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Cost-benefits Analysis and Law and Economics in the Evaluation of Scrapping Subsidies: An Empirical Analysis of the Italian Case

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Abstract[1]**:** This study presents an economic evaluation of the scrapping subsidies which have been often proposed in Italy during the past few years and represent-as the legislator clearly pointed out - a policy tool directed to reduce air pollution according to the EU's politics of environmental conservation. As it's clear, in this period of crisis of the whole economics and in particular of the automotive sector, such incentives might also offer support to the automotive industry. We carry out a regulatory impact evaluation (RIE, ex-post evaluation of existing norms) investigating the efficacy and efficiency (cost and benefits) of the subsidies that were in force in Italy in 2007, reaching useful conclusions for the improvement of this kind of measures. In this sense we try to define an example of Regulatory Impact Evaluation, complementary to a Regulatory Impact Analysis (RIA). From a methodological point of view, our work highlights three basic issues: (1) the importance of considering all the possible consumers' strategic choices that follow the government's introduction of incentives; (2) the importance of a correct specification of the time horizon considered in the evaluation of costs and benefits resulting from the introduction of the incentives, especially when they bring forward the purchase of goods which remains nevertheless inevitable at a later date and (3) the importance of a disaggregated analysis of all the costs and benefits for each subject directly or indirectly involved in the measure.

Key words: Economic evaluation, costs benefits analysis, regulatory impact assesment, scrapping subsides, law and economics

INTRODUCTION

Within the context of a growing interest in environmental issues, from the 90's EU has considered the reduction of car pollution as a priority policy. Following this European policy recommendation, in 1997 (L.n.30/1997) Italy introduced for the first time scrapping subsidies, providing lump sum incentives to those changing their old high pollution cars with new, less polluting ones. This kind of measure was adopted again during the following years, in 2002 and 2003.

In 2007 (L. n. 296/2006) the government introduced again a lump sum incentive (800 €), together with a two-year car tax exemption, to stimulate the scrapping of Euro 0 and Euro1 cars and the purchase of new ones endowed with Euro 4 engine and characterized by a CO_2 pollution under 140 g km^{-1}.[2]

Like in the past years, this measure had more than one aim: whereas the explicit one was the reduction of the number of pollutant car, implicit purposes were to reduce pollution in general, renew the national car fleet and support the auto sector.

REGULATORY IMPACT ASSESSMENT (RIA) AND REGULATORY IMPACT EVALUATION (RIE) IN ITALY: A GLANCE AT CURRENT DISCIPLINE AND STATE OF THE ART

In the short period of two decades, Regulatory Impact Assesment (RIA) and Regulatory Impact Evaluation (RIE) have become prominent tools by which governments can improve the quality of their own regulatory design. Following the OECD (1995,1997) and EU's (MGBR, 2001) recommendations, almost all of european countries introduced and experienced RIA and RIE during the last years. Anyway, as it is well known, the implementation of these evaluation tools still exhibit many differences across national contexts; while RIA and RIE

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[1]This study is the result of shared ideas of the two authors; however Salvatore Ercolano wrote paragraphs 2, 3.3, 3.5 while Giuseppe Lucio Gaeta wrote paragraphs 1, 3.1, 3.2, 3.4 and 4. We would like to thanks Professors Amedeo Di Maio and Pietro Rostirolla for useful comments

[2]Old cars had to be at least ten years old to receive the subsidy. A three-years car tax exemption was granted to those purchasing new vehicles up to 1300 cc

practices seem to be well-established and widely spread in some countries (UK, Denmark, Netherlands, often reported as "best practices"), it appears clear that others, Italy in particular, need more experience as well as an improvement of technical knowledge (Italian, Irish and DPCEU (2004).

RIA and RIE history in Italy is rather recent; the Regulatory Impact Assessment was experimentally introduced by law n. 50/1999 and by the Prime Minister's directive 27-3-2000. This first experimental phase was carried out with few tests until 2001 when RIA was experimentally extended to all the governmental regulations[3]. From 2005 (law n. 246/2005) RIA has to be considered as an ordinary step of any governmental regulatory process, even if its detailed discipline was approved only during 2008 (Prime Minister's directive 11- 09 -2008).

While RIA had an evolution during the last years, the Italian government devoted less attention to the ex-post evaluation of existing norms (the so called RIE): even if it was formally introduced in 2001 and its importance was stressed in law n. 246 of 2005, no applications are known and no debate on methodological issues are reported to date. It seems clear, anyway, that RIE represents a useful monitoring tool, complementary (preparatory) to the ex ante evaluations provided by RIA.

THE EVALUATION MODEL

In the followings pages we present our model of RIE based on a disaggregated cost-benefit analysis focusing on each category of subjects directly or indirectly involved in the scrapping measure.

Subsidies' impact on consumers' choices: The impact of the incentives has been estimated looking at the variation in the number of cars demolitions between the year 2007 and the average registered for 2005-2006 (points A-F in Table 1).

Comparing the total number of demolitions with the number of induced demolition we estimated the number of consumers that would have changed their car even in the absence of incentives (point G in Table 1): it is clear that only the 56.81% of the incentives stimulated the purchase of new cars otherwise not foreseen for 2007, while about the 43.19% of the incentives went to consumers that would have changed their car even in the absence of subsidies.

We considered cars like goods characterized by a reduced average life span (about 14 years in Italy). As the substitution of an old car with a new one is inevitable, the introduction of the government subside may induce consumers to bring their car substitution forward.

For this reason, the consumers who wouldn't have changed their old car without incentives may be divided into three categories:

- Those that would have changed their car in 2 years
- Those that would have changed their car in 5 years
- Those that would have changed their car in 10 years

Table 1: Estimation of the variation of demolitions between 2007 and 2005-2006.

Parameters for the estimation of the number of demolition	N-% of vehicle
A) scrapping number with incentive 2007	362.278
Euro 0	136.825
Euro 1	225.453
B) car fleet 2007**	2.493.774
C) scrapping 2007 / car fleet 2007	4,21%
D) scrapping average value 2005-2006 (% car fleet)**	3,63%
E) expected scrapping without subside in 2007	1.287.841
F) difference between real and expected scrapping	205.816
G) A-F	156.462
Euro 0	59.092
Euro 1	97.369

*Source , www.unrae.it ** Source www.aci.it

Table 2: Scenarios' definition

Scenarios	% of Consumers
Scenario 1	
Would have changed their car in 2007 without subside too	100
Scenario 2	
Would have changed their car 2 years after subside's introduction	100
Scenario 3	
Would have changed their car 5 years after subside's introduction	100
Scenario 4	
Would have changed their car 10 years after subside's introduction	100
Mixed Scenario 1	
Would have changed their car in 2007 without subside too	43.19
Would have changed their car at a later date among them	56.81
Would have changed their car 2 years after subside's introduction	18.75
Would have changed their car 5 years after subside's introduction	18.75
Would have changed their car 10 years after subside's introduction	19.32
Mixed Scenario 2	
Would have changed their car in 2007 without subside too	43.19
Would have changed their car at a later date among them	56.81
Would have changed their car 2 years after subside's introduction	28.41
Would have changed their car 5 years after subside's introduction	22.72
Would have changed their car 10 years after subside's introduction	5.68

[3] Guidelines for RIA where published by the Prime Minister's Office in December 2000 and revised in 2003.

We made some hypothesis to divide the 56,81% of incentives that stimulated the purchase of new cars among these three categories. In this way, we obtained some scenarios to evaluate the impact of the incentives (Table 2). In particular we built four scenarios in which all the consumers belong to one category (Table 2) and two mixed scenarios that, in our opinion, result to be more realistic.

Benefits for the community: the pollution's reduction: Benefits concerning the reduction of pollution may be estimated assuming that:

$$E = f\left[N, \delta Ig(V_r, V_i, K, Y)\right] \quad (1)$$

where:

- E = The overall emission reduction (expressed in grams)
- N = The number of cars bought with incentive
- δI = The variation of emissions
- V_r = The characteristics of the scraped old cars (Euro1/Euro2; petrol/diesel; <1300 cc,>1300 cc)
- V_i = The typology of the new purchased cars (Euro4/Euro5; petrol/diesel; <1300 cc,>1300 cc)
- K = The Average number of kilometers covered by cars annually
- Y = The number of years in which the old car would have circulated without incentive

Using the Database of Emission Factors (Barlow *et al*., 2001) we considered the emissions of CO, NOx, PM and COVNM by engine power (<1400 cc; >1400cc), environmental technology (EURO 1-2-3-4) and kind of fuel (petrol or diesel) given an average speed of 60 km/h.

Figure 1-3 show the emissions reduction in relation to the kind of substitution (EURO 0-EURO 4; EURO 1-EURO 4; EURO 2-EURO 4). Clearly the reduction is more consistent when older cars are changed.

Few hypotheses were made to build the model:

New cars have the same characteristics (fuel and engine's power) of the scrapped ones (Table 3). This means that the consumers maintain their "car category" in relation to fuel (diesel or petrol) and engine power (<1400; >1400); average driving per year is 23000 km for diesel cars and 13000 for petrol cars.

Following Eq. 1, we estimated the overall reduction for each scenario proposed (Table 4) using a discount rate of 5%[4]. it's evident that the efficacy of the incentives increases when consumers' bring their purchase forward and we move from the first scenario to the following ones.

Benefits for the consumers: Benefits for the consumers are calculated assuming that:

$$B_{con} = \partial CA + \partial T + \partial F \quad (2)$$

where:

- B_{con} = Consumers' benefit
- ∂CA = Benefits in terms of discount on the price of new cars
- ∂T = Benefits generated by the reduction of car taxes
- ∂F = Benefits generated by the variation of fuel consumption

To better explain each term of Eq. 2, we assume that:

$$\partial CA = (CA_t - D) - \frac{CA_n}{(1+r)^i} \quad (3)$$

where:

- (CA-D) = car cost after government's discount in t-th year (in which the regulation is in force)
- $CA_n/(I+r)^i$ = present value of the car cost bought in ith year
- t = 2007
- n = Number of years considered by each scenario
- r = 5%

The government's discount on car price represents the benefit mostly perceived by the consumer. Using the discount method, we calculated the financial cost for the consumers for all the scenarios, except the first one in which we considered that all the consumers would have changed their car also without the incentives.

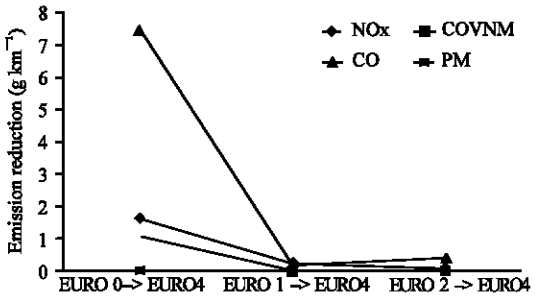

Fig. 1: Emissions reduction-Petrol cars <1400. (Source: our elaboration on data from Barlow, Hickman and Boulter, 2001)

[4]The choice of this discount rate is based on direction given by the European guidelines to Costs Benefits Analisys.

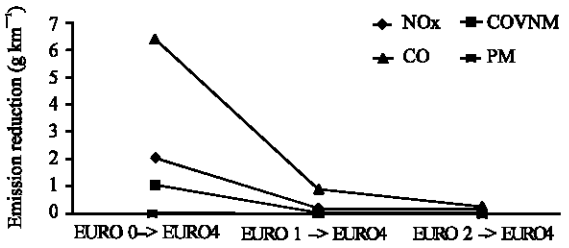

Fig. 2: Emissions reduction-Petrol cars >1400. (Source: our elaboration on data from Barlow, Hickman and Boulter, 2001)

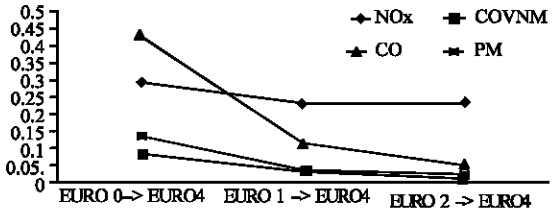

Fig. 3: Emissions reduction-Diesel cars. (Source: our elaboration on data from Barlow, Hickman and Boulter, 2001)

Given the hypotheses of the model and considering a rationale consumer, the financial incentive alone can't stimulate consumers to bring their substitution forward (Table 5).

The second term of Eq. 2 explains the car tax reduction, defined as:

$$\partial T = \sum_{i=t}^{n} \frac{T_o - T_n}{(1+r)^i} \quad (4)$$

where:

T_o = old car tax, paid in the whole period considered;
T_n = new car tax to be paid
t = 2007
n = number of years considered by each scenario
r = 5%[5]

The values of car taxes used in the analysis are presented in Table 6, while Table 7 presents the results obtained.

Finally, the third term of Eq. 2 is given by:

$$\partial F = \sum_{i=t}^{n} \frac{F_n - F_0}{(1+r)^i} \quad (5)$$

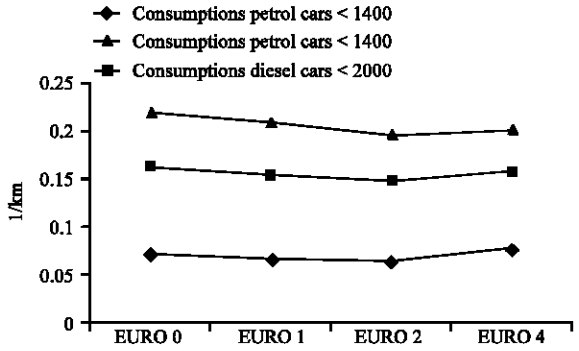

Fig. 4: Fuel consumption of Cars (l/km) (Source: www.sprintmotor.de)

Table 3: Hypothesis on the characteristics of scrapping and new car bought.

Car's category	Scrapping and new bought %
% petrol <1400	52
% petrol > 1400	14
% diesel<1400	5
% diesel>1400	29

(Source: our elaboration on ACI - www.aci.it)

where:

F_0 = Fuel expenditure using old car in whole period considered in the different scenario
F_n = Fuel expenditure using a new car
t = 2007
n = Number of years considered by each scenario
r = 5%

The substitution of old cars for new ones should generate a fuel saving, but there are some difficulties to find reliable data on this point. In this work we use data resulting from car owner's voluntary recommendations reported by the Springmotor web site[6].

The fuel consumption's variation seems to be characterized by a general increase in the last technological jump (EURO 2-EURO 4). But for petrol car <1400 there seems to be an increase also in the substitution EURO 0 EURO 4 (Fig. 4).

The F_0 and F_n values have been calculated using the substitution's number of EURO 0-1 with EURO 4 Table 1-3 an average distance covered of 12000 km for petrol cars and 23000 km for diesel cars and an average price of 1,4-/l for petrol and 1,3-/l for diesel.

In Table 8 we can observe the results for each scenario considered. The negative results in all scenarios (except clearly the first one) can be explained by the hard incidence of the substitutions of <1400 petrol category (Table 3).

[5]To obtain a positive result in the second scenario we must reduce the interest rate to 2%
[6]www.spritmonitor.de/en

Table 4: Overall emission reduction

Scenario	Polluting agent	Present value emission reduction
1	NOx	-
	VOCS	-
	CO	-
	PM	-
2	NOx	98.746.374.171.727
	VOCS	36.133.980.534.142
	CO	1.446.258.905.404.790
	PM	462.432.392
3	NOx	229.922.407.767.159
	VOCS	84.134.854.330.686
	CO	3.367.489.009.845.320
	PM	1.076.733.903
4	NOx	410.072.630.510.160
	VOCS	150.056.714.210.790
	CO	6.006.004.764.354.090
	PM	1.920.383.091
Mixed Scenario 1	NOx	140.827.934.594.288
	VOCS	51.532.766.544.358
	CO	2.062.593.753.392.380
	PM	659.501.669
Mixed Scenario 2	NOx	103.595.823.019.623
	VOCS	37.908.525.592.034
	CO	1.517.284.891.334.930
	PM	485.142.514

Table 5: Benefits in term of car cost's variation

Scenario	Benefit (€)
Scenario 1	289,822,400
Scenario 2	- 215,395,219
Scenario 3	- 886,533,212
Scenario 4	-1,808,238,615
Mixed scenario 1	- 430,697,765
Mixed scenario 2	- 240,206,530

Table 6: Parameter used for car taxes' elaborations (our elaboration on)

Type of vehicle	Annual car tax (€)
EURO 0 petrol	204.00
EURO 1 petrol	197.20
EURO 0 diesel	204.00
EURO 1 diesel	197.20
EURO 4 petrol	175.44
EURO 4 diesel	175.44

Quattroruote (www.quattroruote.it) data; all cars have been considered 1400cc and 68 Kw)

Table 7: Fiscal benefits

Scenario	Benefit (€)
Scenario 1	118.180.505,45
Scenario 2	134.568.566,69
Scenario 3	156.338.691,33
Scenario 4	186.236.628,43
Mixed Scenario 1	191.916.042,16
Mixed Scenario 2	141.177.248,64

Table 8: Variation in fuel expenditure

Scenario	Variation of fuel costs (€)
Scenario 1	0,00
Scenario 2	101.502.230,62
Scenario 3	236.339.181,61
Scenario 4	421.517.114,56
Mixed Scenario 1	144.758.221,40
Mixed Scenario 2	106.487.019,98

Table 9: Consumers' balance

Scenario	Consumers'balance (€)
Scenario 1	289.822.400
Scenario 2	- 182.328.883
Scenario 3	- 966.533.702
Scenario 4	- 2.043.519.101
Mixed Scenario 1	- 383.539.944
Mixed Scenario 2	- 205.516.301

Table 9 reports the consumers' balance while in Table 10 results for one typical consumer are presented.

As the results are negative in most of the cases, the consumers' choice to bring the substitution of their cars forward, as a consequence to the introduction of the incentives, seems to be irrational but it could be interpreted considering that they have a willingness to pay to obtain non-financial benefits - in terms of safety, reliability, pleasure to own a new fashion car - that are generated by the substitution.

Benefits for the car industries: During its application, the incentives stimulates cars sales that wouldn't have been realized otherwise. These additional sales would have been realized during at a later date. This means that, thanks to the incentives, the car industry brings their income forward. Formalizing, we estimate the car industry's benefit assuming that:

$$B_a = R_t - \sum_{i=t}^{n} \frac{R_i}{(1+r)^i} \quad (6)$$

where:

R_t = Incomes obtained in year t .

t = 2007

$\sum_{i=t}^{n} \frac{R_i}{(1+r)^i}$ = Present value of incomes that, without the measure, would have been obtained only at a later date

n = Number of years considered by each scenario

I = 5%

Table 11 reports the benefits for the car industries in all the considered scenarios (an average income of 15000-for each car is assumed). Again, the benefits increase when consumers' bring their purchase forward.

Government's balance: Now we try to estimate the impact of the incentives on the government balance, assuming that:

$$B_a = R_t - C_s = CT + \partial T - \partial I \quad (7)$$

where:

C_s = Overall cost for government

CT = Costs generated by the supply of grant, given by single grant amount plus the subsided demolitions number

Table 10: Single owner balance

	Petrol<1400		Petrol>1400		Diesel	
Scenario	euro0-->euro 4	euro1-->euro 4	euro0-->euro 4	euro1-->euro 4	euro0-->euro 4	euro1-->euro 4
Scenario 1	1.126,21	1.126,21	1.126,21	1.126,21	1.126,21	1.126,21
Scenario 2	-387,05	- 546,51	115,89	- 31,08	435,24	344,76
Scenario 3	- 2.397,29	- 2.768,58	- 1.226,25	- 1.568,45	- 482,66	- 693,33
Scenario 4	- 5.158,04	- 5.820,26	- 3.069,47	- 3.679,79	- 1.743,26	- 2.119,00

Table 11: Car industry's Benefits

Scenario	Benefits (€)
1	0
2	287.022.777,42
3	668.307.759,36
4	1.191.944.376,07
Mixed Scenario 1	409.339.839,20
Mixed Scenario 2	301.118.507,91

Table 12: Government balance

Scenario	A VAT benefit	B Car's taxes loss	C Subside	A-(B+C) Government's balance
1	0	118.180.505,45	289.822.400	- 408.002.905
2	101.043.524	134.568.566,69	289.822.400	- 323.347.443
3	235.271.122	156.338.691,33	289.822.400	- 210.889.969
4	419.612.203	186.236.628,43	289.822.400	- 56.446.825
Mixed Scenario 1	144.104.033	191.916.042,16	289.822.400	- 337.634.409
Mixed Scenario 2	106.005.786	141.177.248,64	289.822.400	- 324.993.863

∂T = Variation in car taxes caused by the years of exemption[7]

∂I = Variation given by an anticipation of VAT, in reason of the different consumer's choices defined by each scenario δT represents the present value of the lost fiscal returns given by the exemptions estabilished by the regulation. In our model we estimated this value as follows:

$$\partial T = \sum_{i=t}^{n} \frac{T_o - T_n}{(1+r)^i} \quad (8)$$

where:

T_o = Fiscal return given by the car taxes that, without incentives, would have been obtained with old car during the considered period

T_n = Fiscal return after incentives

t = 2007

n = Number of years considered by each scenario

r = 5%

The variation in terms of VAT, defined ∂I in the Eq. 7, has been estimated as follows

$$\partial I = I_t - \sum_{i=t}^{n} \frac{I_i}{(1+r)^i} \quad (9)$$

where:

I_t = The overall VAT return in t-th year

$\sum_{i=t}^{n} \frac{I_i}{(1+r)^i}$ = The VAT present value that would beobtained at a later date (depending n each scenario)

t = 2007

n = Number of years considered by each scenario

r =5%

Table 12 present the results obtained. Once more, it's evident the role played by the different strategic choices defined in each scenario. The efficacy of the incentives increases when consumers' bring their purchase forward and we move from the first scenario to the following ones.

CONCLUSION

Performing a disaggregated analysis, the regulation evaluation proposed in this paper gives different results referring to its different explicit and implicit aims.

Considering the reduction of pollution emissions, the impact of the incentives seems to be positive but, without a relevant technological jump, the cyclic reintroduction of incentives reduces their positive effects regarding pollution emissions reduction; in fact, as seen above in paragraph 3.2, the marginal reduction in passage from EURO 0-EURO 4 to EURO 2-EURO 4 decreases

[7]As described in par.1, for all the new cars bought using incentives there is a car tax exemption for 1 year in the case of EURO1 →EURO4 substitution and a 2 years exemption in the case of EURO → EURO4 substitution. Adopting a prudential approach, in our model we considered only the 2 years exemption.

considerably. From this point of view, it could be more efficient and effective a set of incentives based on coercive policies like traffic ban for some car categories etc.

More in general, as we demonstrated that the impact of the incentives is largely based on their capacity to bring cars substitutions forward, their cyclic reintroduction reduces their positive effects.

The regulation doesn't generate market distortions, given that the incentive is a general grant; of course, some car brands could take advantage if regulation would start together with the introduction of new car models.

Considering as an implicit aim of the regulation the economic support to the automotive industry, it must be noticed that this kind of incentive only bring forward the incomes deriving form sales. In this sense subsidies to research and development in car industry could be more effective generating a hard technological jump for engine and new demand in the sector, as well as a hard reduction of pollution emissions.

While we were writing this study, many European governments were deciding about new scrapping subsidies to face the economic crisis. As newspapers report, Germany, France and Italy were deciding about the reintroduction of lump sum incentives very similar to the ones we analysed in this work. As we pointed out, this kind of subsidies don't represent the best way to pursuit either explicit or implicit aims (environmental protection, economic support to the auto sector, etc etc).

In USA indeed, some of the new President Barack Obama's declarations seem to follow the guidelines traced by our study. As the Washington Post reported, Obama declared: "Our goal is not to further burden an already struggling industry (...) but to help American automakers prepare for the future and thrive by building the cars of tomorrow".

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