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Núcleo de Economia Regional e Urbana
da Universidade de São Paulo
The University of São Paulo
Regional and Urban Economics Lab



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Crisis Monitor: Using High-Frequency Traffic Data in a Trade-Based Regional Economic Activity Index

*CURRENT TRENDS IN REGIONAL / URBAN
RESILIENCE AND SUSTAINABLE DEVELOPMENT*
July 23, 2020

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State of São Paulo, Brazil

Area: 248,222.8 km²
(Romania – 238,397 km²)

Population: 45,919,049
(Romania – 19,405,156)

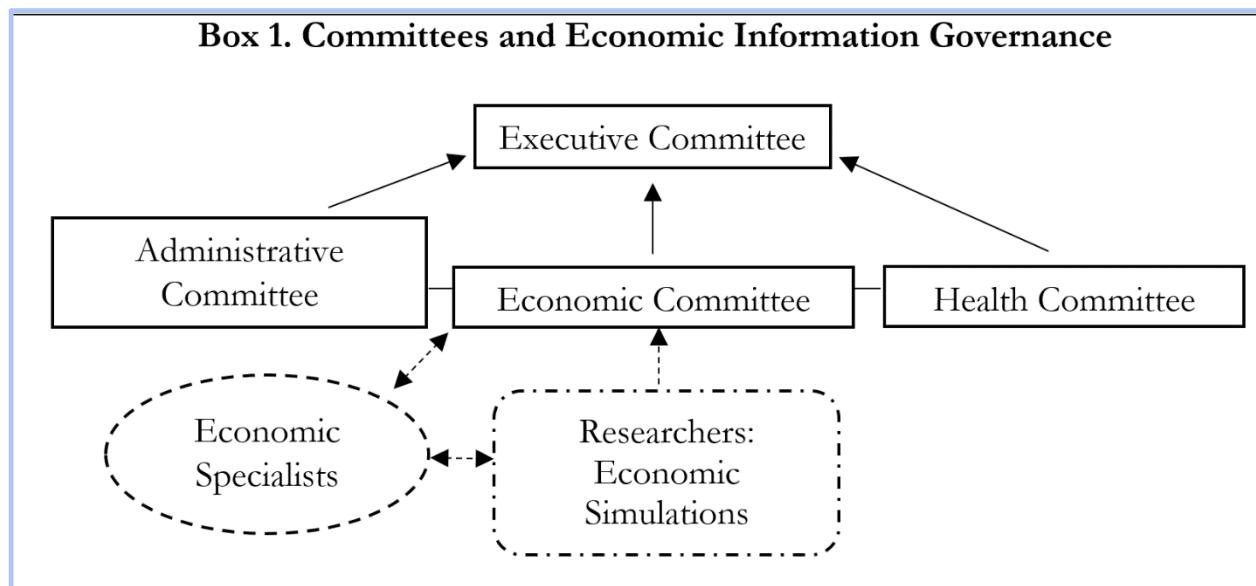
GDP (PPP): US\$744 billion
(Romania – US\$262 billion)

Per capita GDP (PPP): US\$16,535
(Romania – US \$13,414)

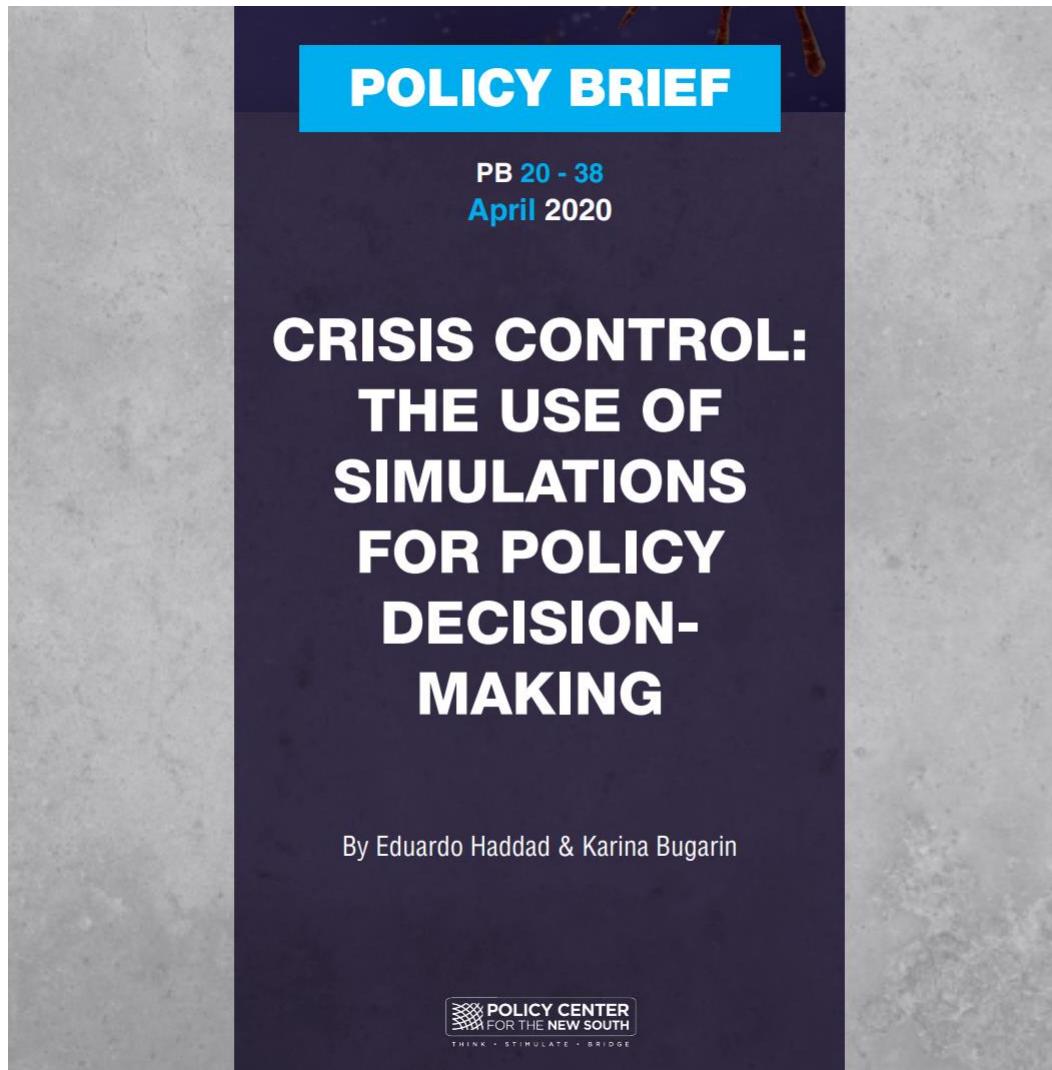


Expert committees to examine initial control measures and define gradual relaxing of social restrictions

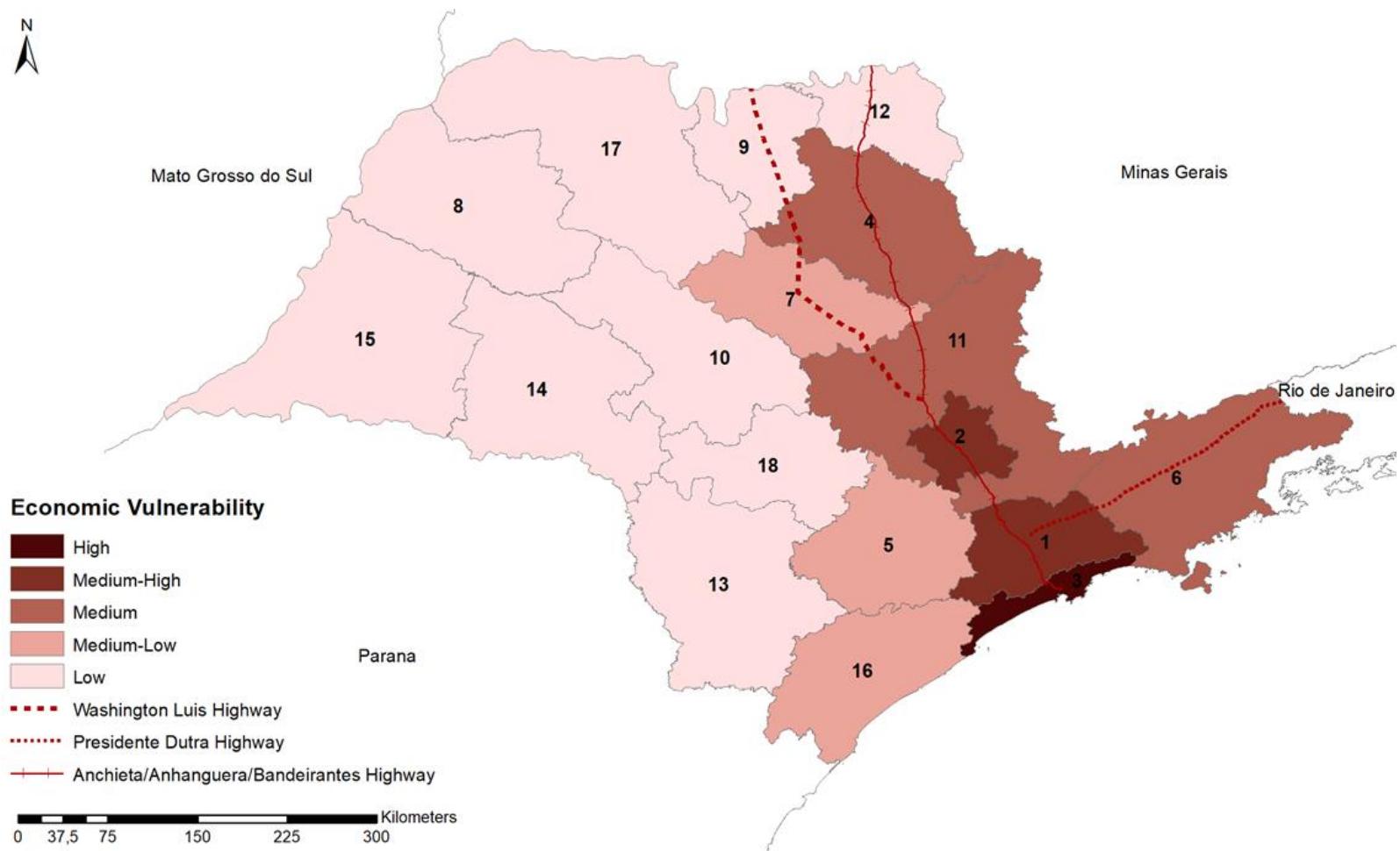
Up against enormous uncertainties, combining epidemiological and socioeconomic simulation-based scenarios to **assess and monitor impacts** is fundamental for informing officials before committing to a strategy



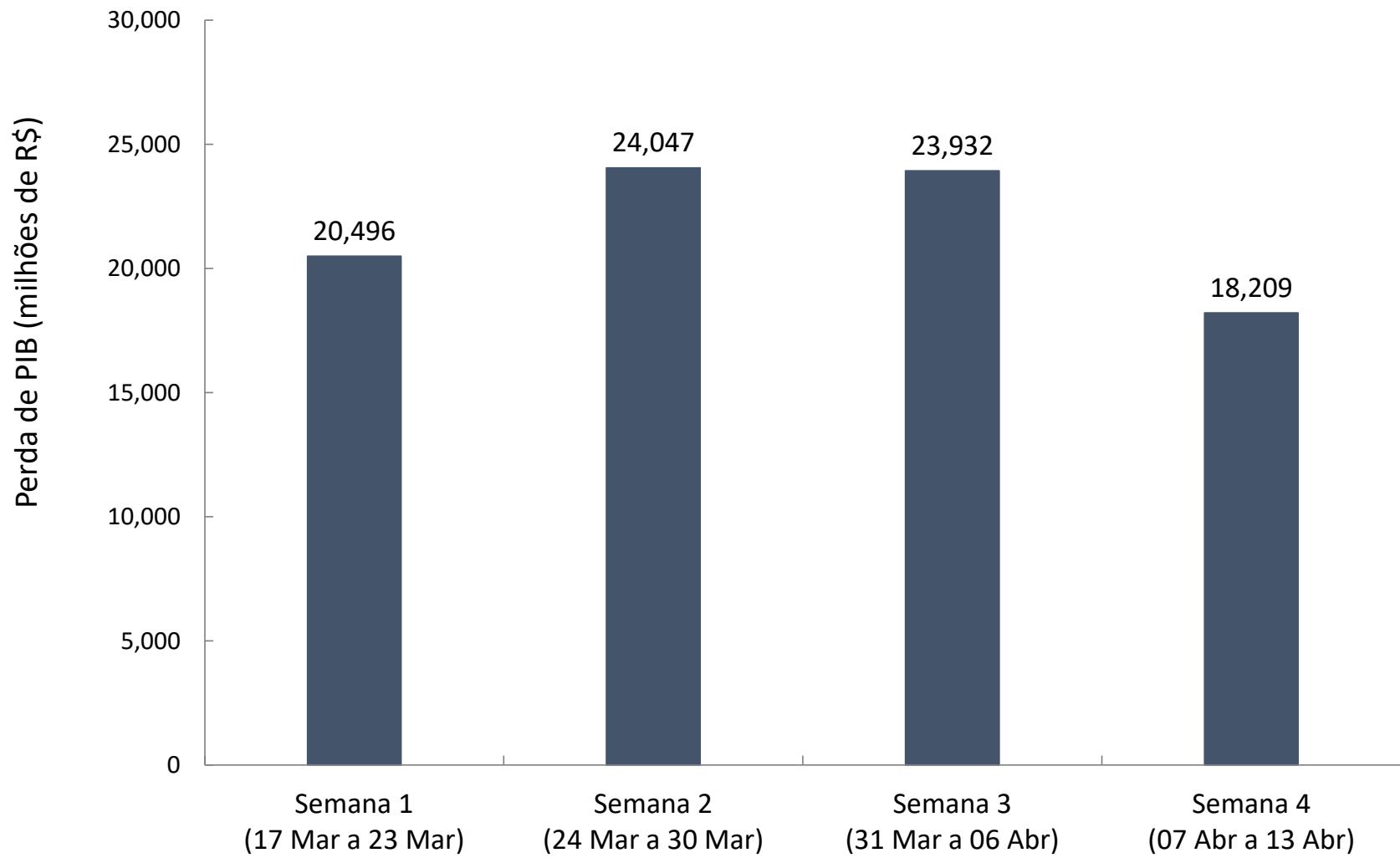
Impact of initial control measures



Heterogeneous sectoral and regional costs



There are also time-related economic costs, which adds another layer of complexity



Main take-away

The main losses are concentrated in the regions that most contribute to the state's GDP, which coincide with the most densely populated areas.

The most affected sectors are labor and flow intensive.

More densely populated regions are also the main vector for promoting contamination.

Therefore, a possible flexibility measure would be to loosen the grip in rural areas, *pari passu* increasing restrictive measures in urban areas, while adopting a series of protocols in labor-intensive sectors with the aim of reducing contamination.

“São Paulo Plan”: gradual relaxing of social restrictions as health indicators improve



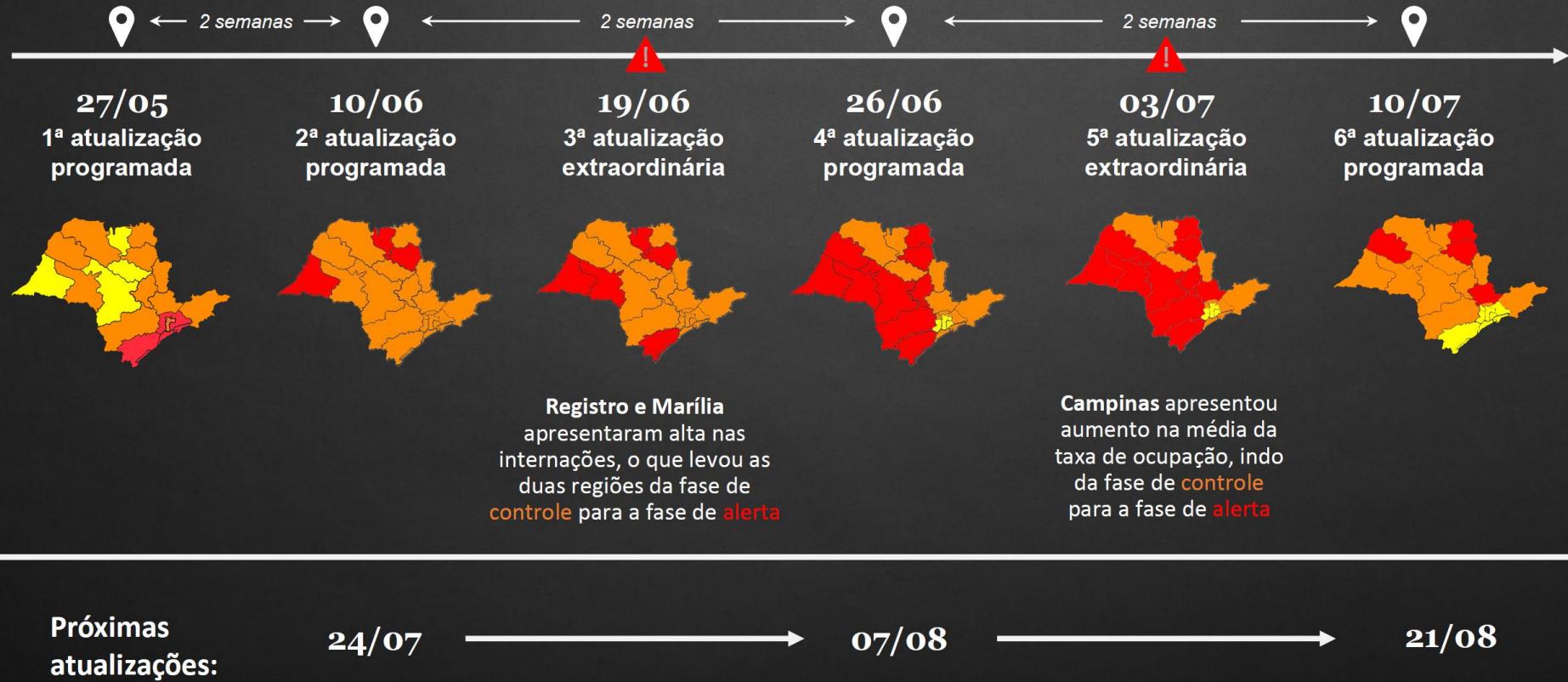
CRITERIA FOR THE PHASES CALCULATION

The criteria for the risk phases are currently defined by objective indicators and a weighting and rating methodology; The final classification is considered as the most restricted among the two sets of indicators

Set of indicators	Indicator	Weight	Phase 1 Maximum alert	Phase 2 Control	Phase 3 Flexibilization	Phase 4 Partial reopening	Phase 5 Controlled normal
Health System Capacity 	Average occupancy rate of ICU COVID beds in the last 7 days (%)	4	Above 80%	Between 70% e 80%	Between 60% e 70%	Below 60%	TBD
	COVID ICU Beds / 100k habitants	1	Below 3.0	Between 3.0 e 5.0	-	Above 5.0 ¹	TBD
Evolution of the epidemic 	# of new cases in the last 7 days / # of new cases in the previous 7 days	1	Above 2.0	-	Between 1.0 e 2.0 ²	Below 1.0	TBD
	# of new hospital internments in the last 7 days / # of new hospital internments in the previous 7 days	3	Above 1.5	Between 1.0 e 1.5	Between 0.5 e 1.0	Below 0.5	TBD
	# of deaths by COVID in the last 7 days / # of deaths by COVID in the previous 7 days	1	Above 2.0	Between 1.0 e 2.0	Between 0.5 e 1.0	Below 0.5	TBD

1. In case the number of COVID ICU Beds is above 5.0, the indicator becomes automatically green; 2. In case the # of new cases in the last 7 days / # of new cases in the previous 7 days is below 2.0, the indicator becomes automatically yellow

Every two weeks, there is a reassessment of the regional classification based on health indicators



Monitor of regional economic activity

State Treasury follows daily value-added tax (VAT) collection and VAT-generating transactions

Partial coverage of the State economy

- Formal versus informal
- Restricted number of sectors (<30% of GRP)

Need to complement tax monitoring with a broader indicator of regional economic activity

- Same frequency and regionalization of health indicators
- Combine input-output analysis and traffic data

An Index of Regional Sectoral Economic Activity

We consider there are n domestic regions, $r = 1, \dots, n$, and the rest of the world, row , which exhaust the space of the economy

Economic interactions take place inside and outside each region (intraregional, interregional and international trade)

In our multi-sectoral economy, there are j sectors, $s = 1, \dots, j$, provided by $n+1$ different sources

We then assume we can measure, for each sector s in region r , the value added contents embedded in trade flows associated with each regional origin-destination pair, such that we can complete the information in Table 1

**Table 1. Regional Value Added in Trade Flows,
by Sector**

Origin	Destination					
	R ₁	R ₂	...	R _{n-1}	R _n	ROW
R ₁	$va_{1,1}^{r,s}$	$va_{1,2}^{r,s}$	...	$va_{1,n-1}^{r,s}$	$va_{1,n}^{r,s}$	$va_{1,ROW}^{r,s}$
R ₂	$va_{2,1}^{r,s}$	$va_{2,2}^{r,s}$	...	$va_{2,n-1}^{r,s}$	$va_{2,n}^{r,s}$	$va_{2,ROW}^{r,s}$
⋮	⋮	⋮		⋮	⋮	⋮
R _{n-1}	$va_{n-1,1}^{r,s}$	$va_{n-1,2}^{r,s}$	...	$va_{n-1,n-1}^{r,s}$	$va_{n-1,n}^{r,s}$	$va_{n-1,ROW}^{r,s}$
R _n	$va_{n,1}^{r,s}$	$va_{n,2}^{r,s}$	...	$va_{n,n-1}^{r,s}$	$va_{n,n}^{r,s}$	$va_{n,ROW}^{r,s}$
ROW	$va_{row,1}^{r,s}$	$va_{row,2}^{r,s}$	...	$va_{row,n-1}^{r,s}$	$va_{n,n}^{r,s}$	$va_{row,ROW}^{r,s}$

An Index of Regional Sectoral Economic Activity (cont.)

According to Table 1, a region's sectoral output is potentially associated with transactions involving economic agents located not only in the region, but also elsewhere

Define the sets of origins, O , and destinations, D , both comprising all domestic regions, r , add the rest of the world, row . Thus, we can compute total value added of sector s in region r , va^{rs} , as:

$$va^{rs} = \sum_{o \in O, d \in D} va_{o,d}^{r,s}$$

We also calculate region's r total value added, va^r , as:

$$va^r = \sum_s va^{rs}$$

An Index of Regional Sectoral Economic Activity (cont.)

In order to **monitor** sectoral regional economic activity, we would need to follow va^{rs} over time. This information, when available, is usually published with a delay and at a low frequency (annual).

To circumvent such informational constraint, we could track changes in trade flows for each regional origin-destination pair, and combine them with the information in Table 1 to calculate a trade-weighted index of regional economic activity.

An Index of Regional Sectoral Economic Activity (cont.)

Thus, if we can observe, in each period t , changes in values of flows from each origin o , to each destination d , $\Delta F_{t,o,d}$, a regional index of economic activity could be calculated as

$$EAI_t^{r,s} = \sum_{o \in O, d \in D} w_{o,d}^{r,s} \Delta F_{t,o,d}$$

where $EAI_t^{r,s}$ is the economic activity index for sector s , in region r , in time t , and the weights $w_{o,d}^{r,s}$ are calculated as

$$w_{o,d}^{r,s} = \frac{va_{o,d}^{r,s}}{\sum_{o \in O, d \in D} va_{o,d}^{r,s}} \text{ such that } \sum_{o \in O, d \in D} w_{o,d}^{r,s} = 1$$

Implementation

The implementation of the index depends on two pieces of information: first, we need to define an empirical strategy to estimate values in Table 1, so that we can define the weights, $w_{o,d}^{r,s}$; second, we have to collect timely information to estimate $\Delta F_{t,o,d}$.

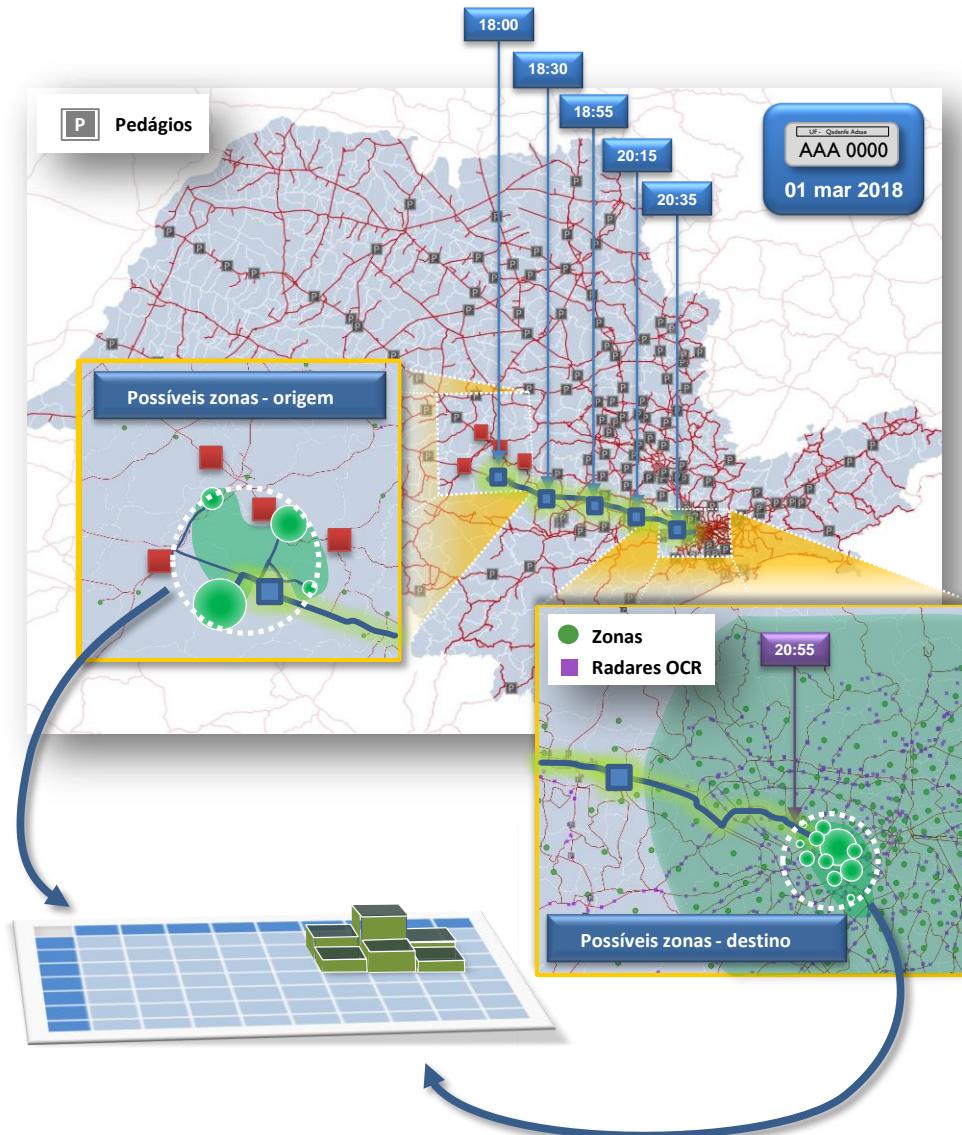
Measurement of domestic value added in trade flows

- Hypothetical extraction method

Traffic intensity indicators as a measure of change in trade volumes (341 toll stations and 4,870 smart cameras)

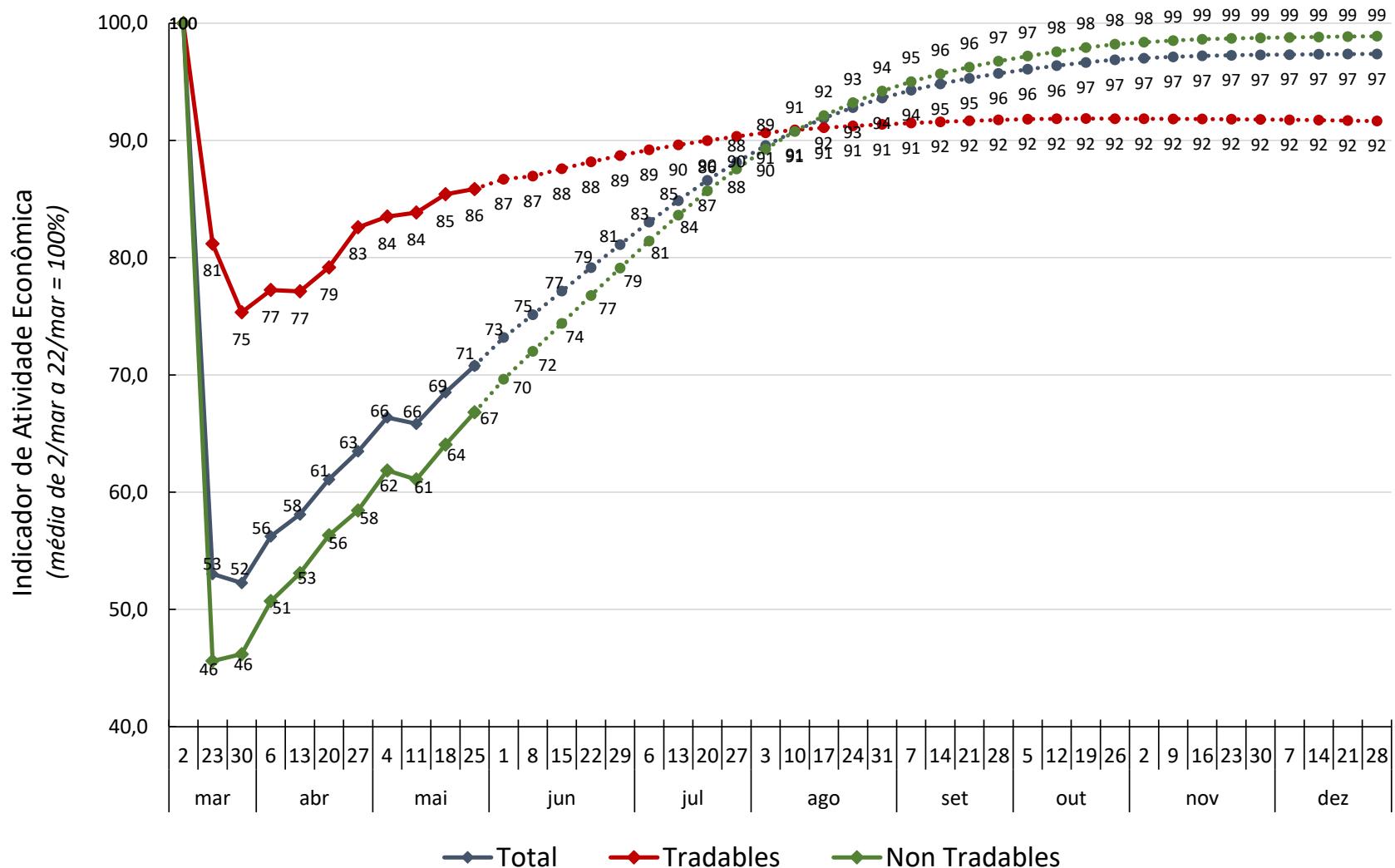
- Daily, OD pair, type of vehicle (trucks and cars)

Analysis of traffic flows



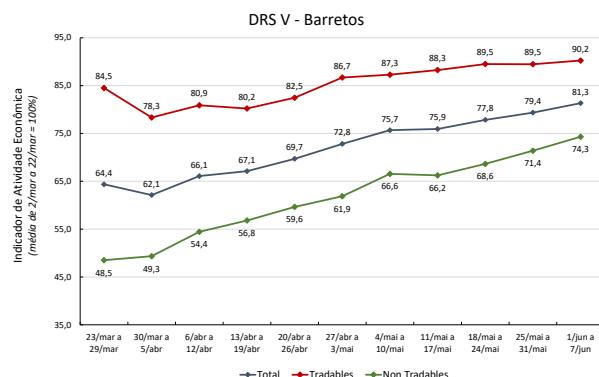
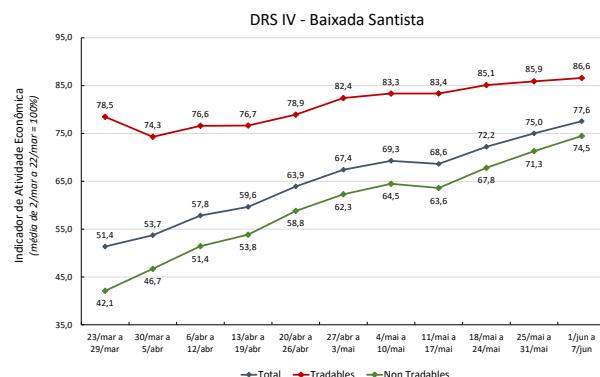
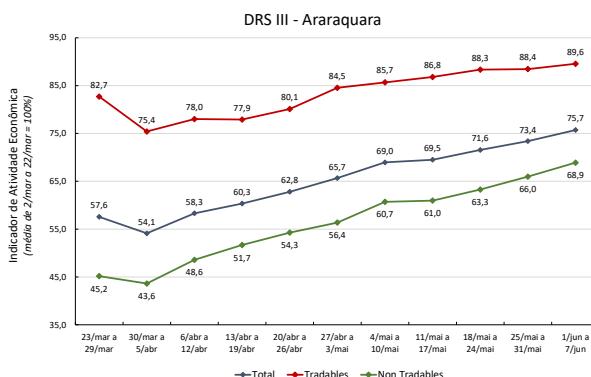
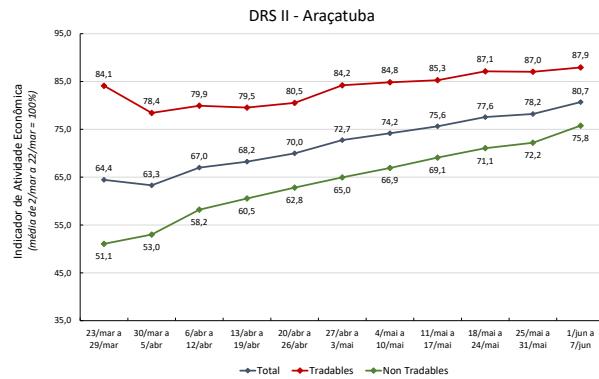
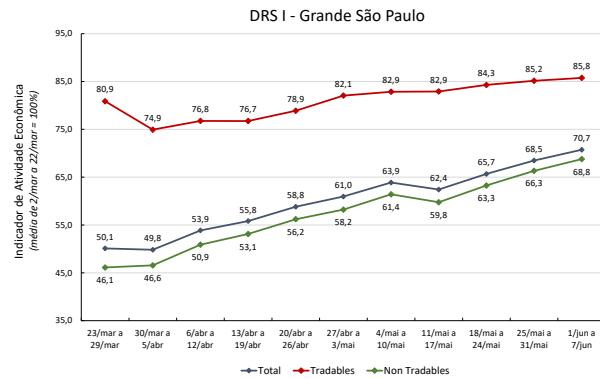
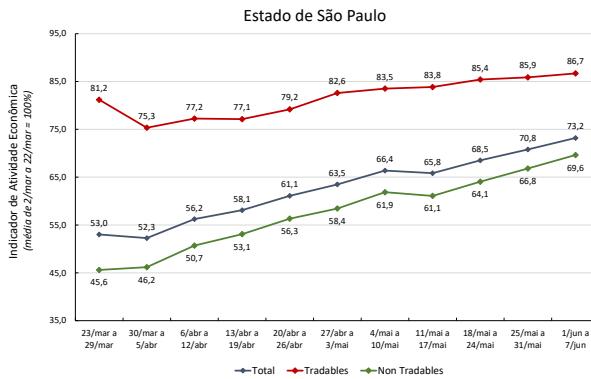
Economic Activity Indicator: State of São Paulo

Period: March 23 to June 07, 2020



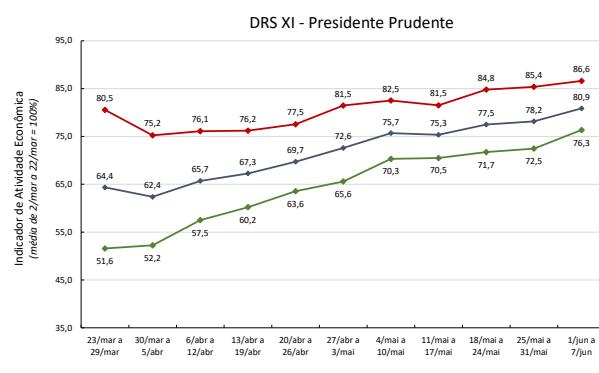
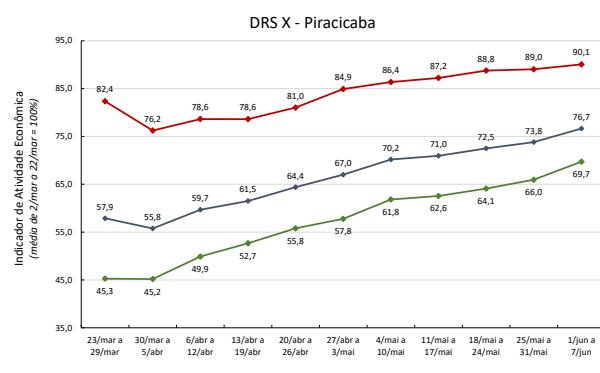
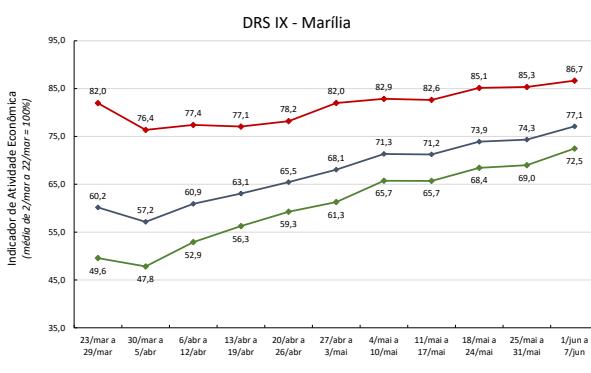
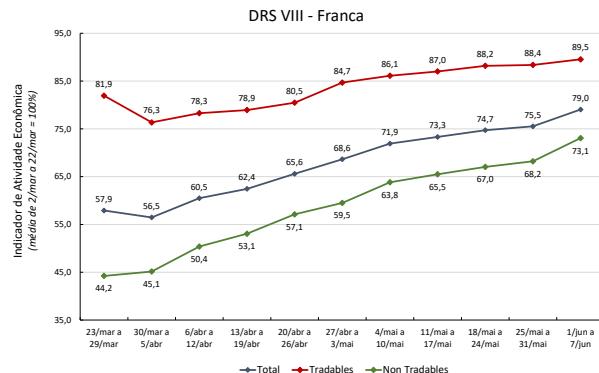
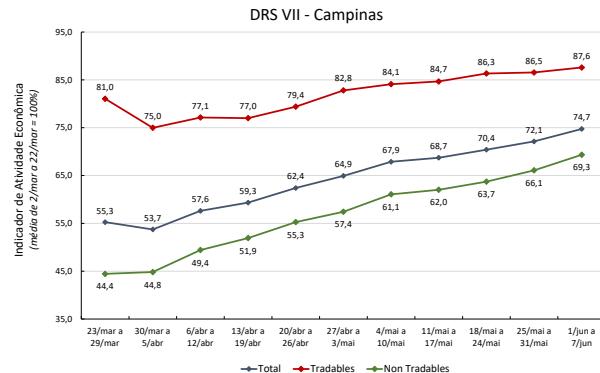
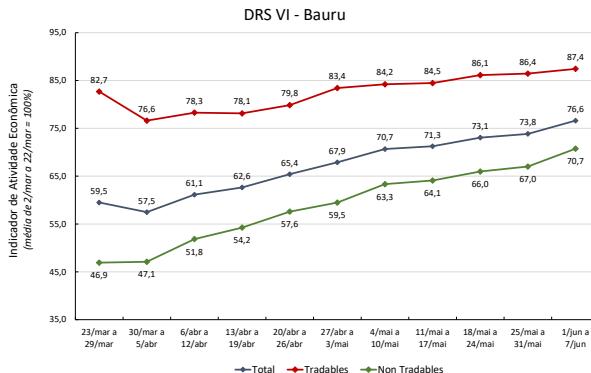
Economic Activity Indicator: State of São Paulo

Period: March 23 to June 07, 2020



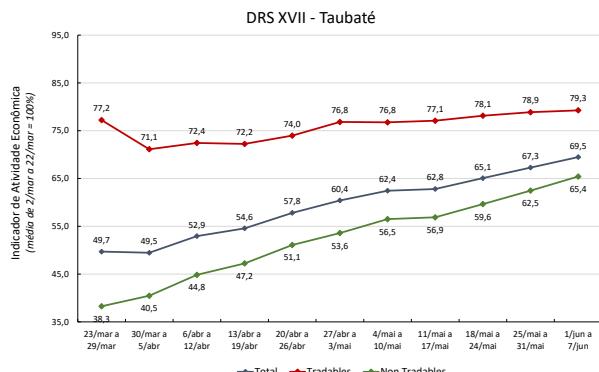
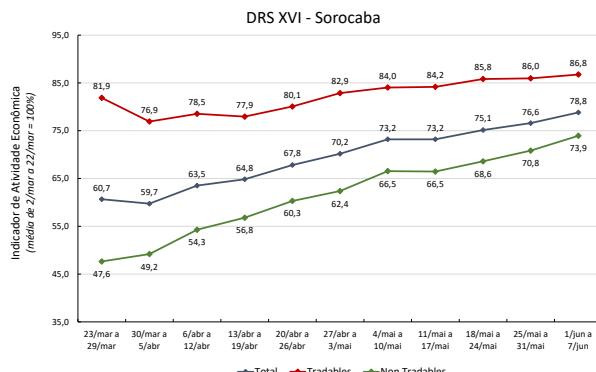
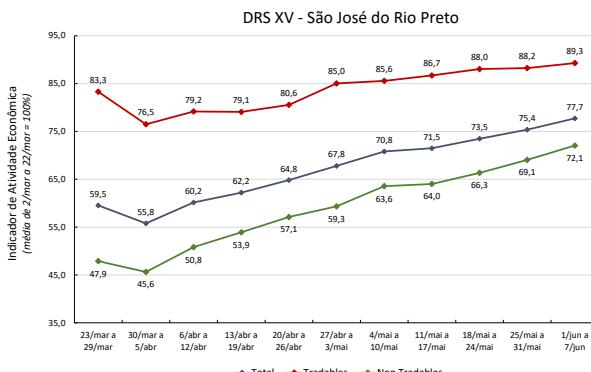
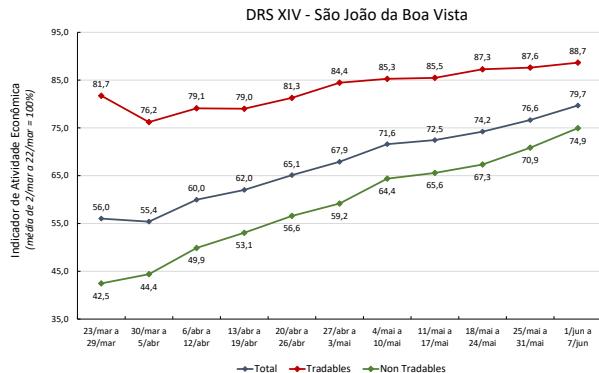
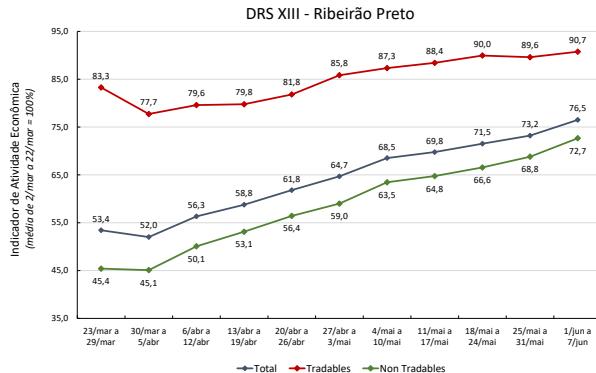
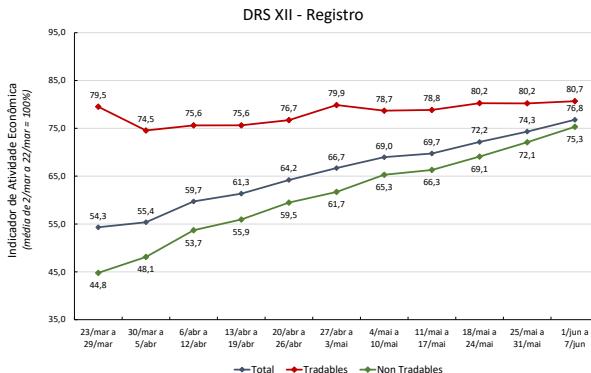
Economic Activity Indicator: State of São Paulo

Period: March 23 to June 07, 2020



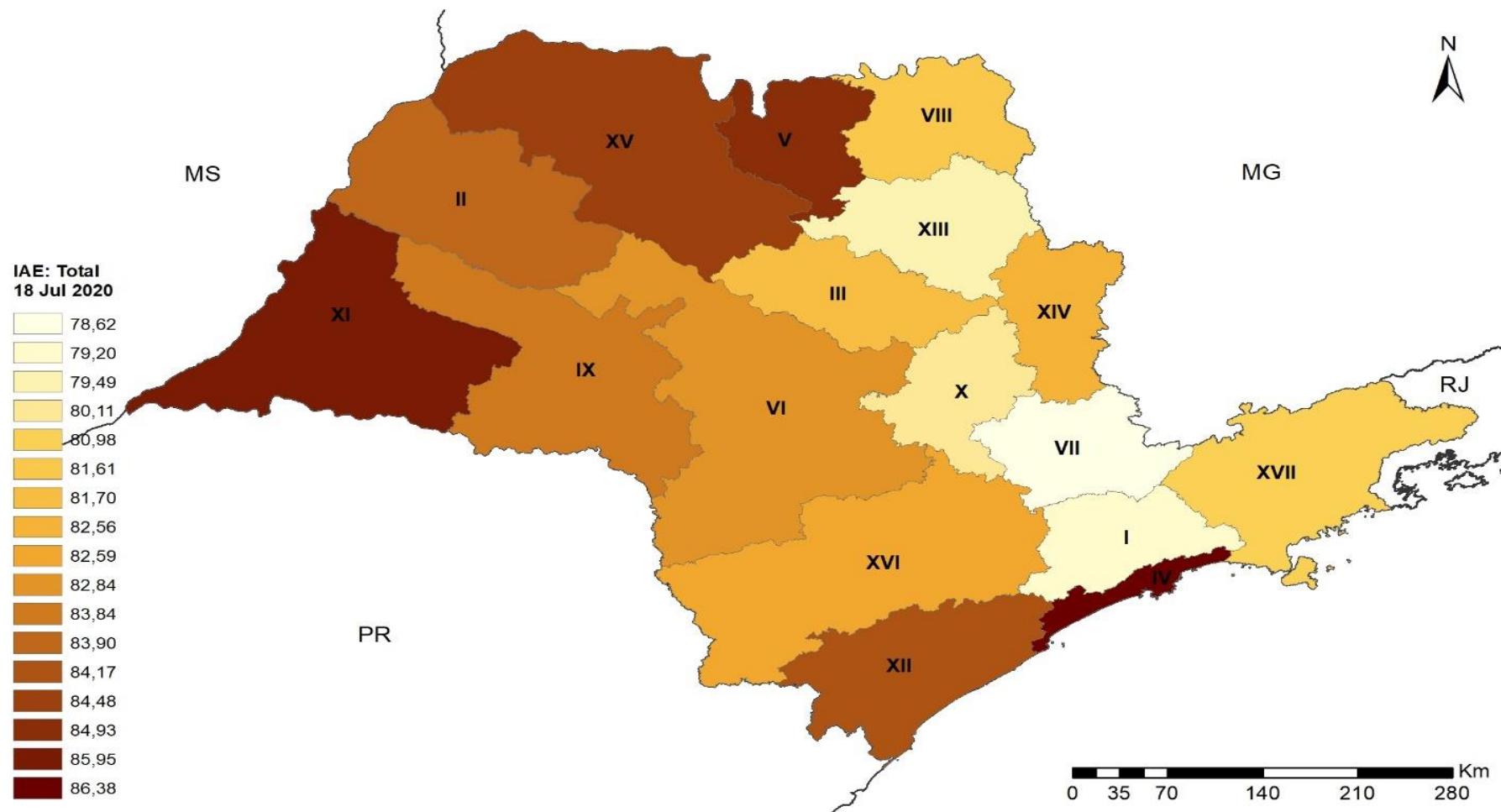
Economic Activity Indicator: State of São Paulo

Period: March 23 to June 07, 2020



Economic Activity Indicator

July 18, 2020



Example: Is there a correlation between economic activity and the evolution of the pandemic?

Economic activity indicator (7-day moving average)

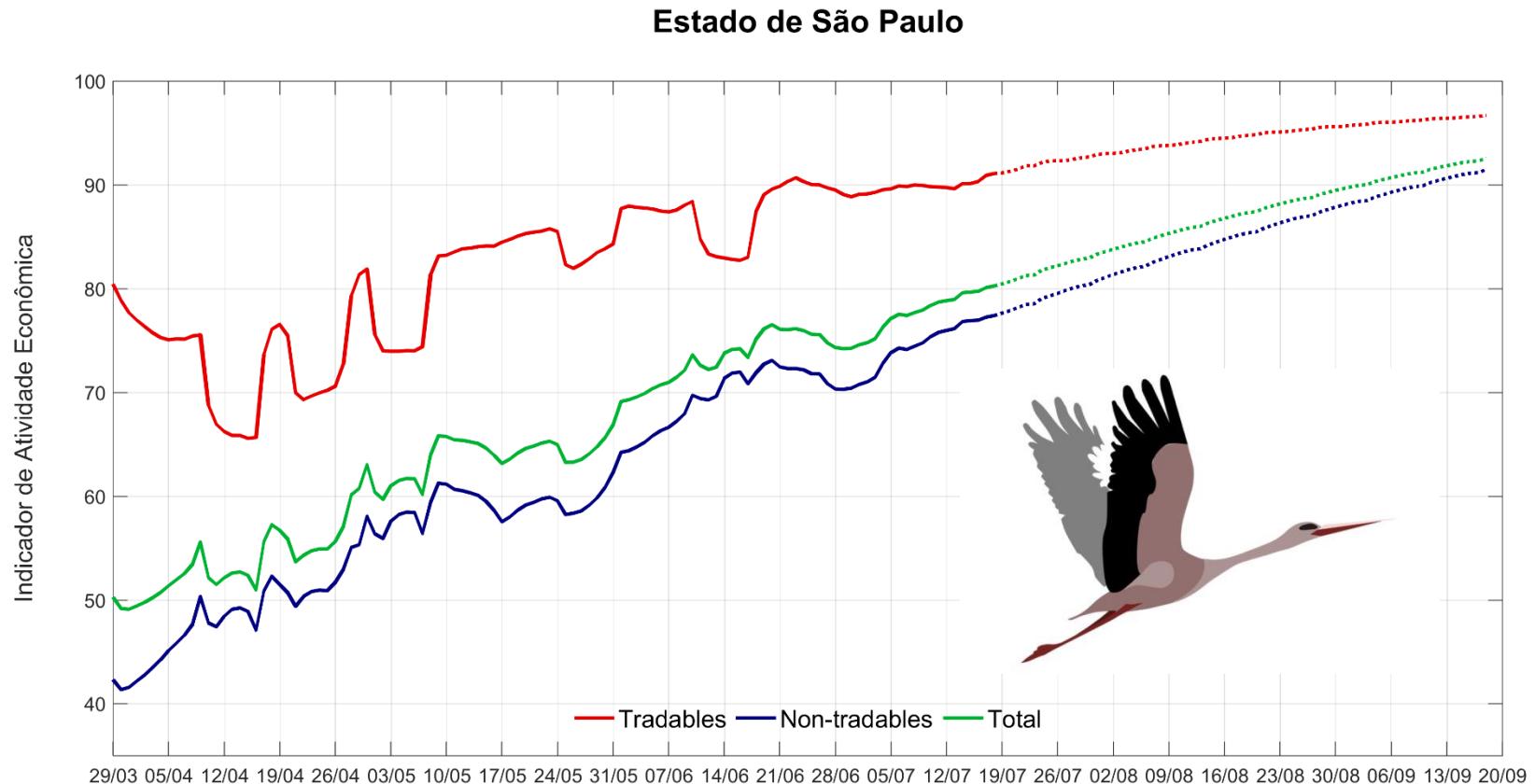
- 17 regions (DRS)
- Daily frequency: Mar-29 to Jun-18

Confirmed cases (7-day moving average)

- 17 regional (DRS)
- Daily frequency: Apr-21 to Jun-23

Economic Activity Indicator: State of São Paulo

Period: March 29 to July 18, 2020 (+ 60-day projection)



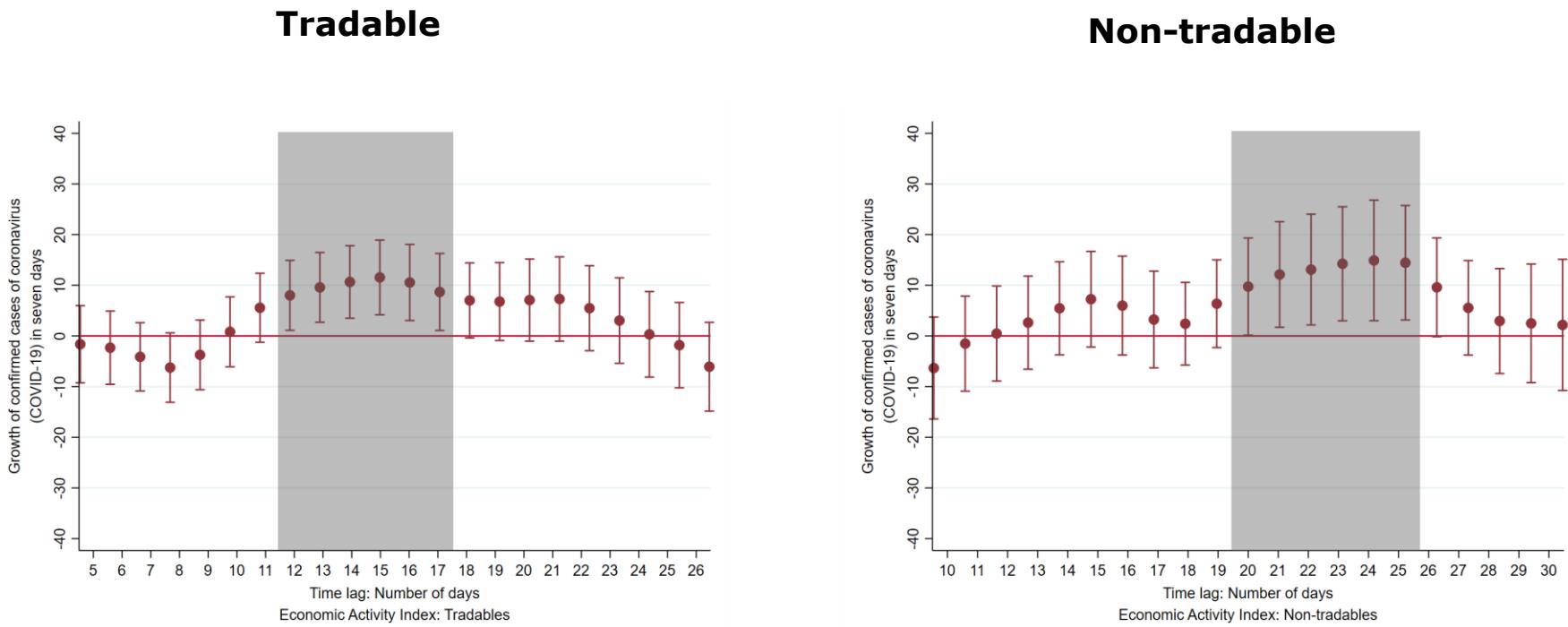
Empirical strategy

Let C_{rt} denote the number of reported cases of coronavirus (COVID-19) in region r in period t .

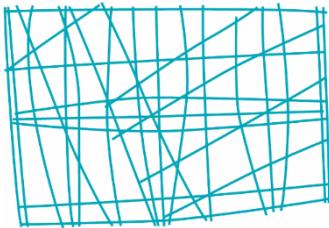
$$\Delta C_{rt} = \beta_j EAI_{rt-j} + \eta_r + \nu_{rt}$$

where Δ is the lag operator defined at the day level, hence, the dependent variable is the growth of confirmed cases of coronavirus in seven days, so that $\Delta C_{rt} = C_{rt} - C_{rt-7}$. EAI is the Economic Activity Index (Tradable and Non-tradable). The parameter β_j measures the effect of lagged explanatory variable with j lags on the growth in average C_{rt} between t and $t - 7$. η_r is a set of region dummies that captures the influence of unobserved and time invariant attributes for each region, which absorb geographically restricted shocks affecting the outcomes of interest; ν_{rt} is the idiosyncratic error term.

Growth of confirmed cases of coronavirus in seven days and temporal lag of Economic Activity Index



Note: Each marker represents the coefficient value and the robust standard errors of the Economic Activity Index (Tradable and Non-tradable) in an individual regress for each lag. Number of observations total on panel: 1,003 (59 days and 17 regions). The regresses controlling for regional fixed effects.



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