CLIMATE CHANGE IMPACTS ON AGRICULTURE AND INTERNAL MIGRATIONS IN BRAZIL

Joaquim Bento de Souza Ferreira Filho
University of São Paulo, Brazil
Mark Horridge
Centre of Policy Studies – Monash University, Australia

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Background and motivation

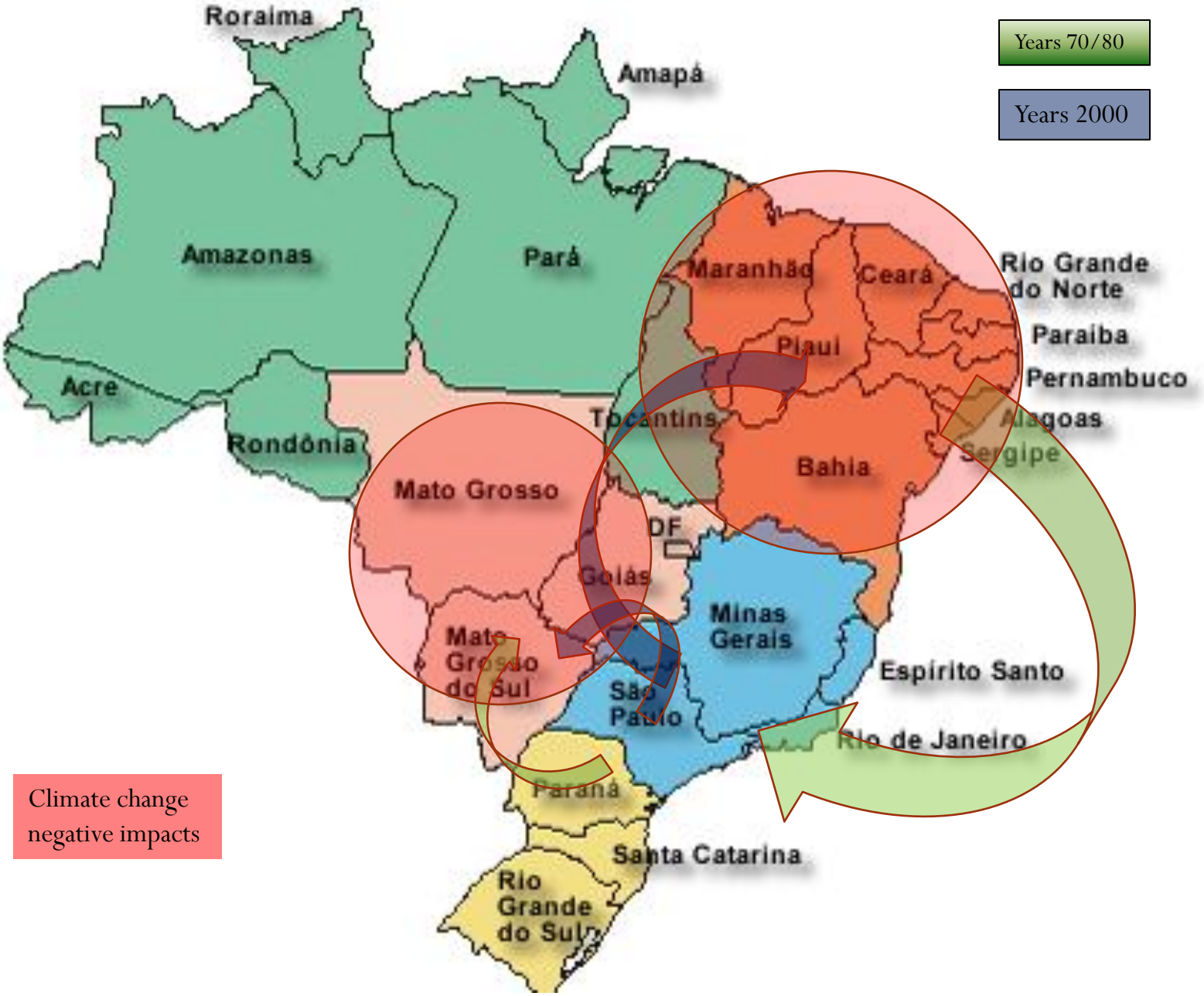
- Climate change is likely to have negative impacts on agriculture in Brazil.
- Those impacts will be more intense in certain regions in the country, mostly located in Northeast and Center-west Brazil.
- Economic activity is geographically concentrated in Brazil:
  - Manufacturing and agriculture: Southeast
  - Agriculture: Center-west
- Climate change has potential to bring new (or to accentuate actual) regional imbalances in the Brazilian economy.
- Internal migration is one of particular interest

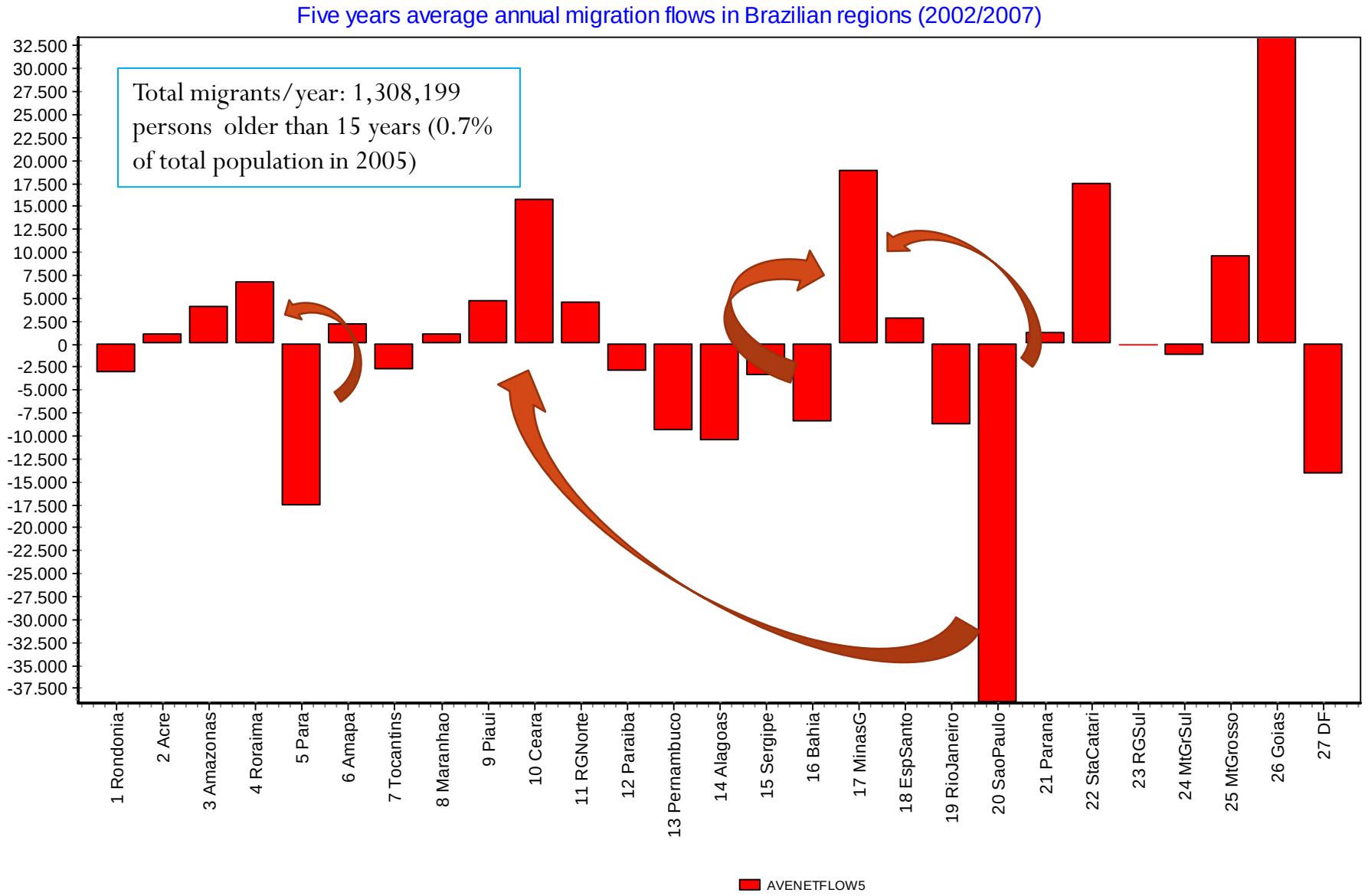
Objective

- Assess the potential impacts on internal migration in Brazil of different climate change scenarios that impact on agriculture.
- Regional details will be emphasized.
- Ongoing research with support by the Inter American Development Bank – IDB. Work in progress.

Internal migration in Brazil

- Internal migrations was an important phenomenon in Brazil during the 70's (import substitution and industrialization process).
- During that time Brazil's model of economic development :
  - transfer of population from rural areas to cities
  - and from the Northeast regions to the Southeast, mainly São Paulo, Rio de Janeiro, and the Center-west (later).
- Population flows in Brazil presently follows different pattern than what was observed in the seventies and eighties.
- São Paulo is the most important source of population movement to other states presently.


Years 70/80
Years 2000
Roraima
Amapá
Amazonas
Pará
Maranhão
Ceará
Rio Grande do Norte
Paraiba
Piaui
Pernambuco
Alagoas
Sergipe
Acre
Rondônia
Tocantins
Bahia
Mato Grosso
DF
Goiás
Minas Gerais
Mato Grosso do Sul
São Paulo
Espirito Santo
Rio de Janeiro
Paraná
Santa Catarina
Rio Grande do Sul
Climate change negative impacts


Five years average annual migration flows in Brazilian regions (2002/2007)
Total migrants/year: 1,308,199 persons older than 15 years (0.7% of total population in 2005)
32.500
30.000
27.500
25.000
22.500
20.000
17.500
15.000
12.500
10.000
7.500
5.000
2.500
0
-2.500
-5.000
-7.500
-10.000
-12.500
-15.000
-17.500
-20.000
-22.500
-25.000
-27.500
-30.000
-32.500
-35.000
-37.500
1 Rondonia
2 Acre
3 Amazonas
4 Roraima
5 Para
6 Amapa
7 Tocantins
8 Maranhao
9 Piaui
10 Ceara
11 RGNorte
12 Paraiba
13 Pernambuco
14 Alagoas
15 Sergipe
16 Bahia
17 MinasG
18 EspSanto
19 RioJaneiro
20 SaoPaulo
21 Parana
22 StaCatari
23 RGSul
24 MtGrSul
25 MtGrosso
26 Goias
27 DF
AVENETFLOW5

Scenarios to be simulated

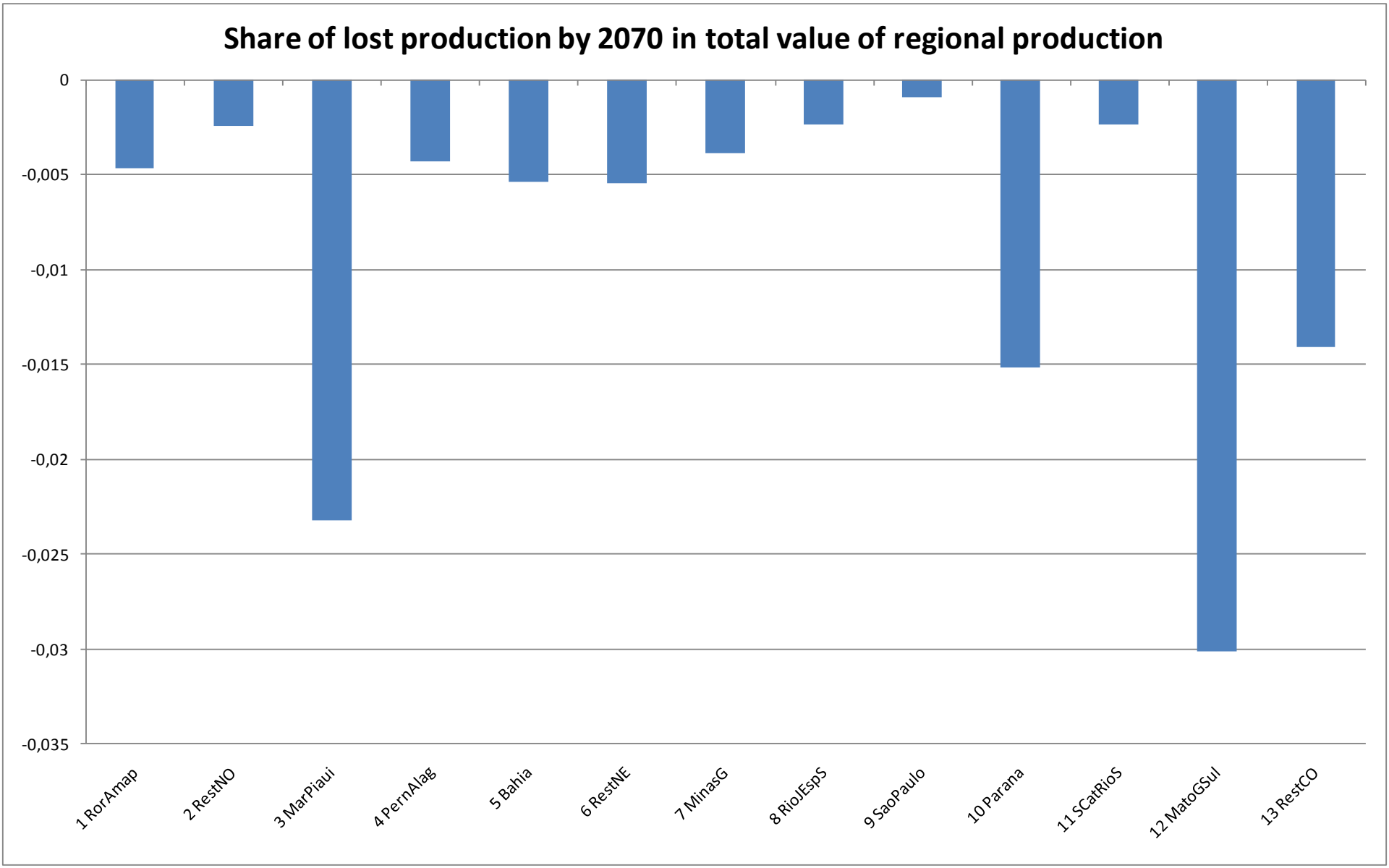
- Total effect amounts to the B2 scenario for 2070
- A mixing of two scenarios:
  - A2 scenario for 2020 (2015-2025)
  - B2 scenario for 2070 (2026-2070)
- Worse scenario for the closer period, adaptation afterwards.
- First period scenario: entails a positive effect on sugar cane productivity, which disappears in the total 2070 scenario.
- Shocks to: production by region, land availability by region.
- Land availability shocks follow closely production shocks (small differences due to regional productivity differences)

Shocks to production, year 2020 (% variation)

Region	Rice	Corn	Sugarcane	Soybean	Cassava	Cotton	Coffee	Other ag
1 RorAmap	0	0	0	0	-49,4	0	0	0
2 RestNO	-4,2	-1,7	0,4	-17,2	-1,9	0	-80	-0,1
3 MarPiaui	-39,3	-30,8	-1,1	-80	-2,5	-4,4	-80	-11,3
4 PernAlag	-80	-67,7	-5	-79,4	-63,4	-62,2	-80	-7
5 Bahia	-3,5	-13,4	-5	-0,4	-18	0	-80	-5,4
6 RestNE	-80	-60,7	-4,3	-79,4	-22,1	-80	-80	-18,6
7 MinasG	-4	-1,4	5	-3,2	-11,6	-7	-3,5	-2
8 RioJEspS	0	-0,8	2,3	0	0	0	-4,3	-0,8
9 SaoPaulo	0	-2	5,5	-7	0	0	-19,2	-0,2
10 Parana	0	0	7	-45,3	-4,9	0	0	0
11 SCatRioS	0	0	0	-30,6	-20,2	0	0	0
12 MatoGSul	0	-14,6	6	-60	0	0	-80	0
13 RestCO	-1,9	-2,6	6	-25,2	0	0	-80	-0,4

Shocks to production, year 2070 (% variation)

Shock	Rice	Corn	Sugarcane	Soybean	Cassava	Cotton	Coffee	Other ag
1 RorAmap	0	0	0	0	-49,4	0	0	0
2 RestNO	-5,2	-3,3	-0,2	-20,2	-0,6	0	-80	-0,2
3 MarPiaui	-47,4	-50,3	-2,1	-80	-2,5	-14,2	-80	-23,6
4 PernAlag	-80	-71,3	-10	-79,4	-63,4	-62,2	-80	-9,4
5 Bahia	-3,5	-36,2	-10	-0,4	-19,6	0	-80	-6,3
6 RestNE	-80	-68,5	-8,6	-79,4	-22,1	-80	-80	-18,6
7 MinasG	-4	-1,4	-2	-33	-1,1	-7	-16,6	-2,6
8 RioJEspS	0	-1,6	-3,6	0	0	0	-66,6	-1,1
9 SaoPaulo	0	-7,2	-3,5	-32,1	0	0	-72,2	-0,3
10 Parana	0	0	-4	-76,3	-6,8	0	-14,7	0
11 SCatRioS	0	0	6	-64,7	-3,8	0	0	0
12 MatoGSul	0	-17	-1,5	-61,5	0	0	-80	0
13 RestCO	-1,9	-2,6	-1,5	-26,8	0	0	-80	-0,6


Share of lost production by 2070 in total value of regional production
0
-0,005
-0,01
-0,015
-0,02
-0,025
-0,03
-0,035
1 RorAmap
2 RestNO
3 MarPiaui
4 PernAlag
5 Bahia
6 RestNE
7 MinasG
8 RioJEspS
9 SaoPaulo
10 Parana
11 SCatRioS
12 MatoGSul
13 RestCO

Methodology

- CGE model for Brazil: TERM-MIG
  - Recursive dynamic – 65 years
  - Inter-regional (13 regions), bottom-up.
  - Sectors/products: 35
  - 10 household types and 10 labor grades
  - Migration module which models bilateral regional migration flows
  - Core database: Brazilian 2005 IO Tables
  - Migration database: PNAD 2005 (Household Survey).
  - Historical simulation: three years of observations.

Migration concept used

- Migrant: someone living in a region in the last 5 years, but not originally from that region.
- This concept avoids temporary people flows like students.
- Only persons above 15 years old, both male and female.
- Bilateral migration flows: source (region of birth) x destination (actual region).

Recursive dynamics in the model

- Consists basically of three mechanisms:
  - a stock-flow relation between investment and capital stock, which assumes a 1-year gestation lag;
  - a positive relation between investment and the rate of profit; and
  - a relation between wage growth and regional labor supply
- Migration function

Migration in the model

- $M_{ord} = F_{ord}. [L_{or} . (L_{od}/L_{o})].[Realwage_{od}/Realwage_{or}]^{a}$
- where:
- M_{ord} no. of workers skill type **o** migrating from region **r** to region **d**
- L_{or} employment of workers skill type **o** in region **r**
- L_{o} national employment of workers skill type **o**
- $Realwage_{od}$ real wage of workers skill type **o** in region **d**
- a elasticity, currently set to 3
- F_{ord} constant of proportionality, set to replicate initial data
- In linear form: xmig(o,r,d) = fxmig(o,r,d) +

  xlab_i(o,r) + [xlab_i(o,d) - xlab_id(o)] +

  3 * [realwage_i(o,d)-realwage_i(o,r)]

Historical simulation and baseline

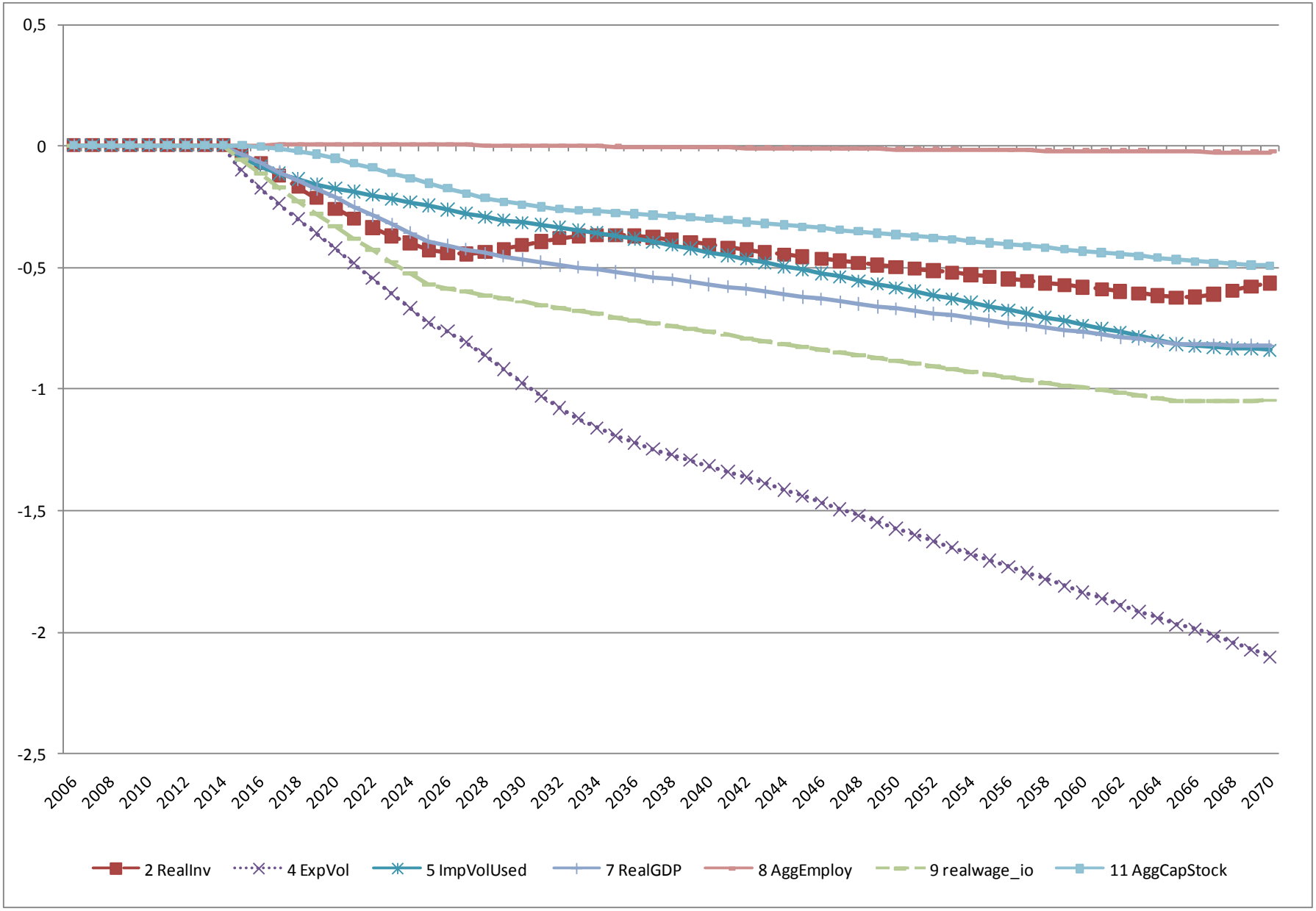
Table 1: Historical simulation shocks, Percentage changes,

Variable	Observed annual average rate of growth (%)
Population	Regional values by IBGE until 2030
Land productivity	1,0
Real government spending	2,9
Real GDP	Regional values by IBGE
Real household consumption	5,8
Real exports	4,9
Real investment	9,7
GDP deflator	7,0

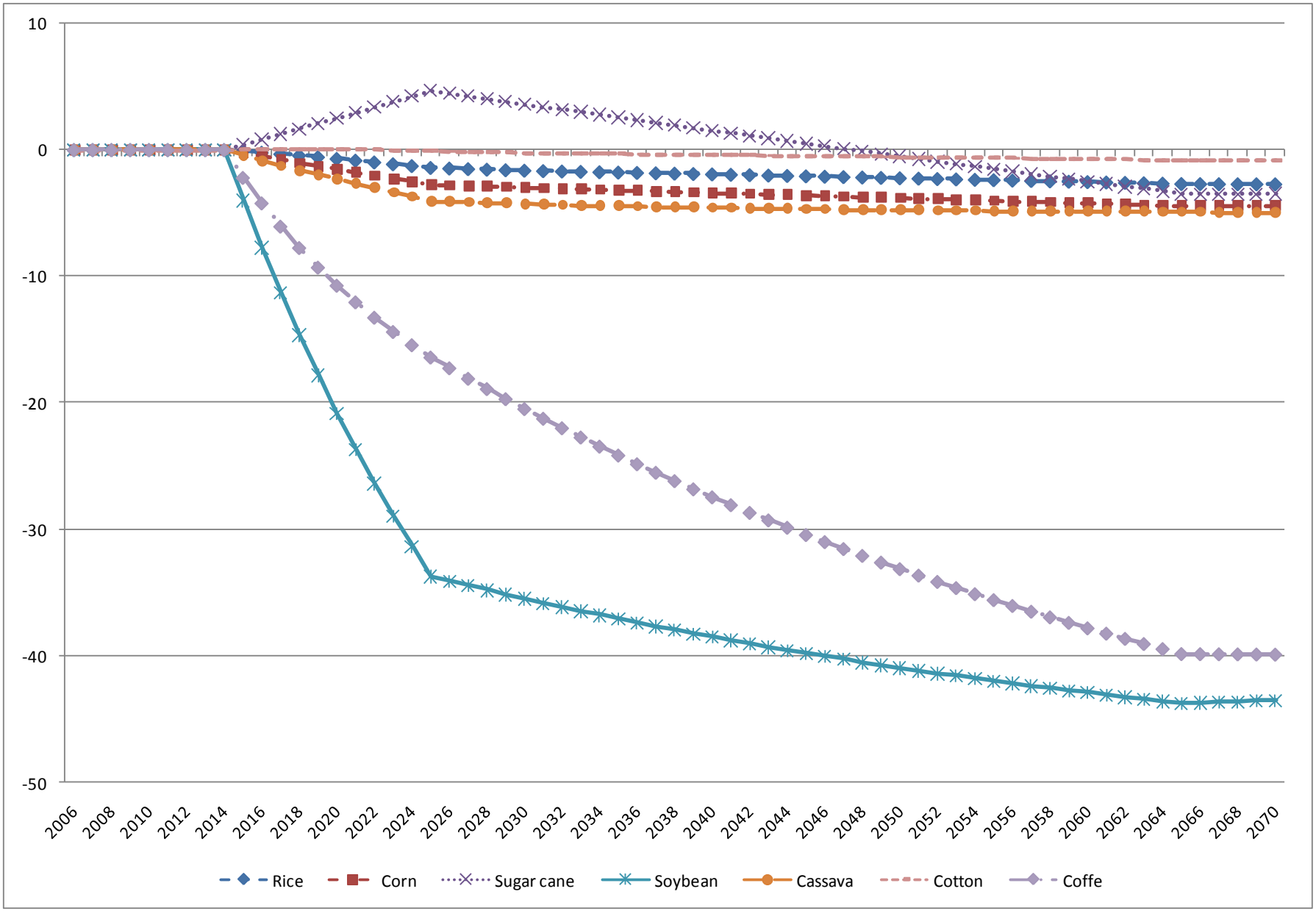
Table 1: Baseline projections, Percentage change,

Variable	Projected annual average rate of growth (%)
Export demand shifter	3,0
Population	Regional values by IBGE until 2030
Primary factor prductivity increase	1,5
Real government expenditures	3,0
GDP deflator	5,0

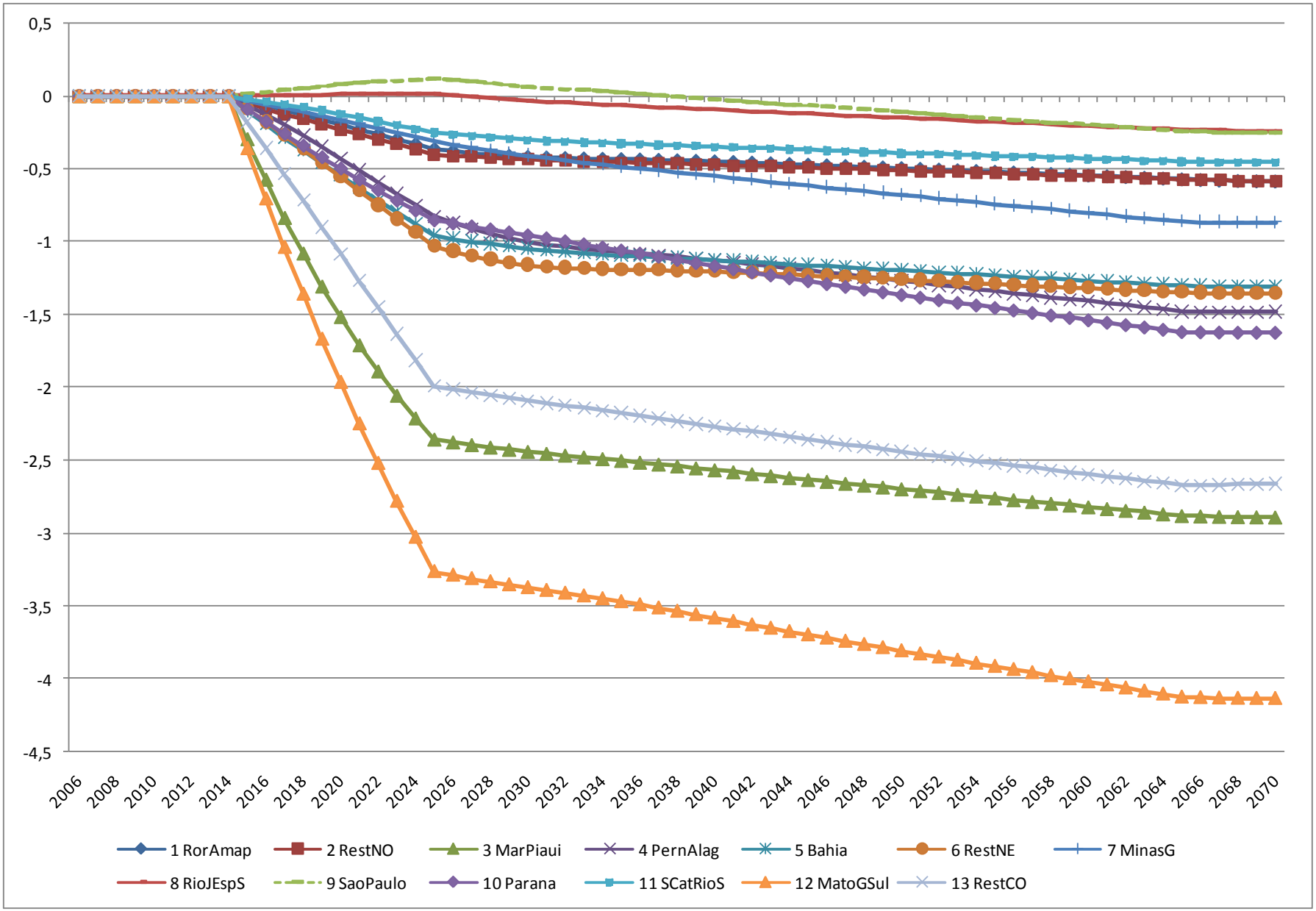
Macros (% deviation from baseline)



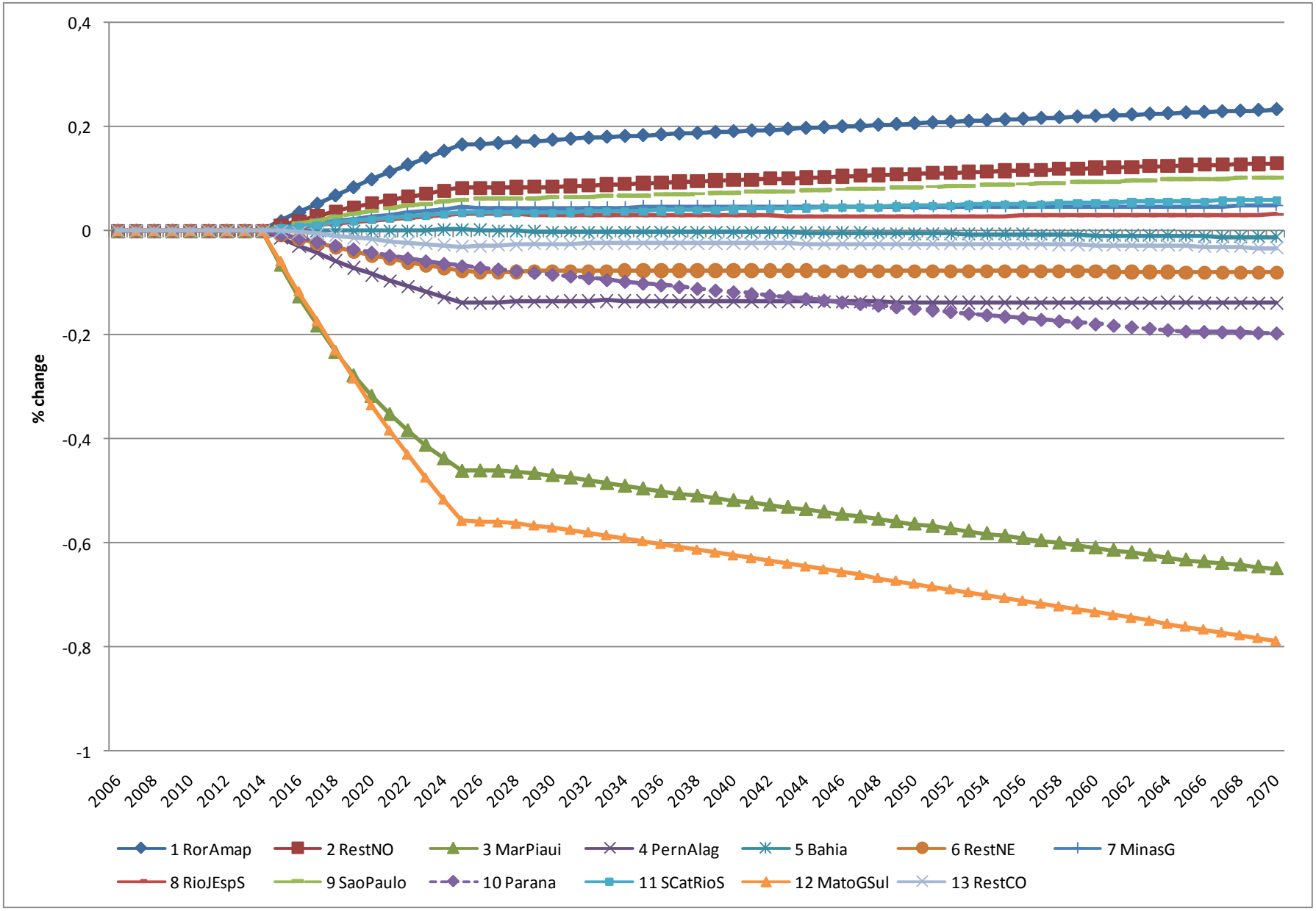
Agricultural production (% deviation from baseline)



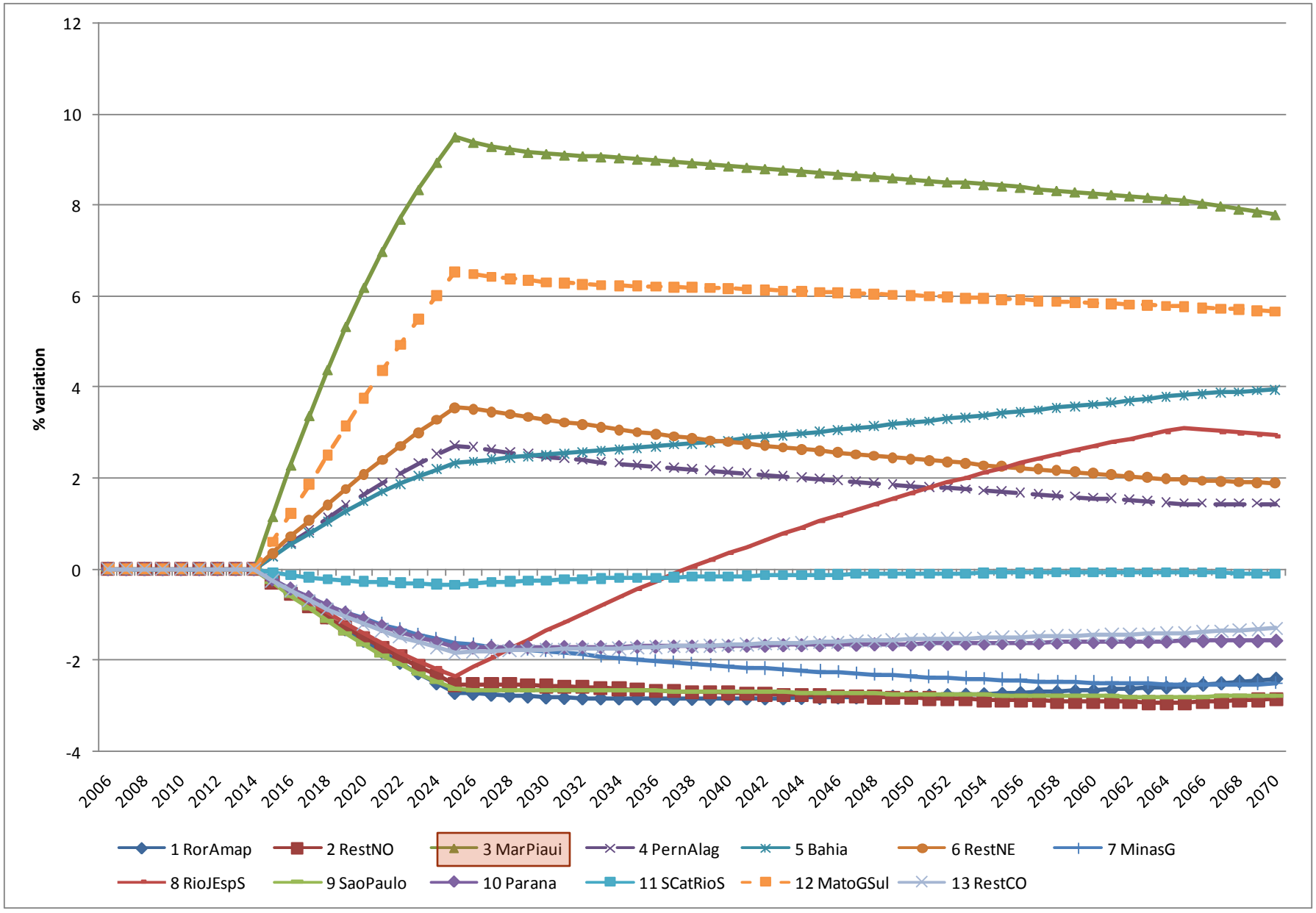
Regional GDP variation (% deviation from baseline)



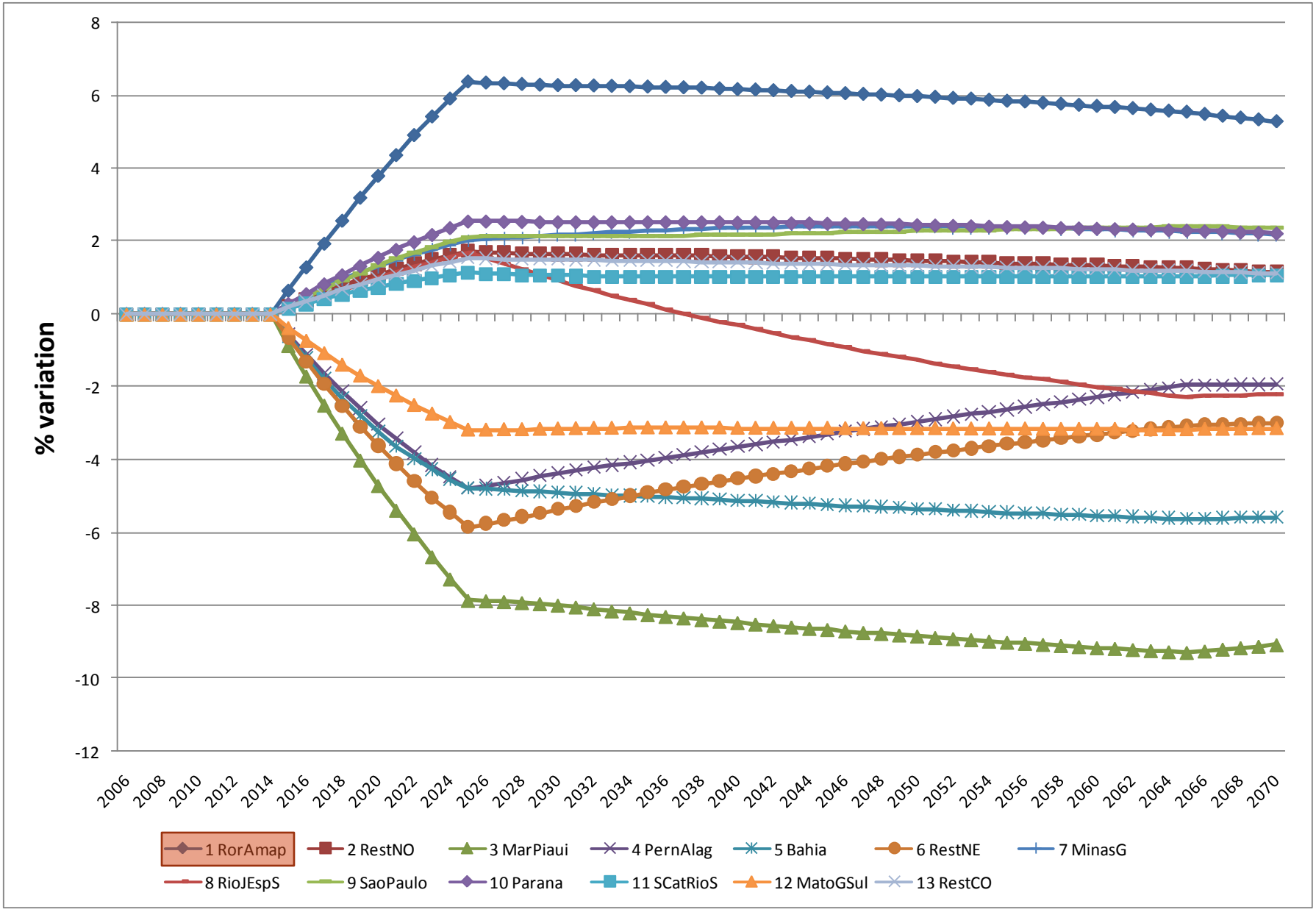
Regional employment variation (% deviation from baseline)



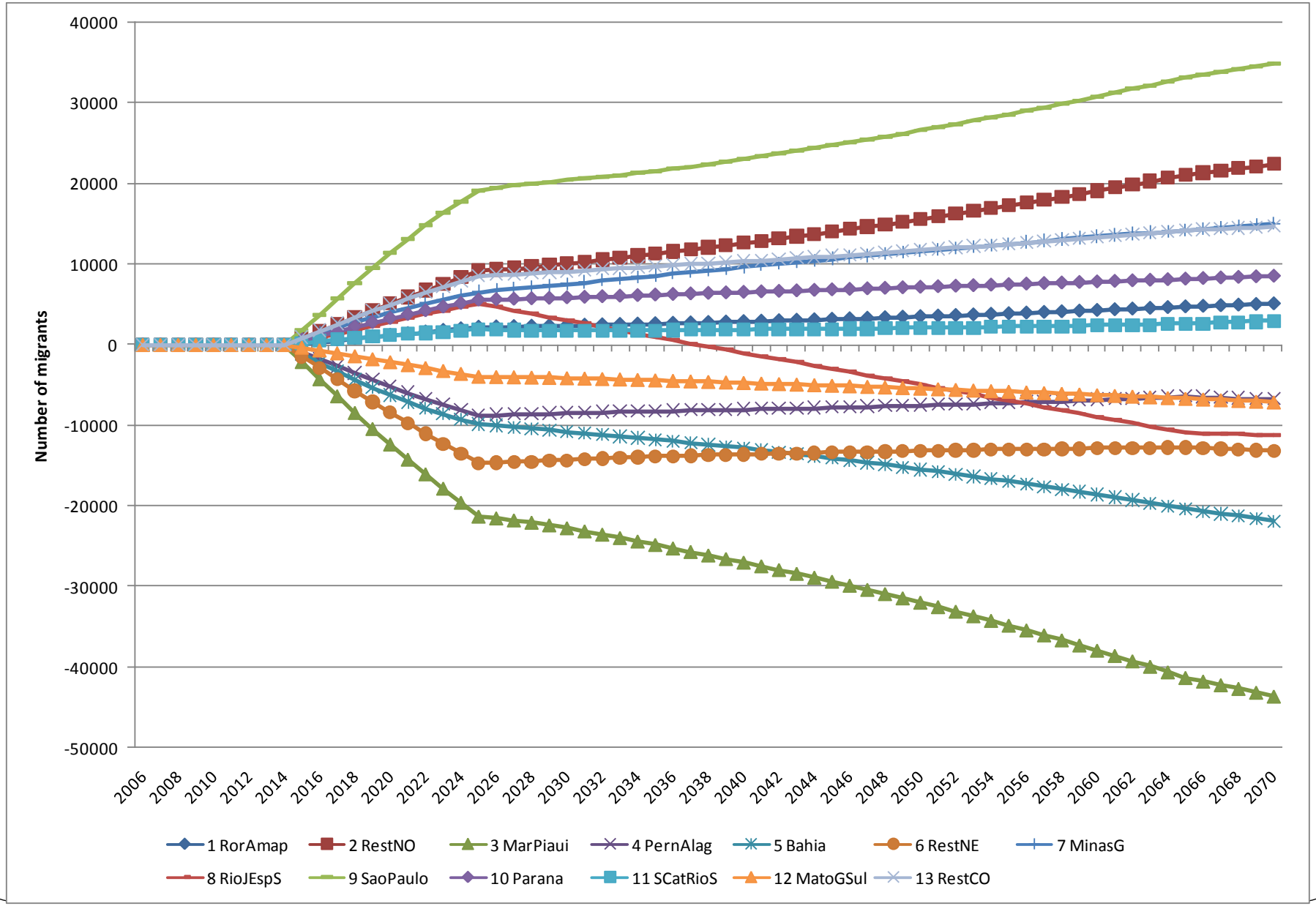
Migration by origin



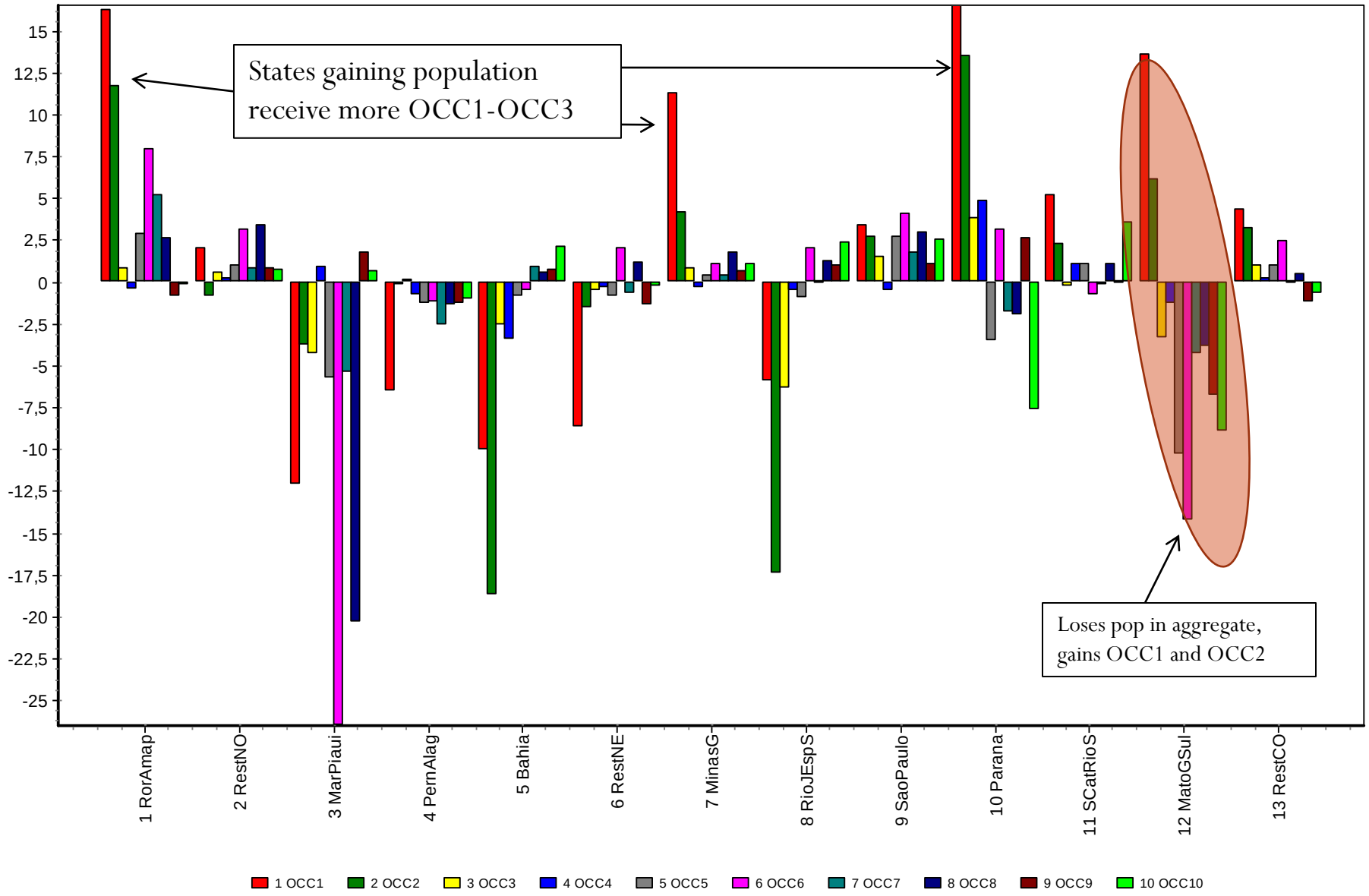
Migration by destination



Net migration by region



Migration by occupation and destination (accumulated, 2070, % change from baseline).



Conclusion

- Reversal of actual migration flows towards Southeast:
  - From Northeast (Maranhao and Piaui)
  - From Center-west (Mato Grosso do Sul)
- Less skilled workers would be the bulk of migrants.
- Migration towards the North regions (Amazon): pressure on natural resources in the region.
- Absolute number of migrants not very big.
- Limitations:
  - Migration function still under calibration through historical simulation.

- Thank you.

- Email: jbsferre@esalq.usp.br