Distributional Effects of Gasoline Tax in Brazil[1]

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Abstract: Gasoline tax has been used to increase government revenue, mitigate pollution, and promote the use of alternative energies, but it may have also worsened the income distribution. This paper analyzes the distributional impacts of Brazil's gasoline tax by calculating the Suits Index for this tax using a rich Consumer Expenditure Survey (POF 2017/2018). Our results indicate that Brazil's gasoline tax places a relatively higher burden on the country's poorest, which implies that the tax is regressive. In a state-level analysis, in 18 of 27 states the gasoline tax is regressive; in two states it is progressive; and in the remaining seven states it is proportional. To explain the state-level results, we found an inverse relationship between income and tax progressivity for the gasoline tax: in states with lower average income, Brazil's gasoline tax is more progressive. The same pattern held for fleet per capita: in states with lower car ownership shares, gasoline taxes are more progressive.

Keywords: Inequality, Gasoline Tax, Distributional Effects.

Resumo: O imposto sobre a gasolina tem sido usado para aumentar a receita do governo, mitigar a poluição e promover o uso de energias alternativas, mas ele pode ter piorado a distribuição de renda. Este artigo analisa os impactos distributivos do imposto sobre a gasolina no Brasil calculando o Índice de Suits para esse imposto usando a POF 2017/2018. Os resultados indicam que o imposto sobre a gasolina no Brasil impõe uma carga relativamente maior aos mais pobres do país, o que implica que o imposto é regressivo. Em uma análise estadual, em 18 dos 27 estados o imposto sobre a gasolina é regressivo; em dois estados é progressiva; e nos restantes sete estados é proporcional. Sobre os resultados estaduais, encontra-se uma relação inversa entre renda e progressividade tributária: nos estados com renda média mais baixa, o imposto sobre a gasolina no Brasil é mais progressivo. O mesmo padrão ocorreu para a frota per capita: em estados com menor participação na propriedade de automóveis, os impostos sobre a gasolina são mais progressivos.

Palavras-chave: Desigualdade, Impostos sobre gasolina, Efeitos distributivos.

JEL: H22, O13, Q48, D63.

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1. Introduction

Taxes not only support the government's basic functions; they can also be used to encourage consumption of goods that benefit society and discourage consumption of goods that hinder welfare, among other purposes. Subsidies are often adopted to incentivize exports, encourage the purchase of health-related goods, increase education, and encourage the use of clean energy, while taxes have tried to discourage imports and the consumption of unhealthy goods (e.g., alcohol, tobacco, and sugary drinks).[5] These subsidies and taxes can cause differences between domestic and international prices; although fossil fuels are usually underpriced to increase energy affordability (Inchauste and Victor, 2017), they are sometimes overpriced to correct negative externalities. These interventions are also sometimes used to redistribute income (Limberg, 2020), with improvements in distribution of income occurring when income taxes require the nation's wealthiest individuals to pay relatively more compared to its poorest individuals. On the other hand, a consumption tax reduces income inequality when goods mostly (or more often) consumed by the richest are taxed more than goods consumed by the poorest.

According to the 2018 Gini index (World Bank, 2020), Brazil is the eighth most unequal economy in the world. Even though, governments commonly use taxation and social spending to reduce inequality, the use of taxation to fight income inequality in Brazil has been little explored (Silveira et al., 2013). In this paper, we investigate the distributive effects of Brazil's gasoline tax, using a rich household dataset to estimate the Suits Index (1977) at both the national and state levels. This analysis allows us to also understand the impact of subsidies in this market. Understanding the impact of subsidies is particularly important for Brazil because the country is prone to enact energy subsidies, often in times of high prices and, notably, before presidential elections. In 2021, for example, end-user gasoline prices increased 44% between January 2021 and October 2021 (*Agência Nacional do Petróleo, Gás Natural e Biocombustíveis* (ANP), 2021). The sharp rise in gasoline prices prompted alternative policies to control fuel prices, such as a ninety-day freeze on state taxes beginning at the end of October 2021.

Not all consumption taxation is regressive. The rate at which each good is consumed across income brackets determines how each good contributes to the overall

[5] Taxes on cigarettes, alcohol and unhealthy food goods are known as "sin taxes." They are used to deter overconsumption of goods with high negative externalities, which impose an extra and unfair burden on society. For an interesting review of sin taxes, see Allcott et al. (2019).

regressivity of the tax system. For example, taxes on cigarettes and sugary drinks tend to fall disproportionately on low-income households (Allcott et al., 2019); subsidies for solar panels and hybrid and electric cars disproportionately benefit high-income households (Borenstein and Davis, 2016). As a result, the push for a healthier and more sustainable society sometimes comes at a cost: these taxes and subsidies can increase income inequality. In high-income countries, tax and subsidy policies toward fuel consumption are usually regressive (e.g., Chernick and Reschovsky, 1997; Spiller et al., 2017; Tiezzi and Verde, 2019; Wier et al., 2005). On the other hand, the regressivity of these taxes in poor and middle-income countries is not clear. For instance, high-income households pay the largest share of gasoline taxes in Costa Rica (Blackman et al., 2010) and Chile (Agostini and Jiménez, 2015). Nigeria experiences different levels of regressivity between fuels: the wealthiest benefit more from petrol subsidies, but kerosene subsidies are more equally distributed across the population (Soile and Mu, 2015).

Few papers have estimated the regressivity of fuel taxes in Brazil. Most of the previous studies addressed the issue by investigating the distributional effects of carbon pricing (*e.g.*, Freitas and Kaneko (2016) and Garaffa et al. (2021)). Moz-Christofoletti and Pereda (2021) found that Brazil's gasoline and diesel taxes mainly affect wealthier households, implying these taxes are progressive. They used an input-output approach, in addition to a censored demand estimation, to link energy taxes and their distributional effects at the national level. Our paper differs in its definition of regressivity, which depends on the original income distribution. Even though Brazil's gasoline taxes are paid mainly by the wealthy, such taxes can still be regressive if the share of gasoline taxes paid by the wealthy is smaller than their income share. Our paper also differs in that we also investigate gasoline regressivity at the state level, given that each state has its own regulations and can add more tax layers to the country's federal gasoline taxes. Also, income distribution, demand preferences, and the technological level of the fleet vary among states. Altogether, these differences can produce differing levels of regressivity.

Our paper also builds on the literature investigating several side effects of energy policies, such as reduction of biological diversity and emergence of rebound effects from renewable energy policies (Andersen, 2013). Our paper is in line with the literature studying energy-related taxes, such as airline transportation taxes (Daniel, 2001) and congestion tolls (Arnott et al., 1994). To some extent, all these studies are interested in the side effects of internalizing energy consumption externalities. Because we seek to understand whether Brazil's gasoline tax can worsen the country's income distribution, we benefit from the literature analyzing the distributional effects of carbon taxes (Gonzalez, 2012; Speck; 1999, Freitas et al., 2016).

The paper is organized as follows. Section 2 presents the background of taxation, insights from previous literature, and a brief discussion of the Brazilian fuel market. Section 3 presents the methodology of the Suit Index and the data used to compute it. After that, Section 4 presents the results and discusses them. Finally, we present conclusions and policy implications in Section 5.

2. Background

The current debate on energy solutions to climate change suggests using renewable sources as one means of decarbonizing the energy system (Kern and Rogge, 2016). Brazil entered this route a few decades ago unintentionally. Brazil's *Proalcool Program*[6] was implemented in the 1970s, aiming mainly at energy security (decreasing oil dependence), rural development (increasing sugarcane production), and reducing macroeconomic issues (reducing pressure on the balance of payments). At that point, addressing environmental concerns was not a centerpiece of the program. Rather, addressing environmental concerns became an unintended positive effect of the program, caused by the shift from gasoline to ethanol. Another reason for Brazil's high use of primary energy from renewable sources is its widespread use of hydropower for electricity generation. As a result, Brazil had a higher share of low-carbon energy in 1970 than the world did in 2020 (see Figure 1). Although the global energy matrix remains highly dependent on fossil fuels (84% based on coal, oil, and gas), Brazil's fossil fuel use is only around 50% (Ritchie et al., 2021).

[6] Proalcool Program was a strategic policy to decrease oil dependence in Brazil by substituting gasoline for ethanol.

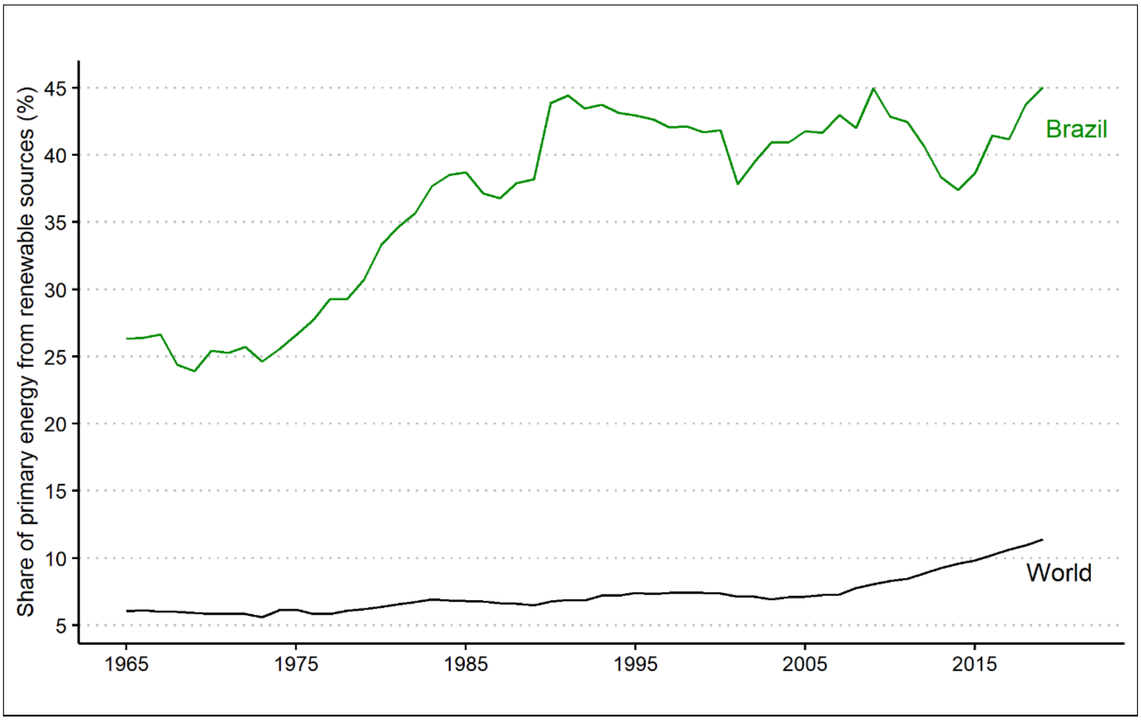


Figure 1- *Share of primary energy from low-carbon sources. Elaborated by authors. Data from Ritchie and Roser (2021).*

Even though Brazil was a pioneer in the use of clean energy (and has been since the 1970s), it failed to achieve a more equal income distribution and remains one of the most unequal countries globally. In the last two decades, Brazilians have experienced economic growth along with some decrease in income inequality. However, the country remains a middle-income country and the eighth most unequal country based on the 2018 Gini index (0.54). In 2015, around 40% of the country's income was held by the richest 10% of its citizens (World Bank, 2020). Figure 2 shows the relationship between income inequality and renewable energy use for selected countries. As Figure 2 demonstrates, Brazil is an outlier in both clean energy use and income inequality.

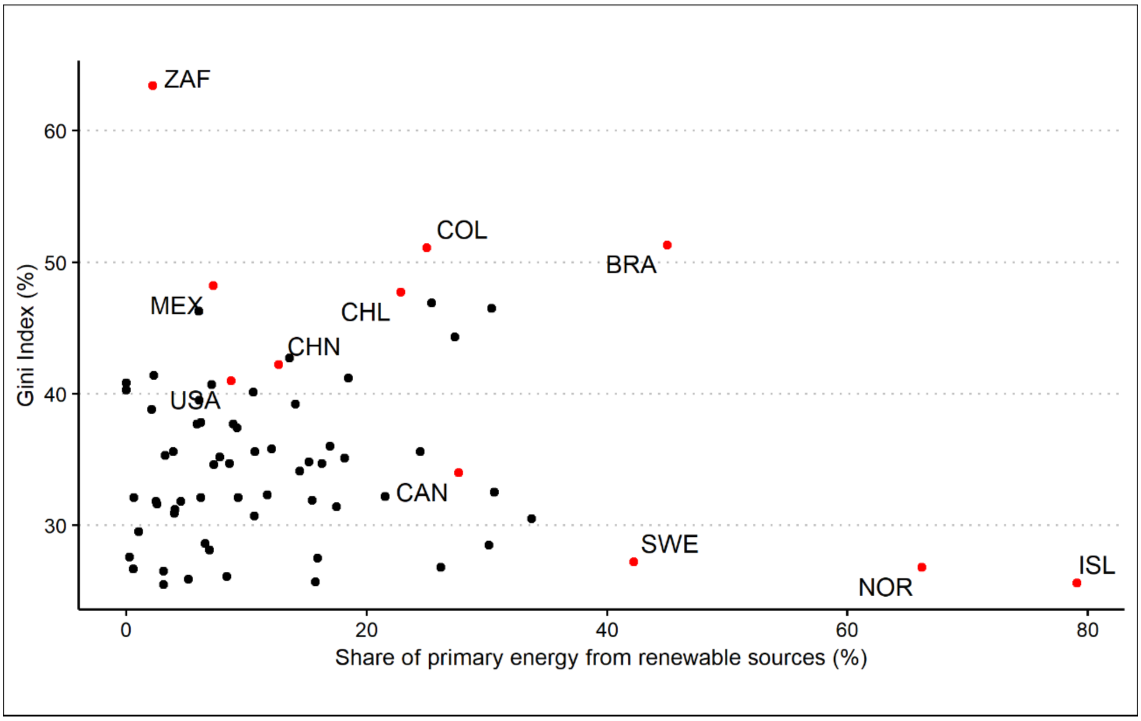


***Figure 2**- Share of primary energy from Renewables by Gini Index in 70 countries. Elaborated by authors. Gini index from World Bank (2020) with the last available Gini. The share of primary energy is from B.P. (2020), with shares in 2019. Labels stand for Alpha-3 code for countries. MEX = Mexico; USA = United States; CHL= Chile; COL= Colombia; CAN = Canada; SWE = Sweden; NOR=Norway; BRA=Brazil; ISL=Iceland.*

As Sterner (2012b) indicated, fuel taxes tend to be progressive in low-income countries and regressive in high-income ones. Automobiles are considered luxury goods in some developing countries. In Brazil, 47% of households owned cars in 2014 (Statista, 2020). The percentage of car ownership is higher in wealthier countries like the United States (88%), Germany (85%), Malaysia (82%), and Russia (55%), and lower in poorer countries like South Africa (31%), China (17%), India (6%) and the Philippines (6%). Based on the 2015 National Household Sample Survey (PNAD) conducted by the Brazilian Statistical Agency (IBGE), 61% of Brazilian households owned vehicles (including motorcycles). Vehicle ownership is positively associated with income: among the poorest 10% of the population, only 32% of families had a vehicle in 2015. At the same time, among the wealthiest 10% of households, 94% owned a vehicle. Figure 3 displays the distributions of vehicle ownership and household income across deciles.

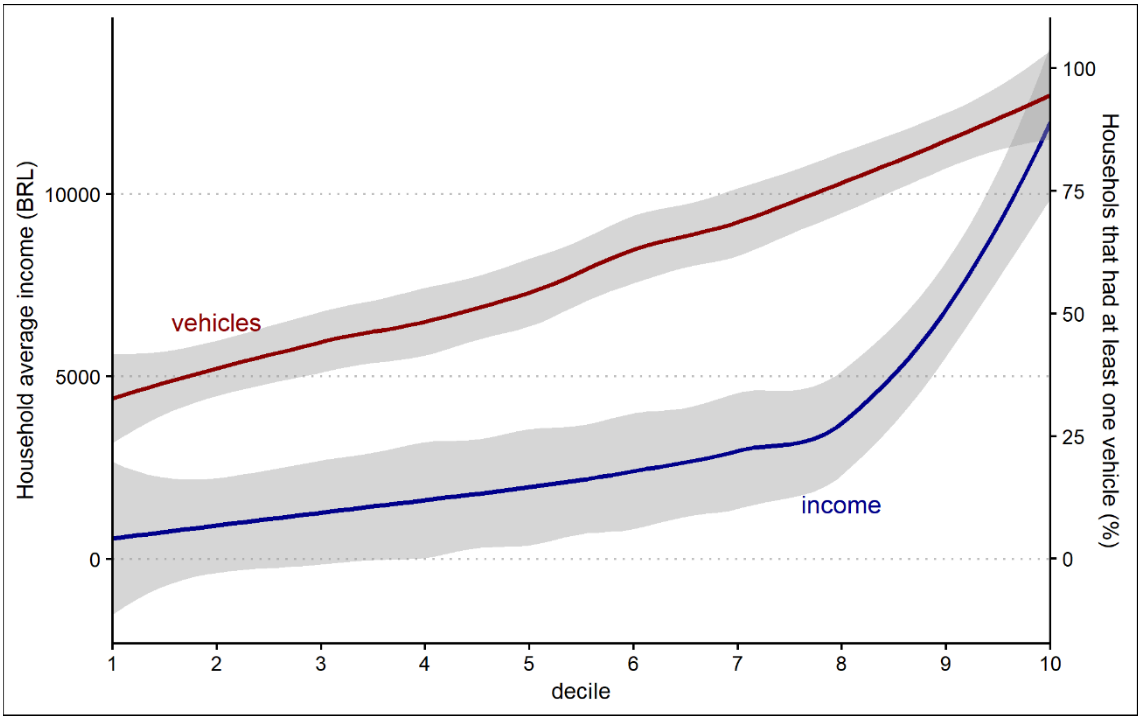


Figure 3 *– Household average income and vehicle ownership by income deciles. Authors' elaboration based on PNAD (2015). Deciles are organized from the poorest to the richest. In 2018, 1 USD = 3.30 BRL.*

The direct relationship between household income and vehicle ownership might be associated with a trend in the progressivity of Brazil's gasoline tax. On the other hand, Sterner (2012a) argues that higher-income households in rich countries may have more efficient vehicles than low-income households. Sterner's hypothesis implies that wealthier households benefit more than poorer households from both subsidies for clean energy and better efficiency of newer vehicles. This last trend remains unclear in Brazil, because cars purchased by low-income households tend to have less powerful engines. Additionally, different transportation needs can reverse this initial trend of progressivity. In some cities, wealthier families may choose to live in the city center, closer to work, reducing trip distances and car dependence. These market characteristics and the tax structure might affect the progressivity of gasoline taxes.

In Brazil, both state and federal governments impose a tax on fuel consumption. The federal government collects three different taxes: the *Contribuições de Intervenção no Domínio Econômico (CIDE), Programa de Integração Social (PIS),* and the *Contribuição para o Financiamento da Seguridade Social (Cofins)*. States collect only one tax: the *Imposto sobre Circulação de Mercadorias e Serviços (ICMS)*. Gasoline is the most taxed fuel, with 44% of the final price composed of taxes, followed by diesel (23%) and ethanol (21%). In Brazil, there is also a legal market separation: light-duty vehicles can use either gasoline or ethanol, but diesel can be used only by trucks, buses, and service vehicles (all-wheel-drive vehicles that can carry more than a ton of cargo). Of the federal government's taxes, CIDE is the one that changed the most in recent years. The average CIDE in 2002-2012 was BRL 0.39 per liter. In the most recent period, the average was 0.06 BRL; no CIDE whatsoever was charged between 2012 and 2015. From 2015 through the first half of 2021, CIDE was 0.10 BRL per liter (Fecombustíveis, 2021).

Several factors made Brazil prone to energy price interventions. First, the country dealt with a long period of high inflation, with annual inflation of more than 100 percent in some years between 1980 and 1994 (Ayres et al., 2019). The debate over possible tools to fight inflation in Brazil often included the artificial control of energy prices, especially when inflation rates and energy prices were both relatively high. Second, because energy expenses are a large share of most Brazilians' budgets, controlling energy prices was a key point in the political agenda during the campaigns. Both right- and left-wing voters supported market interventions to maintain low energy prices. For example, the last two elected presidents, Dilma Rousseff (January 2011 to August 2016) and Jair Bolsonaro (the incumbent since January 2019), were on the opposite side of the political spectrums. Yet, both attempted to control energy prices using populist energy policies. Third, the institutional framework and the market structure of the Brazilian energy market are both susceptible to interventions. The Brazilian government is the single largest shareholder in Petrobras, the largest oil company in Brazil, which is responsible for 90% of the oil refining market (ANP, 2020). Control of Petrobras allows the federal government to use Petrobras to decrease refinery prices, with the goal of reducing the price at the pump.

3. Methodology and Data

To analyze the distributional impacts of Brazil's gasoline tax, we use the Suits Index (1977). Like the Gini index, the Suits Index allows a visual representation based on the accumulated distribution. The Suits Index separates the population into equal-sized income classes (quintiles, deciles, or percentiles) to plot the accumulated percentage of taxes paid on the accumulated income of classes (see Figure 4). The 45-degree line (A.C.

line in Figure 4) represents the proportionality line, which implies a proportional[7] distribution of the tax across the income distribution. In Figure 4 (left graph), the curves R and C display hypothetical and actual accumulated distributions of taxes. Curve R (and any curve above the proportionality line) represents a regressive tax. Curve C (and any curve below the proportionality line) stands for a progressive tax. Therefore, the distance to the 45-degree line measures how much the tax worsens the income distribution (if it is above the line) or improves the income distribution (if it is below the proportionality line). The tax is proportional if the actual accumulated distribution of taxes coincides with the 45-degree line.

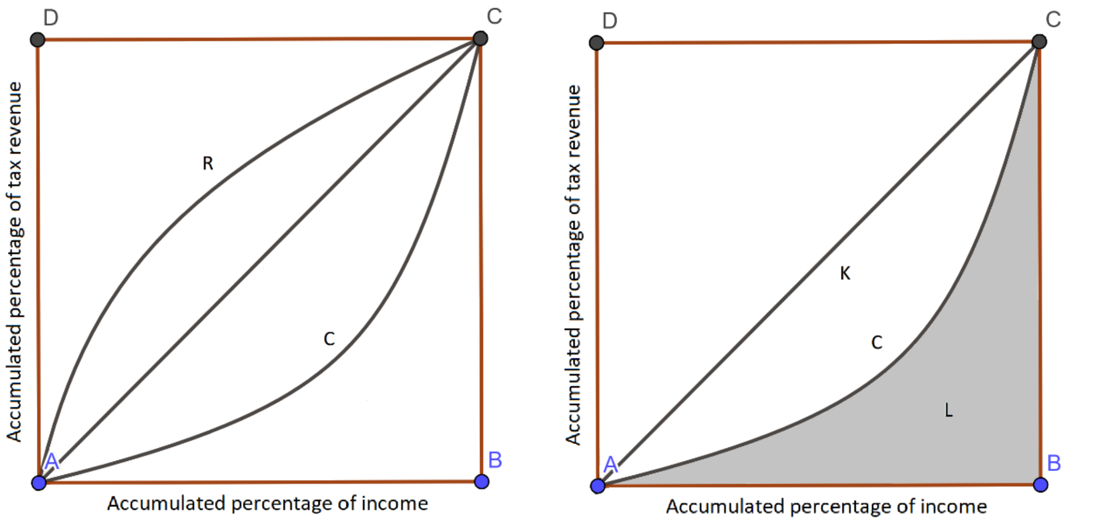


***Figure 4** – Suits Index. Authors' elaboration. Note that the K area is the entire area formed by the triangle ABC.*

The calculated index (S) ranges from -1 to $+1$. The closer to -1, the greater the regressivity, with $S = -1$ indicating that the lowest-income class pays 100% of the tax. In contrast, the $+1$ value indicates extreme progressivity, when the highest income class pays 100% of the tax. The tax burden is proportional when the value of the index is zero. Formally, the Suits Index (S) is:

$$S = 1 - \frac{L}{K} = 1 - \frac{\int_0^{100} T(y)dy}{5000} \qquad (1)$$

where L is the gray area in Figure 4 (right) and K is the whole area formed by the triangle ABC, y is income, and T(y) is the income tax.

[7] *Proportional* here does not imply that the taxes will be paid equally across the population, but rather proportional to the income distribution.

In this paper, the data is organized by income percentiles, so an approximation of the integral for area L will be used, as Suits (1977) suggested. The index will then present the formulation described in Equation (2):

$$S \cong 1 - \frac{\sum_{1}^{100}(1/2)[T(y_i) + T(y_{i-1})](y_i - y_{i-1})}{5000} \quad (2)$$

where $[T(y_i) + T(y_{i-1})]$ represents the sum of the accumulated taxes paid by the decile *I* and *i-1,* and $(y_i - y_{i-1})$ represents the subtraction of the accumulated income of decile *i* by decile *i-1*. The area of triangle K gives the denominator. The S value now represents an average statistic of the regressivity of the studied tax.

The outcome of the index depends on the measure of income used, such as the family's disposable income or total household expenditure on goods and services. Poterba et al. (1989) argue that household expenditure is the better proxy for the family's ability to pay taxes, because disposable income tends to overestimate the calculated regressiveness of a tax. On the other hand, Chernick and Reschovsky (1997) argue that the use of total spending as a proxy for permanent income assumes that: (i) income has high mobility; (ii) gasoline consumption depends on permanent income and not on disposable income; and (iii) the fraction of income allocated to fuel consumption is constant. In this paper, we calculate the Suits Index using disposable income.

Another concern regarding the index is whether families without vehicles should be included in the calculation (Sterner, 2012a). Excluding the poorest families, which mostly do not own vehicles, would lead to a more progressive index (Teixidó and Verde, 2017). In this paper, we aim to assess the regressiveness of taxation for the entire population. Therefore, we included families that do not own vehicles in our sample. As the Suits Index is a point estimator, to create confidence intervals allowing assessment of whether changes are statistically significant, we followed a bootstrap methodology based on Anderson et al. (2003). We used 1000 resamples ($k = 1000$).

3.2 Data

To calculate the Suits Index, we used data on more than a million households from the 2017/2018 *Pesquisa de Orçamento Familiar* (POF, Consumer Expenditure Surveys) database. We first calculated the sum of expenses (in BRL) for regular, additive, and special gasoline by household (i) and state (e), $ConsumptionG_{i,e}$. Then we calculated the sum of the nominal monetary and non-monetary incomes (in BRL) of all individuals in the household (i) and in each state (e), $DisposableIncome_{i,e}$. Finally, to calculate the index, we needed to estimate the taxes paid on gasoline by household. In equation (4), $\%Tax_e$ represents a proxy for the share of taxes on gasoline prices for each Brazilian state:

$$\%Tax_e = \frac{Tax_e}{Price_e} \tag{4}$$

where Tax_e is the nominal value of the sum of the four taxes charged on gasoline (ICMS, PIS, Cofins and CIDE) for each state e, with data collected from the *Federação Nacional do Comércio e Lubrificantes* (Fecombustíveis, 2021), and $Price_e$ is the nominal gasoline price in BRL at the pump. These prices are available at the *Agência Nacional do Petróleo, Gás Natural e Biocombustíveis* (ANP, 2020). The values are in BRL per liter of gasoline for each Brazilian state in January 2019.

Using estimates of the share of tax per gasoline liter per state ($\%Tax_e$) and how much each family spends on gasoline ($ConsumptionG_{i,e}$), we assessed the amount of tax that each family pays on its gasoline consumption specifically ($TaxG_{i,e} = ConsumptionG_{i,e} \times \%Tax_e$). Disposable income was used as a measure of income, where households were grouped into deciles. Households with no income were removed from the sample. Figure 5 shows the results of this procedure.

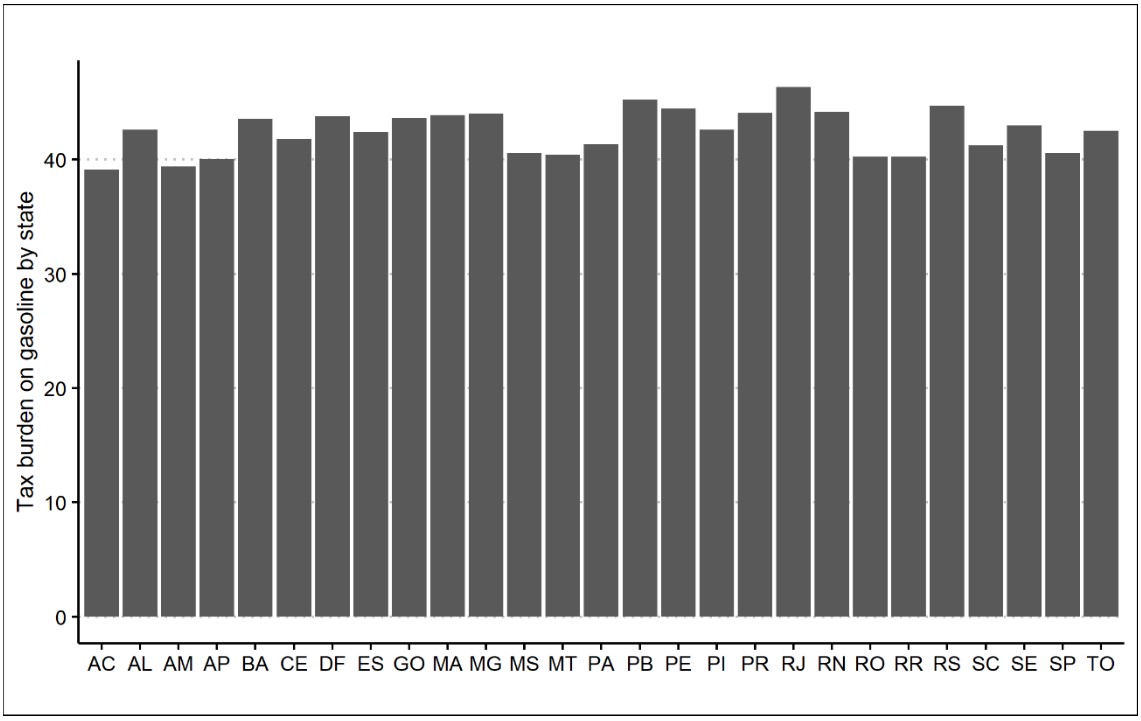


Figure 5 *– Tax burden on final gasoline prices (by state) (%Tax_e). Authors' elaboration. Each Brazilian state is represented by a two-letter abbreviation: Acre (AC), Amazonas (AM), Amapá (AP), Roraima (RR), Rondônia (RO), Mato Grosso (MT), Mato Grosso do Sul (MS), São Paulo (SP), Santa Catarina (SC), Pará (PA), Ceará (CE), Espírito Santo (ES), Tocantins (TO), Piauí (PI), Alagoas (AL), Sergipe (SE), Bahia (BA), Goiás (GO), Distrito Federal (DF), Maranhão (MA), Minas Gerais (MG), Paraná (PR), Rio Grande do Norte (RN), Pernambuco (PE), Rio Grande do Sul (RS), Paraíba (PB) and Rio de Janeiro (RJ).*

Acre (AC) had the lowest tax burden for gasoline; Rio de Janeiro (RJ) had the highest. According to data from Fecombustíveis (2021), in January 2018 federal taxes PIS/COFINS and CIDE totaled approximately BRL 0.65 per liter of gasoline. The ICMS, a state tax, was 25% to 34% of the gasoline tariff. Thus, using the average gasoline price in January 2018 (BRL 4.21), the state-administered ICMS was the tax that most burdened end-user gasoline prices.

4. Results

We first discuss the results at the country level, then explore the state differences. For Brazil, we find that distributions of total disposable income and gasoline tax collected were both highly unequal. Figure 6 indicates that the Suits Index will be negative: gasoline taxes worsen income distribution, once gasoline taxes (red curve) are more equally distributed than income (blue curve). Indeed, the value of the Suits Index for

Brazil in 2018 was -0.102 (see Table 2). Although the wealthiest pay a large share of gasoline taxes—the top 10% pays 30% of these taxes—they hold an even higher share of income (40%). Hence, gasoline taxes worsen the income distribution in this decile. This is evident between the 60th and 100th percentiles in Figure 6, in contrast to the percentiles lower than the 60th, where both lines follow a close path. Although the tax collected on gasoline consumption is quite uneven, the income distribution is even more uneven. This implies that the tax would be progressive if high-income households paid a higher share of taxes than the share of income earned. This would imply a Lorenz curve for taxes collected on gasoline even further from the 45-degree line than the curve for household income.

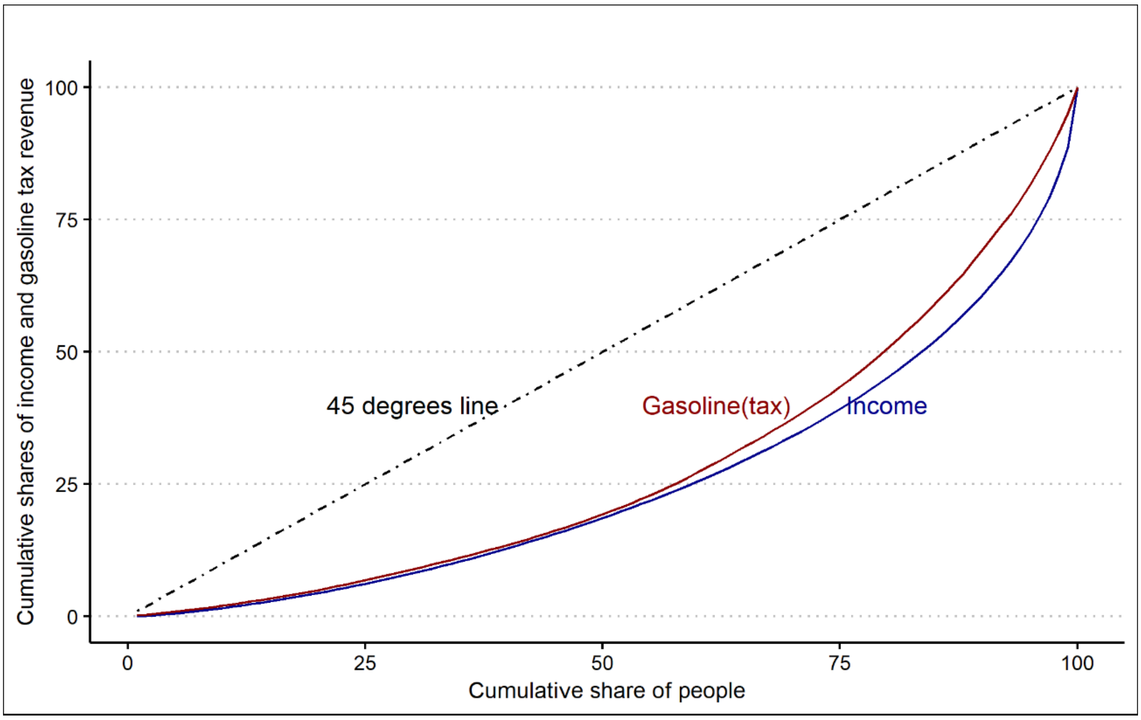


Figure 6 *– Lorenz curves of income and gasoline tax revenue in Brazil (2018). Authors' elaboration.*

Understanding how taxes are distributed across the population helps understand who benefits from gasoline subsidies. A negative Suits Index means that the tax worsens income distribution and that subsidies would improve income distribution. But in Brazil, as said before, until the 60th percentile, income and gasoline tax curves are very close to each other. Thus, subsidies would eventually yield the same unequal income distribution for the bottom 60 percent of Brazilians, but would reduce inequalities displayed among the top 40 percent.

Income, inequality, and gasoline tax burden differ among Brazilian states, affecting the Suits Index's magnitude (and sign). This can be seen in Table 2. In most states, the tax burden on gasoline is regressive. Mato Grosso do Sul (MS) stands out for having the lowest value in the index; Alagoas (AL) has the highest value. In Sergipe (SE) and Alagoas (AL) states, the index assumes values greater than zero at the midpoint (0.081 and 0.103, respectively). As a result, gasoline taxes place a greater burden on the higher income classes in these states, having a positive distributional impact. Note that Amapá (AP), Maranhão (MA), Paraíba (PA), Piauí (PI), Ceará (CE), Pernambuco (PE), and Rondônia (RO) had values close to zero or negatives and were not statistically significant. This implies that the gasoline taxation is proportional in these states.

***Table 2** – Suits index and confidence interval for Brazil and its states.*

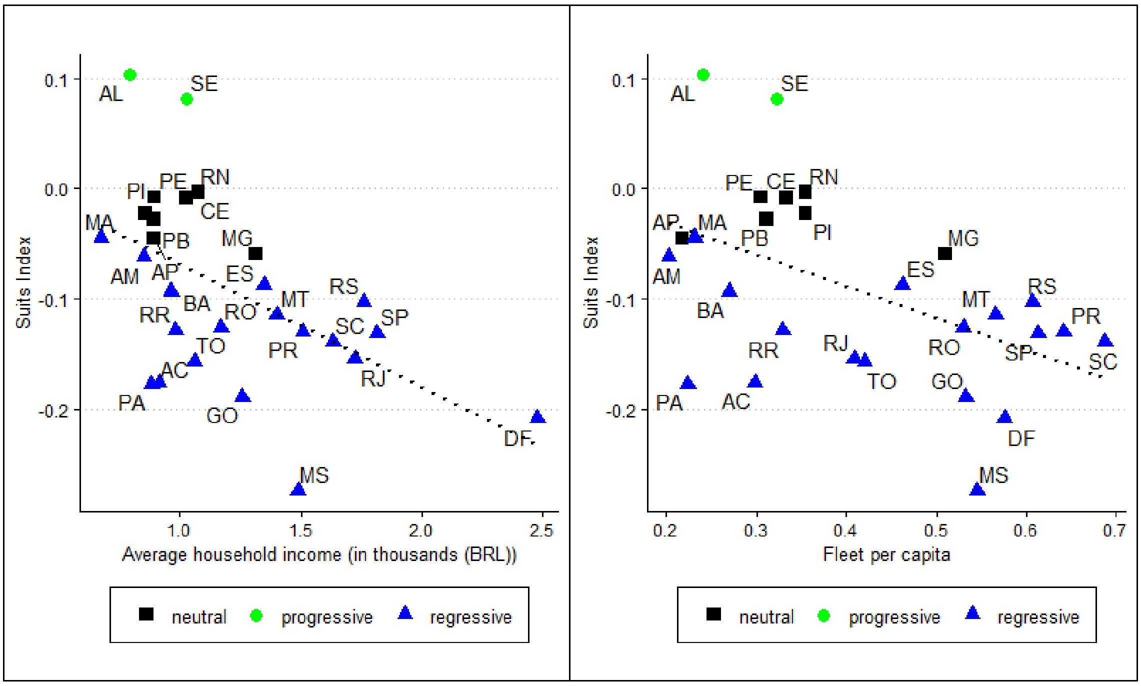
Country/state	Suits Index	Bootstrap Error	*Z*	Confidence Interval	
				Min.	Max.
Brazil	-.102	0.006	-16.91*	-.114	-.090
MS	-.273	.031	-8.87*	-.334	-.213
DF	-.209	.024	-8.70*	-.256	-.161
GO	-.189	.046	-4.10*	-.279	-.098
PA	-.177	.045	-3.92*	-.266	-.088
AC	-.175	.047	-3.73*	-.268	-.083
TO	-.157	.019	-8.27*	-.194	-.119
RJ	-.155	.034	-4.57*	-.221	-.088
SC	-.139	.020	-6.83*	-.178	-.099
SP	-.131	.016	-8.09*	-.163	-.099
PR	-.130	.039	-3.32*	-.206	-.053
RR	-.129	.037	-3.46*	-.202	-.056
RO	-.126	.023	-5.50*	-.171	-.081
MT	-.114	.021	-5.31*	-.156	-.072
RS	-.102	.030	-3.40*	-.161	-.043
BA	-.093	.027	-3.42*	-.146	-.039
ES	-.087	.029	-3.04*	-.143	-.031
AM	-.061	.022	-2.79*	-.105	-.018
MG	-.059	.038	-1.52	-.135	.017
AP	-.045	.036	-1.25	-.116	.025
MA	-.044	.021	-2.06*	-.086	-.002
PB	-.027	.030	-.92	-.086	.031
PI	-.022	.022	-.98	-.067	.022

CE	-.008	.024	-.35	-.056	.039
PE	-.008	.018	-.43	-.044	.028
RN	-.003	.032	-.10	-.066	.060
SE	.081	.031	2.59*	.019	.142
AL	.103	.035	2.94*	0.034	.172

Source: Authors' elaboration. *Significant at 95% confidence level. To construct confidence intervals, we adopt a bootstrap strategy based on 1,000 replications, following Anderson et al. (2003).

We find that gasoline taxes did not worsen the distribution of income in some of the poorest states in Brazil, corroborating a trend of regressivity observed in richer areas (Figure 7a). This result seems to be directly associated with car ownership (Figure 7b). We observed a negative association between fleet per capita and the Suits Index. These results indicate that the tax could become more regressive in the future, as the Brazilian Central Bank expects Brazil's Gross Domestic Product (GDP), a proxy for income, to grow 0.5% in 2022, 1.9% in 2023, and 2% in 2024 (Banco Central, 2022).

It is worth noticing that between 2009 and 2020, the size of the motor vehicle fleet increased 57% (Sindipeças, 2021), the population increased 9%, while the GDP per capita *decreased* 8% (Richie and Roser, 2021). This implies that car ownership will increase in the future given that predicted increase in income. Therefore, we expect an increase in regressivity in Brazil in the next decades.



(a) *(b)*

Figure 7 – Suits index, income, and fleet per capita (by state). Authors' elaboration. In Graph-a, the average household income is for 2018. In Graph-b, fleet and population are for 2021. The two-letter abbreviations on scatter points stand for states in Brazil. The dashed line represents the fitted values. Green points indicate states where we accept the null of progressivity, the gasoline tax is proportional (or neutral) in those black squares, and we accept the null of regressivity in those blue triangles. We adopt a bootstrap strategy based on 1,000 replications to construct confidence intervals.

5. Conclusions

Fuel taxes and subsidies have been frequently at the heart of the energy policy discussion in Brazil—both in times of high energy prices (when subsidies are promoted as a short-run remedy) and in times of low energy prices (when the debate turns to reforming tax structures that promote greenhouse gas abatement). Nevertheless, little is known about the effects of these policies, especially their distributional effects. The literature is even more sparse in developing countries. Our study aims to fill this gap for Brazil by calculating the Suits Index at both the national and state level, using a rich household dataset to determine whether the gasoline tax burden is progressive, regressive, or proportional.

Our results suggest that, at the national level, the gasoline tax burden is regressive, placing a relatively higher burden on the poorest Brazilians. This result has been driven mainly by percentiles higher than the 60th, when income and gasoline tax move apart. On the other hand, the implementation of subsidies in this market could improve the income distribution. However, as shown in Figure 6, it would be limited to the percentiles higher than the 60th.

We found that the results vary by state, most of them showing regressivity. However, seven states had an index showing proportionality and, in two states, the gasoline tax burden was actually progressive. These results imply that, on average, gasoline taxes worsen the income distribution in Brazil, but this is not the case for the entire country. In some states, notably among the poorest ones, the gasoline tax improves, or at least does not worsen, the income distribution. Because most gasoline taxes are assessed at the state level, this result illustrates how income distribution might affect each state. We found a negative association between income and calculated Suits Indexes by states (see Figure 7a), confirming reports in the literature that wealthier regions tend to have more regressive taxes (lower index values) (Morris and Sterner, 2013; Tiezzi and Verde, 2019; Agostini and Jiménez, 2015). This might be explained by the distribution of car ownership: in poorer states, where car ownership is more unequally distributed towards the wealthier, the gasoline tax tends to be progressive (see Figure 7b).

Gasoline taxes can help reduce negative externalities from the consumption of fossil fuels, e.g., carbon emissions and traffic accidents (Teixidó and Verde, 2017). In Brazil, there is a tradeoff between using gasoline taxes to reduce carbon emissions on the one hand and income inequality on the other. Note also that the way taxes are reintroduced into the economy can help to mitigate adverse distributional consequences. Proceeds from the gasoline tax in Brazil are used mainly to build and repair roads. In other words, government spending from this tax benefits directly those that are being taxed. Expenditures of gasoline taxes to build and repair roads do not contribute to improvements in the welfare distribution, and they further encourage fossil fuel consumption. Alternatively, revenues from this tax could be used to subsidize transport modes used primarily by the poor such as bus and metro (Blackman et al., 2010), or to improve and encourage use of environmentally friendly fuels such as ethanol.

In this paper, we calculated the distributional effects of direct spending on gasoline. Future research should also investigate indirect effects: how gasoline tax incidence affects different income brackets through spending on other goods and services. Future researchers could also expand this research to other fuels in Brazil (such as diesel, ethanol, liquified petroleum gas and aviation fuel). Finally, our paper does not address one of the main purposes of tax reform in developing countries: the attempt to buy political support. This is also a subject for future research.

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Appendix

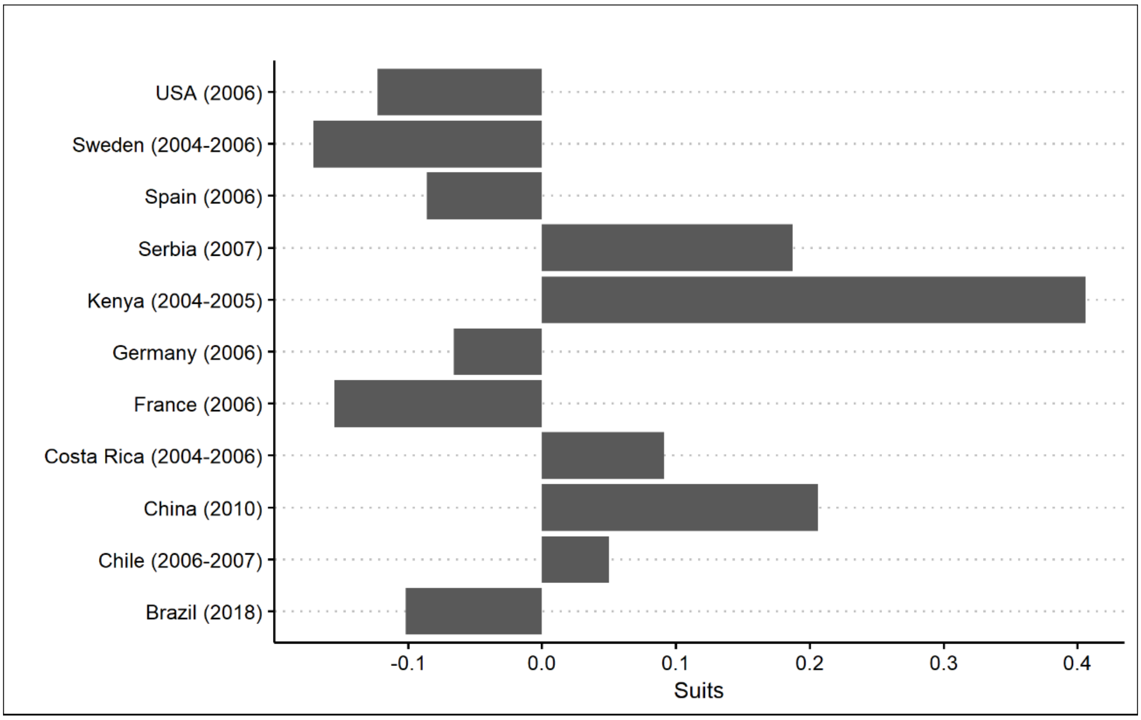

Figure A1 *– Suits Index in the literature. Authors' elaboration. The results for Sweden, France, the USA, Spain, Germany, and Serbia are from Sterner (2012b). Chile is from Agostini and Jiménez (2015), Costa Rica is from Blackman et al. (2010), China is from Jiang and Shao (2014), Kenya is from Mutua et al. (2009), and the result for Brazil is from this current paper. Mutua et al. (2009) considered all taxes paid on private transportation, not just on gasoline. Nevertheless, 80% of these taxes are due to fuel consumption, with gasoline expenses being the largest part.*