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# ARE "FLEXIBLE" TAXATION MECHANISMS EFFECTIVE IN STABILIZING FUEL PRICES? AN EVALUATION CONSIDERING THE ITALIAN FUEL MARKETS

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# Are "flexible" taxation mechanisms effective in stabilizing fuel prices? An 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 reductions in specific taxes matching the rise in oil prices. Our simulations suggest that "flexible" taxation mechanisms could not be a proper policy for stabilizing price levels in fuel markets. A more effective control on prices can be obtained by focusing on the market structure of these industries, where Antitrust Authority could play a significant role.

**Keywords**: fuel markets, specific taxes, tax incidence, sterilization policy, antitrust policy
**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 have suggested (and policy makers have experimented) the introduction of “flexible” taxation mechanisms on fuels. First experiences of these policies can be found in different countries: in the U.S., a temporary tax moratorium – i.e., a suspension of the 5% sales tax – was introduced by the Indiana and Illinois governors as a reaction to the gasoline price peaks during summer 2000 (Doyle and Samphantharak, 2008). In France, the government modified the TIPP, the French specific tax on petroleum products, by introducing in 2000 the “TIPP flottante”, i.e. a fiscal mechanism able to change the tax in accordance with crude oil price trends. The system was abandoned in 2002 because it caused large losses to government revenues. In Italy, two policy interventions were proposed in 2007 and 2008, but never implemented. Both of them envisaged some form of flexibility in the taxation mechanisms for fuels as a response to oil price peaks (see Galeotti and Lanza, 2007). The idea of “flexible” taxation is very simple and easy-to-understand for consumers: in order to keep (gross) prices at a long-run equilibrium level, specific taxes should react one-to-one to observed variations 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 (as the example of the “TIPP flottante” suggests). However, such a sterilization policy should be carefully evaluated, as for the likely impact on consumers, producers, and tax revenues. On the 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 for the industrial structure of these markets, a particularly acute problem in Italy. The price of fuels has been traditionally regulated by public bodies. 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, ...). 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 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 Italian Antitrust Authority (AGCM, 2000 and 2006) established the presence of collusive 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 Italian Antitrust Authority 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 and diesel prices ranging from 0.1% to 0.5%. We also evaluate the incidence of specific taxes. Again depending on the chosen specification, we estimate that a 1% increase in the specific tax on gasoline is found to reduce wholesale gasoline price by 0.5% – 2.7%. For motor diesel, the effect of a 1% increase in the specific tax corresponds to a reduction in wholesale prices ranging between 0.6% and 2%. We finally simulate the impact on wholesale prices of a sterilization policy that makes specific taxes react to oil price increase. In particular, we assess both the effects of a one-to-one reduction of specific taxes in response to oil price increase, and a sterilization policy that considers the equivalence ratio between crude oil and refined fuels. 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 1% - 9.5%, depending on the adopted specification.

The remainder of the paper is organised as follows: next section provides a conceptual framework and reviews the relevant literature on fuel taxes and oil prices, while in section 3 the data and 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. Conceptual framework and literature review

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. To understand how fuel taxation can influence equilibrium prices in fuel markets and interpret available results in the literature, it is useful to sketch a conceptual framework. We borrow from Hamilton (1999), who presents a discussion encompassing different market structures. Let $P(Y) = p(Y) - t(Y,\theta)$ be the net price for producers, $Y$ the level of output, $p$ the gross price, and $t$ the tax schedule (with $\theta$ identifying a fiscal policy parameter). We are interested in understanding how changes in the policy parameter $\theta$ affect $P$. By differentiating $P(Y)$ we obtain:

$$\frac{dP(Y)}{d\theta} = \left[\frac{dp(Y)}{dY} - \frac{dt(Y,\theta)}{dY}\right]\frac{dY}{d\theta} \qquad [1]$$

Considering that, according to Italian legislation, $t(Y,\theta) = \{[t^S + P(Y)]t^V + t^S\}$, where $t^S$ and $t^V$ are the tax rate of specific tax and VAT respectively, we can rewrite Eq. (1) as:

$$\frac{dP(Y)}{d\theta} = \left[\frac{dp(Y)}{dY}\left(1 - t^V\right)\right]\frac{dY}{d\theta} \qquad [2]$$

Since the term in square brackets on the right-hand side of Eq. [2] is negative, we have:

$$sign\left[\frac{dP(Y)}{d\theta}\right] = -sign\left[\frac{dY}{d\theta}\right] \qquad [3]$$

If the tax schedule is output elastic (which hints at an elastic demand schedule), then Hamilton (1999) shows that $dY/d\theta > 0$ and net price $P$ for producers reduces after a tax increase; on the contrary, if the tax schedule is output inelastic, then $dY/d\theta < 0$ and net price $P$ increases following an increase in the tax rates. These results hold for different market structures, and show that pass-through of taxes is related to demand elasticity.

Given this theoretical result and a demand for fuel products rather inelastic[2], it is unsurprising that most studies find that specific taxes are passed-through to a large

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

[2] Gasoline demand studies are copious. Most econometric estimates show that the short-run price and income elasticities are very small, while long-run responsiveness is much greater. In particular, Dahl and Sterner (1991) find in their survey that the average short run price elasticity is -0.26, while Baltagi and Griffin (1997) find large variability across OECD countries and average price elasticities range between -0.1 and -0.3, depending on the considered specification. Similarly Kayser (2000) estimating a gasoline demand function at the household level, finds short run price elasticities close to zero.

extent to final consumers. 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 rather than for large states. In a related paper, Chouinard 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 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, then, as already emphasised above, the available evidence suggests that – at least in the U.S. – there is a large pass-through of specific taxes to final consumers. In the following sections, we provide first evidence for the Italian fuel market by concentrating on the impact of specific taxes on net wholesale prices.

## 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. Gasoline and motor diesel represent the main motor vehicles fuels. Over our observed period, gasoline average monthly sales amount to approximately 1 million tonnes, while diesel monthly average sales are much larger, reaching 1.8 million tonnes. For gasoline and motor diesel, we gather monthly data on wholesale prices 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 tax $t^S$ and sale tax $t^V$) and retailers' profits, that are incorporated in the retail price $p$ to consumers. 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 1.2 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)[3]. 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 December 2007[4]. 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. 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[5]. We argue that an important role in shaping this reduction was played by the Italian Antitrust Authority. In 1999, the Italian Antitrust Authority 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 Italian Antitrust Authority started other investigations on the fuels companies (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 sample till approximately the end of

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

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

[5] Actually the measurement units are different: wholesale prices refer to 1000 litres of gasoline (or diesel), while oil prices refer to 1000 litres of oil.

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, following the literature, 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% but it decreased over time, also as a consequence of the divestiture of one of 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 operating, 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 of 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[6]. 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. In one specification we also include quarterly per capita Gross Domestic Product, as an additional demand side determinant of prices. Its average value is 6,157 Euro per capita per quarter.

## 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 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 $\Lambda$ exogenous market power shifters; we can then express marginal costs as $MC = C(W)$ and market power as $MP = M(\Lambda)$. 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 $P = h(Z, W, \Lambda)$ – 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:

[6] 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).

$$PGAS_t = \beta_0 + \beta_1 TAXGAS_t + \beta_2 POIL_t + X_t'\gamma + \varepsilon_t$$
$$PDIES_t = \alpha_0 + \alpha_1 TAXDIES_t + \alpha_2 POIL_t + X_t'\delta + \nu_t \qquad [4]$$

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 [4] 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 considered 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 at 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*_T1, *TAX*_T2 and *TAX*_T3 are obtained by interacting the variable for specific tax (*TAX*) with the dummy T1 for the first period (equal to one for observations from January 1996 to December 2000), the dummy T2 for the second period (equal to one for observations from January 2001 to December 2003), and the dummy T3 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*_T1, *POIL*_T2, and *POIL*_T3. 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 Italian Antitrust Authority, 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 Italian Antitrust Authority for the potential presence of a price cartel.

Table 3 reports a series of additional specifications that consider the role of demand side and supply side factors. In the first two columns of table 3 we include the market share of the leader distributor in the Italian fuel industry (MODEL 3). We introduce the *LEADER* variable in both price equations. Products' elasticities with respect to the specific tax become 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*) are found to be positively signed in the gasoline equation while it is not significant at conventional statistical levels in the diesel equation. The evidence suggests that higher industry concentration turns out to actually rise wholesale prices, especially those 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.

Columns three and four of table 3 present results of a model (MODEL 4) that 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*) [7]. The coefficients on specific tax and oil price (still interacted with the three periods' dummies) are similar in magnitude to our previous specifications and are statistically significant, lending additional credibility to our strategy. The coefficients for *LEADER* do not have the expected positive sign, probably because of the presence of some collinearity problem between this variable and the additional covariates. Conversely, the new variables are all significant and have the 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*) and per capita Gross Domestic Product (*GDP*). Previous results for specific tax and oil price are confirmed, while the newly included variables *RETAIL* and *GDP* are positive and significant, except for *GDP* in the diesel equation. A one percent increase in the number of gas stations is found to increase gasoline and motor diesel prices by approximately 1.7-1.8%. 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 Italian Antitrust Authority, together with many scholars (e.g. Scarpa, 2008), point out that the number of retailers is too high, and this causes inefficiencies and high 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

[7] All variables are expressed in natural logarithms.

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 sign of *GDP* suggests a positive relationship between motor fuel prices and income, especially in the gasoline equation.

Table 4 addresses the potential econometric issues arising from the endogeneity of our specific tax measure. If specific taxes co-move together with some of the unobserved determinants of fuel prices, the endogeneity concern may be serious. This is exactly what can happen in the presence of "flexible" taxation mechanism: policy makers may decide to decrease taxes when oil prices peaks (i.e., when wholesale fuel prices increase), making the tax measure simultaneously determined with our dependent variable. We are unaware of any explicit policy of this kind in Italy effectively implemented. Most changes in specific taxes over our sampled time period were motivated by the EU harmonization requirements of excise duty structures and rates in EU countries, in accordance with Council Directive 1992/81/EC (and all its successive modifications, as Council Directive 2003/96/EC).

However, to address the issue of endogeneity, we estimate MODEL 1 and MODEL 2 from table 2 by using a three-stage least squares procedure (3SLS), where we instrument gasoline and diesel specific taxes using specific tax rates for ethyl alcohol, other alcoholic products, and beer as exogenous instrumental variables (see table 1 for some descriptive evidence on these variables). The first stage regressions reported in the last two columns of table 4 seem to support our strategy as the exogenous instrumental variables are relevant according to statistical significant coefficient estimates and the F-test on the excluded instruments (see Staiger and Stock, 1997). 3SLS 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 (MODEL 2-IV). Estimates for specific tax coefficients are always lower in magnitude when compared to results from table 2. Moreover in the motor diesel equation the tax measure is never statistical significant. However Wald tests on the equality of the three period specific tax coefficients is rejected for both gasoline and diesel.

*4.3. Tax incidence*

Table 5 offers some insights on the effect of specific tax on predicted gasoline and motor diesel wholesale prices. Using estimation results from MODEL 1, 2, 2-IV and 5, we compare two sets of predicted prices:

- the predicted (gasoline and diesel) prices when all variables are set at their sample mean values, $\hat{P}_0\left(\overline{TAX};\overline{POIL};\overline{X}\right)$;
- the predicted (gasoline and diesel) prices when all variables are set at their sample mean values while the tax measure is increased by one standard deviation $\sigma$, $\hat{P}_1\left(\overline{TAX}+\sigma;\overline{POIL};\overline{X}\right)$:

$\overline{TAX}$ , $\overline{POIL}$ and $\overline{X}$ are the sample mean values for specific tax, oil price and any other regressors included in the model, respectively (see table 1 for the descriptive statistics).

In table 5, the row under the heading MODEL 1 shows the percent change in predicted prices for gasoline and diesel as a consequence of a one standard deviation increase in the mean specific tax. MODEL 1 is our baseline specification, where a single coefficient is estimated for specific tax and oil price (first two columns of table 2) and we find that gasoline and motor diesel prices decrease by 2.7% and 2.9% respectively: a one standard deviation increase in specific tax (which amounts to about 5%) is expected to reduce wholesale fuel prices by about 3%.

When we allow for differing coefficients across sub-periods, our estimated effects vary 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, while computations based on MODEL 2-IV are smaller. 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 one standard deviation increase in specific tax results in approximately a 6% wholesale gasoline price reduction in period T1 and T3, while in the sub-period T2 the price reduction is about 5%. For MODEL 2-IV, wholesale gasoline price reduction amounts to about 4% in period T1 and T3, and 3% in the sub-period T2. Under MODEL 5, the effect of a one standard deviation increase in specific tax produces even larger wholesale gasoline price reductions: around 10% in period T1 and T3, and

9% in sub-period T2. For motor diesel prices results are very similar. From MODEL 2, price decreases by 5% in periods T1 and T3, and by 4% in sub-period T2. Under MODEL 2-IV price reduction are 2.5% and 1% in periods T1-T3 and T2 respectively. Under MODEL 5, the effects are again greater: 9% decrease in motor diesel price in periods T1 and T3 and 8% reduction in period T2. As for the differing trends, according to the considered period, we already referred to the likely impact of Italian Antitrust Authority intervention at the end of year 2000.

### *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 (see, e.g., Doyle and Samphantharak, 2008, for the fiscal policy on fuel markets in some US States). A complete evaluation of the welfare impact (on producers, consumers, State and regional finances, etc) 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 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)[8]. 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 effects of an increase in oil price can be computed starting from our estimation results. All variables are in natural logarithm, so that estimated coefficients can be directly interpreted as price elasticities. Under the simplest specification (MODEL 1, see table 2), a one percent increase in crude oil price brings

[8] We experimented with a number of empirical specifications that could account for the asymmetric response of fuel prices to oil price changes. In particular the coefficient of a dummy that equals one when oil prices increase is found negative and significant suggesting some form of asymmetry. However, when we account for some delays in the fuel prices adjustments (i.e., lagging the dummy) we obtain a positive and statistical insignificant effect. In both cases, our main estimation results are unaltered.

about a 0.3% increase in gasoline price and a 0.4% increase in diesel wholesale price. Under MODEL 5 (the richest model, see table 3), in period T1 and period T3, a one percent increase in oil price causes higher gasoline and diesel prices by approximately 0.5%, while in the middle period 2, the same magnitude drops to 0.2%. This implies that, depending on the adopted specification, the impact of a 1% increase in oil price may result in a rise in fuels' price ranging between 0.2% and 0.5%.

Table 6 shows the predicted effects from a sterilization policy. We present results on predicted gasoline and diesel prices from three model specifications under three possible situations[9]:

- the predicted prices when all variables are set at their sample mean values and the mean oil price increases by 10 Euro, $\hat{P}_{before}\left(\overline{TAX};\overline{POIL}+10;\overline{X}\right)$;
- the predicted prices when all variables are set at their mean values, and we subtract 10 Euro from the mean specific tax value, as an automatic fiscal policy response to sterilize the oil price increase of 10 Euro, $\hat{P}_{after\,1}\left(\overline{TAX}-10;\overline{POIL}+10;\overline{X}\right)$;
- the predicted prices when all variables are set at their mean values, and we subtract 20 Euro from the mean specific tax value, as an automatic fiscal policy response to sterilize the oil price increase of 10 Euro, $\hat{P}_{after\,2}\left(\overline{TAX}-20;\overline{POIL}+10;\overline{X}\right)$.

The last computation is motivated by the production equivalence ratio between crude oil and refined fuels (gasoline and diesel production). The U.S. Energy Information Agency reports that one barrel (42 gallons) of crude oil, when refined, yields approximately 19.6 gallons of finished motor gasoline, corresponding approximately to a two to one ratio: for each two gallons of oil, it is possible to obtain one gallon of gasoline (the ratio for motor diesel is approximately the same). We exploit this equivalence by suggesting that a 10 Euro crude oil price increase should be offset by a 20 Euro specific tax decrease on refined fuels.

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[10].

[9] 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.

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

Our simulations point to a positive 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 increase in oil price by 10 Euro and a decrease in specific tax by 10 Euro[11] would result approximately in a 1% rise in fuel prices (computed as $[(\hat{P}_{after1} - \hat{P}_{before}) / \hat{P}_{before}]$): gasoline and diesel prices go up by 3.5 Euro and 5.7 Euro, respectively (i.e. $[\hat{P}_{after1} - \hat{P}_{before}]$). Otherwise stated, no intervention by the government would guarantee wholesale prices lower by around 1%. This figure is higher when we consider richer model specifications and when we concentrate on the first and third sub-periods in our sample. Under MODEL 5, periods T1 and T3, a 10 Euro increase in oil price and a contemporaneous decrease in gasoline specific tax would produce an increase in gasoline wholesale price by about 14 Euro (14.7 and 14.2 Euro, respectively), corresponding to a 3.4% rise with respect to a situation where no fiscal intervention follows the oil price growth. The wholesale price for motor diesel is particularly sensitive to specific tax and oil price changes. The wholesale price rise ranges between 16 and 20 Euro, depending on the considered sub-period, corresponding to about 4% - 4.6% price changes.

A policy that would exploit the two-to-one equivalence ratio between oil and refined fuels, would create even larger effects. Gasoline wholesale prices would increase by 1.8% - 7.1%, depending on the chosen specification and observational period; while motor diesel prices would rise by 2.8% - 9.5%.

On the whole, price increases are quite large, especially for motor diesel and in the first and last time intervals of our sample. As suggested by the conceptual framework discussed above in Section 2, 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.

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oil.

[11] A ten Euro increase in oil price corresponds approximately to +3.96% variation (evaluated at the sample mean). A ten Euro decrease in gasoline specific tax is equivalent to –1.63% change, while a ten Euro decrease in motor diesel specific tax is about –2.21% (both evaluated at the sample mean).

## 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 an automatic fiscal mechanism consisting of reductions 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 1% – 9.5%, depending on the chosen model specification, in response to an increase in oil price matched with a reduction in specific taxes. This evidence supports the idea 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. As suggested by our results – that hint at a strong potential role of Antitrust Authority in influencing price reactions – probably more effective policies should be focused on the supply side of these markets. Vertical integration, high market concentration and regulatory inefficiencies are some of the issues that can be successfully addressed by the policy maker in order to reduce the burden of excessive fuel prices on consumers.

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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 lt.) | *PGAS* | 395.89 | 85.76 | 326.02 | 381.66 | 464.72 |
| *Diesel price* (Euro/1000 lt.) | *PDIES* | 392.67 | 111.38 | 295.30 | 361.98 | 487.31 |
| *Crude oil price* (Euro/1000 lt.) | *POIL* | 252.73 | 164.24 | 129.28 | 196.43 | 356.28 |
| *Gasoline specific tax* (Euro/1000 lt.) | *TAXGAS* | 614.86 | 31.80 | 592.00 | 601.87 | 649.72 |
| *Diesel specific tax* (Euro/1000 lt.) | *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* ($10^3$) | | 41,572.70 | 4,080.33 | 37,859.84 | 41,871.99 | 45,127.06 |
| *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 |
| *Quarterly per capita GDP* (Euro) | *GDP* | 6,156.80 | 302.15 | 5,914.81 | 6,268.02 | 6,372.99 |
| *Ethyl alcohol specific tax* (Euro/100 lt.) | *TAXALC* | 771.89 | 36.30 | 744.45 | 778.93 | 802.50 |
| *Other alcoholic products specific tax* (Euro/100 lt.) | *TAXOTALC* | 60.67 | 5.04 | 56.80 | 59.84 | 62.03 |
| *Beer specific tax* (Euro/100 lt.) | *TAXBEER* | 1.81 | 0.29 | 1.62 | 1.71 | 1.79 |

[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**

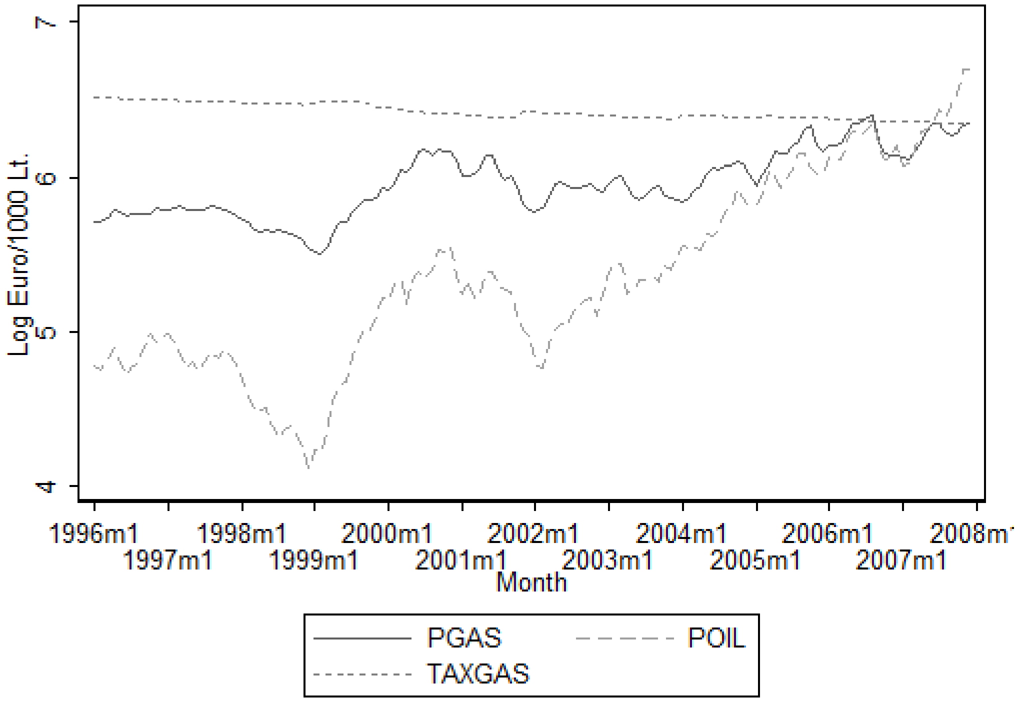


**Figure 2. Motor diesel price, specific tax and crude oil price**

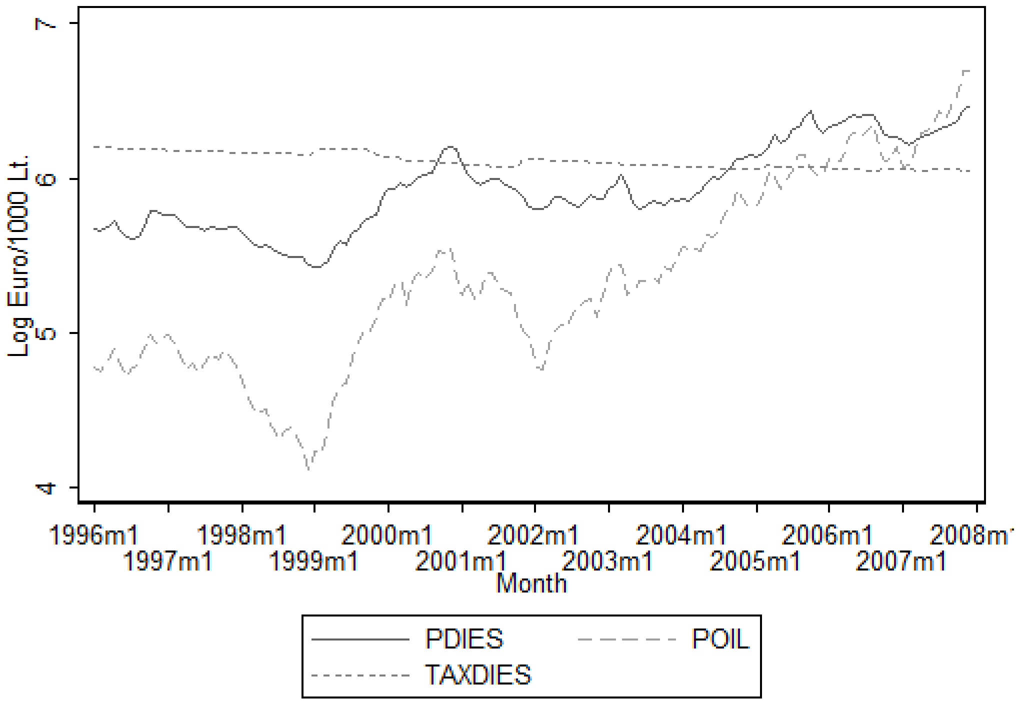

**Table 2. SUR estimation: dependent variables are gasoline (*PGAS*) and diesel (*PDIES*) prices** [a]

| | MODEL 1 | | MODEL 2 | |
|---|---|---|---|---|
| Regressor | *PGAS* | *PDIES* | *PGAS* | *PDIES* |
| *TAX*_T1 | -0.537*** | -0.600*** | -1.246*** | -1.079*** |
| | (0.19) | (0.21) | (0.24) | (0.27) |
| *TAX*_T2 | | | -1.046*** | -0.793*** |
| | | | (0.24) | (0.27) |
| *TAX*_T3 | | | -1.233*** | -1.114*** |
| | | | (0.24) | (0.28) |
| *POIL*_T1 | 0.287*** | 0.395*** | 0.404*** | 0.472*** |
| | (0.02) | (0.02) | (0.02) | (0.03) |
| *POIL*_T2 | | | 0.138*** | 0.124** |
| | | | (0.05) | (0.06) |
| *POIL*_T3 | | | 0.349*** | 0.480*** |
| | | | (0.03) | (0.03) |
| $R^2$ | 0.99 | 0.99 | 0.99 | 0.99 |
| *Breusch-Pagan test of independence* [p-value] | 94.93 [0.00] | | 85.93 [0.00] | |
| *Wald test on TAX* [p-value] | | | 25.25 [0.00] | 39.60 [0.00] |
| *Wald test on POIL* [p-value] | | | 29.35 [0.00] | 39.89 [0.00] |
| *Monthly dummies* | Yes | Yes | Yes | Yes |
| *Nr. of observations* | 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 3 | | MODEL 4 | | MODEL 5 | |
|---|---|---|---|---|---|---|
| Regressor | *PGAS* | *PDIES* | *PGAS* | *PDIES* | *PGAS* | *PDIES* |
| *TAX*_T1 | -2.006*** | -1.258*** | -2.627*** | -2.124*** | -2.032*** | -1.965*** |
| | (0.28) | (0.28) | (0.37) | (0.26) | (0.40) | (0.29) |
| *TAX*_T2 | -1.800*** | -0.983*** | -2.449*** | -1.879*** | -1.860*** | -1.699*** |
| | (0.28) | (0.28) | (0.36) | (0.26) | (0.40) | (0.29) |
| *TAX*_T3 | -2.035*** | -1.275*** | -2.693*** | -2.183*** | -2.077*** | -1.996*** |
| | (0.29) | (0.30) | (0.36) | (0.27) | (0.40) | (0.30) |
| *POIL*_T1 | 0.385*** | 0.451*** | 0.400*** | 0.456*** | 0.431*** | 0.488*** |
| | (0.02) | (0.03) | (0.02) | (0.02) | (0.02) | (0.03) |
| *POIL*_T2 | 0.108** | 0.109** | 0.179*** | 0.174*** | 0.221*** | 0.183*** |
| | (0.05) | (0.05) | (0.04) | (0.04) | (0.04) | (0.04) |
| *POIL*_T3 | 0.380*** | 0.431*** | 0.466*** | 0.514*** | 0.471*** | 0.511*** |
| | (0.04) | (0.04) | (0.04) | (0.04) | (0.04) | (0.04) |
| *LEADER* | 0.287*** | -0.177 | -0.565*** | -1.277*** | -0.384*** | -1.138*** |
| | (0.11) | (0.11) | (0.13) | (0.13) | (0.15) | (0.15) |
| *POP*65 | | | -10.562*** | -12.695*** | -7.872*** | -10.347*** |
| | | | (1.40) | (1.37) | (1.81) | (1.82) |
| *VEHICLES* | | | 57.040*** | 59.000*** | 29.648** | 42.912*** |
| | | | (8.22) | (8.34) | (11.96) | (12.16) |
| *POP65_VEHICLE* | | | -19.835*** | -20.277*** | -10.295** | -14.754*** |
| | | | (2.92) | (2.96) | (4.19) | (4.26) |
| *RETAIL* | | | | | 1.820** | 1.658** |
| | | | | | (0.80) | (0.84) |
| *GDP* | | | | | 1.134** | 0.139 |
| | | | | | (0.49) | (0.49) |
| $R^2$ | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| *Breusch-Pagan test of independence* [p-value] | 97.78 [0.00] | | 73.11 [0.00] | | 73.25 [0.00] | |
| *Wald test on TAX* [p-value] | 28.27 [0.00] | 34.29 [0.00] | 38.35 [0.00] | 57.42 [0.00] | 28.60 [0.00] | 50.94 [0.00] |
| *Wald test on POIL* [p-value] | 31.10 [0.00] | 37.23 [0.00] | 39.26 [0.00] | 56.89 [0.00] | 28.57 [0.00] | 50.19 [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 4. 3SLS estimation: dependent variables are gasoline (*PGAS*) and diesel (*PDIES*) prices. *TAX* variables are instrumented. Exogenous instruments are specific taxes on ethyl alcohol (*TAXALC*), beer (*TAXBEER*) and other alcoholic products (*TAXOTALC*)** [a]

| | MODEL 1-IV | | MODEL 2-IV | | *First-stage* | *First-stage* |
|---|---|---|---|---|---|---|
| Regressor | *PGAS* | *PDIES* | *PGAS* | *PDIES* | *TAX_GAS* | *TAX_DIES* |
| *TAX*_T1 | -0.518** | -0.223 | -0.838*** | -0.500 | | |
| | (0.23) | (0.30) | (0.28) | (0.38) | | |
| *TAX*_T2 | | | -0.639** | -0.218 | | |
| | | | (0.28) | (0.38) | | |
| *TAX*_T3 | | | -0.825*** | -0.513 | | |
| | | | (0.28) | (0.39) | | |
| *POIL*_T1 | 0.289*** | 0.422*** | 0.424*** | 0.501*** | -0.058*** | -0.070*** |
| | (0.02) | (0.02) | (0.02) | (0.03) | (0.00) | (0.00) |
| *POIL*_T2 | | | 0.163*** | 0.163*** | | |
| | | | (0.05) | (0.06) | | |
| *POIL*_T3 | | | 0.371*** | 0.490*** | | |
| | | | (0.03) | (0.03) | | |
| *TAXALC* | | | | | 1.796*** | 1.174*** |
| | | | | | (0.10) | (0.13) |
| *TAXOTALC* | | | | | -1.834*** | -1.358*** |
| | | | | | (0.11) | (0.14) |
| *TAXBEER* | | | | | 0.526*** | 0.469*** |
| | | | | | (0.03) | (0.05) |
| $R^2$ | 0.99 | 0.99 | 0.99 | 0.99 | | |
| *F-test on excluded instruments* [p-value] | | | | | 142.77 [0.00] | 46.63 [0.00] |
| *Wald test on TAX* [p-value] | | | 24.82 [0.00] | 34.07 [0.00] | | |
| *Wald test on POIL* [p-value] | | | 27.87 [0.00] | 33.95 [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. In model 2-IV all instrumental variables are interacted with the set of three dummy variables, one for each of the three periods characterizing our sample: T1 for the first period (equal to one for observations from January 1996 to December 2000), T2 for the second period (equal to one for observations from January 2001 to December 2003), and T3 for the third period (from January 2004 to December 2007).

**Table 5. Percent change in predicted wholesale *gasoline* and *diesel* prices from one standard deviation in specific taxes (evaluated at the sample mean values)** [a]

| | Period T1 | Period T2 | Period T3 |
|---|---|---|---|
| *TAXGAS* | | | |
| MODEL 1 | -2.673 | -2.673 | -2.673 |
| | (0.925) | (0.925) | (0.925) |
| MODEL 2 | -6.088 | -5.137 | -6.030 |
| | (1.134) | (1.160) | (1.142) |
| MODEL 2-IV | -4.139 | -3.172 | -4.075 |
| | (1.333) | (1.360) | (1.342) |
| MODEL 5 | -9.741 | -8.953 | -9.944 |
| | (1.837) | (1.824) | (1.822) |
| *TAXDIES* | | | |
| MODEL 1 | -2.925 | -2.925 | -2.925 |
| | (0.994) | (0.994) | (0.994) |
| MODEL 2 | -5.196 | -3.846 | -5.364 |
| | (1.264) | (1.290) | (1.318) |
| MODEL 2-IV | -2.445 | -1.073 | -2.508 |
| | (1.822) | (1.849) | (1.897) |
| MODEL 5 | -9.265 | -8.063 | -9.403 |
| | (1.324) | (1.323) | (1.363) |

[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, those in rows named MODEL 2-IV are based on MODEL 2-IV in table 4 , while MODEL 5 is from table 3. Period T1 is from January 1996 to December 2000, Period T2 from January 2001 to December 2003, while Period T3 goes from January 2004 to December 2007.

**Table 6. Policy simulation - Effects on *gasoline* and *diesel* predicted prices from two possible sterilization policies involving: 1] a 10 Euro decrease in the specific tax as a reaction to a 10 Euro increase in oil price (*1-to-1 sterilization policy* evaluated at the sample mean values); 2] a 20 Euro decrease in the specific tax as a reaction to a 10 Euro increase in oil price (*2-to-1 sterilization policy* evaluated at the sample mean values)** [a]

| | *Gasoline* | *Diesel* |
|---|---|---|
| MODEL 1 | | |
| Predicted price: no policy (Euro/1000 lt.) | 393.26 | 419.30 |
| | (7.95) | (8.90) |
| Predicted price: *1-to-1 sterilization* (Euro/1000 lt.) | 396.74 | 424.96 |
| | (7.93) | (8.89) |
| Predicted price: *2-to-1 sterilization* (Euro/1000 lt.) | 400.31 | 430.84 |
| | (8.11) | (9.33) |
| Absolute [and %] change: *1-to-1 sterilization* (Euro/1000 lt.) | 3.48 [0.88%] | 5.67 [1.35%] |
| Absolute [and %] change: *2-to-1 sterilization* (Euro/1000 lt.) | 7.05 [1.79%] | 11.54 [2.75%] |

| MODEL 5 | Gasoline Period T1 | Gasoline Period T2 | Gasoline Period T3 | Diesel Period T1 | Diesel Period T2 | Diesel Period T3 |
|---|---|---|---|---|---|---|
| Predicted price: no policy (Euro/1000 lt.) | 434.41 | 407.85 | 409.05 | 448.77 | 418.20 | 424.11 |
| | (9.49) | (11.42) | (10.90) | (10.04) | (11.90) | (11.61) |
| Predicted price: *1-to-1 sterilization* (Euro/1000 lt.) | 449.13 | 420.48 | 423.22 | 468.94 | 434.40 | 443.47 |
| | (10.35) | (11.15) | (12.00) | (11.21) | (11.78) | (11.91) |
| Predicted price: *2-to-1 sterilization* (Euro/1000 lt.) | 464.61 | 433.73 | 438.13 | 490.50 | 451.62 | 464.19 |
| | (12.07) | (11.55) | (13.77) | (13.30) | (12.34) | (12.98) |
| Absolute [and %] change: *1-to-1 sterilization* (Euro/1000 lt.) | 14.72 [3.39%] | 12.63 [3.10%] | 14.17 [3.46%] | 20.17 [4.49%] | 16.20 [3.87%] | 19.36 [4.56%] |
| Absolute [and %] change: *2-to-1 sterilization* (Euro/1000 lt.) | 30.20 [6.95%] | 25.88 [6.35%] | 29.08 [7.11%] | 41.73 [9.30%] | 33.42 [7.99%] | 40.08 [9.45%] |

[a] Asymptotic standard errors in round brackets. Computations under headings MODEL 1 are based on results from MODEL 1 in table 2, those under headings MODEL 5 are from table 3. Period T1 is from January 1996 to December 2000, Period T2 from January 2001 to December 2003, while Period T3 goes from January 2004 to December 2007.

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