The Long-run Effects from Lockdown in Ceará Economy in Light of Productivity*

A Recursive CGE Approach

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Resumo

O artigo investiga alterações na produtividade da economia cearense advindas dos efeitos do Lockdown na estrutura de capital humano. Para tanto, é proposta uma modificação do modelo CGE do Ceará (Mares-CE) onde se incorpora dinâmica e se considera heterogeneidade nos níveis de instrução da força de trabalho, dividindo a mão de obra em baixa, média e alta qualificação. Supondo que o Lockdown faça com que as pessoas socialmente vulneráveis interrompam sua escolarização e entrem mais cedo no mercado de trabalho, realizamos simulações e comparamos os resultados com um cenário de benchmark. O aumento na desigualdade de instrução torna a economia abundante em mão de obra pouco qualificada. No longo prazo, isso resulta numa produção industrial crescente, com menores níveis de preços, e num aumento da dependência de importações de serviços, com preços mais elevados. De modo agregado, a alteração na composição de capital humano resulta numa redução de 8,75% do PIB real quando comparado ao cenário base. A maior inflação percebida foi da família de alta qualificação, 15,76% maior do que o cenário base. O governo desempenha um papel importante na poupança doméstica e na seguridade social por diminuir seu débito, abrindo espaço para uma poupança interna maior (5,04% superior ao cenário contrafactual), e por prover 33,29% da renda da família de baixa qualificação.

Classificações: Área 1. **JEL:** C68, I24, J11.

Palavras-chave: *Lockdown*; Produtividade; CGE Recursivo; Curva de Kuznets; Ceará.

Abstract

The article investigates changes in productivity in the Ceará economy arising from the effects of Lockdown on the human capital structure. Therefore, a modification of the CGE model of Ceará (Mares-CE) is proposed, which incorporates dynamics and considers heterogeneity in the levels of education of the workforce, dividing the workforce into low, medium, and high qualifications. Assuming that Lockdown causes socially vulnerable people to interrupt their schooling and enter the labor market earlier, we ran simulations and compared the results with a benchmark scenario. The increase in educational inequality makes the economy abundant in unskilled labor. In the long run, this results in growing industrial production, with lower price levels, and increased dependence on service imports, with higher prices. In aggregate, the change in the composition of human capital results in a reduction of 8.75% of real GDP when compared to the baseline scenario. The highest inflation perceived was from the high-skilled family, 15.76% higher than the baseline scenario. The government plays an important role in domestic savings and social security by reducing its debt, opening space for greater domestic savings (5.04% higher than the counterfactual scenario), and by providing 33.29% of the low-skilled family's income.

Classifications: Area 1. **JEL:** C68, I24, J11.

Keywords: Lockdown; Productivity; Recursive CGE; Kuznets Curve; Ceará.

1 Introduction

We calculate the long-run impacts from Covid-19 Pandemics in Ceará's economy bearing in mind the different effects caused by lockdown on the education process and so on the productivity of labor. As way of finding such impacts, we modify the Ceará's CGE-model [1] by expanding the household's representation in three different

[1]Computable General Equilibrium

agents by education level (low, middle, and high), and therefore your respective supply of labor; inserting time recursion in the model; and simulating scenarios with and without pandemic's shock. This shock is on the growth rate of three families during a discrete-time. To find the measures of growth rates we estimate the schooling Kuznets Curve for Ceará as a mean to show us what stage of distribution of education the labor market is in and where this distribution will move.

Therefore, this paper brings a methodological novelty in the literature by considering the impact as for changements related to the pandemic in the economic environment through time with the interaction of heterogeneous households. We don't expect being the same the sensibility of wages to education after the entire workforce offers differently less education, for instance. In order to estimate the new income level, we should consider the interaction in the labor market, and this is what CGE models do.

The CGE-instrumental is largely adopted for taking into account holistic aspects from shocks in the economy. In the national context, Domingues [2002] uses the SPARTA multicountry model to analyze the sectoral impacts of trade openness of Alca in São Paulo. Cury et al. [2005] construct a model that divides the families by urbanization (urban and rural), categories of *per capita* income (poor, average, and high), and households head characteristics (active and non-active) with involuntary unemployment, provided by an empirical Wage Curve to analyze distributional aspects regarding fiscal policies. Haddad and Domingues [2001] develop the EFES model: a Johansen-type recursive model [2] for Brazil that forecasts changes in exports and technological progress of sectors (1999 to 2004). They adopted the expected return of capital in the next period to allocate the capital in the present period using deterministic equations and a single-family representation.

Ceará's government and scholars usually stand at attention general equilibrium models for guiding public policies decisions. Lucio et al. [2020] make use of a recursive CGE directly applied to Ceará in order to analyze efficiency in tax collection as way to overcome fiscal puzzles issued from COVID-19 pandemic; they focused on the revenue structure of government argent. Paiva [2019] build a dynamic CGE model to examine lasting and passing effects of public investment occurred lately in Ceará whether it was indeed effective in the long-run term, attempting to the marginal return of the public capital stock. Paiva and Neto [2021] proposed a wide CGE model employed to advise state decisions, called MARES-CE, provided with a single-family, many sectors openness, and foreign trade with rest-of-the-Brazil and world. This model will be modified in this work in view of our aims.

In our proposed model, we have three types of families, each one labeled by education level. Such apparatus enables us to grasp whether families with different instructional structures differ in consummatory behavior. As Michael [1975] has pointed out, the level of formal education directly influences consumer behavior apart from its result on money income, and this educational effect is not purposeless, but is systematically related to the changes in consumption patterns due differences in levels of income. We believe that this structure is meaningful to explain much better the consumption decision taken by families, as consequence becoming model robust.

The issue of schooling tied with advances in the labor productivity (or human capital) is fairly uncontroversial in the literature (Schultz [1963] and Hanushek [2002]), i.e, there is a connection between labor productivity, income and economic growth to the quality of educational systems. Such point serves to justify the current weight put by local government on education. By the way, Carneiro and Irffi [2017] let us know that Ceará pioneered, since 1996, the improvement of education in order to reach its quality by scoring external exams using transfer funds. As consequence, the state became nationally ranked in Basic Education Development Index (IDEB) [3]. Our work intends to offer to policy makers a mean to predict, in the pandemic context, what

[2] A wide-sector model with linearized equations of interaction among sectors, highly inspired in the Input-output matrix. Also called as Australian-tradition of CGE models. For more details, see Dixon et al. [2013].

[3] *News* accessed on September, 2021.

will happen with schooling levels of labor via Educational Kuznets Curve pattern.

Separation of households by schooling entails a sensible representation of the private/public unequal conditions that face the students, and the Educational Kuznets Curve considers it by assumption concerning pattern between average and variance of the quantity as for envisaged groups. Cavalcante et al. [2020] says that "the Covid-19 pandemic will impact educational inequality among students" and Henares et al. [2021] find that students, whose parents have superior education, scored 43% higher than others students in standardized math and writing tests, which seems to stand a high correlation between family environments with high education levels and a needed structure for making new high-skilled labor family.

To take the long-term is useful for contemplating the maturing-time as for results about human capital through education; this level of education entails consequences for entire labor-life. According to OECD [4], Brazil is up average regarding time of closed-school, and predictions show that it will affect the worldwide economy until the end of the century.

In line with such sort of works, de Barros [2020] estimates that around 5.3% or 23% from national GDP is lost in case of a year delayed for ending the studies, although ensures that Brazilian students will learn well regarding allowance to advance through the school year without ensuring that they learned well during the lockdown, respectively. The author takes, for the first instance, the present value of the mean to income lost if the students delay a year entry into the labor market, keeping constant the reported years of study; and, for the second instance, the contracting firm considers one year of study less than the years reported. In addition, González and Capilla [2020] reported that the Spanish youngers would be the wages reduced by 0.5 p.p. during their lives if remotes classes during one year of lockdown have half of the efficacy of the presential classes. They apply to Spain an empirical estimate of Jaume and Willén [2019] for Argentine, where finds that 88 days of the teachers strike reduced the wages of males and females students of the primary school by, respectively, 3.2% and 1.9% for ten years starting at the ages of 30, this is a loss in annual aggregate earnings of labor of 2.99%.

2 Methodology

2.1 The CGE Recursive Model

We adopt the Ceará's CGE-model, named MARES-CE, adduced by Paiva and Neto [2021] and modify them according the structure of Hosoe et al. [2010], and recusiveness in Hosoe [2013]. The proposed model is schematized as follows in Figure 1.

There is three different labor factors (L^1, L^2, L^3) which are divided by instruction level[5] belonging to each family, $l = (F^1, F^2, F^3)$, respectively. Conjoined with capital (K) are inputs in first aggregation using an Cobb–Douglas function to results the aggregated-factor (Y). In the next step, a Leontief function joins the aggregated factor (Y) with intermediate inputs of the firms (X^{int}) to make the gross domestic output (Z).
Now, we enter in the trade with foreign. The gross domestic output is separated to domestic market (Q^s), world exports (E^w), and to rest-of-the-Brazil (E^{br}) using an CET [6] function. The goods to domestic market (Q^s) is joined with imports from world (M^w) and the remaining Brazil (M^{br}) using an CES [7] function to forms the

[4] *News* accessed on April, 19.

[5] In the division by schooling for labeling families, L^1 was considered people with incomplete high school to no education. For L^2, complete high school, and for L^3, complete or incomplete college education.

[6] Constant Elasticity of Transformation

[7] Constant Elasticity of Substitution

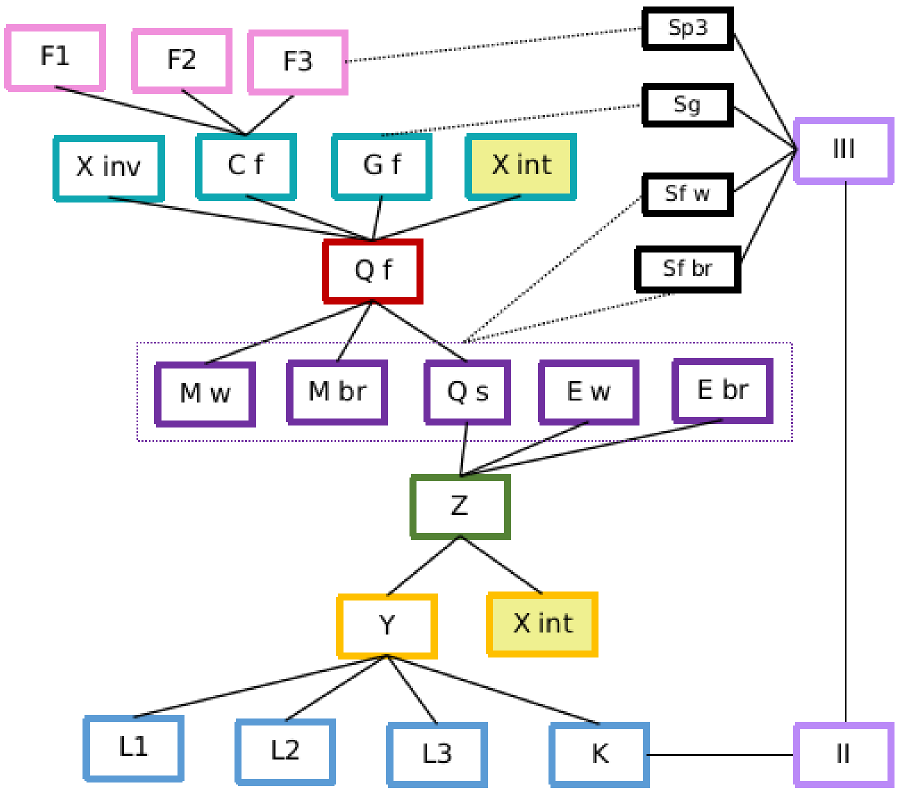

Figure 1: Representative Scheme of Proposed Model. Own elaboration.

Ceará's aggregate supply (Q^f).With respect balance of payments as foreign trade, we have also net savings from world (S^w) and remaining Brazil (S^{br}).
The aggregate supply is divided among the consumption of each families (C_{f1}, C_{f2}, C_{f3}), government consumption (G^f), intermediate inputs of the firms (X^{int}), and investment good (X^{inv}). Each family and government also have saving in their corresponding balance of payments (S_l^p and S^g, respectively). All savings are summed and divided by the price of capital-commodity (p^{III}) to make the real amount of capital available (III) that will be adopted in two ways: output of investment good (X^{inv}) function and shared in each sector as investment (II), to form the capital of every firm (K). The equations will be detailed in next section.

The SAM [8] put forwarded by Paiva and Neto [2021] to Ceará's economy is reduced (details in Table 3, Appendix 1). Regard divisions between families, we apply rates for new SAM to Ceará following what is proposed in Section 2.1.9.

2.1.1 Firm

We get three firms representative of three commodities, namely: agriculture, industry, and services. For each period, t, each firm, i, four inputs are required, h, to maximize the profits:

$$Max_{(Y_{i,t},F_{h,t})} \quad \Pi_{i,t} = p^Y_{i,t} Y_{i,t} - \sum_h p^F_{h,i,t} F_{h,i,t} \tag{1}$$

[8]Social Accounting Matrix

Where $\Pi_{i,t}$ is the profit of each firm in each period; $p^Y_{i,t}$ is the price of each output; $p^F_{h,i,t}$ is the price of each factor; and $F_{h,i,t}$ is the factor needed for each firm in time. This profit-equation is subjected to production function:

$$Y_{i,t} = b_{i,t} \prod_h F_{h,i,t}^{\beta_{h,i}} \tag{2}$$

In which $b_{i,t}$ is the TPF [9] that change in time; and $\beta_{h,i}$ is the elasticity of production. Resulting this demand for factor:

$$F_{h,i,t} = \left(\frac{p^Y_{i,t} \beta_{h,i}}{p^F_{h,i,t}} \right) Y_{i,t} \tag{3}$$

2.1.2 Intermediate Inputs

In this step, every firm employs each one final-commodities as intermediate input, with a profit maximization:

$$Max_{(Z_{i,t}, Y_{i,t} X^{int}_{i,t})} \quad \Pi_{i,t} = p^Z_{i,t} Z_{i,t} - (p^Y_{i,t} Y_{i,t} + \sum_j p^{Qf}_{j,t} X^{int}_{j,t}) \tag{4}$$

In which $i \equiv j$; $p^Z_{i,t}$ is the price of each gross domestic output in time ($Z_{i,t}$); and $p^{Qf}_{j,t}$ is the price of each final-commodity supplied in Ceará. Subject to a Leontief:

$$Z_{i,t} = min \left(\left[\frac{X^{int}_{j,i,t}}{ax_{j,i}} \right]_j , \frac{Y_{i,t}}{ay_i} \right) \tag{5}$$

Where $ax_{j,i}$ and ay_i are the proportion of final-commodity X^{int}_j and $Y_{i,t}$, respectively. That are used as intermediate input for gross domestic output ($Z_{i.t}$). What results in equations for demand of intermediate inputs:

$$X^{int}_{j,i,t} = ax_{j,i} Z_{i,t} \tag{6}$$

$$Y_{j,i,t} = ay_{j,i} Z_{i,t} \tag{7}$$

With a price-formation [10] of $Z_{i,t}$:

$$p^Z_{i,t} = ay_{j,i} p^Y_{i,t} + \sum_j (ax_{j,i} p^{Qf}_{j,i,t}) \tag{8}$$

2.1.3 Foreign Trade

First, we get a maximization representative of optimal choice between exports and sell for domestic demand:

[9] Total Productivity of the Factors

[10] We can't find the optimal solution of an Leontief-type by differential coefficients. So, we apply the Equations (6) and (7) in zero-profit condition of perfect competitive market ($\Pi_{i,t} = 0$) in Equation (4).

$$Max_{(E^w_{i,t}, E^{br}_{i,t}, Q^s_{i,t}, Z_{i,t})} \quad \Pi_{i,t} = (p^{E^w}_{i,t} E^w_{i,t} + p^{E^{br}}_{i,t} E^{br}_{i,t} + p^{Q^s}_{i,t} Q^s_{i,t}) - (1 - \tau^Z_{1,i} - \tau^Z_{2,i}) p^Z_{i,t} Z_{i,t} \tag{9}$$

Such as $p^{E^w}_{i,t}$ and $p^{E^{br}}_{i,t}$ are, respectively, the price in domestic currency of exported commodities to world and remaining Brazil. The domestic prices are endogenous while the two foreign prices are exogenous once Ceará is a price-taker of the world and of the rest-of-the-Brazil. Exchange rates are replaced by broader variables: external/ internal margin of commerce (Mg^w, Mg^{br}), both endogenous. $p^{Q^s}_{i,t}$ is the price of commodities that stay in Ceará; $\tau^Z_{1,i}$ is tax on the circulation of goods and services, called ICMS; and $\tau^Z_{2,i}$ is others taxes rate. Subject to:

$$Z_{i,t} = \theta_i (\xi_1 (E^w_{i,t})^\phi + \xi_2 (E^{br}_{i,t})^\phi + \xi_3 (Q^s_{i,t})^\phi)^{\frac{1}{\phi}} \tag{10}$$

$$\sum_{s=1}^{3} \xi_s = 1 \tag{11}$$

$$0 \leq \xi_s \leq 1 \ \ \forall s \tag{12}$$

Where θ_i is scale parameter; ξ_s is share coefficients; and ϕ is a parameter defined by the elasticity of transformation [11] .That results in demand equations:

$$E^w_{i,t} = \left[\frac{\theta^\phi_i \xi_1 (1 + \tau^Z_{1,i} + \tau^Z_{2,i}) p^Z_{i,t}}{p^{E^w}_{i,t}} \right]^{\frac{1}{1-\phi}} Z_{i,t} \tag{13}$$

$$E^{br}_{i,t} = \left[\frac{\theta^\phi_i \xi_2 (1 + \tau^Z_{1,i} + \tau^Z_{2,i}) p^Z_{i,t}}{p^{E^{br}}_{i,t}} \right]^{\frac{1}{1-\phi}} Z_{i,t} \tag{14}$$

$$Q^s_{i,t} = \left[\frac{\theta^\phi_i \xi_3 (1 + \tau^Z_{1,i} + \tau^Z_{2,i}) p^Z_{i,t}}{p^{Q^s}_{i,t}} \right]^{\frac{1}{1-\phi}} Z_{i,t} \tag{15}$$

In second stage, is jointed what stay in Ceará with imports from world and remaining Brazil to form the aggregate supply of the territory in a maximization issue:

$$Max_{(M^w_{i,t}, M^{br}_{i,t}, Q^f_{i,t}, Q^s_{i,t})} \quad \Pi_{i,t} = p^{Q^f}_{i,t} Q^f_{i,t} - [(1 - \tau^{M^w}_i) p^{M^w}_{i,t} M^w_{i,t} + p^{M^{br}}_{i,t} M^{br}_{i,t} + p^{Q^s}_{i,t} Q^s_{i,t}] \tag{16}$$

Where $p^{M^w}_{i,t}$ and $p^{M^{br}}_{i,t}$ are, respectively, the price in domestic currency of imports commodities from world and from world and remaining Brazil; $p^{Q^f}_{i,t}$ is commodity prices, which are aggregated supply in Ceará; and $\tau^{M^w}_i$ is rate tax on international imports. Subject to:

$$Q^f_{i,t} = \vartheta_i (\delta_1 (M^w_{i,t})^\eta + \delta_2 (M^{br}_{i,t})^\eta + \delta_3 (Q^s_{i,t})^\eta)^{\frac{1}{\eta}} \tag{17}$$

$$\sum_{s=1}^{3} \delta_s = 1 \tag{18}$$

$$0 \leq \delta_s \leq 1 \ \ \forall s \tag{19}$$

[11] $\phi = \frac{\psi+1}{\psi}$ and ψ is the elasticity of transformation, was been considered equal to 1.5.

Here, ϑ_i is scale parameter; δ_s is shared coefficients; and η is an parameter defined by the elasticity of substitution [12] .That results in demand equations:

$$M^w_{i,t} = \left[\frac{\vartheta_i^\eta \delta_1 p^{Q^f}_{i,t}}{(1+\tau_i^{M^w}) p^{M^w}_{i,t}} \right]^{\frac{1}{1-\eta}} Q^f_{i,t} \tag{20}$$

$$M^{br}_{i,t} = \left[\frac{\vartheta_i^\eta \delta_2 p^{Q^f}_{i,t}}{p^{M^{br}}_{i,t}} \right]^{\frac{1}{1-\eta}} Q^f_{i,t} \tag{21}$$

$$Q^s_{i,t} = \left[\frac{\vartheta_i^\eta \delta_3 p^{Q^f}_{i,t}}{p^{Q^s}_{i,t}} \right]^{\frac{1}{1-\eta}} Q^f_{i,t} \tag{22}$$

That are constrained by the national and international balance of payments, respectively:

$$S^{br}_t = (Mg^{br})^{-1} \sum_i (p^{M^{br}}_{i,t} M^{br}_{i,t} - p^{E^{br}}_{i,t} E^{br}_{i,t}) \tag{23}$$

$$S^w_t = (Mg^w)^{-1} \sum_i (p^{M^w}_{i,t} M^w_{i,t} - p^{E^w}_{i,t} E^w_{i,t}) \tag{24}$$

2.1.4 Government

In MARES-CE, every three levels (national, state and municipal) as for the State are viewed in a unique locally acting agent. The government have revenue based in households income taxation, production taxation, and international imports taxation as follows:

$$T^D_t = \sum_h \sum_l \sum_i \tau^D_{l,h} p^F_{h,i,t} FF_{h,l,t} \tag{25}$$

$$T^Z_t = \sum_i (\tau^Z_{1,i} + \tau^Z_{2,i}) p^Z_{i,t} Z_{i,t} \tag{26}$$

$$T^{M^w}_t = \sum_i \tau_i^{M^w} p^{M^w}_{i,t} M^w_{i,t} \tag{27}$$

Where T^D_t, T^Z_t, and $T^{M^w}_t$ are the amount of revenue from income, production, and importation, respectively. τ^D_h is the tax rate on the endowments of the families; and $FF_{h,l,t}$ is the endowments of the families, whose the demand-behavior is the following:

$$G^f_{i,t} = \frac{\mu_i}{p^{Q^f}_{i,t}} (T^D_t + T^Z_t + T^{M^w}_t) \tag{28}$$

Such as μ_i is the shared expenditure with each final-commodity. Restricted by:

[12] $\eta = \frac{\sigma - 1}{\sigma}$ and σ is the elasticity of substitution, was been considered equal to 2.

$$\sum_i G^f_{i,t} = (1 - ss^g)(T^D_t + T^Z_t + T^{M^w}_t - \sum_l TF_{l,t}) \tag{29}$$

$$\sum_i \mu_i = 1 \tag{30}$$

In which ss^g is the rate of the government savings and TF_l are direct transfers to each family, every exogenously given.

2.1.5 Heterogeneous Households

Consuming the final-commodities ($Q^f_{i,t}$), each family maximize the felicity-function:

$$Max_{C^f_l} \ UU_{l,t} = a_l \prod_i (C^f_{l,i,t})^{\alpha_{l,i}} \tag{31}$$

Where $UU_{l,t}$ is a consumption measure; a_l is a scale parameter; $\alpha_{l,i}$ is a share parameter of consumption. Restricted by:

$$\sum_i p^{Cf}_{i,t} C^f_{l,i,t} = \sum_h \sum_i (1 - ss^p_l - \tau^D_{l,h}) p^F_{h,i,t} FF_{h,l,t} + TF_{l,t} \tag{32}$$

$$\sum_i \alpha_{l,i} = 1 \tag{33}$$

That result in a demand function:

$$C^f_{l,i,t} = \frac{\alpha_{l,i}}{p^{Cf}_{i,t}} [\sum_h \sum_i ((1 - ss^p_l - \tau^D_{l,h}) p^F_{h,i,t} FF_{h,l,t}) + TF_{l,t}] \tag{34}$$

Therefore, the model maximizes the Benthamite Social Welfare Utility Function (SWU), that is neutral among families:

$$Max_{UU_{l,t}} \ SWU = \sum_l \sum_t \frac{UU_{l,t}}{(1 + ror)^{t-1}} \tag{35}$$

ror is the rate of return of the capital stock to capital service firms adopt.

2.1.6 Savings and Investment

We have three fonts of savings: the foreign sectors (Equations (23) and (24)); the government (Equation (36)); and the families (Equation (37)).

$$S^g_t = ss^g (T^D_t + T^Z_t + T^{M^w}_t - \sum_l TF_{l,t}) \tag{36}$$

$$S^p_{l,t} = ss^p_l \sum_h \sum_i [p^F_{h,i,t} FF_{h,l,t}] - TF_{l,t} \tag{37}$$

The aggregate saving forms the total investment in each period (III_t):

$$III_t = \frac{\sum_l S^p_{l,t} + S^g_t + (Mg^{br})S^{br}_t + (Mg^w)S^w_t}{p^{III}_t} \tag{38}$$

Will be used as output in production-function of the investment good and their demand, as follows:

$$III_t = \Lambda \prod_i (X^{inv}_{i,t})^{\lambda_i} \tag{39}$$

$$X^{inv}_{i,t} = \lambda_i \left(\frac{p^{III}_t}{p^{Qf}_{i,t}} \right) III_t \tag{40}$$

Λ is the scale parameter of production-function and λ_i is the share coefficient of production. This total investment is shared for each sector with:

$$II_{i,t} = \left(\frac{(p^F_{h=K,j,t})^\zeta F_{h=K,j,t}}{\sum_i (p^F_{h=K,i,t})^\zeta F_{h=K,i,t}} \right) III_t \tag{41}$$

Therefore:

$$\sum_j \left(\frac{(p^F_{h=K,j,t})^\zeta F_{h=K,j,t}}{\sum_i (p^F_{h=K,i,t})^\zeta F_{h=K,i,t}} \right) = 1 \quad \rightarrow \quad \sum_i II_{i,t} = III_t$$

ζ is an sensitivity-parameter of allocations to marginal rate of return of the investment, i.e., the price paid for capital. The higher ζ, greater will be the investment in better payers sectors, the less the size of the sectors will matter. Each investment destined to sector will update your capital stock ($KK_{i,t}$), that is immobilized in the sector once installed. The capital stock of the sector also forms the capital used by an rate (ror), as follows:

$$F_{h=K,i,t} = ror KK_{i,t} \tag{42}$$

2.1.7 Dynamics and Market-clearing Condictions

The dynamics side, there is an law motion of capital; growth of the three family-labor types; and technological progress, respectively:

$$KK_{i,t+1} = (1 + dep)KK_{i,t} + II_{i,t} \tag{43}$$

$$FF_{h,l,t+1} = (1 + pop_l)FF_{h,l,t} \tag{44}$$

dep is rate of depreciation of the capital stock; pop_l is the growth rate of each endowments.

To macro-closures, join with the Equations (23), (24), (29), (32), and (42):

$$Q^f_{i,t} = \sum_l C^f_{l,i,t} + G^f_{i,t} + X^{inv}_{i,t} + \sum_j X^{int}_{j,i,t} \tag{45}$$

$$\sum_i F_{h,i,t} = FF_{h,l,t} \quad \forall h = (L^1, L^2, L^3) \tag{46}$$

$$p^F_{h,i,t} = p^F_{h,j,t} \quad \forall h = (L^1, L^2, L^3) \tag{47}$$

As notice in Equations (46) and (47), equality is not covered by demanding factor, endowments, and price when $h = K$. This happens once the formation of the capital factor follows Equation (42) and endowments follows the population growth rate pop_l as observed in Equation (44); differences between capital stocks, given by Equation (43), lead to different prices of capital-factor. This is the key to capital immobility installed in sector.

2.1.8 Adjustment of Assumed Capital Growth

Until now, we have two different motions of capital: one attached by growth of families (Equation (44)), that is, the capital-endowment; and other attached by growth of the capital stock (Equation (43) and (42)), the capital-factor. Given these two movements, we have adjusted the investment good (X^{inv}) to the intended economic growth, following the growth of the capital-endowment:

$$II^{ASS}_t = \sum_l \left(\frac{pop_l + dep}{ror} \right) FF_{h=K,l,t} \tag{48}$$

The ratio of this lack, $adjust = \frac{II^{ASS}}{II^{SAM}}$, is employed to record the new investment good in the SAM:

$$X^{inv}_{i,t=00} = adjust X^{inv,SAM}_{i,t=00} \tag{49}$$

To maintain the equality between the sums of the rows and columns of the SAM, we apply the difference in exports as for remaining Brazil:

$$E^{br}_{i,t=00} = E^{br,SAM}_{i,t=00} - (X^{inv}_{i,t=00} - X^{inv,SAM}_{i,t=00}) \tag{50}$$

We have a new formation of foreign saving:

$$S^{br}_{t=00} = \sum_i (M^{br,SAM}_{i,t=00} - E^{br}_{i,t=00}) \tag{51}$$

The model will be calibrated by means of SAM values, namely the parameter $t = 00$.

2.1.9 Modiffing the SAM

To modify the SAM (Table 3), we use the Continuous National Household Sample Survey[13] from 2013 to divide the amount of the aggregated wages between instruction levels. To identify and divide the consumption,

[13]Known as PNAD-C, in portuguese: *Pesquisa Nacional por Amostra de Domicílios Contínua*, from Brazilian Institute of Geography and Statistics (IBGE).

private savings, and capital remuneration between families, we use the Consumer Expenditure Survey[14] (2008). In addition, we use the data of the Siconfi[15] for dividing the amount transferred directly and indirectly from the government to families, following the weight shared in population. To divide the share of the amount paid to income tax, we employ data related to the tax income (by levels of income), from Federal Revenue Service Agency[16] of 2013. The transfer and the income tax are also residually adopted to balance the sum of the SAM rows and columns. The results will be described in the next section.

2.2 Modelling the Shock

Lockdown will impact labor productivity in the long-term through the education process during the school closing. This impact will change the rates of growth of the groups of instruction, pop_l. But where were these rates going and where are they going? To answer such question, Langoni [1973] and de Barros and Mendonça [1995] finds a pattern of development in the labor market of many countries, in the distribution of instruction. Starting from a minimum level of education, while the average of education grows, the inequality in education level also grows. And it happens until a maximum level of inequality, forming an inverted-U-shaped curve between average and variance, called Kuznets Curve of Education, as seen in Figure 2.

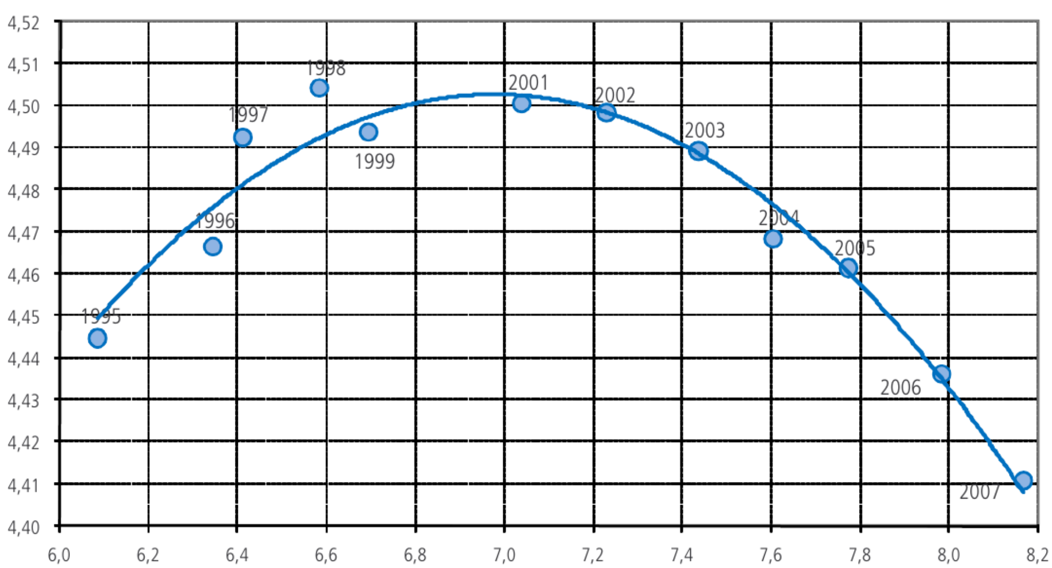

Figure 2: Level Inequality Evolution in Instruction of Brazilian Labor Force - Average Years Education, 1995-2007, de Barros et al. [2010] .

This pattern modeled to Ceará will lead us to new distributions of the families' population by finding in what stage of labor market Ceará lies. The rates of growth and decrease of the population will be used as counter-factual and Lockdown's shock scenarios, respectively.

[14]Known as POF, in portuguese: *Pesquisa de Orçamentos Familiares*, from Brazilian Institute of Geography and Statistics (IBGE).
[15]*Brazilian Public Sector Accounting and Tax Information System*. Annual Balance of the Financial Statements Applied to the Public Sector, for Ceará, 2013.
[16]Known as DIRPF, in portuguese: *Grandes Números das Declarações do Imposto de Renda das Pessoas Físicas*.

3 Results

3.1 The Ceará's Labor Market

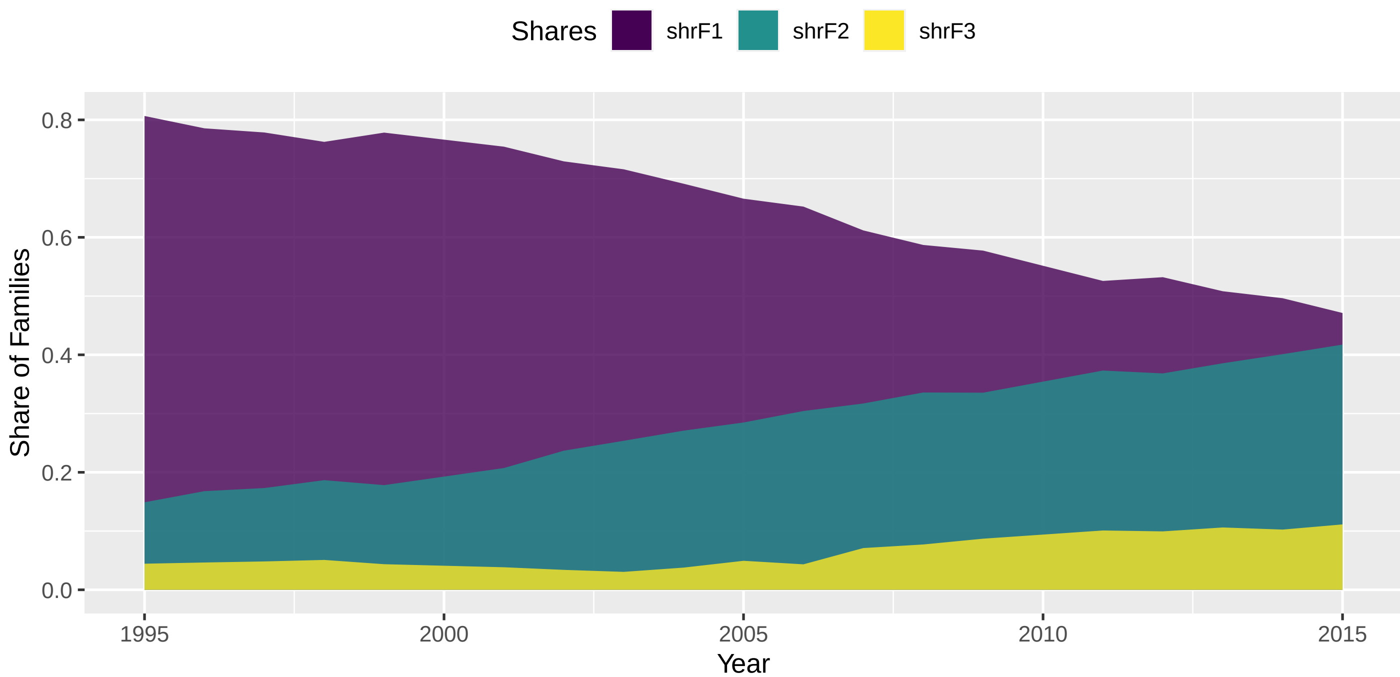

Figure 3: Share of the Families in Ceara Labour Market. 1995-2015. Authors Elaboration

Figure 3 shows what happens with the instructions group supplied in Ceará's labor market: a transition from low to the middle level concerning instruction. While the average growth rate of all periods to F^1 is -0.35%, to F^2 is 8.71%, and 8.04% to F^3. As result, the average of instruction has a mean of the annual growth rate of 3.86% The reduction of discrepancy is clear, as shown in the Kuznets Curve of Education, in Figure 4.

Regard the SAM- 2013, on this point, in Figure 4, any increase in the average of instruction leads to a smaller variance, and any reduction of average will move to greater variance. The rates of increase and decrease, starting in 2013, will be used in the simulation of scenarios of the model, as show the Table 1.

Table 1: Rates of Growth of the Population to Counterfactual and Lockdown Scenarios

	Counterfactual	Lockdown
pop_{F^1}	-0.04342	0.04539
pop_{F^2}	0.03855	-0.03712
pop_{F^3}	0.03435	-0.03321

Source: Authors elaboration.

3.2 The New SAM

The new SAM used to model is placed in Table 4, in Appendix 1. The shares to expand the amounts of SAM in Table 3 is detailed in Table 2 bellow.

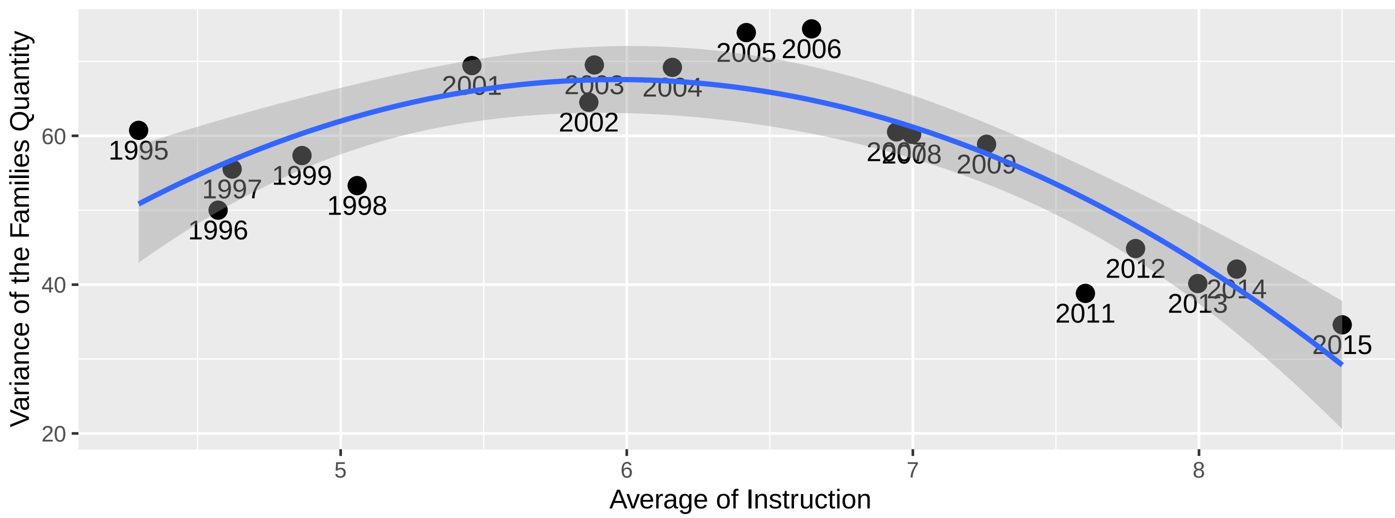

Figure 4: Ceara's Kuznets Curve – Education, 1995-2015. Average years in Instruction by Variance of the Count – Groups of Familie. Authors Elaboration

Table 2: Shares of Divide Original Amounts.

Variables	Family 1	Family 2	Family 3
Consumption of Goods			
Agriculture	0.3773	0.3261	0.2967
Industry	0.3202	0.2915	0.3883
Services	0.2925	0.3013	0.4062
Saving			
Invesment	0.0506	0.1473	0.8022
Factors Remuneration			
Agriculture	0.8685	0.1117	0.0198
Industry	0.6193	0.3067	0.0741
Services	0.2451	0.2992	0.4557
Capital	0.0512	0.1701	0.7787
Government			
Income Tax	0.0043	0.0248	0.9709
Transfers	0.6052	0.3601	0.0347

Source: Authors elaboration.

To better understand the picture around these shares, economically active population is composed of 55.64% (Family 1), with low education level; 30.12% (Family 2) with middle instruction; and 14.24% (Family 3) with high instruction. Despite this participation, Family 1 is the owner of 32.17% of the wage mass while Family 2 and Family 3 are the owner of 29.41% and 38.42%, respectively.

The offer of public education, public security, and public health represents purchases from the families to sectors that are possible due to transfers from government to families. We see the redistribution nature of the government activity, for example: while the direct tax of the total income is 19.33% (Family 3), 0.17% (Family 1); and while the direct transfers from the government represent 0.78% of the Family 3 revenue; 27.57% is from Family 1.

In the savings line of the SAM, we see, thanks to the dissaving of the government, the calibration of the saving share (ss^g) results in -0.6263 making a structurally indebted agent. The major endogenous font of savings is the Family 3 who owns, according to Table 2, 88.22% of all private investment and has $ss^p_{l=F^3}$ = 0.2391, the major between the families. The capital-endowment is highly concentrated in this family too, that have 77.88% of the total of this remuneration. This shows us that pop_{F^3} may guide, through time, almost entire of domestic savings and, thus, the good-of-investment ($X^{inv}_{i,t}$) and the investment immobilized ($II_{i,t}$)[17].

The capital-remuneration of the Agriculture, Industry and Services are 83.92%, 47.03%, and 42.78%, of the total remuneration of the factors of each, respectively. So, Agriculture is most capital-intensive and Service is a high-skilled labor-intensive production process. Between the labor-force employed by each sector, we see in Table 5 high participation of L^1 in the Industry production process. This gives us the sense that, under pop_{F^1} = -0.0434 of the counterfactual scenario, Industry will suffer more with this diminishing population, and Agriculture, because pop_{F^3} = 0.0343, will benefit from the increase of the savings and consequently increase of the investment immobilized. Additionally, 45.57% of the labor-remuneration of the Service is to high-skilled family; in Lockdown's scenario, will suffer more with this diminishing population. This gives us a sense of what will happen with the factor-aggregation of each sector during the time in the simulations. The parameters from the calibration are shown in Appendix 2.

3.3 Counterfactual Instance

The main model result in counterfactual simulation is the power purchase of the different instruction levels analyzing side-by-side the Laspeyres index to perceived prices (Table 17) and to remuneration (Table 18)[18]. Because L^1 becomes rare, reaching 9.69% of the labor market population, the corresponding remuneration grows up by 6.47% per year, in twenty years, and the remuneration of L^2 and L^3 decrease at 1.89% and 1.44%

[17]Rearranging the Equations (38) and (40), we see the relationship between savings and good-of-investment:

$$X^{inv}_{i,t} = \lambda_i \left(\frac{\sum_l S^p_{l,t} + S^g_t + S^{br}_t + S^w_t}{p^{Q^f}_{i,t}} \right)$$

and rearranging the Equations (38), (41), (43), and (42) we see the relationship between savings and capital-factor:

$$F_{h=K,i,t+1} = ror \left[(1+dep)KK_{i,t} + \left(\frac{(p^F_{h=K,i,t})^{\zeta} F_{h=K,i,t}}{\sum_j (p^F_{h=K,j,t})^{\zeta} F_{h=K,j,t}} \right) \left(\frac{\sum_l S^p_{l,t} + S^g_t + S^{br}_t + S^w_t}{p^{III}_t} \right) \right]$$

[18]The Laspeyres perceived price index is:

$$IP_l = \left(\frac{\sum_i p^{Q^f}_{i,t=20} C^f_{l,i,t=1}}{\sum_i p^{Q^f}_{i,t=1} C^f_{l,i,t=1}} \right) - 1$$

And the Laspeyres remuneration index is:

$$IR_l = \left(\frac{\sum_h \sum_i p^F_{h,i,t=20} FF_{h,l,t=1}}{\sum_h \sum_i p^F_{h,i,t=1} FF_{h,l,t=1}} \right) - 1$$

The reason to consider the Laspeyres index is to purge the quantity growth effect of the pop_l under endowments and the government transfers in the utility measure. In the model, the single representative family is receiving more transfers, paying more tax, and consuming more, as example. This means that the population is receiving, paying, and consuming a larger amount as it grows, not that every person in the population is receiving more net transfers or consuming more.

per year while the remuneration of the capital falls. As result, the Laspeyres remuneration index for families decrease to F^2 and F^3, in 28.09% and 23.56%, respectively. The Laspeyres price index for the three families are 0.18%, 0.39%, and 0.33%, respectively; it means that all families need a bit less money to keep the same living standard. We understand that the new set of factor remunerations decrease more than the price index to families F^2 and F^3, so these two families have decreasing power purchase; i.e., we can explain the growth of the F^2 and F^3 utilities only by populations growth. Let's understand how this happens.

Despite the government dissaving, which grows up at 2.77% per period, the domestic savings is positive but diminishing at 0.23% per year. In the series beginning, domestic savings reached 12.99% as a whole; but foreign savings grew at 2.47% per year, becoming 91.74% in the simulation end. There was an average growth of III of 2.10% per year (Table 14), thanks to the foreign savings, which marks this importance to Ceará's economy. The transformation from savings to investment became a bit more expensive: Mg^{br}/p^{III} and Mg^{w}/p^{III} decreased 0.04% and 0.15% per year, respectively. The III allocation to sector follows Figure 12, we find that Industry decreases its return to capital-factor while the marginal remuneration of capital in Services grows, as well as its receipt of new investments. With III growth, grows too X^{inv} (Table 15).

As we see in Figure 5, to maintain the education growth level in Ceará would cause a reduction in low-skilled labor that implies a higher price for that factor, which is explained by the bargaining power mechanism[19]. The remuneration of L^2 and L^3 reduce by both Quantity Effect and Price Effect: greater quantity offered not only causes a decrease in remuneration, because of bargaining power, but also due to a lower premium sensibility for one higher instruction level. The diminishing price effect is largely found in developing economies[20]. Under these factors-price dynamics, the aggregated factor (Y_i) and gross production (Z_i) grew at the same average rate to Agriculture, Industry, and Service at 2.17%, 1.11%, and 2.23% per year, respectively. So, Agriculture benefits because is capital-intensive, Services benefits because is high-skilled labor-intensive between labors, and Industry grows less because is low-skilled labor-intensive. Indeed, by the cost Laspeyres index perceived by each firm[21], in Table 19, Industry felt the higher increase costs. So, in this scenario, the nominal and real GDP[22] grow at an average of 1.88% and 2.62% per year, respectively.

The prices received from gross domestic production ($p^{Z}_{i,t}$) represented in Figure 8, is used with $p^{Q^s}_{i,t}$, $p^{E^{br}}_{i,t}$, and $p^{E^{w}}_{i,t}$, as in Figure 9 and 10, to decide how much stay in domestic market and how much is exported. We see that sell Industry to the internal market is more interesting because $p^{Q^s}_{i,t}$ grow at 0.38% per year while the export price to world and remaining Brazil grows 0.01% and 0.11%, respectively. The decrease of $p^{Q^s}_{i,t}$ to Agriculture and Service, at 0.42% and 0.22%, causes exportation grows more than what stays in the economy, as detailed in Table 15. On the other hand, the Industry's $p^{Q^s}_{i,t}$ growth rate also leads to imports growth rate higher than the domestic growth rate. Concluding the foreign relations, it comes to supply the internal need for industrial products.

The imports in total Ceará's supply started with 18.13% and ends with 16.17%. Agriculture, Industry, and Service went from 4.18%, 47.82%, and 47.99% to 4.06%, 45.25%, and 50.69%, respectively, under the prices showed in Figure 13. With the fall of F^1, the price of the Industry's output increases, a pattern that we see in all model steps. It happens a substitution from Industry to Services in agents consumption (Table 15). This scenario still results in an increase in welfare to all families (Table 16). Finally, the government increases its

[19] See Barufi et al. [2017] for more details and empirical finds to Brazil's regions.

[20] See de Barros et al. [2007] for more details and empirical finds to Brazil.

[21]

$$IC_i = \left(\frac{\sum_h p^F_{h,i,t=20} F_{h,i,t=1}}{\sum_h p^F_{h,i,t=1} F_{h,i,t=1}} \right)$$

[22] Gross Domestic Product, the total of remunerations: $\sum_i \sum_h p^F_{h,i,t} F_{h,i,t}$. The real-value is $\sum_i \sum_h p^F_{h,i,t=1} F_{h,i,t}$.

revenue through the market taxes and tax income from growing F^2 and F^3 while decreasing their transfers as F^1 population decline either; its structural debt space grows at 2.77% per year (Table 14).

Concluding the counterfactual scenario, we saw a specialization of the economy in Services, with the high-skilled labor-intensive process, and Agriculture, which is capital-intensive; the foreign trade improves industrial product; and growth of utility to all families.

3.4 The Pandemic Turn

The lockdown simulation responds to the question: "what will happen if only the proportions of education levels change, even keeping the foreign savings inflow constant?" The main answer lies in the Government, which plays an important role in growing its transfers to the growing low-skilled population (Table 16). In this scenario, with diminishing F^2 and F^3, our total tax revenue reached to be 82.13% of the total revenue in the counterfactual scenario at the end of the period's simulation. On other hand, its total transfers reach 147.61% in the final period's comparison with counterfactual. This difference implies a reduction in its debt capacity: its dissaving grown 0.15% per year and ended being 61.14% of the counterfactual debt. This open space to major domestic savings, which ends being 161.09% of the counterfactual. Let's understand how this works.

The domestic savings growth causes a growth in total savings, that ends 105.04% of the counterfactual total. The transformation from foreign savings to investment (Mg^{br}/p^{III} and Mg^{w}/p^{III}) grow 0.28% and -0.24%, respectively. As result, the total investment grows and ends being 103.44% of the base scenario.

Occurs that Industry and Agriculture grow more because the economy is becoming low-skilled and capital abundant. Differing from counterfactual, the remuneration to capital-factor decreases faster and Agriculture becomes the better payer to this factor. As result, the nominal and real GDP grew at 1.33% and 2.13% per year, respectively. In comparison with Counterfactual, this GDP ends 8.75% smaller; the difference grows at an average of 13.91% per year.

The Ceará's economy goes to the foreign market with expending Services and cheaper Industry and Agriculture. The higher fall speed to $p_{i,t}^{Q^s}$ in comparison to $p_{i,t}^{M^{br}}$ and $p_{i,t}^{M^w}$ makes Agriculture exportation grow to world and remaining Brazil. The Industry exportation grows to both economies and especially more to the world. The import stage fills the need in the Services sector, with imports of the Services commodity from the remaining Brazil being the fastest growing in the period, at 3.73% per year (Table15).

The final supply reaches the end of the simulation's period with 20.33% of imports and is composed of 5.30%, 54.11%, and 40.59% of Agriculture, Industry, and Services, respectively. As result, under the prices shown in Figure 13, the Laspeyres price index for three families grown -0.21%, 0.73%, and 1.23%, respectively. In comparison with the Laspeyres remuneration index, in Table18, we conclude that, excepting the population growth effects, the remuneration growth exceeds the growth of the costs only to families F^2 and F^3. This means that F^1 depends on government transfers to at least keep its life standard, contributing with 33.29% of its budget in the end period.

Concluding the lockdown instance, we saw Industry and Agriculture's specialization, due to a low-skilled and capital abundance, with importation to meet the need for Services, with high-skilled labor intensity. The government plays an important role with transfers to F^1 and fiscal discipline, which improve more domestic savings and investment good.

4 Conclusions

The main objective of this work was to estimate the long-run impacts of lockdown in Ceará's economy, as a sanitary response against Covid-19, through productivity translated in wages, considering productivity as developed human capital attained through the educational process. To do this, we built a regional model of general equilibrium with three representative families: F^1, F^2, and F^3, categorized as low-skilled labor owner (L^1), middle-skilled labor owner (L^2), and high-skilled labor owner (L^3), respectively; domestic factor-aggregation and intermediary consumption step; foreign trade and savings inflow with remaining Brazil and world; one agent that represents the government; and a sector that transforms savings in investment and share it to firms. The model is recursively applied to discrete-time with some law motions and, among them, the growth rates of families, that is our key variable to represent the simulation of scenarios: a counterfactual-base instance and a lockdown instance; under the assumption that lockdown instance renders Ceará's labor supply structure return to previous levels of disparity along the educational Kuznets Curve for Ceará.

Is important to keep in mind some limitations that this parsimonious model has: the population growth is identically to active population and the labor offer by families is exogenous; we don't consider monetary effects like interest rates; the marginal propensity to saving of the agents is fixed; there is one single agent to represent government; we maintain the foreign savings inflow constant between scenarios and not impose any change in international prices of the commodities; we not assume any change in remaining Brazil's economy between both instances. The aim is to select only the effects of changes of the populations in endogenous variables.

Finding the Ceará's Kuznets Curve, we see that, since 2006, the growth of the educational level average of the labor market is accompanied by a decrease of inequality of the instruction. This traduces, following the theory and empirical findings, in lower marginal premium for more education. Geometric average of growth and decrease in families group around 2013 is used to extend the model's population in scenarios (Table 1). The new SAM used in the model reveals, by calibration of parameters, that Agriculture is capital-intensive, Industry is low-skilled labor-intensive between the labors, and Services is a high-skilled labor-intensive process.

In the counterfactual instance, the economy becomes high-skilled abundant, and domestic savings grow at decreasing rates thanks to the government, whose transfers are reduced by decreasing F^1 growing its goods consumption by increasing its dissaving. The remuneration to F^1 grows 6.47% per year; it happens because L^1 is becoming rare and its labor gains the power of bargaining, even in the same positions of jobs. So, Agriculture and Services grow faster and real GDP grows at an average of 2.62% per year. The final supply-demand match happens under decreasing prices to Agriculture and Services, then, the inflation perceived by each family, using Laspeyres index, fell 0.18%, 0.39%, and 0.33%, respectively. We conclude, considering also the remuneration index, that the utility of F^2 and F^3 grow only to the quantity growth of these families.

The first movement simulated to the pandemic scenario in our model is the growth of the low-skilled labor. In the real economy, this means a growth in the participation in the potential and traditional workforce[23] population: working-age people, especially those who are financially vulnerable, that stop their studies and go to the labor market. The data to Ceará[24], we see that the potential workforce grew at 5.77% per quarter from the beginning of 2020 until the second quarter of 2021, in accordance with the model. Regard Brazilian data[25] it

[23] The definition used by IBGE: the group of people of appropriate age who are not in the traditional workforce (employed or looking for a job), but who had the potential to become the labor force. Composed of: 1) people who looked for work but were not immediately available to work; 2) people who did not look for work but would like to have a job and were available to work, including discouraged people: people outside the workforce who were available to take a job immediately but did not take action to get a job. We focus on the potential workforce because in the Lockdown the employment seeker cannot look for a job personally.

[24] Available in *the page of the IBGE*.

[25] As of the writing date, there was no publication of the statistics for the states. Collected from the IBGE: *PNAD-COVID*.

can be divided by instruction levels, we see that F^1, F^2, and F^3 diminished their participation in the workforce by a geometric average of 1.83%, 1.16%, and 0.94% per quarter in the same period, respectively. The smaller decrease on the participation of the high-skilled family possible indicates that the social security offered by the government can pay the reserve salary of some part of the low-skilled families and keep this share out of the labor market. In contrast, the high-skilled family has more to lose despite the adverse scenario. This means an inverse relationship between social security, transfers, and entry into the labor market. Indeed, The population with incomplete elementary education was declining much faster in the lockdown period. Some part of the population used the lockdown period to end the elementary school level. But this not happen with *no instruction* and *incomplete high school* population, who grew more faster than before the pandemic, in accordance with the model.

In the lockdown scenario, the economy becomes low-skilled abundant and ends with 5.44% more investment than the base scenario: the fall in government revenue joined with an increase in transfers coerce to decrease its dissavings, which results in more domestic savings and, thus, more investment. The Industry and Agriculture commodities grow faster and the Service's output becomes more expensive, which suffers with the higher cost as well increased 47.83% in simulation. The labors remuneration grow -3.17%, 5.20%, and 4.87%, respectively. As result, the real GDP grows at 2.13% per year and ends 8.75% smaller than the base scenario; the difference grows at an average of 13.91% per year. Then, the inflation perceived by each family, using Laspeyres index, grow -0.21%, 0.73%, and 1.23%, respectively. The fall in remuneration of F^1 is higher than the decrease in its price index, the growth of its utility is thanks to the quantity effect of the population growth. Indeed, the government transfers to F^1 ends the simulation being 33.29% of its income, compared with 11.29% of the counterfactual.

This results of the lockdown scenario appoint to question raised by Lucio et al. [2020] in their model to analyze fiscal government activity, complementing the importance of alternatives against diminishing fiscal revenue such as efficiency in tax collection to Ceará state as a way to a solution. Also connects with Paiva [2019] results to Ceará about the trade-off of the government between rising current consumption and improve domestic capital stock, through savings in our model, to long-term production: a consumption-focused policy brings a sub-optimum scenario than a focus in a policy of domestic capital stock improvement. The government activity in the model also converges with the described spends by Lima et al. [2020] during the fists months of the lockdown, a higher spend at the municipal level in Ceará with social assistance.

Is clear the key role that government makes in the lockdown scenario, keeping assistance to the most vulnerable population and discipline to not upset the domestic savings through your debt space, more adverse scenario requires higher strategic public expends. In addition to taking care to reduce the trend of population increase that interrupts studies, i.e., break your productivity development due to lockdown.

5 Appendix

5.1 Appendix 1: Social Accounting Matrices

Table 3: Reduced Social Accounting Matrix.

Agents	Agr	Ind	Srv	Inv	Cap	Lab	Fam	Gov	ICMS	Out	Im	RoW	Rob
Agr	332	2 650	416	879			4 200	6				272	773
Ind	1 120	25 387	11 369	21 452			35 973	322				2 326	20 829
Srv	307	9 283	19 183	3 585			43 270	27 952				510	4 508
Inv							12 848	-15 534				3 983	24 620
Cap	4 095	9 099	30 223										
Lab	785	10 249	40 420										
Fam					43 416	51 453		12 054					
Gov							10 634	6 903	8 621	4 900	645		
ICMS	226	7 321	1 075										
Out	93	2 760	2 047										
Im	22	617	6										
RoW	866	6 175	50										
Rob	1 683	45 238	3 810										

Source: @ipece21. Authors elaboration.

Table 4: Social Accounting Matrix Used in the Model.

Agents	**Agr**	**Ind**	**Srv**	**Inv**	**Cap**	**L1**	**L2**	**L3**	**F1**	**F2**	**F3**	**Gov**	**ICMS**	**Out**	**Im**	**RoW**	**RoB**
Agr	332	2 650	416	879					1 585	1 369	1 246	6				272	773
Ind	1 120	25 387	11 369	21 452					11 520	10 485	13 968	322				2 326	20 829
Srv	307	9 283	19 183	3 585					12 655	13 037	17 578	27 952				510	4 508
Inv									650	1 892	10 306	-15 534				3 983	24 620
Cap	4 095	9 099	30 223														
L1	681	6 347	9 908														
L2	88	3 143	12 092														
L3	16	759	18 420														
F1					2 224	16 936						7 295					
F2					7 383		15 323					4 341					
F3					33 809			19 194				419					
Gov									46	263	10 324	6 903	8 621	4 900	645		
ICMS	226	7 321	1 075														
Out	93	2 760	2 047														
Im	22	617	6														
RoW	866	6 175	50														
RoB	1 683	45 238	3 810														

Source: Authors elaboration.

5.2 Appendix 2: Parameters From The Calibration

Table 5: Parameters of the Cobb–Douglas function of Y

Parameters	AGR	IND	SRV
Elasticities			
K	0.8392	0.4703	0.4278
L1	0.1396	0.3280	0.1403
L2	0.0180	0.1624	0.1712
L3	0.0032	0.0392	0.2607
TFP			
b	1.6695	3.1352	3.6378

Source: Authors elaboration.

Table 6: Parameters of the Leontief function of Z

Sector	AGR	IND	SRV
ax			
AGR	0.0500	0.1687	0.0462
IND	0.0468	0.4480	0.1638
SRV	0.0041	0.1119	0.1888
ay			
Zi	0.7351	0.3414	0.6952

Source: Authors elaboration.

[1] Reads 'from columm to line'.

Table 7: Parameters of the CET function

	AGR	IND	SRV
Qs	0.1251	0.1719	0.0526
Xc	0.3204	0.2037	0.2352
Xw	0.5545	0.6244	0.7122
TFP	4.0564	3.3121	7.0392

Source: Authors elaboration.

Table 8: Parameters of the CES function

	AGR	IND	SRV
Qs	0.5300	0.4483	0.8236
Mc	0.2708	0.3923	0.1563
Mw	0.1992	0.1594	0.0201
TFP	2.5459	2.6636	1.4224

Source: Authors elaboration.

Table 9: Parameters of the Good-of-Investment's Cobb-Douglas function

	AGR	IND	SRV
Elasticities	0.0339234	0.827753	0.138324
TFP		1.72442	

Source: Authors elaboration.

Table 10: Parameters of the Cobb–Douglas Utility function and Budget Constraint .

Products	F1	F2	F3
Elasticities			
AGR	0.0615	0.0550	0.0380
IND	0.4472	0.4212	0.4259
SRV	0.4913	0.5238	0.5361
TFP			
a	2.4123	2.3690	2.2751
Savings Share			
ss	0.0246	0.0706	0.2391

Source: Authors elaboration.

Table 11: Government Parameters

	AGR	IND	SRV
Production.Tax	0.0340	0.1292	0.0106
Other.Tax	0.0139	0.0487	0.0202
Import.Tax	0.0251	0.0999	0.1272
Consumption	0.0002	0.0114	0.9884

Source: Authors elaboration.

5.3 Appendix 3: Visualization Results

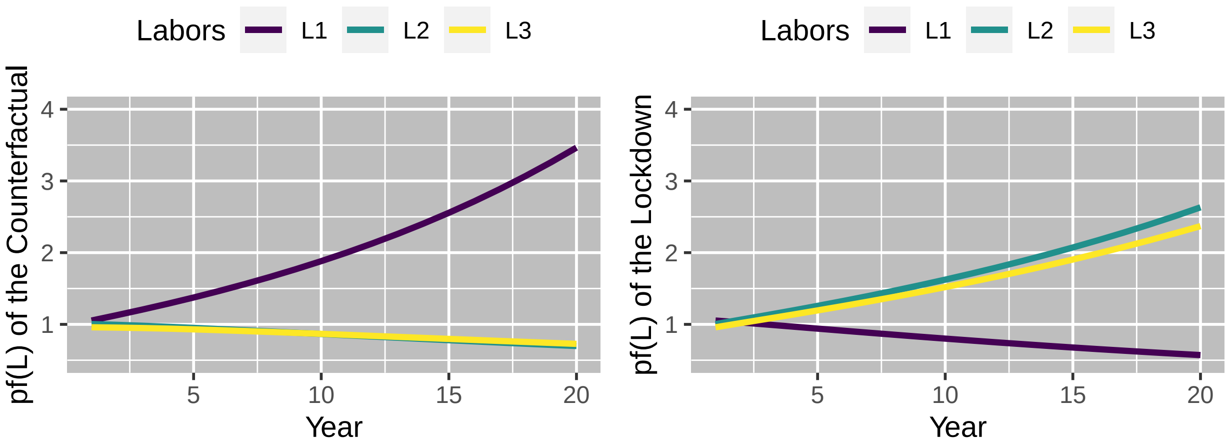

Figure 5: Price of the Labor Factors. Authors elaboration.

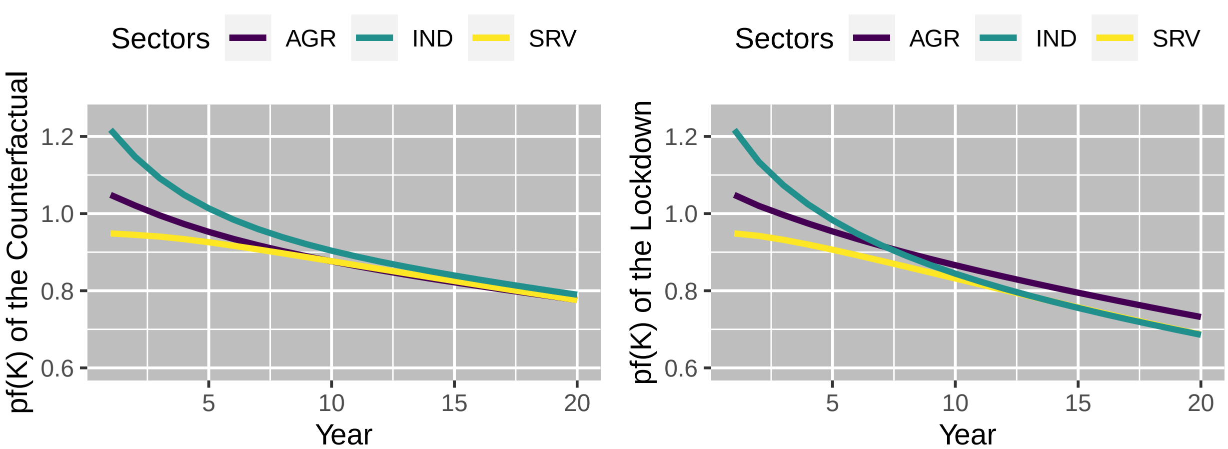

Figure 6: Price of the Capital-Factor for Sectors. Authors elaboration.

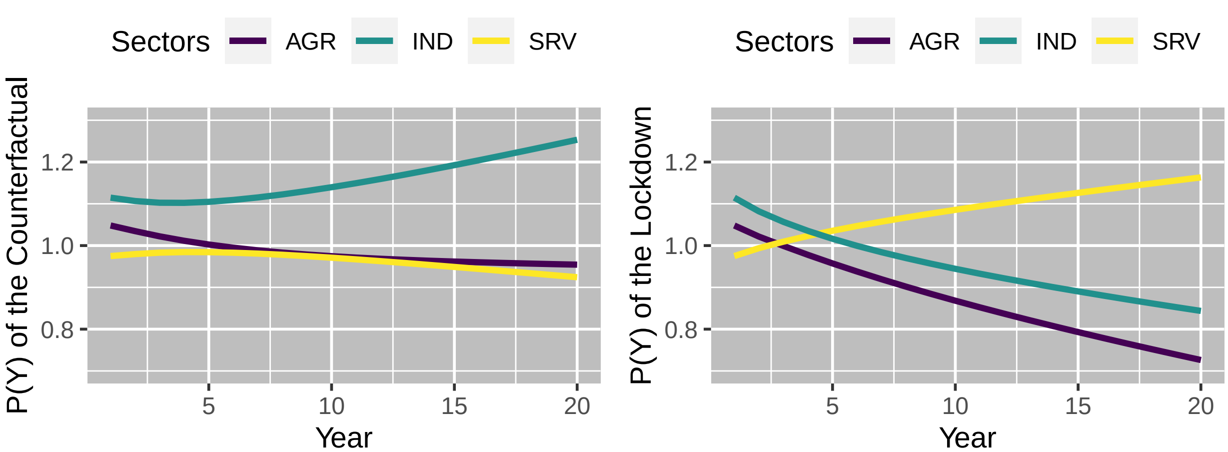

Figure 7: Price of the Aggregated-Factor for Sectors. Authors elaboration.

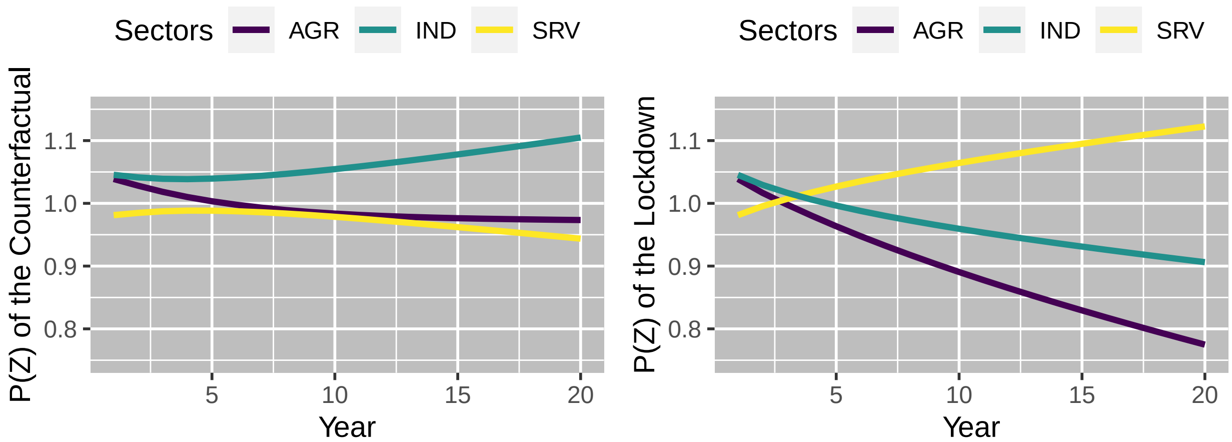

Figure 8: Price of the Gross Domestic Product for Sectors. Authors elaboration.

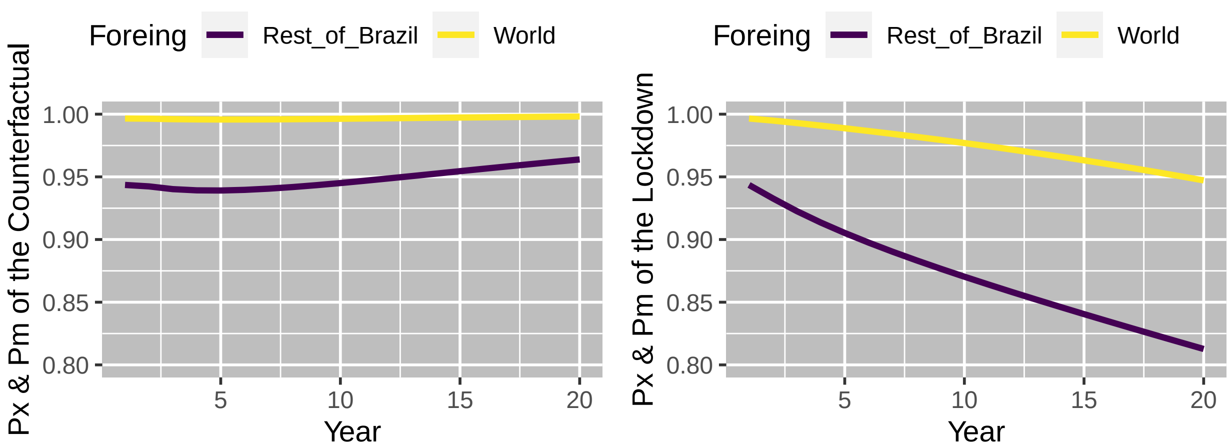

Figure 9: Prices of the Exports and Imports. Authors elaboration.

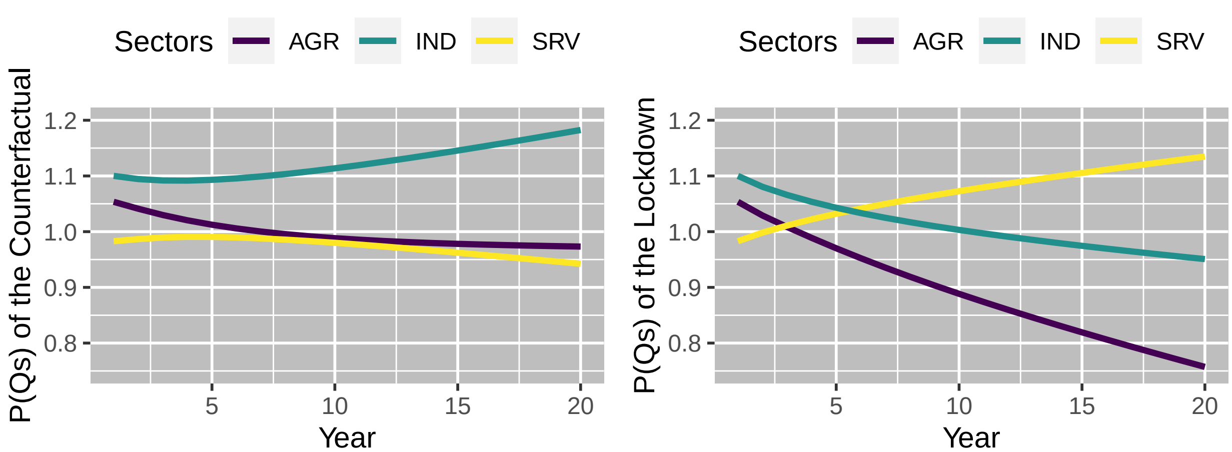

Figure 10: Prices of the Domestic Market. Authors elaboration.

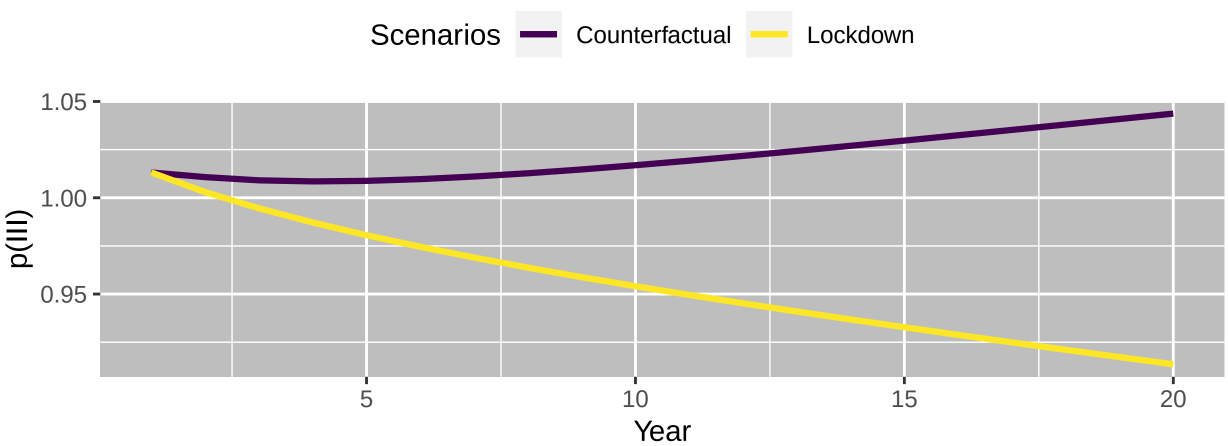

Figure 11: Prices of the Investment. Authors elaboration.

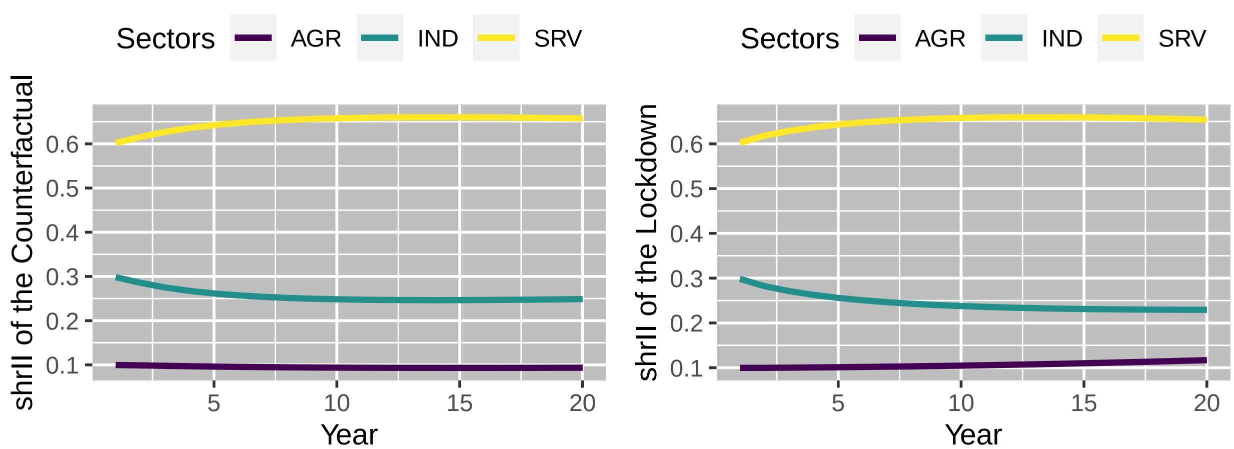

Figure 12: Investment Allocation Coefficients. Authors elaboration.

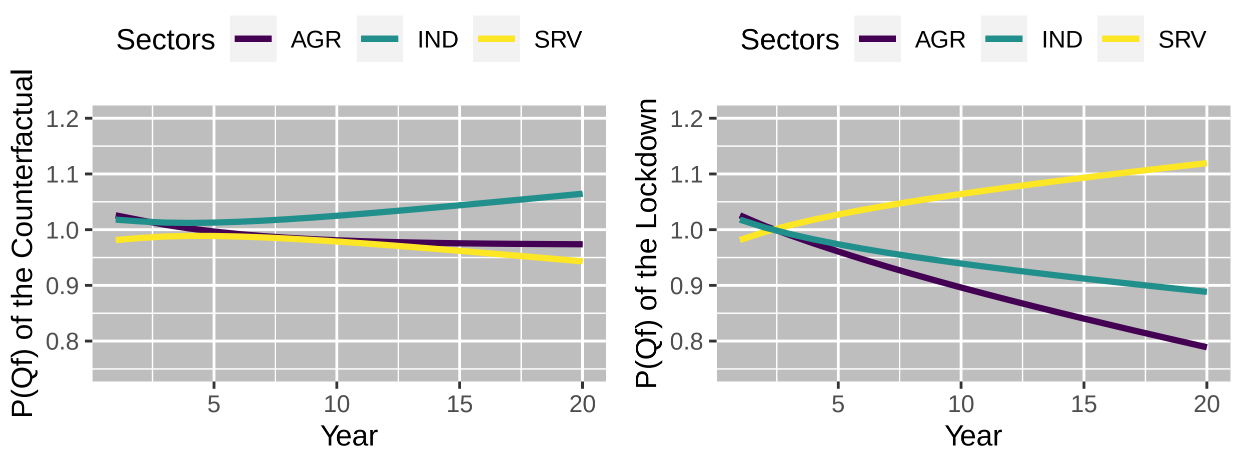

Figure 13: Prices of the Internal Supply. Authors elaboration.

5.4 Appendix 4: Tables Results

Table 12: Geometric Average Growth of the Variables of the Counterfactual Scenario

	Usage of Factor			Price of Factors		
Factor	**Factor 0 AGR**	**Factor 0 IND**	**Factor 0 SRV**	**pf0 AGR**	**pf0 IND**	**pf0 SRV**
K	0.0329	0.0408	0.0303	-0.0157	-0.0225	-0.0105
F1	-0.0451	-0.0444	-0.0425	0.0647	0.0647	0.0647
F2	0.0363	0.0370	0.0391	-0.0189	-0.0189	-0.0189
F3	0.0316	0.0323	0.0344	-0.0144	-0.0144	-0.0144

Source: Authors elaboration.

Table 13: Geometric Average Growth of the Variables of the Lockdown Scenario

	Usage of Factor			Price of Factors		
Factor	**Factor 1 AGR**	**Factor 1 IND**	**Factor 1 SRV**	**pf1 AGR**	**pf1 IND**	**pf1 SRV**
K	0.0397	0.0400	0.0316	-0.0187	-0.0298	-0.0169
F1	0.0536	0.0421	0.0473	-0.0317	-0.0317	-0.0317
F2	-0.0302	-0.0408	-0.0360	0.0520	0.0520	0.0520
F3	-0.0272	-0.0378	-0.0330	0.0487	0.0487	0.0487

Source: Authors elaboration.

Table 14: Geometric Average Growth of the Variables for Scenarios

Scenarios	**Sg**	**Sc**	**Sw**	**III**	**mgW**	**mgC**	**pIII**	**US**
Counterfactual	0.0277	0.0247	0.0247	0.0210	0.0001	0.0011	0.0016	0.0167
Lockdown	0.0015	0.0247	0.0247	0.0239	-0.0027	-0.0078	-0.0054	0.0162

Source: Authors elaboration.

Table 15: Geometric Average Growth of the Variables for Scenarios

	Counterfactual			Lockdown		
Variables	**AGR 0**	**IND 0**	**SRV 0**	**AGR 1**	**IND 1**	**SRV 1**
Y	0.0217	0.0111	0.0223	0.0401	0.0240	0.0048
Z	0.0217	0.0111	0.0223	0.0401	0.0240	0.0048
Qs	0.0202	0.0129	0.0220	0.0361	0.0236	0.0057
Xc	0.0310	0.0075	0.0288	0.0560	0.0233	-0.0248
Xw	0.0289	0.0054	0.0267	0.0670	0.0339	-0.0146
Mc	0.0094	0.0184	0.0152	0.0165	0.0240	0.0373
Mw	0.0119	0.0208	0.0176	-0.0047	0.0027	0.0156
II	0.0176	0.0113	0.0258	0.0325	0.0097	0.0283
KK	0.0329	0.0408	0.0303	0.0397	0.0400	0.0316
shrII	-0.0033	-0.0095	0.0047	0.0084	-0.0138	0.0044
Ti	0.0182	0.0141	0.0202	0.0242	0.0163	0.0119
To	0.0182	0.0141	0.0202	0.0242	0.0163	0.0119
Tm	0.0120	0.0209	0.0177	-0.0073	0.0000	0.0129
Gf	0.0305	0.0253	0.0299	0.0154	0.0087	-0.0054
Xinv	0.0254	0.0202	0.0247	0.0325	0.0256	0.0113
Qf	0.0173	0.0159	0.0218	0.0287	0.0226	0.0071
pxW	0.0001	0.0001	0.0001	-0.0027	-0.0027	-0.0027
pmW	0.0001	0.0001	0.0001	-0.0027	-0.0027	-0.0027
pxC	0.0011	0.0011	0.0011	-0.0078	-0.0078	-0.0078
pmC	0.0011	0.0011	0.0011	-0.0078	-0.0078	-0.0078
py	-0.0049	0.0062	-0.0028	-0.0191	-0.0146	0.0093
pz	-0.0034	0.0029	-0.0020	-0.0153	-0.0075	0.0071
pqs	-0.0042	0.0038	-0.0022	-0.0172	-0.0076	0.0076
pqf	-0.0027	0.0024	-0.0021	-0.0137	-0.0071	0.0069

Source: Authors elaboration.

Table 16: Geometric Average Growth of the Variables for Scenarios

Scenarios	F1	F2	F3
Counterfactual			
shrK0	-0.0739	0.0055	0.0014
Ss0	0.0035	0.0236	0.0200
Tdh0	0.0137	0.0208	0.0198
trh0	-0.0412	0.0365	0.0325
UU0	0.0037	0.0239	0.0202
Lockdown			
shrK1	0.0728	-0.0119	-0.0079
Ss1	0.0320	0.0043	0.0083
Tdh1	0.0274	0.0095	0.0086
trh1	0.0430	-0.0352	-0.0315
UU1	0.0326	0.0045	0.0082

Source: Authors elaboration.

Table 17: Price Index Perceived by Families for Scenarios

Index	F1	F2	F3
Counterfactual			
Laspeyres	-0.0019	-0.0040	-0.0034
Paasche	-0.0037	-0.0058	-0.0052
Fisher	-0.0028	-0.0049	-1.0043
Lockdown			
Laspeyres	-0.0021	0.0073	0.0123
Paasche	-0.0227	-0.0133	-0.0075
Fisher	-0.0124	-0.0031	0.0024

Source: Authors elaboration.

Table 18: Remuneration Laspeyres Index Perceived by Families for Scenarios

Scenarios	F1	F2	F3
Counterfactual	2.0060	-0.2809	-0.2356
Lockdown	-0.4421	0.9854	0.3059

Source: Authors elaboration.

Table 19: Cost Index Perceived by Firms for Scenarios

Index	**AGR**	**IND**	**SRV**
Counterfactual			
Laspeyres	0.0954	0.5268	0.1280
Paasche	-0.1710	-1.0991	-1.1348
Fisher	-0.0471	0.1728	-0.0121
Lockdown			
Laspeyres	-0.2836	-0.0346	0.4783
Paasche	-0.3188	-0.3411	-0.0202
Fisher	-0.3014	-0.2024	0.2035

Source: Authors elaboration.

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