# Remote work, real effects: The impact of telework on Brazil's sectoral structure

Pedro Leite* Matheus Nascimento† Fernando Perobelli ‡

**Abstract**

The growing adoption of teleworking has reshaped labor market dynamics and sectoral interdependencies. This study examines the systemic impact of teleworkers on the Brazilian economy, focusing on their contributions to employment, income flows, and sectoral demand. Using input-output analysis, we estimate type I multipliers to assess the broader economic effects of teleworkers in knowledge-intensive service industries (KIS). In addition, we apply the hypothetical extraction method to assess the role of teleworkers in sectoral structures, comparing telework-intensive industries with key economic sectors. The analysis is based on the Brazilian input-output matrix, estimated from the Resource and Use Tables (TRU) of the System of National Accounts (SCN). Household consumption is included using data from the Household Budget Survey (POF), disaggregated by income level, while household income is derived from the National Continuous Household Sample Survey (PNAD-C), which identifies teleworkers and their income. The results indicate that teleworkers generate positive employment and income spillovers, especially in professional, scientific and technical services. While telework-intensive sectors show higher employment multipliers, technology-driven industries show lower indirect job creation, likely due to productivity-driven processes. The extraction analysis also shows that the consumption effects of teleworkers are more pronounced than their direct labor contributions, with higher-income teleworkers having the largest economic impact. Compared to key economic sectors, telework-intensive industries show greater sensitivity to the removal of teleworkers, reinforcing their dependence on demand-driven interactions. These findings suggest that teleworkers influence economic activity not by driving core production chains, but through their role in revenue flows and service-based transactions. As telework continues to be concentrated in knowledge-intensive sectors, understanding its implications for sectoral resilience, labor market transformation, and economic policy will be critical to shaping the future of work.

**KEYWORDS:** Telework. Remote Work. Hypothetical extraction method. Knowledge-intensive services (KIS).

*PhD student at Universidade Federal de Juiz de Fora (UFJF) (pedroleite880@gmail.com)
†PhD student at Universidade Federal de Juiz de Fora (UFJF) (mhsn.nascimento@gmail.com)
‡Professor at Universidade Federal de Juiz de Fora (UFJF) (fernando.perobelli@ufjf.br)

# 1 Introduction

Remote work, understood as the performance of professional activities in an alternative location, usually the worker's home, represents a significant shift in the dynamics of the current labor market (IBGE, 2023b). The evolution of information and communication technologies (ICTs) has allowed employees to connect to company systems from anywhere, facilitating instant communication and real-time collaboration even at a distance (Messenger and Gschwind, 2016; Homberg et al., 2023). Beyond considerations of technological feasibility, the increasing adoption of remote work reflects a broader demand for flexibility and autonomy in the modern labor market. This demand is valued by both workers and companies (Eurofound and ILO, 2017; Reisinger and Fetterer, 2021; Metselaar et al., 2023).

The rapid and widespread transition from in-person to remote work that occurred in the wake of the COVD-19 pandemic transformed a practice once limited to specific sectors into a global norm (Adams-Prassl et al., 2020; Crowley et al., 2020; Okubo, 2022). At the peak of the pandemic, approximately half of the U.S. workforce transitioned to remote work (Brynjolfsson et al., 2020), while in Brazil, about 10% of workers adopted remote arrangements (Góes et al., 2021). This large-scale shift introduced changes to economic structures, altering sectoral demand, consumption patterns, and employment dynamics.

The decline in the necessity of commuting has led to a decrease in demand for public transportation, fuels, and other services associated with physical workplace attendance (Elldér, 2020; Kaya and Arı, 2023; Bedon-Chamorro and Pujol-Lopez, 2023). Simultaneously, businesses dependent on office-based workers, such as restaurants, cafes, and convenience stores, encountered a decline in revenue (Green, 2023; Alekseev et al., 2023; Annamalah and Paraman, 2023). Conversely, remote work has fueled growth in industries such as technology and e-commerce (Microsoft, 2021; Van Nieuwerburgh, 2023), reshaping sectoral interdependencies in ways likely to persist beyond the pandemic.

These structural changes have been observed to extend to household consumption patterns, with notable differences across income groups (Avdiu and Nayyar, 2020). Higher-income households, with greater financial capacity to adapt their homes for remote work, tend to reallocate spending toward home-related goods and services while benefiting from increased flexibility and productivity (Baruffini and Rossi, 2024). In contrast, lower-income households frequently lack adequate space and technological resources, remain more dependent on non-teleworkable jobs, and face greater economic constraints, reinforcing social and economic disparities (Garrote Sanchez et al., 2021).

Understanding the role of teleworkers - defined as remote workers who utilize information and communication technologies (ICTs) - in shaping economic structures is essential for evaluating long-term transformations in labor markets and sectoral interdependencies. While extant

studies have examined how the economy adapted to telework, this study takes the reverse approach—assessing how teleworkers themselves influence economic structure. Specifically, the present study investigates the systemic impact of telework on Brazil's sectoral economic configuration and household consumption patterns. By analyzing the role of teleworkers in the economy, we evaluate their contributions to employment generation, income flows, and sectoral interdependencies. Additionally, we examine how teleworkers—classified by gender, race, and educational attainment—shape production and demand structures, influencing sectoral dynamics.

To address this research question, we employ the 2021 National Input-Output Table (IOT) in conjunction with microdata from the Household Budget Survey (POF) and the National Household Sample Survey (PNAD). The POF is used to categorize households into seven consumption brackets, while the PNAD classifies workers into seven income groups. These classifications allow for the disaggregation of household consumption and wage vectors in the IOT. Since the POF does not explicitly distinguish teleworkers' consumption patterns, we hypothesize that the proportion of teleworkers within each income bracket, as identified in the PNAD, can serve as a weighting factor to approximate this group's consumption structure.

Our methodological approach integrates two complementary techniques. Employment and income multipliers are used to assess the capacity of various sectors to generate jobs and distribute income, distinguishing between teleworkers and non-teleworkers at an aggregate level. Additionally, separate multipliers are estimated exclusively for teleworkers across gender, race, and educational attainment to capture demographic variations in their economic impact. To evaluate telework's influence on sectoral structures, we employ the hypothetical extraction method, simulating the removal of teleworkers' labor income from value-added and their consumption from final demand. This approach enables us to quantify the extent to which different sectors depend on teleworkers as both producers and consumers.

The COVID-19 pandemic and the subsequent increase in telework created a natural experiment for analyzing its economic impact. This has led to a growing body of research examining mobility restrictions and the shift to telework using various methodologies, including input-output models (Fadinger et al., 2020; Bonet-Morón et al., 2020; Yusa, 2021). These studies often emphasize the disproportionate impact on sectors with limited teleworkability, while others examine sectoral vulnerabilities (del Rio-Chanona et al., 2020), the propagation of economic shocks (Pichler and Farmer, 2021), and broader structural changes (Han, 2022; Spithoven and Merlevede, 2025). While much of this literature focuses on how the economy adapts to remote work, this study shifts the focus from how the economy adapted to telework to how teleworkers actively shape economic structures and sectoral dynamics.

A complementary line of research has employed the hypothetical extraction method to

assess the structural significance of specific sectors and labor groups within the economy. This approach has been widely used to analyze intersectoral dependencies and the systemic role of different economic agents. Leão et al. (2022) applied hypothetical extraction to examine knowledge-intensive business services (KIBS) in Brazil, assessing their sectoral linkages and geographic concentration, revealing that these services are predominantly located in major urban centers. Stamopoulos et al. (2022) used the method to construct a composite ICT sector in Greece, analyzing its production linkages and finding that ICT services are more integrated into the economy than ICT manufacturing, though their overall contribution to other sectors remains limited. Haddad et al. (2021) employed a partial hypothetical extraction approach to estimate the economic costs of lockdown measures in São Paulo, using simulations to guide sectoral and territorial policy decisions. Bazzazan (2009) and Carleton (2016) assessed the role of the ICT sector in Canada and Iran, respectively, demonstrating its importance in employment generation and output contribution. Giammetti et al. (2022) simulated the withdrawal of older workers due to age-based lockdowns, illustrating how such labor-specific restrictions propagate through global value chains and disrupt sectoral output.

More closely aligned with this study, Ferreira dos Santos et al. (2020) and Ribeiro et al. (2024) applied hypothetical extraction to informal workers, estimating the economic consequences of their removal from the labor market. Their results indicate that the exclusion of informal work leads to a significant contraction of output and employment, especially in the service sectors. This methodological framework is directly relevant to the present study, which applies hypothetical extraction to teleworkers by income bracket to assess their systemic role in sectoral interdependencies. By integrating employment and income multipliers with hypothetical extraction, this study provides a dual perspective: one that quantifies the structural importance of teleworkers within the economy, and another that assesses the capacity of different sectors to generate employment and income in response to telework-related shifts.

The remainder of this paper is structured as follows. Section 2 provides an overview of remote workers in Brazil, Section 3 describes the data and methodology used, Section 4 presents the results, and Section 5 offers concluding remarks.

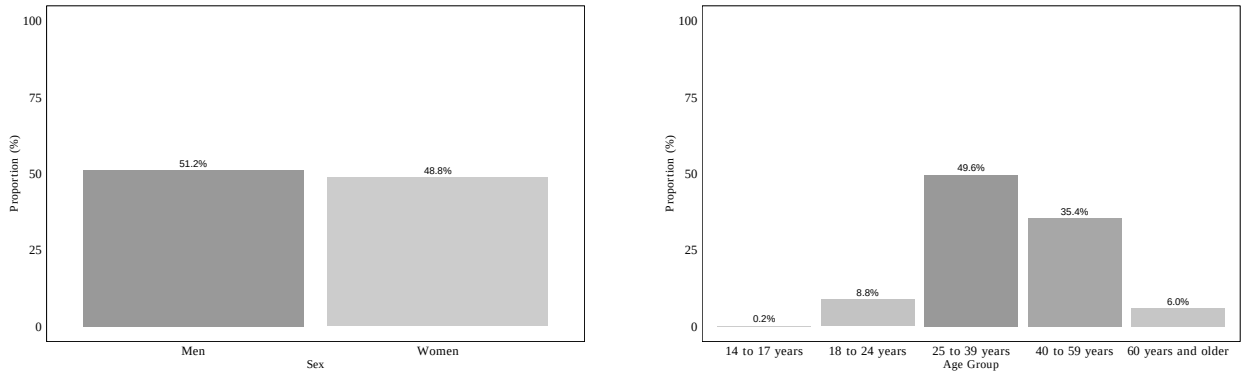
# 2 Background

Remote work in Brazil has grown significantly in recent years. Although many workers returned to on-site work after the pandemic, a significant portion of the workforce continues to telework. By 2022, 7.7% of the Brazilian workforce was teleworking, reflecting both ongoing digital transformation and evolving labor market demands (IBGE, 2023b).

The demographic distribution of teleworkers indicates a relatively balanced representation

in terms of gender, with 51.2% being men and 48.8% women, as shown in Figure 1b. Regarding age, telework is most prevalent among individuals aged 25 to 39 years (49.6%), followed by those between 40 and 59 years old (35.4%). These figures suggest that telework adoption is highest among middle-aged workers, which aligns with the need for experience, professional specialization, and digital adaptability in sectors where remote work is more prevalent.

Figure 1: Distribution of teleworkers by gender and age group



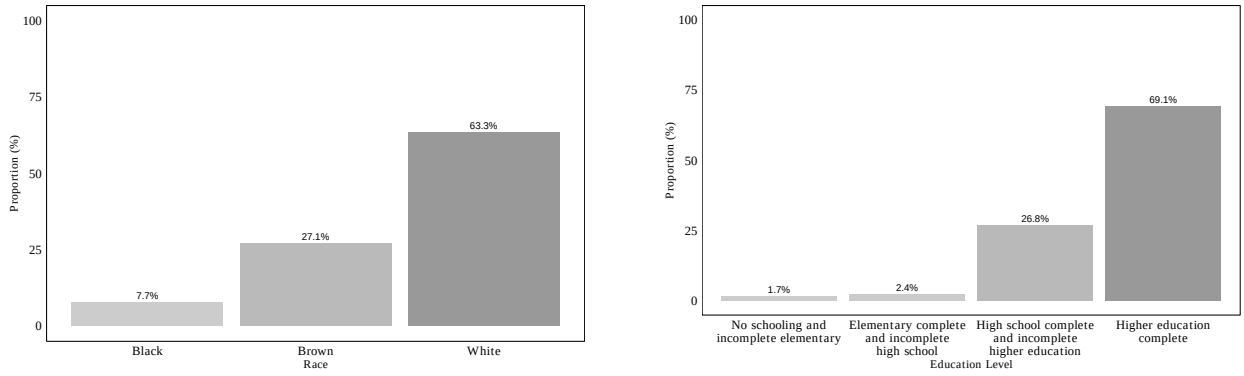

(a) Proportion by gender

(b) Proportion by age group

Source: IBGE (2023b)

The racial and educational distribution of teleworkers reveals a notable concentration among white and highly educated professionals, as illustrated in Figure 2b. Specifically, 63.3% of teleworkers self-identify as white, whereas Black and Brown individuals represent 7.7% and 27.1%, respectively. Furthermore, a considerable proportion of teleworkers possess higher education degrees, with 69.1% having completed tertiary education, while only 26.8% have completed high school. This pattern underscores the role of educational attainment as a key determinant of telework feasibility, likely reflecting disparities in access to technology, digital skills, and professional networks that enable remote work arrangements.

Figure 2: Distribution of teleworkers by race and education level




(a) Proportion by race

(b) Proportion by education level

Source: IBGE (2023b)

The sectoral distribution of teleworkers highlights their concentration in knowledge-intensive and service-oriented industries. As shown in table 1, the highest prevalence of telework is observed in industries such as development of systems and other information services (60.1%), print-integrated publishing and editing (45.1%), and financial intermediation, insurance, and supplementary pension (34%). These sectors rely heavily on digital tools, autonomous tasks, and high levels of qualification, which facilitate remote work adoption.

Table 1: Industries with the highest proportion of teleworkers

| Sector | Occupied workers | Teleworkers | Share of teleworkers |
|---|---|---|---|
| Development of systems and other information services | 994,507 | 597,343 | 60.1% |
| Print-integrated publishing and editing | 64,438 | 29,080 | 45.1% |
| Financial intermediation, insurance and supplementary pension | 1,610,927 | 547,867 | 34.0% |
| Other professional, scientific and technical activities | 1,038,324 | 331,994 | 32.0% |
| Architecture, engineering and R&D services | 757,588 | 233,081 | 30.8% |
| Television, radio, cinema and others | 193,182 | 57,494 | 29.8% |

Source: IBGE (2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

These findings reveal clear patterns in telework adoption that are shaped by demographic, educational, and industry factors. Telework is most prevalent among highly educated, white professionals in the digital, financial, and creative industries, while its adoption remains minimal in manufacturing, agriculture, and service industries that require physical presence.

The industries with the highest prevalence of teleworking are aligned with knowledge-intensive services (KIS) (Eurostat, 2009). These sectors, including technology, financial services, and professional and scientific activities, rely heavily on specialized expertise, digital tools,

and innovation-driven processes that make teleworking a viable and integrated practice. The concentration of teleworkers in KIS suggests that the adoption of telework is closely linked to the structural characteristics of these sectors, where digitization and knowledge-based tasks facilitate remote collaboration.

The distribution of telework also reflects the increasing role of human capital and digital skills in labor market transformations. As telework evolves, it is likely to remain concentrated in sectors where intellectual and creative activities drive production, reinforcing the link between the feasibility of telework and knowledge-intensive economic structures.

# 3 Methodology and Data

This study is interested in exploiting the dynamics of telework in the relationships between sectors in the economy. According to Miller and Blair (2009), from an input-output matrix we can analyze the distribution of an activity through other activities in the whole economy and extend to other parameters.

This approach is the best option for our work because we can go further than the individual analyses and exploit how the sectors relationship will be carried out through an income and employment multipliers and extraction of income and consumption of teleworkers in household bands.

## 3.1 Employment/Income Multipliers

To assess the impact of exogenous changes in employment and income across sectors, we calculate the respective multipliers Miller and Blair (2009). Specifically, we examine how a change in output affects the income of individuals in each sector of the economy and how many jobs this new output creates per sector.

First, we compute the sectoral employment and income coefficients, as shown in the formula below. Since the calculation is similar, let's assume that M can be either employment (e) or income (r).

$$c_j^M = v_j^M / x_j \quad \forall j = 1, 2, \ldots, n \tag{1}$$

$v_j^M$ is the total number of employed workers (e) or the income of workers (r) in sector j, and x is the sectoral output. For all sectors we have a vector with the gross income or employment values, $M'$. For $B$ inverse matrix of Leontief and y is the final product vector for income multiplier or final demand vector for employment, we have the following equation of $M'$.

$$M' = \hat{C}^M By \tag{2}$$

The income generator or job creation matrix is called M and is defined by the product of the coefficients matrix and the inverse matrix of Leontief.

$$M = \hat{C}^M B \tag{3}$$

Assuming that $m*$ are the elements of the matrix $M$, we can calculate the simple multiplier of employment or income of each sector $j$, $m(M)_j$.

$$m(M)_j = \sum_{i=1}^{n} m_{ij}^* \tag{4}$$

The Type I [1] multiplier of employment or income is given by the ratio between the simple multiplier and the coefficient.

$$m^I(M)_j = m(M)_j / c_j^M \tag{5}$$

We then created employment and income multipliers for different demographic groups based on gender, race, and education. Specifically, using individual data from the 2022 PNAD-C Supplement, we determined the income and number of teleworkers categorized by male, female, white, non-white, high school graduate and college graduate for five household income bands.

## 3.2 Hypothetical extraction method

The purpose of hypothetical extraction is to analyze how the economy will behave, in terms of change in output, if we remove the overall production distribution of some productive sector or agent of the matrix. The extraction works in three different ways: i) total linkage, which removes the columns and rows of a given sector or agent, ii) backward linkages, which represents only the extraction of the column and iii) forward linkage, the extraction of the row (Miller and Blair, 2009). This paper is interested in analyzing the backward linkages and the foward linkage.

To construct our approach, we follow Perobelli et al. (2015), who constructs a closed input-output model by adding households into productive sectors. We know that in an open Leontief model, there are exogenous sectors that are separated from productive sectors, so in the case of a closed model, we need to endogenize household income and household consumption. If we call the productive sectors $s$ and the household bands $h$, our matrix has the dimension: $(s+h)x(s+h)$. And the model is

[1] See Miller and Blair (2009) for other three types

$$x = A^* x + f^* \tag{6}$$

For $x$ is an output vector with $(s+h)$ elements, $A^*$ is a matrix of inputs with $(s+h)x(s+h)$ dimension, and $f^*$ is a vector of final demand, $(s+h)$, excluding household consumption.

The solution to Eq.1 for a backward linkage is given by:

$$x = B^* f^* \tag{7}$$

B is the Leontief inverse matrix $B^* = (I - A^*)^{-1}$. This equation represents the impact of an extraction of a specific sector or agent in the whole framework in terms of outputs. For a forward linkage, the solution to Eq.1 is:

$$x = G^* f^* \tag{8}$$

Where G is the Gosh inverse matrix $G^* = (I - A^*)^{-1}$, but now $f^*$ is a vector of added value. In our paper, we will remove the rows (income) and columns (consumption) of each household band, so we will compare the solutions of a complete matrix and an extracted matrix. This difference can be disregarded by sector.

## 3.3 Database

Following Guilhoto and Sesso Filho (2010), we estimate the Brazilian input-output matrix of 2021 based on the Resource and Use Tables (TRU) of the System of National Accounts (SCN) of IBGE (2023a). Our matrix is built at the most disaggregated level of activity, consisting of 68 productive sectors. It is important to note that our study does not take into account regions, so our analysis focuses only on the interdependence between sectors.

To include Brazilian Household Consumption, we use current price data from IBGE's Household Budget Survey (POF) in 2017-2018, the latest version of this research. Our estimation matrix already includes household consumption, but we use POF to disaggregate these values according to the level of household income. We can't tell from POF whether a person teleworked or not, so we use the ratio of teleworkers to total employed workers as a weight.

For Brazilian Household Income, we collect data from last trimester of 2022 of IBGE's Continuous National Household Sample Survey (PNAD-C), which contains a complementary theme on teleworking and work through digital platforms. From this we can identify if and individuals teleworked and calculate their income within the levels of household income[2]. Both

[2]The household income bands we used were based on the PNAD-C, which are: teleworkers up to 1 of the minimum wage, more than 1 up to 2 of the minimum wage, more than 2 up to 3 minimum wage, more than 3 up to 5 minimum wages, more than 5 minimum wages and non-teleworkers.

PNAD-C and POF are compatible with the productive sectors of the SCN through the codes of CNAE 2.0 (National Classification of Economic Activities).

Both PNAD-C and POF are compatible with the productive sectors of the SCN through the codes of CNAE 2.0 (National Classification of Economic Activities). We use the converter of IBGE to transform the sectors of PNAD-C and POF in the sector of activity SCN and we realize that the activity of private education did not have a compatibilization in CNAE2.0 and the activity of private healthcare has some inconsistencies, so we add its input-output values to the public education activity and we create a new sectors called education and healthcare. Now we have a 66x66 matrix. Then we created 6 vectors of household consumption by adding the prices, grouped by the 66 sectors, of the POF 17-18 database for each range of household income. As described before, we add these vectors in the matrix weighted by the proportion of teleworkers. To create the 6 vectors of household income, we used the same range to categorize each vector and identify teleworkers by occupied individuals who worked at an alternative workplace in the last 30 days and used ICT equipment such as a computer, tablet, landline or mobile phone. We again grouped by 66 sectors and added the annual individual income into 6 different household income ranges. By adding these vectors, our matrix now has 72 rows and 72 columns.

# 4 Results

We begin by presenting Type I income and employment multipliers for different categories of teleworkers within the fifth household income band, which includes individuals whose earnings exceed five times the minimum wage threshold. These multipliers facilitate the quantification of the broader economic impact of teleworkers beyond their direct income and employment generation. Next, we analyze the impact of removing teleworkers through the hypothetical extraction method, which measures the structural dependence of key sectors on telework-based labor and consumption. To elucidate the findings, the focus is directed towards the six sectors that account for the highest proportion of teleworkers: print-integrated publishing and editing, television, radio, cinema and sound and image recording/editing activities, development of systems and other information services, financial intermediation, insurance and supplementary pension, architecture, engineering, technical testing/analysis, and R&D services, and other professional, scientific, and technical activities.

## 4.1 Multipliers

As illustrated in Table 2, the employment and income multipliers for teleworkers and non-teleworkers in the six sectors with the highest proportion of teleworkers are presented. The employment multipliers indicate the total number of jobs created for each teleworker employed,

while the income multipliers capture the additional income generated in the economy for each unit of income earned by a teleworker.

The highest employment multipliers are observed in Other professional, scientific, and technical activities (2.33) and Television, radio, cinema, and sound/image recording (2.21), suggesting that these sectors generate significant employment spillovers. In contrast, Development of systems and other information services, have a relatively lower employment multiplier (1.40), despite their high telework participation, indicating that their job creation effects are more limited.

In terms of income multipliers, the highest value (5.17) is found in Other professional, scientific and technical activities, making it the only sector where teleworkers have a higher income multiplier than non-teleworkers. This suggests that the income generated by teleworkers in this sector circulates more widely in the economy, possibly due to the high value-added nature of their work and their integration into broader business networks. In contrast, the income multiplier in Development of systems and other information services is significantly lower (1.29), reflecting a more limited diffusion of income effects despite the sector's high telework intensity.

Table 2: Multipliers of teleworkers in the fifth household income band and non-teleworkers

| Sector | $m^I(e)_j$ | | $m^I(r)_j$ | |
|---|---|---|---|---|
| | Teleworker | Non-Teleworker | Teleworker | Non-Teleworker |
| Development of systems and other information services | 1.40 | 9.65 | 1.29 | 2.39 |
| Print-integrated publishing and editing | 1.67 | 5.06 | 1.79 | 2.48 |
| Financial intermediation, insurance and supplementary pension | 2.07 | 9.42 | 1.56 | 2.49 |
| Other professional, scientific and technical activities | 2.33 | 4.46 | 5.17 | 4.31 |
| Architecture, engineering and R&D services | 1.42 | 2.90 | 1.77 | 2.36 |
| Television, radio, cinema and others | 2.21 | 7.89 | 1.80 | 3.08 |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

Table 3 disaggregates the employment and income multipliers by gender and shows consistent patterns for male and female teleworkers. Employment multipliers remain above one for both groups, but there are notable differences in specific sectors. The employment multiplier in Other professional, scientific and technical activities is higher for male teleworkers (2.49) than for female teleworkers (2.10), suggesting that the employment spillovers from telework are stronger for men in this sector. Conversely, in Television, radio, cinema, and sound/image recording, male and female teleworkers have similar employment effects, although male teleworkers have a significantly higher income multiplier (2.12) than female teleworkers (1.53), which may reflect differences in earnings structures or spending patterns within the industry. These results suggest that the economic effects of telework are not uniform across gender categories, particularly in terms of income circulation. In some industries, male teleworkers contribute more to job creation, while in others female teleworkers have comparable effects.

Table 3: Multipliers gender classes of teleworkers in the fifth household income band

| Sector | $m^I(e)_j$ | | $m^I(r)_j$ | |
|---|---|---|---|---|
| | Male Teleworker | Female Teleworker | Male Teleworker | Female Teleworker |
| Development of systems and other information services | 1.35 | 1.53 | 1.26 | 1.38 |
| Print-integrated publishing and editing | 1.64 | 1.75 | 1.72 | 2.00 |
| Financial intermediation, insurance and supplementary pension | 2.07 | 2.07 | 1.57 | 1.54 |
| Other professional, scientific and technical activities | 2.49 | 2.10 | 5.22 | 5.08 |
| Architecture, engineering and R&D services | 1.41 | 1.44 | 1.79 | 1.75 |
| Television, radio, cinema and others | 2.24 | 2.16 | 2.12 | 1.53 |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

Tables 4 and 5 further disaggregate the multipliers by race and educational attainment, highlighting additional disparities in the economic effects of telework. The income multiplier in Other professional, scientific, and technical activities is significantly higher for white teleworkers (6.16) than for non-white teleworkers (3.44), reflecting a notable difference in how income generated by these groups is distributed throughout the economy. Similarly, employment multipliers in television, media, and creative industries tend to be higher for non-white teleworkers, suggesting that these industries may provide more indirect employment opportunities for underrepresented racial groups.

Analysis by educational attainment shows that employment multipliers for high school educated teleworkers in professional services (2.48) are slightly higher than for college educated teleworkers (2.30), although the income multiplier remains higher for the latter. This suggests that while lower-educated teleworkers may generate more employment spillovers, higher-educated teleworkers contribute more to income generation, likely due to differences in wages and occupational roles.

Table 4: Multipliers of race classes of teleworkers in the fifth household income band

| Sector | $m^I(e)_j$ | | $m^I(r)_j$ | |
|---|---|---|---|---|
| | White Teleworker | Non-white Teleworker | White Teleworker | Non-white Teleworker |
| Development of systems and other information services | 1.44 | 1.30 | 1.31 | 1.22 |
| Print-integrated publishing and editing | 1.90 | 1.38 | 2.06 | 1.42 |
| Financial intermediation, insurance and supplementary pension | 2.01 | 2.32 | 1.53 | 1.68 |
| Other professional, scientific and technical activities | 2.44 | 2.02 | 6.16 | 3.44 |
| Architecture, engineering and R&D services | 1.42 | 1.45 | 1.75 | 1.89 |
| Television, radio, cinema and others | 2.10 | 4.26 | 1.73 | 2.52 |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

The results of the multiplier analysis highlight several important findings. First, teleworkers generate positive employment and income spillovers, but these effects vary across sectors.

Table 5: Multipliers of scholarships classes of teleworkers in the fifth household income band

| Sector | $m^I(e)_j$ | | $m^I(r)_j$ | |
|---|---|---|---|---|
| | High School | College | High School | College |
| Development of systems and other information services | 1.44 | 1.39 | 1.20 | 1.30 |
| Print-integrated publishing and editing | - | 1.58 | - | 1.69 |
| Financial intermediation, insurance and supplementary pension | 2.48 | 2.02 | 1.64 | 1.55 |
| Other professional, scientific and technical activities | 2.48 | 2.30 | 5.88 | 5.07 |
| Architecture, engineering and R&D services | 1.86 | 1.39 | 2.95 | 1.72 |
| Television, radio, cinema and others | 3.35 | 2.14 | 2.38 | 1.76 |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities. For Print-integrated publishing and editing, there are no teleworkers with High School level of education in the fifth household income band.

Professional and technical services show the strongest economic multipliers, while technology-driven sectors such as systems development show more limited employment spillovers, likely due to their productivity-driven nature.

Second, gender, race, and education significantly influence how telework income circulates in the economy, with differences in employment multipliers, income effects, and sectoral dependencies. These differences suggest that telework policies must take into account demographic and skill-based differences to ensure equitable economic benefits.

## 4.2 Extraction

This section examines the structural dependence of telework-intensive sectors on the labor and consumption of teleworkers using the hypothetical extraction method. The analysis assesses how removing teleworkers affects sales (forward linkages) and output (backward linkages). Forward linkages measure the loss of sectoral sales and indicate the extent to which industries depend on teleworkers as providers of labor and services. Backward linkages quantify the reduction in total sectoral output, capturing how industries rely on teleworkers' income and consumption as demand drivers. To contextualize these results, we compare telework-intensive sectors with key sectors of the economy, as shown in tables 6 and 7. This comparison provides insight into how teleworkers contribute to sectoral dynamics and assesses whether their removal leads to more pronounced effects in telework-intensive industries compared to other key sectors of the economy.

Table 6 shows the percentage reductions in sectoral sales following the removal of teleworkers at different income levels. Losses increase as higher-income teleworkers are removed, reinforcing their role in sustaining business activity. Print-integrated publishing and editing consistently show the highest percentage losses, ranging from 0.0005% in the third income band to 0.02% in the fifth income band, indicating that it is proportionately more dependent on teleworkers than

other industries.

Compared to key sectors, telework-intensive industries show larger sales losses, especially at higher income levels. This distinction reflects differences in the structure of the economy: while telework-intensive sectors are more dependent on professional services and business transactions, key sectors often have broader supply chains and more diversified input-output relationships, reducing their sensitivity to the loss of teleworkers. However, the relatively small percentage of losses across all sectors indicate that teleworkers are widely dispersed across industries, diffusing their direct impact on supply chains.

Table 6: Decrease in sectoral sales in percentages after extraction of the sales structure

| Sector | Third income range of Teleworkes | Fourth income range of Teleworkes | Fifth income range of Teleworkes |
|---|---|---|---|
| Panel A: Telework-intensive sectors | | | |
| Development of systems and other information services | 0,0001% | 0,0003% | 0,0046% |
| Print-integrated publishing and editing | 0,0005% | 0,0020% | 0,0207% |
| Financial intermediation, insurance and supplementary pension | 0,0001% | 0,0006% | 0,0136% |
| Other professional, scientific and technical activities | 0,0001% | 0,0004% | 0,0055% |
| Architecture, engineering and R&D services | 0,0001% | 0,0002% | 0,0031% |
| Television, radio, cinema and others | 0,0001% | 0,0005% | 0,0069% |
| Panel B: Some Key Sectors | | | |
| Manufacturing of textile products | 0,0001% | 0,0003% | 0,0039% |
| Beverage manufacturing | 0,0001% | 0,0003% | 0,0037% |
| Slaughter and meat products, including dairy and fish products | 0,0001% | 0,0004% | 0,0052% |
| Other food products | 0,0001% | 0,0004% | 0,0054% |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

Table 7 shows the percentage reductions in total sectoral output after removing teleworkers across income bands. Compared to forward linkages, backward linkages show larger losses, suggesting that teleworkers' consumption plays a stronger role in sustaining output than their direct employment.

Sectoral losses vary by income level. The development of systems and other information services experiences the highest percentage loss in the third income band, while print-integrated publishing and editing exceed 1% in the fourth income band. At the highest income level, development of systems and other information services again experience the largest percentage loss, with most other telework-intensive sectors also exceeding 1% output loss.

Compared to key sectors, telework-intensive industries experience much larger percentage declines, underscoring the importance of teleworkers' purchasing power in sustaining service-based industries. While key sectors also experience declines, their lower sensitivity suggests greater resilience to shifts in telework participation.

Table 7: Decrease in sectoral output in monetary values and percentages after extraction of the demand structure

| Sector | Third income range of Teleworkes | Fourth income range of Teleworkes | Fifth income range of Teleworkes |
|---|---|---|---|
| Panel A: Telework-intensive sectors | | | |
| Development of systems and other information services | 0,45% | 0,72% | 2,27% |
| Print-integrated publishing and editing | 0,16% | 1,08% | 1,16% |
| Financial intermediation, insurance and supplementary pension | 0,26% | 0,55% | 1,53% |
| Other professional, scientific and technical activities | 0,28% | 0,53% | 1,06% |
| Architecture, engineering and R&D services | 0,28% | 0,57% | 0,91% |
| Television, radio, cinema and others | 0,29% | 0,52% | 1,53% |
| Panel B: Some Key Sectors | | | |
| Manufacturing of textile products | 0,08% | 0,16% | 0,37% |
| Beverage manufacturing | 0,08% | 0,16% | 0,36% |
| Slaughter and meat products, including dairy and fish products | 0,10% | 0,26% | 0,42% |
| Other food products | 0,10% | 0,13% | 0,32% |

Source: IBGE (2023a, 2023b)
Note: In Television, radio, cinema and others, others means sound and image recording/editing activities.

The extraction results provide a nuanced perspective on the economic role of teleworkers. The forward linkages suggest that higher-income teleworkers are particularly important for maintaining sectoral sales. However, given their wide dispersion across industries, their removal does not lead to highly concentrated sectoral disruptions.

The backward linkages reinforce this pattern, showing that the consumption effects of teleworkers are more pronounced than their direct employment effects. The technology, publishing and media-related sectors experience higher percentage losses at higher income levels. This suggests that teleworkers contribute more to economic activity through their consumption patterns than as direct labor inputs in production processes.

Overall, these findings suggest that teleworkers affect the economy not by driving core production chains, but through their role in sustaining demand and revenue streams in service-based industries. Their presence in sectors such as financial intermediation, technology and creative industries suggests that continued participation in remote work arrangements may contribute to the stability of these markets. The observed losses in telework-intensive sectors also highlight the importance of digital infrastructure and accessibility to remote work as factors that shape economic outcomes. While the long-term implications of telework remain an area for further research, these findings suggest that understanding how teleworkers interact with sectoral structures can provide insights into the resilience of service-oriented industries.

# 5 Final Remarks

This study analyzed the systemic role of teleworkers in the Brazilian economy, evaluating their impact on sectoral interdependencies, employment generation, and income flows. Through

the use of input-output multipliers and the hypothetical extraction method, we quantified the extent to which teleworkers contribute to economic activity, both as labor providers and as demand generators.

The results show that teleworkers generate positive employment and income spillovers, especially in knowledge-intensive services (KIS). Multipliers indicate that the employment of teleworkers is associated with additional job creation, although these effects vary across sectors. Professional, scientific and technical services show the strongest employment and income multipliers, while technology-driven sectors such as systems development show smaller employment spillovers, probably due to their productivity-driven nature.

The extraction analysis provides further evidence of the economic importance of teleworkers, particularly through consumption-driven effects. While forward linkages suggest that teleworkers' direct contributions to sales are relatively diffuse, backward linkages confirm that teleworkers' consumption plays a more pronounced role in shaping sectoral output. The impact of teleworker distance is particularly evident in service-based industries, with higher-income teleworkers having the largest absolute and relative effects. Compared to the main sectors of the economy, telework-intensive industries show greater sensitivity to teleworker extraction, reinforcing the idea that teleworkers influence revenue flows and business transactions rather than serving as direct labor inputs in production processes.

These findings highlight two key dimensions of the role of teleworkers in the economy. First, their employment effects are concentrated in knowledge-intensive services, where specialized expertise and digital infrastructure facilitate the adoption of remote work. Second, their spending patterns have broader economic implications, particularly in sectors dependent on professional services, finance and digital markets. The relatively small percentage losses observed in the extraction analysis suggest that teleworkers are widely dispersed across economic structures, reducing their impact on core supply chains while contributing more significantly to service-oriented and business-to-business interactions.

While this study provides a detailed assessment of the economic contributions of teleworkers, several areas for future research remain. Further research could examine long-term changes in telework adoption, particularly in response to technological advances and evolving labor market policies. In addition, analysis of regional variations in telework adoption and its spatial economic effects could provide a more nuanced understanding of how remote work affects urban economies, labor mobility, and regional productivity dynamics.

In summary, teleworkers influence the economy not by driving core production chains, but by shaping demand, income flows and employment in knowledge-intensive industries. Their influence is particularly pronounced in sectors where human capital, digital connectivity, and innovation drive economic activity. As telework continues to evolve, understanding its implications for

economic resilience, sectoral dynamics, and policy formulation will be essential to navigating the future of work.

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