A DYNAMIC MODEL TO EVALUATE MIXED AUTOMOBILE FUEL MARKET IN ITALIAN ENVIRONMENT.

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ABSTRACT

The automobile fuel market in Italy is appreciably different from that in other European countries and even more unlike the American context.

As a matter of fact, the alternative and available automobile fuels in this country are the following:

- gasoline (petrol),
- gas oil (diesel oil),
- liquefied gas (LPG),

plus a very small amount of natural gas, each with its own price. In addition, price differences are considerably greater than in other countries.

In view of the fact that gasoline is the most expensive fuel and gas oil the least expensive, the Italian Government has adopted a peculiar tax called "Superbollo" meant to penalize car owners with diesel powered engines and those with both gasoline and LPG powered engines, but to a different degree.

The alternative access by drivers (car-users) to different fuel resources has influenced and continues to influence the automobile industry's approach to the Italian market.

On the other hand, the different fuel prices, plus the varying annual amount of the "Superbollo" tax, influences the motorist's decision in buying and using differently powered cars.

The decision is obviously affected by the consumption rate for each type of fuel and the driver's expected mileage per year.

This paper aims to underline and analyze the hypothesis on the mix of the three main fuels used in Italy, trying to give results principally on the basis of:

- price-changing of each fuel,
- tax-value of "Superbollo",
- different driver-mileage,

taking into account the pollution-cost of each of the three fuel solutions. The system, which is the subject of the study, will be analyzed using System Dynamics methodology, with a dynamic model.

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Introduction

The Italian market for car fuels has undergone different stages which have concurred to define certain distinctive features having some characteristics differing from those in other European countries.

In Italy, because of the difficulty in finding sufficient quantities of gasoline in war time, technologies have been developed for the use of natural and liquefied gas (LPG) as well as gas oil in fueling cars.

Nevertheless, the utilization of these types of fuels as an alternative to gasoline was always undervalued until the first energy crisis in 1974-75.

It was during that period that the technology of the diesel engine was improved in order to reduce the noise and smoke and to achieve better performance.

As a consequence of the technological improvement of the vehicles and of the increase in price differential when compared to gasoline that took place in the eighties, the sales of diesel automobiles increased.

Later, an additional yearly tax (superbollo) on diesel cars was imposed; this was added to the normal car tax that existed for all types of vehicles.

Subsequently, since there was also a significant gap between LPG and gasoline prices, a "superbollo" tax was also introduced for LPG cars.

The new tax (superbollo), which can be considered as a fixed cost, stimulated an increase in the yearly mileage covered by the diesel/LPG cars. Indeed, the incidence of the additional tax on the total amount of car expenses is checked by the increase of the mileage covered by the car.

Hence, the advantage in using of diesel cars as compared with gasoline fueled vehicles depends principally on the difference between the prices of the fuels and the number of miles covered annually.

The breakeven point is thus situated at different mileage levels and depends on the type of vehicle and on the additional yearly tax that must be paid. It also depends on the difference existing at any given time between the price of gasoline and that of gas oil, with the result that any change in either fuel price changes the breakeven point too.

In most recent years, growing concern about environment pollution caused by diesel cars (expecially sulphur) induced the authorities to raise the surtax in order to discourage the use of this kind of vehicle.

This led to a shift of the breakeven point to very high mileage levels, thus many of the drivers owning a diesel car were induced to consider going back to a four-stroke engine.

Actually, those who decide to give up their diesel cars often buy a gasoline car and subsequently transform it to an LPG car.

On the other hand, Italy's lack of liquefied gas (LPG), limits the number of vehicles furnished with this type of fuel.

The Process

Presently, nearly 85% of Italian families own at least one car. What should be underlined is that whereas the number of families owning only one car represents about 50% , the number of families with two or more cars is increasing day by day.

This means that cars turn out to be more and more individual rather than family possessions and therefore that their use together with their performance requirements and technical and economical features tend to vary.

The number of young people and women having a car of their own increases; and, in consequence of a statistical 'shift', the number of old men possessing a car - often the same one which used to be the family car in previous years - increases too.

Statisical experts and market-researchers can grasp only some of the aspects of these changes:

- the increasing yearly mileage together with today's different uses of the car;
- the differentiation of the market with regard to the typology of vehicles and fuels;
- purchasing behaviour with reference to the point of sale;
- the reactions to variations in the fuel price and, in general, to variations in the car ownership and operating costs.

Presently, the cars in Italy total to 22 million units, of which 85% are gasoline fueled, 10% are of the diesel type and 5% are cars using liquefied gas together with gasoline (as an alternative) and a very small number of natural gas fueled cars.

Excluding from this analysis the automobiles fed by natural gas, which are limited to very specific fields (taxi cabs, company-owned cars) and areas of the country, the factors that act on the evolution connected with the demand for gasoline, diesel and LPG can be examined from different points of view:

First of all we must underline some important economic and technical considerations:

- in Italy, taxation (government gain) on the gasoline price has always been and continues to be much greater than in any other Western European country;
- during the last decade, taxation on gas oil for vehicles was lower than that of other European countries;
- in Italy, the registration tax on gasoline cars (bollo) is proportional to the nominal engine horse power and is generally lower than in other European nations;
- diesel cars pay a yearly additional tax (superbollo), which is also basically proportional to the diesel horse power;
- the purchase price of a diesel car is usually 5% to 10% greater than that of the corresponding gasoline car;
- the number of dealers that distribute gas oil is nearly 60% of those that sell gasoline; and generally refueling is less easy (few pumps, no self service facilities, and pumps generally placed in secondary areas of the filling station);

- European automobile manufacturers do not make LPG cars. The transformation, keeps the gasoline fuel system too, represents an additional cost to the owner and takes place in specialized garages. The cost of transformation from gasoline fuel to both LPG and gasoline fuel - which also includes the installation of an LPG tank in the luggage-compartment, with a consequent reduction by 30-70% of the space available for the luggage - is not very high: about 500,000 liras ($ 400);

- the cars thus transformed can be fed either with gasoline or LPG: in the latter case, they may suffer a decrease in level of performance, i.e, speed and acceleration. Like diesel cars, these cars too are liable to a yearly additional tax, but it is less expensive (about 40%). This happens because the shortage of LPG sale points (only 1800 units in 1990) often leads users to drive part of their yearly mileage on gasoline instead of LPG, thus reducing proportionally the savings linked to this kind of fuel;

- the price of automobile car fuels expressed in Lire/litre up to date are as following:

	L/LT	%
GASOLINE	1425	100
GAS-OIL	916	64
LPG	575	40

- the medium specific consumption rates for different car categories having the same potential as the gasoline model are the following:

gasoline = 100
gas oil = 70
LPG = 120

Summarizing, the following tables (1&2) show a comparison between the ownership and operating costs for similar vehicles, considering the different additional taxes (superbollo) and the different degrees of efficiency (km/lt); the costs are related to varying levels of yearly mileage, always excluding, when referring to LPG, the difference between the cost of purchase and the cost of transformation:

(1989) Medium Direct management costs	Mileage (Km) 10,000	20,000	30,000
Gasoline **Specific Consumption; 10 km/lt.**			
Car tax (bollo) (14 HP) 60,000 Lire	6 L/km	3 L/km	2 L/km
Additional tax (Superbollo) 0 Lire	0	0	0
Fuel cost ~1400 Lire/lt	140 L/km	140 L/km	140 L/km
Gas oil (Diesel) **Specific Consumption; 12 km/lt.**			
Car tax (bollo) (17 HP) 100,000 Lire	10 L/km	5 L/km	3,4 L/km
Additional tax (Superbollo) 600,000 Lire	60 L/km	30 L/km	20 L/km
Fuel cost ~800 Lire/lt	67 L/km	67 L/km	67 L/km
GPL **Specific Consumption; 8 Km/lt.**			
Car tax (bollo) (17 HP) 100,000 Lire	10 L/km	5 L/km	3,4 L/km
Additional tax (superbollo) 300,000 Lire	30 L/km	15 L/km	10 L/km
Fuel cost ~520 Lire/lt	65 L/km	65 L/km	65 L/km

Table 1

The Italian driver

The sudden growth in the number of cars, which as noted earlier has now reached 22 millions, has determined an extremely varied articulation of the market from the psycho-social point of view with regard to purchase behaviour and to the development of supply.

This market articulation has great importance as a basis for the hypothesis of adaptation to the development of some market supply considerations. Thus, in order to hasten market development through a series of interventions, knowledge of driving habits and other factors that contribute to defining the market structure seems indispensable.

Indeed, nowadays we can talk about different kinds of market, each with its own characteristics nevertheless, there are certain overlapping areas.

Proposal	Gasoline	LPG	Diesel
MILEAGE			
< 10,000	60%	13%	3%
10-20,000	35%	40%	12%
20-30,000	2%	24%	34%
> 30,000	3%	23%	45%
	100%	100%	100%
MAIN USE			
Work	22%	37%	54%
Home/Work	30%	25%	24%
Other uses	16%	13%	5%
Vacations/ Journeys	32%	25%	17%
	100%	100%	100%
AGE			
< 25 years	19%	14%	14%
25-40 years	31%	47%	45%
> 40 years	50%	39%	39%
	100%	100%	100%

Table 2

Moreover, it is interesting to see, according to the results of market research, what the drivers' opinion is of the most evident disadvantage of their choice:

Gasoline: high price of the fuel

LPG: lack of points of sale

Gas oil: great noise; the efficiency is generally lower than that of similar gasoline cars; the cost of the additional tax (superbollo).

The prespectives

The aim of our project is to determine the prospects for the evolution of the demand for the three types of fuel, taking into account the above-mentioned characteristics of the levels of the market and the modifications that some of the main elements can undergo.

In particular:

1) We must consider that the Italian price of gasoline is the highest in Europe and that a community adjustment is to be expected, with a drop in price as possible consequence.

2) The second problem is whether the additional taxes on gas oil and LPG cars will still remain the same, even after the community adjustment, or whether they will be reduced or even abolished.

3) At present, LPG use is restricted by lack of points of sale. Recent measures, which could imply a significant rise in their number, may lead to a new increase in the LPG use.

4) The whole operation may cause a modification in fiscal revenue, which could be balanced by modificating the car tax to all types of cars.

The model

As has been shown above, there are more than a few variabiles and parameters that influence the decision of a potential driver in choosing between one type of car and another.

The dynamic model based on a system-dynamics approach which we constructed takes into account the most important characteristics of the Italian fuel market mix .

The principal dynamic of the model is shown in Table 1 and represents how the rate (increasing/decreasing) of the market level of different automobile categories (gasoline, diesel, LPG) changes by the share of demand.

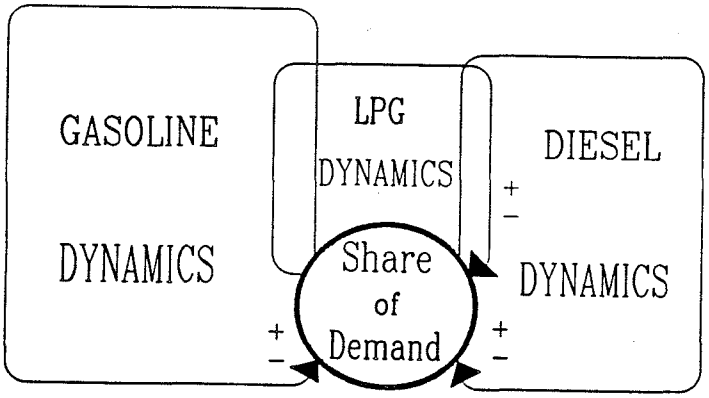

Fig. 1 CAR-MARKET DEMAND

Again, as shown in Fig. 1, each type of car has its own dynamics. These dynamics are evaluated, in the model, through a cost function which is defined for each car fuel considered.

The cost function is calculated applying a number of quantitative and qualitative parameters:

- maintenance cost (Lire/km)
- normal and additional (superbollo) taxation (Lire)
- mileage per year (km)
- fuel consumption rate (Lt/km)
- pollution cost (Lire/km)
- community disturbance cost (Lire)
- number of fuel sale points
- ...

Each of the model parameters for each type of car has a heavy or light influence. For example, as shown in Fig. 2, the diesel car cost is strongly influenced by superbollo

and pollution costs and at the same time the superbollo cost itself depends heavily on the level of the diesel car market, which increases/decreases on the basis of drivers' average mileage.

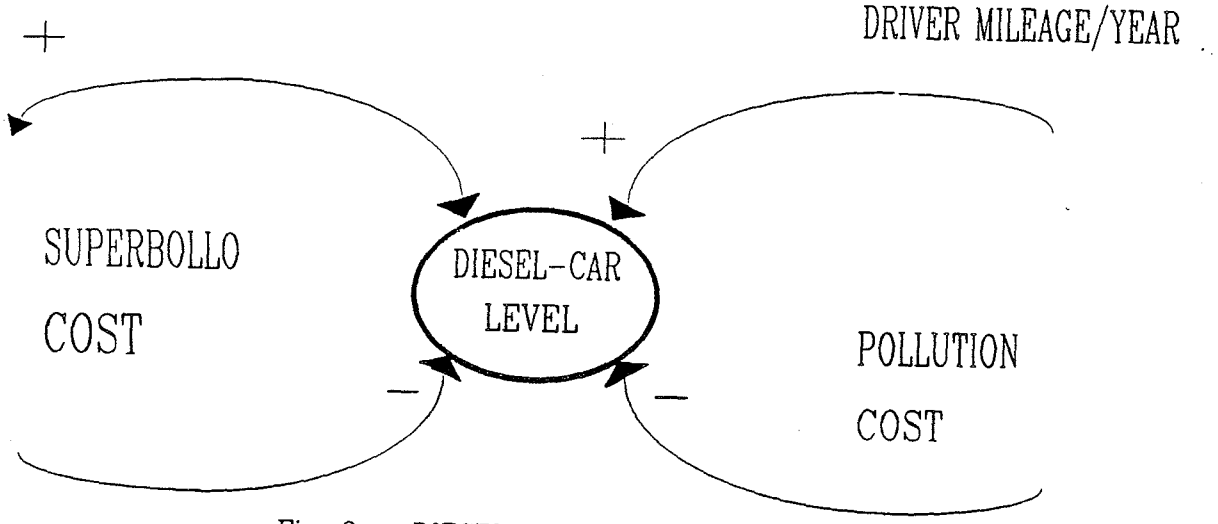

Fig. 2 DIESEL DYNAMICS

Results

The model is being run for a period of 10 years beginning with 1986. This has been done with the aim of verifying the validity of the model for the period 1986-1989.

The simulation interval is one year and the automobile fleet that has been taken into account is not the total number of Italian cars, but rather the so called "critical fleet" which represents the automobiles in the share of market which can potentially be of the three different fuel types. However, some specific production-market constraint is considered.

Even though in this first version of the model we have over simplified some situations the early results are particularly interesting.

In fact, the model experimented over this 1986-1989 period gave surprising results compared to real data.

The simulation for future years, with some realistic assumptions, confirms the tendency of the market share for diesel for long mileages (> 30,000 km/year) and LPG for medium mileages (20,000 km/year), leaving the gasoline car market concentrated principaly over the short mileages. This tendency, however, is seen over the long term.

The model is still in the development phase, and the authors hope to present more concrete results by conference time.