Tax exemption in Brazil in 2009: why vehicles and not agriculture? An interregional general equilibrium analysis

Leonardo Coviello Regazzini, Carlos José Caetano Bacha and Joaquim Bento de Souza Ferreira Filho

Abstract

Tax exemption has been used systematically in Brazil to stimulate the economy. In 2009, in an attempt to stem the economic slowdown, the Brazilian government adopted a countercyclical economic policy that included lowering taxes on vehicle prices. Why was this sector chosen rather than another? This article seeks to analyse the effects of this policy on the Brazilian economy in 2009, using as a counterfactual a tax exemption policy targeted on the agriculture sector. Based on an interregional computable general equilibrium model (TERM-BR), the two policies are simulated and compared. The results show that lowering taxes on agricultural products can be considered superior to an equivalent tax reduction for vehicles, in terms of the effects on employment, income, household consumption, GDP and, especially, the distribution of economic activity across the regions of Brazil and the income distribution.

Keywords

Fiscal policy, taxation, tax exemption, automobile industry, agriculture, economic development, regional development, income distribution, macroeconomics, econometric models, Brazil

JEL classification

C68, H25, R58

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I. Introduction

In recent decades particularly, the Brazilian government has adopted temporary tax and contribution reduction policies aimed at protecting its economy from the fallout of international economic crises (especially in terms of the level of production and, as a result, employment and prices). Most of these policies have covered only a few sectors of domestic industry, including automobiles and the "white goods" industry (refrigerators, washing machines and household appliances in general).

The use of tax exemption (also referred to as tax reduction or tax relief) as a mechanism to protect the economy is grounded in economic theory. Since the mid-1930s, economists have believed that expansionary fiscal policies —such as cuts in taxes and contributions or increases in public spending— can have significant short-term effects on the main macroeconomic variables (such as employment, income and inflation). This is because policies of this type would directly influence aggregate demand.

Tax exemption —specifically eliminating or lowering the rates of taxes and indirect contributions that affect the sale of goods and services— has a direct impact on the main macroeconomic variables, since it causes the price received by the seller to rise (and, therefore, improves business profitability), or lowers the price paid by the consumer. The equilibrium level of production also rises, which boosts employment and real wage levels.

In terms of its direct effects on the economy (not forgetting that government functions have to be funded), any tax exemption policy is therefore welcome. However, as the design of the national tax system can have significant effects on other important indicators (such as employment, inflation, the external accounts, fiscal revenues, the income distribution and regional balance), some tax exemption policies may not only be more effective than others in promoting lower prices and higher employment but may also have more positive effects on other economic indicators.

As was discovered years later, the choice of the automotive sector for tax relief in Brazil in 2009 was not a purely economic decision. In economic terms, one might think that reducing taxes and contributions on agricultural products would have more positive effects on the regional income distribution and inequality than the same policies targeting the automotive industry. The reasons would be the following: (i) the agriculture sector employs less-skilled labour; (ii) agricultural products represent a larger share in the consumption basket of lower-income families; (iii) agricultural production is of major importance in all states of the federation, especially the poorest ones; and (iv) agricultural and agribusiness products have become more important in Brazil's trade balance.

A study that can identify the differential impact on the national economy of a tax reduction policy benefiting the automotive industry, as adopted from the late 2000s until the early 2010s, compared to one that favours agriculture, could be highly valuable in the analysis of the fiscal policies adopted by the Brazilian government in recent years. It could also inform the formulation of future tax policies.

Accordingly, the aim of this article is to compare the economic and social effects of tax exemption policies targeting the automotive industry in 2009 with those that could have targeted the agriculture sector in the same year. These effects include traditional macroeconomic variables (production, employment, wages and price levels), as well as other equally important elements, such as the income distribution and the concentration of economic activity between regions. The aim is, therefore, to evaluate a past experience (of choosing sectors to be stimulated through tax reduction) which may be considered again in the future, especially given the need to revive the economy after the crisis caused by the coronavirus disease (COVID-19) pandemic.

This comparative analysis uses an applied interregional computable general equilibrium (CGE) model, with 2009 as the base year —the year in which the tax exemption policy was implemented in depth in Brazil. The model makes it possible to analyse the effects of policies (such as taxation) on

other variables, such as the income distribution (through their impacts on consumer price indices at each income level), and regional balance, in other words the share of the various federative units in Brazilian GDP.

Even when they target certain sectors only, the effects of changes in tax policy can propagate throughout the economy; so any analysis of their impacts must consider the economy as a whole. A CGE model makes it possible to do this.

II. Literature review

There are various studies in the literature that seek to analyse the effects that changes in tax policy have had on the Brazilian economy. Many of them, including those by Varsano and others (2001), Siqueira, Nogueira and Souza (2001), and Kume (2004), use a partial equilibrium approach and seek to measure only the direct impact of the tax changes.

Given their characteristics, general equilibrium models have been used widely to analyse the impact of tax policy changes. Shoven and Whalley (1972 and 1973) were the first to visualize this possibility; and following the first applied study using this methodology (Whalley, 1977), the methodology began to disseminate. In the belief that equity is a desirable feature of an "ideal" tax system, Adelman and Robinson (1978) seek mechanisms to analyse factors such as the effects of changes in tax policy on the income distribution in developing countries. Dervis, De Melo and Robinson (1982) apply this methodology to developing countries whose economies have specific characteristics. Ballard and others (1985) develop a general equilibrium model to analyse taxation in the United States (known as the Ballard, Fullerton, Shoven and Whalley (BFSW) model). This work has been supported by a succession of taxation studies that have appeared since. For example, Shoven and Whalley (1992) discuss how general equilibrium models can be used to structure public policies; Berck, Golan and Smith (1996) used a general equilibrium model to study the economy of California; and Fehr (2000), Baylor and Beauséjour (2004) and Ahmed, Ahmed and Abbas (2010) used general equilibrium models to study the economies of Germany, Canada and Pakistan, respectively.

In the case of Brazil, major studies have used general equilibrium models to analyse fiscal and tax policy. Pioneering papers include Sousa (1985, 1987 and 1993) and Sousa and Hidalgo (1988), who estimated the impacts of changes in tariff protection on a set of macroeconomic variables (including output, prices and others). Subsequently, Araújo and Cavalcanti (1999) and Lledo (2005) investigated the economic effects of tax reform measures implemented between the late 1990s and the early 2000 decade. Araújo and Ferreira (1999) use a dynamic general equilibrium model, with an infinite lifetime agent, to compare the efficiency of the measures in the long run. Lledo (2005), in contrast, uses an overlapping generations general equilibrium model to analyse the effects of the measures on the distribution of income across generations. Fochezatto (2003) also evaluates the effects of tax reform, but in a more general context, analysing its effects on growth and the income distribution.

In Brazil, five different taxes and contributions are levied on the sale of goods and services and affect their prices. These are: (i) the Goods and Services Sales Tax (ICMS); (ii) the Industrialized Products Tax (IPI); (iii) the Social Integration Programme/Civil Servant Asset Formation Programme (PIS/PASEP) (iv) the Social Security Funding Contribution (COFINS); and (v) the Tax on Services (ISS). These five levies are equivalent to value added tax (VAT) in other countries. There is also a contribution levied specifically on agricultural activity: the Rural Workers Assistance Fund (FUNRURAL). These six charges are referred to as commercial taxes and contributions, and Bacha (2016) describes how they operate in Brazil.

Silva, Tourinho and Alves (2004) analyse the effects of the transformation of COFINS into VAT and the incidence of PIS/PASEP and COFINS (both approved in 2003) on imports. These authors also studied the effects of the abolition, in 2007, of the Provisional Contribution on Financial Movements (CPMF).[1] Salami and Fochezatto (2009) analyse changes in tax revenue through an overlapping generations model for long-term analysis. Similarly, Paes (2012) uses a general equilibrium model incorporating the external sector to analyse the effects of the abolition of the industrial employer's contribution on exports, among other variables.

The studies referenced above use models that consider the Brazilian economy as a single region, which does not make it possible to analyse the regional-balance effects of shocks derived from tax changes. Regional analyses for Brazil first appear in the works of Fochezatto (2002), Domingues and Haddad (2003), Porsse (2005), Paes and Bugarin (2006), and Palermo, Porsse and Portugal (2010).

Other studies, including those by Ponciano and Campos (2003), Santos (2006), De Souza, Petterini and Miro (2010) and Paes (2012), specifically analyse taxation by sector, including the automotive industry and the agriculture sector, but considered separately. The present article makes two contributions in relation to these studies: (i) a comparative evaluation of the effects of similar tax exemption policies applied to two sectors (the automotive industry compared to the agriculture sector); and (ii) an analysis of the regional effects of lowering taxes on the two sectors, and in particular on income inequality between the regions of Brazil.

III. Methodology

Computable general equilibrium models are representations of real economies that connect producers and consumers —among other agents— with their respective markets. They consist of a set of equations that simulate the relations that exist between the various agents in the economy and, unlike input-output models, require both the demand and the supply side to be specified. By considering the transactions made between the various economic agents and by modelling their behaviour, CGE models are able to capture both the direct and the indirect effects arising from economic shocks such as tax breaks for eligible sectors. Accordingly, CGE models are used to simulate exogenous events, including government policies. The ability to observe both direct and indirect effects, as well as induced effects, is essential for analysing the impact of a cost-of-living shock on families of different income levels, for example.

To analyse the effects of different tax relief policies on the Brazilian economy, this paper performs simulations using an applied bottom-up interregional general equilibrium model, known as The Enormous Regional Model (TERM) adapted to the Brazilian economy (TERM-BR). This model is based on the TERM developed for the Australian economy (Horridge, Madden and Wittwer, 2005), which was adapted by Ferreira and Horridge (2006) to analyse the Brazilian economy. It is a Johansen-type model, of the Australian school, which uses linearized non-linear equations, so that the solutions are presented in the form of percentage variations. The modelling thus allows for a comparative-static analysis.

The "Australian school" of CGE modelling originated in the 1970s when the ORANI model was developed (Dixon and others, 1997). Over the years, the growing demand for regionalized information led the authors to develop regionally disaggregated models, designed with a top-down approach. The top-down models have since been refined by a second generation of "bottom-up" models, so called because they are structured from the base upwards, that is with behavioural equations and parameters defined for regional agents. Each region is thus represented as a complete national economy, which is related to others (trade flows between regions, as well as origins and destinations, are added to the model); and national results are obtained by aggregating the provincial results.

[1] This was a flat charge on every bank withdrawal.

These models require a much larger amount of data and may run into computational constraints when there are many sectors and regions (Horridge, Madden and Wittwer, 2005). The TERM model has been developed to address this problem, with a more compact data structure based on several simplifying assumptions. The main assumption is that all products are regionally pooled, irrespective of the user (or region) acquiring them. In other words, instead of each user in each region purchasing a given product 'c' from nearby regions, the model assumes that all users in a given region 'd' purchase product 'c' from all producing regions, in proportion to each producing region's share in the purchases of all users in region 'd'. For example, the share Minas Gerais share in all autoparts purchased by the São Paulo automotive industry is assumed equal to the Minas Gerais share of autoparts purchased by São Paulo families.[2]

Based on the above, this article performs an analysis through TERM-BR. This model is an adaptation of TERM developed in 2005 for the analysis of the Brazilian economy, and which has previously been used for similar purposes by Santos (2006). To make the model suitable for the purposes of this study, the following need adjustment: the level of aggregation (that is, the number of elements in the main sets); the way the model describes taxes; the regional shares in sectoral production; and, of course, the data used, which come from different periods.

The models used make it possible to capture endogenous variations in the tax base, resulting from changes in tax or contribution rates, in addition to the effects of such variations. It is thus possible to observe not only the direct (first order) effects on tax collection caused by the change in tax rates, but also the indirect (second order) effects associated with the change in the tax base resulting from this change.

Apart from making it possible to identify the second order effects, the change in the tax base is fundamental for the entire estimation of the model's results, since this forms the basis for updating all of the model's matrices. This, in turn, makes it possible to identify the effects of tax rate changes not only on tax revenues, but also on all the other economic variables observed.

The specification used in this study encompasses 15 products; two origins (domestic or imported); two types of margin (trade and transport); 10 occupation levels (classified according to the wage categories of the Household Budget Survey (POF); 15 sectors and four final demanders (totalling 19 users); 27 regions of origin (26 states and the Federal District); 27 regions of destination and 27 margin-producing regions.

Detailed descriptions of the model's supply and demand structures, as well as the process of building its databank, can be found in Santos (2006), Fachinello (2008), Moraes (2010) and Santos (2013). The latter also provides a detailed description of the database updating process used in this study.

1. Closure of the CGE model

In applied general equilibrium models, consistency requires opposing macroeconomic aggregates to be in equilibrium. This means that the equilibrium conditions between saving and investment, government spending and revenues, and capital inflows and outflows must be respected. The way in which an applied general equilibrium model determines these equilibrium conditions is called "closure". When macroeconomic aggregates behave very differently in the short and long runs, the short and long run closures of the model also have different characteristics.

Kehoe and others (1988) argue that changes in indirect tax rates usually produce their effects after a relatively long period. Long-term analyses therefore afford a clearer view of the policy effects on economic variables, once equilibrium has been established after all transitory effects and all direct and

[2] São Paulo and Minas Gerais are Brazil's two leading provincial economies.

indirect impacts have been manifested and played out (Silva, Tourinho and Alves, 2004). However, the tax reduction policies adopted by the federal government in Brazil, which are analysed in this paper, were not permanent, but circumstantial. They were not even backed by law, but were established by decree and could be revoked —as, in fact, happened, when the need for short-term fiscal adjustment gave rise to new circumstances. It is therefore understood that tax relief policies have been adopted in Brazil for their potential short-term effects, but without considering a horizon of ten years or more. Accordingly, this article observes the effects of these exemption policies based on short-term closure characterized by the following factors.

- The stock of fixed capital is constant at all levels (sectors and regions).
- Each production sector's investment varies according to its income.
- Population and real wages are fixed at all levels (exogenous variables). Increases in labour demand are met through reductions in the unemployment rate (endogenous variable).
- Government expenditures are held fixed in real terms. In other words, it is assumed that the tax breaks are financed by reducing the primary surplus or increasing public debt, but not by cutting government expenditures.
- Real family consumption is an endogenous variable, at all levels.
- The trade balance outturn is an endogenous variable. In the short run, trade deficits can be financed through foreign savings, and surpluses can be converted into reserves.
- Technology shock variables are exogenously determined.
- The nominal exchange rate serves as the model's *numéraire*. The consumer price index (CPI) is determined within the model (endogenous variable).

2. Effects on regional inequality

To analyse the effects of simulated tax exemption policies on income inequality among Brazilian states, this study uses Theil's L index. The Theil-L index is highly suitable for analysing regional inequality and has been used in several published studies (see, for example, Ferreira and Diniz (1995), Azzoni (1997 and 2001), Ferreira (1998), Esteban (2000), Beblo and Knaus (2001), and Cavalcante (2003)).

Mathematically, Theil's index can be expressed as follows:

$$J = \sum_e \left(\frac{N_e}{N}\right) ln\left[\frac{N_e}{N} \Big/ \frac{P_e}{P}\right] = \sum_e n_e ln j_e \qquad (1)$$

Where:

N_e = Income of state e;

N = National income;

P_e = Population of state e;

P = National population;

J_e = State e share in national income relative to its share of national population.

The Theil index can be used to measure the level of inequality between the country's different states (and not just between the largest and the smallest, as is the case with the per capita income ratio, another frequently used indicator). The observed value of the Theil index can vary between zero and log N (Conceição and Galbraith, 1998).

3. Effects on income distribution

Income distribution and welfare effects can be analysed in different ways in CGE models. This paper does so by observing the behaviour of consumer price indices for different income groups and labour demand at different wage levels.

The indices are constructed from values observed in the model and are of the Laspeyres type (the same methodology as used to calculate the main price indices in Brazil). The variation in the cost of each consumer price basket is fundamentally associated with the variation in prices in the economy, which the model itself should identify from the simulated shocks. There are 10 income levels, based on the Family Budget Survey (POF) classification. The price indices were constructed on the basis of the share of each good in the consumption basket of each income bracket in each state, using data from the 2008/2009 POF (IBGE, 2009).

The results generated by the model make it possible to observe the behaviour of labour demand at different wage levels in each of the simulations. This approach has been used by various authors, including Ferreira and Horridge (2005), Santos (2006), Fachinello (2008), Moraes (2010), and Santos (2013). A greater increase in the demand for labour at lower income levels, than at higher ones, is expected to reduce unemployment relatively more among the less skilled economically active population in the short run. In the long run, however, the wage gap between higher and lower skilled workers will narrow.

4. The simulations

To analyse the effects of potential tax relief policies targeting the agriculture sector, compared to those that have actually been deployed in the automotive industry, simulations were performed of a reduction in taxes and contributions in each sector. A tax reduction totalling R$ 3.634 billion was assumed in both cases, to make the comparison possible. The amount in question was the estimated annual cost of the tax relief actually granted to the automotive industry by the Brazilian government in 2009, to combat the recessionary fallout from the real estate crisis in the United States (IPEA, 2011).

The tax exemption for vehicles is simulated by reducing the amount of industrial product tax (IPI) collected by the automotive industry (mirroring what actually happened in 2009); and in the case of agricultural products, the taxes selected are PIS, COFINS and FUNRURAL, since agricultural products are exempt from IPI, and the tax with the greatest impact on the sector (ICMS) is not under federal jurisdiction. So, a reduction in PIS, COFINS and FUNRURAL is the alternative policy that could have been applied to agricultural activity.

The effects of two alternative tax relief scenarios are thus compared. The first scenario is the actual reduction of R$ 3.634 billion in IPI on products sold by the domestic automotive industry. The second scenario is a potential reduction, also of R$ 3.634 billion, in the amount of PIS, COFINS and FUNRURAL levied on crop and livestock products sold in Brazil. In both cases, the reduction is distributed proportionally, both across all products sold and among all regions in which the sectors in question are present.

IV. Results

1. Impacts on the macroeconomic aggregates

Table 1 reports the main results of the simulations in terms of macroeconomic aggregates. All of them refer to the short-term simulations described above, which aim to analyse the effects of shocks over a period of approximately one to two years.

Table 1
Variations in the main macroeconomic aggregates in response to tax relief for the agriculture sector and the automotive industry
(Percentages)

	Tax relief for the agriculture sector	Tax relief for the automotive industry
Real GDP	0.184	0.179
Real household consumption	0.349	0.269
Real private investment	0.244	0.328
Real government expenditure	0.000	0.000
Exports (volume)	-0.390	-0.072
Imports (volume)	0.422	0.503
Aggregate employment	0.332	0.280
Real average wage	0.000	0.000
Capital stock	0.000	0.000
GDP deflator	0.312	0.186
Consumer price index	0.303	0.184
Population	0.000	0.000
Nominal household consumption	0.653	0.453
Nominal GDP	0.497	0.366

Source: Prepared by the authors, on the basis of the model simulation results.

First, the effect of lowering taxes on agricultural products boosts real GDP (growth of 0.184%, which is slightly more than the effect of an equivalent tax break for vehicles (+ 0.179%). An analysis of the behaviour of the components of GDP shows that the main factor responsible for this advantage is household consumption, where the effect of the tax break for the agriculture sector (an increase in consumption of 0.349%) is significantly greater than the effect of the same tax relief granted to the automotive industry (+ 0.269%). This difference stems mainly from the labour intensity of agricultural activity (and, consequently, the sectoral wage bill), which is much higher than in the automotive industry. An increase in agricultural output therefore has a greater effect on income and, hence, on household consumption.

The opposite is true in the case of private investment (increases of 0.244% and 0.328% resulting from tax reductions for the agriculture sector and the automotive industry, respectively). However, this component has a much smaller share in GDP, so the effects on consumption predominate.

The tax cuts, and the resultant economic uptick, have an impact on Brazilian exports and imports. The reallocation of factors of production to meet growing domestic demand reduces exports in both scenarios. Since the tax reduction in the agriculture sector produces a greater economic stimulus, and the goods produced by this sector represent a large share of domestic demand, this scenario caused a steeper reduction in exports (a drop of 0.390%), while the export effects of the tax break for the automotive industry are more modest (a reduction of 0.072%).

In terms of the effect on imports, table 1 shows that reducing the tax on vehicles has a greater effect on Brazilian imports than the tax break for agricultural products (increases of 0.503% and 0.422%, respectively). Figure 1 identifies the sectors for which imports vary by most in each case. In both cases, the only sectors that report a reduction in imports are those in which taxes are lowered, since this makes the products in question more competitive with imported substitutes. For all other sectors, there is a slight increase in imports, as a result of the uptick in economic activity and income generated by the tax reduction.

Figure 1
Variation in imports in response to tax relief for the agriculture sector and the automotive industry, by sector
(Percentages)

Source: Prepared by the authors, on the basis of the model simulation results.

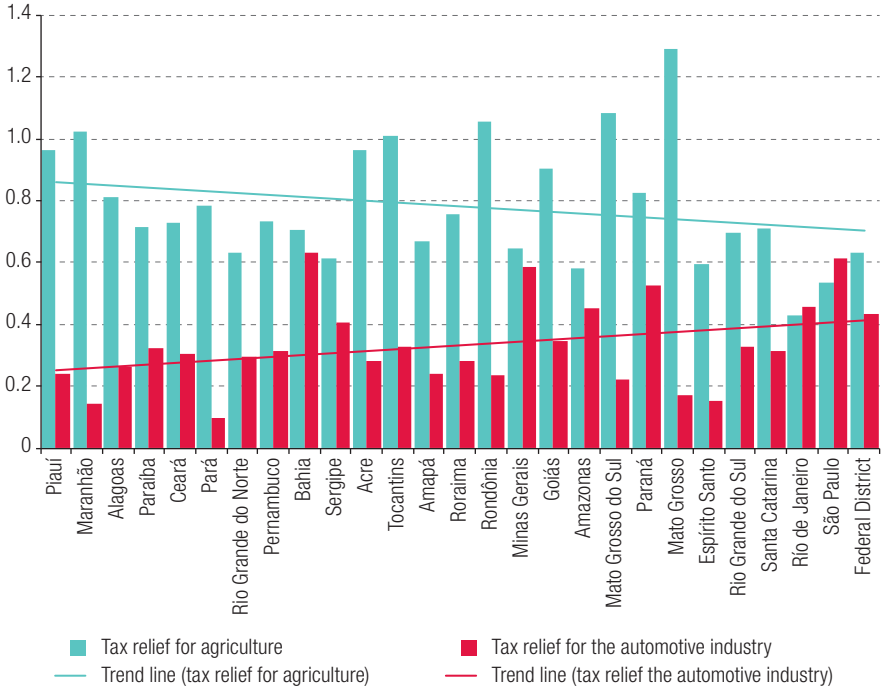
In general, the tax exemption generates higher imports in all sectors of the economy, except for those actually receiving the relief, where imports drop sharply. In the case of agriculture, sectoral imports decrease by 5.08%, whereas in the automotive industry vehicle imports fall by 9.56%. In the latter case, there was also an increase of 4.69% in imports of autoparts, owing to the increased output of the domestic automotive industry and, consequently, in the demand for parts.

Lastly, as agriculture is the more labour-intensive sector, lowering taxes in that sector boosts employment by more than the tax break for the automotive industry (+0.332% compared to +0.280%, respectively). This includes direct, indirect and induced employment —in other words, jobs created in all sectors of the economy as a result of the shocks, and not just in the sectors receiving the relief.

2. Regional impacts

Figure 2 reports the variation in total real factor remuneration for each Brazilian state under the two simulations. To analyse the impact of the shocks on the regional concentration of economic activity in Brazil, the states were ranked in ascending order by per capita income during the period in question. A trend line was drawn for each scenario to facilitate interpretation of the figure.

Figure 2
Variation in real total factor remuneration, in Brazilian states ranked in ascending order by per capita GDP
(Percentages)



Source: Prepared by the authors, on the basis of the model simulation results.

Although the effects generated by the two simulated shocks differ only slightly in terms of the behaviour of macroeconomic aggregates, this is not the case when the impacts are considered from a regional perspective. As agricultural activity is more spatially dispersed than the automotive industry, the tax relief for agriculture affects all Brazilian states. As many of these states have low levels of economic activity, the percentage variations are quite large (see, for example, the states of Mato Grosso, Rondônia, Tocantins and Maranhão).

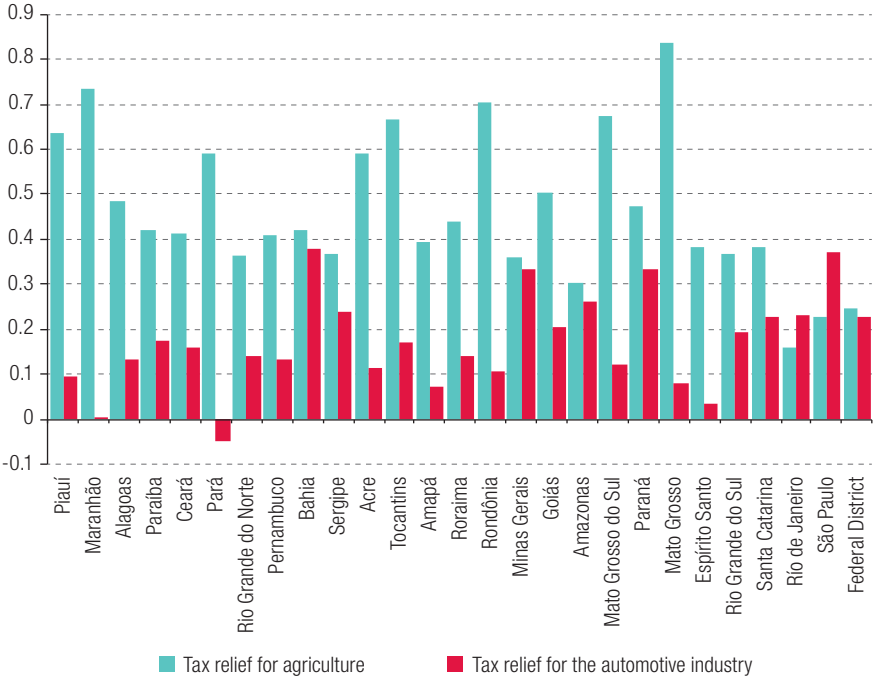
The trend lines show that, while the tax reduction for the agriculture sector produces stronger effects on total factor remuneration in the poorest states, the opposite occurs in the case of vehicles. In the automotive industry, the effects of the tax relief are concentrated in the few states where this economic sector is present. As these are the states with the largest economies (except for Bahia), the effects in terms of percentage variations are smaller.

The percentage variation in factor remuneration in the states is mirrored by the behaviour of labour demand, as shown in figure 3. Reducing taxes on agricultural products stimulates labour demand the most in the states of Mato Grosso and Maranhão (the latter has the second lowest per capita income in Brazil), whereas cutting the tax on vehicles increases labour demand by most in Bahia and São Paulo (the richest state in Brazil), followed by Minas Gerais and Paraná.

The wage bill also displays similar behaviour since it is directly associated with employment (especially considering the wage rigidity imposed by the closure of the CGE model) (see figure 4).

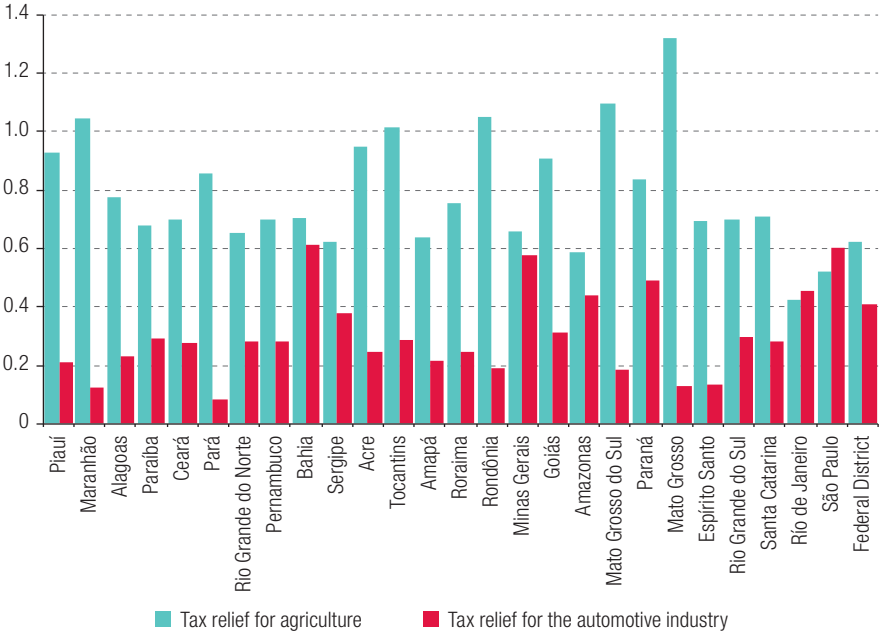
As wages account for the largest share of household income in Brazil, aggregate wage growth fuels an increase in household consumption (see figure 5).

Figure 3
Variation in the demand for labour, in Brazilian states ranked in ascending order by per capita GDP
(Percentages)



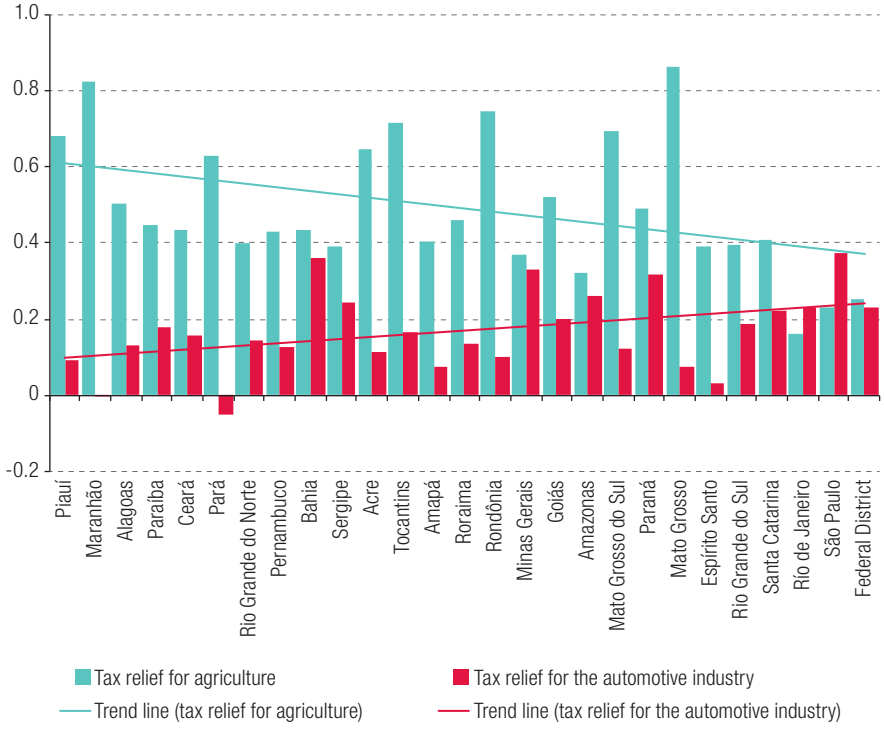
Source: Prepared by the authors, on the basis of the model simulation results.

Figure 4
Variation in the wage bill, in Brazilian states ranked in ascending order by per capita GDP
(Percentages)



Source: Prepared by the authors, on the basis of the model simulation results.

Figure 5
Variation in real household consumption, in Brazilian states ranked by per capita GDP in ascending order
(Percentages)

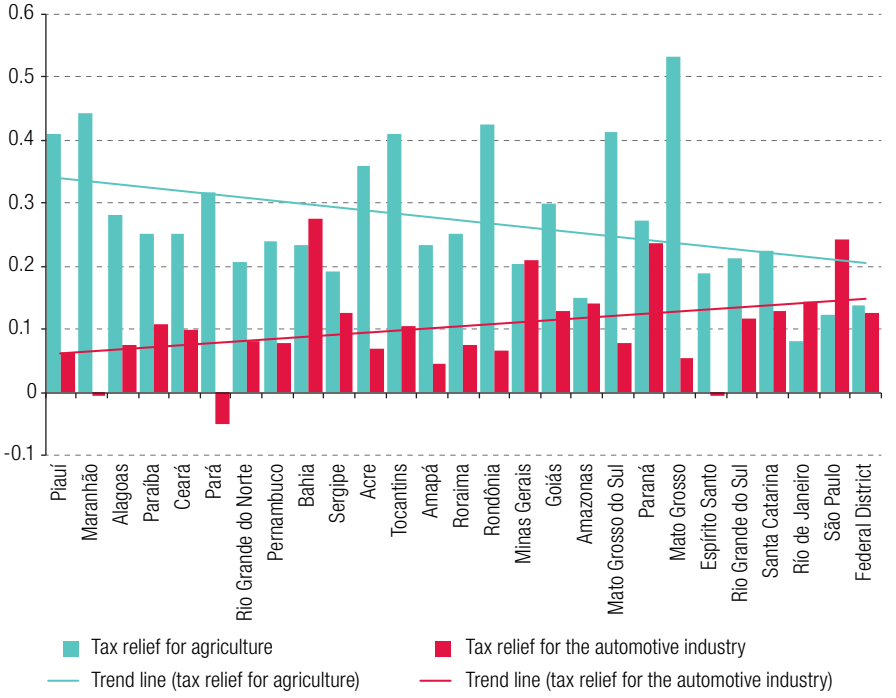


Source: Prepared by the authors, on the basis of the model simulation results.

Lastly, figure 6 reports the results of the two tax relief simulations in terms of real GDP in each Brazilian state. The magnitude of the GDP variations in each state under each scenario, together with the trend lines, show that the two policies have very different effects on the concentration of economic activity. Lowering taxes on agricultural production generates larger increases in GDP in the states with lower per capita income, thereby helping to reduce per capita income differences between states. In contrast, the tax break for the automotive industry leads to greater variations in GDP in the states with higher per capita income, thereby aggravating further the regional concentration of economic activity in Brazil.

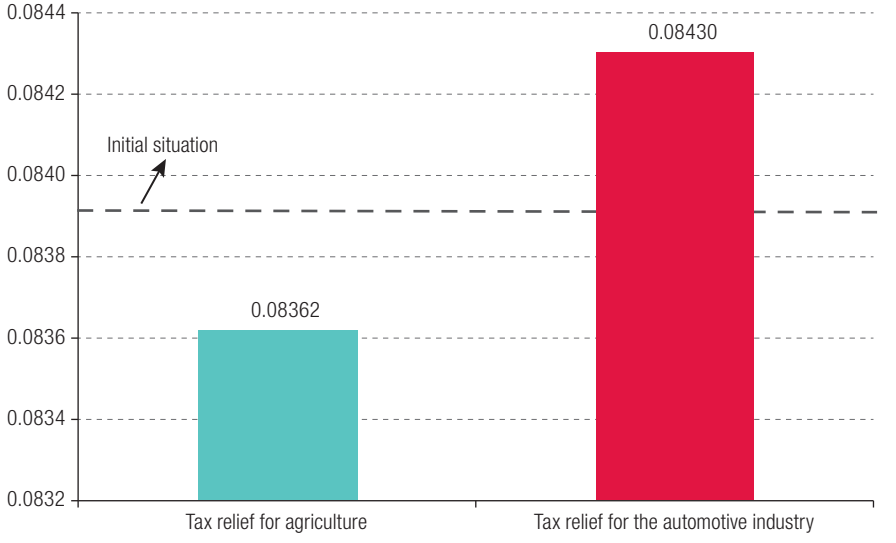
The results obtained by calculating the Theil index, which measures the degree of inequality in the distribution of per capita income between the Brazilian states, confirm the effects noted above (see figure 7).

Figure 6
Variation in real GDP measured through aggregate demand, in Brazilian states ranked in ascending order by per capita GDP
(Percentages)



Source: Prepared by the authors, on the basis of the model simulation results.

Figure 7
Distribution of per capita income among Brazilian states, in the initial situation and after the simulated tax relief scenarios
(Teil index)



Source: Prepared by the authors, on the basis of the model simulation results.

It can be seen that, while tax relief targeted on the agriculture sector produces very positive effects in terms of reducing the concentration of income among Brazilian states, the tax reduction on vehicles has the opposite effect by increasing regional inequality in the country still further. The first scenario results in a 0.43% reduction in the Theil index, while the second produces a 0.39% increase. This reflects the way in which the production activities of the two sectors are distributed across the different Brazilian states. While agriculture is a major player in all states, especially the poorest ones, the automotive industry is concentrated in just a few states, most of which are among the country's wealthiest.

3. Distributive impacts

While higher-wage workers absorb a larger share of the aggregate wages paid by the automotive industry, the opposite is case in agriculture: lower-paid workers receive a larger share of total wage bill in this sector. Thus, a tax break for agricultural products would be expected to generate a relatively larger increase in the demand for labour in the less-skilled and lower-wage job categories. The effect of the tax exemption on the income distribution can be captured by considering the behaviour of labour demand at each of the ten different wage levels. A steeper increase in the demand for lower-paid labour reduces unemployment by more at those levels and creates a long-term trend of significant real wage hikes in the corresponding wage categories. This narrows the gap between the wages of agricultural workers and helps reduce inequality in the individual distribution of income (at least in respect of wages, which generate the largest share of national income). In the long run, lowering taxes on agricultural products can be expected to have a greater positive impact on the income distribution than cutting the tax on vehicle prices. The model used in this paper reveals the impacts of labour demand shocks at each wage level.

The model also makes it possible to analyse the effects of these shocks (the tax exemption on prices) on income inequality, acting through the variation in the cost of living for different groups of people classified according to their income level. Each group has its own average standard of consumption, which is reflected in different average consumption baskets. The model makes it possible to observe and compare how the cost of each of these ten consumption baskets behaves under the two simulated tax break scenarios. This affords a better understanding of which policy generates more positive (or less negative) effects on the cost of living of the poorest families, and which of them produces more positive cost of living effects among the richest families. Since a large proportion of agricultural production consists of food, and food is relatively more important in the consumption basket of the poorest families, lowering tax on agricultural products is likely have more positive effects on the cost of living of families at lower income levels.

It should be noted that the variable used (the cost of a consumption basket) is not the same as agents' income. However, since the importance of income patterns in analysis of economic change fundamentally lies in the possible consumption that a given basket offers to families, then the cost of the goods and services that families consume may not be higher than the amount of their income.

As was the case in the regional analysis, the differences between the effects of the two simulated policies are also significant in distributional terms. Figure 8 displays the impacts on labour demand at the different wage levels.

Figure 8
Variation in labour demand, by wage class
(Percentages)

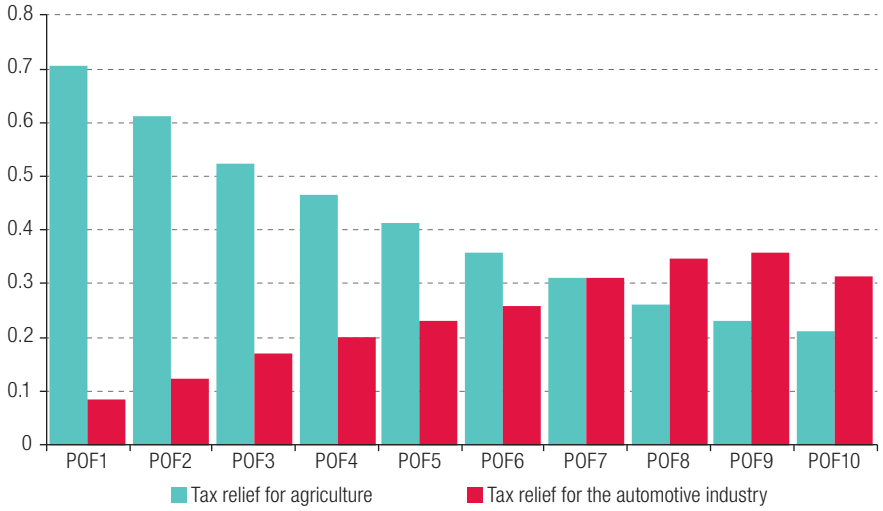
Source: Prepared by the authors, on the basis of the model simulation results.
Note: OCC = Wage classes obtained from the Household Budget Survey.

In eight of the ten defined wage classes, the demand for labour increases by more when a tax break is given to agricultural products than when it is applied to vehicles. The exceptions are the two highest wage brackets, where the demand for labour increases by more when tax relief is provided for the automotive industry than when it is applied to agricultural products. Nonetheless, the difference in this case is very small (growth of 0.290% versus 0.270% at the highest wage level, respectively). In contrast, at the lowest wage levels, the additional labour demand generated by lowering taxes on agricultural product prices is much greater than that resulting from tax relief for the automotive sector (growth of 0.893% compared to 0.088% in the lowest wage group, and 0.850% compared to 0.089%, respectively, in the second lowest group). In other words, tax relief on agricultural activity boosts labour demand by more, especially among the lower paid —that is, the poorest families.

These results are very important because it is precisely at the lowest wage levels that the poorest workers are found. The increase in the demand for labour in these groups, therefore, plays an important role in boosting the incomes of the poorest families and improving the pattern of income inequality across the country. Estimating the magnitude of these effects through the statistical measures used to analyse income inequality, such as the Gini coefficient, could be the subject of future research.

Figure 9 shows the behaviour of real household consumption in ten different income groups. It is reasonable to assume that the scenario that produces stronger effects on labour demand at the lowest wage levels will also have stronger effects on income and, consequently, on consumption by lower-income families.

Figure 9
Real household consumption, by income level
(Percentages)

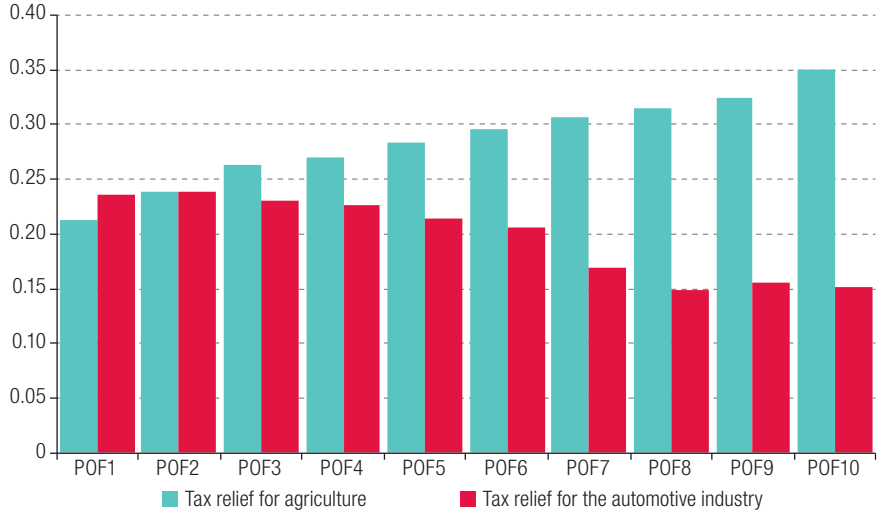


Source: Prepared by the authors, on the basis of the model simulation results.
Note: POF = Family Budget Survey.

In fact, in addition to a significantly greater increase in real household consumption nationwide, reducing the tax on agricultural product prices has more positive effects for lower-income families. In contrast, the effects of lowering the tax on vehicles are more concentrated in those with higher average incomes.

Lastly, figure 10 shows how the cost of living, measured through the consumer price index (CPI), varies for ten different income groups. As explained above, the CPI impact of the tax relief tends to be greater for the agriculture sector than for vehicles, because the first shock generates a larger increase in aggregate demand. Thus, the CPI variation benefits most income groups. The exceptions, however, are precisely those at the lower income levels. At the two lowest income levels (POF1 and POF2), cutting taxes on agricultural products is preferable to reducing the tax on vehicles, from the cost of living standpoint. This is because food has a much larger share in the standard consumption basket of the poorest households.

Figure 10
Variation in the consumer price index (CPI), by income group
(Percentages)



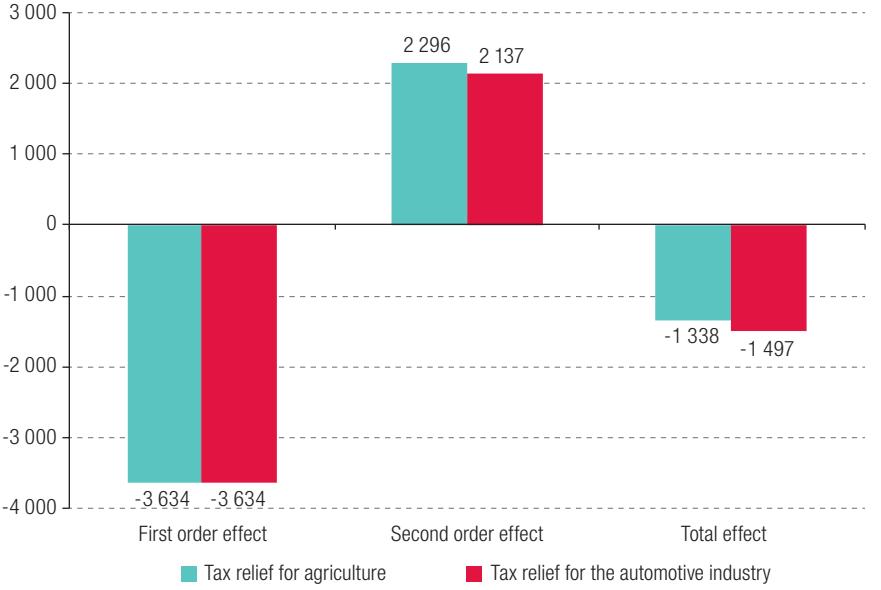
Source: Prepared by the authors, on the basis of the model simulation results.
Note: POF = Family Budget Survey.

4. Budgetary impacts

Although the simulations specify an amount by which taxes and contributions collected by the government are reduced, this does not mean that total government revenue will decrease by the exact same amount. This is because, as noted above, a tax cut in one sector triggers changes throughout the economy, many of which can generate either an increase or a reduction in tax revenue. The change in tax revenue resulting directly from a reduction or increase in taxes is a "first-order effect", whereas the subsequent indirect changes in tax revenue are "second-order effects".

The characteristics of a CGE model mean that it is fully capable of estimating the total (first- and second-order) effects of changes in government tax policy. The effects of the simulations described in this paper are shown in figure 11.

Figure 11
Effects of the policies on tax revenue
(Millions of reais at current prices)



Source: Prepared by the authors, on the basis of the model simulation results.

A tax exemption for agricultural products is capable of neutralizing a slightly larger portion of the initial drop in tax revenue through second-order effects, since it generates a slightly stronger economic recovery than in the case of tax relief for vehicles. Under the tax reduction for agriculture, total tax revenue is ultimately reduced by R$ 1.338 billion. In comparison, the tax cut for the automotive industry produces positive second-order effects amounting to R$ 2.137 billion, which results in a net reduction of R$ 1.497 billion in the government's overall tax revenue.

V. Final considerations

Given the need for economic recovery following the crisis caused by the COVID-19 pandemic, Brazil may decide to adopt a new tax relief policy in the future. If so, a key question is which sector should benefit from the lower taxes. Considering that the agriculture sector and other parts of Brazilian agribusiness have trended countercyclically in years of recession or low economic growth, such as in 2020, this paper

has sought to analyse the effects on the main macroeconomic variables of the Brazilian government's 2009 policy of cutting taxes on vehicles to combat the recessionary effects of the crisis in the United States housing market. This comparative study considers the hypothetical alternative of a tax break of equal value for the domestic agriculture sector. For this purpose, a static interregional CGE model (TERM-BR) was used to simulate both shocks and trace their effects on a wide range of macroeconomic variables. The model was calibrated for 2009, the year in which the policy under review was implemented; and it was aggregated as needed to achieve the aims of this study.

The analysis showed that lowering taxes on agricultural products would be superior to the same reduction applied to vehicles, in terms of its effects on the main variables analysed, especially when considered at the regional level. Given its wide spatial distribution, with the incentive provided by tax relief, the agriculture sector could generate much stronger effects in the poorer states of the Brazilian federation. In contrast, the effects of the incentives granted to the automotive sector are concentrated in the richer states. Whereas the vehicle tax relief would have led to an increase in the regional concentration of per capita income in Brazil (raising the Theil index of regional income distribution from 0.0840 to 0.0843), an equivalent tax break for agricultural products would lead to a decrease in regional income concentration (lowering the Theil index from 0.0840 to 0.0836) (see figure 7).

As it uses skilled labour more intensively, the automotive industry, benefiting from the tax cut, increases labour demand at the higher wage levels, whereas the equivalent tax relief for the agriculture sector increases the demand for labour by more at the lower levels. While lowering taxes for the automotive industry causes increases in the demand for labour of 0.08% at the lowest wage levels and 0.29% at the highest, the same tax relief for the agriculture sector would generate increases of 0.89% and 0.27%, respectively.

Moreover, since agricultural products account for the largest share of the consumption basket among the poorest families, lowering taxes on these products would result in a smaller increase in the cost of living for these families than the tax relief on vehicles (CPI increases of 0.21% and 0.23%, respectively). For the highest-income families, on the other hand, the tax reduction for vehicles generated more modest increases in the cost of living than the tax cut for agricultural products (0.15% and 0.35%, respectively).

The general conclusion of this study is that the federal government should have granted tax relief to agricultural products instead of vehicles in 2009. Furthermore, other things being equal, future tax relief policies should prioritize agriculture ahead of the automotive sector, since tax breaks for the former produce much better economic results than cutting taxes for the latter.

Lastly, it is worth noting that this article does not offer any political economy arguments to justify prioritizing the automotive sector to the detriment of agriculture.

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