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Quarterly unemployment estimates for the Brazilian Labour Force Survey using state-space models in small areas

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Outline

- Introduction
- Survey
- Model
- Results
- Next steps

Introduction

Production of **regional statistics** for understanding local realities. Many actions of public policy are taken at this level.

The 2030 Agenda for **Sustainable Development** contemplates subnational indicators with a perspective of **localizing** the context of municipalities and states (GLOBAL TASKFORCE OF LOCAL AND REGIONAL GOVERNMENTS, 2016).

Example: *Observatório do Milênio de Belo Horizonte* monitors indicators such as:

- Total unemployment rate
- Unemployment rate among the age group of 18 to 24 years
- Proportion of workers employed in non-agricultural informal activities

Administrative political division

5 regions

Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coordenação de Geodésia e Cartografia.

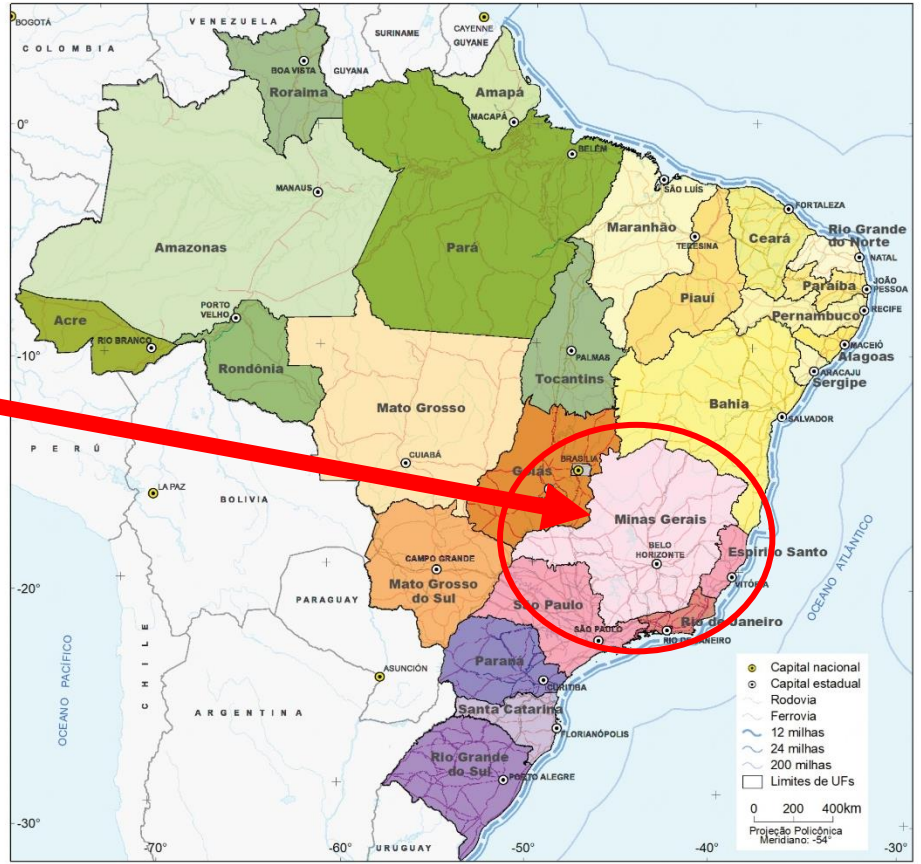
Administrative political division

27 states

Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coordenação de Geodésia e Cartografia

Administrative political division

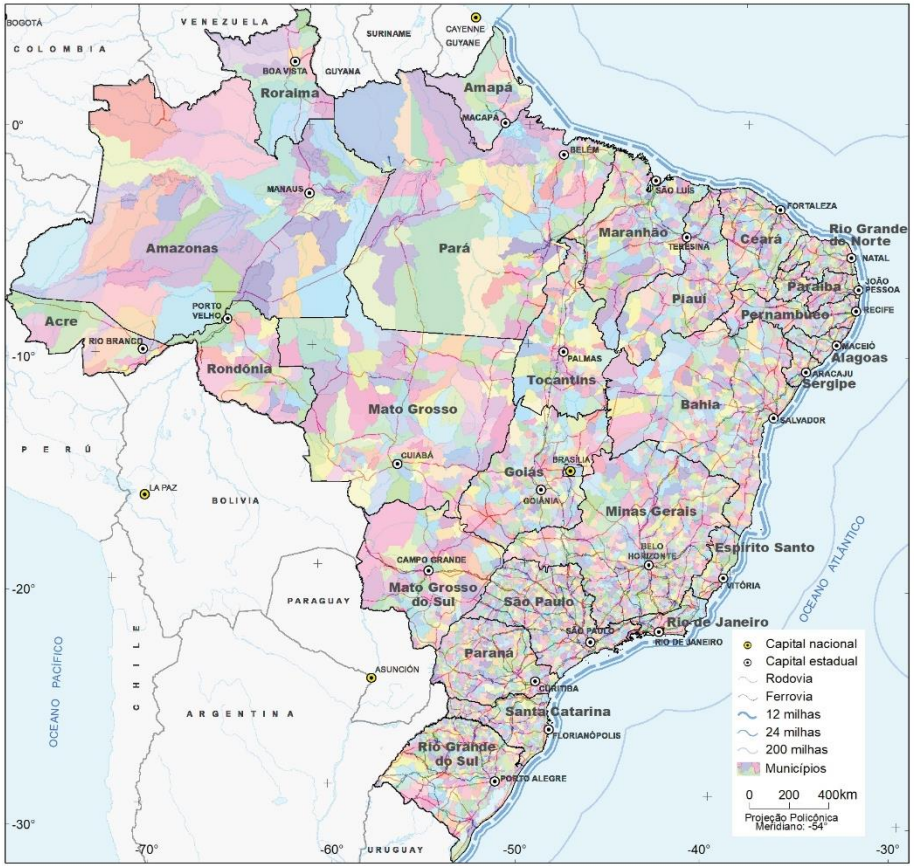
Focus: Minas Gerais



Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coordenação de Geodésia e Cartografia

Administrative political division

5570 municipalities (Brazil)



Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coordenação de Geodésia e Cartografia.

Introduction

The Population and Housing Census (Brazilian Demographic Census):

- contains comprehensive set of information on various topics
- provides support to various public policies
- serves as the basis for the design and selection of household samples.

One of its main advantages is the production of statistics at the **municipal level**.

Brazilian Labour Force Survey (BLFS)

Pesquisa Nacional por Amostra de Domicílios Contínua (PNADC):

Monthly release (using rolling quarters) of labour market indicators for Brazil.

Quarterly release (using calendar quarter) of labour market indicators for Brazil, Regions, Federative Units, Metropolitan Regions and Municipal Capitals.

Brazilian Labour Force Survey (BLFS)

- Implemented in 2012.
- It has a stratified two-stage cluster sample design: census tracts as the primary unit and households as secondary units.
- A rotation scheme with **partial overlap** of households is used: 1-2 (5)

Recent release (2022) with experimental statistics for **geographic strata**.

https://painel.ibge.gov.br/pnadc/

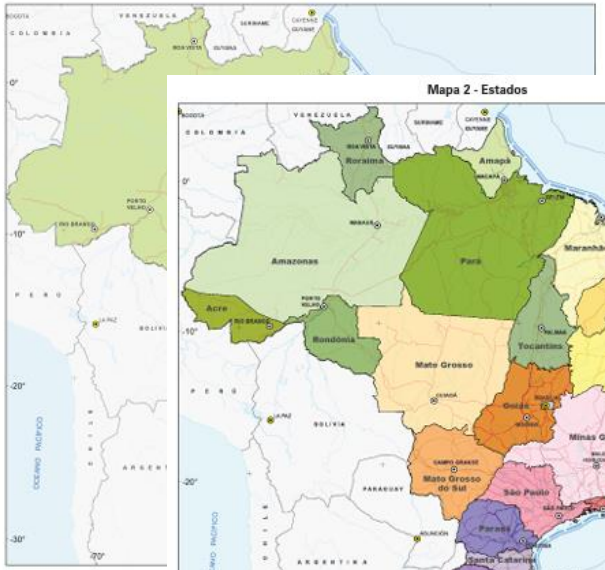
Brazilian Labour Force Survey (BLFS)

The **geographic strata** are **sets of municipalities** that are present in the survey. Direct estimates can be produced, but with caution when disaggregated data and even general data during the pandemic period.

While this does not yet imply the production of statistics at the municipal level, it is at an intermediate level within states.

Administrative political division

Mapa 1 - Grandes Regiões

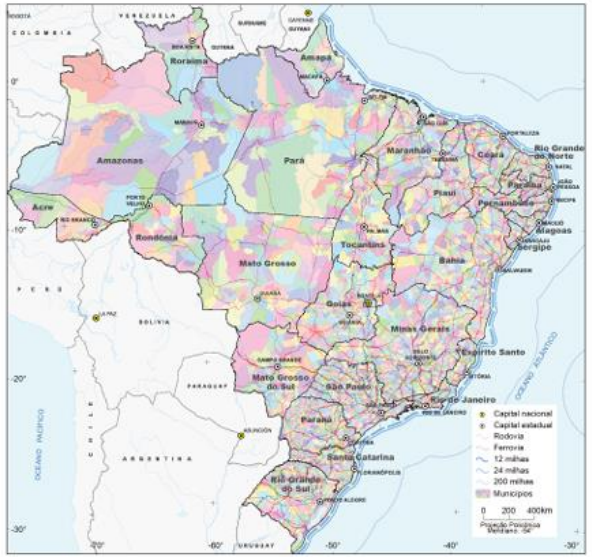


Fonte: IBGE, Diretoria de Geoci
de Geodésia e Cartografia.

Mapa 2 - Estados

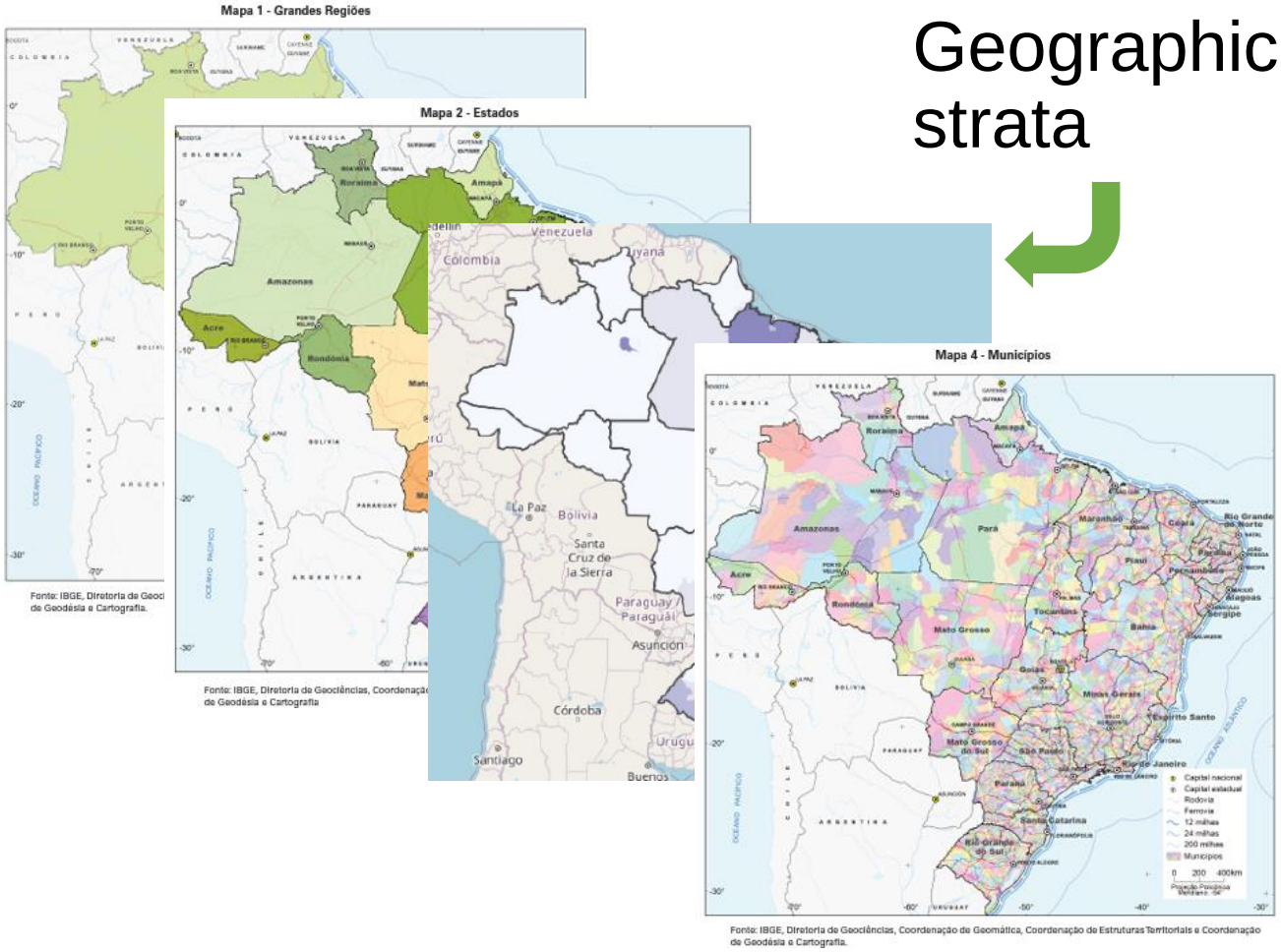
Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coo
de Geodésia e Cartografia

Mapa 4 - Municípios

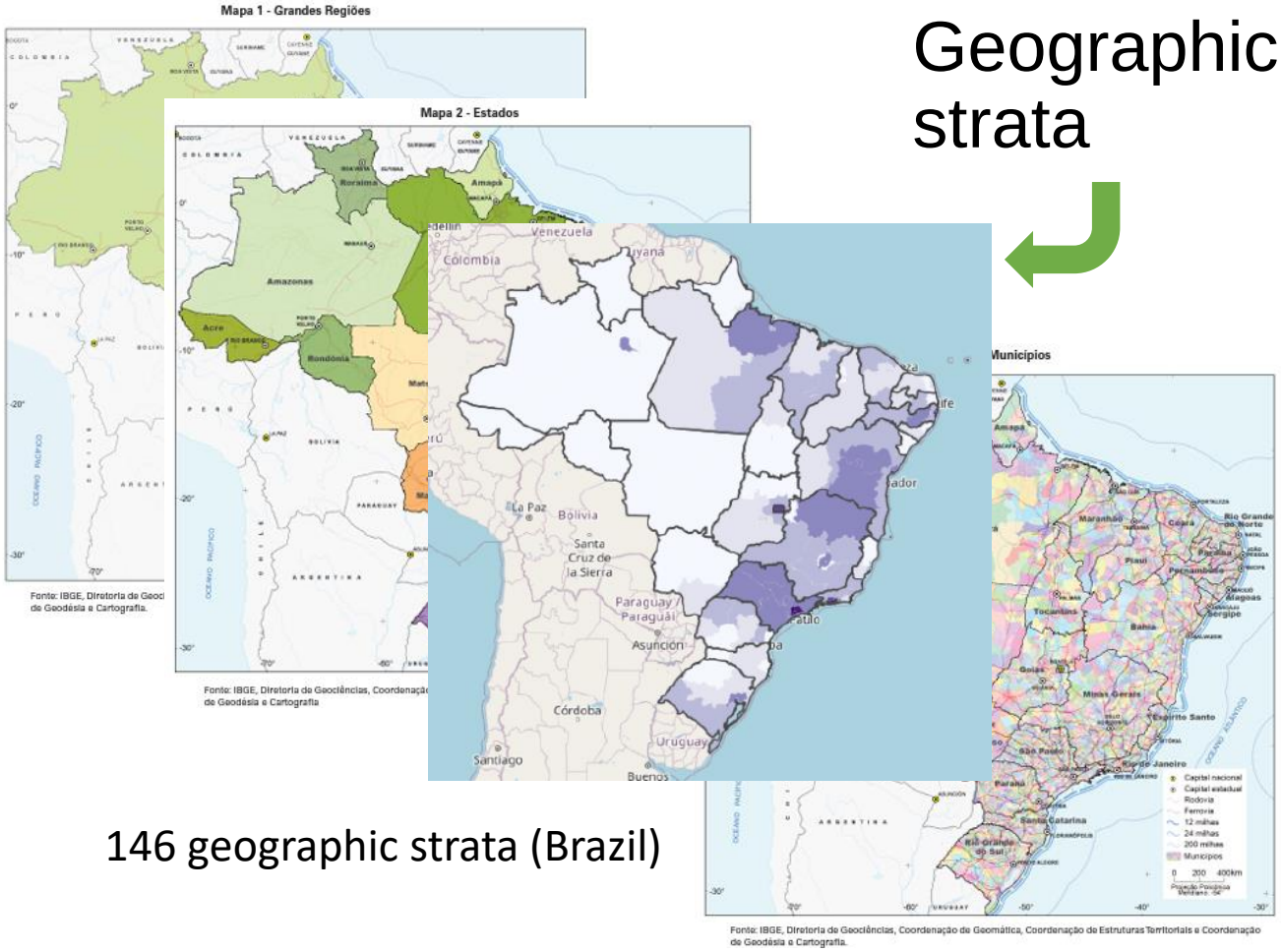


Fonte: IBGE, Diretoria de Geociências, Coordenação de Geomática, Coordenação de Estruturas Territoriais e Coordenação de Geodésia e Cartografia.

Geographic strata



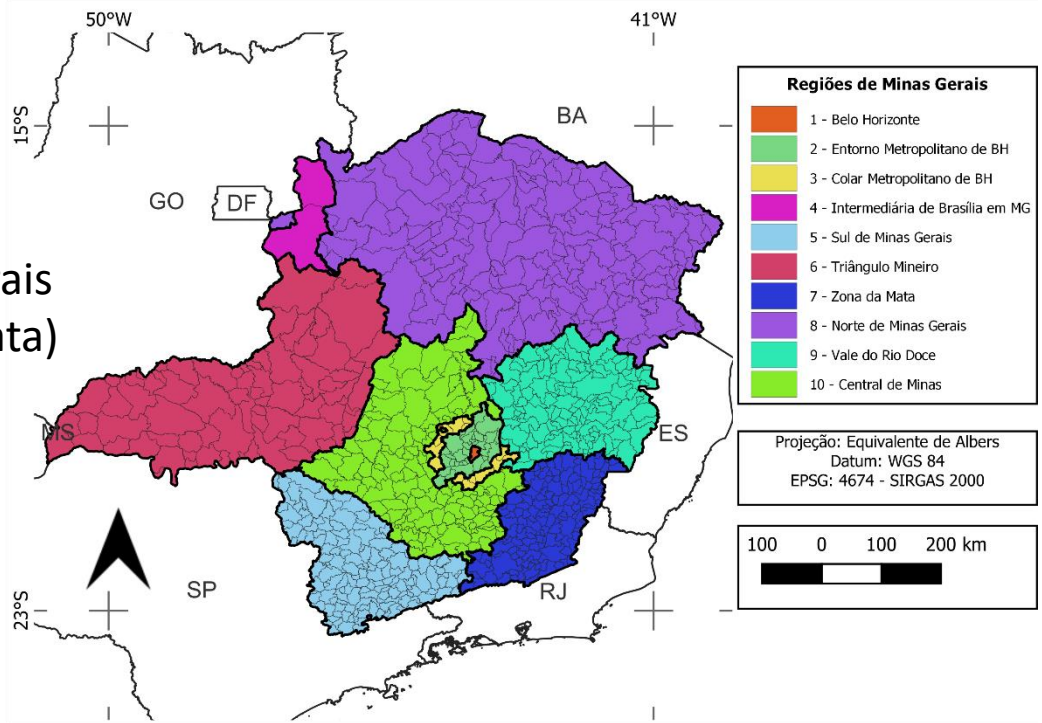
Geographic strata



146 geographic strata (Brazil)

BLFS Geographic strata

State of Minas Gerais
(10 geographic strata)



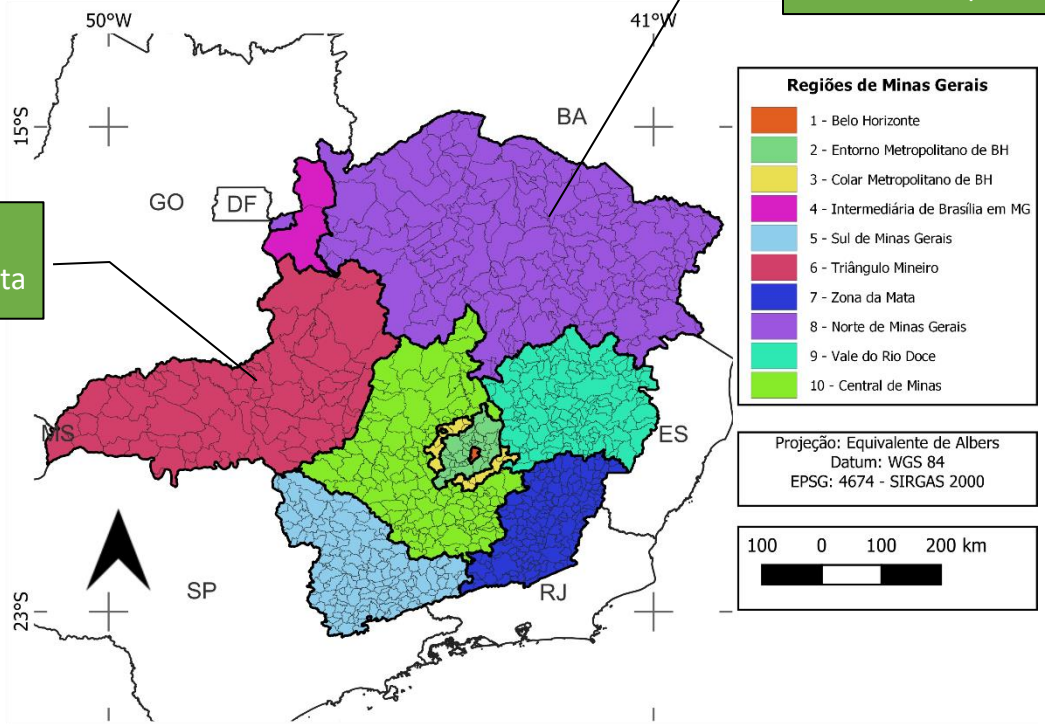
BLFS Geographic strata

Norte de Minas Gerais

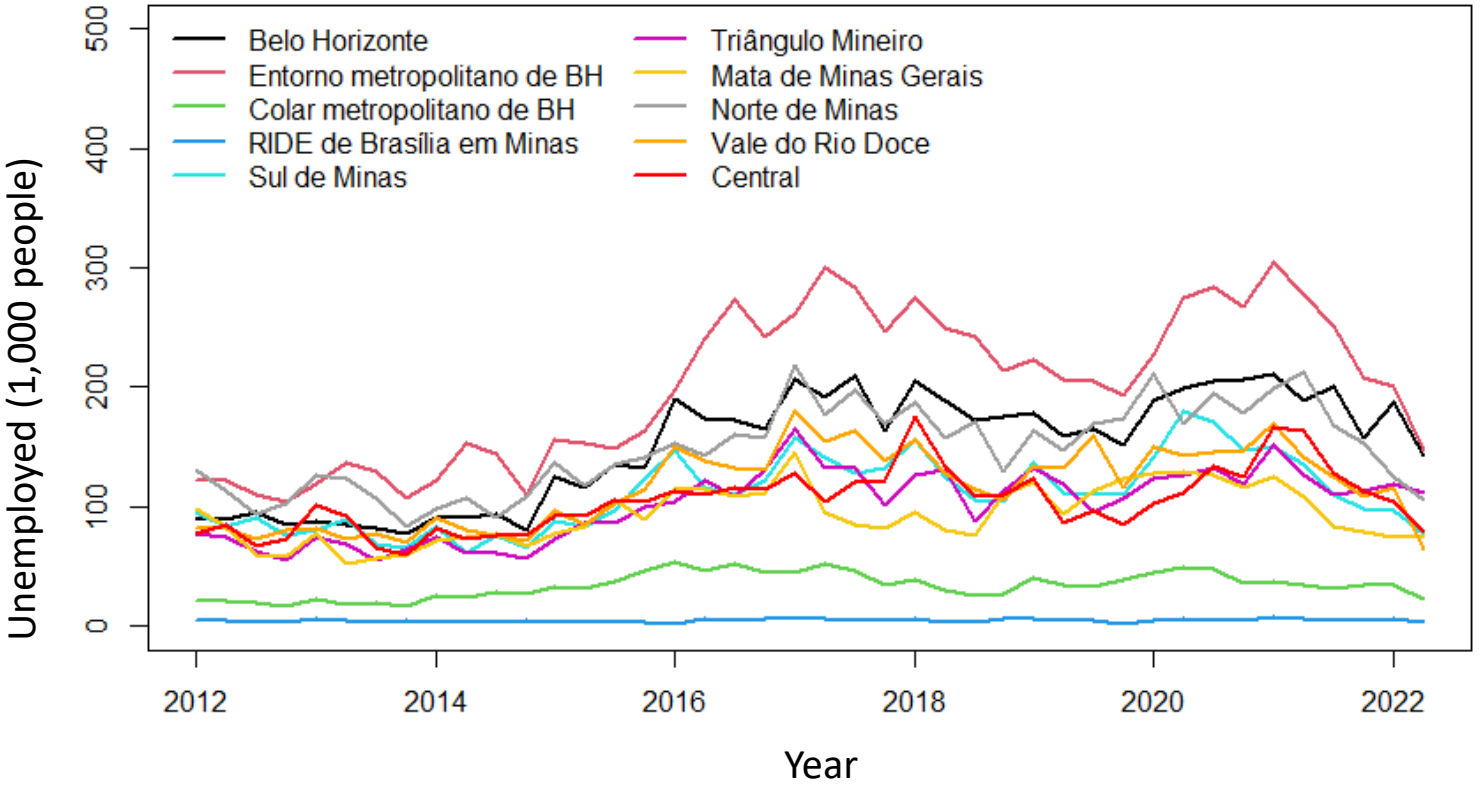
- Lower GDP per capita

Triângulo Mineiro

- Higher GDP per capita



Direct estimates of the total number of unemployed (in 1,000 people) in geographic strata of Minas Gerais - 1st quarter of 2012 - 2nd quarter of 2022.



Direct estimates of the total number of unemployed (in 1,000 people), confidence intervals at 95% and coefficients of variation (%) - geographic strata of Minas Gerais - 2nd quarter of 2022.

Geographic stratum	$\hat{y}$	$cv(\hat{y})$	CI 95%
1 - Belo Horizonte	142.6	8.8	[118 ; 167.3]
2 - Entorno metropolitano de BH	147.6	8.2	[123.9 ; 171.4]
3 - Colar metropolitano de BH	21.7	17.7	[14.1 ; 29.2]
4 - RIDE de Brasília em Minas	3.5	28.2	[1.6 ; 5.5]
5 - Sul de Minas	77.8	12.6	[58.6 ; 97]
6 - Triângulo Mineiro	111.9	15.8	[77.1 ; 146.6]
7 - Mata de Minas Gerais	75.2	16.5	[50.9 ; 99.5]
8 - Norte de Minas	105.2	12.7	[79 ; 131.4]
9 - Vale do Rio Doce	63.5	10.3	[50.6 ; 76.3]
10 - Central	79.0	17.6	[51.8 ; 106.2]

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Topics already discussed...

GONÇALVES, C.; HIDALGO, L.; SILVA, D. B. N.; BRAKEL, J. van den. Single-month unemployment rate estimates for the Brazilian Labour Force Survey using state-space models. Journal of the Royal Statistical Society Series A (General), Wiley-Blackwell, v. 185, n. 4, p. 1707–1732, 2022. https://doi.org/10.1111/rssa.12914

Can the same multivariate model approach be used to improve estimates at the geographic strata level?

This paper…

Produce quarterly estimates of the total number of unemployed for all ten geographical strata of Minas Gerais:

- Using multivariate model
- Identify short term significant changes.

Is it possible to build a continuous production system of labour market statistics for the geographic strata of the PNADC?

Local Area Unemployment Statistics (LAUS) – EUA
U.S. BUREAU OF LABOR STATISTICS (2018)

Time series models for repeated surveys in small areas

$\hat{y}_{j,t}$: Direct estimate (design-based) of the total number of unemployed for quarter t in stratum j.

Signal extraction:

$$\hat{y}_{j,t} = \theta_{j,t} + e_{j,t}$$

Scott and Smith (1974)
Scott et al. (1977)

Unobservable Components of the unknown population quantity $\theta_{t,j}$:

$$\theta_{t,j} = T_{t,j} + S_{t,j} + I_{t,j} \qquad I_{t,j} \sim N(0, \sigma^2_{I,j})$$

Time series models for repeated surveys in small areas

Trend: $T_{t,j} = T_{t-1,j} + R_{t-1,j}$

$R_{t,j} = R_{t-1,j} + \eta_{R,t,j} \qquad \eta_{R,t} \sim N(0, \sigma_R^2)$

Durbin and Koopman (2012)

the goal is to estimate:

$$\hat{\theta}_{j,t}$$

Multivariate model

$\hat{y}_{j,t}$: Direct estimate (design-based) of the total number of unemployed for quarter t in stratum j.

$$\begin{pmatrix} \hat{y}_{1,t} \\ \vdots \\ \hat{y}_{J,t} \end{pmatrix} = \begin{pmatrix} \theta_{1,t} \\ \vdots \\ \theta_{J,t} \end{pmatrix} + \begin{pmatrix} e_{1,t} \\ \vdots \\ e_{J,t} \end{pmatrix}, \qquad j = 1, \dots, J$$

Borrows strength from time and space:

$$cov\left(\eta_{R,y_j,t}, \eta_{R,y_{j'},t}\right) = \rho^{R}_{y_j,y_{j'}} \cdot \sigma_{R,y_j,t} \cdot \sigma_{R,y_{j'},t}, \qquad j \neq j'$$

$\rho^{R}_{y_j,y_{j'}}$ indicates the correlation between the error terms of the slopes of $\hat{y}_{j,t}$ of strata j and j'.

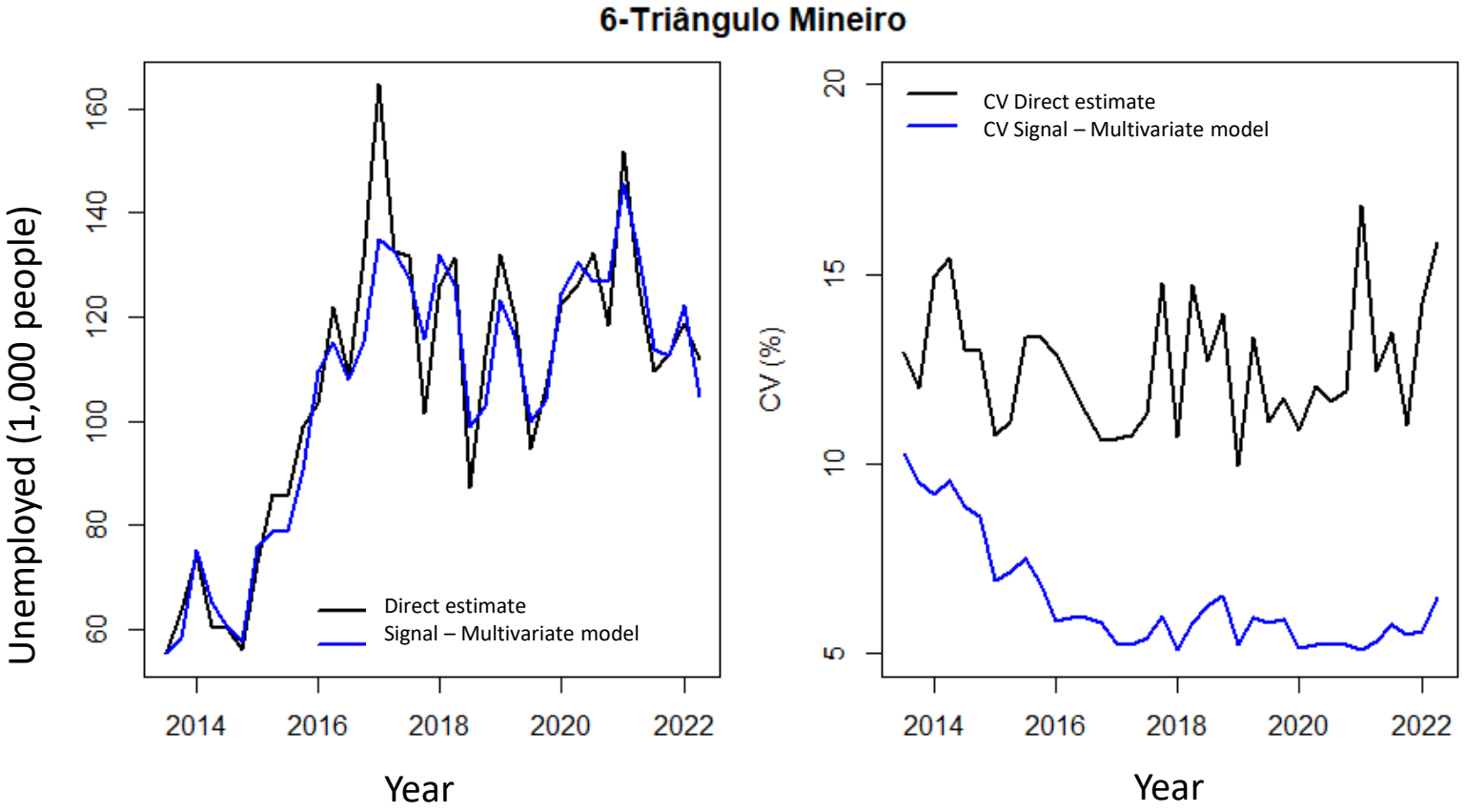
Results

Estimated correlation matrix of slope disturbances of the geographic strata of Minas Gerais.

Geographic stratum	1	2	3	4	5	6	7	8	9
1-Belo Horizonte (BH)									
2-Entorno Metrop. de BH	0.75								
3-Colar Metropolitano de BH	0.55	0.41							
4-Integrada de Brasília em MG	0.71	1.00	0.43						
5-Sul de Minas Gerais	0.82	0.89	0.98	0.83					
6-Triângulo Mineiro	0.85	0.90	0.92	0.87	0.99				
7-Mata de Minas Gerais	0.71	-0.63	0.94	-0.61	0.96	0.88			
8-Norte de Minas Gerais	0.99	0.43	0.47	0.37	0.97	0.87	0.66		
9-Vale do Rio Doce	1.00	0.57	0.58	0.51	0.81	0.83	0.90	0.99	
10-Central de Minas	0.70	1.00	0.60	0.99	0.99	0.93	0.01	0.55	0.57

There is evidence of an association between the behavior of the series.

Direct and model based (signal) estimates of the total number of unemployed and their respective coefficients of variation – 3rd quarter of 2013 to 2nd quarter of 2022.



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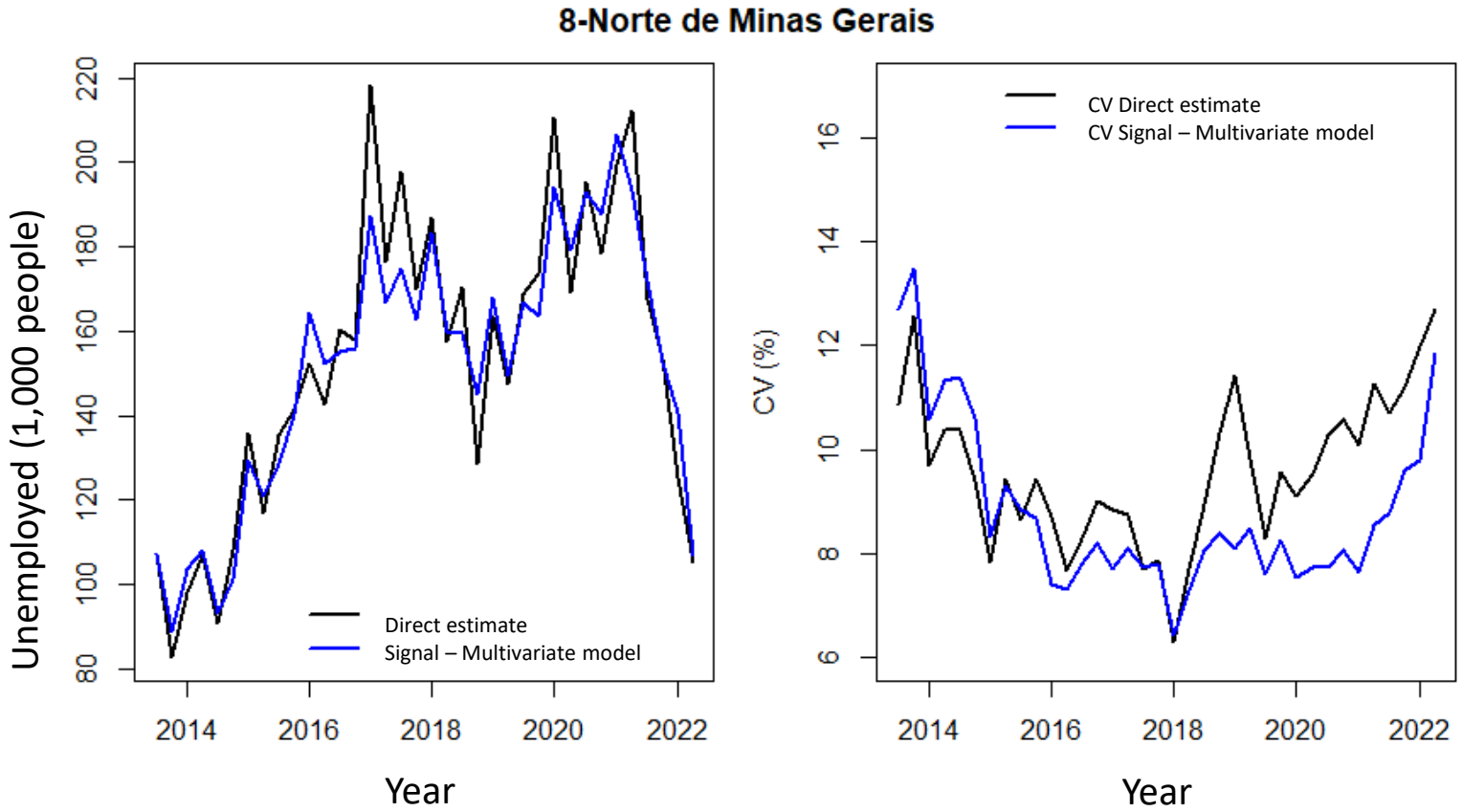

Direct and model based (signal) estimates of the total number of unemployed (in thousands of people), confidence intervals at 95%, and coefficients of variation (%) - geographic strata of Minas Gerais - 2nd quarter of 2022.

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6 - Triângulo Mineiro	111.9	15.8	[77.1 ; 146.6]	104.6	6.5	[91.3 ; 117.9]
7 - Mata de Minas Gerais	75.2	16.5	[50.9 ; 99.5]	70.4	11.8	[54 ; 86.7]
8 - Norte de Minas	105.2	12.7	[79 ; 131.4]	107.0	11.8	[82.2 ; 131.9]
9 - Vale do Rio Doce	63.5	10.3	[50.6 ; 76.3]	63.8	9.0	[52.6 ; 75.1]
10 - Central	79.0	17.6	[51.8 ; 106.2]	85.5	10.6	[67.8 ; 103.2]

Reduction of the coefficients of variation in the range of 7.7% to 48.6%, depending on the region.

Direct and model based (signal) estimates of the total number of unemployed (in thousands of people), confidence intervals at 95%, and coefficients of variation (%) - geographic strata of Minas Gerais - 2nd quarter of 2022.

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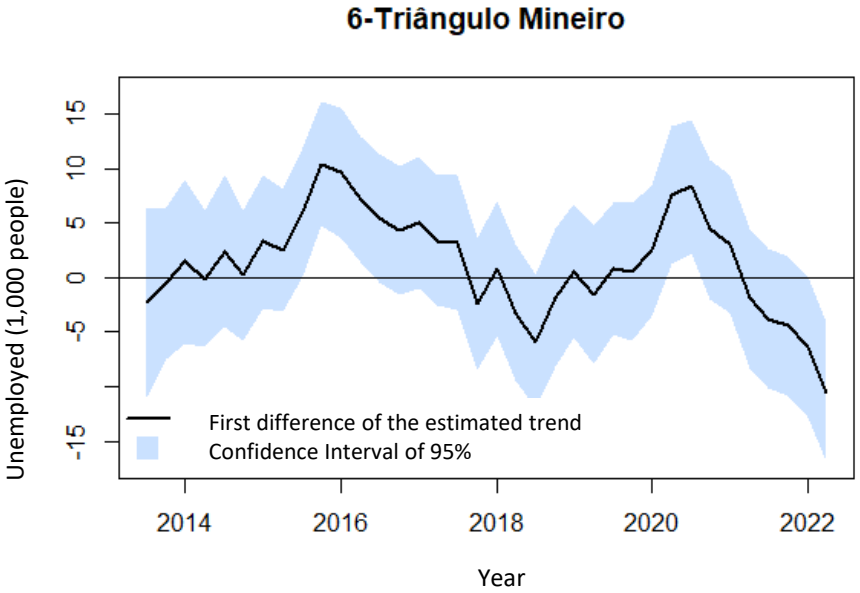
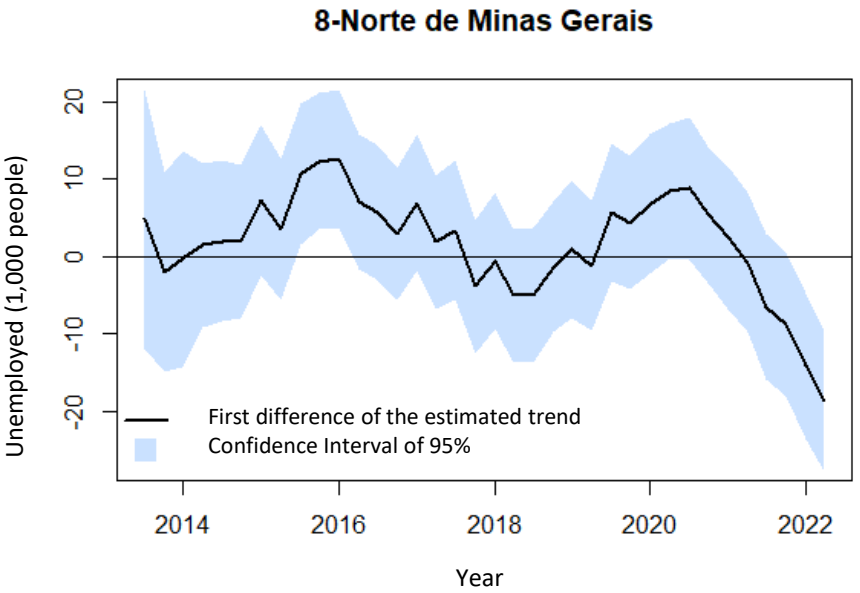
Reduction of the coefficients of variation in the range of 7.7% to 48.6%, depending on the region.

Quarterly estimates of the first difference of the trend based on the multivariate model of the total number of unemployed and 95% confidence intervals - geographic strata of Minas Gerais - 3rd quarter of 2013 to 2nd quarter of 2022.





There is evidence of significant differences from quarter to quarter.

Conclusion and next steps

Multivariate models that borrow strength across areas hold promise, even for the regular production of official statistics.

Next steps:

- Estimate for employed and the unemployment rate
- Other indicators such as the breakdown for young people and the informally employed
- Reconciliations/benchmarking

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THANK YOU.