REMOTE WORK, REAL EFFECTS: THE IMPACT OF TELEWORK ON BRAZIL'S SECTORAL STRUCTURE

Pedro Leite, **Matheus Nascimento**, Fernando Perobelli

31st International Input-Output Association Conference

INTRODUCTION

- Remote work enables professional activity outside traditional workplaces, usually from home
- Enabled by ICTs: **connectivity**, **collaboration**, **digital platforms**
- Reflects demand from **both workers and employers** for **flexibility** and **autonomy**
- The COVID-19 pandemic acted as a **global shock**: ~50% of U.S. workers and ~10% of Brazilian workers went remote (Brynjolfsson et al., 2020; Góes et al., 2021)

MOTIVATION

- Telework has reshaped **sectoral demand**, **consumption patterns**, and **employment dynamics**
- *Declining sectors*: services reliant on physical presence (e.g., restaurants, commuting)
- *Growing sectors*: **ICT**, **e-commerce**, **knowledge-intensive services**
- **Household heterogeneity**: high-income groups adapted and benefited; lower-income workers faced structural constraints

RESEARCH QUESTION

- Most studies examine **how the economy adapted** to telework
- This paper asks the reverse: **how do teleworkers shape economic structure**?

Main question

How does telework influence Brazil's **sectoral configuration** and **household consumption patterns**?

RESEARCH OBJECTIVES

- Quantify the **systemic role** of teleworkers in the Brazilian economy
- Estimate their contribution to **employment**, **income**, and **sectoral demand**
- Compare telework-intensive sectors to traditional key sectors using **input-output analysis**

LITERATURE REVIEW

- The COVID-19 pandemic created a **natural experiment** for evaluating telework's economic effects.
- Studies explore:
  - **Mobility restrictions** and sectoral asymmetries (Fadinger et al., 2020; Bonet-Morón et al., 2020; Yusa, 2021)
  - **Teleworkability and vulnerability** by sector (del Rio-Chanona et al., 2020)
  - **Shock propagation** via input-output networks (Pichler & Farmer, 2021)
  - **Structural shifts** in economic configuration (Han, 2022; Spithoven & Merlevede, 2025)
- These papers mostly focus on **how the economy adapts to telework**.

LITERATURE REVIEW – HYPOTHETICAL EXTRACTION

- A second strand applies the **hypothetical extraction method** to assess structural importance of sectors or labor groups.
  - **KIBS and urban concentration** in Brazil (Leão et al., 2022)
  - **ICT sectors**: contribution to **output and employment** (Bazzazan, 2009; Carleton, 2016; Stamopoulos et al., 2022)
  - **Pandemic-induced restrictions**, spatial effects, and age-based withdrawals (Haddad et al., 2021; Giammetti et al., 2022)
  - **Informal labor** and exclusion effects (Santos et al., 2020; Ribeiro et al., 2024)
- These studies assess the **removal of groups or sectors** from the economy to quantify structural significance.

MAIN CONTRIBUTION

- We shift the focus: from economy reacting to telework **to teleworkers shaping the economy**.
- Evaluate teleworkers as **economic agents** via:
  - **Employment and income multipliers** (by demographics and sector)
  - **Hypothetical extraction** of labor income and consumption
- Integrate labor market and consumption effects in a single IO framework

BACKGROUND – TELEWORK IN BRAZIL

- Telework expanded rapidly in Brazil during the pandemic, stabilizing at **7.7%** of the workforce by 2022 (IBGE, 2023b).
- Demographics:
  - Balanced gender distribution (~51% men, ~49% women)
  - Most teleworkers are aged **25–39**, followed by **40–59** years
  - Strong concentration of **white** and **highly educated** individuals
- Sectoral distribution:
  - Dominated by **knowledge-intensive services**: ICT, finance, professional and scientific activities
  - Low telework prevalence in manufacturing, agriculture, and service industries

DATA SOURCES

- **Input-Output Table (2021)** – Estimated from IBGE's Resource and Use Tables (SCN)
- **Household Budget Survey (POF 2017–2018)** – Consumption structure by income bands
- **PNAD-C (2022)** – Telework identification and demographic segmentation
- All sources harmonized via **CNAE 2.0 classification** into 66 economic sectors

DATABASE CONSTRUCTION

- Input-output matrix disaggregated into **66 productive sectors**, extended to include **6 income bands**
- Household vectors created by combining:
  - POF consumption data by income
  - PNAD-C income and telework shares per bracket
- New dimensions added:
  - **Labor income** and **consumption vectors** for each teleworker income band
  - Matrix extended to **72 rows and columns** including households
- Allows simulating the removal of teleworker demand or income via **hypothetical extraction**

METHODOLOGY

- Combines **input-output analysis** with labor and consumption structure from household data
- Two complementary tools:
  - **Type I Multipliers**: estimate spillover effects on income and employment
  - **Hypothetical Extraction**: simulate the structural impact of removing teleworkers from income and demand vectors
- Enables disaggregation by **income band**, **gender**, **race**, and **education**
- *Multipliers* capture the propagation potential of a sector; *extraction* quantifies its structural relevance.

MULTIPLIERS

- **Employment and income coefficients** are derived for each sector
- Multiplied by the Leontief inverse to obtain total effects on the economy
- Disaggregated by **teleworker status** and **demographics** (gender, race, education)
- Final result: **how much employment or income is generated** for each unit of output

HYPOTHETICAL EXTRACTION

- Household sector is **endogenized** in the IO matrix (closed model)
- Simulations remove:
  - **Household consumption** of teleworkers (backward linkages)
  - **Labor income** from teleworkers (forward linkages)
- Allows comparing full-economy equilibrium with extracted equilibrium
- Effects measured on **sectoral output** and **sales**
- Goal: assess **how dependent** sectors are on teleworker demand and supply

RESULTS

- The analysis is restricted to teleworkers within the **fifth household income band** (above five minimum wages)
- We concentrate on the **six sectors** with the highest share of teleworkers

EMPLOYMENT AND INCOME MULTIPLIERS

- **Other professional, scientific and technical activities** show the highest multipliers: 2.33 (employment), 5.17 (income)
- **Only sector where teleworkers outperform non-teleworkers** in income effects

Sector	$m^{l}(e)_{j}$		$m^{l}(r)_{j}$	
	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

MULTIPLIERS BY DEMOGRAPHIC PROFILE

Gender

Men and women show similar job and income effects overall.

▸ See Gender Table

Race

Differences vary by sector — non-white teleworkers show higher multipliers in finance, architecture, and media; whites lead in other services.

▸ See Race Table

Education

Teleworkers with high school education create more jobs, while those with college degrees generate more income.

▸ See Education Table

EXTRACTION – FORWARD LINKAGES

- Measures reduction in **sectoral sales** from removing teleworkers
- Sectoral **sales losses** increase with income level.
- **Print-integrated publishing and editing** most affected (0.02% in highest income band).
- **Telework-intensive sectors** show greater sensitivity than traditional key sectors.
- Overall losses are small, reflecting wide dispersion of teleworkers.

TABLE – FORWARD LINKAGES (SALES LOSS %)

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%

EXTRACTION – BACKWARD LINKAGES

- Measures **reduction in output** from removing teleworkers' consumption
- Output losses are **larger than sales**, indicating stronger role of teleworkers as consumers
- **Development of systems and other information services** faces highest loss in both lowest (0.45%) and highest (2.27%) bands
- Most telework-intensive sectors cross 1% in the fifth income band.
- Key sectors experience smaller declines, showing greater resilience.

TABLE – BACKWARD LINKAGES (OUTPUT LOSS %)

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%

EXTRACTION – SUMMARY

- Teleworkers influence the economy more through **consumption** than direct production
- **High-income teleworkers** are key to sustaining sales and output
- **Service sectors** face higher losses from their removal — especially media, tech, finance
- Effects are diffuse, reflecting teleworkers' **broad sectoral distribution**
- Reinforces need for **digital infrastructure and access** to sustain economic stability

CONCLUSION

- Teleworkers play a **systemic role** in the Brazilian economy through both employment generation and demand
- Input-output multipliers reveal **positive spillovers**, especially in **knowledge-intensive services**
- Hypothetical extraction shows teleworkers' **consumption** is more impactful than their direct labor contribution
- Effects are **dispersed across sectors**, reducing disruption in core chains but shaping revenue and business flows
- Highlights the role of **digital access** and **human capital** in leveraging telework for economic resilience

Please contact me for any questions or suggestions:

Email: mhsn.nascimento@gmail.com

APPENDIX – TABLE 3: MULTIPLIERS BY GENDER

Sector	$m^{l}(e)_{j}$		$m^{l}(r)_{j}$	
	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

▸ Back to Summary

APPENDIX – TABLE 4: MULTIPLIERS BY RACE

Sector	$m^{l}(e)_{j}$		$m^{l}(r)_{j}$	
	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

▸ Back to Summary

APPENDIX – TABLE 5: MULTIPLIERS BY EDUCATION

Sector	$m^{l}(e)_{j}$		$m^{l}(r)_{j}$	
	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

▸ Back to Summary