The Response of Industrial Production to Climate Shocks in Different Brazilian Regions

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AGENDA

- Introduction
- Climate and Industry in Brazil
- Theoretical Background
- The data
- Preliminary Results
- Final Comments

CLIMATE AND INDUSTRY IN BRAZIL

CLIMATE AND INDUSTRY IN BRAZIL

- Some types of economic works related to climate:
  - To study the impacts on sectors traditionally dependent on climate, like agriculture;
  - To study the impacts of extreme climate events, like hurricanes and tsunamis.
- This study deals with the linkages between key sea surface temperatures and regionalized physical industrial production in Brazil

CLIMATE AND INDUSTRY IN BRAZIL

- Sea surfaces temperatures are important determinants of local (and global) climate and climate variability.
- By concentrating on the responses of industrial activity to climate variability we hope to build the basis for the understanding of economic responses to climate change.

CLIMATE AND INDUSTRY IN BRAZIL

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- Different regions of Brazil are influenced by oceanic conditions in different parts of the world:
  - Central Pacific Ocean influences the Northern, Northeastern and Southern Regions;
  - Atlantic Ocean influences the Northeastern and Northern regions, and the transport of humidity to the Southeastern region;

CLIMATE AND INDUSTRY IN BRAZIL

- Southern Atlantic Ocean influences the Southern and Southeastern regions;
- Pacific and Atlantic Ocean can be correlated due to atmospheric teleconnections, or physical connections between these oceans through atmospheric systems.

CLIMATE AND INDUSTRY IN BRAZIL

- Brazilian economy:
  - 56% of the GDP in the Southeastern region
  - 17% of the GDP in the Southern region
  - 13% of the GDP in the Northeastern region
  - 09% of the GDP in the Center-Western region
  - 05% of the GDP in the Northern region

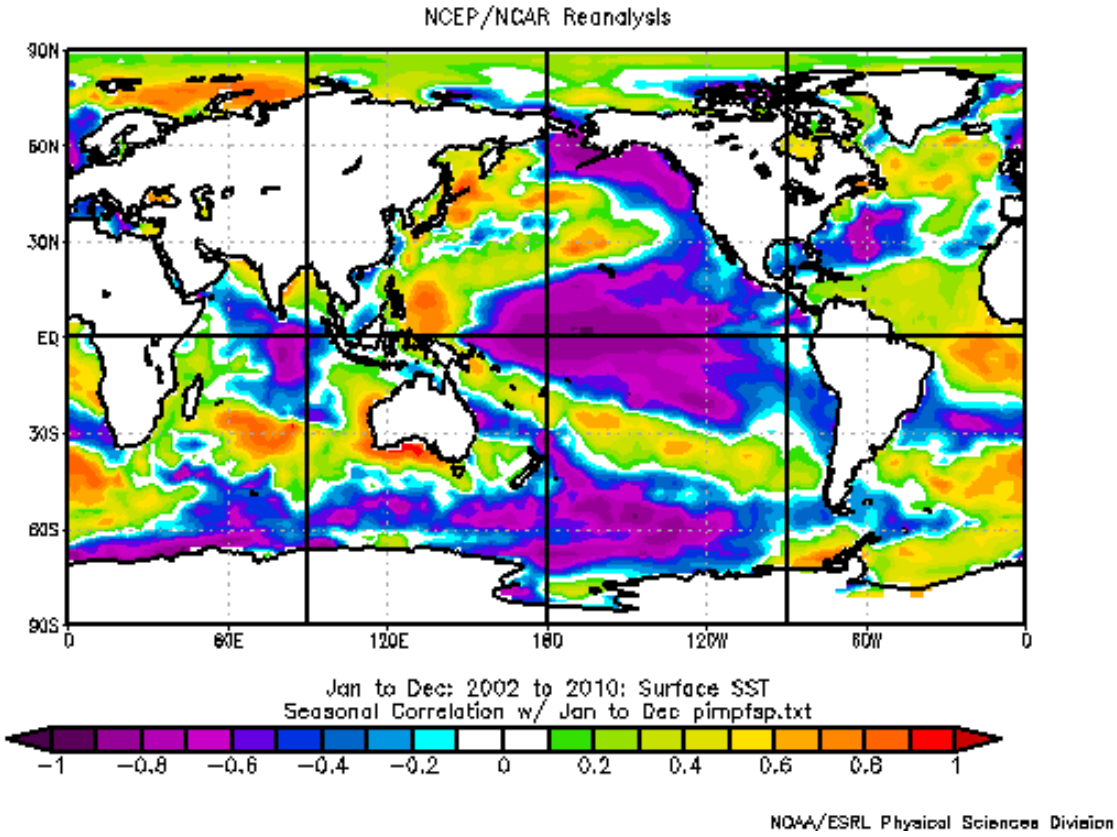
CLIMATE AND INDUSTRY IN BRAZIL

- Brazilian economy:
  - Services – 66% of GDP;
  - Industry – 28% of GDP;
  - Agriculture – 6% of GDP.

CLIMATE AND INDUSTRY IN BRAZIL

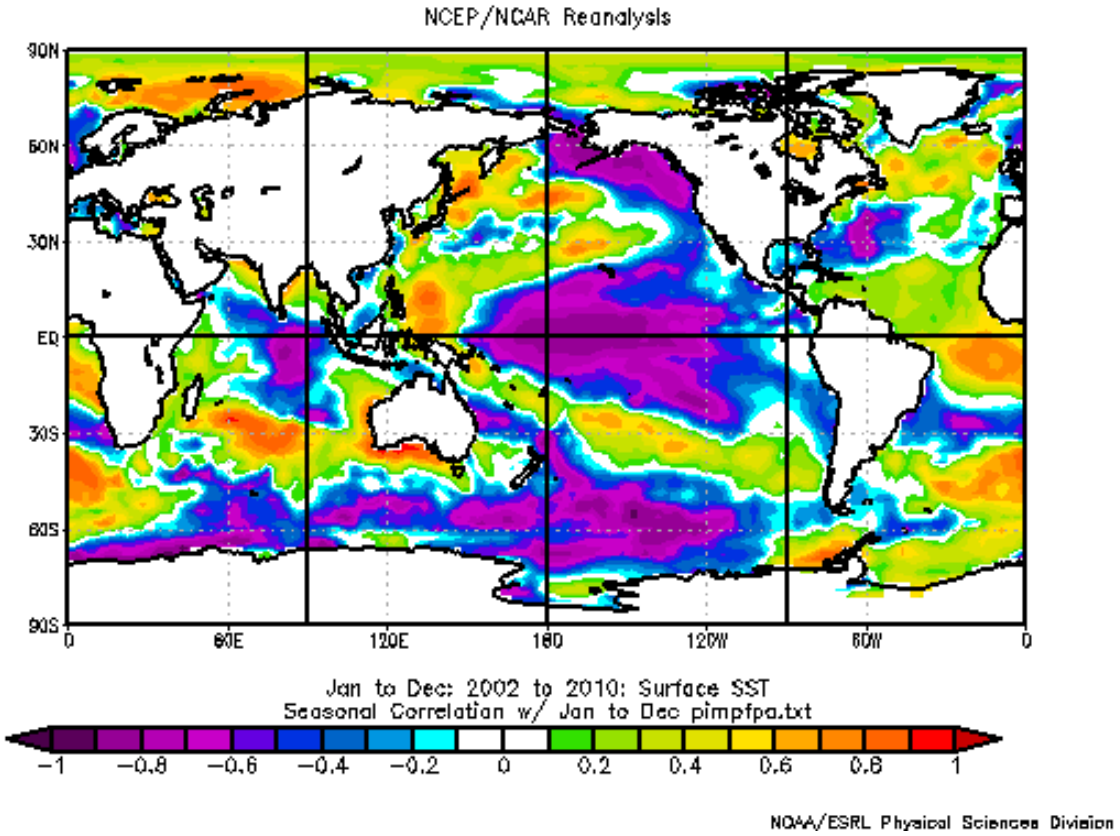
- Although the industrial sector is diversified with activities that would typically be considered to be resilient to climate variability, maps of correlation suggest a statistically significant climate vulnerability of the industrial sector in different regions of the country.

CLIMATE AND INDUSTRY IN BRAZIL



Correlation map for SSTs and physical industrial production of Sao Paulo, Brazil (5% significance level = 0.19)

CLIMATE AND INDUSTRY IN BRAZIL



Correlation map for SSTs and physical industrial production of Pará, Brazil (5% significance level = 0.19)

CLIMATE AND INDUSTRY IN BRAZIL

- The above figures suggests that climatic shocks can have a significant impact on industry, a sector thought to be largely insulated from climatic shocks, and can have a widespread geographic impact, ranging from the wealthiest to the poorest regions of the country.

THEORETICAL BACKGROUND

STATISTICAL MODEL

- SVAR model:
  - $\Gamma Y_t = BX_t + \varepsilon_t$
- Can be rewritten as:
  - $y_t = \gamma_1 s_t + B_{yy}(L)\, y_t + B_{ys}(L)\, s_t + \varepsilon_{yt}$
  - $s_t = \gamma_2\, y_t + B_{sy}(L)\, y_t + B_{ss}\,(L)\, s_t + \varepsilon_{st}$,
- Γ of interest to us is given by:

$$\Gamma = \begin{bmatrix} 1 & -\gamma_1 \\ -\gamma_2 & 1 \end{bmatrix}$$

NATIONAL INPUT-OUTPUT MODEL

$$X = AX + Y$$

$$(I - A)^{-1} = B$$

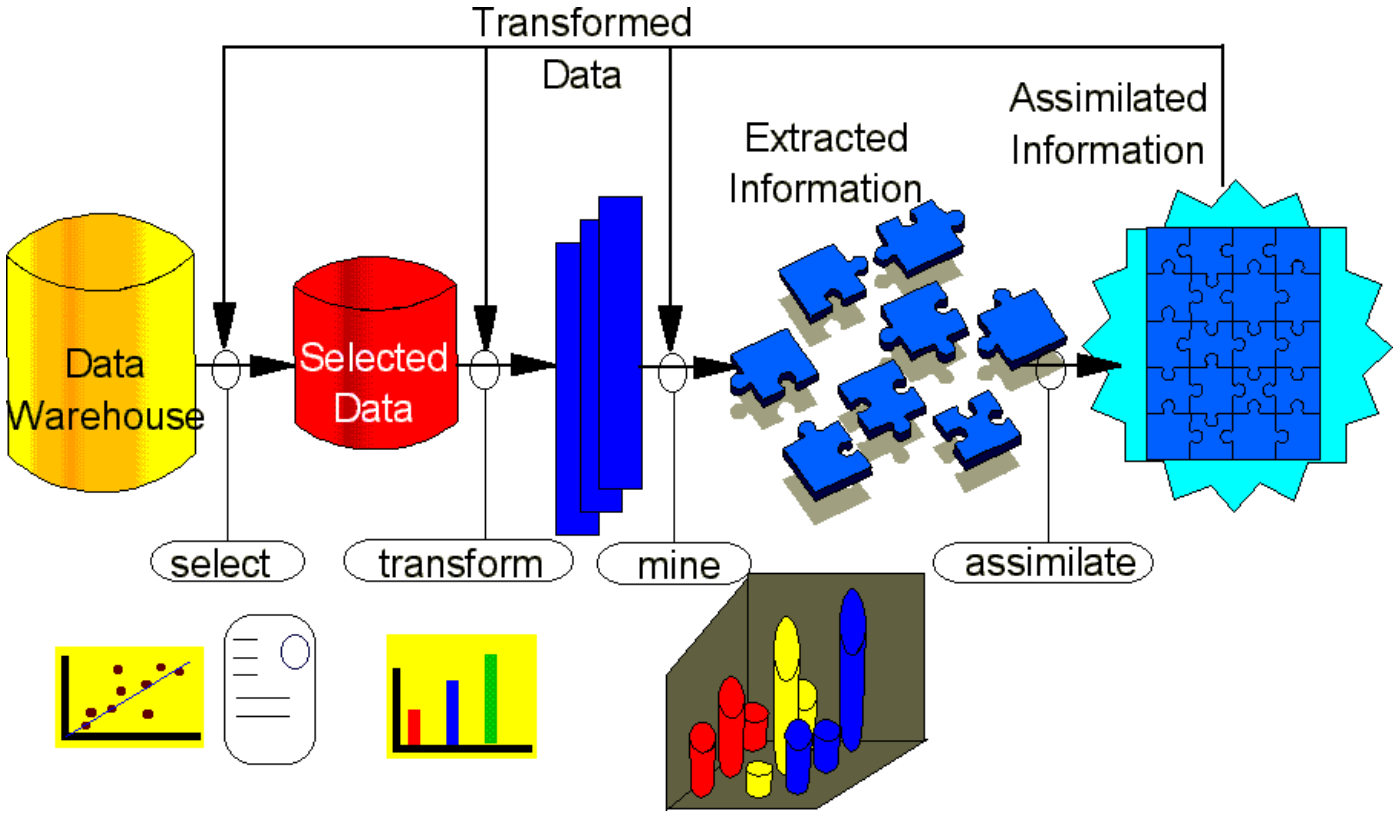
$$X = BY$$

INTERREGIONAL INPUT-OUTPUT MODEL

$$\begin{bmatrix} x_{11}^{11} & \vdots & x_{1n}^{1r} \\ \cdots & \ddots & \cdots \\ x_{n1}^{r1} & \vdots & x_{rr}^{rr} \end{bmatrix} = \begin{bmatrix} B^{11} & \vdots & B^{1r} \\ \cdots & \ddots & \cdots \\ B^{r1} & \vdots & B^{rr} \end{bmatrix} \begin{bmatrix} y_{11}^{11} & \vdots & y_{1n}^{1r} \\ \cdots & \ddots & \cdots \\ y_{n1}^{r1} & \vdots & y_{rr}^{rr} \end{bmatrix}$$

$$\begin{bmatrix} X^{\bullet 1} & \cdots & X^{\bullet r} \end{bmatrix} = \begin{bmatrix} B^{11} & \vdots & B^{1r} \\ \cdots & \ddots & \cdots \\ B^{r1} & \vdots & B^{rr} \end{bmatrix} \begin{bmatrix} Y^{\bullet 1} & \cdots & Y^{\bullet r} \end{bmatrix}$$

$$D^{lm} = \frac{\sum_{i=1}^{n} X_i^{lm}}{\sum_{i=1}^{n} X_i^{lT}}$$


Transformed
Data
Assimilated
Information
Extracted
Information
Data
Warehouse
Selected
Data
select
transform
mine
assimilate

THE DATA

THE DATA

- Monthly time series on physical industrial production in different regions of the country;
- Sea surface temperature anomalies (SSTA) in selected regions of the Atlantic and Pacific Oceans:
  - SSTA are the difference between the temperature for a given month and the average for the same month for the last 30 years of observations;

THE DATA

- Interstate input-output matrix for the 27 states of the Brazilian economy, for the year of 2004.

PRELIMINARY RESULTS

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- Three separate sets of SVAR models to elicit the impact of SSTAs on industrial production in:
  - São Paulo state;
  - Pará state;
  - Northeastern region.

PRELIMINARY RESULTS

Table 1: Contemporaneous impacts of sea surface temperature anomalies on physical industrial production in Sao Paulo, Northeast and Para regions, Brazil.

	Nino3.4	S.Atlantic		Nino3.4	S.Atlantic		Nino3.4	S.Atlantic		Nino3.4	S.Atlantic
SP.L1	-2.144572	1.911174	NE.L5	-0.5047591	3.688318	PA.L1	-0.3384582	3.527246	PA.L5	0.07556621	3.726495
N=107	(-5.639578)	(3.309797)	N=103	(-1.254593)	(5.702930)	N=107	(-0.892092)	(6.111342)	N=103	(0.183610)	(5.970916)
SP.L3	-2.11039	1.600061	NE.L6	-0.9413805	3.983992	PA.L2	0.003565645	2.786435	PA.L6	-0.0447929	4.88255
N=105	(-5.445829)	(2.683522)	N=102	(-2.258792)	(6.158691)	N=106	(0.009305)	(4.701845)	N=102	(-0.108311)	(7.727986)
SP.L5	-1.689435	1.555239				PA.L3	0.07941155	1.756816	PA.L8	-0.2876421	6.086779
N=103	(-4.171281)	(2.477079)				N=105	(0.202855)	(2.892898)	N=101	(-0.711423)	(9.384767)
SP.L6	-1.713637	1.644043				PA.L4	0.3534193	3.110447			
N=102	(-4.219065)	(2.566792)				N=104	(0.908505)	(4.980094)			

Note: t-statistics in parenthesis, critical values for 80 degress of freedom for 0.05, 0.02 and 0.01 significance levels: 1.99, 2.374 and 2.639, respectively.

PRELIMINARY RESULTS

- For São Paulo state:
  - The El Niño effect negatively local industrial production:
    - 1º C departure of the SST from the historical average has an approximate impact of -1.63% in the state physical industrial production index
  - South Atlantic Ocean has the opposite impact:
    - 1º C departure of the SSTA has an approximate impact of 1.43 % points in the state physical industrial production index

PRELIMINARY RESULTS

- For Northeastern region:
  - The El Niño effect negatively local industrial production:
    - 1º C departure of the SST from the historical average has an approximate impact of -0.66% in the state physical industrial production index
  - South Atlantic Ocean has the opposite impact:
    - 1º C departure of the SSTA has an approximate impact of 3.49 % points in the state physical industrial production index

PRELIMINARY RESULTS

- For Pará state:
  - The El Niño effect negatively local industrial production:
    - 1º C departure of the SST from the historical average has an approximate impact of -0.02% in the state physical industrial production index
  - South Atlantic Ocean has the opposite impact:
    - 1º C departure of the SSTA has an approximate impact of 2.83 % points in the state physical industrial production index

FINAL COMMENTS

FINAL COMMENTS

- Our findings suggests a significant and large impact of SSTs on physical industrial production in Brazil.
- A one degree departure from historical averages for selected SSTs can imply shocks in physical industrial production in the order of 1% to 3% depending on the ocean and economic regions of Brazil

FINAL COMMENTS

- We need to interpret our results with caution if we rely on them to make inferences about climate change, since large uncertainties as to what climate change means for SSTs and overall behavior of the oceans still remain.

FINAL COMMENTS

- We prefer to look at our results as **indicators** of the **vulnerability** of the local economy to climate change, even if we specialize to sectors that are typically seen as insulated from climate.

FINAL COMMENTS

- Next steps:
  - Incorporation of other Brazilian regions and states;
  - Integration of the interregional input-output system to better understand the relation of dependence among the Brazilian states and the vulnerability of the economy to climate change.

FINAL COMMENTS

Thank You!

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