INFORMAL LABOR MARKETS AND MOBILITY: AN INTER-REGIONAL COMPUTABLE GENERAL EQUILIBRIUM (CGE) ANALYSIS FOR BRAZIL

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ABSTRACT

The informal labor market is a complex and heterogeneous phenomenon, particularly when considering the transition dynamics involving occupations within this sector. In this context, this study proposes incorporating detailed components of both the demand for informal labor and an endogenous labor supply based on the concept of transition matrices into a dynamic and interregional Computable General Equilibrium (CGE) model called SHIFT. This paper aims to analyze the economy-wide impacts of a policy aimed at reducing the costs of formal employment, assessing its macroeconomic, sectoral, and regional effects. A positive impact is observed as a result of changes in relative labor prices—specifically, the reduction in domestic production costs—leading to a 0.95% increase in GDP growth rate, highlighting that this type of public policy may, in principle, generate economic benefits over time. Among skill levels, the policy's impact was found to be more significant for low-skilled formal workers. Additionally, when analyzing labor supply behavior, a new worker reallocation is observed in response to wage variations resulting from the payroll tax reduction policy, with most transitions involving movement into informal employment.

Keywords: Labor market. Informality. Computable General Equilibrium Model. Inter-regional. Public Policies.

RESUMO

O mercado de trabalho informal é um fenômeno complexo e heterogêneo, especialmente quando se consideram as dinâmicas de transição entre ocupações dentro desse setor. Nesse contexto, este estudo propõe a incorporação de componentes detalhados tanto da demanda por trabalho informal quanto da oferta de trabalho, baseada no conceito de matrizes de transição, em um modelo dinâmico e inter-regional de Equilíbrio Geral Computável (EGC) denominado SHIFT. O objetivo do artigo é analisar os impactos macroeconômicos, setoriais e regionais de uma política voltada à redução dos custos do emprego formal. Observa-se um impacto positivo decorrente das mudanças nos preços relativos do trabalho — especificamente, da redução nos custos domésticos de produção — resultando em um aumento de 0,95% na taxa de crescimento do PIB, evidenciando que esse tipo de política pública pode, em princípio, gerar benefícios econômicos ao longo do tempo. Entre os diferentes níveis de qualificação, o impacto da política mostrou-se mais significativo para os trabalhadores formais de baixa escolaridade. Além disso, ao analisar o comportamento da oferta de trabalho, verifica-se uma nova realocação de trabalhadores em resposta às variações salariais decorrentes da política, com a maior parte das transições envolvendo o emprego informal.

Palavras-chave: Mercado de trabalho. Informalidade. Modelo de Equilíbrio Geral Computável. Inter-regional. Políticas Públicas.

Área 11: Mercado de trabalho, Demografia e Migração.

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1. Introduction

The informal labor market is present worldwide and plays a significant role in the global economy (Ulyssea, 2020; Sugiharti, Aditina, & Padilla, 2022; Natarajan, Schotte, & Sem, 2023). In this context, the scale of informality is considered a critical issue, as it exposes workers to heightened vulnerability, including a lack of social protection, greater income volatility, and precarious employment relationships (La Porta & Shleifer, 2014; ILO, 2018; Ohnsorge & Yu, 2021).

The relevance of studying the informal sector becomes even more pronounced when analyzing the specific characteristics of developing economies such as Brazil. According to the Pesquisa Nacional por Amostra de Domicílios Contínua (PNADC), approximately 40 million people were employed in the Brazilian informal labor market in 2024, representing 38.8% of the country's employed population. Moreover, regional data from the PNADC reveal significant disparities. While regions such as the North and Northeast exhibit the highest informality rates—exceeding 50% of the total employed workforce—other regions, such as the South and Southeast, report lower yet still concerning levels, with approximately 20% to 30% of workers engaged in informal occupations (IBGE, 2025)[4].

Beyond the economic development disparities among Brazil's regions, the growth and persistence of informality in the Brazilian labor market over the past decades must be understood within a context of historical transformations driven by factors such as industrialization, globalization, economic crises, changes in the Brazilian productive structure, and the economic policies adopted in the country. Many of these transformations have had significant impacts on the composition of the labor force, perpetuating high informality rates (Hirata & Machado, 2010; Corseuil & Foguel, 2012; Ulyssea, 2018, 2020; Manzano, Krein, & Abílio, 2021).

Despite advancements in the economic literature regarding public policies aimed at mitigating informality, designing effective public policies tailored to different contexts and types of informality remains a controversial issue. This complexity arises because informality is a heterogeneous phenomenon. In an analysis of Brazil, Ulyssea (2018, 2020) emphasizes that formal and informal workers often coexist within well-defined industrial sectors, contradicting the traditional dualist view of informality, which assumes a complete separation between these groups in the economic space. Additionally, both national and international literature on occupational mobility provide important contributions to understanding the dynamics of informal labor market supply. Studies such as those by Hirata and Machado (2010), Gutierrez et al. (2019), Folawewo and Orija (2019), Natarajan, Schotte, and Sem (2023), and Maurizio and Monsalvo (2021) indicate that labor supply among individuals engaged in the informal labor market, characterized by their transition dynamics, exhibits greater volatility. That is, informal workers tend to experience higher-than-average mobility across different occupational conditions in the labor market.

The above motivates this paper, which aims to assess the economy-wide impacts of a public policy aimed at reducing the cost of entry into formal employment in the Brazilian labor market. The analysis considers that firms can hire both formal and informal workers across different skill groups and that labor supply responds endogenously to relative price changes. To this end, the simulation experiment will be conducted using the Computable General Equilibrium (CGE) model called SHIFT. The proposed model is built upon the theoretical structure of The Enormous Regional Model (TERM), developed by the Center of Policy Studies (CoPS), and employs the Brazilian Input-Output Database (2015 release).

We aim to contribute to the accounting literature in the following ways: (1) First, through general equilibrium analysis, we can better understand the impact of the simulation from

[4] The Figure A1, attached, shows the evolution of the informality rate in Brazil, measured using PNADC data from 2012 to 2023.

a broader perspective compared to a partial equilibrium study, as it accounts for the systemic effects resulting from the interactions and interdependencies of different sectors and agents in the economy, thereby contributing to more comprehensive policy planning and development. (2) Second, we adopt a comprehensive framework to study informality by integrating two crucial discussions in a CGE model: the incorporation of the informal labor market and the inclusion of labor supply behavior based on transition matrices at the regional level in a country of continental dimensions such as Brazil. (3) Finally, the findings can inform sectoral and regional policies because the model is disaggregated by 27 Federative Units (UFs). Additionally, the literature on this topic for developing countries remains scarce, particularly at the subnational level.

According to Resende et al. (2024), the spatial distribution of employment is influenced by social, institutional, and productive factors specific to each location, which can either reinforce segmentation between central and peripheral areas or, conversely, drive transformations capable of reshaping this structure. However, these transformations do not occur automatically. On the contrary, their realization requires the implementation of public policies adjusted to regional specificities, emphasizing the need for a nuanced understanding of local labor market dynamics. aprofundada da dinâmica do mercado de trabalho em diferentes territórios.

The remainder of the paper is structured as follows. Section 2 presents a brief literature review. Section 3 explains the methodology as well as the research instrument, namely the Democratic Republic of Congo Formal-Informal Model (TERM-UF-INF) that was used to analyse the policy shock and discusses the model closure. The findings of this study and their implications for future research are outlined in sections 4 with policy implication and concluding remarks following in section 5.

2. Literature review

From a theoretical perspective, the discussion on the heterogeneity and mobility within the informal labor market can be considered an adjacent issue to the extensive economic literature that seeks to conceptualize and understand both the causes and consequences of the existence and persistence of informality in various economies (La Porta & Shleifer, 2014; Maurizio & Monsalvo, 2021; Ulyssea, 2020). The following section presents a brief theoretical and empirical review of studies that explore this theme, aiming to highlight the importance of considering informality as a heterogeneous category, as well as to analyze the determining factors of labor market transitions for workers engaged in this sector. Given the complexities and broad scope of the topic, this review does not intend to exhaust the literature but rather to provide a foundation for understanding the results and discussions raised in this study.

La Porta and Shleifer (2014) identify two major conceptual characterizations of informality in the literature. The first concerns the origins and persistence of informality in developing countries, which result from the prevailing legal and regulatory frameworks in these nations. As argued in the pioneering work of De Soto (1989), workers and firms evaluate the benefits of formalization and decide whether to remain in informality. Additionally, another strand of analysis highlights the dualistic nature of this market, composed of formal employment, which offers higher wages and better working conditions, and informal employment, characterized by lower wages and poorer working conditions, as suggested by the Dual Labor Market Theory (Lewis, 1954; Harris & Todaro, 1970; Rauch, 1991).

Maurizio and Monsalvo (2021) argue that the heterogeneity of informality allows for both of the aforementioned approaches to be complementary rather than mutually exclusive. According to the authors, mobility within the informal labor market can be both a strategic response by workers to economic and institutional conditions—where opting for informality may

be a rational choice given labor regulations and the low benefits associated with formal employment—and a consequence of labor market segmentation, wherein lower-skilled workers with limited access to formal opportunities remain confined to the informal sector.

Studies such as Estrades and Terra (2011), Mwangi et al. (2017), Traoré and Ouedraogo (2021), and Bonga-Bonga and Erero (2024) contribute to the analysis of informality dynamics in the labor market and highlight the differences and challenges in formulating public policies aimed at reducing informality and increasing formalization in emerging countries using the Computable General Equilibrium (CGE) methodology.

In this regard, Estrades and Terra (2011) investigate the impact of informality in the Uruguayan labor market under five scenarios involving payroll tax reductions, which differ in two main aspects: (i) the sectors that would benefit from the tax reduction and (ii) the type of labor affected. The study employs a national static CGE model that differentiates between formal and informal occupation sectors. Additionally, the model incorporates a hierarchical demand structure with three skill categories: low, medium, and high. Labor supply is considered exogenous, meaning fixed, with labor market adjustments occurring through wages.

The main findings indicate that both policies were effective in reducing informality; however, their effects on poverty and wages differ. A policy reducing formal labor taxes effectively decreases informal employment by lowering the cost of hiring less-skilled workers and increasing demand for these workers, who constitute the majority of the informal labor force in the country. However, this policy negatively impacts government revenues. In this context, a policy that combines a reduction in formal labor taxes with an increase in capital taxes has a greater impact on reducing informality, as it offsets the negative fiscal deficit effects on public investment.

Furthermore, Estrades and Terra (2011) also assess the impact of public policies that enhance the monitoring of informal sector firms. Although these policies are more effective in directly reducing informality, they negatively affect the wages of lower-skilled workers, who are predominantly informal. For this reason, stricter enforcement policies have a negative impact on the income of poorer households. While wealthier households also experience income reductions, these are proportionally smaller. Consequently, poverty increases, and income distribution becomes less equitable.

Mwangi et al. (2017) analyze the effects of minimum wage increases on the labor market and income distribution in Kenya using a national static CGE model. The study aims to assess how changes in minimum wage policies influence labor migration between rural and urban areas and the differentiation of demand for formal and informal labor. Specifically, the labor market is classified into four categories: rural formal labor, urban formal labor, rural informal labor, and urban informal labor. Three distinct scenarios were simulated: (i) a uniform 5% increase in the minimum wage for formal workers in both urban and rural areas; (ii) a differentiated increase of 10% for rural workers and 5% for urban workers; and (iii) a reduction in minimum wages in both sectors. These simulations were uniformly applied across all economic activities.

The study finds that increasing the minimum wage drives labor migration from rural to urban areas due to the greater attractiveness of the urban formal labor market. However, the impact on economic growth was negative in the wage increase scenarios, primarily due to rising labor costs and the consequent decline in demand for formal labor. Conversely, the minimum wage reduction in the third scenario led to GDP growth, reflecting greater hiring of formal workers and increased production. Government expenditures were directly affected, with tax revenues decreasing by up to 0.14% in the wage increase scenarios due to economic contraction, whereas minimum wage reductions led to a 0.35% increase in revenue, reflecting the expansion of the formal sector.

In Burkina Faso, as in many developing countries, the informal sector represents a significant share of the labor force and GDP. In this context, Traoré and Ouedraogo (2021) use a

national static CGE model to simulate the effects of public policies aimed at improving access to capital and mitigating liquidity constraints in the informal sector, which employs approximately 74% of the non-agricultural workforce and contributes around 25% of the country's GDP. As in the study by Estrades and Terra, labor supply is considered exogenous, meaning the model assumes that the total labor supply in the economy remains unchanged in response to simulated shocks.

Bonga-Bonga and Erero (2024), using a national CGE model, analyzed the impacts of a wage subsidy policy targeting low-skilled formal workers in the Democratic Republic of the Congo (DRC). Compared to the baseline scenario, GDP increased by 1.19% in the short term and 3.19% in the long term, driven by growth in formal sector production. The expansion of formal production also led to an increase in export volumes of 6.96% in the short term and 7.09% in the long term, while the growth rate of gross fixed capital formation remained constant. The subsidy also influenced relative prices in the economy, with the Consumer Price Index (CPI) declining by 2.19% in the short term and 1.25% in the long term. The study further reveals that the subsidy reduced income inequality, particularly benefiting low-skilled workers in the formal sector. These findings underscore the effectiveness of wage subsidies as a tool for stimulating formal employment and reducing economic disparities in the DRC, provided they are accompanied by complementary policies aimed at informal sector inclusion.

In Brazil, although some studies do not explicitly consider the informal labor market, research has been conducted to assess the impact of public policies that increase the benefits (or reduce the costs) of formalization, such as Souza, Cardoso, and Domingues (2016) and Porsse and Carvalho (2019). For example, Souza, Cardoso, and Domingues (2016) evaluated the economic impacts of a payroll tax reduction policy. The CGE model used was calibrated for the Brazilian economy in 2005, and the authors' simulations included three main scenarios: (1) a partial payroll tax reduction for selected sectors in the short term; (2) an extension of this reduction in the long term; and (3) a comprehensive payroll tax reduction covering all economic sectors in the long term.

The results indicate that, in the short term, payroll tax reductions restricted to specific sectors may generate negative employment (-0.11%) and GDP (-0.06%) impacts due to rigid capital adjustments and increased gross revenue taxes for beneficiary companies. However, in the long term, the effects are positive, with total employment increasing by 0.27% and GDP by 0.10%, reflecting the economy's gradual adjustment to new fiscal conditions. Nonetheless, the policy's effects on the external sector are ambiguous. While exports decline by 0.65% in the long term, imports increase by 0.29%. This suggests that, although the policy fosters domestic growth, it may reduce the competitiveness of Brazilian exports due to rising internal costs and shifts in companies' cost structures. Specifically, sectors benefiting from the tax reduction, such as capital goods, experience production and employment gains, whereas non-beneficiary sectors, such as the food industry, face competitiveness losses.

Similarly, Porsse and Carvalho (2019) examine the economic impacts of payroll tax reduction and reinstatement policies in Brazil. The study uses a dynamic CGE model, ORANIGBR, adapted to the Brazilian economy to simulate the effects of these policies between 2013 and 2025, incorporating labor disaggregation into eight income classes. To assess policy impacts, two scenarios were applied: the first simulates the continuation of the payroll tax reduction policy initiated in 2011, while the second considers its reinstatement from 2016 onward.

The simulation results indicate that maintaining the payroll tax reduction until 2025 would lead to an accumulated GDP growth of 0.34% compared to the baseline scenario. Conversely, reinstating payroll taxes from 2016 would result in an accumulated GDP loss of 0.37%. The primary factor explaining this difference is the dynamics of investment and consumption: while tax reductions stimulate household consumption and employment, tax reinstatement increases production costs, particularly in capital-intensive sectors such as

construction and capital goods. Additionally, the authors highlight distinct impacts across income classes. While tax reductions relatively favor higher-income groups, reinstating taxes has a more uniform impact across different income classes. However, sectors employing lower-skilled workers, such as wood and cement industries, are most negatively affected by reinstatement, exacerbating the policy's regressive effects.

In this context, the empirical analysis of public policies across various national and international contexts has highlighted different strategies that can be employed to reduce informality in the labor market. The next section will discuss the methodology, detailing the modifications in the labor demand and supply module, the database, and the model used to evaluate the impact of a payroll tax reduction policy on the Brazilian labor market.

3. Methodology

The SHIFT[5] CGE model is based on the theoretical framework and data structure of the TERM-UF model, which represents the 27 Federative Units (UFs) of Brazil. It was developed by researchers at the Núcleo de Desenvolvimento Urbano e Regional (NEDUR) at the Federal University of Paraná (UFPR) and follows the theoretical framework and solution mechanisms of the Australian tradition TERM model (The Enormous Regional Model), originally proposed by Horridge, Madden, and Wittwer (2005), with its dynamic extension formulated by Dixon and Rimmer (1998, 2002). For Brazil, several studies have been developed based on this model, including Porsse et al. (2020) and Ribeiro et al. (2024).

The model consists of a system of linear equations that describe the theoretical foundations of economic participants' behavior. It includes equations representing:i) firms' demand for inputs and primary factors; ii) final demand for commodities by end users, such as households, investors, the government, and the external sector; iii) price-setting mechanisms, ensuring that pure profits across all activities are equal to zero, meaning that firms operate under perfect competition, where price equals marginal cost; iv) various definitional variables, such as GDP, aggregate employment, and the Consumer Price Index (CPI) (Horridge, 2012).

Table 1, on Appendix, presents the main economic agents adopted in the model, as well as the regions and sectors considered.presents the main economic agents and sectors adopted in the model, as well as the regions considered. Regarding economic agents, the model includes a representative firm for each sector in each of Brazil's 27 Federative Units, allowing for the capture of sectoral and regional specificities. Additionally, a representative household is included for each region, along with other agents such as the government, investors, and the external sector, to reflect institutional interactions and economic openness dynamics. To enable the disaggregation of the labor factor in accordance with this study's objectives, the TERM-UF model, originally composed of 124 sectors and products, was restructured to include 35 activity sectors and 35 products. This aggregation was necessary due to data availability constraints, particularly regarding the proposed labor market extension at regional and sectoral levels, which limits further disaggregation in the analysis.

Figure 1 presents the modification implemented in the demand structure for primary factors in a representative industry in each of the regions within the SHIFT model. To achieve the objectives of this study, the labor factor was disaggregated into different occupational types, each of which is allocated across different economic sectors based on wage differentials.

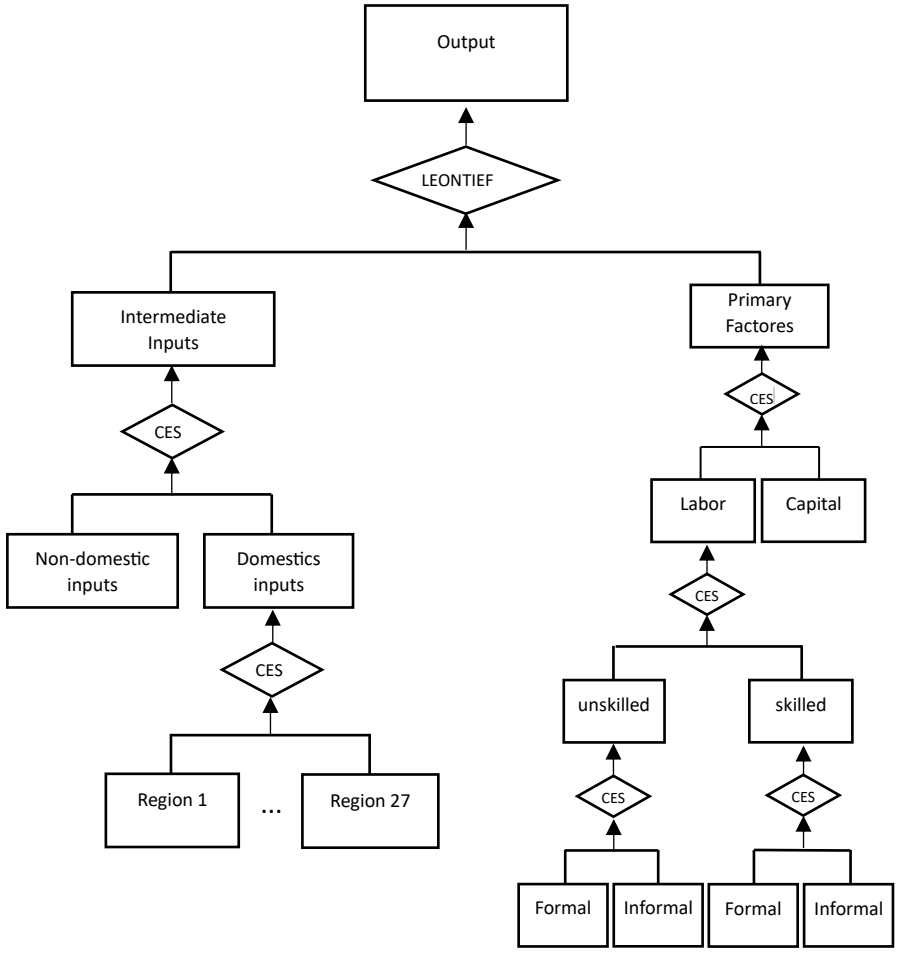
In general, considering that firms' decisions to employ informal workers are often related to strategies for managing high regulatory costs, rather than solely differences in the labor force, the demand for the primary labor factor is further disaggregated into additional layers

[5] The name of the model refers to the acronym "Structural Hierarchical Informative Framework for Transitions." Thus, the term "SHIFT" alludes to both changes (transitions) in the labor market and the hierarchical demand structure.

through a nested two-tier system. Each level of the hierarchy reflects business decisions on how to combine different types of labor based on their characteristics—such as skill level and formality category—as well as relative costs.

Initially, there is substitution between primary factors—capital and labor—governed by a Constant Elasticity of Substitution (CES) function, which constitutes the first level of the nested structure in Figure 2. For this study, two additional nested structures were incorporated. At the first level, each industry, when employing the labor factor, may choose—via a CES function—between high- and low-skilled labor. At the second level, within each skill category, labor can be classified as formal or informal, also according to a CES substitution elasticity function.

Figure 1 – Production Structure of a Representative Industry in the SHIFT Model[1]



Source: Own elaboration based on SHIFT model.

Note:[1] The functional forms specified for each main optimization stage correspond to trapezoid-shaped figures, while rectangles represent inputs or products.

In general terms, within the theoretical framework of the TERM model, there are no behavioral equations that explicitly determine the dynamics of labor supply, as is the case in most CGE models. This requires the researcher to specify a labor supply function based on the study's objectives (Boeters & Savard, 2011). In this study, we enhanced the dynamic specification by incorporating the modeling of regional labor supply, which is based on the concept of labor classes and transition matrices. This new set of equations and definitions describes how formal and informal labor classes and unemployment are distributed and utilized by sectors across each region over time, supporting workers' behavioral responses to relative

price changes. This extension allows for a more realistic modeling of labor supply, as it reflects workers' behaviors and decisions in response to changes in market equilibrium conditions.

Labor mobility is determined by a regional transition matrix, expressed in terms of Full-Time Equivalent (FTE) workers—that is, the total number of working hours relative to the standard full-time schedule, which assumes a five-day workweek with eight hours per day, totaling 40 hours per week. This measure provides a uniform basis for comparing the workforce's capacity, as it converts different work schedules (part-time or full-time) into a common metric. To account for transitions involving unemployment, the average total working hours of formal and informal workers was used as a reference for this group, ensuring that, on average, the sum does not alter the total counted working hours.

Thus, the regional transition matrices represent changes between labor classes over two periods and can be expressed as shares, meaning that row totals equal one, indicating Markov probabilities that a given labor class will transition to another class in the next period. Furthermore, the model considers: Exogenous labor force growth; Regional mobility across formal and informal occupation categories, and The possibility of unemployed workers entering these categories in year t+1. As a result, the transition matrix is adjusted annually, as is the labor supply. In the model, these probabilities or proportions are modeled as a function of nominal labor compensation using the following equation:

$$S_{pqr} = \mu_{pr}.\mathrm{L}_{pqr}.P_{qr}^{\alpha}.M_{qr} \quad (14)$$

The subscript *r* represents each of the 27 Federative Units (UFs) considered in the model. S_pqr denotes the share of labor class p that transitions to q in region r. μ_pr and L_pqr are calibration constants based on the initial values of S_pqr. P_qr^α represents the average wage of labor class q. α is a sensitivity parameter that measures the labor supply response to wage variations. M_qr is a shift variable with an initial value of 1.The total labor supply in period t+1, expressed in Full-Time Equivalent (FTE), depends on transitions between labor classes. When equated to labor demand, which is determined within the model's core by the production structure of economic sectors and relative prices, it establishes the labor market equilibrium condition in each period.

Consequently, if formal labor wages increase relative to informal wages in year t (on the demand side), the conversion rate from informal to formal employment will rise. As a result, the supply of formal workers in t+1 will also increase, subject to the total labor supply constraint and workforce growth.

The model also includes households, investors, the government, and the external sector as final demanders. The treatment of household demand in the TERM-UF model considers that there is a representative family in each region whose consumption decisions are based on the preference function, the functional specification of which combines the Stone-Geary utility function with a CES function. Families initially choose between domestic and imported goods through a CES-type function based on the Armington (1969) hypothesis of product differentiation, where goods from different origins are considered imperfect substitutes. Subsequently, using the Stone-Geary function, the total consumption of each commodity compound is divided into two components: subsistence and luxury.

Other users of final demand are treated as follows. Government demand is considered exogenous, meaning it is not endogenously modeled by the model based on a theory; in this work, it is assumed that government spending follows household consumption. However, the government's activity in the production of public goods, such as the Public Administration sector, is decided by the same cost-minimization logic as the private sector. Furthermore, external sector demand is also exogenous, assuming negatively sloped demand curves in international market prices. In the TERM-BR model, a vector of elasticities represents the response of external

demand to changes in the Free On Board (FOB) price of exports. Thus, changes in price and demand for exports allow for shifts in demand curves.

Finally, another user of the final demand in the TERM-UF model is represented by "investors," who are responsible for the production of new units of capital, i.e., gross fixed capital formation. For the creation of new units of capital, investors in the economy have a model similar to that of producers, meaning that the choice of inputs used in the capital generation process also occurs through cost minimization, subject to a hierarchical technology structure. At the first level, the capital good is produced using domestic and imported inputs, the combination of which is specified by a CES function. Then, an aggregate of the set of composite intermediate inputs is formed by a fixed-proportions combination – Leontief function, defining the level of capital production in the sector.

3.1 Model Closure and Shock Definition

For the proposed simulation, the model closure has the following general characteristics: capital accumulates over periods and follows the dynamic investment mechanism. Labor force growth is exogenous, and there is labor mobility, meaning that labor moves between regions according to wage differentials, as determined by the endogenous labor supply mechanism. Additionally, regional government spending demand follows the regional household demand pattern. The nominal exchange rate is chosen as the numéraire, meaning that all other prices should be interpreted relative to the nominal exchange rate.

Furthermore, by the model's recursive capacity, the solutions of the SHIFT model initially require the specification of a reference scenario, which represents the trajectory of the Brazilian economy without any policy interventions to control informality, and a policy scenario, which introduces an exogenous "shock", such as a new economic policy, an external disturbance, or any other factor that affects economic agents' decisions and market equilibria. The reference scenario consists of two parts: historical closure and forecast closure. In the historical closure, the model is assigned observed data for some of the main macroeconomic variables that are naturally endogenous. In the forecast closure, the prospective economic growth behavior for the coming years is defined, meaning that it includes data that has not yet been observed. Table 1 presents the information used in the historical closure of the reference scenario, updating data from 2016 to 2023.

Table 1 – Macroeconomic indicators of the historical closure of the Reference Simulation

Indicators	Historical Closure							
	2016	2017	2018	2019	2020	2021	2022	2023
Output	-3.28	1.32	1.32	1.14	-0.50	4.72	3.01	4.60
Consumption	-3.84	1.98	2.05	1.84	-5.40	3.60	2.90	4.14
Government	0.21	-0.67	0.36	-0.44	-4.60	4.17	2.13	1.67
Exports	0.86	4.91	4.00	-2.54	-1.80	4.80	5.70	9.13
Investment	-12.42	-2.56	3.91	-0.44	-0.50	12.90	1.08	-3.00
Employment	-1.56	1.25	1.20	1.70	-7.50	6.20	7.39	1.37

Source: Own elaboration.

Note: In the forecast closure of the reference scenario, that is, for the period between 2024 and 2040, a business-as-usual projection scenario is considered, assuming exogenous aggregate GDP growth rates of 2% per year, in line with the average growth of the Brazilian economy over the past twenty years. Additionally, throughout the simulation period of the reference scenario, an annual increase in labor productivity of 2% and a trend employment growth of 1.5% are assumed.

The objective of the reference scenario is to represent the initial trend of the economic system, where all variables and their respective trajectories remain unchanged. This scenario serves as a baseline for comparing the effects of different policies or shocks. These data reflect

observed changes in indicators such as Gross Domestic Product (GDP), household consumption, government expenditures, exports, investment, and employment over the historical period. The inclusion of these indicators allows the model's numerical structure to be updated for the year of policy implementation. Thus, between 2016 and 2023, key macroeconomic aggregates—such as real GDP, investment, household consumption, government expenditures, export volumes, and aggregate employment—are treated as exogenous variables.

In addition to the reference scenario, a policy scenario is also defined, representing an exogenous "disturbance" in the economic system that affects the decisions of agents and markets, causing a deviation from the equilibrium of the base scenario. In this study, the policy scenario considers, in the year 2024, a payroll tax reduction for formal workers. This policy represents a decrease in the cost of labor as a production factor in the production function of economic sectors. Specifically, the simulation models a 10% reduction in the costs of formal occupations, benefiting all sectors and formal occupation categories. To assess both the short- and long-term impacts of this policy, the simulation covers 24 annual periods (2024-2040).

It is important to highlight that this policy results in a loss of government tax revenue, as the SHIFT model does not incorporate an endogenous theory of public finance, nor does it assume any compensatory tax measure to offset the revenue loss. In this context, the model assumes that the government responds to the decline in tax revenue by reducing its consumption, maintaining an unchanged fiscal balance.To determine the percentage reduction in government expenditures, the analysis considers the proportion of employer contributions to gross labor compensation, based on data from the 2019 Resource and Use Table (TRU) for Brazil, published by IBGE, relative to the share of government spending in the SHIFT model database. As a result, this tax exemption leads to a 4.8% reduction in government expenditures.

Therefore, government consumption is exogenously fixed in 2024. The negative shock to government spending is thus incorporated into the model as a way to capture the secondary effects of the formal occupation cost reduction policy: as the government loses revenue, its expenditures are adjusted (reduced) proportionally, allowing for a more realistic analysis of the macroeconomic and sectoral impacts of this policy change.

5. Results

Table 2 presents the accumulated impact from 2024 to 2040 of the simulation on key macroeconomic variables relative to the reference scenario. A positive impact is observed due to changes in relative labor prices, specifically the domestic production cost, leading to a 0.95% increase in GDP growth rate. This result suggests that such a public policy could, in principle, generate economic benefits over time. Studies such as Domingues et al. (2012), Souza, Cardoso, and Domingues (2016), Porsse and Carvalho (2019), and Bonga-Bonga and Erero (2024), which analyze the effects of payroll tax reduction on the economy using a Computable General Equilibrium (CGE) approach, report findings that are consistent with these results.

Indeed, the GDP growth observed in this study is associated with the performance of key macroeconomic aggregates, such as the increase in household consumption (1.88%), investment (0.45%), and exports, with the latter showing the largest variation relative to the reference scenario, at 1.91%. These results stem from the adjustment of relative prices in the economy, producing different effects on macroeconomic variables. The tax cut directly reduces costs associated with the formal labor factor, thereby lowering domestic production costs. As a result, firms are incentivized to increase production, as they can now produce at lower costs, positively impacting Brazilian production (GDP). The decline in costs puts downward pressure on price indices. Lower prices make domestic products more competitive compared to imported goods, stimulating domestic consumption as well as exports. Imports show a slight accumulated increase by 2040 because, despite becoming relatively more expensive, the economic activity expansion effect outweighs the substitution effect toward domestic goods.

Table 2 – Macroeconomic Aggregates, Accumulated Percentage Variation Relative to the Reference Scenario, 2040

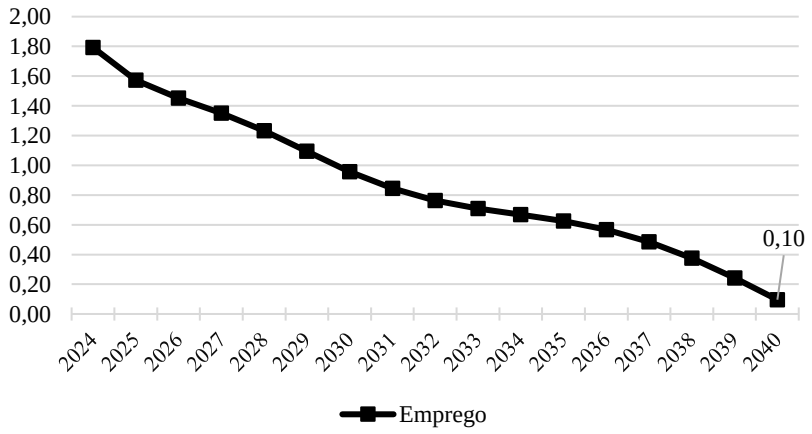
Macroeconomic Impacts	**2040**
Gross Domestic Product (GDP)	0,95
Real household consumption	1,88
Government	-4,38
Investment	0,45
Exports	1,91
Exports	0,04
Employment	0,10
Real Wage	0,22
CPI	-1,64

Source: Own elaboration based on SHIFT model.

The rise in economic activity leads to an increase in income, which mainly translates into a higher impact on household consumption (1.88%). This is also because household income is linked to labor compensation, which is the factor directly affected by the shock. Additionally, higher levels of economic activity positively influence sectoral rates of return, which stimulates investment.Moreover, as government consumption is reduced in the year of the tax cut, corresponding to the revenue loss from lower taxes, there is an initial negative effect on aggregate domestic demand, which further intensifies price reductions, enhances competitiveness, and favors the redirection of national production toward exports.

Real wages increase over the period, as demand for labor rises, exerting upward pressure on wages. National employment, although converging toward its trend level, still shows a slight accumulated increase in 2040 compared to the reference scenario. Specifically, by the end of the simulation period, real wages will be 0.22% higher than in the reference scenario However, the 0.10% effect observed for employment in Table 8 can be interpreted as the long-term impact of the payroll tax reduction policy. When analyzing this variable's trajectory over the simulation periods, the policy initially generates a significant impact, which gradually declines over time before returning to its trend level—as illustrated in Figure 2.

Figure 2 – Employment, Accumulated Percentage Variation Relative to the Reference Scenario, 2024-2040



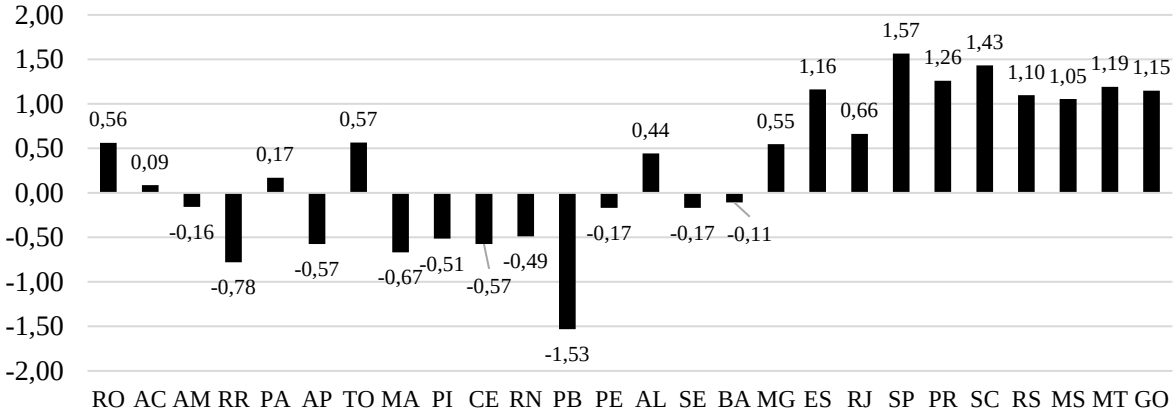
Source: Own elaboration based on SHIFT model.

The regional GDP impacts are directly related to the productive structure of each Federative Unit (UF) and the regional variation of GDP components, particularly considering

each state's export profile. In this regard, Figure 3 presents the percentage variation in regional GDP relative to the reference scenario, accumulated by 2040. While the states in the South, Southeast, and Center-West regions show a positive deviation from the reference scenario, most UFs in the North and Northeast regions experience a negative deviation, except for Rondônia (RO), Tocantins (TO), and Alagoas (AL). The states of São Paulo (SP), Santa Catarina (SC), and Paraná (PR) recorded the highest GDP gains, with accumulated variations of 1.57%, 1.43%, and 2.15%, respectively. A more significant decline is observed in Pernambuco, with a reduction of 1.53% in regional GDP.

These regional results highlight the importance of considering regional disparities when evaluating the impact of public policies in Brazil, as emphasized by Souza et al. (2019). While many studies reviewed in Chapter 2, such as those by Fernandes, Gremaud, and Narita (2004) and Souza, Cardoso, and Domingues (2016), predominantly focus on national-level analyses, understanding how informality mitigation policies affect Brazil's territory unevenly is crucial for more effective planning and efficient allocation of public resources. This is particularly relevant given the heterogeneous distribution of informality across states.

Figure 3 – Regional GDP, Accumulated Percentage Variation Relative to the Reference Scenario, 2040



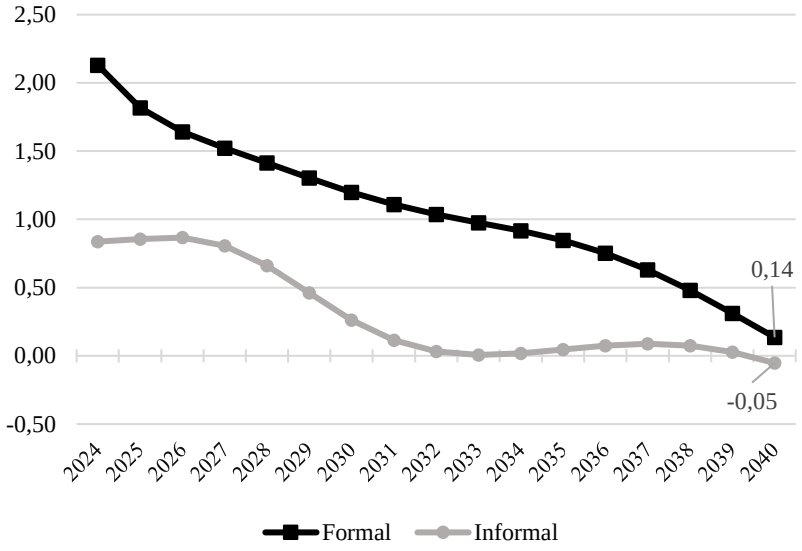
Source: Own elaboration based on SHIFT model.

In this context, Figure 4 presents the accumulated percentage variations in formal and informal employment throughout the simulated scenario (2024-2040). As expected, the payroll tax reduction policy influences sectoral production levels, leading to differences in employment levels across different occupations. The results indicate that the expansion of sectoral output, as observed in Table 2, positively impacts employment levels in the labor market. The accumulated deviation from the baseline scenario for formal employment shows growth ranging from 2.13% in 2024 to 0.14% in 2040. Meanwhile, informal employment, although also benefiting from the increase in economic activity, exhibits a less significant variation, with a positive deviation of 0.84% in 2024. However, this trend declines over time, becoming marginal from 2032 onward and reaching a slight decline of -0.05% in 2040.

The increase in demand for informal labor can be explained by second-order effects that arise in response to the initial changes induced by the payroll tax reduction policy. Initially, the policy enhances the competitiveness of sectors that employ formal labor, prompting firms to reallocate production factors to optimize output levels. As these sectors expand and economic activity increases, there is a greater demand for formal labor, which pushes real wages upward. Consequently, as the increase in demand surpasses the initial reduction in informal labor costs, the costs of informal employment follow an upward trend over time. Additionally, the expansion of productive activity requires more inputs—both intermediate and primary—stimulating the hiring of all productive factors, including both formal and informal labor as well as capital.

However, given the model's dynamics, which impose a trend employment level, these effects gradually stabilize over time, and the variation in demand for informal labor becomes nearly zero from 2030 onward.

Figure 4 – Employment by Type of Occupation (Formal and Informal), Accumulated Percentage Variation Relative to the Reference Scenario, 2024-2040

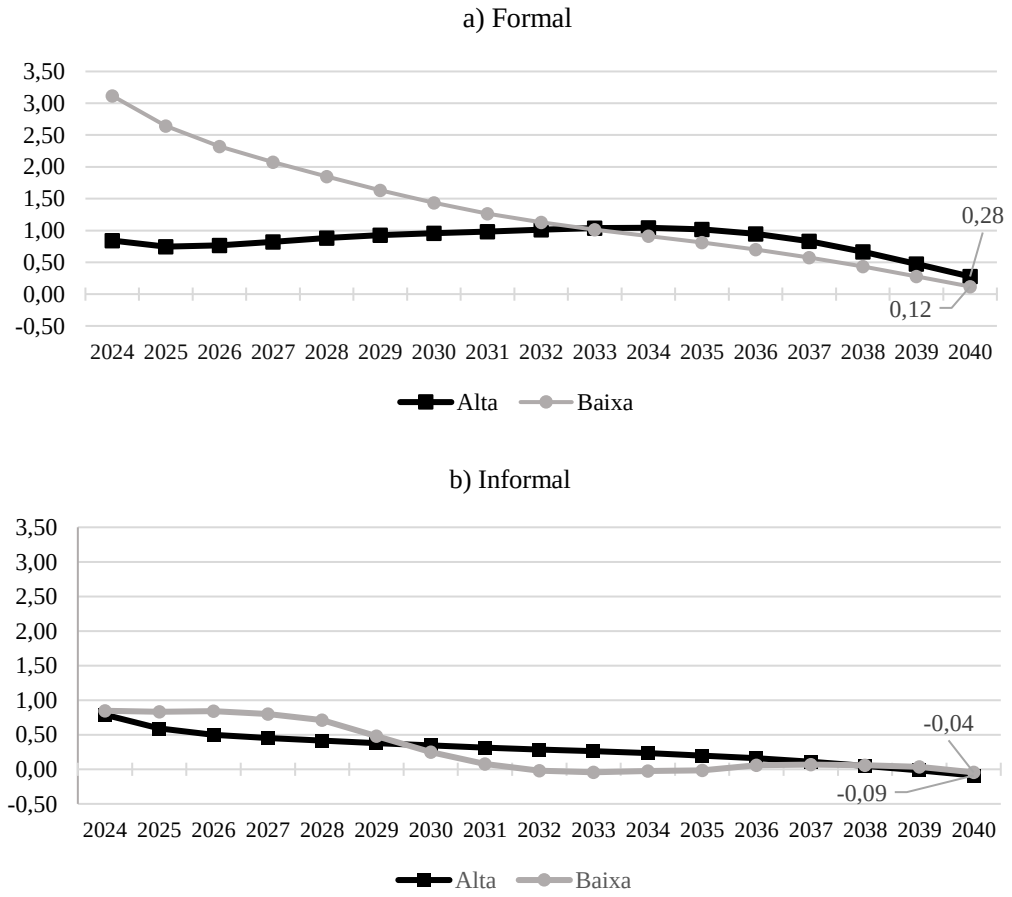


Source: Own elaboration based on SHIFT model.

Figure 5 represents the accumulated variations in labor demand by skill level relative to the reference scenario, divided into two graphs. In the upper section, the results correspond to formal occupations, while in the lower section, they represent informal categories. The demand results by skill type follow the same trends observed for formal and informal categories presented earlier. However, among formal occupations, the impact of the payroll tax reduction policy is greater for low-skilled formal workers, reaching an accumulated effect of 0.28% and 0.12% in 2040, respectively. Additionally, no significant differences are observed in the demand for high- and low-skilled informal workers over the years, with an accumulated negative variation of -0.09% and -0.04% in 2040, respectively.

These results align with the findings of Estrades and Terra (2011) and Bonga-Bonga and Erero (2024), who also identified higher employment gains for low-skilled formal workers as a result of a wage subsidy policy. Their studies conclude that policies reducing hiring costs for formal workers have a greater potential to generate positive impacts on formal employment, especially in labor-intensive sectors employing lower-skilled workers.

Figure 5 – Formal and Informal Employment by Skill Level, Accumulated Percentage Variation Relative to the Reference Scenario, 2024-2040



Source: Own elaboration based on SHIFT model.

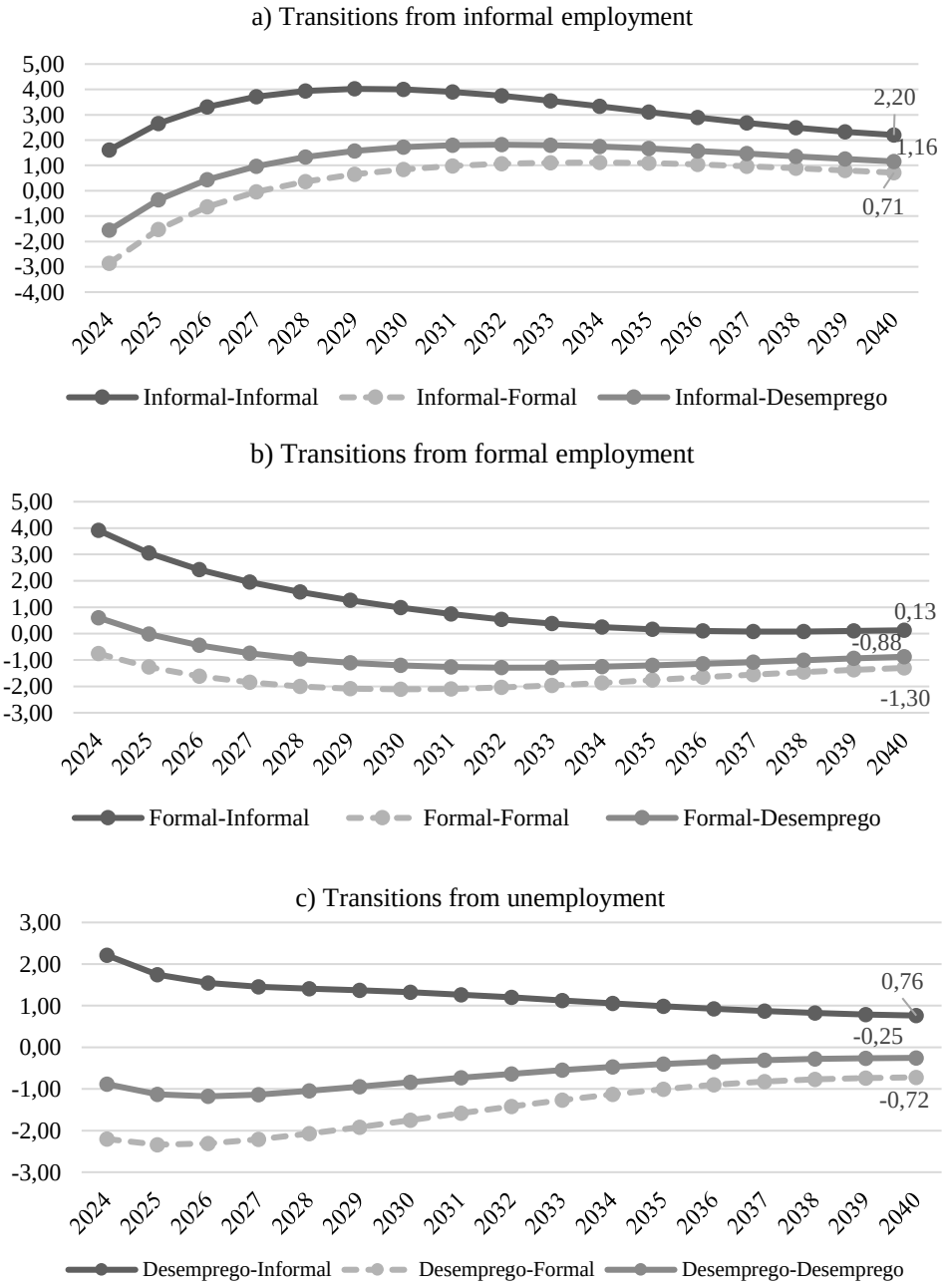
Regarding the results of the labor supply mechanism in the SHIFT model, Figure 6 initially presents the accumulated variation in labor supply. The indicated values reflect differences in labor market transitions between two periods, comparing them to the reference scenario, and illustrate whether the stock of individuals in each category—informality, formality, or unemployment—has increased or decreased. In general, the largest deviations occur in transitions into informality, which expanded over the analyzed period. Parallel to the growth in informality, the differences in the stock of workers in formality and unemployment declined, although to a lesser extent. These results align with the model's dynamics, as labor supply depends both on transition probabilities and on variations in nominal wages.

One of the key contributions of this model is its ability to assess differences in labor market transitions that influence the aggregate behavior of labor supply—that is, to compute worker transition mobility rather than merely the final number of workers in each occupation. Analyzing the dynamics of labor market transitions is crucial because it provides a more detailed and realistic perspective on changes in employment and unemployment over time. In this regard, Figure 6 illustrates the trajectories of deviations caused by the payroll tax reduction policy on labor market transitions, considering informality, formality, and unemployment.

Driven by wage differentials, Figure 6 reveals an increase in the persistence of informality, as well as a rise in transitions into informality from both unemployment and formality, particularly in the early years of the simulation. In general, as highlighted in the descriptive analysis, there is a significant disparity between wages in formal and informal occupations. Furthermore, this new reallocation of labor supply results from earnings variations

induced by the payroll tax reduction policy, combined with workers' sensitivity to wages, which represent the nominal price of labor. Regarding transitions of initially unemployed individuals, the results show a decline in unemployment persistence compared to the reference scenario, driven by an increase in transitions into informality.

Figure 7 – Transitions in National Labor Supply from Informality, Formality, and Unemployment, Accumulated Percentage Variation Relative to the Reference Scenario, 2024-2040



Source: Own elaboration based on SHIFT model.

Overall, these results raise an important discussion on (in)formality, labor market mobility, public policies, sectoral interdependence of labor, and regional disparities in Brazil. While existing studies in the literature have considered informality within a Computable General Equilibrium (CGE) approach, such as Estrades and Terra (2011), Erero and Bonga-Bonga (2018),

Akbulut and Eğen (2021), and Bonga-Bonga and Erero (2024), these analyses are based on national-level models. As a result, such simulations overlook the fact that even labor market policies designed at the national level—without an explicit regional focus—can significantly impact regional disparities, especially when considering the transition dynamics of labor supply and the workforce reallocation patterns in the labor market. This finding represents one of the key contributions of the proposed model in this study.

5. Conclusion

Informality is a significant characteristic of the Brazilian labor market and a structural issue that affects a substantial portion of the workforce. Although it is a recurring topic among economists and policymakers, less emphasis has been placed on studying the dynamics of transitions and worker mobility between formal and informal occupations, as well as the regional disparities observed in a country of continental dimensions such as Brazil, where different states and economic sectors exhibit distinct patterns of informality and formalization.

In this context, the general objective of this paper was to develop a Computable General Equilibrium (CGE) model incorporating detailed components of both the demand for and supply of informal labor within a dynamic and interregional CGE model called SHIFT. Specifically, regarding labor demand, in the proposed model, each productive sector requires a set of occupations, hierarchically distributed between low- and high-skilled workers and, subsequently, between formal and informal workers. Furthermore, the model includes the endogenous behavior of labor supply through transition matrices, which support workers' responses to variations in relative prices.

Using these incorporated details, this study aimed to assess the macroeconomic, sectoral, and regional impacts of a policy aimed at formalizing Brazilian workers. Specifically, the simulation analyzed the impact of a 10% payroll tax reduction across all economic sectors, observing its short- and long-term effects. It is important to note that the reduction in formal labor costs was offset by a cut in government spending equivalent to the tax revenue loss caused by the policy.

Initially, the results of the descriptive analysis confirmed that mobility within the informal labor market is high, whereas transitions to formal employment are more restricted, occurring more frequently in the southern states of Brazil. Conversely, in the northern and northeastern states, both a higher prevalence of informality in the labor market and a greater permanence of workers in this occupational category were observed.

The simulation results indicated that the payroll tax reduction policy generates positive effects on long-term economic growth, fostering increases in production, employment, and exports. These outcomes are driven by the reduction in labor costs, which consequently lowers production costs across different economic sectors. As expected, formal employment was the most impacted by the policy. However, albeit to a lesser extent, informal labor also benefited indirectly due to the overall increase in economic activity. Among skill levels, the payroll tax reduction policy had a greater impact on the demand for low-skilled formal workers.

Regionally, however, these effects are heterogeneous. The observed positive impact on formal employment at the national level is primarily driven by the contributions of the southern and southeastern states, whereas the northern and northeastern states predominantly exhibit a negative impact on formal employment. Several factors may explain these results. Since informality is more prevalent in these regions, the reduction in formal labor costs makes production relatively more expensive in these areas due to the limited substitutability between different types of labor.

Additionally, when analyzing labor supply behavior, a new reallocation of workers in response to wage variations resulting from the payroll tax reduction policy was observed, with most transitions involving movement into informal employment. Consequently, the overall

conclusion of this analysis underscores the need for differentiated regional public strategies, given that disparities in informality levels across Brazil make the implementation of uniform policies nationwide challenging. Moreover, different transition patterns are observed across Brazilian states, suggesting the existence of structural barriers that hinder this transition in certain regions.

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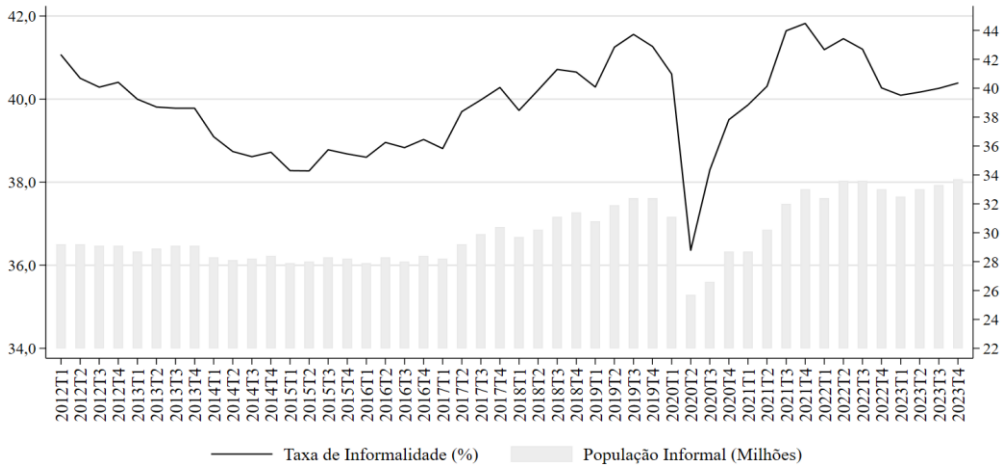
Appendix

Figure A1 – Informality Rate, Brazil, 2012-2023



Source: Own elaboration based on PNADC data.

Table A1 – Basic Structure of Economic Agents and Regions in the SHIFT Model

Economic agents		**Regions**	
A representative firm for each of the 35 sectors		27 federative units (26 states and a federal district)	
35 Sectors in each of the regions.			
One representative family for each region.			
Government.			
Investors.			
External Sector			
Sector			
1	Agriculture	19	Water, Sewage, Recycling, and Waste Management
2	Livestock, Fishing, and Forestry	20	Construction
3	Extractive Industry	21	Commerce
4	Food	22	Transportation
5	Beverages	23	Lodging and Food Service
6	Textile Product Manufacturing	24	Information and Communication Services
7	Apparel and Accessories	25	Financial Intermediation, Insurance, and Supplementary Pension
8	Footwear and Leather Artifacts	26	Rent and Real Estate Activities
9	Pulp, Paper, Cardboard, Packaging, Paper Artifacts, and Printing Services	27	Professional, Scientific, and Technical Activities
10	Pulp, Paper, Cardboard, Packaging, Paper Artifacts, and Printing Services	28	Administrative and Support Services
11	Chemical Products	29	Collective Public Administration Services
12	Rubber and Plastic	30	Public Education
13	Non-metallic Minerals, Metallurgy, and Metal Products	31	Private Education
14	Electrical and Electronic Machinery and Equipment	32	Public Health
15	Mechanical Machinery, Vehicles, and Parts	33	Private Health
16	Manufacture of Furniture Articles	34	Arts, Culture, Sports, and Recreation Services
17	Other Industries	35	Associative Organizations and Other Personal and Domestic Services
18	Electricity, Gas, and Other Utilities		

Source: Own elaboration based on SHIFT model.