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DISCUSSION PAPER SERIES

IZA DP No. 15922

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Gustavo Canavire-Bacarreza
The World Bank and IZA

Lyliana Gayoso de Ervin
Meredith College and The World Bank

Juan José Galeano
Ministry of Finance, Government of Paraguay

Juan Pablo Baquero
Boston College

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Understanding the Distributional Impacts of Increases in Fuel Prices on Poverty and Inequality in Paraguay*

The recent global increases in fuel prices threaten the gains in poverty reduction that countries like Paraguay have achieved over the past few decades. Therefore, policy makers must understand the potential distributional impacts of increases in fuel prices to evaluate the implementation of alternative measures that could mitigate these impacts. This paper analyzes the potential effects of fuel prices on poverty and inequality in Paraguay. Using microsimulation methods and based on the Commitment to Equity framework, it estimates the impact of higher fuel prices on welfare, poverty, and inequality based on three scenarios: (a) increases in gasoline prices, (b) increases in diesel prices, and (c) simultaneous increases in gasoline and diesel prices. The results obtained suggest that the total impact of increasing fuel prices tends to be more regressive in Paraguay. At the same time, the results of the simulations indicate small effects on income inequality.

JEL Classification: D6, Q4, I3, P36

Keywords: fuel prices, poverty, inequality, Paraguay

Corresponding author:
Gustavo Canavire-Bacarreza
The World Bank
1818 H Street
NW Washington
DC 20433
USA
E-mail: gcanavire@worldbank.org

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1. Introduction

Paraguay is characterized by abundant access to clean hydropower energy, giving the country a unique opportunity to become the regional leader in implementing environmental policies (OECD 2018). However, most of the energy consumed in the country continues to be in the form of fossil fuels and biomass. Without proven oil reserves, the country depends entirely on crude oil imports, which represents a source of external shocks for the country: the economy and population are subject to impacts due to the constant changes in international fuel prices. While the country is committed to increasing the consumption of renewable energy sources and reducing the use of fossil fuels,[1] the progress toward these goals has been slow.

The need for fuels in Paraguay is vital, as they are used throughout the supply chain of production, thus affecting the country's main economic sectors, such as agriculture and cattle ranching. In addition, Paraguayan households rely primarily on fossil fuels for transportation and cooking. With fuel being a widely used product, increases in its price can impact all sectors of the economy, pushing all other prices up, eventually leading to periods of high inflation. The empirical evidence suggests that high fuel prices affect livelihoods differently. For instance, Arndt et at. (2008) explore the impact of Mozambique's higher food and fuel prices on macroeconomic and poverty indicators using different approaches and considering short- and long-term effects. These authors conclude that the short-run effects show primarily regional differences, with urban households and those living in the southern region experiencing the highest negative impacts, while the long-term effects indicate that significant negative impacts on poverty reduction and economic growth are felt nationwide. In another study, Ersado (2012) investigates the direct poverty and distributional impacts of increases in energy prices in Armenia, focusing mainly on gas. This study shows that sharp increases in gas prices in Armenia tend to have regressive effects, as poor and vulnerable households are more likely to be disproportionally impacted by energy price shocks. In another study, Aziz, Yaseen, and Anwar (2016) explore the impact of higher energy prices on Pakistan's consumer welfare within the compensating variation framework. The authors estimate the losses of consumption that could result from higher energy prices, finding a significant reduction in consumers' welfare. More recently, Muthalib (2018) argues that rising fuel prices represent a barrier to access to employment and thus can lead to social and economic exclusion. Finally, Feng et al. (2018) examine the impact of higher

[1] Both goals are reflected in the objectives set forth in the National Development Plan (NDP 2030), adopted in 2014 and revised in 2021 (STP 2014).

energy prices on different income groups using an energy-extended input-output approach in Latin America. The results of the study indicate that households in the top levels of the income distribution consume higher amounts of fuels. Therefore, high-income households benefit more than low-income households from energy subsidies.

The global rise in fuel prices has increased concerns about the Paraguayan economy for two main reasons. First, the need to change the energy matrix to reduce the dependency on fossil fuels and biomass has become a topic of public debate and represent a national development goal (STP, 2014)[2]. Second, the rapid increase in fuel prices is creating inflationary pressures, threatening the stable macroeconomic framework the country has enjoyed in the last few decades as well as the positive socioeconomic outcomes achieved in recent years.

The current global context raises questions about how these shocks could affect the poorest households. This study examines rising fuel prices' direct and indirect effects on household welfare and poverty and inequality in Paraguay. We do this through a series of microsimulation models that capture fuel increases' direct and indirect effects on household spending and, by extension, on poverty. This study suggests that higher fuel prices in Paraguay tend to be regressive because they disproportionally and negatively impact the poorest households, mainly through their indirect effects. Regarding inequality, the results of our simulations indicate negligible positive effects on income inequality, which is explained by the higher fuel consumption of richer households. The analysis presented in this paper seeks to contribute to an evidence-based discussion on potential interventions aiming at helping to mitigate the effects of higher fuel prices in the country.

The remainder of the study is organized as follows: section 2 provides a brief background of the fuel sector in Paraguay. Section 3 describes fuel consumption in the country, and section 4 describes the empirical framework and the data used in the study. Section 5 then presents the results and discusses the findings, and section 6 concludes the paper.

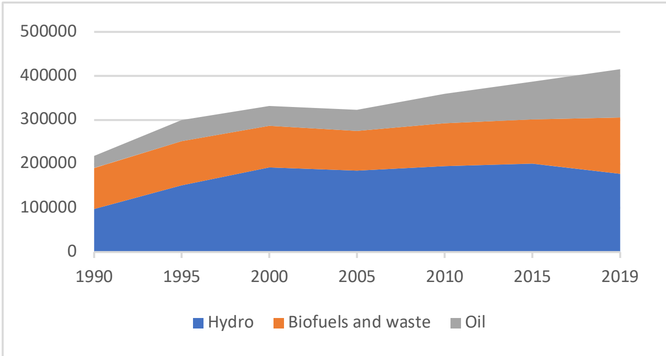
2. Fuels in Paraguay

Paraguay's energy matrix is based on an abundant supply of primary energy of renewable and local origin, specifically hydrogen and biomass (Figure 1). At the same time, the country is characterized by its significant dependency on fossil fuels, ranking 102nd in the consumption of barrels per day for petroleum and other

[2] The National Development Plan states as one of country goals to reduce 20 percent of their fossil consumption by 2030.

liquids as of 2019.[3] While Paraguay largely relies on fuels to meet its domestic energy needs, it ranks sixth in the global electricity exports ranking, reflecting the country's comparative advantage in producing and exporting electricity.

Figure 1. Total energy supply (TES) by source, Paraguay, 1990–2019



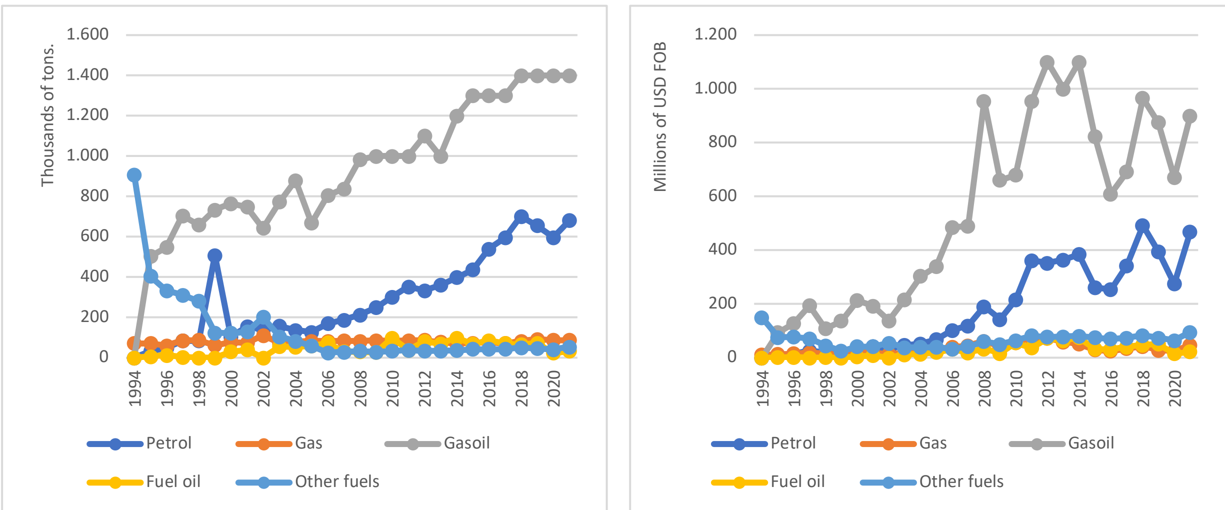
Source: IEA World Energy Balances: https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.

All fuels consumed since 2006 have been imported, making the country a net importer of this commodity. The quantity of fuels imported has substantially increased since the early 2000s, particularly those of gas, oil and gasoline (the latter to a lesser extent than the former) (Figure 2, panel a). The value of imports (in millions of USD) has also shown an increasing trend in recent decades, with some volatility since 2010 that is likely due to substantial fluctuation in international fuel prices.

Figure 2. Quantities and values of imports of fuels, 1994–2021

(a) Evolution of fuel imports by fuel type (in thousands of tons), 1994–2021

(b) Evolution of fuel imports by fuel type (USD FOB, millions), 1994–2021



Source: Central Bank of Paraguay

[3] https://www.eia.gov/international/overview/country/PRY.

As imported goods, fuels are subject to the excise tax (Impuesto Selectivo al Consumo, ISC) which represent an important source of revenue for the government. As of 2018, about 74 percent of revenues from excise taxes came from fuels and derivatives.[4] Excise taxes were implemented in 2011 and gradually increased over time (Table 1). The rates range between and within groups of goods subject to this tax differ by good. Table 1 shows the current taxes by fuel type.

Table 1. Evolution of excise tax rates per section and goods

SECTION	GOODS	2011	2012	2016	2018
IV	Unleaded gasoline, 88 octanes	24%	24%	24%	24%
	Leaded, unleaded, or super gasoline above 88 octanes, up to 96.9 octanes	34%	34%	34%	34%
	Lead-free gasoline, 97 octane or higher	38%	38%	38%	38%
	Aviation gasoline	20%	20%	20%	20%
	Virgin gasoline	-	-	20%	20%
	Kerosene	10%	10%	10%	10%
	Turbo fuel	1%	1%	0%	0%
	Gas oil	18%	18%	18%	18%
	Fuel oil	10%	10%	10%	10%
	Liquid gas	10%	10%	10%	10%
V	Perfume, eau de toilette, and makeup beauty preparations	5%	5%	5%	5%

Source: Ministry of Finance of Paraguay.

In September 2019, the Congress of Paraguay approved Law No. 6,380: Modernization and Simplification of the Tax System, presented by the Ministry of Finance, which introduced several changes to the tax system in Paraguay. With this new law, while the personal income tax (PIT) experienced the most substantive changes, the law did enact changes to corporate and indirect taxes, including the ISC. In the case of the ISC, the maximum tax rates, the highest rates that the government can impose on the goods subject to this tax, were increased. However, the actual rate the government could impose may lie between the current and maximum rates. The following process takes place when the executive branch of the government presents changes in the rate of ISC by issuing a decree with the new rates, and then, the new rates go into effect immediately since the period that it mentioned.

In this case, the maximum fuel rate determined by the law is 50 percent. Among the ISC regulations, Decree No. 3,109/19 establishes the tax rates and bases for each of the fuels, as shown in Table 2.

[4] Ministry of Finance of Paraguay.

Table 2. Excise tax rates per type of fuel (2019)

GOODS	TAX BASE	TAX RATE
Gasoline up to 88 octanes	Average selling price	24%
Gasoline or super gasoline with or without lead of more than 88 octane up to 96 octanes	Average selling price	34%
Unleaded gasoline with an octane rating of 97 or more	Average selling price	38%
Aviation gasoline	Average selling price	20%
Virgin gasoline (straight-run topping gasoline)	Customs value expressed in foreign currency and average selling price	20%
Kerosene	Average price	10%
Turbo fuel (Aviation kerosene)	Average price	0%
Gas Oil	Average selling price for Type I and Gs. 3.778,78 per liter for Tipo III y Marine.	18%
Fuel Oil	Average selling price	10%
Liquid gas	Average selling price	10%
Deorized propellant gas – Isopropane Butane	Average selling price	1%
Other derived fuels for vehicular use	Average selling price	38%

Source: Ministry of Finance of Paraguay.

Notes: Any other fuel not shown in the table is exempt from this tax. Guaranies is the local currency of the country, represented by Gs.

The average price considered as the tax base is calculated by taking into account the weighted average price of fuel sales to the public at the outlet of gas stations. In terms of the payment process of this tax, in the case of diesel, 25 percent of the imports have to be declared as Type I and the remaining 75 percent as Type III, according to Decree No. 3,109/19. Furthermore, for virgin gasoline, Decree No. 3,785/20 established that the tax to be paid needs to be calculated based on 60 percent of the average price. As a result of the successive increases in fuel prices, Decree No. 6,620/22 recently reduced the tax bases of the fuels presented in Table 3, that were effective since February 2022. With this reduction, the effective tax rate shows a decrease as well.

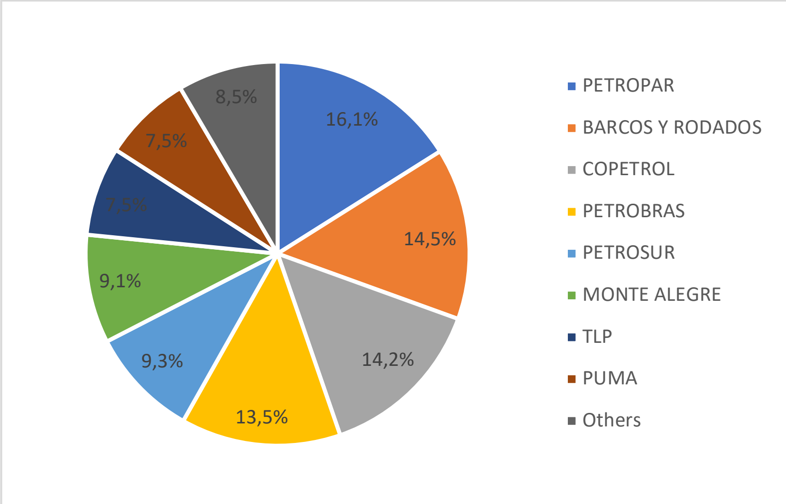
Table 3. Excise tax rates and bases for certain fuels (2022)

GOODS	CURRENT TAX BASE	PREVIOUS TAX BASE	EFFECTIVE TAX RATE
Gas Oil / Diesel Type III	G 2.388,9 per liter	G 3.778,78 per liter	6%
Virgin Gasoline	G 3.045,6 per liter	Average selling price	8%
Gasoline 91 octane	G 6.033,3 per liter	Average selling price	27%

Source: Ministry of Finance of Paraguay.

Regarding the market structure of the fuel sector, eight firms account for over 91 percent of the country's imports and sales of fuels. Therefore, the market tends to be an oligopoly. The firm with the highest market share is the government enterprise PETROPAR, with 16.1 percent of the market, followed by Barcos y Rodados and Copetrol, with 14.5 and 14.2 percent of the market, respectively (Figure 3).

Figure 3. Main firms' market shares



Source: Authors' own elaboration based on administrative data from the Ministry of Industry and Commerce of Paraguay.

3. Empirical framework

a. Methodology

To understand the underlying effects of changes in gasoline and diesel prices in Paraguay, we propose a static partial framework in line with Choe and Moose (1998) and Medinacelli (2003), with a linear production function and nonlinear adjustment costs with respect to fuel demand. This is estimated based on a classical maximizing problem with heterogeneous agents:

$$u_i = f(x_{i1}, x_{i2}) + v_i(y_i)$$

where x_{i1} is the individual's consumption of gas; x_{i2} represents the consumption of diesel; $f(x_{i1}, x_{i2})$ stands for the output from fuel consumption; while, on the other hand, $v_i(y_i)$ is the individual's valuation of the consumption of good y_i. It is further assumed that individuals demand either gas or diesel; thus, these goods are perfect substitutes. Likewise, the individual requires a fixed output of fuel consumption:

$$f(x_{i1}, x_{i2}) = \bar{Z}_i$$

Even though fuels are assumed to be perfect substitutes, it is also assumed that an adjustment cost for the use of one good instead of the other (k_{jh}):

Table 4: Turning cost

	k_1	k_2
k_1	$k_{11} = 0$	$k_{12} = \bar{k}_1$
k_2	$k_{21} = \bar{k}_2$	$k_{22} = 0$

where subscript j represents the fuel intended to replace the consumption of h. The adjustment cost is assumed fixed and equal to $\bar{k}_1$ —for transitioning from gas to diesel— and $\bar{k}_2$ —vice versa—i.e., this cost is incurred only if the individual makes the switch. Therefore, the individual's expenditure function is:

$$g_i = \sum_{j=1}^{2} (p_j + k_{jh}) x_{ij} + y_i$$

where p_1 and p_2 are the prices of gas and diesel, respectively. Both prices are given exogenously by the market; nevertheless, it is assumed that $p_1 = \bar{p} + \varphi^s$, where the superscript s refers to the scenario: $\varphi^1 = 0$ —fundamental state—; whereas $\varphi^2 = \bar{\varphi}$ —a shock in the price of gas. Given this setup, the individual maximizes her utility subject to the following constraint:

$$Max \qquad u_i = f(x_{i1}, x_{i2}) + v_i(y_i)$$

$$s.t. \qquad m_i = g_i = \sum_{j=1}^{2} (p_j + k_{jh}) x_{ij} + y_i$$

$$f(x_{i1}, x_{i2}) = \bar{Z}_i$$

In this type of problem, the demand for each of the goods will depend on the type of fuel used. Respectively, consumers of gas and diesel will have the following demand functions:

$$x_{i1}^d = \frac{m_i - y_i}{\bar{p}} \quad if \left| -\frac{f^1(x_{i1}, x_{i2})}{f^2(x_{i1}, x_{i2})} \right| > \left| -\frac{\bar{p} + \varphi^s}{p_2 + \bar{k}_2} \right|$$

$$x_{i2}^d = \frac{m_i - y_i}{p_2} \quad if \left| -\frac{f^2(x_{i1}, x_{i2})}{f^1(x_{i1}, x_{i2})} \right| > \left| -\frac{p_2}{\bar{p} + \varphi^s + \bar{k}_1} \right|$$

The solutions presented in the previous equations assume that individuals who use gas do not use diesel and vice versa, namely, "corner solutions." This implies that $f(x_{i1}, x_{i2})$ must be either a linear function without interdependence between x_{i1} and x_{i2}. Based on this notation established, it is possible to determine that families that use gas will perceive their welfare as reduced whenever there is an increase in the price of gas, but this shock could lead to two different scenarios:

$$y_i^2 = m_i - \left[\frac{\bar{p} + \bar{\varphi}}{\bar{p}}\right]\left[m_i - y_i^1\right] \quad if\ \bar{\varphi} \leq \left(p_2 + \bar{k}_2\right)\frac{f^1(x_{i1}, x_{i2})}{f^2(x_{i1}, x_{i2})} - \bar{p}$$

$$y_i^2 = m_i - \left[\frac{p_2 + \bar{k}_2}{p_2}\right]\left[m_i - y_i^1\right] \quad if\ \bar{\varphi} > \left(p_2 + \bar{k}_2\right)\frac{f^1(x_{i1}, x_{i2})}{f^2(x_{i1}, x_{i2})} - \bar{p}$$

This is a simulation of what happens when the price of gas increases in $\bar{\varphi}$. The individual will stick to gas if the price increase is not large enough to encourage the fixed cost payment to transition to diesel. On the other hand, if the price increase is large enough, the individual will find herself in the second equation. Notice that since every individual has her specific demand $\bar{Z}_i$. And price increase does not necessarily encourage all individuals to turn to diesel or stick with gas, i.e., a shock to the gas price could encourage some individuals to turn to diesel while others do not. It is possible to demonstrate that, whenever $m_i > y_1^i$ is satisfied, then, $y_i^2 < y_i^1$ holds for both equations:

$$y_i^2 - m_i = \left[\frac{\bar{p} + \bar{\varphi}}{\bar{p}}\right]\left[y_i^1 - m_i\right]$$

Given,

$$\left[\frac{\bar{p} + \bar{\varphi}}{\bar{p}}\right] > 1$$

then,

$$y_i^2 - m_i < y_i^1 - m_i$$
$$y_i^2 < y_i^1$$

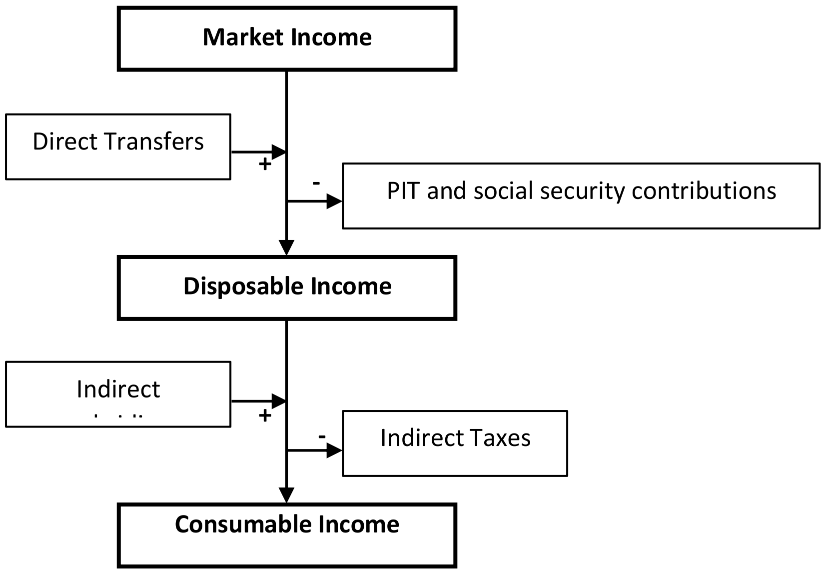
This implies that, since individuals have a fixed demand for fuels, they will sacrifice other goods consumption for fuel until necessary, thus, reducing welfare.

Income Concepts

To conduct the incidence analysis of a fuel price shock for Paraguay, we follow the Commitment to Equity (CEQ) method (Lustig et al., 2018). This approach is mainly used to examine the incidence of individual tax and subsidy policies, estimate each fiscal intervention's poverty and inequality impact, and assess whether taxes and transfers are progressive and pro-poor. The core of the CEQ is the construction of the income concepts: market income (before any fiscal intervention), disposable income (market income after direct taxes), and consumable income (disposable income after indirect taxes and indirect subsidies).

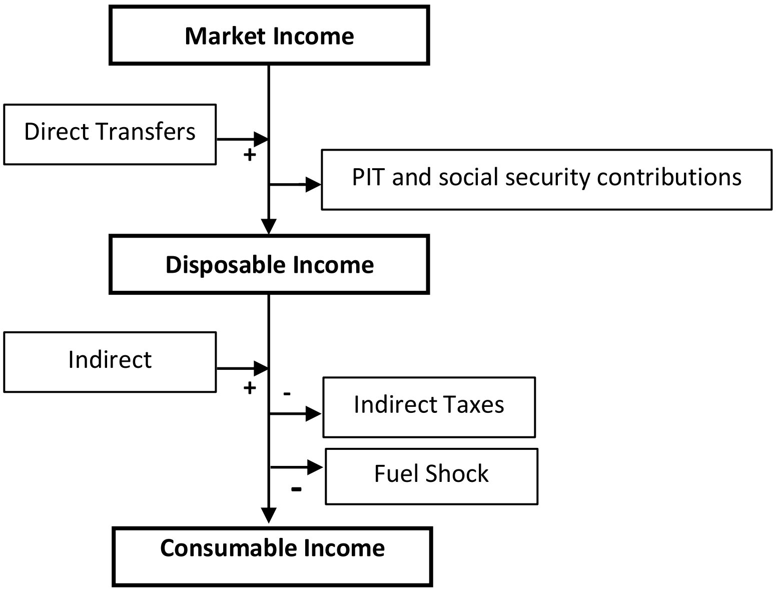
For instance, if the researcher is interested in analyzing the impact of direct transfers, she must consider that direct transfers directly affect disposable income and do not affect market income. Furthermore, assume that the researcher is interested in analyzing indirect taxes. Then, she must consider that indirect taxes only affect consumable income and do not affect disposable and market income. Figure 4 exhibits the relation between the CEQ income concepts and the fiscal institutions that composes them. In this paper, the fuel shock is analyzed similarly to an indirect tax, i.e., it affects consumable income and does not affect disposable income and market income. **Figure 5** shows the proposed approach to analyze the fuel shock within the CEQ approach.

Figure 4 - CEQ income concepts



Source: Lustig et al. (2018)

Figure 5 - Fuel shock within the CEQ methodology



Source: Lustig et al. (2018)

Price Shock

In order to measure the welfare loss of a fuel shock, two channels are taken into account: the direct and indirect effects. The direct effect measures the purchasing power loss of households that mainly consume fuel for cooking and transportation. The indirect effect measures the purchasing power loss due to various expensive goods because their production costs highly depend on fuels. In the case of Paraguay, some services, transportation, meat, and agricultural goods are some of the goods that get more expensive because of the fuel price shock. In turn, the participation of the fuels within the structure of the household consumption basket is 1.3639 percent for common diesel and 0.5179 percent for common gasoline, so the increase in the prices of these goods could also have an immediate impact on people's mobility and income levels. The distributive impacts then will depend on the consumption of fuel across income groups. If higher-income groups' consumption baskets are relatively more fuel-intensive than those of lower-income groups, then the impact on higher-income groups will be relatively significant (Coady et al., 2015).

Direct Effects

The main issue in calculating the welfare loss of a price shock is that it is impossible to know the counterfactual quantity that the individual would consume with the price shock in cross-section expenditure records. As long as we only observe expenditure without the price shock, we must make assumptions to approximate a counterfactual expenditure with the price shock. Following the CEQ Handbook, we assume an inelastic demand for every good, which implies that prices do not lead to changes in the quantity demanded. Thus, if we observe fuel expenditure E_t, then the counterfactual expenditure E_{t+1} after the price, shock Δ can be obtained as follows

$$E_t = P_t Q_t$$

$$E_{t+1} = P_{t+1} Q_{t+1}$$

But we assume that $Q_t = Q_{t+1}$ and we know that $P_{t+1} = P_t(1+\Delta)$

$$E_{t+1} = Q_t P_t (1+\Delta)$$

Once we obtain the counterfactual expenditure (E_{t+1}) we can calculate the expenditure increase at two points in time using:

$$PV = E_{t+1} - E_t$$

which equals

$$PV = Q_t P_t \Delta$$

Where PV stands for Paasche Variation, which measures purchasing power variation due to the price shock. It is not a welfare measure as long as consumers with inelastic demand are as well as off (in welfare terms) at any price level as long as the quantity remains constant. The decrease in purchasing power (measured by PV) is subtracted from disposable income to arrive at consumable income (Lustig et al., 2018).

Indirect Effects

The fuel shock's indirect effects involve an increasing price of goods that heavily rely on fuel as an intermediate good. The extent to which these price changes are passed forward onto output prices or backward onto factor prices will depend on such things as the structure of the economy (Gillingham, 2008). Essentially, the fuel shock affects economic sectors such that the structure of the production costs highly depends on fuels. We implement a simple price-shifting model to measure the price change in economic sectors due to a fuel shock. The model is easy to implement as long as it only requires the current structure of an economy at current levels of production reflected in an input-output matrix (Lustig et al., 2018).

The general procedure to calculate the fuel shock's indirect effects is as follows. Firstly, we map the household consumption expenses to the IO matrix sectors. Secondly, we match the Gasoline and Diesel item to a fuel sector in the IO matrix. We then determine the price shock according to the forecasted price change.[5] Finally, the model is solved, and the percentage change in final prices is matched with the items in the household survey according to the mapping of the first step. The purchasing power variation due to the percentage change in final prices is calculated similarly to the Paasche Variation for the direct effect shock.

b. Data manipulation

Data comes from two main sources, the "Encuesta de Ingresos y Gastos 2011-2012 (EIG)" and the "Encuesta Permanente de Hogares 2019 (EPH)", both household surveys available in Paraguay. The EIG is a household survey that contains expenditure records for almost 6,000 households and is representative at the national level, urban and rural areas, the country's capital , Asunción, and the following departments: San Pedro, Caaguazú, Itapúa, Alto Paraná, and Central. The EPH surveys 5,099 households and is representative at the national level, urban and rural areas, and Asunción, and the following departments: San Pedro, Caaguazú, Itapúa, Alto Paraná, Central, and a group assigned as "others" that agglomerates the rest of the deparments in the country. The EPH survey contains information on unemployment, income, and the main demographic characteristics of the household that allow measurement of household welfare in Paraguay.

In order to construct market income and disposable income (see

) following the CEQ approach, we use income and demographic information from the EPH. However, as the EPH does not contain expenditure records, it is necessary to impute expenditure records from the EIG to construct consumable income and construct the fuel shock incidence. To do this, we implement a survey-to-survey imputation method, which is a predictive mean matching model (PMM). Essentialty, the PMM imputes the missing value in the EPH from observed values in the EIG; so that, the

[5] We calculate a weighted price shock based on gasoline and diesel annual sales based on Paraguay's Ministry of Industry and Commerce data.

distribution of the imputed values in the EPH will coincide with the original distribution of the EIG (White et al. 2014).[6]

c. Simulation scenarios

To understand the distributional effects of increasing fuel prices on poverty and inequality in Paraguay, we assume that only gasoline and diesel prices change because these two fuels are the most consumed. The scenarios simulated in this study are

- *Scenario 1*: Considers an increase in final gasoline prices, everything else constant. Shocks considered are increases in final prices of 5, 10, and 20 percent.
- *Scenario 2*: Considers an increase in the final prices of diesel, everything else constant. Shocks consider increases in final prices of 5, 10, and 20 percent.
- *Scenario 3*: Considers an equal increase in the final prices of both gasoline and diesel, everything else constant. Shocks consider increases in final prices of 5, 10, and 20 percent.

4. The importance of households' expenditure on fuels

To understand who is more likely to be affected by rising fuel prices across the income deciles in Paraguay, it is necessary to explore households' consumption and expenditure habits in the country, which we do in this section.

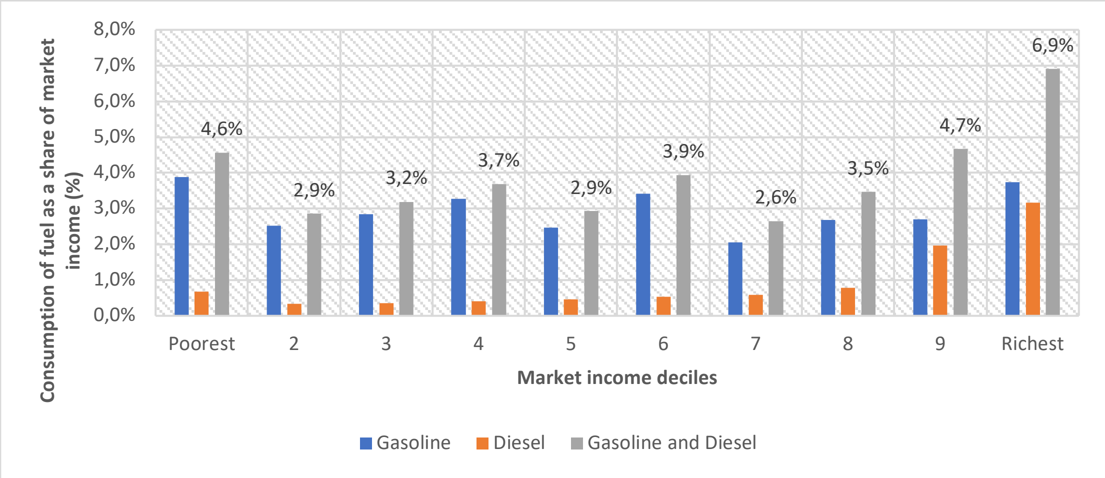
a. Who consumes fuels?

We begin by presenting the consumption patterns of fuels in Paraguay. **Fehler! Verweisquelle konnte nicht gefunden werden.** below shows the share of households' consumption of gasoline and diesel relative to households' market income. When gasoline and diesel consumption are taken together, the figure denotes the existence of large disparities between those at the bottom and the top of the consumption distribution. In particular, we observe that households in the top decile of the distribution consume 1.5 times as much fuel as those at the lowest. These statistics suggest that any fuel price shock will directly impact richer households. However, we cannot draw any conclusions on the potential indirect impacts with a descriptive analysis of this type. When analyzing the consumption of each fuel individually, it is notable that households at the bottom of the distribution are more likely to consume more gasoline than diesel. However, the

[6] For a more detailed explanation of the imputation method, see Van Buuren (2018).

richest households tend to consume more similar levels of gasoline and diesel, measured as a share of market income.

Figure 6. Gasoline and diesel consumption as a share of market income

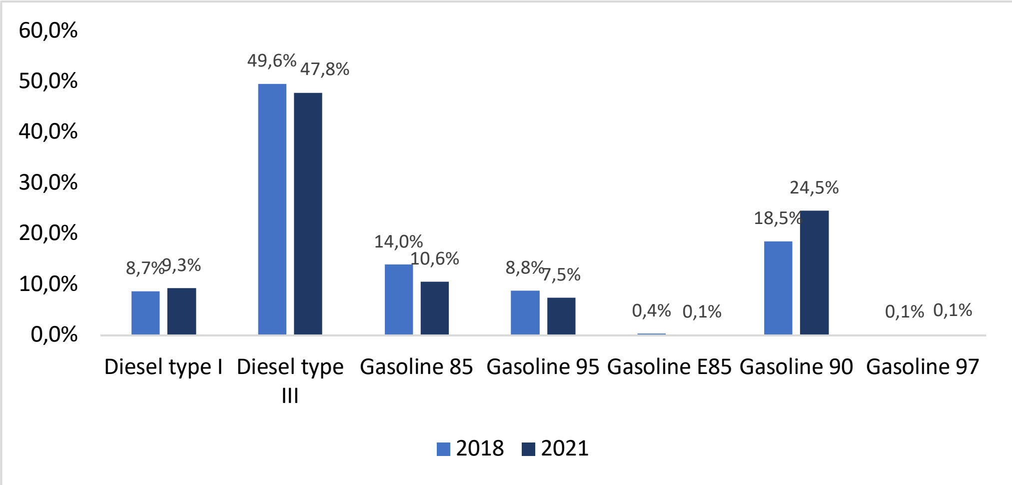


Source: Authors' calculations based on the EPH 2019.

The types of fuels with the greatest incidence in the aggregate economy are diesel (type III) and gasoline 90 octanes, which account for more than 80 percent of the total national fuel consumption (see Figure 7). These two fuels are mainly used by consumers and large economic sectors, such as agriculture; livestock; transportation, manufacturing, and particular units (families, households, and individuals).

Notably, gasoline is one of the most used fuels in the national production structure; therefore, the effects of increases in international oil prices and their impacts on the final price in the domestic market represent an important source of external risks for the country. High fuel prices can have adverse repercussions, at the macroeconomic and microeconomic levels, mainly through the deterioration of the population's income level.

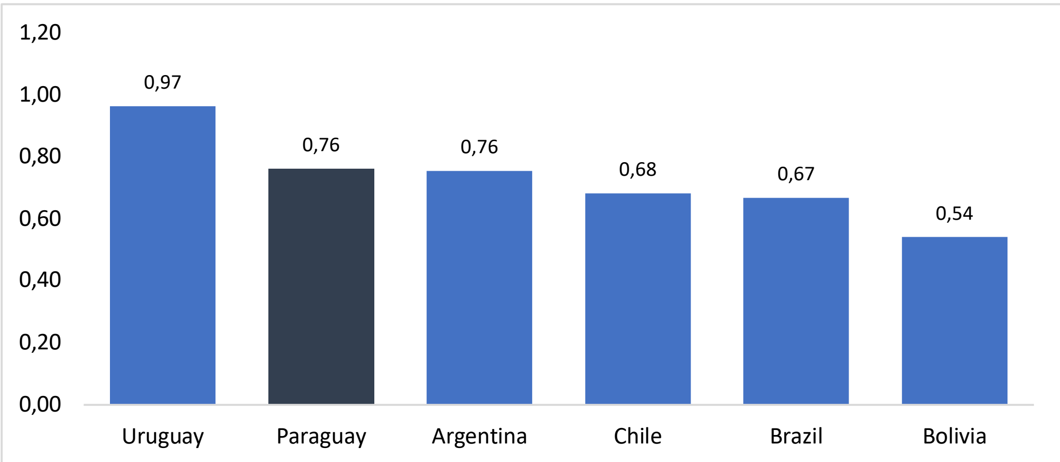
Figure 7. Share of fuel consumption by type



Source: Author's elaboration based on administrative data from the Ministry of Industry and Commerce of Paraguay.

In addition, Paraguay, as a landlocked country, has relatively more expensive import costs than other countries in the region. In this sense, the price of gasoline in Paraguay is one of the most expensive in the region. Figure 8 shows that Paraguay is the second country in the region with the highest diesel prices. Among the logistics expenses of import, freight, international price, insurance and exchange rate, they reach just over 90 percent of the structure of the total cost of importing gasoline (type III).

Figure 8. Diesel price in countries of the region (current dollars per liter – 2020)



Source: The United Nations Economic Commission for Latin America and the Caribbean.

5. Results

This section presents and discusses the results obtained based on the simulation scenarios considered in the study.

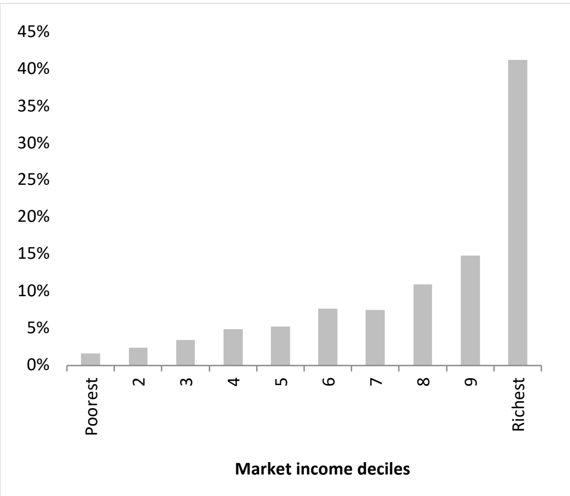
a. Impacts on welfare

i. Gasoline-price shocks

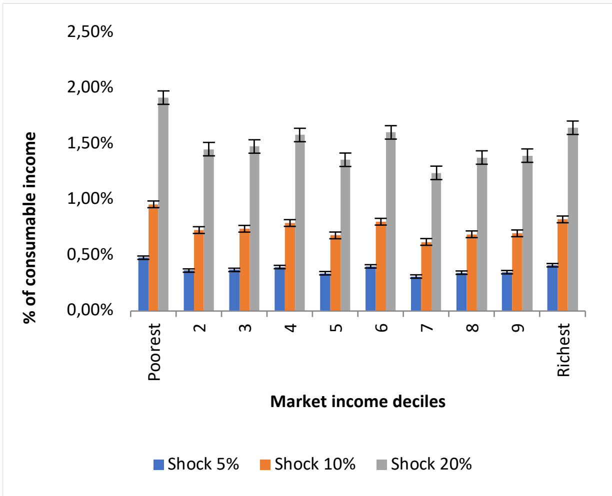
Panel (a) in Figure 9 below shows how much of the total impact (direct and indirect effects) of increasing gasoline prices on welfare as a share of market income is concentrated across the income distribution. Per the figure, almost 37 percent of the estimated impact will be concentrated in the top decile of the income distribution, with the burden being 20 times that on those in the lowest decile of the distribution. While in absolute terms the impact of higher petrol prices is concentrated in the upper tail of the income distribution, the incidence in relative terms shows that those at the bottom of the distribution will bear a higher impact than those at the top of the distribution (panel b in Figure 9). For each price shock considered, namely increments of 5, 10, and 20 percent, the welfare loss as a share of households' market income is larger for the households at the bottom of the distribution. For instance, given a price shock of 5 percent, the loss in welfare for the poorest households is around 0.48 percent of households' market income, while for those at the top of the distribution it is 0.41 percent. Nevertheless, the impact tends to show similar levels across the distribution.

Figure 9 - Simulation results of the impact of higher gasoline prices

(a) Total consumption of gasoline as a share of market income by decile



(b) Relative incidence of the impact of the gasoline price shocks of 5%. 10% and 20%



Source: Authors' calculations.
Note: 95% confidence intervals are shown in panel b.

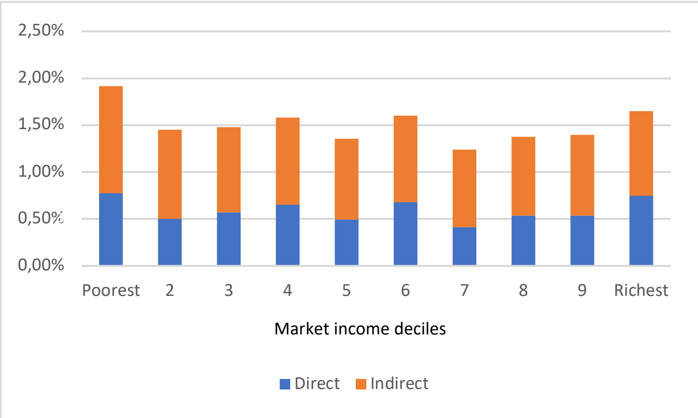
Notably, because the richest households tend to consume a larger quantity of fuel relative to their income (or expenditure) levels than poorer households, the direct impacts of changes in fuel prices are likely to affect them more. However, indirect impacts can be large and affect households disproportionally. These indirect impacts of increases in fuel prices are transmitted through the supply chain, impacting, therefore, the prices of all the other final goods consumed by households. The analysis of the indirect effects by sector suggests that the largest indirect impacts will be felt in other sectors, followed by the transport sector and the sector of meat and derivatives (Figure 10, panel a).

A decomposition of the total impact by direct and indirect effects by income deciles for the simulation with prices increasing by 20 percent shows that 60 percent of the total impact in the lowest decile of the income distribution is due to the indirect effects of higher fuel prices, compared to 55 percent for the top income decile (Figure 10, panel a).

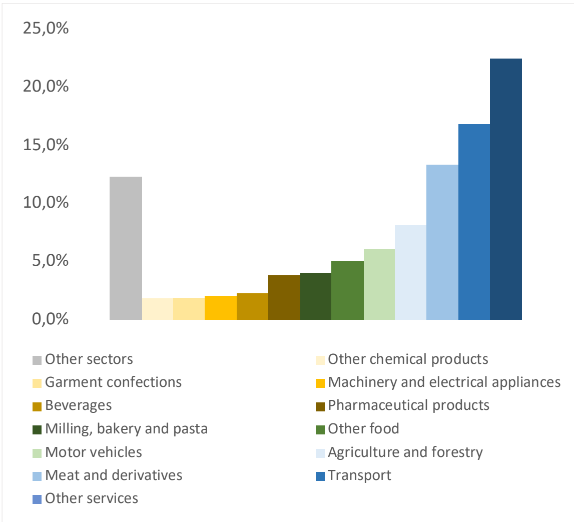
Aditionally, an analysis of the indirect effects on these three sectors by income decile suggests that those who bear the highest welfare loss burden are at the bottom of the income distribution. This is largely due to price increases in the services sectors, particularly that of meat and derivatives (Figure 10, panel b). Finally, the indirect effects, measured as the loss of welfare as a share of market income, are presented by market income deciles for the top three economic sectors affected in panel c of Figure 10. This graph shows that the poor bear most of the indirect impacts from higher gasoline prices, particularly through the impacts on the meat and derivatives and other services sectors. The results obtained for the simulation of increases in gasoline prices presented in this subsection indicate that higher gasoline prices tend to have regressive effects in Paraguay.

Figure 10 - Indirect effects of higher gasoline prices

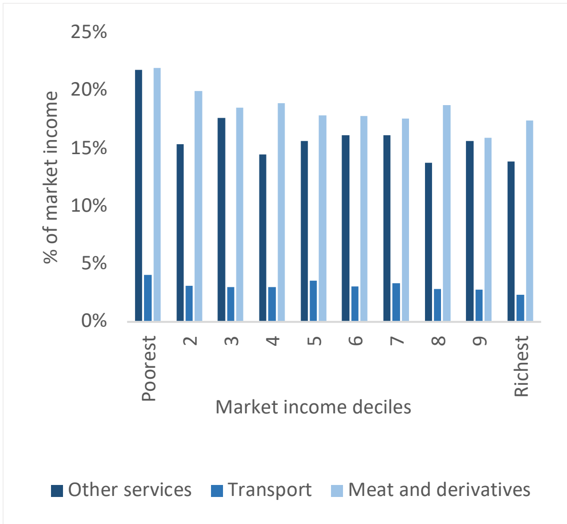
(a) Direct and indirect effects of a 20% increase in gasoline price by income deciles (%)



(b) Indirect effects by sector (% of total indirect effects)



(c) Distribution of indirect effects on the top three sectors by income decile (%)

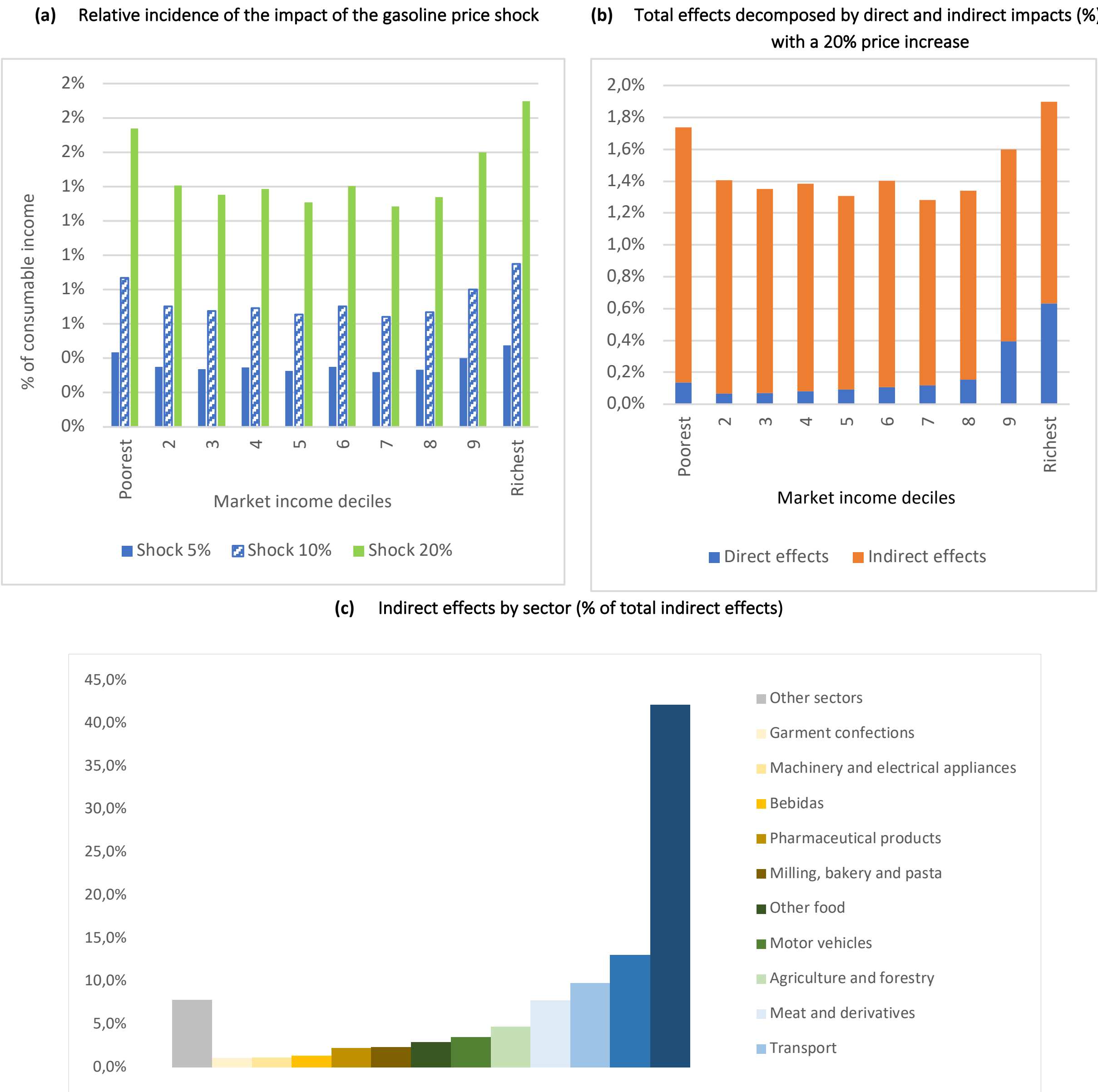


Source: Authors' calculations.

ii. Shocks in diesel prices

The simulation results of increasing diesel prices suggest that the total impact, measured as a share of market income, is slightly higher for those at the top of the income distribution relative to those at the bottom of the distribution (Figure 11, panel a). This result implies that changes in diesel prices, in contrast to gasoline, tend to have more progressive or pro-poor results. Notably, the indirect impact on the poorest households, measured as the share of market income, is significantly higher relative to households in the top decile of the distribution (Figure 11, panel b). Finally, in terms of the impacts of indirect effects on the different economic sectors, the results indicate that the indirect impacts of rising gasoline prices are mostly concentrated in the refined oil and fuel sector, which accounts for 42 percent of the total indirect effects, followed by other services and transport (Figure 11, panel c).

Figure 11 - Simulation results of the impact of higher diesel prices



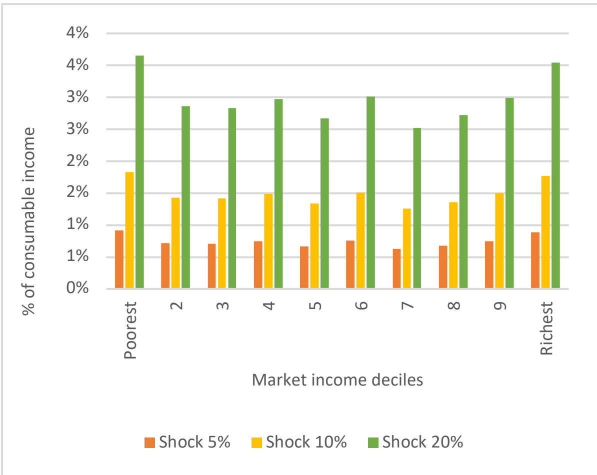
Source: Authors' calculations.

iii. Simultaneous shocks in gasoline and diesel prices

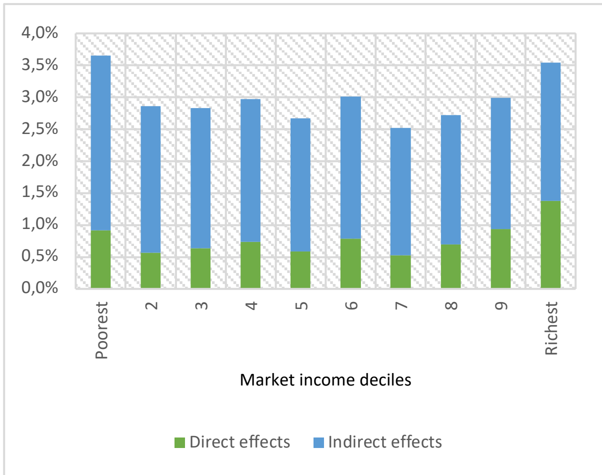
The impacts of a simultaneous increase in gasoline and diesel prices show similar results as those presented for gasoline; however, the magnitude of the impact is larger than expected, particularly for the simulation where prices increase by 20 percent. The total impact, measured as a share of households' market income, is slightly higher for poorer households than richer ones (Figure 12, panel a), indicating that simultaneous increases in gasoline and diesel prices tend to be biased toward impacting the poor more disproportionally. The impact of indirect effects is consistent with this implication because the indirect impact of increasing gasoline and diesel prices is larger for the poorest households (Figure 12, panel b), through the impact on the sectors of other services, meat and derivatives, and transport (Figure 12, panel d).

Figure 12 - Results of the impact of higher gasoline and diesel prices

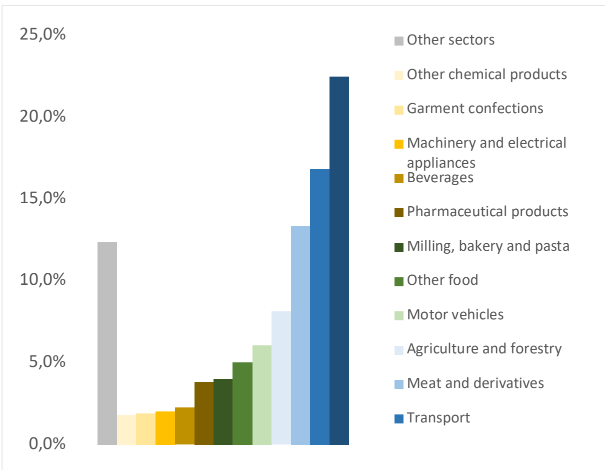
(a) Relative incidence of the impact of a shock on gasoline and diesel prices



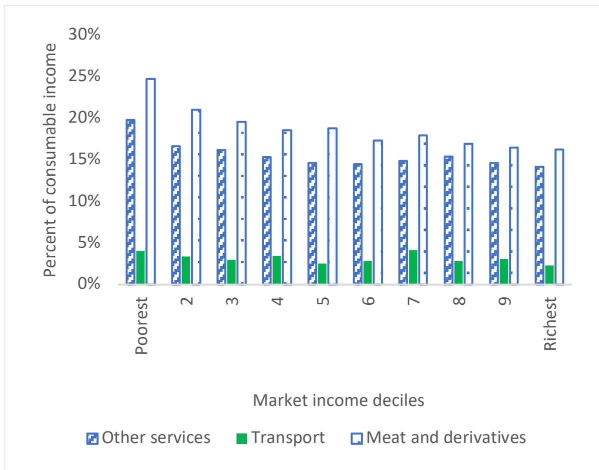
(b) Total effects decomposed by direct and indirect effects by income decile (%), with a 20% price increase



(c) Indirect effects by sector (% of total indirect effects)



(d) Indirect effects for top three impacted sectors by income decile (%)



Source: Authors' calculations.

b. Impacts on poverty and inequality

As presented in the subsections above, the total impacts of increasing diesel and gasoline prices are higher for households at the bottom of the income distribution, and thus, can have significant consequences for poverty in the country. This section presents the results of the simulations of estimated poverty rates in each scenario considered in this study.

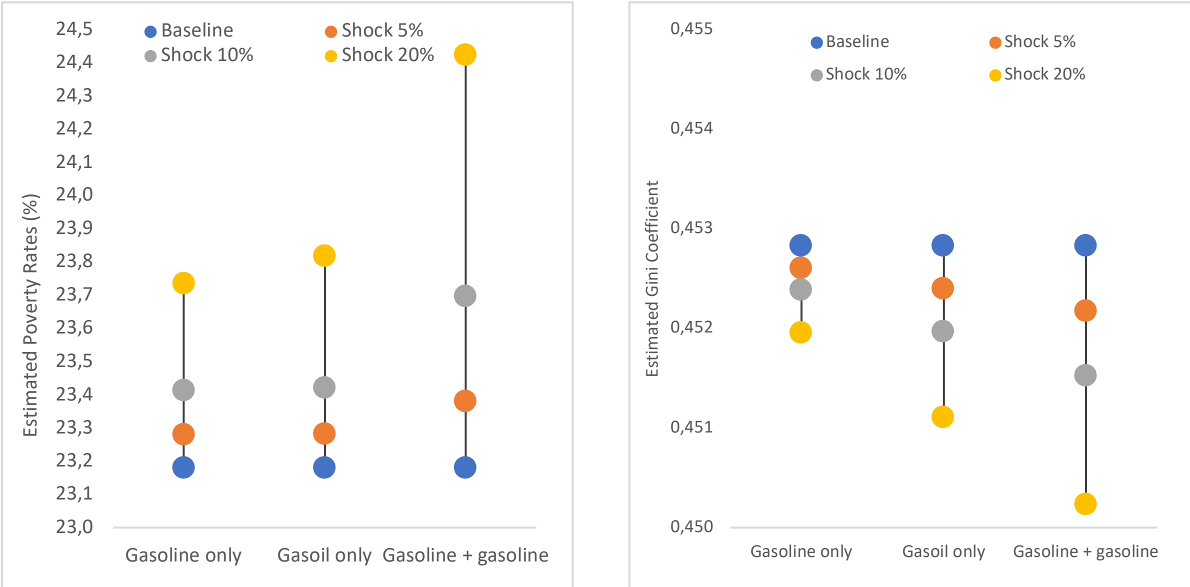
Figure 13 below presents the baseline poverty rate and the estimated poverty rates based on the three scenarios considered in this study, which include increases in gasoline prices alone, diesel prices alone, and simultaneous increases in both prices. The results indicate that increases in gasoline prices alone, for instance, by 20 percent, could lead to an increase in the poverty rate from 23.2 to 23.74 percent, resulting in an increase of 0.55 percentage points in the poverty rate of Paraguay.[7] The simulation of increasing diesel prices yields results that vary slightly only in magnitude. For example, an increase in the price of diesel, holding everything else constant, leads to an increase of 0.64 percentage points in the poverty rate. Finally, when the prices of both fuels rise by the same percentage, we observe a larger increase in poverty. For instance, an increase of 20 percent in gasoline and diesel prices leads to an increase in the poverty rate on the order of 1.24 percentage points.

In terms of inequality, the Gini coefficient, a measure of income inequality, decreases in all of our simulations. This suggests that income inequality tends to improve when fuel prices increase. However, in our simulations, the greatest reduction in the Gini coefficient is observed with the simultaneous increase of diesel and gasoline prices is in the order of 20 percent. In this case, the Gini coefficient only falls by 0.003 points—therefore, the impact is negligible. Nevertheless, further increases in the prices of fuels could lead to a significant equalizing effect on the income distribution if current consumption patterns remain the same. This effect could be explained by the patterns of consumption across the distribution of income (or consumption): richer households tend to consume, on average, a higher share of fuels relative to their total consumption compared to poorer households.

[7] Note that the poverty rate simulated by applying the CEQ approach might not necessarily match the official rates of the country.

Figure 13 - Impacts on poverty headcount and the Gini coefficient

(a) Estimated poverty rates **(b)** Estimated Gini coefficients



Source: Authors' calculations.

In addition to providing the results described above, we complement our analysis by calculating synthetic indices of redistributive effects. These indices comprise the Kakwani coefficient, a measure of progressivity, and the marginal contribution, which measures the individual contribution to the reduction (increase) of poverty and inequality of a given shock. The results of these indices are presented in Table 5. The regressive and pro-rich profile findings of increasing diesel and gasoline prices are consistent with the results from calculating the synthetic indices. First, the results of the Kakwani coefficient show a negative sign for every shock simulated, which indicates that a more equitable income distribution could be reached with higher fuel prices. While the magnitude of the coefficient does not vary for the scenarios considered, a larger index would imply that the shock of interest is more regressive (or progressive, depending on the sign). Second, the results of the marginal contribution suggest an increase in the poverty rate and a reduction in inequality, which are consistent with our previous findings.

Table 4 Results of synthetic indices of redistributive effects

	Shock 5%	Shock 10%	Shock 20%
Marginal contribution to poverty headcount	0.003215	0.005429	0.011663
Marginal contribution to Gini	-0.000359	-0.000712	-0.001394
Kakwani	-0.067224	-0.067224	-0.067224

Source: Authors' calculations.

6. Conclusions

The current context of increasing fuel prices raises questions about the potential effects of such shocks, in particular on the most vulnerable populations. In this paper, we explore consumption patterns based on household survey data and assess the potential redistributive effects of increases in fuel prices across three scenarios: (a) increases in gasoline prices, on the order of 5, 10, and 20 percent; (b) increases in diesel prices, on the order of 5, 10, and 20 percent; and (c) simultaneous increases in gasoline and diesel prices, on the order of 5, 10, and 20 percent. This analysis aims to contribute to an evidence-based discussion of the potential ex-ante effects of higher fuel prices.

The results presented in this paper suggest that increases in fuel prices in Paraguay tend to have regressive effects, as, on average, the poorest households tend to be disproportionally impacted. By fuel type, our results indicate that shocks in the prices of gasoline tend to be more pro-rich or regressive, while shocks in diesel prices tend to have more-progressive or pro-poor results. When both prices increase simultaneously and at the same rate, however, the regressive effects dominate.

However, the effects on inequality indicate that higher fuel prices tend to have equalizing effects on income distribution. That said, given the rate of price increases considered in the simulations, the effects are negligible.

Finally, while our analysis and results are subject to some assumptions and do not incorporate the effects of other wider reforms ongoing in the country, we provide informative results on the economic impact of the higher fuel prices and their direct, indirect, and induced effects across all other industries.

References

Arndt, C., R. Benfica, N. Maximiano, A. M. Nucifora, and J. T. Thurlow. "Higher fuel and food prices: impacts and responses for Mozambique." *Agricultural Economics* 39 (2008): 497-511.

Aziz, S., M. R. Yaseen, and S. Anwar. "Impact of rising energy prices on consumer's welfare: a case study of Pakistan." *The Pakistan Development Review*, 2016: 605-618.

Chakravarty, S., and A. Mitra. "Growth, Prices and Poverty." *Journal of Modelling & Simulation of Systems* 1, no. 4 (2010).

Choe, Chongwoo, and Imad A. Moosa. "A Dynamic Forecasting Model of Oil Demand in Developing Countries." *The Journal of Energy and Development* 23, no. 2 (1998): 195-206.

Coady, Mr David, Valentina Flamini, and Louis Sears. *The unequal benefits of fuel subsidies revisited: Evidence for developing countries*. International Monetary Fund, 2015.

Ersado, L. "Poverty and distributional impact of gas price hike in Armenia." *World Bank Policy Research Working Paper No. 6150*, 2012.

Gillingham, Mr Robert. "Poverty and social impact analysis by the IMF: Review of methodology and selected evidence." (2008).

Lustig, Nora, ed. *Commitment to equity handbook: Estimating the impact of fiscal policy on inequality and poverty*. Brookings Institution Press, 2018.

Medinaceli Monrroy, Sergio Mauricio. "Subsidio al precio del Gas Licuado de Petróleo en Bolivia." *Revista Latinoamericana de Desarrollo Económico* 1 (2003): 99-133.

Muthalib, A. A. "The influence of fuel prices and unemployment rate towards the poverty level in Indonesia." *International Journal of Energy Economics and Policy* 8, no. 3 (2018): 37-42.

OECD. *Multi-dimensional Review of Paraguay Volume 1. Initial Assessment.* OCDE Development Pathways, 2018.

STP. *Plan Nacional de Desarrollo 2030.* Asuncion: Secretaria Tecnica de Planificacion, 2014.

Van Buuren, Stef. *Flexible imputation of missing data*. CRC press, 2018.

White, Ian R., Patrick Royston, and Angela M. Wood. "Multiple imputation using chained equations: issues and guidance for practice." *Statistics in medicine* 30, no. 4 (2011): 377-399.