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The distributional incidence of the gasoline tax in Chile

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HIGHLIGHTS

- Gasoline tax is an optimal tax and is a significant instrument of climate policy.
- Despite its benefits, it faces political economy challenges in its implementation.
- In the public discussion in developing countries the tax is considered regressive.
- The estimation of the distributional incidence shows that it is slightly progressive.
- Increases in gasoline taxes can reduce both negative externalities and inequality.

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ABSTRACT

This paper analyzes the distributional incidence of the excise tax on gasoline in Chile using Household Budget Surveys. The incidence is calculated with respect to both income and expenditure distributions in order to consider the potential differences between transitory and permanent income. The Suits Index is estimated as a measure of the degree of progressivity of the tax, and confidence intervals are calculated using a bootstrap methodology to statistically compare changes in the incidence given changes in the tax. The results show that the tax, contrary to the evidence for several developed countries, is slightly or moderately progressive, with a lower degree of progressivity observed in the calculations based on income than those based on expenditure. The simulation of the 25% reduction in the tax rate implemented in 2008 shows that, in terms of incidence, its effect is to reduce the progressivity of the gasoline tax, which is the opposite of what was sought by the government with this policy.

1. Introduction

The consumption of gasoline, which is mostly used by automobiles, generates negative externalities both directly, such as pollution (emissions of carbon dioxide, nitrogen oxide and carbon monoxide), and indirectly, such as traffic congestion and accidents.

Hence, a gasoline tax is an optimal tax that allows the internalization of externalities and the improvement of resource allocation in the economy (Musgrave and Musgrave, 1989; Innes, 1996; Thorpe, 1997; Parry et al., 2007) and Chile, like most governments, taxes fuels to reduce private vehicles trips. In general, the empirical evidence confirms the theoretical effects of the gasoline tax on the reduction of negative externalities (Haughton and Sarkar, 1996; Johansson and Schipper, 1997; Portney et al., 2003; West and Williams, 2004; Bento et al., 2005; Grabowski and Morrisey, 2006; Li et al., 2014; Spiller et al., 2014). Consistently, the evidence for European countries shows that the effects of gasoline taxes on global carbon emissions makes it a significant instrument of climate policy (Sterner, 2007).

Despite its benefits in terms of economic efficiency, there is resistance to the gasoline tax and it often faces important political economy challenges in its implementation (Goel and Nelson, 1999; Nivola and Gandalff, 1995; Hammar et al., 2004). In particular, when gasoline prices rise too much, most often as a result of higher oil prices, the reduction or elimination of the tax is demanded. For example, in the early 2000s there was a surge of unrest and opposition to fuel taxes in Europe, especially in Britain, France, and Spain where they were successful in cutting back some tax increases (Hammar (op.cit.)) The case of Chile is no different, but the public discussion strongly includes a distributional component based on the perception that the tax is regressive (Blackman et al., 2010). Thus, the negative impact of the tax on the middle class is repeatedly mentioned among the arguments systematically used by legislators in Congress to demand the

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elimination of the tax. For example "It is not true that this tax affects wealthier groups of people, this tax particularly affects the poor, this tax affects the middle class" (Senator Baldo Prokurica, June 21, 2006) or "There is no doubt that the excise tax on fuel is stifling the middle class" (Senator Sergio Romero, January 17, 2008)[1]. However, there is no evidence regarding the distributional incidence of the gasoline tax in Chile that confirms or rejects this perception, and thus be able to assess the distributional effects of the reduction or elimination of the tax. Furthermore, if the gasoline tax was progressive it would be a tax with positive effects on economic efficiency and that also helps to reduce after tax income inequality. The latter might be important given the unequal distribution of income in Chile and the public concern with inequality in the country.

The aim of this paper is precisely to analyze the distributional incidence of the gasoline tax and estimate the degree of progressivity or regressivity of the tax. For this purpose, the Suits Index of tax progressivity is estimated using household consumption and income data from Household Budget Surveys in 1997 and 2007. Subsequently, confidence intervals are generated using the bootstrap methodology to assess changes in the progressivity or regressivity of the gasoline tax given changes in the tax rate. The results show that gasoline taxes in Chile are slightly or moderately progressive, with a lower degree of progressivity observed in the calculations based on income than those based on expenditure. Finally, a simulation of the distributional impact of the reduction of the gasoline tax implemented by the government in 2008 is performed. The results show that the tax cut makes the tax less progressive, favoring households in the higher income deciles, which is exactly the opposite of the goal pursued by government and Congress with the tax cut.

The rest of the paper is organized as follows. The rest of Section 1 describes the tax on fuels in Chile and also discusses the existing evidence in the economic literature regarding the distributional incidence and the way it is measured. In Section 2, the data used for the empirical analysis is described in detail. Section 3 presents and discusses the results. Section 4 focuses on a simulation of the effects of the 2008 tax cut. Finally, Section 5 concludes, discusses some policy implications and raises important issues for future research.

1.1. Gasoline tax in Chile

In Chile, the excise tax on fuel was introduced in 1986 and not with the objective of reducing negative externalities but rather to finance the recovery of the country after the 1985 earthquake. A tax of 3 Monthly Tax Units (UTM)[2] per cubic meter plus 70% of the difference between US$233 and the sale price before taxes of one cubic meter was established for gasoline used by automobiles. In the case of diesel, the tax was 1.5 UTM per cubic meter plus 70% of the difference between US$196 and the value of one cubic meter of fuel. However, the variable component of the tax was subsequently reduced on multiple occasions until it reached 0% in April 1988.

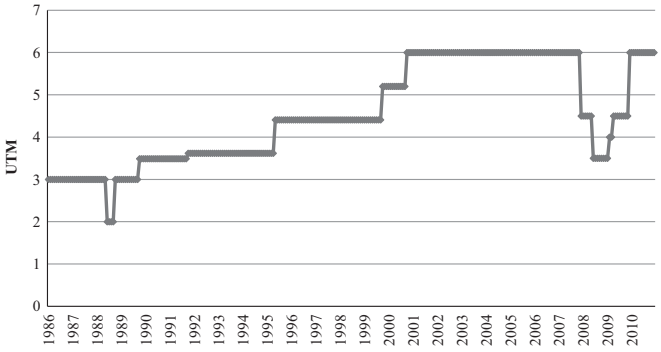

Fig. 1. Gasoline tax rate over time.

As shown in Fig. 1, the tax rate has been modified on several occasions after the tax was established in 1986.[3]. In addition to the excise tax, gasoline is also subject to Value Added Tax (VAT), currently set at 19%. The VAT is calculated on prices before the excise tax.

Finally, it is important to mention that the revenue from the excise tax on gasoline represents about 5.1% of total tax revenue in 2013. In 2008, when the tax rate was reduced by the government, the revenue generated from this tax amounted to 3.1% of the total tax revenues, a significant decrease with respect to 2007 in which the tax revenue represented 4.0%. This reduction in tax revenue reflects the effects of the two tax cuts of 2008. On average, the revenue from the gasoline tax has represented between 72% and 80% of the total revenue obtained from fuel taxes, mainly due to the higher rate of the tax levied on gasoline compared to that imposed on diesel. As a result of this tax differential, diesel cars have increased significantly during the last decade (Agostini, 2010).[4]

1.2. Evidence of distributional incidence

The first analyses of tax incidence were conducted in the nineteenth century and studied the changes in the supply and demand of a good, resulting from variations in prices induced by tax rates. However, it was not until the seminal work of Harberger (1962) that the study of tax incidence acquired greater formality and relevance in the economic literature. The analysis of Harberger (op.cit.) focused on the incidence of corporate profit taxes on the factors of production. However, the tax incidence can be assessed in other equally important dimensions: between producers and consumers of a good or service, between different consumers based on their income, or even between consumers or between producers located in different geographical areas. For example, focusing on distributional effects, Poterba (1989) estimates the incidence of excise taxes, including gasoline, on income quintiles and different age groups in the U.S.

In the case of the distributional incidence of a tax, the goal is to determine how the fraction of income spent on taxes, i.e. the tax

[1] Some additional examples: "This is an issue that no longer works and that becomes untenable by maintaining a regressive tax that affects the middle class" (Congressman Gustavo Hasbun, September 26, 2011); "the solution is not to review the current system, … but to temporarily reduce the excise tax to directly benefit the middle class, who can no longer bear the continued increases" "(Congressman Aldo Cornejo and Congressman Pablo Lorenzini, September 26 2011); "a measure of this type [tax cut] will directly benefit the middle class" (Senator Victor Perez, March 2009); "The current development [rise in the price of gasoline] is destroying the heart of the middle class in Chile" (Senator Juan Antonio Coloma, January 11, 2008); "[The fuel tax] has negative effects on an important sector of Chilean entrepreneurs, as well as on the middle class" (Congressman Jaime Mulet, April 29, 2009);. Statements are available through the websites of the Senate (www.senado.cl) and the House of Representatives (www.diputados.cl).

[2] The UTM is a measure used by the Internal Revenue Service to maintain the values of the taxes constant in real terms; hence, it is adjusted for inflation on a monthly basis. In October 2014: 1UTM=$42,431 Chilean pesos, around US$72.

[3] It was reduced to 2 UTM in late 1988, it returned to the original rate of 3 UTM in January 1990, then it increased to 3.4893 UTM in June 1991, to 4.4084 UTM in August 1995, to 5.2 UTM in January 2000, and finally to 6 UTM in January 2001. Subsequently, the tax was reduced to 4.5 UTM in March 2008 and then further to 3.5 UTM in September 2008, after which it increased back to 4 UTM in May 2009, then to 4.5 UTM in July 2009, and finally increased back to the original 6UTM in March 2010.

[4] The share of diesel automobiles in the total has increased from 12.7% in 2002 to 22.6% in 2013 in the country as a whole, and from 9.1% to 17.7% in the Metropolitan Region over the same period.

Table 1
Description of the households surveys V and VI.

		V Survey (1996–97)	VI Survey (2006–07)
Sample size		8445 households, representative of an expanded population of 5,233,796 persons.	10,092 households, 7243 in Greater Santiago. It represents an expanded population of 9.433.750 persons.
Geography		Greater Santiago	Greater Santiago, and regional capitals
Dates		August 1996 and July 1997	November 2006 and October 2007
Type of Expense	All expenses	Daily registry for 15 days for household members older than 15 years	Daily registry for 15 days for household members older than 15 years
	–Travel	Open question asking for other expenditures last month	Specific question asking for this type of expense over the last 6 months
	–Sports equipment		
	–Entertainment equipment		
	–Medical		
	–Education		
	–Furniture		Specific question asking for this type of expense over the last 12 months
	–Home appliances		
	–Computing		
	–Recreation		
	–Automobiles		
	Recurrent expenses	Last receipt	Last receipts corresponding to one month of expenses

burden, changes as income increases. If the fraction is increasing with income, then the tax is considered to be progressive; if it is proportional to income, then the tax is neutral; and if it falls as income increases, then it is considered to be regressive.

One of the difficulties in the analysis of distributional incidence is how to determine the relevant tax burden, as there may be significant discrepancies between annual burden and the burden that falls on a consumer throughout his lifetime. In general, household income measured over long periods of time is less variable than annual household income. This is particularly true if low-income households in one year have some positive probability of being higher income households in some other years. In that case, even if the fraction of income consumed by low-income households is higher than that for high-income households, consumption taxes may be less regressive than what estimations based on annual income show. For this reason, the calculation of distributional incidence using annual income data may be an inaccurate measure of the lifetime incidence of a tax, particularly in the case of consumption taxes (Poterba, 1989; Fullerton and Metcalf, 2002). Hence, using data on expenditure, instead of on income, could be a better alternative for assessing the long-run incidence of a tax since it reduces the importance of the annual income variations and implicitly incorporates earnings, consumption, and asset accumulation patterns in the analysis. It is important to highlight that income and expenditure are complementary measures to assess the distributional incidence, as the former provides information of the current incidence and the latter of a longer period incidence.

In this way, Poterba (op.cit.) empirically shows that the taxes on gasoline, tobacco and alcohol in the United States are regressive when household income is considered, but the degree of regressivity decreases significantly if expenditure data is used. Fullerton and Rogers (1991) also compare the annual incidence using income with a longer period incidence using expenditures for the income and consumption taxes in the United States. The results show that the income taxes are less progressive and those on consumption are less regressive in a lifetime perspective – proxy by expenditure – compared to the annual perspective. However, they show that to estimate the incidence in the long run (lifetime) it is important to use data for longer periods of time, since households change income deciles over time. Therefore, the lifetime incidence analysis is a complement to the annual incidence analysis rather than a substitute. Similarly, Metcalf (1994) studies the distributional incidence of the sales tax in the United States and the results show that the tax is regressive if annual household income is considered, but it is practically proportional if annual household expenditure is analyzed.

Few studies exists on distributional incidence in the economic literature and these are heavily concentrated on income and sales taxes. For gasoline taxes there exist few studies and most of them for developed countries. In the case of the United States, Poterba (1991) shows that the gasoline tax is regressive, although the regressivity is much lower when using the expenditure distribution than when using the household income distribution, and attributes greater validity to the results using expenditures since household consumption does not change substantially during a lifetime. In that sense, the expenditure data would provide better information on long-run income. Similarly, the Congressional Budget Office found that Federal Fuel taxes were regressive with respect to annual income, but proportionate with respect to total household expenditures (CBO, 1999). Chernick and Reschovsky (1997) estimate the medium-term incidence of gasoline tax for the U.S., as opposed to the two alternative annual or lifetime incidences. To do so, they analyze the incidence using income and average household gasoline consumption data for an 11 year period, which reduces the problem of households changing deciles. The results show that the tax is regressive, but to a lesser degree when compared with the annual incidence and for a 5 year period.

There are few studies on gasoline tax incidence for other countries. For the United Kingdom, Santos and Catchsides (2005) show that gasoline taxes are regressive when all households are considered and strongly regressive if only car-owning households are taken into account. In the case of Denmark, Jacobsen et al. (2003) find evidence that petrol taxes are progressive. This result seems surprising, given that Denmark is a very high-income country and the evidence for some other rich countries like the U. S. and England show that the gasoline tax is regressive. One plausible explanation for this difference is that in Denmark households in higher income deciles live further away from their work place than do lower income populations. Additionally, Denmark has a much lower level of income inequality and offers a very efficiency and high-quality public transport, which is extensively used by lower income households. Finally, in the two only studies for a developing country, Blackman et al. (2010) present results showing that for Costa Rica an increase in gasoline taxes would be progressive and Anton-Sarabia and Hernández-Trillo (2014) show evidence that the fuel tax in Mexico is progressive.

Table 2
Descriptive statistics on real income and expenditure.

Geographic area	EPF	Real income Households	Average (Ch$)	Std. Dev. (Ch$)	Real expenditure Households	Average (Ch$)	Std. Dev. (Ch$)
Greater Santiago	V	1,363,622	665,871	873,574	1,363,622	618,309	859,877
	VI	1,632,376	713,656	910,468	1,632,376	740,739	922,437
Regional capitals	VI	1,018,457	571,212	696,397	1,018,457	590,482	687,530
National	VI	2,650,833	658,929	837,611	2,650,833	683,009	843,166

2. Methods

2.1. Data

Data from the Vth and VIth Household Budget Surveys (EPF), which are conducted every 10 years by the National Institute of Statistics (INE) in Chile, are used in the estimation of the distributional incidence of the gasoline tax. The objective of these surveys is to determine the structure of household consumption expenditure and its changes over time in order to be able to adjust some indicators such as the CPI basket or the poverty line. For this reason and given the survey frequency of every 10 years, effective final household consumption is measured, that is, the expenditure at spot price on goods purchased by the household regardless of whether the good is already paid in full or not. This is particularly relevant for measuring the consumption of durable goods. Additionally, the survey records the current disposable household income (net income), the imputed rent[5] in the case of homeowners and debts and outstanding loans.

Table 1 shows each survey specification details. The Vth survey was conducted between August 1996 and July 1997, has a sample of 8455 households that are representative of an expanded population of 5,233,796, and considered only the Greater Santiago, the country's capital. The VIth survey was conducted between November 2006 and October 2007, considered 10,092 households that represent a population of 9,433,750, and included not only the Greater Santiago but also the other 14 regional capitals of the country. In both surveys, households were requested to keep a daily record of all the expenses of its members older than 15 years, for a period of 15 days. For recurrent expenditures, the last receipt was requested in the Vth survey and the last receipts corresponding to one month's expenditure were requested in the VIth survey.[6] Purchases of durable goods made during the last 12 months and the expenditures on health, education and travel within the last 6 months were also recorded in the VIth survey. However, in the case of the Vth survey, these expenses were recorded only for the month prior to the survey.

Table 2 shows basic descriptive statistics of household income and expenditures, in pesos of April 2007,[7] for Greater Santiago available from the two surveys and for the regional capitals and the entire country available only from the VIth survey.

Data from the VIth survey shows that the average household expenditure is lower than household income, which could reflect a transitory income for the period 1996–1997 that is lower than the permanent income. On the contrary, the average household expenditure is higher than the household income for the period 2006–2007. Given the discussion in the literature regarding the differences between the annual and the lifetime distributional tax incidences, it is relevant to compare the income and the expenditure distributions and then to analyze the difference in the tax incidence based on the distribution used.

Table 3
Fraction of households that spend on gasoline by income decile.

Income Decile	V EPF (%)	VI EPF Greater Santiago (%)	National (%)
1	4.5	6.3	5.8
2	5.7	9.1	10.3
3	11.8	16.9	17.8
4	14.9	21.3	22.6
5	16.2	22.1	24.2
6	22.5	29.6	31.1
7	30.7	38.5	41.9
8	47.1	49.9	49.9
9	64.5	63.6	67.8
10	84.3	83.0	86.0

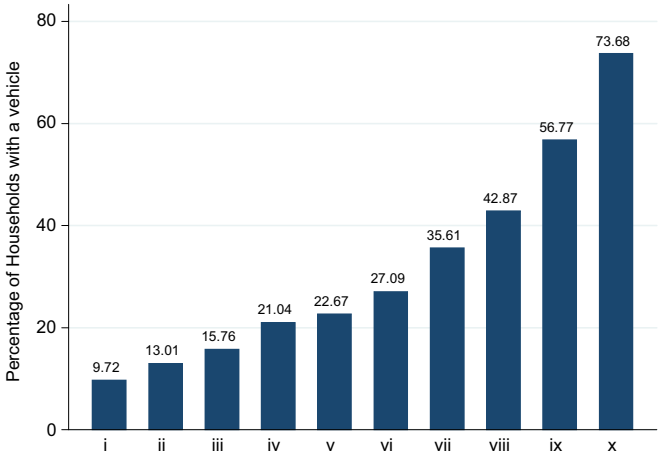

Fig. 2. Percentage of households owning a vehicle by income decile in 2006.

A standard way to statistically compare two distributions is to use the Kolmogorov–Smirnov test, which for Greater Santiago does not reject the equality of the two income distributions and the equality of the two expenditure distributions of the two surveys. Additionally, the test does not reject the hypothesis that the income distribution is equal to the expenditure distribution in each of the surveys.

Considering expenditure on vehicles, less than 1% of the households in Greater Santiago purchased a vehicle in 1996–1997, while 7.2% did so in 2006–2007. While this difference is consistent with the growing number of vehicles in the metropolitan region in recent years, it is possible that part of the difference between the two surveys is due to the fact that the relevant question in the Vth survey made reference to the previous month while that in the VIth survey referred to the previous 12 months. However, for gasoline tax purposes this change in the fleet of vehicles could have important effects on the distributional incidence of tax over time.

Similarly, 30% of the households in Greater Santiago incurred some level of positive spending on gasoline in 1996–1997 while 35.7% reported gasoline expenditures in 2006–2007. In the regional capitals, 31.3% of households spend on gasoline, with an

[5] Imputed rent is defined as the estimated value that the household should pay if they were to lease the home they occupy.

[6] Expenditures on rent, dividend, water, electricity, gas, telephone, cable TV, building maintenance, property taxes, garbage removal, and education services.

[7] The average exchange rate in 2007 was US$1=Ch$522

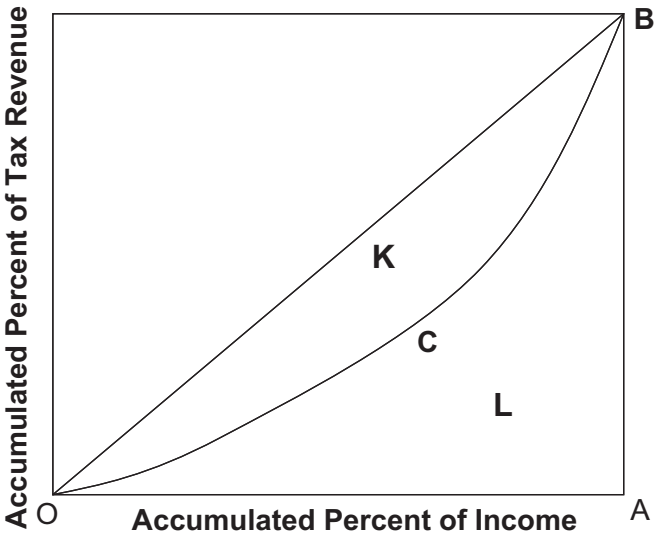

Fig. 3. Suits Index.

average expenditure of Ch$53,484, significantly less than the average expenditure of Ch$70,389 observed in Santiago. The differences in the fraction of households that spend on gasoline as well as in the level of spending between Greater Santiago and the regional capitals also reflect the different sizes of the vehicle fleet, the levels of income and the degrees of urbanization of the cities. It is, therefore, relevant in the incidence analysis to separately estimate the distributional tax effects in regions and in Santiago.

Table 3 shows how households that spend a positive amount of money on gasoline are distributed by income decile. The fraction of households that spend on gasoline increases monotonically with the level of income, from 9.72% in decile 1 to 73.7% in decile 10. This is consistent with the distribution of vehicles by income decile revealed by the Casen 2006 survey, which also shows that car ownership increases significantly with income level, from 5.8% in decile 1 to 86% in decile 10 (Fig. 2).[8] Therefore, both distributions, that of households that spend on gasoline and that of households that have a vehicle, indirectly suggest that the gasoline tax could be progressive. However, if higher income households have vehicles that are more efficient in terms of fuel consumption and/or drive fewer miles per year, the tax incidence may be less progressive or even neutral compared to what these data suggest. Hence, it is important to analyze in detail the gasoline expenditure and to calculate the Suits Index to measure the progressivity of the tax, which is what is done in Section 3.

An important aspect to note is that during the period between the two surveys, the number of households that spend on gasoline in Greater Santiago increased in all income deciles, except in the top two. One possible explanation is that higher income households are increasingly purchasing vehicles powered by diesel, which has a lower tax than gasoline. If this were the case and this were a trend, the gasoline tax should be less and less progressive over time. A complementary explanation is that households in the top quintile that already have increased the number of cars they owned over time.

2.2. The Suits Index

The progressivity or regressivity of a tax can easily be shown through the distribution of the tax burden by income decile or quintile, but that complicates the comparison between different taxes, as well as of the same tax over time (for example, before and after a change in the tax rate or base). The index proposed by Suits (1977) to measure the progressivity of a tax eliminates this difficulty and remains one of the most widely used indicator for these purposes in the tax economic literature.

As shown in Fig. 3, the Suits Index is calculated using a Lorenz curve of the cumulative tax revenue distribution by decile relative to the cumulative income distribution (OCB curve).

The intuition of the Suits Index is similar to that of the Gini coefficient. In the case of a neutral or proportional tax, the Lorenz curve would be identical to the diagonal OB; for a progressive tax, the curve would be under the diagonal line; and for a regressive tax, the curve would be above the diagonal. Thus, the index is defined as:

$$S = 1 - (\Delta ABC/\Delta OAB) = 1 - (L/K) = 1 - (1/2)\int_0^1 T(y)dy$$

where L is the area under the Lorenz curve and K is the area under the diagonal OB. If the tax is proportional, then the two areas are equal and the index is equal to zero; if the tax is progressive, then the area under the Lorenz curve is less than the area under the diagonal and the index is positive with a maximum value of 1; the opposite occurs with a regressive tax and the index takes on negative values with a maximum of -1. One of the virtues of this indicator is that any tax change, which transfers the tax burden from a household or an individual to a higher income household or individual, increases the value of the index. Similarly, any transfer of the tax burden to a lower income household reduces the value of the index. Additionally, the progressivity index of a tax system consisting of multiple taxes simply corresponds to a weighted average of the indices of each tax, where the weights are the respective average tax rates.

One of the practical limitations in the use of the Suits Index has been the difficulty of being able to statistically test the difference between two indices or the change in value of the index when there is a tax change. However, the research of Anderson et al. (2003) suggests a way to construct confidence intervals for the Suits Index using a bootstrap methodology, which eliminates this restriction. The main idea behing the bootstrap is to use the sample data, resampling with replacement, to empirically determine the distribution function for the Suits Index and then use that estimated distribution to test hypotheses. More specifically, the method computes the bootstrap-t statistic with the purpose of constructing a student-t table that can then be used to build a confidence interval around the point estimate provided by the Suits Index.[9]

3. Results

Following what has become the standard in the literature since Poterba (1991), the distributional incidence of the gasoline tax is estimated using household income and expenditure. However, there is an additional consideration to take into account since the survey assigns a value for rent in the case of homeowners. The

[8] The percentage of individuals who report owning a vehicle in the Casen 2006 survey is 27.3%; of these, 66% are individuals in the 4th and 5th quintiles.

[9] More generally, the method can be used to compare the progressivity of two tax regimes. In that case, the following two hypotheses can be specified. The null hypothesis is that a tax regime 2 is no more progressive than a tax regime 1: Hn: $S2-S1 \leq 0$, where $S1$ and $S2$ are population values of Suits Index calculated for tax regimes one and two. The alternative hypothesis is: Ha: $S2-S1 > 0$, stating that tax regime two is more progressive than tax regime one. The method is used to estimates the bootstrap confidence interval of the difference between the two Suits Indices: $S2$-$S1$. If the confidence interval for the difference contains only positive values it is possible to reject the null hypothesis and conclude that the tax regime 2 is more progressive than the tax regime 1.

Table 4
Incidence of the gasoline tax at the national level 2006–2007.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.46	1	0.25	1	0.15
	2	1.48	2	0.93	2	0.53
	3	2.45	3	1.36	3	1.01
	4	2.56	4	1.61	4	1.26
	5	2.53	5	1.95	5	1.78
	6	3.11	6	2.45	6	1.85
	7	3.39	7	3.06	7	2.69
	8	3.78	8	3.60	8	3.16
	9	4.15	9	4.22	9	3.83
	10	3.78	10	4.10	10	3.61
Suits Index	0.05		0.14		0.17	
95% C.I.	[0.0294929		[0.1171538		[0.1506757	0.1888222]
	0.0696405]		0.1564493]			
$p>z$	0.00		0.00		0.00	

Table 5
Incidence of the gasoline tax in Greater Santiago 1996–1997.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	1.38	1	0.09	1	0.09
	2	0.90	2	0.62	2	0.40
	3	1.39	3	0.89	3	0.53
	4	1.59	4	1.42	4	0.71
	5	1.53	5	1.75	5	1.44
	6	1.84	6	2.45	6	1.60
	7	2.21	7	2.69	7	2.16
	8	2.82	8	3.17	8	2.53
	9	3.04	9	3.31	9	2.80
	10	2.49	10	2.93	10	2.57
Suits Index	0.07		0.09		0.14	
95% C.I.	[0.0458967		[0.0623857		[0.1168876	0.1635541]
	0.09004]		0.111212]			
$p>z$	0.00		0.00		0.00	

Table 6
Incidence of the gasoline tax in Greater Santiago 2006–2007.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.32	1	0.10	1	0.09
	2	1.60	2	0.99	2	0.51
	3	2.42	3	1.63	3	1.19
	4	2.78	4	1.58	4	1.44
	5	2.80	5	2.05	5	1.62
	6	3.20	6	2.48	6	2.05
	7	3.48	7	3.13	7	2.75
	8	3.98	8	3.96	8	3.29
	9	4.30	9	4.25	9	3.85
	10	3.96	10	4.40	10	3.87
Suits Index	0.05		0.13		0.16	
95% C.I.	[0.0203828		[0.1075037		[0.1390425	0.1853189]
	0.0697385]		0.1551166]			
$p>z$	0.00		0.00		0.00	

value of the imputed rent is reported by the households themselves and corresponds to their own approximation of the amount they would be required to pay in rent for the property they occupy. Hence, this expenditure could have important biases that would affect the incidence estimation if it were correlated with the income or expenditure level (for example, if higher income households overestimate the rent compared to lower income households or vice versa). Therefore, the incidence is estimated with respect to expenditures calculated with and without the imputed rent, which implies to perform a third calñculation on top of the two traditional ones (income, expenditures with inputed rent, and expenditures without inputed rent).

The incidence results for the households using the distributions of income, expenditure, and expenditure plus imputed rent are presented below. In each case, the Suits Index was calculated and a confidence interval for the index was estimated using a simultaneous bootstrap of the vectors of income, expenditure, imputed rent and the expansion factors of households.

3.1. Gasoline tax incidence on households

Table 4 shows the results of tax incidence in the entire country for the 2006–07 EPF. The fraction of the expenditure on gasoline varies between 1.5% and 4.2% of household income and between 0.2% and 4.2% of household expenditures. In general, the fraction of expenditure increases as income increases. However, the increase occurs more slowly in the top five deciles compared to the bottom five deciles. The Suits Index shows that the tax is progressive with respect to both income and expenditure since, as shown by the confidence interval, the hypotheses that the index is zero or less than zero is rejected in all cases. However, in the case of income, the progressivity is very low and in terms of economic relevance, rather than statistical, it is not very different than that of a neutral tax. The tax is moderately progressive with respect to expenditure and it is even more progressive with respect to expenditure including imputed rent. Consequently, the incidence of the gasoline tax of a particular year is less progressive than the incidence in the long run, a similar result to what Jacobsson et al. (op.cit.) find for Denmark.

The results for Greater Santiago obtained with data from the 1996–97 and 2006–07 EPF are presented in Tables 5 and 6, respectively. The fraction of the household expenditure on gasoline was significantly lower in 1996–1997 compared to that in 2006–2007, reflecting the increase in the motorization rate during this time period. Although the deciles distribution has not changed dramatically, in both cases the fraction of the household expenditure on gasoline increases with income and it does so more rapidly in the highest deciles than in the lowest deciles, with the exception of the highest income decile. In particular, the participation of expenditure in the bottom two deciles has changed very little over the last 10 years, increasing from 0.1 to 0.3 percentage points, while the participation increased by about 1.5 percentage points in the top two deciles.

The Suits Index once again shows that the tax is progressive, slightly with respect to income and moderately with respect to expenditure that includes imputed rent. The degree of progressivity with respect to the expenditure is slightly lower in 1996–1997 than in 2006–2007, while the degree of progressivity with respect to income is slightly higher. Since the expenditure better reflects the permanent income and the magnitude of the changes is very small, the evidence is that even though the level of income in Chile has significantly increased in this period and automobiles have been more accessible to many households, the tax has not become less progressive over time, at least not in Greater Santiago. This is an important result for the effects of public discussion regarding fuel tax since the evidence does not confirm the perception that the tax is regressive now that automobiles are much more accessible to the majority of the population compared to 10 years ago.

Appendix 2 shows the results of the analysis for the regional

Table 7
Incidence at the national level eliminating households that purchased Vehicles 2006–2007.

	With total income		With total expenditure		With total expenditure-+Imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.192	1	0.224	1	0.160
	2	1.221	2	0.787	2	0.447
	3	1.950	3	1.381	3	0.910
	4	2.104	4	1.488	4	1.258
	5	2.385	5	1.828	5	1.427
	6	2.550	6	2.136	6	1.824
	7	3.046	7	2.898	7	2.454
	8	3.228	8	3.273	8	2.751
	9	3.506	9	3.760	9	3.393
	10	3.644	10	4.310	10	3.758
Suits Index	0.08	0.19	0.22			

Table 8
Per capita incidence of the gasoline tax at the national level 2006–2007.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.49	1	0.39	1	0.28
	2	2.31	2	0.80	2	0.71
	3	2.55	3	1.24	3	1.28
	4	2.13	4	1.76	4	1.30
	5	2.81	5	2.18	5	1.80
	6	2.66	6	2.82	6	2.42
	7	3.13	7	2.78	7	2.31
	8	4.09	8	3.55	8	3.03
	9	3.99	9	4.22	9	3.43
	10	3.57	10	3.83	10	3.38
Suits Index	0.02		0.11		0.13	
95% C.I.	[−0.0076627		[0.0878203		[0.1126548	0.153902]
	0.0448986]		0.1305416]			
$p>z$	0.17	0.00	0.00			

capitals excluding Santiago. The results are very similar and there is no evidence that the progressivity of the tax is different in Santiago than in the rest of the country.

An interesting aspect of the results is that, although households in the top income deciles generally bear a greater burden of the gasoline tax, the tax incidence is greater on households in the ninth decile and not the 10th. One possible explanation for this, as previously mentioned, is that households in the top income decile own diesel powered vehicles.[10] Another explanation, that can even be complementary, is that in the top income decile the head of household uses a company vehicle or that the company includes vehicle expenditures among non-monetary benefits. In both of these cases, the tax incidence does not fall directly on the household. This explanation might be more likely because in Chile fringe benefits are not taxable. Therefore, it is a common practice that managers of large firms use a company car as a fringe benefit (and the gasoline is paid by the firm too) and most, if not all, executives and managers in Chile are in the top 5% of the income distribution.

3.2. Sensitivity analysis

There are at least two additional analyses that are relevant to performed in an effort to check the robustness of the above results to the relevance of car purchases to the per capita measure used. The first sensitivity analysis then, is related to the potential bias that could be introduced by automobile expenditures incurred by some individuals in the months in which the surveys were conducted, which has the effect of overestimating the annual expenditure for those households and this may occur in greater proportions in specific deciles. To avoid this potential bias, the incidence is estimated eliminating from the sample the households that purchased vehicles. Table 7 shows the results of incidence at the national level for the VI survey. As can be seen from the table, the effect is a small increase in the progressivity of the tax, between 0.03 and 0.05 points in the Suits Index.[11]

The second sensitivity analysis is related to the size of households. On average, households in the bottom income deciles have more individuals than those in the top income deciles. Hence, the distributional incidence on households can differ from that on individuals. In particular, since households in the top income deciles have a higher proportion of vehicles, the incidence of fuel tax on households may be less progressive than that on individuals. To consider this possibility the incidence is also calculated using per capita household income and expenditure. Table 8 shows the per capita distributional incidence at the national level using the VIth survey of 2006–2007. The Suits Index is slightly lower for the incidence on individuals than for the incidence on households and shows once more that the tax is slightly or moderately progressive. However, the hypothesis that the tax can be neutral is not statistically rejected in the case of the incidence with respect to income.

As in the case of the incidence on households, there are no significant changes in the incidence between 1996–1997 and 2007–2008, despite the increase in vehicle ownership during the same period and the increase in the average household income, which makes it more feasible for a greater proportion of households to purchase a vehicle. This is an important result for the purpose of public discussion regarding fuel tax since the evidence does not confirm the perception that the tax is regressive now that automobiles are much more accessible to the majority of the population compared to 10 years ago. Still, it is surprising that after more than a decade of sustained economic growth the progressivity is about the same. There might several explanations for this result. However, the fact is that the fraction of households owning a car has not increased significantly over time and it has steadily been around 71% between 2003 and 2011. If we consider only the top income decile, 67% of the households owned a car in 2006, which increased to 74% in 2011. Additionally, the fraction of households with two cars increased from 2.7% to 3.5% between 2006 and 2011 and these households are highly concentrated in the top income decile. Therefore, one possible explanation is that the increase in the number of cars over time has been concentrated in households not owning one that belong to the top income deciles and in households already owning one. Even though there might be other complementary explanations, this is consistent with the fact that Chile has high income inequality that has been steady over time and that income mobility is quite low, especially in the top income deciles (Nuñez and Risco, 2004;

[10] The fraction of diesel cars in the country has increased over time from 12.7% in 2002 to 22.6% in 2013. However, there is no data available in Chile that would allow checking if diesel cars represent a large share of the top income decile's cars. It might also be the case that owners of small business, which are usually not rich, buy diesel cars for their business and personal use (and the purchase of the car is reported as a business expense). If this were the case, then not rich people might have a larger share of diesel cars.

[11] An alternative robustness analysis is to estimate the distributional incidence eliminating expenditure on vehicles from the total household expenditure. The results in that case also show that the progressivity of the tax is a slightly higher, about 0.02 points in the Suits Index.

Torche; 2005; Nuñez and Miranda, 2010).

Finally, it is important to note that, in general, these results show that the distributional incidence at the per capita level does not differ much from the incidence at the household level

4. Discussion and analysis of the 2008 tax policy change

The previous results consistently show that the gasoline tax is progressive in Chile. Therefore, any reduction in the tax should make the incidence of the tax less progressive and benefit more higher income people than the middle class of the poor. However, the Congress constantly pushes for a reduction in the tax rate to reduce the tax burden of the poor and the middle class when oil prices increase. In 2008, as a result of this political pressure and with the goal of lessening the impact of the increase in oil prices on the consumers, the excise tax on gasoline was transitorily reduced from 6 UTM/m^3 to 4.5 UTM/m^3 until May 2010. The government announced that this reduction would mostly benefit the middle class and also relief the poor, who mostly use the car for working purposes. However, no distributional impacts of this policy were ever provided and if the price of oil increases again the future it might be implemented again as Congress will demand it. Therefore, it would be informative and relevant for public policy discussions to simulate the distributional impact of the 2008 gasoline tax reduction.

To estimate the impact of this reduction on the distributional incidence of the tax, information on two important parameters is required: the rate of the tax pass-through to prices and the price elasticities of household demand. Unfortunately, there are no estimations for neither of the two parameters for the case of Chile. However, it is possible to estimate the impact using some assumptions and the evidence available for other countries. This yields at least a range of the effects of the tax cut on the distributional incidence of the tax.

On one hand, economic theory shows that the transfer rate of a tax to prices is 100% in competitive markets with constant marginal costs. Even if the short-term marginal costs are increasing, the transfer rate in the long run when all inputs are variable is 100%. On the other hand, if demand is completely inelastic, the transfer rate is 100% regardless of the shape of the supply curve. In the case of non-competitive markets, the transfer rate may be higher or lower than 100% even in the long run (Katz and Rosen, 1985). The retail market of fuel distribution is often considered a competitive market, even though there exists some degree of market power resulting from spatial competition between service stations (Anderson et al., 2001), where the demand is also very inelastic. For these reasons, in the analysis of distributional incidence, studies for the United States have assumed a pass-through rate to prices of 100% (Poterba (op.cit.), Chernick and Reschovsky (op.cit)). Similarly, a pass-through of 100% is assumed for the estimation of the effects of tax cuts on the distributional incidence of the tax in Chile. The average monthly prices for all the regional capitals of the country, obtained from the survey conducted by the National Consumer Service (SERNAC), were used for the calculation of prices after the tax cut.

The second important component in the estimation is related to the response of consumers to a price change. As mentioned previously, there are no estimations of price elasticity of gasoline demand for Chile. Hence, the paper presents two estimations of the impact of the tax cut in an effort to capture a range of the effect according to the change in household consumption resulting from the tax cut. The first estimation considers that the demand is completely inelastic, and therefore, households continue to consume the same amount of gasoline prior to the tax cut. The second estimation uses the elasticity of −0.08 estimated by Hughes et al. (2008) for the United States and for the period 2000–2006, which is the period closest to that of the VIth survey.[12]

Table 9
Simulation with inelastic demand.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.263	1	0.231	1	0.140
	2	1.365	2	0.901	2	0.514
	3	2.248	3	1.280	3	0.973
	4	2.355	4	1.504	4	1.162
	5	2.329	5	1.859	5	1.683
	6	2.859	6	2.304	6	1.688
	7	3.113	7	2.792	7	2.527
	8	3.480	8	3.314	8	2.878
	9	3.820	9	3.878	9	3.516
	10	3.474	10	3.786	10	3.330
Suits Index	0.049506		0.134284		0.167582	
95% C.I.	[0.0280762 0.0709354]		[0.1146586 0.1539104]		[0.1486455 0.186518]	
$p>z$	0.00		0.00		0.00	

Table 10
Simulation with demand elasticity of −0.08.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.277	1	0.23	1	0.14
	2	1.373	2	0.91	2	0.52
	3	2.262	3	1.29	3	0.98
	4	2.370	4	1.51	4	1.16
	5	2.343	5	1.87	5	1.70
	6	2.877	6	2.32	6	1.69
	7	3.132	7	2.81	7	2.56
	8	3.501	8	3.33	8	2.89
	9	3.844	9	3.90	9	3.53
	10	3.495	10	3.81	10	3.35
Suits Index	0.049510		0.134469		0.167743	
95% C.I.	[0.0292441 0.0697759]		[0.1146786 0.1542601]		[0.148312 0.1871742]	
$p>z$	0.00		0.00		0.00	

Tables 9 and 10 show the simulation results with an inelastic demand and with an elasticity of 0.08, respectively, for the incidence in the entire country. As seen in the tables, the impact of the tax reduction is minor compared to the distributional incidence of the tax. The point estimators of the Suits Index are marginally lower compared to the base results for the entire country that are presented in Table 4. These results point towards a less progressive tax, but statistically there are no significant changes.[13]

There is no doubt that the impact could increase and the reduction would lead to a less progressive tax with higher price elasticities. However, without estimations that show that the price elasticity in Chile is effectively higher than that estimated in the economic literature for the United States there are no reasons to assume higher elasticities. It is also possible that the price elasticity of the lowest deciles is greater than that of the highest deciles, in which case the tax cut would also make the tax less progressive. Nonetheless, as in the previous case, estimations that can be used for this type of

[12] Additionally, the estimation of the elasticity solves the endogeneity problems present in prior estimations in the literature.

[13] The results per capita and for Greater Santiago and the regional capitals are very similar and are available from the authors upon request.

simulation based on empirical evidence are required.

Finally, it is important to note that the simulations, which are performed to assess the effect of a reduction in the gasoline tax on its distributional incidence, are based on assumptions and estimations that could possibly not be met in the case of Chile. However, they could at least be useful in shedding some light on the public debate on the issue. In particular, the simulations show that the tax cuts do not particularly favor the middle class and most likely makes the tax less progressive, favoring households in the higher income deciles, contradicting the objective pursued with the tax cut.

5. Conclusions and policy implications

The gasoline tax appears in public debate whenever there is a shock in the international oil price that significantly drives up prices. The public visibility of gasoline prices is reinforced by the fact that the National Oil Company (ENAP) announces its sales prices to wholesale distributors on a weekly basis. As the gasoline tax represents a significant fraction of the price, public pressure to alleviate price increases focuses on demanding a tax reduction. In the case of Chile, one of the most strongly used arguments to press for a fuel tax reduction or elimination is that it mostly affects the middle class.

In this paper, the distributional incidence of the gasoline tax is estimated and the results robustly show that the tax incidence is slightly progressive with respect to household income and moderately progressive with respect to expenditures. Household expenditures are generally more stable over time than is the income; and hence, it could be a better proxy of the permanent household income. In that sense, the results might suggest that the gasoline tax is progressive in the long run when permanent household income is considered. Therefore, in terms of public policy the use of gasoline taxes have positive effects not only in terms of reducing negative externalities as pollution, congestion, and traffic accidents, but also has a small but positive impact on income distribution, which has been a political objective in the tax reforms discussed and proposed by the government during 2014.

From these results, the idea that a fuel tax reduction would largely benefit the middle class, or at least the households in the deciles that fall around the mean of the distribution is not supported. A simulation of the tax cut implemented in 2008 shows that its effect is almost null in terms of the progressivity of the tax and probably causes it to decrease, in which case it would greatly benefit the higher income households. Therefore, the use of gasoline taxes would reduce negative externalities caused by vehicles and would not have negative effects on inequality. This is an important policy implication because Chile still has higher inequality and the use of cars has been increasing over the last decade, which increases the negative externalities associated to their use. Still, as income keeps increasing in the country it might be possible that in the future the gasoline tax could start affecting significantly more the middle class. If that were the case, the distributional incidence of the tax might become regressive as shows the evidence for developed countries like the U.S. and United Kingdom.

A more precise estimation of the effects of a tax change requires knowing how different consumers change their gasoline consumption with a change in the price. For example, there is some evidence for the U.S. showing that higher income households have greater price elasticities than lower income households (Wang and Chen, 2014). Unfortunately, there is no empirical evidence for Chile in this regard and further investigations are required. In particular, it would be relevant to estimate price elasticities of gasoline demand by income (or expenditure) decile, so as to be able to accurately determine the distributional effects of a change in the tax rate. Finally, further research is needed to explain the fact that in Chile incidence of the gasoline tax of a particular year is less progressive than the incidence in the long run.

Appendix A. : per capita incidence in Greater Santiago

See Table A1 and A2

Table A1
Per capita incidence of the gasoline tax in Greater Santiago 2006–2007.

	With total income		With total expenditure		With total expenditure+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.55	1	0.41	1	0.41
	2	2.34	2	0.80	2	0.80
	3	2.07	3	0.95	3	0.95
	4	2.58	4	1.15	4	1.15
	5	2.23	5	2.23	5	2.23
	6	2.42	6	2.38	6	2.38
	7	3.03	7	3.40	7	3.40
	8	3.98	8	3.14	8	3.14
	9	3.70	9	3.90	9	3.90
	10	3.05	10	3.43	10	3.43
Suits Index	0.01		0.10		I 0.12	
95% C.I.	[−0.0612369 0.0494926]		[0.0547405 0.1418431]		[0.0828642 0.1669368]	
$p>z$	0.84		0.00		0.00	

Table A2
Per capita incidence of the gasoline tax in Greater Santiago 1996–1997.

	With total income		With total expenditure		With total expenditure+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.26	1	0.42	1	0.34
	2	2.52	2	0.82	2	0.96
	3	2.72	3	1.69	3	1.27
	4	2.06	4	1.80	4	1.24
	5	2.79	5	2.26	5	2.03
	6	2.95	6	2.79	6	2.27
	7	3.51	7	2.57	7	2.40
	8	4.16	8	3.88	8	3.26
	9	4.21	9	4.28	9	3.49
	10	3.65	10	4.11	10	3.51
Suits Index	0.02		0.11		0.13	
95% C.I.	[−0.0050109.0480957]		[0.0824167 0.131297]		[0.1072629 0.1547048]	
$p>z$	0.11		0.00		0.00	

Appendix B

See Table B1

Table B1
Incidence in regional capitals 2006–2007.

	With total income		With total expenditure		With total expenditure-+imputed rent	
	Decile	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*	*Decile*	*% Part. exp. gasoline*
	1	2.57	1	0.41	1	0.20
	2	1.82	2	1.30	2	0.61
	3	2.35	3	0.66	3	0.95
	4	2.20	4	1.44	4	1.02
	5	2.52	5	1.71	5	1.42
	6	2.64	6	2.31	6	2.09
	7	3.17	7	3.07	7	2.51
	8	3.59	8	3.56	8	3.19
	9	3.57	9	3.91	9	3.32
	10	3.48	10	3.52	10	3.28
Suits Index	0.04		0.13		0.17	
95% C.I.	[−0.001431 0.0810516]		[0.0964477 0.1690369]		[0.1359886 0.2071306]	
$p > z$	0.06		0.00		0.00	

References

Agostini, C.A., 2010. Differential fuel taxes and their effects on automobile demand. CEPAL Rev. 102, 101–111.

Anderson, S., De Palma, A., Kreider, B., 2001. Tax incidence in differentiated product oligopoly. Journal of Public Economics 81, 173–192.

Anderson, John, Ghosh, Atrayee, Shoemaker, Paul, 2003. Confidence intervals for the suits index. Natl. Tax J. 56 (1), 81–90.

Anton-Sarabia, A., Hernández-Trillo, F., 2014. Optimal gasoline tax in developing, oil-producing countries: the case of Mexico. Energy Policy 67, 564–571.

Bento, A.M., Goulder, L.H., Henry, E., Jacobsen, M.R., von Haefen, R.H., 2005. Distributional and efficiency impacts of gasoline taxes: an econometrically based multi-market study. AEA Papers and Proceedings 95 (2), 282–287.

Blackman, A., Osakwe, R., Alpizar, F., 2010. Fuel tax incidence in developing countries: the case of Costa Rica. Energy Policy 38, 2208–2215.

Chernick, Howard, Reschovsky, A., 1997. Who pays the gasoline tax? Natl. Tax J. 50 (2), 233–259.

Fullerton, Don, Metcalf, Gilbert E., 2002. Tax incidence. In: Auerbach, Alan J., Feldstein, Martin (Eds.), Handbook of Public Economics, Vol. 4. Elsevier Science B.V., Amsterdam, The Netherlands.

Fullerton, Don, Rogers, Diane, 1991. Lifetime versus annual perspectives on tax incidence. Natl. Tax J. 44 (3), 277–287.

Goel, Rajeev, Nelson, Michael A., 1999. The political economy of motor fuel taxation. Energy J. 20 (1), 43–59.

Grabowski, D.C., Morrisey, M.A., 2006. Do higher gasoline taxes save lives? Econ. Lett. 90, 51–55.

Hammar, Henrik, Logfren, Asa, Sterner, Thomas, 2004, 1-17.. Political economy obstacles to fuel taxation. Energy J. 25 (3).

Harberger, Arnold, 1962. The incidence of the corporation income tax. J. Polit. Econ. 70 (3), 215–240.

Haughton, J., Sarkar, S., 1996. Gasoline tax as a corrective tax: estimates for the United States 1970-1991. Energy Journal 17 (2), 103–126.

Hughes, Jonathan, Knittel, Christopher, Sperling, Daniel, 2008. Evidence of a shift in the short-run price elasticity of gasoline demand. Energy J. 29 (1), 113–134.

Innes, R., 1996. Regulating automobile pollution under certainty, competition, and imperfect information. Environmental Economics and Management 31, 219–239.

Jacobson, H.K., Birr-Pedersen, K., Wier, M., 2003. Distributional implications of environmental taxation in Denmark. Fiscal Studies 24 (4), 477–499.

Johansson, O., Schipper, L., 1997 277-292.. Measuring the long-run fuel demand for cars: separate estimations of vehicle stock, mean fuel intensity, and mean annual driving distance. J. Transp. Econ. Policy 31.

Katz, M., Rosen, H.S., 1985. Tax analysis in an oligopoly model. Public Fiance Quarterly 13 (1), 3–19.

Li, S., Linn, J., Muehlegger, E., 2014. Gasoline Taxes and Consumer Behavior. Am. Econ. J.: Econ. Policy 6 (4), 302–342.

Metcalf, Gilbert E., 1994. Life cycle versus annual perspectives on the incidence of a value added tax. Tax Policy Econ. 8.

Musgrave, R.A., Musgrave, P.B., 1989. Public Finance in theory and Practice. McGraw-Hill, New York.

Nivola, Pietro, Gandalff, Robert, 1995. The Extra Mile. Brookings Institution, Washington DC.

Nuñez, J., Miranda, L., 2010, article 33.. Intergenerational mobility in a less-developed, high inequality context: the case of Chile. B.E. J. Econ. Anal. Policy 10 (1).

Nuñez, J., Risco, C., 2004. Movilidad Intergeneracional del Ingreso en un País en Desarrollo: El caso de Chile, Working Paper No. 120, Economics Department, University of Chile.

Parry, I., Walls, M., Harrington, W., 2007. Automobile externalities and policies. J. Econ. Lit. 45 (2), 373–399.

Portney, P.R., Parry, I.W.H., Gruenspechty, H.K., Harrington, W., 2003. The economics of fuel economy standards. J. Econ. Perspect. 17 (4), 203–217.

Poterba, James, 1989. Lifetime Incidence and the Distributional Burden of Excise Taxes. Am. Econ. Rev. 79 (2), 325–330.

Poterba, J., 1991. Is the Gasoline Tax Regressive?. In: Bradford, DavidF. (Ed.), Tax Policy and the Economy 5, NBER. MIT Press, Cambridge, MA.

Santos, Georgina, Catchsides, Tom, 2005. Distributional consequences of gasoline taxation in the United Kingdom. Transp. Res. Rec. 1924, 103–111.

Spiller, E., Stephens, H., Timmins, C., Smith, A., 2014. The effect of gasoline taxes and public transit investments on driving patterns. Environ. Resour. Econ. 59, 633–657.

Sterner, T., 2007. Fuel taxes: an important instrument for climate policy. Energy Policy 35, 3194–3202.

Suits, Donald, 1977. Measurement of tax progressivity. Am. Econ. Rev. 67 (4), 747–752.

Thorpe, Steven G., 1997. Fuel economy standards, new vehicle sales and average fuel efficiency. J. Regul. Econ. 11 (3), 311–326.

Torche, F., 2005. "Unequal but fluid: social mobility in chile in comparative perspective. Am. Sociol. Rev. 70 (3), 422–450.

U.S. Congressional Budget Office, 1999. Federal Taxation of Tobacco, Alcoholic Beverages and Motor Fuels: CBOP Study, Washington D.C.

Wang, T., Chen, C., 2014. Impact of fuel price on Vehicle Miles Traveled (VMT): do the poor respond in the same way as the rich? Transportation 41, 91–105.

West, S.E., Williams, R.C., 2004. Empirical Estimates for Environmental Policy Making in a Second-Best Setting, NBER Working 10330.