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ARE “FLEXIBLE” TAXATION MECHANISMS EFFECTIVE IN STABILIZING FUEL PRICES? A FISCAL POLICY EVALUATION COSIDERING THE ITALIAN FUEL MARKETS

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Are "flexible" taxation mechanisms effective in stabilizing fuel prices? A fiscal policy evaluation considering the Italian fuel markets[♣]

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Abstract. In this paper we study the incidence of specific taxes in the Italian fuel markets, and exploit these findings to simulate the effects of fiscal policies aimed at mitigating oil price fluctuations. We estimate several reduced-form specifications, using as dependent variables the equilibrium wholesale prices for gasoline and motor diesel over the period 1996-2007. In particular, we assess the impact on wholesale gasoline and motor diesel prices stemming from the creation of an automatic fiscal mechanism consisting of a one-to-one reduction in specific taxes matching the rise in oil prices – a policy which has progressively gained political support after the sharp increase of oil prices experienced in recent years. Our simulations point to a growing effect of sterilization policy on fuel wholesale prices. Hence, no fiscal intervention by the government would guarantee wholesale prices for gasoline and motor diesel lower by around 0.1% – 0.5%, depending on the adopted model specification, in response to a one euro increase in oil price. This evidence suggests that "flexible" taxation mechanisms, focusing on specific tax reductions (rises) to compensate oil price increases (decreases), could not be a proper policy for stabilizing price levels in fuel markets.

Keywords: fuel markets, specific taxes, tax incidence, sterilization policy, antitrust intervention
JEL: H22, H32, L40, L71, Q48

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1. Introduction

As a reaction to the oil price boom recorded in recent years, consumers' associations has suggested (and policy makers has experimented) the introduction of “flexible” taxation mechanisms on fuels. The idea of “flexible” taxation is very simple: in order to keep (gross) prices at a long-run equilibrium level, specific taxes should react one-to-one to variations observed in input prices. Indeed, among the various available measures, the sterilization of the increase in oil prices by a reduction in specific taxes on fuels seems to be one of the most popular actions. However, such a sterilization policy should be carefully evaluated, as for the likely impact on consumers, producers, and tax revenues. On one side, if fuel prices are kept constant, there is a welfare enhancement for drivers and fuel consumers with respect to a situation of volatile prices. On the other side, there is the need for the government to find different sources of tax revenues, or to correspondently reduce public expenditures. These concerns are particularly stringent in the European fuel markets, as fuel taxes account both for a large share of the retail price in many countries (particularly in Italy, where taxes represent about 50% of the final consumer retail price), and for a nontrivial share of government’s budget revenues (about 4-5% of total revenues), and finance both Central government and Local (i.e. Regional) governments expenditures.

Concerns on the impact of sterilization policies aimed at keeping prices at a constant level are likely to arise also as for the industrial structure of these markets. The price of fuels has been traditionally regulated by public bodies in Italy. However, since 1994 a complete liberalization of prices for gasoline and motor diesel allowed the suppliers operating in the Italian market to freely set their prices according to the international crude oil price and their operating costs (including distribution costs, retailers’ margins, etc.). The final consumers’ price for fuels is set by the retailers, while distributors often suggest a “recommended” retail price for gasoline and motor diesel. On several occasions, the Italian Antitrust Authority (AGCM) has investigated the structure and the conduct of the companies operating in this industry. A number of facts have been established (see AGCM, 1996, 2000, 2001, 2006, 2007). First, the fuel market is highly vertically integrated, with a structure of the industry characterized by three main stages: upstream refiners, wholesale distributors, and downstream retailers. Vertical controls can take different forms: the most common is vertical integration, where the same company owns and operates refineries and retail outlets. But also other forms of market restrictions are present, like contractual agreements that impose where and from whom the retailers have to purchase wholesale fuels. Second, the market is highly concentrated and, given the high degree of vertical integration, the same companies are leaders in all three stages of the industry. The market leader is ENI (partly owned by the Italian Government), with a market share around 30% in 2006. The market share of the first three companies (CR3 for ENI, Esso and Kuwait) amounts to 50.5% in 2006. Third, the network of retailers has some peculiar characteristics that differentiate Italy from the other main European countries. About two thirds of the retailers are refiner-owned stations, usually operated by a leasee-dealer, under a franchising arrangement (see Borenstein and Bushnell, 2005). Unlike other European countries, the number of gas stations is high, both in absolute and relative terms; they are small in size and the share of unbranded independent stations (i.e. non refiner-owned, such as, for instance, those owned by large distribution chains) is close to zero. The main consequence of this fragmented and concentrated structure at the retail stage is the likely presence of some inefficiencies, like unexploited scale economies. Finally, in a couple of instances the AGCM (2000 and 2006) established the presence of collusion conduct by the major companies in the industry aimed at controlling final consumer' prices. As the story goes, the fines levied on refiners by the AGCM in 2000 were finally removed after the appeal to the Administrative Court by the sanctioned companies.

The purpose of this paper is to contribute to the current debate on sterilization policies, by providing some insights on the possible effects of government strategies aimed at mitigating the impact of oil price peaks. We concentrate on the role of fuel specific taxes and estimate several reduced-form specifications considering as a dependent variable the equilibrium wholesale prices observed for both gasoline and motor diesel markets in Italy. Depending on the adopted specification and on the sub-period being considered, our results show that a 1% increase in oil price implies an increase of wholesale gasoline price ranging from 0.3% to 0.5% and a rise of wholesale motor diesel price between 0.4% and 0.6%. We also evaluate the incidence of specific taxes. Again depending on the chosen specification, we estimate that a one Euro increase in the specific tax on gasoline is found to reduce wholesale gasoline price by 0.35-1.7 Euros. For motor diesel, the effect of a one Euro increase in the specific tax corresponds to a reduction in wholesale prices ranging between 0.5 and 1.8 Euros. We finally simulate the impact on wholesale prices of a sterilization policy that makes specific taxes react one-to-one to oil price increase. In particular, we assess the effects of a one Euro increase in oil price sterilized by a one Euro reduction of specific taxes. Our evidence points to a positive impact of such a fiscal policy on fuel wholesale prices. In other words, no government policy would guarantee wholesale prices for gasoline and motor diesel lower by around 0.1% - 0.5%, according to the adopted specification.

The remainder of the paper is organised as follows: next section reviews the relevant literature on fuel taxes and oil prices, while in section 3 the data and comments on the descriptive statistics are presented. Section 4 describes the empirical strategy and the main results from model estimation. We then discuss the incidence of specific taxes on gasoline and motor diesel wholesale prices and the implications of fiscal policies aimed at offsetting the impact of oil price increases. Section 5 concludes.

2. Related literature

While a large empirical literature exists on the determinants of gasoline prices and the way they react to changes in oil price (e.g., among the others, Borenstein *et al*., 1997; Borenstein and Shepard, 2002; Galeotti *et al.*, 2003; Wlazlowski *et al.,* 2009), only a scant number of studies consider the effects of fuel price taxation[1]. Moreover, almost all contributions focus on the U.S. gasoline market, while we consider both gasoline and motor diesel markets in a European country. Chouinard and Perloff (2004) study the incidence of Federal and State specific gasoline taxes in the U.S. Market. They exploit a monthly panel dataset covering the 48 mainland states and the District of Columbia from March 1989 through June 1997. They observe both wholesale and retail gasoline prices and estimate a reduced-form price equation, where gasoline prices are explained by a set of demand side and supply side variables, like consumers' income, vehicles per capita, oil prices, market power and taxes. They find that while federal specific taxes are paid by both consumers and wholesalers by approximately the same share, state specific taxes' burden falls almost exclusively on consumers. The consumer incidence is much smaller in the larger states than in smaller ones. The main explanation for these findings is that the residual supply elasticity (affecting tax incidence) is greater for state than for federal taxes and greater for small than for large states. In a related paper, Chouinard

[1] For a comprehensive review of theoretical issues concerning the tax incidence see Fullerton and Metcalf (2002).

and Perloff (2007) consider also the incidence of state *ad valorem* taxes. Using the same dataset and a similar estimation strategy, they find that the burden of the federal specific tax is not any more equally shared between consumers and wholesalers: while consumers pay about three quarters of the tax, wholesalers pay for the remaining one quarter. Almost the entire incidence of a state specific tax falls on consumers, while a 1% increase in state *ad valorem* tax results in a 1.26% increase in retail gasoline price, but it generates almost no effect on the wholesale price.

Alm *et al.* (2009) study the incidence of state excise taxes in the U.S. retail gasoline market. They observe monthly retail prices in all 50 states over the period 1984-1999. Exploiting variation across states in the timing of tax changes, they investigate how taxes affect gasoline prices. The main finding is a complete shifting of gasoline taxes to final consumers, so that interstate differences in gasoline prices fully reflect interstate differences in gasoline taxes, once one controls for other factors that may affect gasoline prices, like crude oil prices.

Doyle and Samphantharak (2008) study the incidence of gasoline state sales taxes using very detailed data on daily gasoline prices at the station level in the U.S. They estimate a reduced-form price equation, where gasoline prices are regressed against a number of demand-side and cost-side variables. Exploiting a temporary tax moratorium in two states during spring 2000, the authors are able to assess gasoline price responses to changes in tax rates. Their results suggest that about 70% of tax reduction is passed on to consumers in the form of lower prices. However, when the tax is reinstated, retail prices increase by 80-100%.

Overall, the available evidence then suggests that – at least in the U.S. – specific taxes are passed-through to a large extent to final consumers. In the following sections, we provide first evidence for the Italian fuel market.

3. Data and descriptive evidence

The main data source is the *Bollettino Petrolifero* (Oil Bulletin) published by the Italian Department for Economic Development. We collect data for three products: gasoline (unleaded and octave rating equal to 95 RON gasoline), motor diesel, and crude oil. For gasoline and motor diesel, we gather monthly data on wholesale prices, retail quantities sold over the whole Italian road network, and the specific taxes over the period January 1996 – December 2007, leading to time series of 144 observations each. We also obtain monthly C.I.F. (cost, insurance, and freight) crude oil prices for the same time period.

The fuel industry being analyzed is characterized by a vertical structure involving three groups of actors: refiners, wholesale distributors, and downstream retailers. Refiners transform crude oil into petroleum products. Distributors receive petroleum products at their wholesale terminals and manage the distribution service to the gas stations. Finally, retailers sell products to final consumers. We concentrate on the segment where fuels (in our case unleaded gasoline and motor diesel) are delivered from the wholesale terminals to the retailers. The net wholesale price P we observe is defined as the price at which products are sold to the retailers: they do not include taxes (specific taxes t_1 and sale taxes t_2) and retailers' profits (π^r), that are incorporated in the retail price P^r defined as $P^r = (P + t_1)(1 + t_2) + (\pi^r)$. This price P is then the equilibrium price in the market where distributors and retailers meet and includes distributors' profit margins, but it is net of specific and *ad valorem* taxes.

Table 1 reports some summary statistics for the variables used in the empirical models. Wholesale prices for gasoline and diesel average 396 Euro and 393 Euro per 1000 litres, respectively. Diesel prices show some higher volatility than gasoline prices, but they are strongly correlated (correlation coefficient 0.96). Specific taxes amount on average to 615 Euro per 1000 litres for gasoline and 452 Euro per 1000 litres for motor diesel; they are lower for motor diesel over the whole sample period. On average, the tax is about 1.6 times the observed gasoline price. For diesel, the specific tax amounts to 1.3 times the wholesale price. These figures are comparable to those from other Western European countries, where the burden of specific taxes on fuel prices approximately ranges between 0.9 (e.g., in Spain) and 1.6 (e.g., in the UK)[2]. Besides specific taxes, ad *valorem taxes* (VAT) contribute to increase gross prices, but they are not considered here since they show no variability across our sample period. The price of crude oil shows a very high variability, and it trends upwards throughout the whole period. On average, crude oil price over the twelve years is about 253 Euro per 1000 litres, and the standard deviation is 164.

Figures 1 and 2 illustrate the behaviour of gasoline and motor diesel prices together with crude oil price and specific tax over the observed time span from January 1996 to

[2] According to data relative to the second semester of 2006 provided by Eurostat, database on Petroleum products.

December 2007[3]. A number of interesting features stand out from the figures. As noted above, oil price increased over the observed time period and wholesale prices closely followed its behaviour. Starting from the beginning of 2007, however, the explosive growth of oil prices was only partially followed by wholesale prices *P*. If we interpret the distance between the oil price and the wholesale price as a proxy for refiners and distributors margins (that seems plausible given the high degree of vertical integration and vertical restrictions existing in the Italian industry), it seems that they reduced over time. We argue that an important role in shaping this reduction was played by the AGCM. In 1999, the AGCM started an inspection process at the premises of the companies operating in the distribution of fuels in the Italian market. In 2000 the scrutiny process ended, and the main companies were fined for running a price cartel. Even if the fines were removed by the Administrative Court in 2001, the AGCM started other investigations on the fuels companies (e.g., in 2005 and 2007). The fear of investigations and fines may have contributed to the reductions in the fuel price – oil price margins over the period. Figures 1 and 2 also allow us to distinguish three main phases in the evolution of prices. In the first period (from the beginning of our time series till approximately the end of 1998), prices were relatively low and stable and they also tended to decrease from the end of 1997. In the second phase, during 1999 and 2000, prices increased and then suddenly decreased during 2001, reaching a quite stable level during 2002 and 2003. Finally, starting from 2004, prices steadily increased. In the meanwhile, specific taxes constantly and slowly diminished. This behaviour of our series will be taken into account in the following empirical analysis, where we need to discuss the possible presence of structural breaks, by testing parameter stability in the estimated price equations.

To enrich our understanding of the industry, we also collect information on the structure of the demand and supply of petroleum products. First, we consider the market share of the industry leader, ENI, whose main shareholder is the Italian Government. Given the high degree of vertical integration, ENI is actually market leader in all three segments of the market: refinery, distribution, and retail sales. The figures displayed in table 1 (and the variable adopted in the estimated specification) refer to the share in the retail market (as stated by ENI in its annual *Fact Book*). The average annual share amounts to 38%

[3] All monetary amounts are deflated using the monthly consumer price index (base month: December 2007).

but it decreased over time, also as a consequence of the divestiture of one its main branches (IP – Italiana Petroli, acquired by API in 2005) and reached its lowest value (29%) in 2007. Second, we consider a set of variables informative on the size of the demand side of the market. Distributors sell gasoline and motor diesel to retailers and an important feature of the retailers is the number of gas stations observed in the country. Data on the yearly number of gas stations distributed over the Italian road network comes from Unione Petrolifera (De Simone, 2008), the nationwide trade organization which associates the major Italian petroleum companies: on average, 20,000 gas stations (selling both gasoline and motor diesel) are present on the territory, and their number is quite stable over time.

The total number of registered vehicles is also introduced in some specifications of our price model. Data are obtained from the annual report (*Annuario statistico*) elaborated by ACI (Italian Automobile Club), a non-profit public institution that represents drivers' interests and manages the Italian register for vehicles. On average, there are about 42 million vehicles corresponding to approximately 727 vehicles per 1000 inhabitants. Both the absolute and the relative number of vehicles increased over time, and this evidence characterises Italy as the country with the largest number of vehicles (per inhabitants) in Europe[4]. Finally we consider the share of population over 65 years old. This variable allows us to control for any change in preferences and habits over the observed period, as population ageing more and more shapes the structure of Italian consumers. The average yearly share of people over 65 is 19% of the whole Italian population, and it sharply increased over time.

4. Econometric analysis

4.1. Empirical strategy

Our aim is to study the relationship between wholesale gasoline and motor diesel prices, on one side, and oil prices and specific taxes, on the other side. From an econometric perspective, two options are feasible to us: the implementation of a structural model or the estimation of a reduced-form specification. The estimation of a structural model requires the formalization of the characteristics of both the demand and the supply. On the demand side (here represented by gasoline and motor diesel retailers), we need to

[4] In 2004, the number of vehicles per 1,000 inhabitants amounts to 597 in France, 625 in Germany, 577 in Spain and 530 in UK (source ACI, *Annuario statistico* 2007).

observe market prices (*P*), total quantities (*Q*) and other exogenous demand shifters *Z*, so that $Q = D(P, Z)$. On the supply side, represented by petroleum product wholesalers, two sets of assumptions are needed: the strategic game played by the competitors and the structure of marginal costs (see Chouinard and Perloff, 2007). Let *W* be exogenous cost shifters and *M* the exogenous market power shifters; we can then express marginal costs as $MC = C(W)$ and market power as $\theta = f(M)$. We decided to estimate a reduced-form specification – i.e. pricing equations where equilibrium prices are functions of exogenous demand, cost and market power shifters $P = h(Z, W, M)$ – for at least two reasons. First, we lack variation in our data. While the dependent variables and the main regressors (specific tax and oil price) vary monthly, most of the other exogenous shifters display only *annual* variation. Second, for the identification of a full structural model, observations over other dimensions would be ideal: either spatial (e.g. region level) or firm level (e.g. prices and quantities associated to each single supplier).
We consider the following multiple time-series model:

$$\begin{aligned} PGAS_t &= \beta_0 + \beta_1 TAXGAS_t + \beta_2 POIL_t + X_t'\gamma + \varepsilon_t \\ PDIES_t &= \alpha_0 + \alpha_1 TAXDIES_t + \alpha_2 POIL_t + X_t'\delta + \nu_t \end{aligned} \quad [1]$$

where the wholesale prices of gasoline (*PGAS*) and diesel (*PDIES*) are simultaneously regressed on a set of independent variables. *TAX* is the specific tax, different for gasoline (*TAXGAS*) and motor diesel (*TAXDIES*), *POIL* is the C.I.F. crude oil price, while *X* is a vector collecting a set of additional covariates that we introduce to control for demand side and supply side factors that are common to both products. In all specifications we also include a set of monthly dummy variables, to capture seasonal effects in wholesale prices. With respect to the error terms, we assume that they are uncorrelated to the set of included regressors, while the contemporaneous errors can be correlated.
We estimate the system of two equations in [1] by Zellner's (1962) seemingly unrelated regressions (SUR) estimator. The main advantage from this empirical strategy is a gain in efficiency with respect to the estimation of separate equations (see Creel and Farell, 1996).
Before the estimation, all variables are transformed in natural logarithm, so as to allow for nonlinear relationships between fuel prices and the regressors. Such a transformation constraints price elasticities to be constant over time. However, we find this not to be a major problem in our data as results are basically unaltered when variables are used in

absolute terms. Moreover, in some specifications we mitigate this strong assumption by interacting some variables with a set of time-specific dummies.

4.2. Estimation results

Table 2 presents the first set of estimation results. MODEL 1 refers to gasoline equation and motor diesel equation, respectively, and shows parameter estimates from our baseline specification that includes only specific tax and oil price as explanatory variables. The coefficients for specific taxation are negatively signed and statistically significant. As expected, oil price positively and significantly affects the wholesale prices for the two products. Coefficients' magnitudes are comparable across the equations. A one percent increase in specific tax decreases gasoline wholesale price by about 0.54% and motor diesel wholesale price by 0.60%, while a one percent increase in oil price rises gasoline and motor diesel prices by about 0.29% and 0.40%, respectively.

Given the price movements as highlighted in figures 1 and 2, we suspect the presence of some structural breaks, that we ascertain by Chow breakpoint test and CUSUM tests (sum of recursive residual test; see Brown *et al.*, 1975). These tests suggest the presence of parameter instability in the equation during the sample period. In particular, it is possible to single out two breakpoints: one around the beginning of 2001, the other at the beginning of 2004. Under the heading MODEL 2 in table 2 we report estimation results from our two baseline equations, where specific tax and oil price are interacted with a set of three dummy variables, one for each of the three periods characterizing our sample. *TAX_P*1, *TAX_P*2 and *TAX_P*3 are obtained by interacting the variable for specific tax (*TAX*) with the dummy *P*1 for the first period (equal to one for observations from January 1996 to December 2000), the dummy *P*2 for the second period (equal to one for observations from January 2001 to December 2003), and the dummy *P*3 for the third period (from January 2004 to December 2007), respectively. Similarly, the variable for oil price (*POIL*) is interacted with the same set of dummy variables, obtaining *POIL_P*1, *POIL_P*2, and *POIL_P*3. All the interacted variables have the expected sign and are statistically significant. More interestingly, the coefficients are different across periods: a Wald test on the equality of the coefficients for specific tax and oil price is rejected for both the gasoline and the motor diesel equations. Tax and oil elasticities are larger than those from the pooled specification of MODEL 1. Moreover, they sharply decreased during the second period (2001-2003), to return to original values in the last interval. The trend in the coefficients is likely to be associated to the scrutiny by the AGCM, which was particularly severe at the beginning of 2000's. The reduction in price elasticities in the second time period, especially with respect to oil price, may signal a change in the conduct by distributors that were under investigation (and successively fined) by the AGCM for the potential presence of a price cartel.

In the last two columns of table 2 we also include the market share of the leader distributor in the Italian fuel industry (MODEL 3). We introduce the *LEADER* variable as a quadratic expression in both price equations. Products' elasticities with respect to the specific tax become even higher for both gasoline and motor diesel, supporting again the hypothesis of the existence of some structural breaks over the observed period (the hypothesis of equality is still rejected by the data). The coefficients on leader market share (*LEADER* and *LEADER_SQ*) are found to be negatively and positively signed, respectively; they are also both significant at conventional statistical levels. The elasticity of wholesale prices increases more than proportionally with the rise in the leader market share: when leader market share is at its minimum, the elasticity of gasoline and motor diesel price is negative (-0.20 and -1, respectively), while at its maximum the same elasticity is positive and particularly large for gasoline (0.83 for gasoline and 0.66 for motor diesel). This evidence suggests that higher industry concentration turns out to actually rise wholesale prices, especially that of gasoline. The increase in magnitude for the estimated parameters for specific tax and oil price may be the result of a better specification of the model.

Table 3 presents the results for price equations [1] when additional exogenous regressors are included. MODEL 4 in table 3 includes the share of population older than 65 out of total population (*POP*65), the number of vehicles per 1000 inhabitants (*VEHICLES*), and the interaction between these two variables (*POP*65_*VEHICLES*) [5]. The coefficients on specific tax and oil price (still interacted with the three periods' dummies) are similar in magnitude to our previous specifications (last four columns in table 2) and are statistically significant, lending additional credibility to our strategy. The coefficients for *LEADER* are not precisely estimated, probably because of the presence of some collinearity problem between this variable (that also enters with a squared term) and the additional covariates. Conversely, the new variables are all significant and have the

[5] All variables are expressed in natural logarithms.

expected sign. All else equal, as the number of vehicles per capita increases, the prices rise. However, such a positive impact comes about at decreasing rates, for the effect of ageing population. Indeed, elderly people is expected to drive less and to be more price sensitive, and an ageing population has negative effects on petroleum products' prices (working through a reduction in fuel demand).

Finally, MODEL 5 of table 3 considers the impact on fuel prices exerted by the number of retailers (*RETAIL*). Many coefficients lose precision, and in some cases (*POP*65 and its interaction) also the coefficients' magnitudes drop. Anyway, previous results for specific tax and oil price are confirmed, while the newly included variable *RETAIL* is positive and significant. A one percent increase in the number of gas stations is found to increase gasoline and motor diesel prices by approximately 2%. This is a quite strong result that can be interpreted on a number of grounds. The retailers represent in our model the "consumers" of the distributors setting wholesale prices. It is therefore intuitive that a larger demand increases equilibrium prices, all else equal. For the Italian market in particular, the AGCM together with many scholars (e.g. Scarpa, 2008) point out that the number of retailers is too high, and this causes inefficiencies and increased prices to consumers (AGCM, 1996). These inefficiencies are even more harmful – as for price competition – since the industry is strongly vertically integrated and the same actors (refiners and distributors) control most of the retailers, through direct ownership of the stations or under a franchising arrangement. It follows that the positive impact of the variable *RETAIL* on gasoline and motor diesel prices is also due to market power that wholesalers enjoy as long as they control the management (i.e. the pricing) at the station level.

The last two columns of table 3 (MODEL 6) address the potential econometric issues arising from the estimations of relationships that involve non stationary variables. We transform our previous specifications using first differences. All variables that do not vary monthly are dropped and we are left with the set of six coefficients for specific tax and oil price. Parameter estimates for oil price are always positive and significant and their magnitude is comparable to that from previous specifications, reproducing also the pattern of larger coefficients for the first and the third period. Estimates for specific tax are now less reliable. They are smaller and never statistical significant for motor diesel equation, while for gasoline they are larger and significant for the second and the third period, but a Wald test on the equality of the three coefficients is not rejected.

4.3. Tax incidence

The advantage of the log-log specification is that marginal effects vary according to the observed level of the variables of interest. Tables 4a and 4b offer some insights on the marginal effects of specific tax and oil price on gasoline and motor diesel wholesale prices. These have been computed as the product of the relevant elasticity by the ratio of variables evaluated at sample mean values. As for the case of the marginal effect (*ME*) of specific tax and oil price on the gasoline price, the formulas used are:

$$ME^{PGAS}_{TAXGAS} = \frac{\partial PGAS}{\partial TAXGAS} = \beta_1 \frac{\overline{PGAS}}{\overline{TAXGAS}} \quad ; \quad ME^{PGAS}_{POIL} = \frac{\partial PGAS}{\partial POIL} = \beta_2 \frac{\overline{PGAS}}{\overline{POIL}} \qquad [2]$$

where β_1 and β_2 are the coefficients estimated from model [1]; $\overline{PGAS}$, $\overline{TAXGAS}$ and $\overline{POIL}$ are the sample mean values of the respective variables (see table 1).

We use the estimation results from three specifications to compare the magnitude and interpret the evolution of tax incidence. Under the heading MODEL 1, we compute *ME* from our baseline specification, where a single coefficient is estimated for specific tax and oil price (first two columns of table 2). In this case *ME* is always the same for all the sub-periods, and it amounts to -0.35 and -0.52 for specific tax on gasoline and motor diesel price, respectively: a 1 Euro increase in specific tax is expected to reduce wholesale gasoline price by about 0.35 Euro and motor diesel price by 0.52 Euro[6]. According to these estimates, wholesalers would pay from one third to a half of tax increase.

When we allow for differing coefficients across sub-periods, *ME* varies significantly with time periods. Under MODEL 2 (table 2), where no additional variables are included, and under MODEL 5 (table 3), where all the additional regressors are considered, tax incidence is higher for both gasoline and diesel products. What we are considering is the impact of specific tax on the wholesale prices, i.e. the price the distributors charge to the retailers. Under MODEL 2, a 1 Euro increase in specific tax results in approximately 0.80 Euro wholesale gasoline price reduction in period 1 and 3, while in the sub-period 2, the price reduction is 0.67 Euro. Under MODEL 5, the effect of a 1 euro increase in specific tax produces even larger wholesale gasoline price reductions: around 1.70 Euro in period 1 and 3, and 1.53 Euro in sub-period 2. For motor diesel prices results are very

[6] All marginal effects have been computed at the sample mean values.

similar. From MODEL 2, a 1 euro increase in specific tax turns out into 0.94 Euro and 0.97 Euro price decrease in periods 1 and 3, while in sub-period 2 the reduction is 0.69 Euro. Under MODEL 5, the effects are again greater: 1.82 Euro and 1.88 Euro decrease in motor diesel price in periods 1 and 3 and 1.59 Euro reduction in period 2. As for the increase in the magnitude, especially for MODEL 5, one should notice that these impacts are computed by keeping constant all the other covariates. As for the trend, we already referred to the likely impact of AGCM intervention.

4.4. Fiscal policy simulation

As a reaction to oil price booming in recent years, the introduction of "flexible" taxation mechanisms on fuel products has been suggested by consumers' associations, with policy makers experimenting some fiscal interventions moving towards this direction. Among the other suggested measures, the sterilization of the rise in oil price through a one-to-one reduction in fuel specific taxes seems to be one of the most popular actions, not only in Italy but also in other countries (see, e.g., Doyle and Samphantharak, 2008, for the fiscal policy in the U.S. fuel markets).

The immediate advantage from the reduction in specific taxes on fuels, as a reaction to oil price increase, should be a cut in consumers' prices. The final goal of this policy will then be to keep retail fuel prices at a long-run equilibrium level[7]. However, this potential beneficial effect (mainly thought for drivers) should be evaluated taking into account the ability of producers to shift taxes, and should be outweighed against the loss in public revenues, which in European countries amount to a non-negligible share of the government budget. Financial issues in both State and Regional budgets should then be carefully considered for a proper understanding of welfare implications in implementing such fiscal policies: on one side, one need to take account of the (potential) welfare improvement for drivers and fuels' consumers (should the price be really "fixed" at a constant level); on the other side, there are redistributive and efficiency issues associated with the need to find different sources of revenues (or to cut public expenditure).

The evaluation of all these welfare effects is clearly beyond the scope of the paper. Here we concentrate on evaluating the impact of sterilization policies on wholesale prices. On the supply side, tax cuts as a reaction to oil price acceleration may have ambiguous

[7] Notice that identifying the long-run equilibrium price for fuels is not an easy task, and constitute a problem *per se*.

effects. A very simple doubt can emerge by considering the asymmetric fuel price responses to variations in oil price, often identified as "rockets" when oil prices go up, and as "feathers" when oil prices go down (e.g. Galeotti *et al.*, 2003). Our aim is just to give some insights on the likely effects of sterilization policies using our estimation results. First, in our model the supply is represented by fuel distributors, while retailers are the demand side of the market under scrutiny. Second, in the absence of sterilization measures by the government, the marginal effects of an increase in oil price are those computed in table 4. Under the simplest specification (MODEL 1), *ME* with respect to *POIL* is 0.45 for gasoline price and 0.61 for motor diesel price. Under MODEL 5 (the richest model), *ME* is high in period 1 and period 3, ranging from 0.68 to 0.78 for gasoline and from 0.76 to 0.85 for diesel, while it is much lower in the middle period 2, around 0.28 for both fuel products. This implies that, depending on the adopted specification, the impact of a 1 Euro increase in oil price may result in a rise in fuels' price ranging between 0.3 and 0.9 Euro.

Tables 5a and 5b show the predicted effects from a sterilization policy. We present results on predicted gasoline and diesel prices from three model specifications under two possible situations[8]:

- the predicted prices when all variables are set at their sample mean values and the oil price increase of 1 Euro, $\hat{P}_1\left(\overline{TAX};\overline{OIL}+1;\overline{X}\right)$;
- the predicted prices when all variables are set at their mean values, but from specific tax mean value we subtract 1 Euro, as an automatic fiscal policy response to sterilize the oil price increase of 1 Euro, $\hat{P}_2\left(\overline{TAX}-1;\overline{OIL}+1;\overline{X}\right)$.

This simulation should give insights on the expected impact of fiscal policies suggested in the recent debate: the creation of an automatic mechanism consisting of a reduction in specific taxes that exactly corresponds (in absolute terms) to the rise in oil price[9].

Our simulations point to a growing effect of the sterilization policy on fuel wholesale prices, which means that "sterilization" policies imply (at least partly) a direct transfer from the government to fuel distributors. In particular, under MODEL 1 a simultaneous

[8] For monthly dummies we experimented with different strategies. Results do not qualitatively change and we decided to present magnitudes that are computed setting the dummy for January equal to 1, while all the other monthly dummies are zero.

[9] Clearly, this kind of mechanism should also work in the opposite direction, with tax recovery when the oil price diminishes. This bring us back to the problem of identifying the long-run equilibrium price of oil.

increase in oil price by 1 Euro and a decrease in specific tax by 1 Euro[10] would result approximately in a 0.1% rise in fuel prices (computed as $\left(\hat{P}_2 - \hat{P}_1\right)/\,\hat{P}_1$): gasoline and diesel prices go up by 0.34 Euro and 0.55 Euro, respectively (i.e. $\left(\hat{P}_2 - \hat{P}_1\right)$). Otherwise stated, no intervention by the government would guarantee wholesale prices lower by around 0.1%. This figure is higher when we consider one of the other two model specifications and when we concentrate on the first and third sub-periods in our sample. Under MODEL 2, periods 1 and 3, a 1 Euro increase in oil price and a contemporaneous decrease in gasoline specific tax would produce an increase in gasoline wholesale price that is very close to 1 Euro (0.91 and 0.72 Euro, respectively), corresponding to a 0.2% rise with respect to a situation where no fiscal intervention follows the oil price growth. Under MODEL 5, magnitudes almost double and in the same sub-periods the percent change is about 0.4%. The wholesale price for motor diesel is particularly sensitive to specific tax and oil price changes. From MODEL 2, the wholesale price rise ranges between 0.67 and 1.08 Euro, depending on the considered sub-period, while under MODEL 5 the wholesale price of diesel increases by 1.72 – 2.10 Euro, depending on the observed sub-period.

We argue that these findings are consistent with a very stylized representation of the market, that we provide in figure 3. The introduction of a specific tax shifts upwards the supply function (from $S_{t=0}$ to S_{t1}): the equilibrium price raises to P_{t1}, but the actual (net) price the suppliers obtain (P_N) is lower than in the absence of a tax. The subsequent increase in the price of oil further shifts upwards the supply function, as a consequence of increasing marginal costs. In the figure, the supply function that does not incorporate the tax is now $S'_{t=0}$, while the supply curve that accounts for both the specific tax and the oil price rise is S'_{t1}. The market equilibrium price is now P'_{t1}, while the price suppliers actually earn is P'_N. The sterilization policy may consist in a reduction of the specific tax such that the supply function exactly returns back to its position before the oil price increase. In our representation, the supply function is again S_{t1}, the equilibrium price is P_{t1} and the price earned by suppliers is P''_N. This price is higher than what the net price would be absent any policy intervention ($P''_N > P'_N$). Our policy simulations try to measure this difference, as we only observe net wholesale prices. On the whole,

[10] A one Euro increase in oil price corresponds approximately to +0.40% variation (evaluated at the sample mean). A one Euro decrease in gasoline specific tax is equivalent to –0.16% change, while a one Euro decrease in motor diesel specific tax is about –0.22% (both evaluated at the sample mean).

price increases are quite large, especially for motor diesel and in the first and last time intervals of our sample. A possible explanation may be the rigidity of the demand function. A steeper demand curve intensifies the effects of a sterilization policy leading to larger suppliers' net prices. Demand for fuels is quite rigid, and elasticity is probably even lower for diesel that is more often used by professional drivers, such as trucks or bus companies.

5. Concluding remarks

In this paper we study the incidence of specific taxes in the Italian fuel markets, and exploit theses findings to simulate the impact of fiscal policies aimed at mitigating oil price fluctuations. We estimate a number of reduced-form model specifications, using as dependent variables the equilibrium wholesale prices for gasoline and motor diesel over the period 1996-2007, and as regressors a set of demand side and supply side variables, including oil price and fuel specific tax. We then compute the effect on wholesale gasoline and motor diesel prices stemming from the resort to an automatic fiscal mechanism consisting of a one-to-one reduction in specific taxes matching the rise in oil price. As originated from the political debate following the peaks in oil price observed in recent years, the sterilization of oil price increase through a reduction in specific taxes seems to be one of the most popular measures.

Our simulations point to a growing effect of such a sterilization policy on fuel wholesale prices. Stated in another way, no fiscal intervention by the government would guarantee wholesale prices for gasoline and motor diesel lower by approximately 0.1% – 0.5%, depending on the chosen model specification, in response to a 1 Euro increase in oil price. This evidence suggests that "flexible" taxation mechanisms, focusing on specific tax reductions (increases) to compensate oil price increases (decreases) could not be a viable policy for stabilizing the price level in fuel markets.

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Table 1. Descriptive statistics [a]

VARIABLE DESCRIPTION	VAR. NAME	Mean	Std. Dev.	25th percentile	Median	75th percentile
Gasoline price (Euro/1000 litres)	*PGAS*	395.89	85.76	326.02	381.66	464.72
Diesel price (Euro/1000 litres)	*PDIES*	392.67	111.38	295.30	361.98	487.31
Crude oil price (Euro/1000 litres)	*POIL*	252.73	164.24	129.28	196.43	356.28
Gasoline specific tax (Euro/1000 litres)	*TAXGAS*	614.86	31.80	592.00	601.87	649.72
Diesel specific tax (Euro/1000 litres)	*TAXDIES*	452.13	22.93	431.86	445.16	475.07
Market share of leader firm (%)	*LEADER*	38.26	6.11	33.00	38.60	43.46
Number of retailers (10^3)	*RETAIL*	20.31	0.30	20.03	20.24	20.57
Number of vehicles (10^3)		41572.70	4080.33	37859.84	41871.99	45127.06
Number of vehicles/population (x 1,000)	*VEHICLES*	726.72	48.47	683.89	742.54	765.27
Share of population over 65 (%)	*POP*65	18.63	0.94	17.82	18.71	19.47

[a] All prices are deflated using the monthly Italian consumer price index (source Istat, base month: December 2007). Number of observations 144.

Figure 1. Gasoline price, specific tax and crude oil price

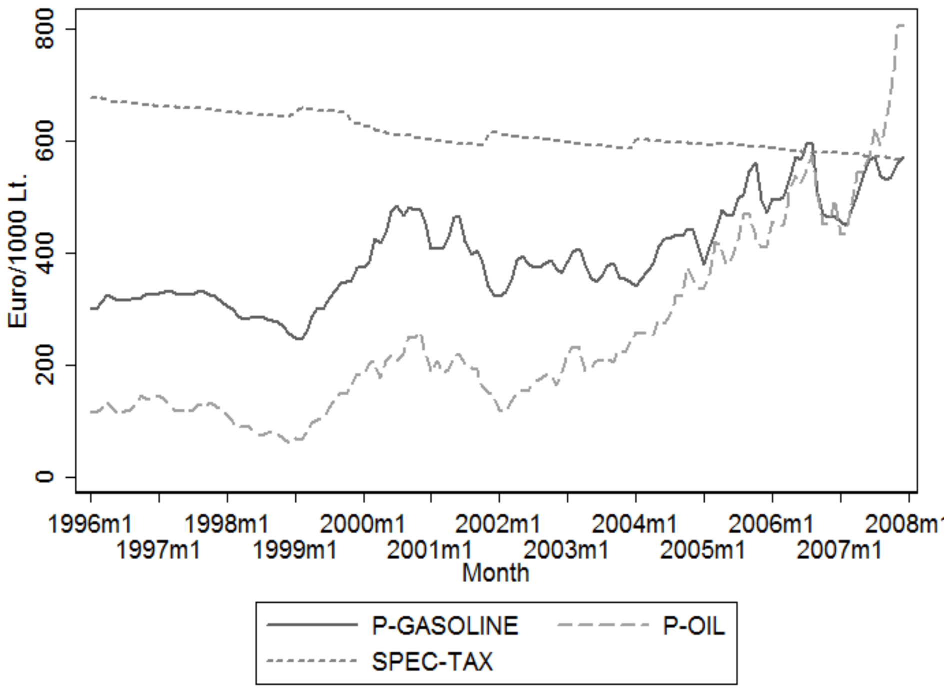

Figure 2. Motor diesel price, specific tax and crude oil price

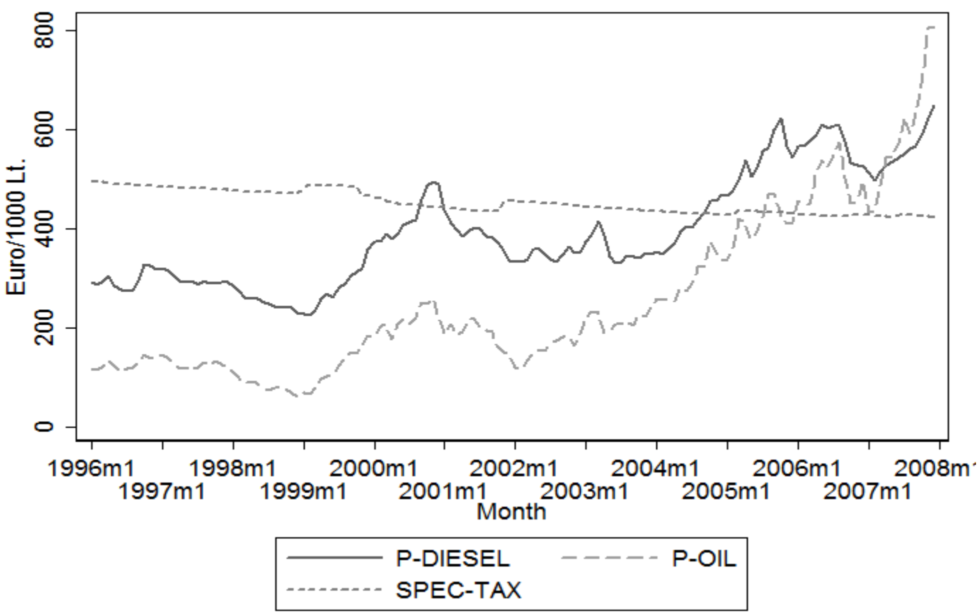

Table 2. SUR estimation: dependent variables are gasoline (*PGAS*) and diesel (*PDIES*) prices [a]

	MODEL 1		MODEL 2		MODEL 3	
Regressor	*PGAS*	*PDIES*	*PGAS*	*PDIES*	*PGAS*	*PDIES*
TAX	-0.537***	-0.600***				
	(0.19)	(0.21)				
POIL	0.287***	0.395***				
	(0.02)	(0.02)				
*TAX_P*1			-1.246***	-1.079***	-2.357***	-1.849***
			(0.24)	(0.27)	(0.38)	(0.31)
*TAX_P*2			-1.046***	-0.793***	-2.130***	-1.536***
			(0.24)	(0.27)	(0.38)	(0.30)
*TAX_P*3			-1.233***	-1.114***	-2.312***	-1.755***
			(0.24)	(0.28)	(0.37)	(0.31)
*POIL_P*1			0.404***	0.472***	0.386***	0.450***
			(0.02)	(0.03)	(0.02)	(0.02)
*POIL_P*2			0.138***	0.124**	0.086*	0.067
			(0.05)	(0.06)	(0.05)	(0.05)
*POIL_P*3			0.349***	0.480***	0.298***	0.308***
			(0.03)	(0.03)	(0.05)	(0.05)
LEADER					-17.424**	-28.529***
					(7.24)	(6.72)
LEADER_SQ					1.079**	1.725***
					(0.44)	(0.41)
R^2	0.99	0.99	0.99	0.99	0.99	0.99
Breusch-Pagan test of independence [p-value]	94.93 [0.00]		85.93 [0.00]		97.18 [0.00]	
Monthly dummies	Yes	Yes	Yes	Yes	Yes	Yes
Nr. of observations	144	144	144	144	144	144

[a] All variables transformed in natural logarithm. Standard errors in round brackets.

Table 3. SUR estimation: dependent variables are gasoline (*PGAS*) and diesel (*PDIES*) prices [a]

	MODEL 4		MODEL 5		MODEL 6	
Regressor	*PGAS*	*PDIES*	*PGAS*	*PDIES*	Δ*PGAS*	Δ*PDIES*
*TAX_P*1	-2.668***	-2.162***	-2.581***	-2.094***	-1.198	-0.708
	(0.38)	(0.27)	(0.38)	(0.27)	(0.93)	(0.62)
*TAX_P*2	-2.493***	-1.923***	-2.379***	-1.828***	-2.936***	-0.767
	(0.38)	*(0.27)*	*(0.38)*	*(0.27)*	*(0.98)*	*(0.67)*
*TAX_P*3	-2.746***	-2.241***	-2.652***	-2.162***	-2.248**	-1.163
	(0.39)	(0.28)	(0.38)	(0.29)	(1.02)	(0.93)
*POIL_P*1	0.398***	0.453***	0.432***	0.486***	0.275***	0.310***
	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)	(0.05)
*POIL_P*2	0.180***	0.176***	0.184***	0.180***	0.235***	0.179***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)
*POIL_P*3	0.478***	0.531***	0.498***	0.547***	0.417***	0.301***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.06)
LEADER	9.747	12.341	26.061	27.317		
	(22.39)	(22.05)	(23.11)	(22.61)		
LEADER_SQ	-0.637	-0.842	-1.635	-1.757		
	(1.38)	(1.36)	(1.43)	(1.40)		
*POP*65	-10.395***	-12.435***	-7.077***	-9.398***		
	(1.45)	(1.44)	(1.98)	(1.97)		
VEHICLES	52.178***	52.393***	25.410	27.812		
	(13.40)	(13.55)	(17.39)	(17.17)		
POP65_VEHICLES	-18.223***	-18.081***	-9.132	-9.737*		
	(4.56)	(4.62)	(5.91)	(5.84)		
RETAIL			2.038**	1.912**		
			(0.85)	(0.87)		
R^2	0.99	0.99	0.99	0.99	0.41	0.37
Breusch-Pagan test of independence [p-value]	72.95 [0.00]		70.87 [0.00]		44.08 [0.00]	
Monthly dummies	Yes	Yes	Yes	Yes	No	No
Nr. of observations	144	144	144	144	143	143

[a] All variables transformed in natural logarithm. In MODEL 6 all variables also transformed in first differences. Standard errors in round brackets.

Table 4a. Marginal effects of specific tax (*TAXGAS*) and oil price (*POIL*) on wholesale *gasoline* price (evaluated at the sample mean values) [a]

	Period 1	Period 2	Period 3
TAXGAS			
MODEL 1	-0.346	-0.346	-0.346
	(0.121)	(0.121)	(0.121)
MODEL 2	-0.802	-0.673	-0.794
	(0.154)	(0.156)	(0.155)
MODEL 5	-1.662	-1.532	-1.707
	(0.244)	(0.244)	(0.247)
POIL			
MODEL 1	0.450	0.450	0.450
	(0.026)	(0.026)	(0.026)
MODEL 2	0.633	0.215	0.547
	(0.035)	(0.076)	(0.045)
MODEL 5	0.677	0.288	0.780
	(0.040)	(0.065)	(0.074)

[a] Asymptotic standard errors in round brackets. Computations in rows named MODEL 1 are based on results from MODEL 1 in table 2, those in rows named MODEL 2 are based on MODEL 2 in table 2, while MODEL 5 is from table 3. Period 1 is from January 1996 to December 2000, Period 2 from January 2001 to December 2003, while Period 3 goes from January 2004 to December 2007.

Table 4b. Marginal effects of specific tax (*TAXDIES*) and oil price (*POIL*) on wholesale *motor diesel* price (evaluated at the sample mean values) [a]

	Period 1	Period 2	Period 3
TAXDIES			
MODEL 1	-0.521	-0.521	-0.521
	(0.180)	(0.180)	(0.180)
MODEL 2	-0.937	-0.689	-0.968
	(0.234)	(0.236)	0.245)
MODEL 5	-1.818	-1.587	-1.878
	(0.236)	(0.238)	0.248)
POIL			
MODEL 1	0.614	0.614	0.614
	(0.027)	(0.027)	(0.027)
MODEL 2	0.734	0.193	0.746
	(0.040)	(0.087)	(0.047)
MODEL 5	0.755	0.280	0.851
	(0.040)	(0.064)	(0.073)

[a] Asymptotic standard errors in round brackets. Computations in rows named MODEL 1 are based on results from MODEL 1 in table 2, those in rows named MODEL 2 are based on MODEL 2 in table 2, while MODEL 5 is from table 3. Period 1 is from January 1996 to December 2000, Period 2 from January 2001 to December 2003, while Period 3 goes from January 2004 to December 2007.

Table 5a. Policy simulation: the effects on *gasoline* predicted price from a sterilization policy involving a 1 Euro decrease in the specific tax as a reaction to a 1 Euro increase in oil price (evaluated at the sample mean values) [a]

		Period 1	Period 2	Period 3
MODEL 1	Predicted price: no policy (Euro/1000 litres)	389.35	389.35	389.35
	Predicted price: sterilization (Euro/1000 litres)	389.69	389.69	389.69
	Absolute change (Euro/1000 litres)	0.34	0.34	0.34
	Percent change (%)	0.09	0.09	0.09
MODEL 2	Predicted price: no policy (Euro/1000 litres)	449.72	371.17	359.07
	Predicted price: sterilization (Euro/1000 litres)	450.63	371.8	359.79
	Absolute change (Euro/1000 litres)	0.91	0.63	0.72
	Percent change (%)	0.20	0.17	0.20
MODEL 5	Predicted price: no policy (Euro/1000 litres)	443.65	411.42	405.25
	Predicted price: sterilization (Euro/1000 litres)	445.51	413.02	407.00
	Absolute change (Euro/1000 litres)	1.87	1.60	1.75
	Percent change (%)	0.42	0.39	0.43

[a] Computations in rows named MODEL 1 are based on results from MODEL 1 in table 2, those in rows named MODEL 2 are based on MODEL 2 in table 2, while MODEL 5 is from table 3. Period 1 is from January 1996 to December 2000, Period 2 from January 2001 to December 2003, while Period 3 goes from January 2004 to December 2007.

Table 5b. Policy simulation: the effects on *motor diesel* predicted price from a sterilization policy involving a 1 Euro decrease in the specific tax as a reaction to a 1 Euro increase in oil price (evaluated at the sample mean values) [a]

		Period 1	Period 2	Period 3
MODEL 1	Predicted price: no policy (Euro/1000 litres)	413.56	413.56	413.56
	Predicted price: sterilization (Euro/1000 litres)	414.11	414.11	414.11
	Absolute change (Euro/1000 litres)	0.55	0.55	0.55
	Percent change (%)	0.13	0.13	0.13
MODEL 2	Predicted price: no policy (Euro/1000 litres)	453.79	379.52	381.29
	Predicted price: sterilization (Euro/1000 litres)	454.87	380.19	382.24
	Absolute change (Euro/1000 litres)	1.08	0.67	0.94
	Percent change (%)	0.24	0.18	0.25
MODEL 5	Predicted price: no policy (Euro/1000 litres)	451.93	423.34	418.64
	Predicted price: sterilization (Euro/1000 litres)	454.03	425.06	420.65
	Absolute change (Euro/1000 litres)	2.10	1.72	2.01
	Percent change (%)	0.46	0.41	0.48

[a] Computations in rows named MODEL 1 are based on results from MODEL 1 in table 2, those in rows named MODEL 2 are based on MODEL 2 in table 2, while MODEL 5 is from table 3. Period 1 is from January 1996 to December 2000, Period 2 from January 2001 to December 2003, while Period 3 goes from January 2004 to December 2007.

Figure 3. Representation of the fuel market: introduction of a specific tax and increase in oil price