From Local Gains to Aggregate Effects: Evaluating ICT Subsidies in Brazil*

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Abstract

Could a targeted policy of subsidizing the information and communication technology (ICT) sector generate significant aggregate effects on the Brazilian economy when only a small percentage of companies benefit from the program? To answer this question, we use a multisector general equilibrium model to assess the effects of the Telecommunications Technological Development Fund (FUNTTEL) through Brazil's production network. We calibrate the model using 2022 data and find that FUNTTEL generates meaningful local effects on production among beneficiary firms and sectors. However, its aggregate effects are negligible because the program has limited coverage. Our counterfactual results further indicate that a broad 5% reduction in the tax wedge on ICT inputs would generate larger aggregate gains than the targeted subsidy.

Keywords: Production networks; Sectoral-level distortions; Technology; Subsidies.

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Resumo

Uma política direcionada de subsídios ao setor de tecnologia da informação e comunicação (TIC) pode gerar efeitos agregados significativos na economia brasileira quando apenas uma pequena parcela das empresas é beneficiada pelo programa? Para responder a essa questão, utilizamos um modelo de equilíbrio geral multissetorial para avaliar os efeitos do Fundo para o Desenvolvimento Tecnológico das Telecomunicações (FUNTTEL) por meio da rede de produção brasileira. Calibramos o modelo com dados de 2022 e constatamos que o FUNTTEL gera efeitos locais relevantes sobre a produção das empresas e dos setores beneficiários. No entanto, seus efeitos agregados são negligenciáveis em razão da cobertura limitada do programa. Nossos resultados contrafactuais também indicam que uma redução abrangente de 5% na cunha tributária incidente sobre os insumos de TIC geraria ganhos agregados maiores do que o subsídio direcionado.

Palavras-chave: Redes de produção; Distorções setoriais; Tecnologia; Subsídios.

JEL: **C67, C68, O11, O41.**

1 Introduction

The Information and Communication Technologies (ICT) sector, which includes infrastructure and networks, hardware, software, and communication devices, showed solid performance in Brazil in 2025, with growth of 6.9% in the first quarter compared to the same period of the previous year (IBGE, 2025). Some researchers argue that the diffusion of these technologies may have positive impacts on the economy, including GDP growth in developing, emerging and developed countries (Awad and Albaity, 2024; Niebel, 2018; Stanley et al., 2018).

In 2000, the Brazilian government created the Telecommunications Technological Development Fund (FUNTTEL), a financing line operated by the National Bank for Economic and Social Development (BNDES) aimed at supporting ICT projects. Generally, the beneficiaries are medium and large-sized companies in the telecommunications, manufacturing, and ICT sectors.[1] In this paper, we analyze whether FUNTTEL, which reduces the acquisition cost of an intermediate good produced by the ICT sector, can generate significant aggregate effects, even when it benefits only a small percentage of companies.

To perform this analysis, we incorporate a tax structure into a multisector general equilibrium model based on Carvalho and Tahbaz-Salehi (2019). The model considers taxes levied on gross production, labor, final consumption, and the use of intermediate goods. Although these different taxes are considered to more fully represent the economy's tax system, the study focuses on the taxation of intermediate inputs. In this context, the subsidy is modeled as a reduction in the tax cost associated with the acquisition of intermediate goods from the ICT sector, decreasing the price effectively paid by beneficiary companies and altering their production and input demand decisions.

We calibrate the model with data from 2022 and show that FUNTTEL benefits a small percentage of firms in four sectors of the economy, and this subsidy generates relevant local effects on the sectors directly related to the use of ICT intermediate goods. By reducing the effective cost of these inputs, the subsidy stimulates demand and modifies the production decisions of the firms served. However, since only a small percentage of companies receive the benefit, these local effects practically disappear when aggregated for

[1] See: https://www.bndes.gov.br, accessed on July 19, 2026.

the economy as a whole. Next, we conduct a counterfactual exercise in which we reduce by 5% the taxes levied on intermediate goods produced by the ICT sector. We show that this policy, by reaching a broader range of sectors and firms, produces substantially greater aggregate effects than the targeted program.

Recent studies identify substantial effects of subsidized credit at the firm and local market levels. Grimaldi and Ornelas (2024) found that a reduction in the cost of targeted credit increases employment by approximately 6% and payroll by 10% among micro and small enterprises, although the effect on employment dissipates after two years. Similarly, Martini et al. (2025) report large effects of different BNDES instruments on investment, employment, revenue, and payroll of supported companies. At the local level, Corseuil et al. (2023) show that greater availability of credit from the BNDES Card increases formal employment, business entry, and the average size of establishments entering the market. Our results corroborate the finding that subsidies can generate significant effects among directly exposed firms and local economies. We extend this literature by showing that the aggregate effects of this type of financing are virtually zero.

Regarding the literature on taxation in the ICT sector, Ribeiro et al. (2019) simulate the effects of reducing import tariffs on capital goods and ICT products in the Brazilian economy. Their results indicate positive effects on GDP, investment, exports, and the trade balance, as well as a decline in the overall price level. Similarly, Katz and Jung (2023) argue that regulatory fees, corporate income taxes, and sector-specific excise taxes constrain investment and indirectly limit network coverage and technology adoption. We show that a broader policy that reduces taxes on the ICT sector in Brazil by 5% increases aggregate gross-output by 0.026% and total demand for intermediate goods by 0.05%.

The remainder of the paper is organized as follows. Section 2 outlines the general equilibrium model. Section 3 presents the datasets and the calibration strategy. Section 4 discusses the results and implications, and Section 5 concludes.

2 Structural Model

Consider an economy with a government and N productive sectors indexed by $i, j \in 1, \ldots, N$.[2] Each sector produces a homogeneous good using labor and intermediate inputs. There is a representative household that supplies labor inelastically and consumes final goods. The government may impose different types of taxes and provide subsidies for all economic activities.

2.1 Firms

Each sector i produces according to the technology

$$Q_i = A_i L_i^{\sigma_i} \left(\prod_{j=1}^{N} X_{ij}^{\beta_{ij}} \right)^{1-\sigma_i}, \tag{1}$$

where Q_i denotes the gross-output of sector i, A_i represents total factor productivity, L_i is the quantity of labor employed, and X_{ij} corresponds to the use of intermediate inputs supplied by sector j. The input-output structure is such that the columns indicate the sectors of origin of the inputs, while the rows indicate their destination sectors. The parameter $\sigma_i \in (0, 1)$ determines the labor share in output, whereas β_{ij} represents the output elasticity of intermediate input j in sector i, satisfying $\sum_{j=1}^{N} \beta_{ij} = 1$.

Sector i consists of two types of firms: a fraction ϕ_i with access to subsidized credit and a fraction $1 - \phi_i$ without such access. Both types operate under the same production technology but differ in the cost structure associated with intermediate inputs. In particular, firms receiving the subsidy face a reduction in the cost of purchasing inputs from a specific sector, interpreted as the ICT sector.

A firm of type $m \in \{s, n\}$, where s denotes subsidized firms and n denotes non-subsidized firms, chooses L_i^m and X_{ij}^m to maximize profits:

$$\max_{L_i^m, X_{ij}^m} \; (1 - \tau_i^q) p_i Q_i^m - (1 + \tau_i^w) w L_i^m - \sum_{j=1}^{N} p_j (1 + \tau_{ij}^{x,m}) X_{ij}^m, \tag{2}$$

subject to Equation (1),

where p_i is the price of the good produced by sector i, w is the wage rate, τ_i^q denotes

[2] This model is based on the study by Barros et al. (2026).

the tax levied on production, and τ_i^w denotes the tax on labor costs. The term $\tau_{ij}^{x,m}$ corresponds to the effective tax rate levied on the use of intermediate input j, which depends on the firm's type.

The difference between subsidized and non-subsidized firms is concentrated in a single element of the matrix of taxes on intermediate inputs. Specifically, for subsidized firms, the cost of purchasing inputs from the ICT sector k is reduced by a subsidy, whereas all other costs remain unchanged. Therefore, $\tau_{ij}^{x,s} = \tau_{ij}^{x,n}$ for every $j \neq k$, and $\tau_{ik}^{x,s} = \tau_{ik}^{x,n} \times \tau_i^{sub}$, where τ_i^{sub} captures the adjustment factor associated with the subsidy.

The first-order conditions of the profit-maximization problem imply that the demands for labor and intermediate inputs are given by

$$L_i^m = \sigma_i \frac{(1-\tau_i^q)}{(1+\tau_i^w)} \frac{p_i}{w} Q_i^m, \tag{3}$$

$$X_{ij}^m = \beta_{ij}(1-\sigma_i) \frac{(1-\tau_i^q) p_i}{(1+\tau_{ij}^{x,m}) p_j} Q_i^m. \tag{4}$$

2.2 Households

The representative household has Stone–Geary preferences:

$$U(c_1, \cdots, c_N) = \sum_{i=1}^{N} \alpha_i \ln(c_i - \bar{c}_i), \tag{5}$$

where $\sum_{i=1}^{N} \alpha_i = 1$, α_i is the weight assigned to the consumption of good i in the utility function, and $c_i > \bar{c}_i$ for all i. We also assume that subsistence consumption $\bar{c}_i$ is nonzero only for the agricultural good, as in Barros et al. (2026).

The representative household chooses c_i to maximize utility subject to the budget constraint

$$\sum_{i=1}^{N} (1+\tau_i^c) p_i c_i = w\bar{L} + \mathcal{T}, \tag{6}$$

where p_i is the price of good i, τ_i^c is the consumption tax rate, w is the wage, $\bar{L}$ is the aggregate labor supply, and $\mathcal{T}$ is the government lump-sum transfer.

The first-order conditions of the household's optimization problem yield the optimal demand functions for each sector $i \in 1, \ldots, N$:

$$c_i = \bar{c}_i + \frac{\alpha_i}{(1+\tau_i^c)p_i}\left(w\bar{L} + \mathcal{T} - \sum_{k=1}^{N}(1+\tau_k^c)p_k\bar{c}_k\right). \tag{7}$$

2.3 Government

The government collects revenue from taxes on gross production, labor compensation, final consumption, and intermediate-input use. At the sectoral level, revenue from each of these sources is given by

$$R_{q_i} = \tau_i^q p_i Q_i, \tag{8}$$

$$R_{w_i} = \tau_i^w w L_i, \tag{9}$$

$$R_{c_i} = \tau_i^c p_i c_i, \tag{10}$$

$$R_{x_i} = (1-\phi_i)\sum_{j=1}^{N}\tau_{ij}^{x,n} p_j X_{ij} + \phi_i \sum_{j=1}^{N}\tau_{ij}^{x,s} p_j X_{ij}. \tag{11}$$

where ϕ_i is the proportion of firms in sector i receiving the subsidy and X_{ik}^s denotes their demand for the ICT input. Therefore, the total gross government revenue associated with sector i is

$$R_{G_i} = R_{q_i} + R_{w_i} + R_{x_i} + R_{c_i}. \tag{12}$$

Government expenditure on the subsidy in sector i corresponds to the subsidy granted to firms with access to subsidized credit. This subsidy applies only to inputs supplied by the ICT sector k, therefore

$$S_{G_i} = \phi_i(\tau_{ik}^{x,n} - \tau_{ik}^{x,s})p_k X_{ik}. \tag{13}$$

Finally, the fiscal equilibrium can be written as

$$\sum_{i=1}^{N} R_{G_i} = \sum_{i=1}^{N} S_{G_i} + \mathcal{T}. \tag{14}$$

where $\mathcal{T}$ is the lump-sum transfer to households.

2.4 Equilibrium

Given the set of parameters $A_i, \sigma_i, \beta_{ij}, \alpha_i, \bar{c}_i, \bar{L}, \tau_i^q, \tau_i^w, \tau_{ij}^{x,m}, \tau_i^c$, a competitive equilibrium is defined by a vector of prices p_i and w, together with allocations c_i, Q_i, L_i, X_{ij}, such that the following conditions are satisfied:

1. For each firm type $m \in \{s, n\}$, the choices of L_i^m and X_{ij}^m solve the profit-maximization problem, given prices, technology, and the structure of taxes and subsidies.

2. A representative producer uses the Cobb–Douglas technology in each sector to combine labor and intermediate inputs allocated between subsidized and nonsubsidized production blocks to produce a single homogeneous sectoral good Q_i, therefore

$$X_{ij} = (X_{ij}^s)^{\phi_i}(X_{ij}^n)^{1-\phi_i}, \tag{15}$$

$$L_i = (L_i^s)^{\phi_i}(L_i^n)^{1-\phi_i}. \tag{16}$$

3. The consumption vector c_i solves the household's utility-maximization problem subject to its budget constraint.

4. Goods markets clear in every sector i, such that total sectoral output is allocated between final consumption and use as an intermediate input:

$$Q_i = c_i + \sum_{k=1}^{N} X_{ki}. \tag{17}$$

5. The labor market satisfies the full-employment condition:

$$\sum_{i=1}^{N} L_i = \bar{L}. \tag{18}$$

6. Total government revenue equals expenditure on subsidies plus lump-sum transfers.

The equilibrium price vector is obtained from the firms' first-order conditions. In particular, prices depend on sectoral productivity, technological parameters, the wage, distortions affecting labor costs, and distortions affecting intermediate inputs. Because subsidized and non-subsidized firms coexist within each sector, the effective distortion on intermediate inputs combines the tax and subsidy structures faced by both types of firms, weighted by the fraction ϕ_i. Therefore, the price system incorporates the within-sector heterogeneity associated with access to subsidized credit.

3 Data and Calibration

3.1 Data

The main data sources used in this paper are the Organisation for Economic Co-operation and Development (OECD), the Annual Report of Social Information (RAIS), and the Brazilian Development Bank (BNDES). Our analysis focuses on 2022, primarily because it is the most recent year for which all the required data are available.

From the OECD, we use the Brazilian input-output table. The institution provides input-output tables for both its member countries and other economies, including Brazil. The database covers the period from 1995 to 2022 and contains information for 50 sectors of economic activity. To make this classification compatible with the other databases used in this study, these sectors were aggregated according to the sections of the Brazilian National Classification of Economic Activities, version 2.0 (CNAE 2.0).

We also use RAIS microdata, which allow us to measure the number of firms and formal workers in each sector. Among other purposes, this information is used to construct measures of sectoral participation and to calculate the proportion of firms benefiting from the credit policies analyzed. The BNDES data, in turn, provide information on the number of beneficiaries and the credit operations to FUNTTEL. Combining this information with RAIS data allows us to estimate, for each sector, the proportion of firms that received subsidies.

The sectoral definition adopted in the model follows the sections of CNAE 2.0. Although this classification originally comprises 21 sections, the analysis considers the 19 sectors presented in Table 1, after excluding sections T and U.[3]

[3] We do not consider the sectors corresponding to sections T and U because of their limited relevance to the economy, both in terms of employment and economic activity. Section T comprises domestic services, while section U covers the activities of international organizations and other extraterritorial institutions.

Table 1: Sectoral classification based on CNAE 2.0

CNAE Section	Description
A	Agriculture, livestock, forestry, fishing, and aquaculture
B	Mining and quarrying
C	Manufacturing
D	Electricity and gas
E	Water supply, sewerage, waste management, and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation, storage, and postal services
I	Accommodation and food services
J	ICT
K	Financial, insurance, and related activities
L	Real estate activities
M	Professional, scientific, and technical activities
N	Administrative and support service activities
O	Public administration, defense, and social security
P	Education
Q	Human health and social work activities
R	Arts, culture, sports, and recreation
S	Other service activities

3.2 Calibration

We need to define thirteen objects of the model described in Section 2: ϕ_i, τ_i^q, τ_i^w, $\tau_i^{x,n}$, $\tau_i^{x,s}$, τ_i^c, α_i, β_{ij}, σ_i, w, $\bar{L}$, A_i, and $\bar{c}_a$. The first nine are calibrated exogenously. In addition, we assume that total labor supply $\bar{L}$ and the wage w are equal to one, while the two remaining parameters are determined endogenously in the model equilibrium. Table A3 in Appendix A presents the calibration results for all these parameters in each respective sector.

3.2.1 Exogenous Calibration

The exogenous calibration was implemented using administrative data, statutory tax rates, and assumptions regarding tax incidence. The proportion of subsidized firms, ϕ_i, was calculated as the ratio between the number of firms in sector i benefiting from FUNTTEL and the total number of firms in the sector, obtained from the 2022 Annual Social Information Report (RAIS). Beneficiary firms were identified using unique national register of legal entities (CNPJ) numbers in the credit-operation records or, when this information was unavailable, using the identifier of each operation.[4]

Regarding tax rates, the tax on gross-output, τ_i^q, was defined as the ratio between

[4]Since we lack more granular data regarding the companies that benefited from FUNTTEL, we assume that they all have the same weight in the analysis.

sectoral tax revenue, net of subsidies, and the value of sectoral output. The tax on wages, τ_i^w, was estimated using the wage distribution from the 2022 RAIS, the contribution brackets for INSS and withholding income tax (IRRF), and the employer contributions associated with FGTS and INSS. The consumption tax rate, τ_i^c, was set at 25%, based on estimates from Brazilian Institute of Economics (IBRE).

Regarding taxation on intermediate inputs, the rate $\tau_i^{x,n}$ was constructed using the tax rates for ISS, ICMS, PIS/Cofins, IPI, IOF, and ITBI, whose incidence was defined according to the characteristics of each sector.[5] In turn, $\tau_{ij}^{x,s}$ is the tax rate faced by subsidized firms. For regular inputs, it is equal to $\tau_{ij}^{x,n}$. The difference arises only for the input supplied by the ICT sector, whose cost is reduced by the subsidy. The magnitude of this reduction is calculated by comparing the fund's interest rate, r_f, with the market interest rate, r_m. In the implementation analyzed, the subsidized wedge is obtained by multiplying the difference between these two interest rates and the regular tax rate[6]:

$$\tau_{ik}^{x,s} = \tau_{ik}^{x,n} \times \tau_i^{sub},$$

where τ_i^{sub} is the adjustment factor associated with the subsidy and it is given by:

$$\tau_i^{sub} = \begin{cases} [1 - (r_m - r_f)]\,, & \text{where } \phi_i > 0 \\ 1, & \text{where } \phi_i = 0. \end{cases}$$

This mapping is a reduced-form approximation that translates the interest-rate advantage offered by FUNTTEL into an equivalent proportional reduction in the wedge on ICT inputs.

The remaining parameters are calculated using the input-output table and National Accounts data. The elasticity of the bundle of intermediate goods with respect to intermediate good j, β_{ij}, is calculated directly from the input-output table. Specifically, β_{ij} represents the share of the intermediate input supplied by sector j in the intermediate-input bundle used by sector i. The elasticity of the good produced in sector i with respect

[5]For example, suppose that an input supplied by the manufacturing sector is subject to an ICMS rate of 15%, a PIS/Cofins rate of 9%, and an IPI rate of 10%. In this case, the tax rate on the intermediate input is given by $\tau_{ij}^{x,n} = 0.15 + 0.09 + 0.10 = 0.34$, regardless of the sector i purchasing the input.

[6]We consider the FUNTTEL interest rate to be 5.8% (fund interest plus the reference rate) and the average market interest rate to be 11.63%.

to labor, σ_i, is given by the ratio between employee compensation and gross sectoral output, taking taxes and subsidies into account. The weight of consumption in household utility, α_i, is represented by the share of consumption in total household income.

3.2.2 Endogenous Calibration

Our calibration strategy consists of selecting values for sectoral productivity A_i and the subsistence consumption level of agriculture, $\bar{c}_a$, such that the model equilibrium reproduces two moments observed in the data: (i) sectoral gross-output per worker and (ii) the labor share in the agricultural sector. For this purpose, we define the following objective function, which is used in our numerical calibration routine:

$$\mathcal{R} = \sum_{i=1}^{N} \left(\frac{q_i^M - q_i^D}{q_i^D} \right)^2 + \left(\frac{L_a^M - L_a^D}{L_a^D} \right)^2, \tag{19}$$

where q_i denotes gross-output per worker, L_a is the labor share in agriculture, and the superscripts M and D denote the model and the data, respectively.

4 Results

In the first counterfactual exercise, we analyze the local effects of FUNTTEL, that is, the impacts of the program on firms that received subsidies to purchase inputs from the ICT sector. To this end, we compare two equilibria of the economy. The first corresponds to the reference scenario, in which no subsidies are granted. In this case, the fraction of beneficiary firms is zero in all sectors, such that $\phi_i = 0$, and all firms are subject only to the regular tax structure applied to intermediate goods, represented by $\tau_{ij}^{x,n}$. This equilibrium is used as the *baseline* for evaluating the effects of the program.

The second equilibrium corresponds to the scenario with the subsidy associated with FUNTTEL. First, we identify the fraction of beneficiary firms in each sector, ϕ_i, and change the effective tax rate applied to the input supplied by the ICT sector. Thus, subsidized firms remain subject to the regular tax structure but face a reduction in the cost of purchasing the input supplied by the ICT sector. Formally, the subsidy is represented by a reduction in $\tau_{ik}^{x,s}$, where k denotes the ICT sector.

The second counterfactual exercise is similar to the first. However, instead of analyzing only the local effects, we examine the aggregate effects of FUNTTEL, that is, the impacts of the program on the entire economy. Finally, in the third counterfactual exercise, we consider a policy involving a 5% reduction in the tax levied on the intermediate good supplied by the ICT sector.[7]

4.1 Effects of FUNTTEL

4.1.1 Local Effects

Table 2 presents the production and fiscal effects for the sectors benefiting from FUNTTEL. The last row reports the total local effect, calculated based on the sectors that received the subsidy. The total percentage change in gross-output, p_iQ_i, is 0.004%, while expenditure on intermediate goods, p_iX_i, changes by 0.01%. The total change in the wage bill, wL_i, is -0.003%, while expenditure on goods from the ICT sector increases by 0.68%. The general pattern is an increase in the use of intermediate goods among subsidized firms, especially in the good supplied by the ICT sector, accompanied by a reduction in labor demand.

Across sectors, the largest increases in p_iQ_i and p_iX_i occur in the ICT sector, at 0.213% and 0.373%, respectively, while the largest reduction in wL_i is observed in professional and scientific activities, at -0.042%. In addition, there is a substantial increase in the demand for inputs from the ICT sector by beneficiary firms, mainly from the sector itself. This change reflects an expansion in the quantity demanded resulting from the reduction in the effective cost of the input.

In the fiscal block, the effect of the subsidy on total government revenue, R_G, is almost negligible. Changes in R_q, R_w, and R_x directly follow the changes in gross-output, labor demand, and intermediate-input consumption, respectively. At the sectoral level, the largest positive change in R_G occurs in the ICT sector, at 0.067%, while the largest reduction is observed in professional and scientific activities, at -0.019%.

The last two columns of Table 2 show the multipliers of gross-output and expendi-

[7] It is important to emphasize that, when conducting the counterfactual exercises, we hold the calibrated structural parameters fixed, namely total factor productivity and agricultural subsistence consumption, denoted by A_i and $\bar{c}_a$. In addition, monetary variables are evaluated at constant *baseline* prices.

ture on ICT goods.[8] From the first measure, we infer that R$ 1 invested in FUNTTEL generates approximately R$ 1.09 of additional gross production among the beneficiary companies, weighted by their sectoral scope. And from the second, that for every R$ 1 invested, approximately R$ 0.79 of additional expenditure on ICT inputs is generated among the beneficiary companies.

Table 2: Production and fiscal effects on firms benefiting from FUNTTEL - Local effects

Sector	**Percentage changes (%)**								**Multipliers**	
	p_iQ_i	p_iX_i	wL_i	ICT	R_q	R_w	R_x	R_G	$\Delta Q/\Delta S_G$	$\Delta ICT/\Delta S_G$
Manufacturing	-0.003	0.002	-0.009	1.264	-0.003	-0.009	0.000	-0.004	–	–
Construction	-0.004	0.001	-0.012	1.261	-0.004	-0.012	0.000	-0.006	–	–
ICT	0.213	0.373	0.020	1.294	0.213	0.020	0.000	0.067	–	–
Prof. & scient. activ.	-0.003	0.025	-0.042	1.231	-0.003	-0.042	0.000	-0.019	–	–
Total	**0.004**	**0.010**	**-0.003**	**0.681**	**0.008**	**-0.003**	**0.000**	**0.000**	**1.088**	**0.795**

Notes: **(1)**: p_iQ_i: Value of gross-output in sector i; p_iX_i: Value of intermediate goods; wL_i: Wage bill; ICT: Expenditure on goods from the ICT sector; R_q: Government revenue from taxes on gross-output; R_w: Government revenue from taxes on wages; R_x: Government revenue from taxes on intermediate goods; R_G: Total government revenue; S_G: Total government spending on subsidies; $\Delta Q/\Delta S_G$: gross-output multiplier; $\Delta ICT/\Delta S_G$: ICT-expenditure multiplier. **(2)**: The last row reports the total local counterfactual effect across all sectors. **(3)**: This table reports the results only for the sectors that benefit from FUNTTEL. The complete set of sectoral results is presented in Table A1 in Appendix A.

In sectors that did not receive the subsidy, the effects are predominantly small and negative, reflecting indirect general-equilibrium effects and the reallocation of resources toward beneficiary sectors and the ICT sector (see Table A1 in Appendix A).

4.1.2 Aggregate effects

Despite the substantial local effects observed among beneficiary firms, the aggregate impact of FUNTTEL on the economy is negligible. The changes in gross output, intermediate-input use, labor compensation, ICT expenditure, and government revenue are all smaller than 0.001% in absolute value and therefore round to zero at the precision reported in the tables. This result is mainly due to the program's limited coverage, represented by the small values of ϕ_i, which measures the share of beneficiary firms in each sector. In the sectoral aggregation, the responses of subsidized firms receive a weight proportional to ϕ_i. Thus, even when these firms exhibit substantial increases in the use of ICT inputs, their small share within each sector prevents these effects from generating economically significant aggregate changes. Therefore, the small aggregate impact does not necessarily indicate that the program is ineffective among its beneficiaries, but rather

[8]The gross-output multiplier is calculated as $\frac{\Delta Q}{\Delta S_G} = \frac{\sum_{i=1}^{N} \phi_i p_i^0 (Q_{i,s}^{\text{FUNTTEL}} - Q_{i,s}^{\text{baseline}})}{\sum_{i=1}^{N} \phi_i (S_G^{\text{FUNTTEL}} - S_G^{\text{baseline}})}$. The ICT multiplier is calculated in a similar way.

that its current scale is insufficient to produce significant effects on the economy as a whole.

4.2 Effects of a reduction in the tax wedge on ICT inputs – Aggregate effects

Table 3 presents the aggregate production and fiscal effects of a 5% reduction in the tax levied on inputs supplied by the ICT sector. This reduction generates positive effects on aggregate economic activity. Total gross-output increases by 0.026%, intermediate-input consumption increases by 0.05%, and labor demand remains stable. The main effect of the policy is on the use of ICT inputs, which increases by 1.42% in the economy as a whole. This result indicates that the reduction in the wedge promotes a broad expansion in the use of these inputs, although its effects on aggregate output and intermediate-input use are more moderate.

At the sectoral level, the largest effect occurs in the ICT sector itself, where gross-output increases by 0.57%, intermediate-input consumption rises by 0.754%, and labor demand increases by 0.37%. This result reflects both the direct increase in demand for its products and the indirect effects transmitted through the production network.

In the fiscal block, total government revenue increases by 0.019%. This growth is mainly explained by the increase in revenue from taxes on gross-output, at 0.041%, and intermediate goods, at 0.044%. Revenue from taxes on consumption and wages also increases (see Table A2 in Appendix A). Therefore, part of the cost associated with the tax reduction is offset by the expansion of the other tax bases.

The last two columns of Table 3 show the multipliers of gross-output and expenditure on ICT goods. The gross production multiplier indicates that each R$1.00 of tax revenue forgone associated with the policy generates approximately R$2.39 of additional gross production among the beneficiary companies. In turn, the ICT spending multiplier shows that each R$1.00 of tax revenue forgone results in approximately R$1.02 of additional expenditure on ICT inputs among these companies.

When comparing this result with that reported in Table 2, we find that the broader tax-expenditure policy produces a larger multiplier than FUNTTEL. This difference likely reflects the broader sectoral coverage of the policy, which generates direct effects in a larger number of industries and strengthens the transmission of the cost reduction through production linkages. By contrast, FUNTTEL is concentrated in a smaller group of beneficiary sectors, limiting the propagation of its effects throughout the economy.

Table 3: Production and fiscal effects of a reduction in the tax wedge on ICT inputs – Aggregate effects

Sector	**Percentage changes (%)**								**Multipliers**	
	p_iQ_i	p_iX_i	wL_i	ICT	R_q	R_w	R_x	R_G	$\Delta Q/\Delta S_G$	$\Delta ICT/\Delta S_G$
ICT	0.579	0.754	0.370	1.675	0.579	0.370	0.861	0.434	–	–
Total	**0.026**	**0.050**	**0.000**	**1.420**	**0.041**	**0.001**	**0.044**	**0.019**	**2.393**	**1.018**

Notes: **(1)**: p_iQ_i: Value of gross-output in sector i; p_iX_i: Value of intermediate goods; wL_i: Wage bill; ICT: Expenditure on goods from the ICT sector; R_q: Government revenue from taxes on gross-output; R_w: Government revenue from taxes on wages; R_x: Government revenue from taxes on intermediate goods; R_G: Total government revenue; S_G Total government spending on subsidies; $\Delta Q/\Delta S_G$: gross-output multiplier; $\Delta ICT/\Delta S_G$: ICT-expenditure multiplier. **(2)**: The total row represents the counterfactual effect on the economy as a whole. **(3)**: The complete set of sectoral results is presented in Table A2 in Appendix A.

5 Final remarks

In this paper, we use a multisectoral general equilibrium model calibrated with 2022 data to assess the local and aggregate effects of the Telecommunications Technological Development Fund (FUNTTEL) on the Brazilian economy. FUNTTEL is a targeted financing program that subsidizes firms' purchases of intermediate inputs produced by the information and communication technology (ICT) sector.

When analyzing the local effects of FUNTTEL, we note that the subsidy produces considerable impacts directly on the ICT sector. These effects are a consequence of the reduction in the effective cost of the intermediate good supplied by the ICT sector, associated with the subsidy that the beneficiary firms and sectors face. However, the total local effects are considerably smaller, mainly because only a small percentage of companies receive the benefit. Additionally, the aggregate effects are negligible because only a small share of firms receives the benefit.

Next, we conducted a counterfactual exercise to access the aggregate effects of a 5% tax reduction policy in the ICT sector. By reaching a broader range of companies, this tax waiver policy generates significantly greater aggregate effects than a targeted program like FUNTTEL. The main mechanism is that a tax reduction lowers the cost of ICT inputs for companies in various sectors, stimulating demand. This raises ICT sector production and its purchases from upstream suppliers, while simultaneously reducing production costs for downstream companies and expanding the use of intermediate inputs throughout the production chain.

The policy implications are clear: the Brazilian government should consider reducing the tax burden on the ICT sector as a broader alternative to targeted policies, since this measure strengthens intersectoral linkages and expands the effects on aggregate output. This discussion is even more relevant in the current context, in which production processes increasingly depend on technologies such as artificial intelligence and the Internet of Things (IoT). Given the evidence that these technologies can increase productivity and promote economic growth, excessive taxation may discourage their adoption and limit the diffusion of their benefits throughout the economy.[9]

References

Awad, A. and M. Albaity (2024). Economic growth and the proliferation of ict infrastructures: which causes the other? *Economic research-Ekonomska istraživanja 37*(1).

Barros, F., B. R. Delalibera, M. J. Ribeiro, and M. Teignier (2026). Production networks and structural transformation. *Economic Modelling 156*, 107461.

Carvalho, V. M. and A. Tahbaz-Salehi (2019). Production networks: A primer. *Annual Review of Economics 11*(1), 635–663.

Corseuil, C. H., L. Machado, F. Roitman, and G. Ulyssea (2023). Firm-level and local labor market effects of a large credit shock: Evidence from Brazil. Discussion Paper 2924, Instituto de Pesquisa Econômica Aplicada, Rio de Janeiro.

Edquist, H., P. Goodridge, and J. Haskel (2021). The Internet of Things and economic growth in a panel of countries. *Economics of Innovation and New Technology 30*(3), 262–283.

[9]See Ribeiro and Prettner (2026), Marioni et al. (2024), and Edquist et al. (2021), for example.

Grimaldi, D. and J. R. H. Ornelas (2024). Do firms need cheaper credit to grow? investigating the effectiveness of subsidized earmarked loans. Working Paper 599, Banco Central do Brasil.

IBGE (2025, May). Contas nacionais trimestrais: Indicadores de volume e valores correntes, janeiro–março 2025. Indicadores IBGE, Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro. Acessed in: 19 jul. 2026.

Katz, R. and J. Jung (2023). The impact of taxation in the telecommunications industry. *Information Economics and Policy 62*, 101016.

Marioni, L. d. S., A. Rincon-Aznar, and F. Venturini (2024). Productivity performance, distance to frontier and AI innovation: Firm-level evidence from europe. *Journal of Economic Behavior & Organization 228*, 106762.

Martini, R. A., F. G. Maciel, B. d. C. Neves, L. Machado, and L. D. W. d. Souza (2025). Financiamento ao investimento e crescimento das empresas: Uma avaliação panorâmica dos produtos de crédito do BNDES. Relatório de Avaliação de Efetividade v. 7, n. 19, Banco Nacional de Desenvolvimento Econômico e Social, Rio de Janeiro.

Niebel, T. (2018). ICT and economic growth–comparing developing, emerging and developed countries. *World development 104*, 197–211.

Ribeiro, F., A. A. Betarelli Junior, W. R. Faria, F. S. Perobelli, and V. d. A. Vale (2019). Avaliação de impacto da eliminação do regime de ex-tarifários e da redução das tarifas de importação sobre bens de capital e bens de informática e telecomunicações. *Boletim de Economia e Política Internacional* (24), 21–35.

Ribeiro, M. J. and K. Prettner (2026). The skill premium across countries in the era of industrial robots and generative AI. *Available at SSRN 5233467*.

Stanley, T. D., H. Doucouliagos, and P. Steel (2018). Does ICT generate economic growth? a meta-regression analysis. *Journal of economic surveys 32*(3), 705–726.

A Additional Results

Table A1: Production and fiscal effects on firms benefiting from FUNTTEL in all sectors of the economy (% change) - Local effects

Sector	p_iQ_i	p_iX_i	wL_i	ICT	R_q	R_w	R_c	R_x	R_G
Agriculture	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000
Mining	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
Manufacturing	-0.003	0.002	-0.009	1.264	-0.003	-0.009	0.000	0.000	-0.004
Electricity and gas	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	0.000	0.000	-0.003
Water and waste	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
Construction	-0.004	0.001	-0.012	1.261	-0.004	-0.012	0.000	0.000	-0.006
Trade and repair	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	-0.001
Transp. and storage	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
Accom. and food	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
ICT	0.213	0.373	0.020	1.294	0.213	0.020	0.000	0.000	0.067
Financial activities	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	-0.001
Real estate activities	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	0.000	0.000	-0.001
Prof. and scientific activ.	-0.003	0.025	-0.042	1.231	-0.003	-0.042	0.000	0.000	-0.019
Administrative activ.	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000
Public administration	-0.001	-0.001	-0.001	-0.001	0.000	-0.001	0.000	0.000	0.000
Education	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Health and social serv.	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	0.000	-0.001
Arts and recreation	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
Other services	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	0.000	0.000	-0.001
Total	**0.004**	**0.010**	**-0.003**	**0.681**	**0.008**	**-0.003**	**0.000**	**0.000**	**0.000**

Notes: **(1)**: p_iQ_i: Value of gross-output in sector i; p_iX_i: Value of intermediate goods; wL_i: Wage bill; ICT: Expenditure on goods from the information and communication sector; R_q: Government revenue from taxes on gross-output; R_w: Government revenue from taxes on wages; R_c: Government revenue from taxes on consumption; R_x: Government revenue from taxes on intermediate goods; R_G: Total government revenue. **(2)**: The last row reports the total local counterfactual effect across all sectors.

Table A2: Production and fiscal effects of a tax reduction in the ICT sector in all sectors of the economy (% change) – Aggregate effects

Sector	p_iQ_i	p_iX_i	wL_i	ICT	R_q	R_w	R_c	R_x	R_G
Agriculture	0.001	0.004	-0.016	1.284	0.001	-0.016	0.000	0.004	0.000
Mining	0.005	0.013	-0.009	1.291	0.005	-0.009	0.002	0.011	0.003
Manufacturing	0.008	0.022	-0.011	1.289	0.008	-0.011	0.006	0.020	0.005
Electricity and gas	0.037	0.042	-0.004	1.296	0.037	-0.004	0.028	0.041	0.033
Water and waste	0.008	0.018	-0.008	1.292	0.008	-0.008	0.004	0.020	0.004
Construction	0.022	0.048	-0.010	1.290	0.022	-0.010	0.019	0.043	0.012
Trade and repair	0.012	0.032	-0.008	1.292	0.012	-0.008	0.007	0.029	0.007
Transp. and storage	0.009	0.027	-0.009	1.291	0.009	-0.009	0.005	0.026	0.005
Accom. and food	0.029	0.063	-0.010	1.290	0.029	-0.010	0.027	0.074	0.024
ICT	0.579	0.754	0.370	1.675	0.579	0.370	0.195	0.861	0.434
Financial activities	0.030	0.059	-0.003	1.297	0.030	-0.003	0.021	0.053	0.021
Real estate activities	0.083	0.084	-0.006	1.294	0.083	-0.006	0.077	0.087	0.083
Prof. and scientific activ.	0.066	0.107	0.010	1.311	0.066	0.010	0.043	0.118	0.049
Administrative activ.	0.027	0.093	-0.008	1.292	0.027	-0.008	0.023	0.098	0.020
Public administration	0.005	0.065	-0.009	1.291	0.000	-0.009	0.001	0.075	-0.001
Education	-0.003	0.072	-0.010	1.290	-0.003	-0.010	-0.006	0.108	-0.006
Health and social serv.	-0.004	0.008	-0.010	1.290	-0.004	-0.010	-0.007	0.008	-0.007
Arts and recreation	0.040	0.092	-0.002	1.298	0.040	-0.002	0.030	0.113	0.033
Other services	0.039	0.083	-0.004	1.296	0.039	-0.004	0.030	0.089	0.028

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Table A2: Production and fiscal effects of a tax reduction in the ICT sector in all sectors of the economy (% change) – Aggregate effects (Continuation)

Sector	p_iQ_i	p_iX_i	wL_i	ICT	R_q	R_w	R_c	R_x	R_G
Total	**0.026**	**0.050**	**0.000**	**1.420**	**0.041**	**0.001**	**0.012**	**0.044**	**0.019**

Notes: **(1)**: p_iQ_i: Value of gross-output in sector i; p_iX_i: Value of intermediate goods; wL_i: Wage bill; ICT: Expenditure on goods from the information and communication sector; R_q: Government revenue from taxes on gross-output; R_w: Government revenue from taxes on wages; R_c: Government revenue from taxes on consumption; R_x: Government revenue from taxes on intermediate goods; R_G: Total government revenue. **(2)**: The last row of the table represents the total counterfactual effect on the economy.

Table A3: Results of the exogenous and endogenous calibration

Sector	N	ϕ	τ^q	τ^w	$\tau^{x,n}$	τ^{sub}	τ^c	Labsh	GO/L_i	σ	α	A	$\bar{c}$
Agriculture	0	0	0.03	0.60	0.15	1.00	0.25	0.04	0.07	0.12	0.02	1.96	0.001
Mining	0	0	0.02	0.74	0.38	1.00	0.25	0.01	0.36	0.31	0.04	8.36	0.00
Manufacturing	7	$1e-5$	0.18	0.65	0.38	0.94	0.25	0.18	0.03	0.42	0.13	1.04	0.00
Electricity and gas	0	0	0.18	0.75	0.28	1.00	0.25	0.00	0.25	0.12	0.00	11.46	0.00
Water and waste	0	0	0.05	0.68	0.09	1.00	0.25	0.01	0.03	0.40	0.01	1.35	0.00
Construction	1	$1.3e-6$	0.05	0.69	0.28	0.94	0.25	0.06	0.02	0.44	0.03	0.69	0.00
Trade and repair	0	0	0.00	0.60	0.28	1.00	0.25	0.23	0.03	0.49	0.17	0.73	0.00
Transp. and sto.	0	0	0.06	0.67	0.28	1.00	0.25	0.06	0.03	0.51	0.05	0.71	0.00
Accom. and food	0	0	0.11	0.54	0.28	1.00	0.25	0.05	0.01	0.48	0.02	0.51	0.00
Info. and comm.	11	$2.9e-5$	0.13	0.73	0.28	0.94	0.25	0.03	0.05	0.48	0.03	1.24	0.00
Financial activ.	0	0	0.12	0.76	0.30	1.00	0.25	0.02	0.10	0.45	0.06	2.85	0.00
Real estate activ.	0	0	0.00	0.62	0.02	1.00	0.25	0.00	0.80	0.02	0.00	10.01	0.00
Prof. & sci. activ.	1	$1.1e-6$	0.05	0.70	0.00	0.94	0.25	0.03	0.04	0.44	0.04	1.69	0.00
Adm. activ.	0	0	0.08	0.60	0.28	1.00	0.25	0.12	0.01	0.65	0.05	0.17	0.00
Public adm.	0	0	0.00	0.74	0.00	1.00	0.25	0.02	0.14	0.82	0.15	0.60	0.00
Education	0	0	0.01	0.71	0.15	1.00	0.25	0.04	0.05	0.92	0.10	0.09	0.00
Health & serv.	0	0	0.02	0.67	0.28	1.00	0.25	0.06	0.02	0.70	0.06	0.15	0.00
Arts and recr.	0	0	0.19	0.59	0.19	1.00	0.25	0.01	0.05	0.56	0.01	0.84	0.00
Other services	0	0	0.01	0.61	0.28	1.00	0.25	0.03	0.03	0.52	0.02	0.75	0.00

Note: N: number of firms benefiting from FUNTTEL; ϕ: proportion of beneficiary firms; τ^q: tax rate on gross-output; τ^w: tax rate on labor costs; $\tau^{x,n}$: tax rate on intermediate inputs for non-subsidized firms; τ^{sub}: adjustment factor associated with the subsidy provided by FUNTTEL; τ^c: consumption tax rate; Labsh: labor share in output; GO/L_i: gross-output per worker; σ: labor share in the output; α: weight of the good in household utility; A: total factor productivity; $\bar{c}$: subsistence consumption.