DECENTRALIZATION AND FUEL SUBSIDIES

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Abstract: This paper explores the role of decentralization in explaining variation in fuel subsidies across countries. Using panel data over the period 1998-2008 and for 108 countries, it emerges that the effect of decentralization (taken to be an increase in government levels) broadly decreases both diesel and gasoline subsidies, with this effect being more pronounced when the level of political accountability is low. For developing countries, for which political accountability is low, decentralization decreases gasoline and diesel subsidies by at least 6.98% and 12.99%, respectively. For developed countries, for which political accountability is high, decentralization does not have any impact on both gasoline and diesel. What this evidence points to is that, in general, in developing economies, where voters are poorly informed and accountability is low, fuel subsides will be an inefficient policy but it will be more so in the absence of multi-leveled governance.

Keywords: Fuel-price subsidies; multi-leveled governance; federalism; decentralization; share responsibility

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1 Introduction

Fuel price-subsidies—meaning deviations of domestic actual prices from specified benchmark ones—are among the most common public policy instruments in current use, Coady *et al.*, (2006).[1] They are causing significant inefficiencies, to the extent that international organizations, such as the IMF, the World Bank and the OECD, have recently called for their phasing out. And there has been declared commitment to the undertaking of significant reforms by the G20 leaders. In the G20 Pittsburgh Declaration the G20 leaders have agreed

> '[t]o phase out and rationalize over the medium term inefficient fossil-fuel subsidies while providing targeted support for the poorest. Inefficient fossil-fuel subsidies encourage wasteful consumption, reduce our energy security, impede investment in clean energy sources and undermine efforts to deal with the threat of climate change.' (2009, paragraph 24).

In similar vein, and linking fuel subsidies to climate change, the OECD Secretary-General Angel Gurría has recently emphasised the need for fossil fuel reforms. As he vividly puts it

> '[t]he time is ripe for countries to demonstrate they are serious about combating climate change, and reforming harmful fossil fuel support is a good place to start,..., [g]overnments are spending almost twice as much money supporting fossil fuels as is needed to meet the climate-finance objectives set by the international community, which call for mobilising 100 billion US dollars a year by 2020. We must change the course.' Opening remarks, 21 September 2015, Paris.

It is evident that energy reforms will continue to be high on the policy agenda partly because of the need for countries[2] to act on their emission reduction pledges, but also because of the wider negative effects they have on economic development.[3] But, though fossil fuel subsidies are inefficient instruments, and there is therefore a strong economic case for removing them, in reality reforms have proven extremely difficult.[4]

It is well know that in perfectly competitive markets, price subsidies, since actual prices deviate from marginal-cost pricing, misallocate resources, thereby generating economic efficiency losses. They are undesirable from a distributional perspective, since any desired redistribution can be achieved with more efficient instruments; have spillover effects (and in particular

[1] There are many types of subsidies and can be provided along the value chain of fossil fuels from exploration, to production and consumption. Here, and driven by data availability, the focus is on gasoline and diesel subsidies.

[2] Following, for example, the December 2015 Paris Agreement on Climate Change.

[3] A concern amplified by the recent volatility in food and energy prices and the ongoing economic crisis.

[4] See, for example, among others, Arze del Granado *et al.*, (2012), Clements *et al.*, (2007), Ellis (2010), UNEP (2008), OECD (2010), and IMF (2013).

so with fuel-price subsidies);[5] put significant strain on public finances with detrimental effects on public sector debts;[6] encourage socially wasteful activities, such as smuggling and black-market transactions; exacerbate energy volatility, since market demand is not very responsive to international prices, and benefit, perversely, the rich (as they are significant users of energy) far more than the poor; and impede economic growth, in particular so in developing countries.

Despite all these inefficiencies, subsidies are significant.[7] Coady *et al.*, (2016), for example, have estimated worldwide subsidies to be US$ 4.9 trillion in 2013 and US$ 5.3 trillion in 2015 (equivalent to 6.5% of global GDP for both years).[8] In terms of revenues, the IMF (2013) estimates that consumption of petroleum, electricity, natural gas and coal were subsidised by about 2% of total government revenue in 2011. The popular justification that is typically given for such extensive use of fuel price subsidies is that it is the only instrument that can be used to alleviate energy poverty. This argument, however, seems to be wholly misplaced as the benefits from subsidies typically accrue to middle-and high-income consumers as poor households are often unable to afford even subsidized energy. And there are of course better instruments that target redistribution more efficiently.[9]

But if they are not a particularly effective instruments for redistribution why are they so popular with policymakers? Why is reforming them so hard? Broad political economy aspects can explain this behaviour, including (a view that will be central to the argument in this paper) the strand of the literature that considers subsidies to be salient instruments implying that households (voters) assign a larger weight on the popularity of the policymakers if the price of fuel is low relative to the weight they would put had the fuel-price been

[5]There are many externalities associated with fuel subsidies (as a consequence of excessive use of fuel). These include soil salinization (due to excessive irrigation), poor water quality (due to excessive use of fertilizers), and increases in global pollution (due to excessive emissions). International energy prices have increased substantially over the past few years (natural gas being an exception). Despite this many low- and middle-income economies have been reluctant to adjust their domestic energy prices to reflect these increases. The resulting fiscal costs have been substantial and pose even greater fiscal risks for these countries if international prices continue to increase as they put immense pressure on fiscal budgets. See also IMF (2013).

[6]In a number of countries fuel subsidies can be as large as public education and health expenditure. See Coady *et al.*, (2006), for some evidence.

[7]They are also widespread. In the data set used in this paper 11% of the countries subsidise gasoline and about 23% subsidise diesel. Gasoline subsidies are almost equally distributed between developed and developing countries with 53% of countries subsidising gasoline being developing countries, whereas for diesel subsidies 65% of countries are developing. And this has been fairly stable across years. Developed countries are considered to be all those belonging to the two groups classified by the World Bank as upper middle-income and high-income countries, whereas developing countries are classified as all those belonging to the two groups of low-income and lower middle-income countries.

[8]The total global deadweight loss from fuel subsidies (gasoline and diesel) in 2012 has been estimated to be US$ 44 billion, Davis (2014).

[9]See Arze del Granado *et al.*, (2012), IEA (2011), and Sterner *ed.* (2012).

determined by market conditions.[10] And it is a very visible instrument too. For low-income countries, for example, sudden rises in energy costs have an immediate impact on households' budgets and they spill very quickly into public unrest, with examples of such episodes taking place in Venezuela in 1989, Yemen in 2005, Cameroon in 2008, and Bolivia in 2010. In Nigeria, to give another example, a subsidy cut in 2012—which resulted in doubling petrol prices overnight—was met with protests that brought the country into a standstill until the subsidies were reintroduced. Neither the protests nor the response, however, are confined to low-income or developing countries. The UK was brought almost to a halt in 2000 because of hauliers protesting against high petrol prices. The response of the government was to announce a range of tax cuts for motorists a couple of months later, resisting from sharp rises in fuel duties for years afterwards. Interestingly, subsidies are often abolished and then re-imposed after public demonstrations.

Evidently, there are complex political economy incentives behind fuel subsidies but intuition would suggest (and the examples above somewhat confirm) that the *visibility* of the policy is a key determinant. As the setting of subsidies is a central government responsibility, it is conceivable that the government architecture of a country is an important determinant of their level: the point here being (and one that we make more precise shortly) that any incentive for political gain can be *weakened* by a multi-leveled political architecture of governance ('decentralization').[11] The reason for this relates to the fact that voters, upon realising the effect of the policy, cannot assign probability one to the government level that enacted the policy.

It is this issue that this paper deals with. In particular, and in the most general form, the paper asks: how does the existence of a multi-leveled government structure affect fuel pricing? Or, to put it differently, is a hierarchical structure of governance conducive to low or high fuel subsidies? One cannot, of course, hope to find an unambiguous answer to the central question that has been the subject of a significant literature—the desirability or otherwise of fiscal decentralization—from a model that is specifically designed to address issues of subsidies. One can, however, hope to find evidence and clarify some of the deeper economic forces at work, developing some sense, for example, of the conditions under which decentralization is likely to be desirable from that perspective. There has previously been no formal analysis, to the best of our knowledge, of this.

This paper contributes to the fast growing literature, termed the second-generation theory of fiscal federalism, that focuses on the political processes and the behavior of political agents

[10]Subsidised fuel (and food) has been frequently seen, too, as part of an implicit contract between governments and their populations. Besley and Prat (2006) explore political incentives more generally, whereas Beers and Strand (2013) relate the political incentives to subsidies. See also Kotsogiannis and Rizzo (2016).

[11]Taken to be a system of governance which disperses authority between 'regional governments and a central government in such a way that each kind of government has some activities on which it makes final decisions', Riker (1987).

and their effects on fiscal outcomes in federal systems (see Oates (2005), and Weingast (2006) for comprehensive surveys on this literature). Evidently, this interest stems from the view that decentralization is the appropriate government structure to ensure an efficient allocation of resources, to promote accountability and to enhance economic growth. The literature in this area is rich in papers and policy documents, reflecting a resurgence of interest in decentralization around the world during the last decade, both in developed and developing world. The implementation of decentralization policies, however, has varied substantially across countries and, in many cases, it has been problematic and not very successful, in particular so in developing countries—and they are those with particular governance and state-building challenges. There are many reasons for this, including the strand of the literature that stresses the need for an effective allocation of responsibilities across levels of government which asymmetric information across those levels imped from achieving.[12]

Making use of a unique data set for 108 countries and for the period 1998-2008, it is shown that decentralization (taken to be an increase in government levels) broadly *decreases* both diesel and gasoline subsidies, with this effect, interestingly, being more pronounced when the level of political accountability is low. In particular, for developing countries decentralization decreases gasoline and diesel subsidies by 6.98% and 12.99%, respectively, relative to the subsample average, where the subsample median level of accountability is assumed, whereas for developed countries, decentralization does not have any impact on both gasoline and diesel subsidies for any subsample median level of accountability. What does this all points to? Interestingly, it points towards the possibility that, in general, in developing economies, where voters are poorly informed and accountability is low, fuel subsides will be an inefficient policy but it will be more so in the absence of multi-leveled governance.

The purpose therefore of this paper is to address the question of whether, in practice, fuel-price subsidies is affected by the number of government levels, an issue of particular interest for developing countries, where accountability of government is in general lower than in developed countries. Work on this issue is, surprisingly, rather limited: one of the reasons being the paucity of reliable data on subsidies. To overcome this obstacle the focus is on gasoline (and diesel) prices. The essence of this paper is, therefore, to examine the determinants of gasoline (diesel) subsidies, paying particular attention to the degree of decentralization and its interplay with accountability.

[12]Expressions of this idea vary, ranging from the role of heterogeneity of information among voters across territories with different capabilities, Boffa *et al.*, (2016), to the inability of voters to hold each level of government individually accountable for its contribution to public good provision, Joanis (2014). This is an issue of particular interest for developing countries, where accountability of government is in general lower than in developed countries, Bardhan and Mookherjee (2006a,b) and Mani and Mukand (2007), so rent seeking behaviour from opportunistic policymakers is easier. There are of course other factors that might play a critical role, such as the lack of hard budget constraints and dysfunctional (especially in developing countries) markets, Sorens (2016).

The plan of the paper is as follows. Section 2 takes a look at a very simple model whose sole purpose is to fix ideas by describing the effect of decentralization on fuel prices. Section 3 defines the key variables of the analysis (subsidies, decentralisation and accountability). Section 4 introduces the econometrics methodology, while Section 5 explores the results and Section 6 performs robustness checks. Finally, Section 7 summarises and concludes.

2 Fixing ideas and stating the hypotheses

This section sets out a simple framework whose sole purpose is to fix ideas. At its heart is identifying a mechanism that links the incentive of the central government to subsidise prices, when policy is set within an economy with many levels of government each of which enjoys some autonomy in fiscal decisions, not necessarily over the same policy instrument, and the households cannot perfectly distinguish which level is setting the price.[13]

It will help matters to cast the analysis in terms of a subsidy (taken to mean a price offered to households/voters which is lower than it would be had the government not intervened), denoted by σ. Suppose further that this subsidy requires some 'effort' (perhaps related to the effort required for finding resources to financing the subsidy) on the part of the central government and takes the simple form

$$\sigma(e) = e. \tag{1}$$

Households prefer low prices and are myopic about that this might entail increases in other prices/taxes. What this translates to is that a higher subsidy induced by higher effort increases the benefit of the incumbent policy maker staying in office. The idea here being that, through higher effort, higher subsidy is rewarded by the voters with reelection as it reveals more competence on the part of policymakers. This benefit is, however, decreasing in the number of government levels, denoted by $\lambda > 0$ (treated here as a continuous variable), as voters do not assign probability 1 to the central government having enacted the policy. This, it has to be noted, is somewhat reminiscent of the externality caused when different levels of government tax the same tax base,[14] Keen and Kotsogiannis (2002). Here there is indeed an externality which is not casued by a fiscal instrument directly, but by the 'inability' of households/voters to assign the policy outcome to the government that has enacted the policy.

[13]This feature appears also in Joanis (2014) who analyses the interplay between public good provision across levels of government that share responsibility and accountability.

[14]While the precise characterisation of the equilibrium is side-stepped (including the other levels of government—being parametrically captured), the reduced form of the simple structure is nevertheless useful in identifying the main mechanism and guide the empirics.

Denote the benefit by[15] $b\left(\sigma(e),\lambda\right)$, assumed to be strictly concave in the level of effort, with[16] $b_e(e,\lambda)>0$ and $b_{ee}(e,\lambda)<0$. It is also assumed that $b_{e\lambda}(e,\lambda)<0$ and so an increase in the number of government levels, λ, reduces the gain from providing effort, as this reduces the likelihood that this policy is enacted by the central government. The cost to the government of exerted effort is $c(e,\alpha)$: this cost is assumed to be strictly increasing and convex in the amount of effort, and so $c_e(e,\alpha)>0$ and $c_{ee}(e,\alpha)<0$, and to depend on the level of some accountability parameter, α, in the sense that $c_{e\alpha}(e,\alpha)>0$. What this captures is that implementing the subsidy is costly, a cost that depends on accountability. [17]

The central government then, by choice of e, maximises

$$v(e,\lambda,\alpha)=b\left(e,\lambda\right)-c(e,\alpha), \tag{2}$$

with the necessary condition of this maximization problem being (a subscript denotes derivative) given by

$$v_e(e,\lambda,\alpha)=b_e\left(e,\lambda\right)-c_e(e,\alpha)=0, \tag{3}$$

and with sufficiency being satisfied by the properties of the $b(\cdot)$ and $c(\cdot)$ functions. Of particular interest is the dependence of $e(\lambda,\alpha)$ on λ and α. Routine differentiation of (3) gives

$$e_\lambda=-\frac{b_{e\lambda}}{b_{ee}-c_{ee}}<0 \quad ; \quad e_\alpha=\frac{c_{e\alpha}}{b_{ee}-c_{ee}}<0, \tag{4}$$

where the inequalities follow from $b_{e\lambda}<0$ and $c_{e\alpha}>0$.

Also

$$e_{\alpha\lambda}=-\frac{b_{ee\lambda}c_{e\alpha}}{\left(b_{ee}-c_{ee}\right)^2}, \tag{5}$$

with its sign, unsurprisingly, being depended on the third derivative of $b(e,\lambda,\alpha)$. We are being agnostic about this—though it is natural to assume that an increase in the number of government levels, λ, dampens the effect of accountability, α, on effort, e, (and so the subsidy, σ).

As long as more accountability of the elected government reduces the marginal gain for the central government—then more accountability reduces the incentive of the central government to subsidise fuel. This will be the case, for given λ, if an increase in accountability,

[15] The exact process for which this benefit is derived is not modeled but it can take the form of the expected rent derived in a two period model, as in, among others, Besley and Case (1995), Besley and Smart (2007), Kotsogiannis and Schwager (2008). The expected rent depends on the probability to be re-elected, whose perception by voters can be distorted in a situation where voters do not clearly understand who enacts the policy, Joanis (2014).

[16] And making use of (1). A subscript denotes a derivative.

[17] The presumption is that in developing countries, where accountability is low, the impact of accountability on the cost will be much lower than in developed countries where voters are better informed regarding political decisions, and so accountability is high. There are examples of this. Aizenman and Jinjarak (2008), for example, show that political instability is associated with reduced effectiveness of VAT.

α, reduces the political gain of the policy enacted by the central government (favourable for voters, on average) which loses its appeal as policy that buys popularity for the central government. Similarly, e_λ is negative as long as the increase in the number of government levels, λ, reduces the marginal gain for the central government of increasing the subsidy.

Equipped with the preceding discussion we test the following two hypotheses.

Hypothesis 1 *For given accountability, α, an increase in the number of government levels, λ, reduces fuel subsidies,*[18] $\sigma_\lambda < 0$.

Hypothesis 2 *For a given number of government levels, λ, an increase in accountability, α, reduces fuel subsidies, $\sigma_\alpha < 0$.*

3 Fuel subsidies: Definitions and preliminary analysis

Fossil fuel-price subsidies are typically calculated by the price-gap method (see Kosmo (1987), Larsen and Shah (1992), Coady *et al.*, (2010), and Beers and Strand (2013)), which implies calculation of the difference between a benchmark price and the actual fossil fuel prices. Consumer subsidies arise when market prices—paid by consumers, including both firms (intermediate consumption) and households (final consumption)—are below a benchmark price. Producer subsidies arise when prices received by suppliers are above this benchmark. When an energy product is internationally traded, the benchmark price for calculating subsidies is based on its international price.[19] The benchmark being used is the average fuel price in the United States in US$ cents per liter. For oil importing countries the benchmark price is reduced by US$ 0.10 per liter to allow for the costs of shipping the fuel from the hub to the country, whereas for oil exporting countries the benchmark price is reduced by US$ 0.20 per liter. What this all implies is that

$$pg_m^j = \overline{p} - p^j - 10 \quad \text{importing country,} \tag{6}$$

$$pg_e^j = \overline{p} - p^j - 20 \quad \text{exporting country,} \tag{7}$$

where pg_m^j denotes the price gap for the j-th net-energy importing-country, pg_e^j the price gap for the j-th net-energy exporting-country, $\overline{p}$ the retail pump price of a unit of energy in the US market, and p^j the retail price of a unit of energy in the domestic market of the j-th country. (6) and (7) apply to both gasoline and diesel prices.

To capture accountability in a given country we make use of the variable *voice*—taken from the Worldwide Governance Indicator (WGI) dataset—indicating 'the perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well

[18] Or, equivalently, increases prices.

[19] This approach to measuring subsidies is often referred to as the price-gap approach and is used widely in analyses by international agencies. For more on this see IMF (2013).

as freedom of expression, freedom of association, and free media'.[20] This variable is computed in percentiles, ranking countries from 0 (corresponding to lowest rank) to 100 (the highest rank). To capture the effect of the number of government levels, we follow the literature[21] and make use of the variable *tiers*, defined as '... the subset of governments in a country such that all members of this subset have jurisdictions that are contained by the same number of (other governments') jurisdictions. For instance, all governments whose jurisdictions are contained only by the jurisdiction of the national government are denoted 'first-tier' subnational governments. All those whose jurisdictions are contained by that of the national government and that of one 'first-tier' government are 'second-tier' governments,' Treisman (2000), pp.3-4. This variable captures well the dimension of decentralization emphasised in this paper.[22]

Many empirical studies in the fiscal federalism literature (see, among others, Fisman and Gatti (2002), Panizza (2009)) have relied on fiscal expenditure and revenue data from the International Monetary Fund's (IMF) Government Finance Statistics (GFS) by using the ratio of central to local tax revenues (or expenditures), Dziobek *et al.*, (2011). These data have some obvious limitations. Firstly, they are somewhat incomplete substantially reducing the number of observations. Secondly, looking at fiscal decentralization without taking account of the actual control local governments have over the collection and spending might be misleading, as an index of decentralized expenditure (or revenue) does not necessarily measure institutional decentralization (and fiscal autonomy). The reason for this is that quite often local expenditures are centrally mandated expenditures and local revenues are collected locally, but without the local authorities having autonomy over either the tax rate or base. Moreover, since gasoline and diesel subsidies are, typically, a central governments responsibility they can affect centralized expenditure and revenue giving rise to an endogeneity problem in the estimation procedure.[23]

Figure 1 plots the relationship between gasoline (diesel) price and the accountability index, showing that as accountability increases gasoline (diesel) prices increase (coming about a reduction in gasoline (diesel) subsidy). Putting this in the context of Section 2, what this suggests is that an increase in accountability implies more transparency in policy and, therefore, an inefficient policy—like that of subsidising fuel—is more costly for the policymakers. The implication of this is that an increase in accountability, for a given level of government levels, induces a reduction in subsidies.

Insert Figure 1 here.

[20]The details of the definitions of the variables are reported in Appendix B.

[21]See, for example, Kessing *et al.,* (2007), Fan *et al.,* (2009), and Albornoz and Cabrales (2013).

[22]And the variable λ in Section 2.

[23]Such problem is not present in *tiers* which is unlikely to change according to the levels of the gasoline and diesel subsidies.

Figure 2 plots the relationship between accountability and the number of government levels showing that they are negatively related.[24]

Insert Figure 2 here.

We then explore further these descriptive statistics by investigating whether they depend on the per capita income level of a country. To do so we classify—using the World Bank classification—countries into low-income, lower middle-income, upper middle-income, and high-income countries. We then pull together the two high-income classes and the two low-income classes and split the sample in developed and developing countries (Table 1).

Insert Table 1 here.

The former contains 423 observations, with the average per capita income being US$ 3,452, whereas the latter contains 480 observations with the average per capita income being US$ 24,207. Interestingly, the distribution of the number of government levels (*tiers*) differs according to the level of development (Figure 3).

Figure 3 here.

In particular, developed and developing countries do not only differ in their median (3 for developed countries and 4 for developing countries), but also the mean of government layers for developing countries (4.10) is statistically different at 1% significance level from that of developed countries (3.4). The level of accountability goes in the opposite direction: its mean for developing countries is 30.62, while that for developed countries is 70.01, with the difference (39.39) being statistically significant at 1% level, implying that developed countries have, on average, a more accountable government than developing countries.

Figures 4a and 4b plot the relationship between gasoline (diesel) price and the accountability index for developing and developed countries, grouping the countries into low- and high-government levels (with the threshold being the median of the number of government levels—3 for developed countries and 4 for developing countries). For the developed countries, the relationship between gasoline (diesel) price and accountability is always positive for both low- and high-government levels sub-sample. For the developing countries the relationship is positive only for the low government levels sub-sample, while the level of accountability does not affect at all the gasoline (diesel) price when the number of government levels is above the median.

Insert Figures 4a and 4b here.

Interestingly, this last evidence gives rise to the question of whether in developing countries the number of government levels has a role in decreasing subsidies. To address this we then

[24] A relationship confirmed in Boffa *et al.*, (2016) who show, in a framework which allows for preference heterogeneity, that accountability increases when decentralization decreases.

look at the difference in mean of gasoline (diesel) price between low- and high government levels sub-samples for developed and developing countries. In the former case, the difference (US$ 2.06 cents per liter of diesel and US$ 1.79 cents per liter of gasoline) is not statistically significant whereas in the latter case the difference (US$ 10.56 cents per liter of diesel and US$ 11.53 cents per liter of gasoline) is positive and statistically significant at 1% (Table 2), meaning that a high level of government layers is effective in decreasing subsidies both for diesel and gasoline.

All in all, the above preliminary evidence seems to suggest that for developing countries—where the accountability level of the government is, on average, lower than that of developed countries, 30.62 out of 100 for the former and 70.01 out of 100 for the latter—decentralization negatively affect the gasoline (diesel) subsidy.

Insert Table 2 here.

The analysis now turns to the empirical estimation.

4 Empirical analysis

To test for the impact of accountability and decentralization on fuel prices, we estimate a reduced form equation of fuel-price subsidies by using a panel dataset, for the years 1998, 2000 and 2002-2008. We have also collected data prior to 1998 in order to build the lag of some of our explanatory variables. Summary statistics are presented in Appendix A, Tables A1 and A2, while the definition and data sources of the variables are provided in Appendix B.

The analysis considers the following specification

$$p_{jt} = \phi_t + \pi\alpha_{jt}\lambda_j + \gamma\alpha_{jt} + \delta\lambda_j + \boldsymbol{\beta}'\mathbf{X}_{jt} + \epsilon_{jt}, \tag{8}$$

where p_{jt} is price and j and t are, respectively, country and time indicators; ϕ_t is a year effect; α_{jt} is a continuous variable ranging from 0 to 100, capturing the degree of accountability in country j and year t; λ_j is a categorical variable assuming a value from 1 to 6 indicating the number of government layers; $\mathbf{X}_{jt}$ is a vector of state-specific time-varying regressors; and ϵ_{jt} is a mean zero, normally distributed random error.

Following Section 2, and the hypotheses derived there, it is expected that:

Hypothesis 1: $\pi\alpha_{jt} + \delta > 0$, implying that an increase in the number of government levels (*tiers*) increases (decreases) fuel price (subsidies), for a given level of accountability (*voice*);

Hypothesis 2: $\pi\lambda_j + \gamma > 0$, implying that an increase in accountability (*voice*) increases (decreases) fuel price (subsidies), for a given number of government levels (*tiers*);

Candidates for inclusion in the vector **X** are variables that affect the level of prices. Drawing on the literature,[25] we include both economic and demographic variables, such as, population (*population*), its square (*population2*) and the inverse of population (*1/population*), per-capita land (*land*), its square (*land2*) and the inverse of per capita land (*1/land*) to allow for scale economies and, per-capita income (*income*) proxied by the gross domestic product converted to US $ using purchasing power parity rates. We also control for the terms-of-trade effect (capturing the possibility that importers of fuel have the incentive to reduce demand of fuel by reducing the price rate) by using the variable *net supply of fuel* (oil production minus oil consumption) and a general openness measure captured by the variable *openness* (exports plus imports of goods as quota of GDP). The specification also allows for a measure of road gasoline consumption per million inhabitants when we estimate gasoline and road diesel consumption per million inhabitants when we estimate the diesel price.

To address potential endogeneity issues the variables *road gasoline consumption per million inhabitants* and *road diesel consumption per million inhabitants*, as well as the per-capita *income* and the *net supply of fuel*, are introduced with a one-year lag. Finally, we control for a series of other institutional characteristics accounting for the quality of public services (*government effectiveness*), political stability (*political stability*), regulatory quality (*regulatory quality*), confidence of the society in the running rule of law (*rule of law*), control of corruption (*control of corruption*) and a dummy variable equals zero if a country is a democracy (*democracy*). Changes in the macroeconomic, or in legal and institutional environment, may also affect the countries' fiscal position, and, therefore, their ability to provide subsidies. To account for this a set of time dummies is included in the estimation.

In a reduced form equation, the fuel price is normally linked to the population size, as this variable influences the use of fuel. Moreover, the level of income can also influence the level of prices (since prices can be used as a redistributive device), and an *oil-exporting* (*oil-importing*) country has the incentive to raise (reduce) the international price of oil. Also the difference between total exports and imports can affect fuel prices, as it is also the case for road gasoline/diesel consumption. Finally, the size of a country can also affect the price level, as the larger the size of the country the higher the need to travel and, therefore, the higher the consumption of fuel and, hence, the benefit from subsidies and so lower fuel prices.

5 Results

We estimate equation (8), both for diesel and gasoline prices (and subsidies) as defined in Section 3, by using a random effect specification. All regressions control for year effects. As it will be shown shortly below, the results confirm the two hypotheses developed in Section 2.

[25] See Beers and Strand (2013).

Central to the issues at hand is the sign of the interaction between *voice* and *tiers* in equation (5). Following Table 3, this coefficient takes the value of -0.22, for both prices, and is statistically significant at 1% implying that an increase in either variable decreases the impact of the other on fuel prices. The impact of increasing the number of government levels on the price of gasoline is given by $\pi\alpha_{jt} + \delta = -0.22 \times voice + 12.45$, which is positive, and significant, as long as the level of *voice* is below, or equal to, the 35th percentile. For diesel, the impact of decentralization is given by $\pi\alpha_{jt} + \delta = -0.22 \times voice + 15.47$, which is positive, and significant, as long as the level of *voice* is below, or equal to, the 50th percentile[26] (*Hypothesis 1*).

Turning now to accountability, one notices, following Table 3, that an increase in this variable implies a change in the price of diesel equal to $\pi\lambda_j + \gamma = -0.22 \times tiers + 1.53$, which is positive and significant as long as the number of government level is below, or equal to, 5.[27] The impact on the price of gasoline is given by $\pi\lambda_j + \gamma = -0.22 \times tiers + 1.36$, which is positive, and significant, as long as the number of government level is below 5 (*Hypothesis 2*).

Strikingly, what emerges, therefore, is that the impact of decentralization on fuel subsidies can be significant if a country is characterized by low accountability. To see this, take a country (such as Congo, Tajikistan, Tunisia and Ivory Coast) which in 2007 had a level of accountability equal to 10. Then decentralization of policy decision making implies an increase in the price of diesel of US\$ $15.47 - 0.22 \times 10 = 13.28$ cents per liter (statistically significant at 1% level). With the average price per liter of US\$ 67.02 this is an increase of 19.82% relative to that average. Take now a country that has the median level of accountability (Ukraine, El Salvador, Mexico and Albania). In this case, decentralization of policy decision making implies an increase in the price of diesel of US\$ $15.47 - 0.22 \times 50 = 4.53$ cents per liter (statistically significant at 10% level), corresponding to an increase of 6.76% relative to the diesel price average. More generally, this also suggests that the increase in price due to an increase in the number of government levels is smaller the higher the level of accountability. The reason for this is as noted in Section 3: the benefit to policymakers of choosing an inefficient policy diminishes as the number of government levels increases.

Close inspection of the coefficients of the covariates reveal that they all have the expected signs, Beers and Strand (2013). Clearly, if the dependent variables are expressed as subsidies (instead of prices) the significance of the results will remain, only the signs will change (Cols. 3 and 4, Table 3).

[26]Notice that the variable *voice* ranks countries in every year in percentiles (from 0 to 100), according to their accountability, meaning that 0 corresponds to the lowest level of accountability and 100 corresponds to the highest level of accountability.

[27]Notice that the variable *tiers* measures the number of administrative layers in each country taking a value from 1 to 6.

Less immediate evident is whether these results depend on the level of income of a given country. We turn to this next.

5.1 Impact of decentralization and accountability on gasoline price and subsidy: Developed *versus* developing countries

To explore whether the level of development matters for the level of subsidies, we modify equation (8) by interacting *voice*, *voice*×*tiers* and *tiers* with the gross national income per capita, GNI, of the country.[28] To deal with the potential endogeneity we also make use of the one-year lagged *GNI*. We thus estimate the following specification

$$p_{jt} = \phi_t + \pi\alpha_{jt}\lambda_j + \gamma\alpha_{jt} + \delta\lambda_j + \rho\alpha_{jt}\lambda_j GNI_{jt} + \tau\alpha_{jt}GNI_{jt} + \psi\lambda_j GNI_{jt} + \eta GNI_{jt} + \boldsymbol{\beta}'\mathbf{X}_{jt} + \epsilon_{jt}, \tag{9}$$

and, therefore, the impact on price, p_{jt}, in country j of adding one government level, λ—for given level of accountability, α, and given level of GNI—is given by

$$\frac{\triangle p_{jt}}{\Delta\lambda_j} = \pi\alpha_{jt} + \delta + \rho\alpha_{jt}GNI_{jt} + \psi GNI_{jt}. \tag{10}$$

To interpret (10), take a low income country, such as Cameroon, Kyrgyzstan, Ivory Coast and Nigeria, which in 2007 was below and close to the upper bound of the first quartile of the *GNI* distribution[29] and had the median value—with respect to the same quartile of the *GNI* distribution—of the accountability index (25). Then, decentralization, when evaluated at the level of *GNI* corresponding to the upper bound of the first quartile of its distribution (US$ 1,120), implies an increase in gasoline price of US$ 5.10 cents (the coefficient is statistically significant at 10% [30]), which corresponds to 7.5% of the gasoline price sub-sample average of those countries belonging to the first quartile of the *GNI* distribution (US$ 68.09). It follows that decentralization decreases the gasoline subsidies by US$ 4.76 cents (the coefficient is statistically significant 10%[31]), which corresponds to 6.98% of the gasoline price sub-sample average. It is worth noting too that if *voice* increases, while keeping the level of *GNI* constant, the impact of adding one government level decreases, whereas if the level of *GNI* decreases, while keeping the level of *voice* constant, the impact of decentralization increases. It thus follows that, for a given median level of *voice*, decentralization decreases subsidies at least by 6.98% of the gasoline price sub-sample average.

Take now a rich country (such as the Australia, UK, France or Canada) which in 2007

[28] *GNI* partitions countries to low, middle-low, middle-high and high income.

[29] The upper bound of the first quartile of the *GNI* distribution corresponds, approximately, to per capita US$ 1,120 below which there are, on average, 25 countries per year—225 observations.

[30] The coefficient is obtained by following the estimated coefficients of Col. 1, Table 4; namely $5.10 = -0.17 \times 25 + 9.44 + 0.000001 \times 25 \times 1,120 - 0.00004 \times 1,120$, with p-value=0.079.

[31] The coefficient is obtained by following the estimated coefficients of Col. 3, Table 4; namely $-4.76 = 0.17 \times 25 - 9.06 - 0.000002 \times 25 \times 1,120 + 0.00005 \times 1,120$, with p-value=0.100.

was above and close to the lower bound of the last quartile of the *GNI* distribution[32] and had the median value— with respect to the same quartile of the *GNI* distribution—of the accountability index (93). It is straightforward to show that decentralization, when evaluated at the level of *GNI* corresponding to the lower bound of the last quartile of its distribution (US$ 18,920), has no effect on the price of gasoline (with the coefficient being not statistically significant[33]), and so decentralization has no impact on gasoline subsidies (with the coefficient being not statistically significant[34]). It is worth noting that if *voice* increases for the same *GNI*, the coefficient remains statistically insignificant and, if *GNI* decreases, for given level of *voice*, the insignificance still holds.

Moreover, the impact of adding a government level on the gasoline subsidy for developing countries is statistically different (with p-value=0.0473) from the same impact for developed countries. What this points to is that decentralization is effective in reducing gasoline subsidies only for developing countries. The same conclusion holds if the dependent variable is gasoline price.

5.2 Impact of decentralization and accountability on diesel price and subsidy: Developed *versus* developing countries

An example will be again useful for the interpretation of the coefficient regarding the impact of decentralization on diesel prices (Table 4). As before, take a poor country (such as Cameroon, Kyrgyzstan, Ivory Coast and Nigeria) which in 2007 was below and close to the upper bound of the first quartile of the *GNI* distribution and had the median value—with respect to the same quartile of the *GNI* distribution—of the accountability index (25). Then, decentralization, when evaluated at the level of *GNI* corresponding to the upper bound of the first quartile of its distribution (US$ 1,120), implies an increase in the diesel price of US$ 7.42 cents (the coefficient is statistically significant at 5%[35]), which corresponds to 13.78% of the diesel price sub-sample average of those countries belonging to the first quartile of the *GNI* distribution (US$ 53.82). It follows that decentralization decreases diesel subsidies by US$ 6.99 cents (the coefficient is statistically significant at 5%[36]), which corresponds to 12.99% of the diesel price sub-sample average. If *voice* increases (while keeping the level of *GNI* constant) the impact of decentralization decreases whereas if *GNI* decreases (while keeping the level of *voice* constant) the impact of decentralization increases. It thus follows

[32]The lower bound of the last quartile of the *GNI* distribution corresponds, approximately, to per capita US$ 18,920 above which there are, on average, 25 countries per year—225 observations)

[33]The coefficient is obtained by following the estimated coefficients of Col. 1, Table 4; namely $-4.85 = -0.17 \times 93 + 9.44 + 0.000001 \times 93 \times 18,920 - 0.00004 \times 18,920$, with p-value=0.210.

[34]The coefficient is obtained by following the estimated coefficients of Col. 3, Table 4; namely $5.23 = 0.17 \times 93 - 9.06 - 0.000002 \times 93 \times 18,920 + 0.00005 \times 18,920$, with p-value=0.176.

[35]The coefficient is obtained by following the estimated coefficients of Col. 2, Table 4; namely $7.42 = -0.08 \times 25 + 9.62 - 0.000001 \times 25 \times 1,120 - 0.00020 \times 1,120$, with p-value=0.012.

[36]The coefficient is obtained by following the estimated coefficients of Col. 4, Table 4; namely $-6.99 = 0.08 \times 25 - 9.11 + 0.000002 \times 25 \times 1,120 + 0.00017 \times 1,120$, with p-value=0.023.

that, for a given median level of *voice*, decentralization decreases subsidies at least by 12.99% of the diesel price sub-sample average.

Take a rich country (such as the Australia, UK, France, or Canada) which in 2007 was above and close to the lower bound of the last quartile of the *GNI* distribution and had the median value—with respect to the same quartile of the *GNI* distribution—of the accountability index (93). Then, decentralization, when evaluated at the level of *GNI* corresponding to the lower bound of the last quartile of its distribution (US$ 18,920), has no effect in the price of diesel (the coefficient is not statistically significant[37]). It follows that adding one government level does not have any impact on diesel subsidies (the coefficient is not statistically significant[38]). Notice that if *voice* increases for the same *GNI*, the coefficient remains not statistically significant and, if the *GNI* decreases, for given level of *voice*, the coefficient is not significant yet.

In this case, too, the impact of decentralization on the diesel subsidy for developing countries, is statistically different (p-value=0.0624) from the impact of adding one government level on the diesel subsidy for developed countries, suggesting that decentralization leads to a decrease in diesel subsidies only for developing countries when compared to developed countries. The same conclusion holds if we take as dependent variable the diesel price.

6 Robustness check

The random effect specification can bias the estimation since the unobserved country characteristics can be correlated with the error term. In order to check for this possible bias, we make use of the Mundlak approach (1978) which allows to incorporate the unobserved effect into the random model specification by including the time averages of the covariates (including time dummies) as additional explanatory variables. In this way, the estimated coefficients of the random model specification are identical to the fixed effect estimator (Wooldridge (2009)) and, therefore, the bias does not hold anymore.

We have run regressions (Cols. 1 and 2, Table 5) by using the Mundlak approach and have obtained results very similar to those obtained by running the random effect specification. In particular, the coefficient of the interaction of accountability with the number of government levels is negative both for the gasoline and diesel price, but it is statistically significant only for the former (-0.25, significant at 5%), and the impact on diesel and gasoline price of decentralization is positive and significant as long as the level of accountability is below the 40th percentile for diesel and, below the 10th percentile for gasoline (*Hypothesis 1*). The impact on diesel and gasoline prices of enhanced accountability is positive and significant as

[37]The coefficient is obtained by following the estimated coefficients of Col. 2, Table 4; namely $-3.65 = -0.08 \times 93 + 9.62 - 0.000001 \times 93 \times 18,920 - 0.00020 \times 18,920$, with p-value=0.429.

[38]The coefficient is obtained by following the estimated coefficients of Col. 4, Table 4; namely $4.04 = 0.08 \times 93 - 9.11 + 0.000002 \times 93 \times 18,920 + 0.00017 \times 18,920$, with p-value=0.384.

long as the number of government level is below, or equal to, 5 for diesel and, below 4 for gasoline (*Hypothesis 2*). These results, of course, do not change if subsidies are used as the dependent variable—only the signs change (Cols. 3 and 4, Table 5).

We then replicate the analysis carried out in Sections 5.1 and 5.2, using again the Mundlak approach. In this case, too, the results are in line with those obtained by the random effect specification.

In the gasoline case (Col. 3, Table 6), decentralization in a poor country, taken here to be again those countries belonging to the first quartile of the *GNI* distribution, implies a decrease in the gasoline subsidies, evaluated for a level of *GNI* equals to US$ 1,120 and for the median level of accountability of poor countries (25), by at least of US$ 11.69 cents (the coefficient is statistically significant at[39] 10%). On the other hand, decentralization in a rich country (taken here to be again those countries belonging to the last quartile of the *GNI* distribution), when evaluated for a level of *GNI* equals to US$ 18,920 and for the median level of accountability of rich countries (93), has no effect on gasoline subsidies.[40] For the diesel case (Col. 4, Table 6), decentralization in a poor country, when, again, evaluated for a level of *GNI* equals to US$ 1,120 and for the median level of accountability of poor countries (25), implies a decrease in the diesel subsidies by at least of US$ 24.73 cents (the coefficient is statistically significant at[41] 1%). On the other hand, decentralization in a rich country, when evaluated for a level of *GNI* equals to US$ 18,920 and for the median level of accountability of rich countries (93), has no effect on diesel subsidies.[42] Again, both for gasoline and diesel prices, if the price is used as the dependent variable the results do not change, only the signs change (Cols. 1 and 2, Table 6).

The robustness analysis, carried out by adopting the Mundlak approach, therefore confirms the results emerged under the random effects estimations: that decentralization strongly impacts on gasoline and diesel subsidies (prices) and that such effect is significant only for developing countries.

7 Concluding remarks

The purpose of this paper has been to address the question of whether, in practice, fuel-price subsidies are affected by the extent of decentralization, an issue of particular interest for developing countries, where accountability of government is in general lower than in developed countries. Despite the importance of understanding the link between policy and decentralization (in particular so for developing countries where fiscal capacity is limited) there has been virtually no existing evidence from such settings. The analysis has shown that

[39] Using the estimated coefficients of Col. 3, Table 6 in (10) gives -11.69 with p-value=0.089.
[40] Using the estimated coefficients of Col. 3, Table 6 in (10) gives -3.77 with p-value=0.779.
[41] Using the estimated coefficients of Col. 4, Table 6 in (10) gives -24.73 with p-value=0.000.
[42] Using the estimated coefficients of Col. 4, Table 6 in (10) gives -17.33 with p-value=0.237.

when the government architecture is a decentralized one, for given level of accountability of the government, the use of a subsidy for political gain become less effective: adding one unit of government level leads to higher level of gasoline and diesel price and, therefore to a lower level of the fuel-price subsidy. Moreover, the increase in the level of accountability of the government mitigates the former effect: the more accountable is the government the more difficult the political benefit of a distortive subsidy is.

We have investigated further whether this effect is driven by developing and/or developed countries. We found that adding one government level leads to a statistically significant increase in gasoline and diesel price (and so a decrease in the subsidy) for developing countries, while it has no effect for developed countries. What this all point to? Interestingly, it points towards the possibility that in developing economies where voters are poorly informed, and the assignment of functions and policy instruments to the various government levels are imperfect, fuel subsides will be an inefficient policy but it will be more so in the absence of multi-leveled governance.

Appendix A

Insert TABLES A1 and A2

Appendix B: Data sources and definitions

Gasoline (*diesel*) price is premium gasoline (diesel) prices measured in November each year in US$ cents per liter. Source: Deutsche Gesellschaft fr technische Zusammenarbeit (GTZ) - https://www.giz.de/de/html/index.html.

Tiers i ($i = 1, 2, 3, 4, 4.5, 5, 6$) measures the number of administrative layers, as defined in Triesman (2002). The variable level i takes the value of 1 if a county has i level(s) of government.

Voice captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governance/wgi/

Democracy dummy variable. 1 indicates that a country was considered to be an electoral democracy for the year; 0 indicates that a country was not. Source: Freedom House, https://freedomhouse.org/report-types/freedom-world.

Population is the total population based on the de facto definition of population, which counts all residents regardless of legal status or citizenship except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. Source: United Nations Population Division and World Population Prospects.

Domestic deflator is given for each country by the ratio of GDP in current local currency to GDP in constant local currency. We use as base year 2005. Source: World Bank national accounts data, and OECD National Accounts data files.

US deflator is given by the ratio of US GDP in current US dollars to GDP in constant US dollars. We use as base year 2005. Source: World Bank national accounts data, and OECD National Accounts data files.

Income (GDPPPP) measures the gross domestic product converted to US dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the US$ has in the United States. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current international dollars. Source: World Bank, International Comparison Program database.

Net supply of fuel (*oil supply-oil consumption*) is given by oil supply minus oil consumption. Oil supply is measured by annual data on total oil supply and the unit is thousand barrels per day. Oil consumption is measured by annual data on total petroleum consumption and the unit is thousand barrels per day. Source: Energy Information Administration (EIA).

Land (area/population) is the land area per km^2 divided by population. In particular, land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the definition of inland water bodies includes major rivers and lakes. Source: Food and Agriculture Organization.

Openness (exports+imports)/GDP is the sum of exports and imports of goods and services measured as a share of gross domestic product. Source: World Bank national accounts data and OECD national account data.

Road gasoline fuel consumption is road sector gasoline fuel consumption (kt of oil gasoline is light hydrocarbon oil use in internal combustion engine such as motor vehicles, excluding aircraft). Source: International Road Federation, World Road Statistics and International Energy Agency.

Road diesel fuel consumption is road sector diesel fuel consumption (kt of oil equivalent. Diesel is heavy oils used as a fuel for internal combustion in diesel engines). Source: International Road Federation, World Road Statistics and International Energy Agency.

Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governance/wgi/

Political stability and absence of violence/terrorism captures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent mean, including politically-motivated violence and terrorism. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governa

Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governance/wgi/

Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governance/wgi/

Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests. Percentile rank indicates the country's rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank and, 100 to highest rank. Source: Worldwide Governance Indicator (WGI). Detailed documentation of the WGI and full access to data are available at: http://info.worldbank.org/governance/wgi/

GNI based on purchasing power parity is gross national income (GNI) converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GNI as a U.S. dollar has in the United States. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Source: World Bank

Appendix C

Insert TABLE A3

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Table 1: developed and developing per capita income countries

Variable	Observations	Mean	Std. Dev.	Min	Max
Developed countries	480	24,206.65	13,845.45	6,668.56	91,712.32
Developing countries	423	3,451.65	2,346.77	223.63	11,048.08

Table 2: Difference in gasoline (diesel) price for developed and developing countries between countries with high and low government layers

	Diesel price		
	low governments layers	high governments layers	difference in mean
Developed	80.47	82.53	2.06
	(2.83)	(3.14)	(4.21)
Developing	47.65	58.21	10.56***
	(1.79)	(2.78)	(3.28)
	Gasoline price		
	low governments layers	high governments layers	difference in mean
Developed	93.87	95.66	1.79
	(2.78)	(3.22)	(4.23)
Developing	61.41	72.94	11.53***
	(1.83)	(2.80)	(3.34)

Notes: Number of observations 891 for diesel (419 for developing countries and 472 for developed countries) and 903 for gasoline (423 for developing countries and 480 for developed countries). Low governments levels is the subsample of countries with number of tiers below the median and, high governments levels is the subsample of countries with number of tiers equal and above the median. The median of *tiers* for developing countries is 4 and, for developed countries is 3.Standard errors are shown in parentheses. Significance at 10% level is represented by *, at the 5% level by **, and at the 1% level by ***.

Table 3: Impact of decentralization on gasoline and diesel price (and subsidy). Random effect regressions**.**

	gasoline price	diesel price	gasoline subsidy	diesel subsidy
Variables	(1)	(2)	(3)	(4)
voice	1.36***	1.53***	-1.35***	-1.50***
	(0.30)	(0.32)	(0.31)	(0.33)
voice*tiers	-0.22***	-0.22***	0.22***	0.22***
	(0.07)	(0.08)	(0.08)	(0.08)
tiers	12.45***	15.47***	-12.16***	-15.09***
	(4.31)	(4.41)	(4.45)	(4.47)
democracy	0.20	-2.07	-0.07	2.05
	(3.74)	(3.31)	(3.96)	(3.43)
population	-0.09*	-0.14**	0.07*	0.13**
	(0.05)	(0.07)	(0.04)	(0.06)
lag income	0.42	-0.02	-0.46	-0.04
	(0.30)	(0.39)	(0.31)	(0.39)
lag of net supply of fuel	-0.28**	-0.15	0.19*	0.07
	(0.11)	(0.21)	(0.11)	(0.20)
land	-0.04	-0.00	-0.00	-0.02
	(0.07)	(0.12)	(0.08)	(0.12)
openness	-0.16***	-0.12**	0.16***	0.12**
	(0.05)	(0.05)	(0.05)	(0.05)
lag of road gasoline fuel consumption per million inhabitants	-0.09***		0.08***	
	(0.02)		(0.02)	
lag of road diesel fuel consumption per million inhabitants		-0.00		0.00
		(0.01)		(0.01)
political stability	0.00	0.07	0.01	-0.06
	(0.09)	(0.09)	(0.09)	(0.09)
government effectiveness	-0.18	-0.14	0.19	0.15
	(0.12)	(0.12)	(0.12)	(0.13)
regulatory quality	0.24	0.18	-0.23	-0.18
	(0.16)	(0.15)	(0.16)	(0.15)
rule of law	0.44***	0.24	-0.45***	-0.25
	(0.16)	(0.17)	(0.16)	(0.18)
control of corruption	-0.05	-0.10	0.06	0.11
	(0.12)	(0.14)	(0.13)	(0.14)
Constant	30.67	31.31	16.05	52.90***
	(19.39)	(20.01)	(18.63)	(19.23)
Observations	903	891	903	891
R-squared within	0.643	0.693	0.300	0.205

Notes: in all regressions we control for *population*^{2}, *1/population*, *land*^{2}, *1/land* and *year effects*. For the price specification (col. 1 and col. 2), we also control for *US Deflator*. For the subsidy specification (col. 3 and col. 4) we also control for the *domestic deflator*. Robust standard errors, clustered at country level, are shown in parenthesis. *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 4: Impact of decentralization on gasoline and diesel price (and subsidy) for developed and developing countries.

	gasoline price	diesel price	gasoline subsidy	diesel subsidy
	(1)	(2)	(3)	(4)
voice	0.87***	0.62*	-0.82**	-0.58
	(0.32)	(0.38)	(0.34)	(0.40)
voice*tiers	-0.17**	-0.08	0.17**	0.08
	(0.08)	(0.09)	(0.09)	(0.10)
tiers	9.44**	9.62*	-9.06*	-9.11*
	(4.51)	(4.91)	(4.80)	(5.25)
voice*lag of GNI	0.00002	0.00003	-0.00002	-0.00004
	(0.00002)	(0.00003)	(0.00002)	(0.00003)
voice*tiers*lag of GNI	0.000001	-0.000001	-0.000002	0.000002
	(0.000005)	(0.000007)	(0.000006)	(0.000007)
tiers*lag of GNI	-0.00004	-0.00020	0.00005	0.00017
	(0.00048)	(0.00064)	(0.00051)	(0.00066)
lag of GNI	-0.00216	-0.00176	0.00231	0.00198
	(0.00188)	(0.00240)	(0.00203)	(0.00252)
democracy	2.44	-0.24	-2.46	0.17
	(3.52)	(3.10)	(3.71)	(3.22)
population	-0.10**	-0.14**	0.09**	0.13**
	(0.05)	(0.06)	(0.04)	(0.06)
lag income	0.87**	0.42	-1.02***	-0.61
	(0.36)	(0.46)	(0.37)	(0.47)
lag of net supply of fuel	-0.19*	-0.06	0.11	-0.02
	(0.11)	(0.16)	(0.10)	(0.16)
land	-0.10	-0.11	0.06	0.08
	(0.06)	(0.09)	(0.07)	(0.09)
openness	-0.18***	-0.12**	0.18***	0.12**
	(0.05)	(0.05)	(0.05)	(0.05)
lag of road gasoline fuel consumption per million inhabitants	-0.08***		0.07***	
	(0.02)		(0.02)	
lag of road diesel fuel consumption per million inhabitants		-0.01		0.01
		(0.01)		(0.01)
political stability	0.05	0.12	-0.04	-0.11
	(0.09)	(0.09)	(0.09)	(0.09)
government effectiveness	-0.15	-0.09	0.16	0.10
	(0.11)	(0.12)	(0.11)	(0.13)
regulatory quality	0.27*	0.22	-0.26	-0.22
	(0.16)	(0.14)	(0.16)	(0.15)
rule of law	0.44***	0.24	-0.45***	-0.25
	(0.16)	(0.17)	(0.16)	(0.18)
control of corruption	-0.03	-0.10	0.04	0.11
	(0.12)	(0.13)	(0.12)	(0.14)
Constant	48.12**	58.48***	-6.25	19.35
	(18.88)	(20.10)	(18.98)	(20.89)
Observations	898	886	898	886
R-squared within	0.650	0.707	0.319	0.244

Notes: see Table 3.

Table 5: Impact of decentralization on gasoline and diesel price (and subsidy). Mundlak approach.

	gasoline price	diesel price	gasoline subsidy	diesel subsidy
VARIABLES	(1)	(2)	(3)	(4)
voice	1.25***	1.16**	-1.27***	-1.17**
	(0.47)	(0.57)	(0.48)	(0.58)
voice*tiers	-0.25**	-0.15	0.25**	0.16
	(0.11)	(0.13)	(0.11)	(0.13)
tiers	11.66**	19.08***	-11.14**	-18.75***
	(5.02)	(5.54)	(4.99)	(5.44)
democracy	3.82	-0.61	-4.45	-0.02
	(4.31)	(4.60)	(4.59)	(4.85)
population	-0.50	-0.63	0.57	0.70
	(0.36)	(0.49)	(0.37)	(0.50)
lag income	-0.23	-0.08	0.35	0.17
	(0.36)	(0.49)	(0.38)	(0.50)
lag of net supply of fuel	-0.21	-0.21	0.13	0.13
	(0.33)	(0.36)	(0.34)	(0.38)
land	1.80***	2.90***	-1.99***	-3.11***
	(0.70)	(0.74)	(0.72)	(0.76)
openness	-0.23***	-0.16**	0.24***	0.16**
	(0.08)	(0.08)	(0.08)	(0.08)
lag of road gasoline fuel consumption per million inhabitants	-0.12***		0.12***	
	(0.04)		(0.04)	
lag of road diesel fuel consumption per million inhabitants		-0.01		0.01
		(0.02)		(0.02)
political stability	0.02	0.08	-0.02	-0.08
	(0.09)	(0.09)	(0.09)	(0.09)
government effectiveness	-0.17	-0.08	0.19	0.10
	(0.13)	(0.14)	(0.13)	(0.14)
regulatory quality	0.16	0.06	-0.16	-0.05
	(0.17)	(0.15)	(0.18)	(0.16)
rule of law	0.44**	0.27	-0.47**	-0.30
	(0.19)	(0.20)	(0.19)	(0.21)
control of corruption	-0.00	-0.02	0.01	0.03
	(0.12)	(0.13)	(0.13)	(0.14)
Constant	89.21	156.26	-36.85	-28.17
	(102.61)	(142.52)	(87.25)	(114.33)
Observations	903	891	903	891
R-squared within	0.658	0.717	0.336	0.269

Notes: in all regressions we control for *population*^{2}, *1/population*, *land*^{2}, *1/land* and *year effects*. In order to perform the Mundlak approach, we also include the time averages of all the covariates (including time dummies) as additional explanatory variables. For the price specification (col. 1 and col. 2), we also control for *US Deflator* and its corresponding time average value by country. For the subsidy specification (col. 3 and col. 4) we also control for the *domestic deflator* and its corresponding time average value by country. Robust standard errors, clustered at country level, are shown in parenthesis. *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 6: Impact of decentralization on gasoline and diesel price (and subsidy) for developing and developed countries. Mundlak approach.

	gasoline price	diesel price	gasoline subsidy	diesel subsidy
	(1)	(2)	(3)	(4)
voice	0.59	0.36	-0.54	-0.30
	(0.52)	(0.68)	(0.53)	(0.70)
voice*tiers	-0.12	-0.02	0.12	0.01
	(0.12)	(0.16)	(0.13)	(0.16)
tiers	13.43**	23.65***	-13.82**	-24.30***
	(6.09)	(5.98)	(5.98)	(5.84)
voice*lag of GNI	0.00005**	0.00007	-0.00006**	-0.00008*
	(0.00003)	(0.00004)	(0.00003)	(0.00005)
voice*tiers*lag of GNI	-0.00001	-0.00001	0.00001	0.00001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
tiers*lag of GNI	0.00096	0.00086	-0.00104	-0.00099
	(0.00071)	(0.00113)	(0.00077)	(0.00121)
lag of GNI	-0.00526**	-0.00532	0.00580**	0.00603
	(0.00244)	(0.00370)	(0.00261)	(0.00394)
democracy	4.94	1.41	-5.64	-2.06
	(4.33)	(4.42)	(4.62)	(4.68)
population	-0.46	-0.66	0.52	0.72
	(0.34)	(0.50)	(0.35)	(0.51)
lag income	0.17	0.22	-0.18	-0.28
	(0.41)	(0.58)	(0.43)	(0.60)
lag of net supply of fuel	-0.03	-0.04	-0.05	-0.04
	(0.29)	(0.32)	(0.30)	(0.35)
land	1.71**	2.55***	-1.85**	-2.71***
	(0.72)	(0.70)	(0.73)	(0.72)
openness	-0.22***	-0.15*	0.23***	0.16*
	(0.08)	(0.08)	(0.08)	(0.08)
lag of road gasoline fuel consumption per million inhabitants	-0.09**		0.09**	
	(0.04)		(0.04)	
lag of road diesel fuel consumption per million inhabitants		-0.02		0.02
		(0.02)		(0.02)
political stability	0.03	0.10	-0.03	-0.10
	(0.09)	(0.08)	(0.09)	(0.08)
government effectiveness	-0.12	-0.01	0.14	0.04
	(0.13)	(0.15)	(0.13)	(0.15)
regulatory quality	0.15	0.07	-0.14	-0.06
	(0.18)	(0.16)	(0.19)	(0.16)
rule of law	0.48***	0.35*	-0.52***	-0.38*
	(0.18)	(0.20)	(0.19)	(0.21)
control of corruption	-0.01	-0.06	0.02	0.06
	(0.13)	(0.13)	(0.13)	(0.14)
Constant	90.54	56.90	-5.09	86.51***
	(96.80)	(76.96)	(76.19)	(31.52)
Observations	898	886	898	886
R-squared within	0.663	0.727	0.349	0.300

Notes: see Table 5.

Figure 1: Gasoline (diesel) price and the accountability index (voice).

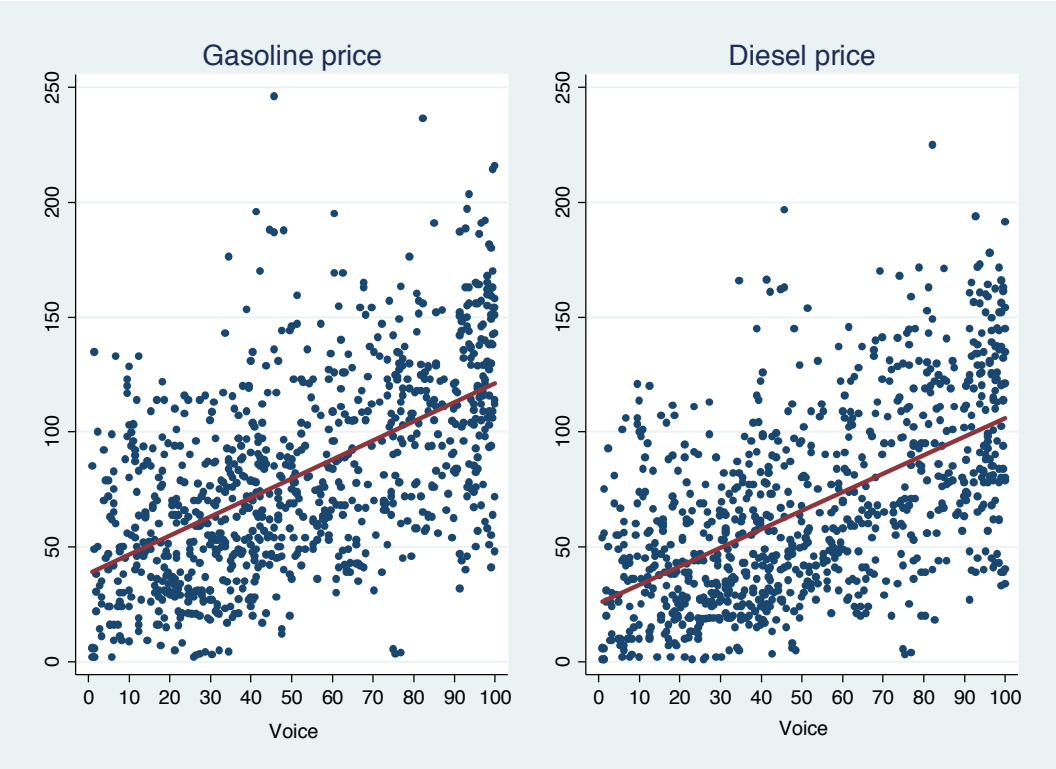
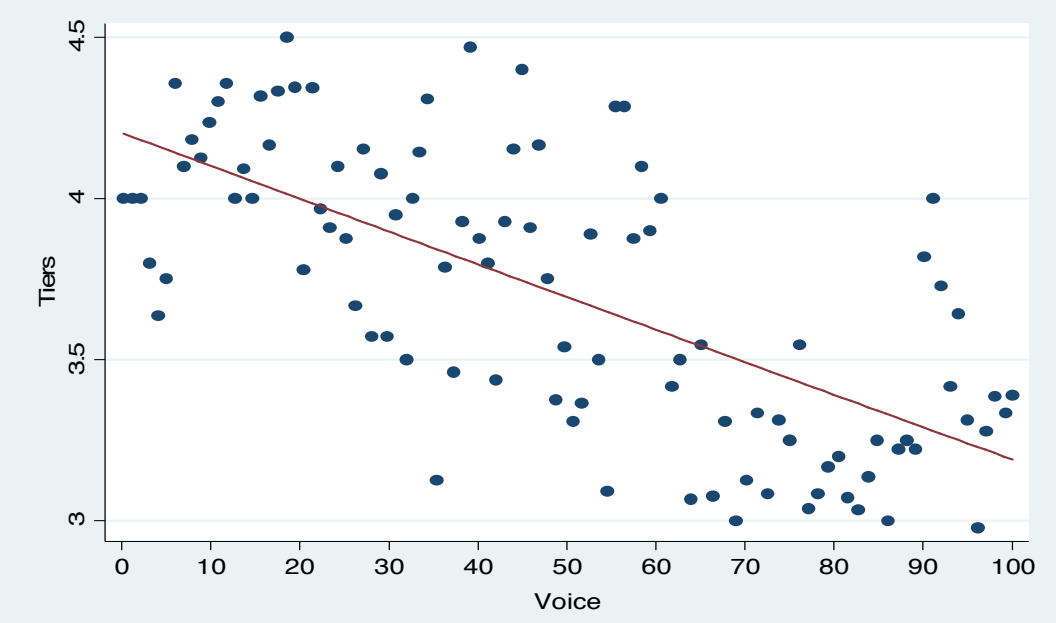


Figure 2: Tiers and the accountability index (voice).



Note: Each dot represents the average value of the number of tiers of the countries contained in the relative centile of the variable voice.

Figure 3: Distribution of tiers for developed and developing countries

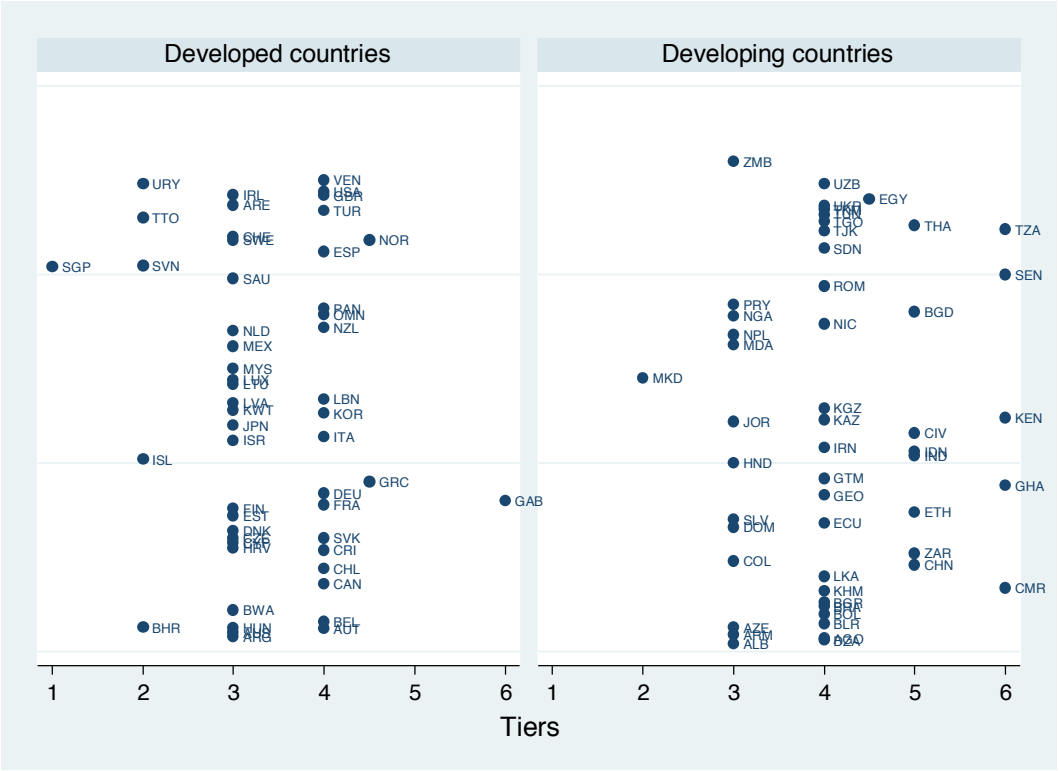
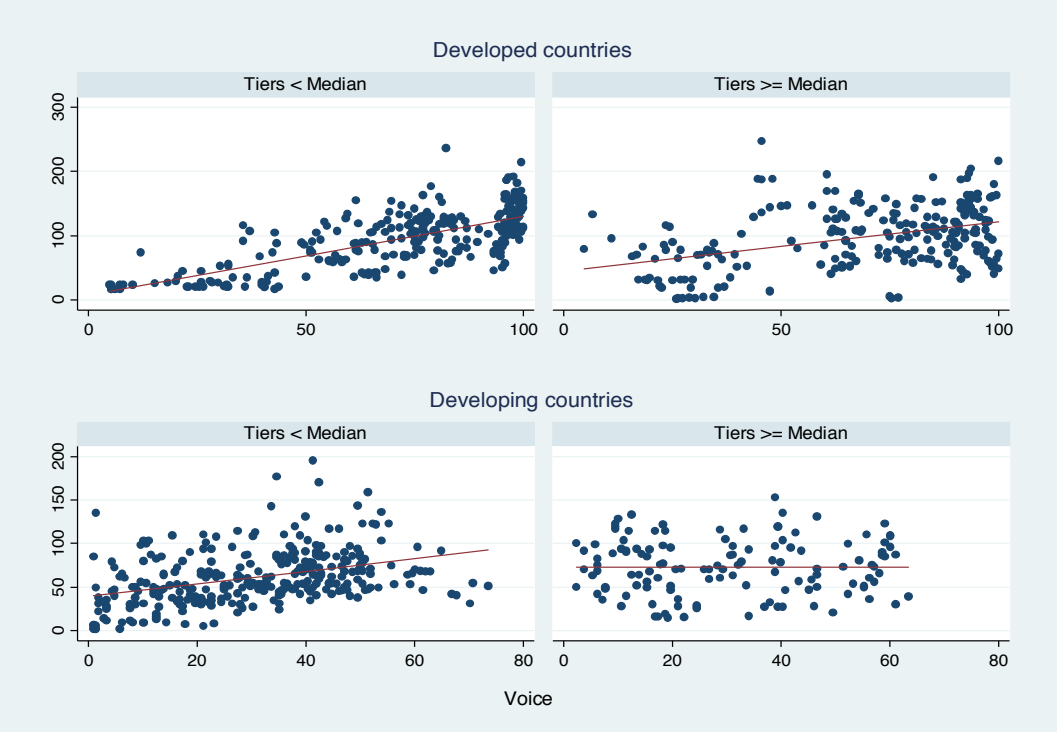
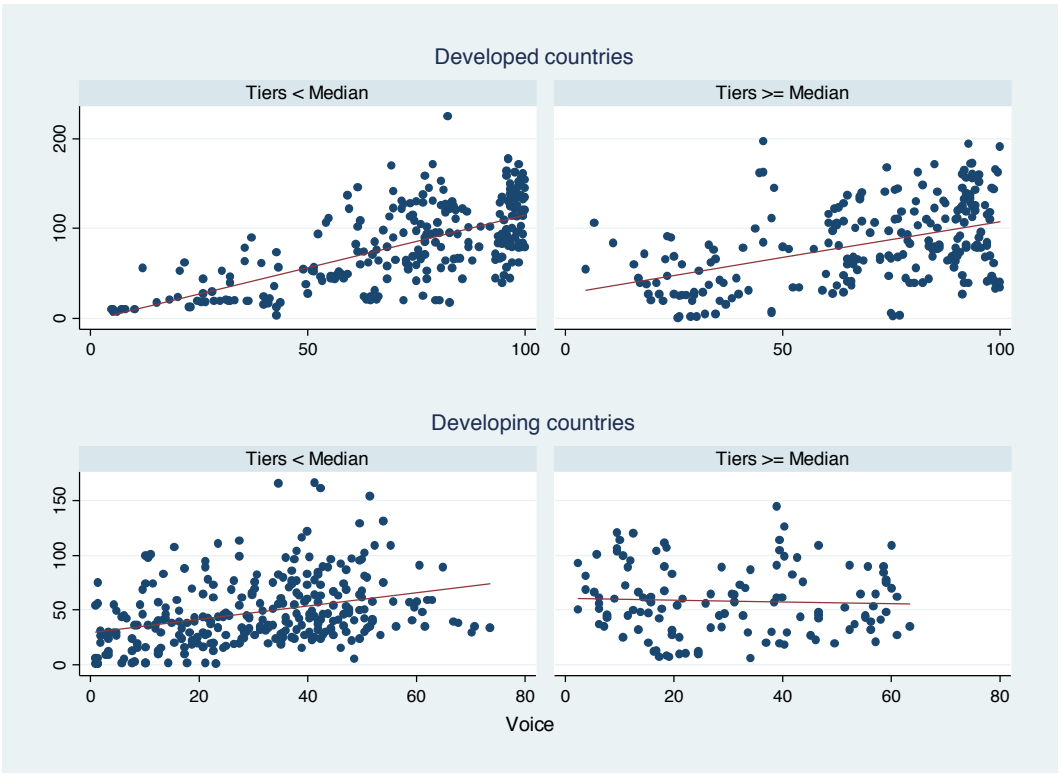


Figure 4a: Relationship between gasoline price and voice for developed and developing countries



Note: For the subsample of developed countries the median of the variable *tiers* is 3. For the subsample of developing countries the median of the variable *tiers* is 4.

Figure 4b: Relationship between diesel price and voice for developed and developing countries



Note: For the subsample of developed countries the median of the variable *tiers* is 3. For the subsample of developing countries the median of the variable *tiers* is 4.

APPENDIX A: Summary Statistics

Table A1. Dataset used when we use gasoline price (and subsidy) as the dependent variable. Years 1998, 2000 and 2002-2008.

Variable	Obs	Mean	Std. Dev.	Min	Max
gasoline subsidy	903	-40.70	37.82	-179.32	61.24
gasoline price	903	80.74	42.84	2.00	246.08
voice	903	51.56	29.72	0.96	100.00
voice*tiers	903	184.40	108.58	3.85	450.00
tiers	903	3.73	0.95	1.00	6.00
democracy	903	0.66	0.48	0.00	1.00
population	903	52.17	168.72	0.27	1324.66
Usdeflator-deflator	903	95.30	24.61	0.18	252.63
deflator	903	2.08	19.68	-144.75	85.64
lag GDPPPP/population	903	13.67	13.73	0.22	84.41
lag of Net supply of fuel	903	-0.68	17.15	-124.80	91.33
area/population	903	38.46	68.27	0.14	410.58
(export + imports) / GDP	903	88.93	50.20	15.87	438.09
lag of road gasoline fuel consumption	903	202.77	239.03	1.47	1300.89
political stability	903	46.99	28.72	0.00	100.00
governemnt effectivness	903	55.49	29.17	0.97	100.00
regulatory quality	903	56.73	28.29	0.49	100.00
rule of law	903	52.06	30.14	0.48	100.00
control of corruption	903	52.61	30.49	0.00	100.00
square population	903	31156.06	201013.00	0.08	1754711.00
inverse of population	903	0.22	0.43	0.00	3.65
square of area/population	903	6135.29	22284.77	0.02	168573.20
inverse of area/population	903	0.17	0.57	0.00	6.94
developed countries	903	0.53	0.50	0.00	1.00
developing countries	903	0.47	0.50	0.00	1.00
lag of GNI	898	852341.30	1353598.00	264.42	7775489
voice* lag of GNI	898	37045.32	50717.56	400.00	346275.00
tiers* lag of GNI	898	2898532.00	4735601.00	1322.09	34500000.00
voice*tiers* lag of GNI	898	10943.69	14577.63	80	79670

Notes: for the variables *lag of GNI*, *voice*lag of GNI*, *tiers*lag of GNI*, *voice*tiers*lag of GNI* the number of observations is lower with respect to the other variables since for the following countries and years, data are missing: Czech Republic 2002, Estonia 2002, Haiti 2004, Nigeria 2000 and Qatar 2004.

Table A2. Dataset used when we use diesel price (and subsidy) as the dependent variable. Years 1998, 2000 and 2002-2008.

Variable	Obs	Mean	Std. Dev.	Min	Max
diesel subsidy	891	-24.67	35.46	-158.94	67.00
diesel price	891	67.02	42.29	1.00	225.00
voice	891	51.54	29.77	0.96	100.00
voice*tiers	891	184.44	108.72	3.85	450.00
tiers	891	3.73	0.94	1.00	6.00
democracy	891	0.65	0.48	0.00	1.00
population	891	52.68	169.78	0.27	1324.66
Usdeflator-deflator	891	95.11	24.64	0.18	252.63
deflator	891	2.21	19.71	-144.75	85.64
lag GDPPPP/population	891	13.62	13.60	0.22	84.41
lag of Net supply of fuel	891	-0.73	17.24	-124.80	91.33
area/population	891	38.45	68.18	0.14	410.58
(export + imports) / GDP	891	88.98	50.40	15.87	438.09
lag of road diesel fuel consumption	891	183.62	317.66	0.00	3710.57
political stability	891	47.06	28.74	0.00	100.00
governemnt effectivness	891	55.53	29.17	0.97	100.00
regulatory quality	891	56.74	28.31	0.49	100.00
rule of law	891	52.12	30.14	0.48	100.00
control of corruption	891	52.63	30.48	0.00	100.00
square population	891	31568.28	202331.90	0.08	1754711.00
inverse of population	891	0.22	0.43	0.00	3.65
square of area/population	891	6121.42	22291.72	0.02	168573.20
inverse of area/population	891	0.17	0.58	0.00	6.94
developed countries	891	0.53	0.50	0.00	1.00
developing countries	891	0.47	0.50	0.00	1.00
lag of GNI	886	855986.1	1359584	264.418	7775489
voice*lag of GNI	886	36990.62	50440.23	400	346275
tiers*lag of GNI	886	2910387	4753709	1322.09	34500000
voice*tiers* lag of GNI	886	10936.88	14544.03	80	79670

Notes: For diesel price and diesel subsidy the number of observations is lower than the number of observations for gasoline price and gasoline subsidy since for the following countries and years, data on diesel price are missing: Albania 2005, Canada 2005, Haiti 2005 and 2007, Panama 2005, Qatar 2008, Thailand 2005, Trinidad & Tobago 2005 and 2008, Uruguay 2005 and Venezuela 2005. In addition, for the variables *lag of GNI*, *voice*lag of GNI*, *tiers* lag of GNI*, *voice*tiers*lag of GNI* the number of observations is lower with respect to the other variables since for the following countries and years, data are missing: Czech Republic 2002, Estonia 2002, Haiti 2004, Nigeria 2000 and Qatar 2004.

APPENDIX C

Table A3. Countries of the dataset

country	Country code	country	Country code	country	Country code
Albania	ALB	Finland	FIN	Netherlands	NLD
Algeria	DZA	France	FRA	New Zealand	NZL
Angola	AGO	Gabon	GAB	Nicaragua	NIC
Argentina	ARG	Georgia	GEO	Nigeria	NGA
Armenia	ARM	Germany	DEU	Norway	NOR
Australia	AUS	Ghana	GHA	Oman	OMN
Austria	AUT	Greece	GRC	Panama	PAN
Azerbaijan	AZE	Guatemala	GTM	Paraguay	PRY
Bahrain	BHR	Haiti	HTI	Qatar	QAT
Bangladesh	BGD	Honduras	HND	Romania	ROM
Belarus	BLR	Hungary	HUN	Saudi Arabia	SAU
Belgium	BEL	Iceland	ISL	Senegal	SEN
Bolivia	BOL	India	IND	Singapore	SGP
Botswana	BWA	Indonesia	IDN	Slovakia	SVK
Brazil	BRA	Iran	IRN	Slovenia	SVN
Bulgaria	BGR	Ireland	IRL	Spain	ESP
Cambodia	KHM	Israel	ISR	Sri Lanka	LKA
Cameroon	CMR	Italy	ITA	Sudan	SDN
Canada	CAN	Ivory Coast	CIV	Sweden	SWE
Chile	CHL	Japan	JPN	Switzerland	CHE
China, Hong Kong	HKG	Jordan	JOR	Tajikistan	TJK
China, P.R.	CHN	Kazakhstan	KAZ	Tanzania	TZA
Colombia	COL	Kenya	KEN	Thailand	THA
Congo, Democratic Rep. Of	ZAR	Korea, South	KOR	Togo	TGO
Costa Rica	CRI	Kuwait	KWT	Trinidad & Tobago	TTO
Croatia	HRV	Kyrgyzstan	KGZ	Tunisia	TUN
Cyprus, South	CYP	Latvia	LVA	Turkey	TUR
Czech Republic	CZE	Lebanon	LBN	Turkmenistan	TKM
Denmark	DNK	Lithuania	LTU	Ukraine	UKR
Dominican Republic	DOM	Luxembourg	LUX	United Arab Emirates	ARE
Ecuador	ECU	Macedonia	MKD	United Kingdom	GBR
Egypt	EGY	Malaysia	MYS	United States	USA
El Salvador	SLV	Mexico	MEX	Uruguay	URY
Estonia	EST	Moldova	MDA	Uzbekistan	UZB
Ethiopia	ETH	Nepal	NPL	Venezuela	VEN
				Zambia	ZMB