduction and an adjustment of the current freight transport regulation.

The discussion of the Ecopass Commission made it clear that the Ecopass policy as it is, although has improved air quality (but without respecting the recommended threshold of not exceeding for more 35-days during a year the 50 $\mu g/m^3$ of PM10 concentration levels), is gradually losing its impact since more and more vehicles belonging to the not-paying classes enter the Ecopass area.
Regarding the extension of the paying area, the Ecopass Commission is in favor of an extension from the current Cerchia dei Bastioni - a 8 km^2-wide area, corresponding to the city size of Milan in 1560, when the Bastioni (fortification) were built by the Spaniards – to the "Circonvallazione filoviaria", or "Circonvallazione esterna" (external circle), known also from the tram lines 90-91 that run along the circle. The size of the area corresponds approximately to the size of the city in 1884. As potential critical issue the Commission indicates that the number of entry gates would increase from the current 43 to more than 150, with higher costs of implementation and of relocation of economic activities. The Commission is instead against extending the area to the current city borders because of the lower public transport accessibility in the peripheral areas.
A fee increase is not judged a promising policy since the number of paying vehicles is already small and both the effect on traffic and on the Ecopass revenues would be consequently small.
The even-odd plate number policy is discarded as ineffective as the previous experiences demonstrate.
Severely restricting car access to the Cerchia dei Navigli (the medieval inner circle), as implemented in the 1980s, simply shifts traffic to the neighboring areas.

[4] The wording in Italian is the following: "Volete voi che il Comune di Milano adotti e realizzi un piano di interventi per potenziare il trasporto pubblico e la mobilità "pulita" alternativa all'auto, attraverso l'estensione a tutti gli autoveicoli (esclusi quelli ad emissioni zero) e l'allargamento progressivo fino alla "cerchia ferroviaria" del sistema di accesso a pagamento, con l'obiettivo di dimezzare il traffico e le emissioni inquinanti?"

The policy improvements proposed by the Ecopass Commission are the following:

- extending the pedestrian-only areas;
- increasing the number of the fee-paying classes to some of the ones currently not-paying and reducing the fee, as a way of increasing both the effectiveness and the equity of the Ecopass policy. In short, the Ecopass Commission is in favor of combining a pollution charge with a congestion charge. It is argued that this would also benefit the environment since an important fraction of PM derives from non-exhaust components, including tires, brakes, road surface, and does not depend on the vehicle emission technology.
- Simplify the fee structure to two fares only, one for cars and freight light duty vehicles, and one for tourist buses and heavy duty vehicles
- Harmonizing the Ecopass policy with the recent policies introduced for freight distribution in the Limited Traffic Zone.
- Allowing free entrance to electric, hybrid and alternative fuels vehicles and ban older vehicles (pre-Euro, Diesel e gasoline Euro 1, Diesel Euro 2 passenger vehicles and Euro 2 and Euro 3 freight vehicles and freight vehicles longer than 7,25 m).
- A paradigm shift from environmental quality goals to urban quality goals to be obtained via car-free zones and traffic calming residential areas.
- Furthermore, a long list of "green" traffic and transport policy are recommended such as reducing the number of parking places, reserved and protected lanes for public transport, cycling lanes, bike sharing and car sharing, electric mobility, park-and-ride infrastructure, enforcement of second-row parking prohibitions, Intelligent Transport Systems, loading\unloading areas for freight distribution and other city logistics policies.

Further proposals are brought forward by the advocacy group "Milano si muove", the main proponent of the referendum of the 12-13 June 2011, aiming at improving the environmental quality and the transport sustainability. They proposed five referenda on mobility, green parks, energy saving and greenhouse effects and other local issues.

Although it is admitted, also by the supporters of the pricing policies such a congestion pricing and road pricing, that the effectiveness and the efficiency of a pricing policy is improved when it is accompanied by other non-pricing policies such a policies promoting public transport (Anas and Lindsay, 2010), it is unclear in the current debate whether the virtues of a pricing policy versus a command-and-control policy will really appreciated. In the literature such virtues are largely debated and described, specifically in the case of road pricing, as having two main advantages: a) it induces adjustments in trip frequencies, destination, mode, time of day and route, as well as in long-run location decisions. b) it can be varied with the magnitude of the congestion externality according to place, time of day and type of vehicle (Anas and Lindsay, 2010). It is our feeling that both the Ecopass Commission and the "Milano si muove" advocacy group put more faith in the command-and-control transport policies than in the Ecopass pricing policy.

Since the Ecopass policy is valid till 30 September 2011, the Pisapia administration, elected in June 2011, is now faced with the task of deciding, in a brief time span, what to do with the policy. The task is not an easy one both because the quantity and quality of the data is not completely satisfactory and because of the inherent complexities, multiplicity of impacts and distributional effects of every transport policy. However, most of the population, as the referenda showed, is in favor of a change, even a radical one, given the current, unsatisfactory air quality levels. Whether the support will last and whether the administration will have the ability to bring a change remains to be seen.

6 Conclusion

The Ecopass policy improved air quality in the city of Milan: the policy has reached its main goal. However, the air quality is still not satisfactory because the PM_{10} threshold is exceeded more than the recommended number of days (86 days versus a recommended maximum number of 35 days in 2010).

Although not designed to optimize congestion, a drastic reduction in the number of vehicles entering the Ecopass area took place in the first year of implementation. In parallel, reductions outside the Ecopass area were documented, as well as improvements in public transport speed and a decrease in the number of

accidents. Evaluating the cost and benefits of the policy for the year 2008, Rotaris et al. (2010) concluded that, for the society as a whole, the benefits exceeded the costs. The benefits from the travel time savings resulted higher than the benefits of the reduced environmental externalities, as in other road pricing applications (Anas and Lindsay, 2010).
As a reaction to the toll which some of the vehicles, depending on their EURO emission technology, are required to pay to enter the Ecopass area, car and freight vehicle users bought new vehicles. As a result, after the first year of drastic reduction, the number of vehicles entering the area is increasing again.
This paper estimates the costs and benefits for the year 2009 and 2010 using the same methodology applied by Rotaris et al. (2010) for the year 2008. It results that, three years after the implementation, the benefits exceed the costs by an increasing amount, but at a decreasing rate of improvement.
The benefits continue exceeding the costs because: a) travel time savings were maintained or slight increased between 2008 and 2009 (but stopped to increase between 2009 and 2010) and b) at the same time the total Ecopass revenues were reduced since vehicle users partly moved to public transport but mostly substituted the old paying vehicles with new not-paying vehicles. Gains also accrued from increased public transport speeds. As far as social costs are concerned, it is confirmed that they mostly derive from accidents' reduction and not from air quality. However, both social cost savings have been slightly increasing over the three years. Although there are still net benefits in the year 2010, the available indicators for the year 2011 show a worrying increase in traffic, mainly attributed to the continuing vehicle substitution.
In summary, the Ecopass scheme proved beneficial and should be maintained since it continues to create a net benefit for the society, but the marginal increase, although positive, is diminishing and there is a concern that in the year 2011 the congestion level could start to increase with respect to the year 2010. That would have a negative impact on the travel time savings, which proved to be the most important element of the positive results of the cost-benefit analysis, and allow little further gains in environmental quality. Since the Ecopass scheme, based on the fiscal incentive to improve the abatement technology of the vehicles, seems to have exhausted its potential to induce a continuing change, a policy of car traffic calming or traffic reduction might be needed.
The Ecopass policy is valid till 30 September 2011. The Moratti administration, who had the courage to introduce such a innovative policy, lost the election. The Pisapia administration, elected in June 2011, is now faced with the task of deciding in a brief time span what to do with the policy.
The prevailing idea coming from the Ecopass Commission and the advocacy groups is to extend the area of application and the number of classes subject to the charge. A move from a pollution charge to a congestion charge, or at least to a combination of pollution and congestion charge, is envisaged. At the same time, it is requested to strengthen public transport, increase the pedestrian-only areas and promote alternative modes of transport (e.g., cycling), fuels (e.g., methane) or vehicles (hybrid or electric).
What role will the pricing policies, supported by economists as superior the command-and-control ones, play and whether the new administration will have the ability and political support to find the right balance between the two types of policies remains to be seen.

References

AMMA (2002) Indagine sulla mobilità delle merci nell'area Milanese, http://217.31.113.127/PDF/Merci/04%20Interviste.pdf

AMMA (2008), Ecopass - Primi dati Marzo (marzo 2008) http://www.comune.milano.it/dseserver/ecopass/report/report_marzo2008.pdf

AMMA (2008b), Monitoraggio indicatori Ecopass. Prime valutazioni. (dicembre 2008) http://www.comune.milano.it/dseserver/ecopass/report/Monitoraggio_Ecopass_11Mesi.pdf

AMMA (2009), Monitoraggio Ecopass, Gennaio-Dicembre 2008, Indicatori sintetici (febbraio 2009) http://www.milanosimuove.it/

AMMA (2010), Monitoraggio Ecopass, Gennaio-Dicembre 2009, Indicatori sintetici (marzo 2010) http://www.milanosimuove.it/

AMMA (2010b), Monitoraggio Ecopass, Gennaio-Giungo 2010, Indicatori sintetici (luglio 2010) http://www.milanosimuove.it/

Anas, A, Lindsey, R. (2011) "Reducing Urban Road Transportation Externalities: Road Pricing in Theory and in Practice", *Revue of Environmental Economics Policy*, doi: 10.1093/reep/req019

Bickel, P., Friedrich, R., Burgess, A., Fagiani, P., Hunt, A., De Jong, G., Laird, J., Lieb, C., Lindberg, G., Mackie, P., Navrud. S., Odgaard, T., Ricci, A., Shires, J., and Tavasszy, L. (2006) Developing Harmonised European Approaches for Transport Costing and Project Assessment. HEATCO Deliverable 5. Proposal for Harmonised Guidelines, http://heatco.ier.uni-stuttgart.de/HEATCO_D5_summary.pdf

Ecopass Commission (2010) Sintesi conclusiva, Milano 14 marzo 2011, http://wwwscribdcom/doc/56923720/Rapporto-della-Commissione-comunale-tecnica-su-Ecopass

Eliasson, J., & Mattsson, L.-G. (2001). Transport and location effects of road pricing: A simulation approach. *Journal of Transport Economics and Policy*, 35(3), 417–456.

Rotaris, L, Danielis, R, Marcucci, E, Massiani, J (2010) "The urban road pricing scheme to curb pollution in Milan, Italy: Description, impacts and preliminary cost–benefit analysis assessment", *Transportation Research Part A* 44: 359–375

Ruprecht, A.A., Invernizzi, G. (2009) "L'effetto del provvedimento di restrizione del traffico nel centro di Milano (Ecopass) sull'inquinamento urbano da polveri: i risultati di uno studio pilota", *Epidemiologia & Prevenzione*, 33(1-2): 21-26.

Maibach, M., C. Schreyer, and D. Sutter (INFRAS), H.P. van Essen, B.H. Boon, R. Smokers, A. Schroten (CE Delft), C. Doll (Fraunhofer Gesellschaft – ISI), B. Pawlowska, M. Bak (University of Gdansk) (2008) "Handbook on estimation of external cost in the transport sector". Produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT, Delft, CE, 2007, Publication number: 07.4288.52, CE-publications are available from www.ce.nl. ec.europa.eu/transport/sustainable/doc/2008_costs_handbook.pdf

Appendix A Estimation of VTTS for car passengers and freight vehicles

168,000	Hours/year	Time savings in 2008 in the tolled area based on the daily time savings of 720 hours estimated by AMMA (2008b, p.7)
571,200	Hours/year	Time savings in 2008 outside the tolled area based on the daily time savings of 720 hours estimated by AMMA (2008b, p.7)
170,520	Hours/year	Time savings in 2009 in the tolled area based on the daily time savings in 2008 and on the average traffic index reduction (-1.5%) estimated for 2009 with respect to 2008reported by AMMA (2010, p. 4).
580,910	Hours/year	Time savings in 2009 outside the tolled area based on the daily time savings in 2008 and on the average traffic index reduction (-1.7%) estimated for 2009 with respect to 2008 reported by AMMA (2010, p. 5).
167,451	Hours/year	Time savings in 2010 in the tolled area based on the daily time savings in 2008 and on the average traffic index increase (+1.8%) estimated for 2010 with respect to 2009 reported by AMMA (2010b, p. 4).
579,479	Hours/year	Time savings in 2010 outside the tolled area based on the daily time savings in 2008 and on the average traffic index increase (+0.2%) estimated for 2010 with respect to 2009 reported by AMMA (2010b, p. 5).
148,347	Hours/year	Time savings in 2009 for passengers inside the tolled area estimated on the bases of the percentage of cars (87%) and freight vehicles (13%) entering the charging area reported by AMMA (2010, p.11).
505,374	Hours/year	Time savings in 2009 for passengers outside the tolled area estimated on the bases of the percentage of cars (87%) and freight vehicles (13%) entering the charging area reported by AMMA (2010, p.11).
22,173	Hours/year	Time savings in 2009 for freight inside the tolled area estimated on the bases of the percentage of cars (87%) and freight vehicles (13%) entering the charging area reported by AMMA (2010, p.11).
75,537	Hours/year	Time savings in 2009 for freight outside the tolled area estimated on the bases of the percentage of cars (87%) and freight vehicles (13%) entering the charging area reported by AMMA (2010, p.11).

146,504	Hours/year	Time savings in 2010 for passengers inside the tolled area estimated on the bases of the percentage of cars (87.5%) and freight vehicles (12.5%) entering the charging area reported by AMMA (2010b, p.11).
507,229	Hours/year	Time savings in 2010 for passengers outside the tolled area estimated on the bases of the percentage of cars (87.5%) and freight vehicles (12.5%) entering the charging area reported by AMMA (2010b, p.11).
20,946	Hours/year	Time savings in 2010 for freight inside the tolled area estimated on the bases of the percentage of cars (87.5%) and freight vehicles (12.5%) entering the charging area reported by AMMA (2010b, p.11).
72,520	Hours/year	Time savings in 2010 for freight outside the tolled area estimated on the bases of the percentage of cars (87.5%) and freight vehicles (12.5%) entering the charging area reported by AMMA (2010b, p.11).
15.59	$€_{2008}$/h per person	Weighted average of Value of Travel Time Savings per passenger travelling by car assuming that 25% of the passengers are businessmen, 55% are commuters and 20% travel for other reasons (estimated as reported in Rotaris et al. 2010 p. 371).
2.37	$€_{2008}$/h per freight vehicle	Weighted average of Value of Travel Time Savings per hour of freight vehicle assuming that the weighted average maximum carrying capacity is equal to 2.4 tonnes, that the weighted average loading factor is 27.8% and that the average tonnes carried per freight vehicle is 0.66 tonnes (AMMA, 2002 p. 48 and 50).
11,350,174	€/year	Total annual VTTSs inside and outside the charging area in 2008 for passenger vehicles based on the hours saved in 2008, on the weighted average of VTTSs per hour for passenger vehicle and on the value of reliability assumed to be equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).
266,613	€/year	Total annual VTTSs inside and outside the charging area in 2008 for freight vehicles based on the hours saved in 2008, on the weighted average of VTTSs per hour for freight vehicle and on the value of reliability estimated equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).
11,590,336	€/year	Total annual VTTSs inside and outside the charging area in 2009 for passenger vehicles based on the hours saved in 2009, on the weighted average of Value of Travel Time Savings per passenger and on the value of reliability estimated equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).
263,071	€/year	Total annual VTTSs inside and outside the charging area in 2009 for freight vehicles based on the hours saved in 2009, on the weighted average of Value of Travel Time Savings per hour of freight vehicle and on the value of reliability estimated equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).
11,590,558	€/year	Total annual VTTSs inside and outside the charging area in 2010 for passenger vehicles based on the hours saved in 2010, on the weighted average of Value of Travel Time Savings per passenger and on the value of reliability estimated equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).
251,646	€/year	Total annual VTTSs inside and outside the charging area in 2010 for freight vehicles based on the hours saved in 2010, on the weighted average of Value of Travel Time Savings per hour of freight vehicle and on the value of reliability estimated equal to 13.7% of the VTTS (as reported in Rotaris et al. 2010 p.372).

Appendix B Estimation of VTTS for surface public transport passengers

9.48	€/ h	Weighted average VTTSs per hour for surface public transport service on the basis of the estimates reported by Bickel et al. (2006) for Italy and assuming 10% of the passengers are businessmen, 65% are commuters, and 25% travel for other reasons.

1.2	%	Speed increase of the surface public transport vehicles in 2010 with respect to 2009 (as reported in AMMA, 2010b, p.46).
2,329	h/year	Travel time savings in 2008 (estimated as reported in Rotaris et al. 2010 p.373) adjusted for the speed increase reported for 2010 with respect to 2009.
2,329	h/year	Travel time savings in 2009 estimated to be equal to 2008 since the speed of surface public transport vehicles reported by AMMA for 2009 (AMMA, 2010, p.43) is equal to the speed reported for 2008.
2,746	h/year	Travel time savings in 2010 (estimated as reported in Rotaris et al. 2010 p.373).
4,946,000	€/year	Total annual VTTSs in 2008 based on the travel time savings estimated for 2008 and on the weighted average VTTSs per hour based on Bickel et al. (2006).
4,946,000	€/year	Total annual VTTSs in 2009 based on the travel time savings estimated for 2009 and on the weighted average VTTSs per hour based on Bickel et al. (2006).
5,831,560	€/year	Total annual VTTSs in 2010 based on the travel time savings estimated for 2010 and on the weighted average VTTSs per hour based on Bickel et al. (2006).

Appendix C Estimation of operating costs for passenger and freight vehicles, fuel duty and VAT

1.5	%	Speed increase in 2009 compared to 2008 inside the charging area based on the traffic index reported for 2009 (AMMA, 2010, p.4).
1.7	%	Speed increase in 2009 compared to 2008 outside the charging area based on the traffic index reported for 2009 (AMMA, 2010, p.5).
1.8	%	Speed increase in 2010 compared to 2009 inside the charging area based on the traffic index reported for the first six months of the year 2010 (AMMA, 2010b, p.4).
0.2	%	Speed increase in 2010 compared to 2009 inside the charging area based on the traffic index reported for the first six months of the year 2010 (AMMA, 2010b, p.5).
20	km/h	Average vehicles (car and freight) speed inside the charging area before the Ecopass implementation estimated as reported in Rotaris et al. (2010) p. 373.
20.8 and 20.2	km/h	Average vehicles (car and freight) speed inside and outside the charging area in the year 2008 estimated as reported in Rotaris et al. (2010) p. 373.
21.1 and 20.5	km/h	Average vehicles (car and freight) speed inside and outside the charging area in the year 2009 estimated on the basis of the average speed for the year 2008 and on the speed increases reported by AMMA for the year 2009.
20.7 and 20.5	km/h	Average vehicles (car and freight) speed inside and outside the charging area in the year 2010 estimated on the basis of the average speed for the year 2008 and on the speed increases reported by AMMA for the year 2010.
132,000	Entries/day	Average number of daily entries in the charging area in the year 2008 as reported by Commissione Ecopass, 2011, p.6)
134,055	Entries/day	Average number of daily entries in the charging area in the year 2009 as reported by Commissione Ecopass, 2011, p.6)
138,800	Entries/day	Average number of daily entries in the charging area in the first six months of the year 2010 as reported by Commissione Ecopass, 2011, p.6)
547,024	€/year	Value of fuel savings for the year 2008 based on the quantity of fuel saved daily estimated as reported in Rotaris et al. (2010) p. 373.
238,241	€/year	Lost fuel duty for the year 2008 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
90,819	€/year	Lost VAT for the year 2008 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
1,318,333	€/year	Value of fuel savings for the year 2009 based on the quantity of fuel saved daily estimated as reported in Rotaris et al. (2010) p. 373.

574,162	€/year	Lost fuel duty for the year 2009 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
218,874	€/year	Lost VAT for the year 2009 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
1,175,885	€/year	Value of fuel savings for the year 2010 based on the quantity of fuel saved daily estimated as reported in Rotaris et al. (2010) p. 373.
512,123	€/year	Lost fuel duty for the year 2010 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
195,224	€/year	Lost VAT for the year 2010 due to the quantity of fuel saved estimated as reported in Rotaris et al. (2010) p. 373.
5,468,298	€/year	Value of fuel savings for the year 2008 due to cancelled trips based on the number of cancelled trips reported by AMMA (2009) p.12 and estimated as reported in Rotaris et al. (2010) p. 373.
1,929,064	€/year	Lost fuel duty for the year 2008 due to cancelled trips based on the number of cancelled trips reported by AMMA (2009) p.12 and estimated as reported in Rotaris et al. (2010) p. 373.
735,370	€/year	Lost VAT for the year 2008 due to cancelled trips based on the number of cancelled trips reported by AMMA (2009) p.12 and estimated as reported in Rotaris et al. (2010) p. 373.
4,491,309	€/year	Value of fuel savings for the year 2009 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
1,584,409	€/year	Lost fuel duty for the year 2009 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
603,986	€/year	Lost VAT for the year 2009 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
4,196,297	€/year	Value of fuel savings for the year 2010 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010b) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
1,480,337	€/year	Lost fuel duty for the year 2010 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010b) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
564,313	€/year	Lost VAT for the year 2010 due to cancelled trips based on the number of cancelled trips reported by AMMA (2010b) p.11 and estimated as reported in Rotaris et al. (2010) p. 373.
2,167,304	€/year	Lost fuel duty for the year 2008 due to vehicles' speed increase and cancelled trips
826,189	€/year	Lost VAT for the year 2008 due to vehicles' speed increase and cancelled trips
2,158,571	€/year	Lost fuel duty for the year 2009 due to vehicles' speed increase and cancelled trips
822,859	€/year	Lost VAT for the year 2009 due to vehicles' speed increase and cancelled trips
1,992,460	€/year	Lost fuel duty for the year 2010 due to vehicles' speed increase and cancelled trips
759,537	€/year	Lost VAT for the year 2010 due to vehicles' speed increase and cancelled trips

Appendix D Estimation of operating and infrastructure costs of the Ecopass

6.5	M€/year	Value of the operating costs of the toll system as reported by AMMA for the year 2008 (2009, p.48).

0.6	M€/year	Value of the infrastructure costs of the toll system as reported in Rotaris et al. (2010, p. 370)

Appendix E Other costs for passenger and freight vehicles

1,232,361	Entry tickets/year	Number of entry tickets sold in the year 2008 as reported by AMMA (2009, p. 47).
1,172,857	Entry tickets/year	Number of entry tickets sold in the year 2009 as reported by AMMA (2010, p. 47).
570,913	Entry tickets/year	Number of entry tickets sold in the first six months of the year 2010 as reported by AMMA (2010b, p. 48).
31 and 69	%	Percentage of freight and passengers vehicles paying the toll in the year 2008 as reported by AMMA (2009, p.12).
32 and 68	%	Percentage of freight and passengers vehicles paying the toll in the year 2009 as reported by AMMA (2010, p.11).
32 and 68	%	Percentage of freight and passengers vehicles paying the toll in the year 2010 as reported by AMMA (2010b, p.11).
388,271	€/year	Transaction costs for passenger vehicles for the year 2008 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
201,966	€/year	Transaction costs for freight vehicles for the year 2008 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
364,264	€/year	Transaction costs for passenger vehicles for the year 2009 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
198,207	€/year	Transaction costs for freight vehicles for the year 2009 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
354,626	€/year	Transaction costs for passenger vehicles for the year 2010 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
192,963	€/year	Transaction costs for freight vehicles for the year 2010 estimated as reported by Rotaris et al. (2010, p.374) on the bases of the number of entry tickets sold and the percentage of freight and passenger vehicles paying the toll.
2,405,520	€/year	Value of the economic loss for cancelled passenger trips for the year 2008 estimated on the basis of the cancelled trips reported by AMMA (2009) p.12 via the procedure described in Rotaris et al. (2010, p. 374).
535,080	€/year	Value of the economic loss for cancelled freight trips for the year 2008 estimated on the basis of the cancelled trips reported by AMMA (2009) p.12 via the procedure described in Rotaris et al. (2010, p. 374).
1,904,448	€/year	Value of the economic loss for cancelled passenger trips for the year 2009 estimated on the basis of the cancelled trips reported by AMMA (2010) p.11 via the procedure described in Rotaris et al. (2010, p. 374).
510,900	€/year	Value of the economic loss for cancelled freight trips for the year 2009 estimated on the basis of the cancelled trips reported by AMMA (2010) p.11 via the procedure described in Rotaris et al. (2010, p. 374).
1,707,732	€/year	Value of the economic loss for cancelled passenger trips for the year 2010

		estimated on the basis of the cancelled trips reported by AMMA (2010b) p.11 via the procedure described in Rotaris et al. (2010, p. 374).
548,964	€/year	Value of the economic loss for cancelled freight trips for the year 2010 estimated on the basis of the cancelled trips reported by AMMA (2010b) p.11 via the procedure described in Rotaris et al. (2010, p. 374).

Appendix F Social costs

5,397,500	€/year	Value of the reduction of costs caused by accidents involving injured people in the year 2008 based on the number of accident decrease reported by AMMA (2009, p. 45) and the assumptions on the cost reduction per accident and the percentage of accidents caused by the Ecopass described by Rotaris et al. (2010, p. 374)
6,207,125	€/year	Value of the reduction of costs caused by accidents involving injured people in the year 2009 based on the number of accident decrease reported by AMMA (2010, p. 45) and the assumptions on the cost reduction per accident and the percentage of accidents caused by the Ecopass described by Rotaris et al. (2010, p. 374)
6,207,125	€/year	Value of the reduction of costs caused by accidents involving injured people in the year 2010 based on the number of accident decrease reported by AMMA (2010b, p. 50) and the assumptions on the cost reduction per accident and the percentage of accidents caused by the Ecopass described by Rotaris et al. (2010, p. 374)
25	€/ tonne	Recommended value for the external costs of climate change (€/tone CO_2) reported by Maibach et al.(2008, p. 264)
45,000	€/year	Value of a 1.8 kton decrease of CO_2 in the year 2008 compared to the year 2007 as reported by AMMA (2010, p. 31)
85,000	€/year	Value of a 3.4 kton decrease of CO_2 in the year 2009 compared to the year 2007 as reported by AMMA (2010, p. 30)
102,471	€/year	Value of a 4.1 kton decrease of CO_2 in the year 2010 compared to the year 2007 based on the data reported by AMMA (2010b, p. 35)
594 and 239	€/tonne	Value per tonne of total PM_{10} emissions for exhaust particles in big cities and for abrasion and re-suspension emissions as reported in Maibach et al.(2008, Table 13)
343,332	€/year	Value of a 0.5 and a 0.7 ton decrease of total PM_{10} emissions for exhaust particles and for abrasion and re-suspension in the year 2008 compared to the year 2007 as reported by AMMA (2010, p. 14)
584,496	€/year	Value of a 0.8 and a 1.2 ton decrease of total PM_{10} emissions for exhaust particles and for abrasion and re-suspension in the year 2009 compared to the year 2007 as reported by AMMA (2010, p. 13)
765,072	€/year	Value of a 1.1 and a 1.6 ton decrease of total PM_{10} emissions for exhaust particles and for abrasion and re-suspension in the year 2010 compared to the year 2007 based on the data reported by AMMA (2010b, p. 13)
7,524	€/ tonne	Value per tonne of NO_X reported in Maibach et al.(2008, Table 13)
63,954		Value of a 8.5 ton decrease of NO_X in the year 2008 compared to the year 2007 as reported by AMMA (2010, p. 27)
121,136		Value of a 16.1 ton decrease of NO_X in the year 2009 compared to the year 2007 as reported by AMMA (2010, p. 26)
155,712		Value of a 20.7 ton decrease of NO_X in the year 2010 compared to the year 2007 as reported by AMMA (2010, p. 31)

Appendix G Financial impacts

12,061,804	€/year	Value of the tolls revenues in the year 2008 as reported by AMMA (2009, p.48).
3,780,676	€/year	Value of the tolls paid by freight vehicles in the year 2008 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2008 as reported by AMMA (2009, p.12).
8,281,128	€/year	Value of the tolls paid by passengers vehicles in the year 2008 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2008 as reported by AMMA (2009, p.12).
9,609,238	€/year	Value of the tolls revenues in the year 2009 as reported by AMMA (2010, p.51).
3,105,849	€/year	Value of the tolls paid by freight vehicles in the year 2009 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2009 as reported by AMMA (2010, p.11).
6,503,388	€/year	Value of the tolls paid by passengers vehicles in the year 2009 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2009 as reported by AMMA (2010, p.11).
10,041,992	€/year	Value of the tolls revenues in the year 2010 as reported by AMMA (2010b, p.52).
3,254,164	€/year	Value of the tolls paid by freight vehicles in the year 2010 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2010 as reported by AMMA (2010b, p.11).
6,787,827	€/year	Value of the tolls paid by passengers vehicles in the year 2010 on the basis of the percentage freight and passengers vehicles paying the toll in the year 2010 as reported by AMMA (2010b, p.11).

Appendix H Parking revenues

1,447,953	€/year	Value of the decrease in public parking revenues in the year 2008 estimated as reported in Rotaris et al. 2010 (p. 374).
965,302	€/year	Value of the decrease in private parking revenues in the year 2008 estimated as reported in Rotaris et al. 2010 (p. 374).
1,189,319	€/year	Value of the decrease in public parking revenues in the year 2009 estimated as reported in Rotaris et al. 2010 (p. 374).
792,879	€/year	Value of the decrease in private parking revenues in the year 2009 estimated as reported in Rotaris et al. 2010 (p. 374).
1,111,198	€/year	Value of the decrease in public parking revenues in the year 2010 estimated as reported in Rotaris et al. 2010 (p. 374).
740,799	€/year	Value of the decrease in private parking revenues in the year 2010 estimated as reported in Rotaris et al. 2010 (p. 374).