The Geography of Manufacturing Productivity Shocks in Colombia

"International Workshop on Interregional Economic Modeling: Applications for the Colombian Economy"

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Research team

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Introduction

The objective of this study is to try to understand **how productivity shocks in the manufacturing sectors propagate across Colombian regions**

➢ Evaluate the impacts of 1% increase in productivity in the manufacturing sectors, classified according to their technological intensities, in each Colombian department

Mapping of regional TFP elasticities will bring additional insights to the understanding of the role regional-specific policies related to manufacturing activities play in the Colombian economy

➢ Regional equity vs. efficiency
➢ Regional competition vs. complementarity

Related literature

Impact of intersectoral and interregional trade linkages in propagating disaggregated productivity changes to the rest of the economy:

➢ Interregional CGE models (reviews): Rickmand and Patridge (1998), Haddad (2009), Gieseck and Madden (2013)

➢ Applications of the EK model (Eaton and Kortum, 2002) at the subnational level: Caliendo et al. (2018), Maggi and Haddad (2018)

Sectoral and regional classifications
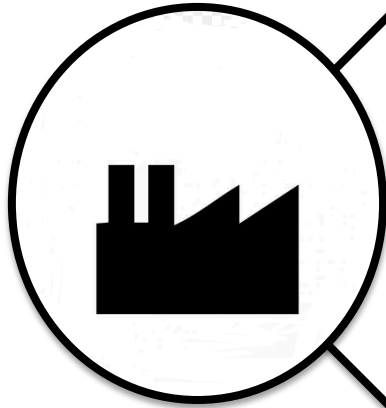
54 sectors, with 23 manufacturing sectors classified by technological intensity:
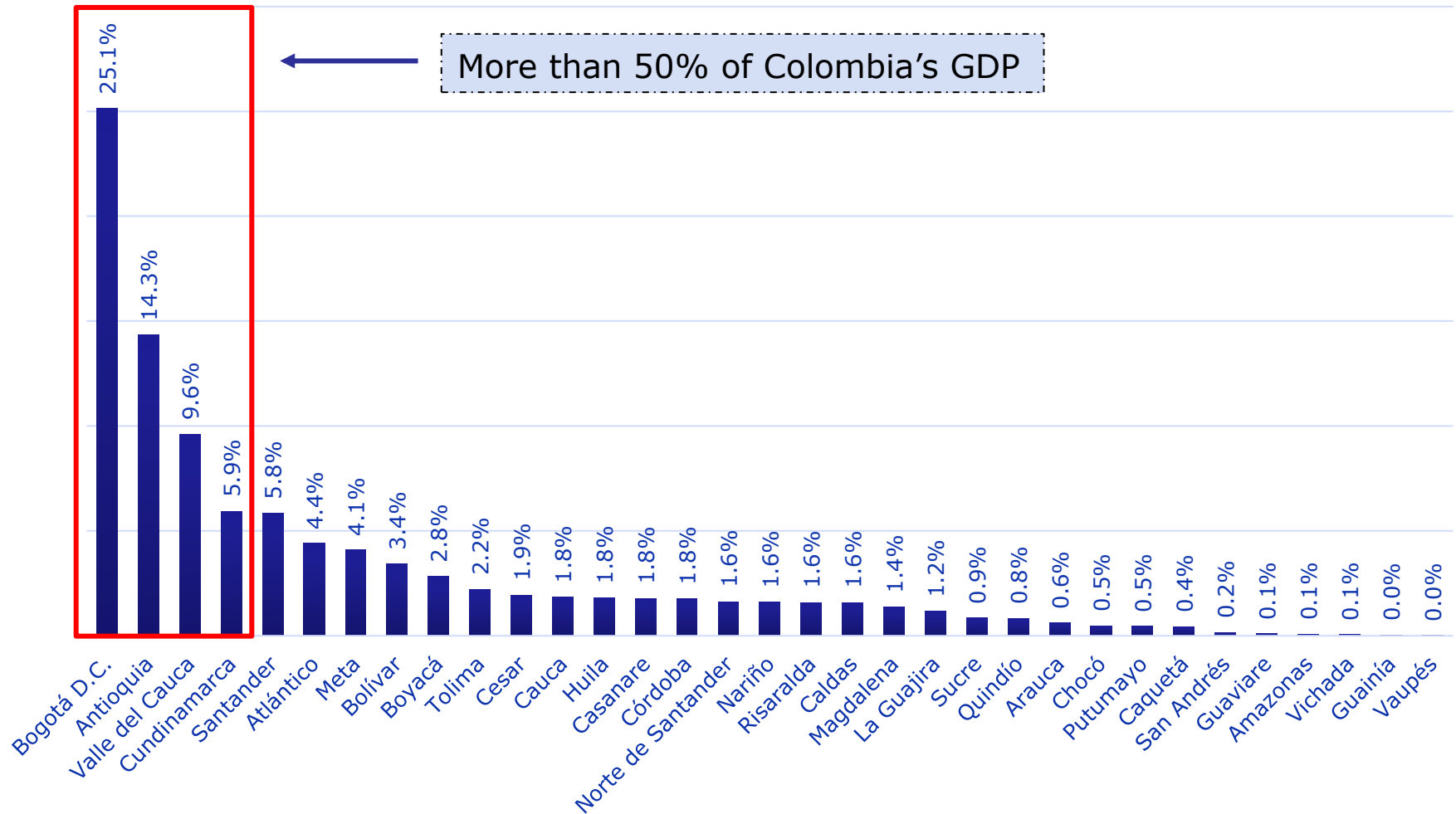
Low Technology Industry

Medium Technology Industry
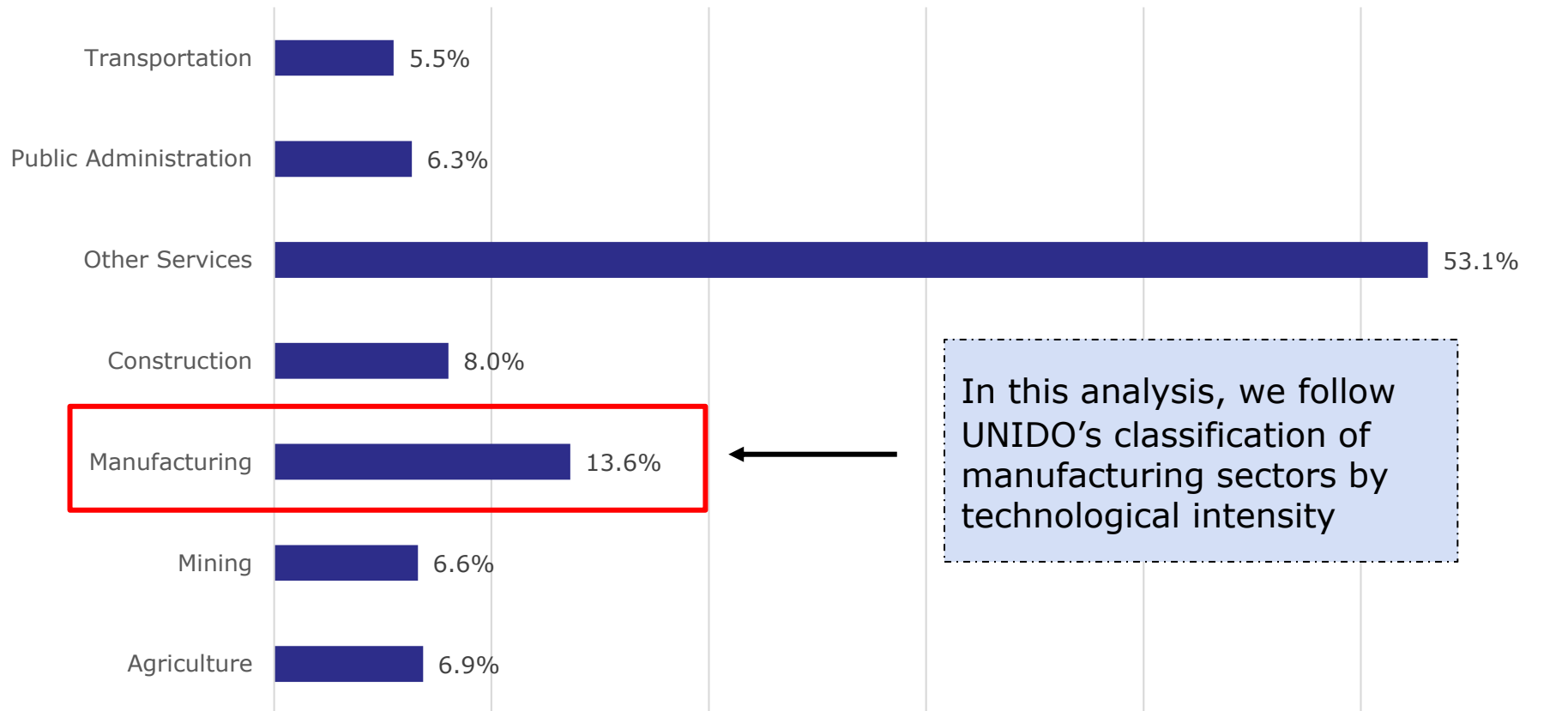
Medium and High Technology Industry

33 regions: Antioquia, Atlantico, Bogotá D.C., Bolívar, Boyacá, Caldas, Caquetá, Cauca, Cesar, Córdoba, Cundinamarca, Chocó, Huila, La Guajira, Magdalena, Meta, Nariño, Norte de Santander, Quindío, Risaralda, Santander, Sucre, Tolima, Valle del Cauca, Arauca, Casanara, Putumayo, San Andrés, Amazonas, Guainía, Guaviare, Vaupés and Vichada.

Regional distribution of GDP

More than 50% of Colombia's GDP

Region	GDP %
Bogotá D.C.	25.1%
Antioquia	14.3%
Valle del Cauca	9.6%
Cundinamarca	5.9%
Santander	5.8%
Atlántico	4.4%
Meta	4.1%
Bolívar	3.4%
Boyacá	2.8%
Tolima	2.2%
Cesar	1.9%
Cauca	1.8%
Huila	1.8%
Casanare	1.8%
Córdoba	1.8%
Norte de Santander	1.6%
Nariño	1.6%
Risaralda	1.6%
Caldas	1.6%
Magdalena	1.4%
La Guajira	1.2%
Sucre	0.9%
Quindío	0.8%
Arauca	0.6%
Chocó	0.5%
Putumayo	0.5%
Caquetá	0.4%
San Andrés	0.2%
Guaviare	0.1%
Amazonas	0.1%
Vichada	0.1%
Guainía	0.0%
Vaupés	0.0%

<u>Source</u>: MIP 2015

Sectoral distribution of GDP

Transportation — 5.5%
Public Administration — 6.3%
Other Services — 53.1%
Construction — 8.0%
Manufacturing — 13.6%
Mining — 6.6%
Agriculture — 6.9%

In this analysis, we follow UNIDO's classification of manufacturing sectors by technological intensity
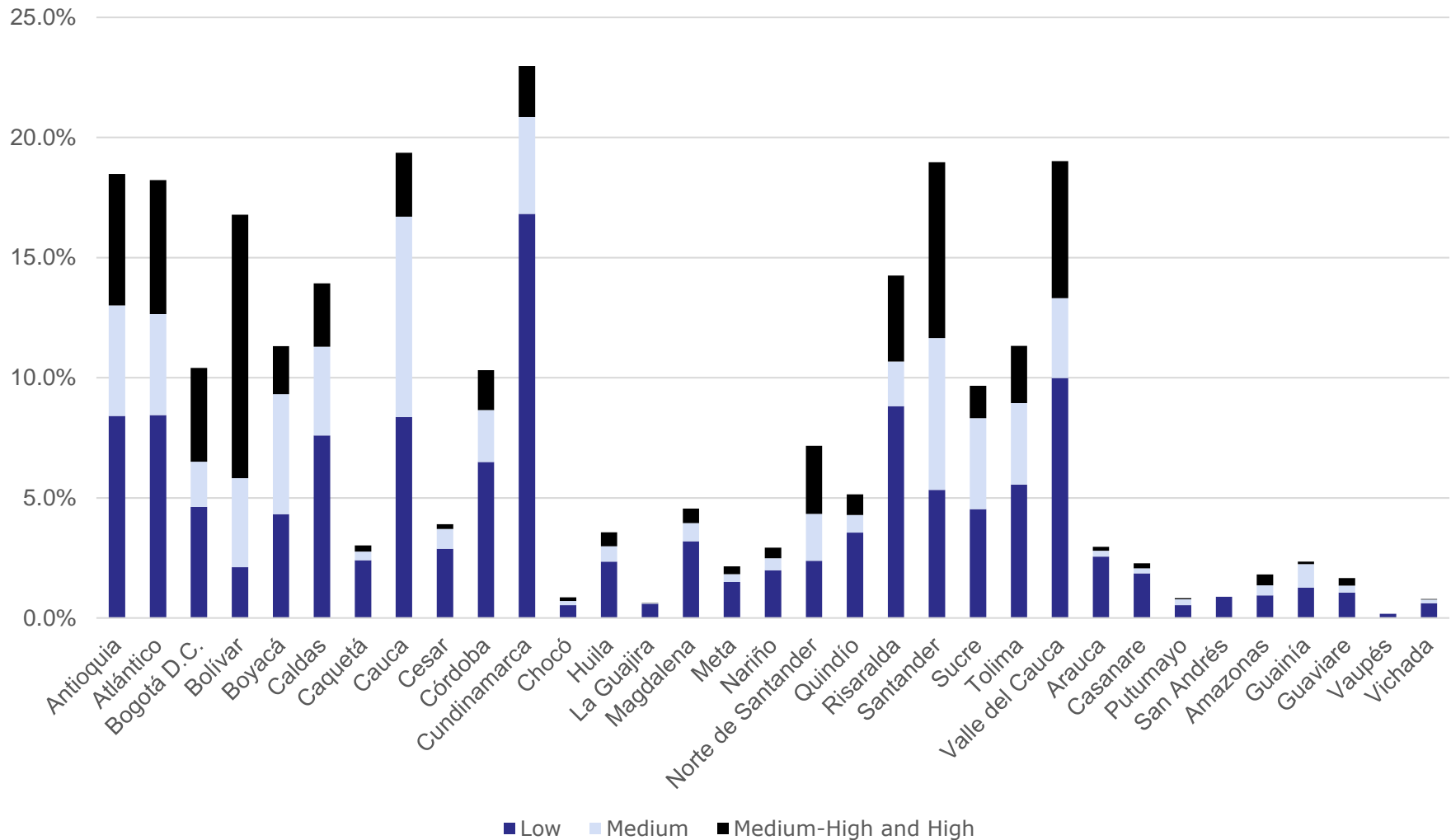
<u>Source</u>: MIP 2015

Manufacturing by technological intensity (% GDP)

The classification of industries by technological intensity (technology classification) is a widely applied method for grouping industries for the purpose of policy-relevant analysis
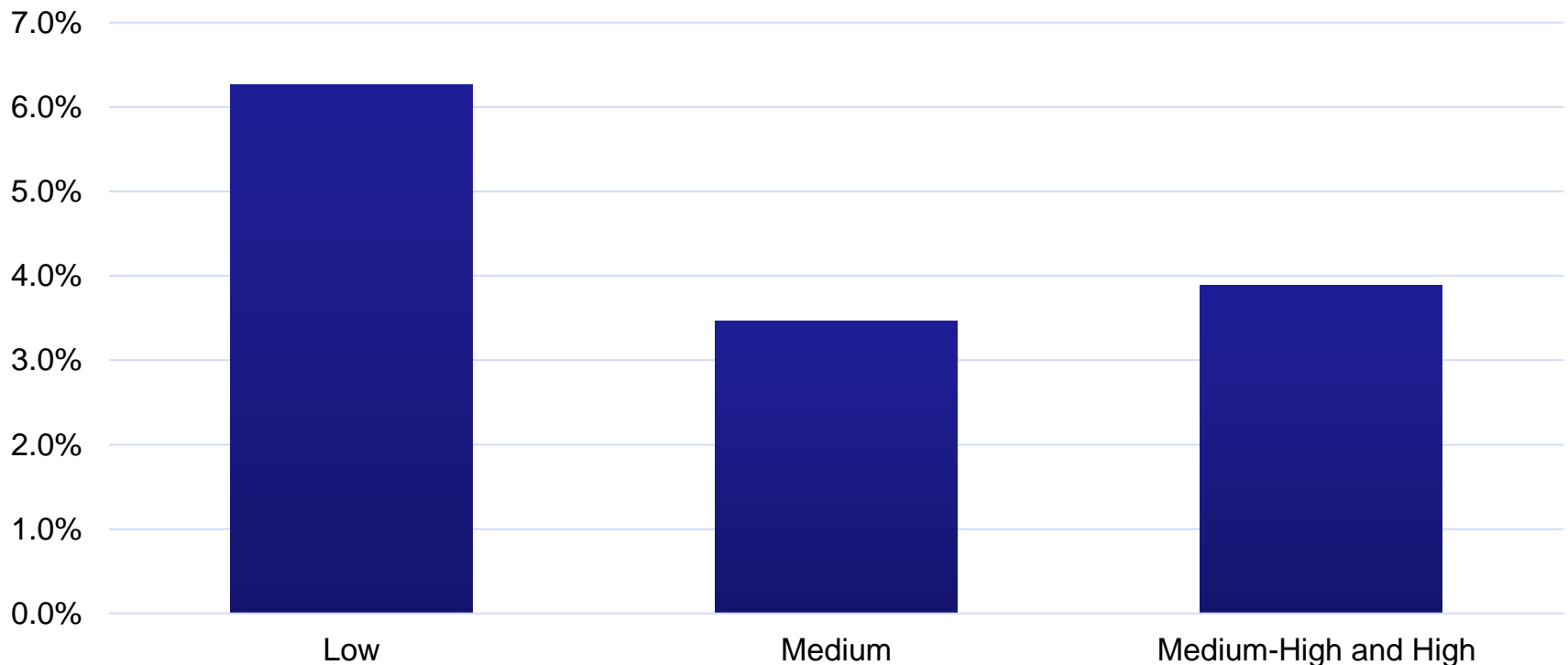
Composition of manufacturing GRP

Low   Medium   Medium-High and High

<u>Source</u>: MIP 2015

Manufacturing in Colombia (13.6% of GDP)

Low technology (6.3% of GDP)

Medium technology (3.5% of GDP)

Medium-high and high technology (3.8% of GDP)

Sectors	Capital requirements	Labor requirements
Low tech	64.6%	35.4%
Medium tech	71.5%	28.5%
High tech	68.3%	31.7%
Average	67.4%	32.6%

R-H backward and forward linkages
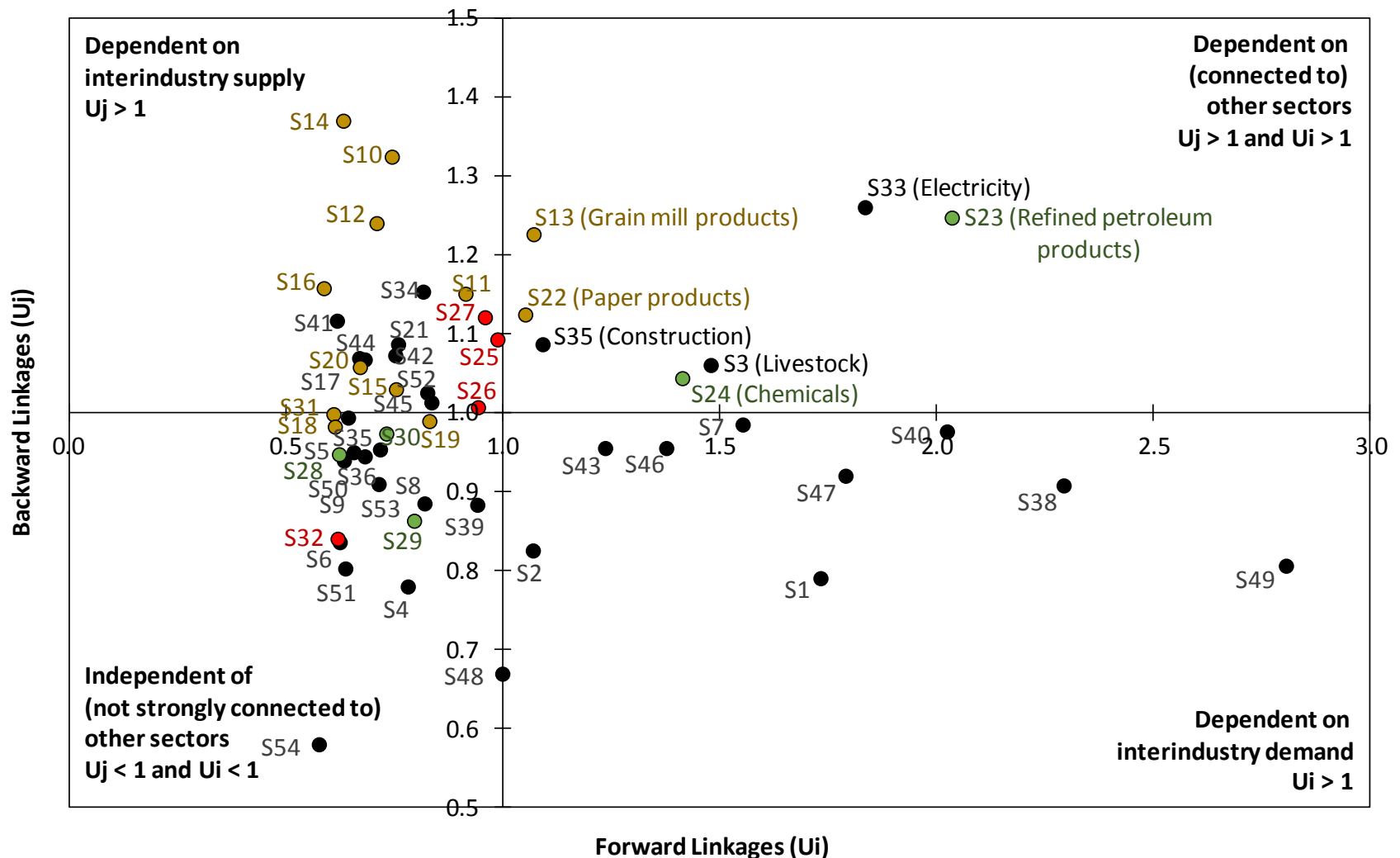
# Spatial patterns of manufacturing activities in Colombia

GDP

Low technology

Medium technology

High technology

Location Curves
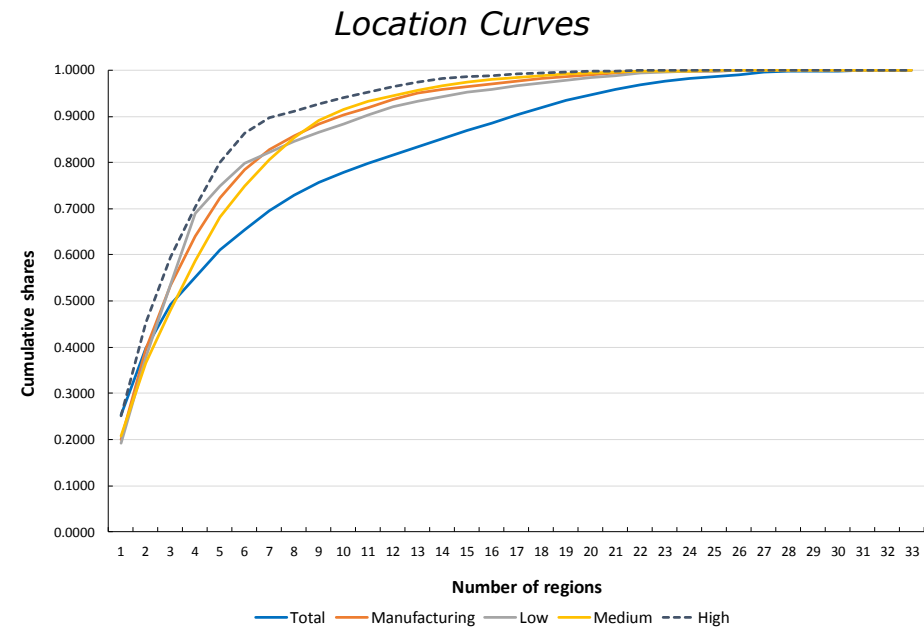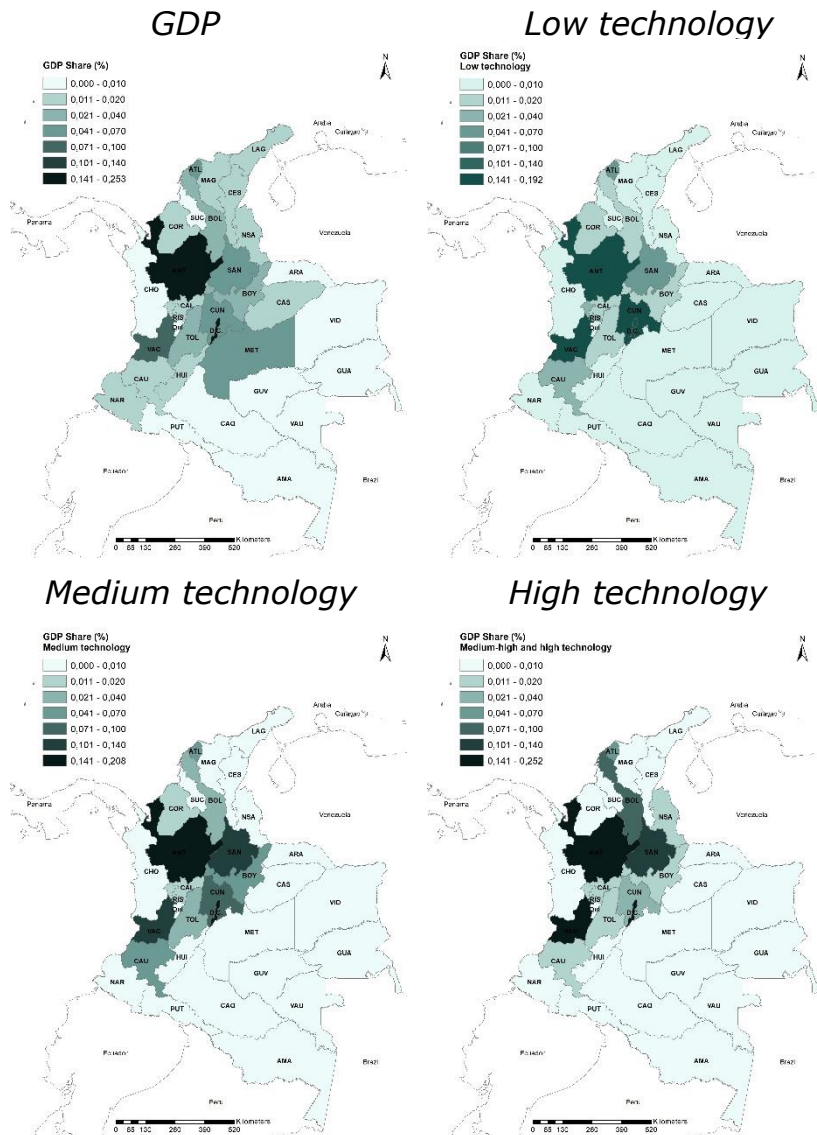
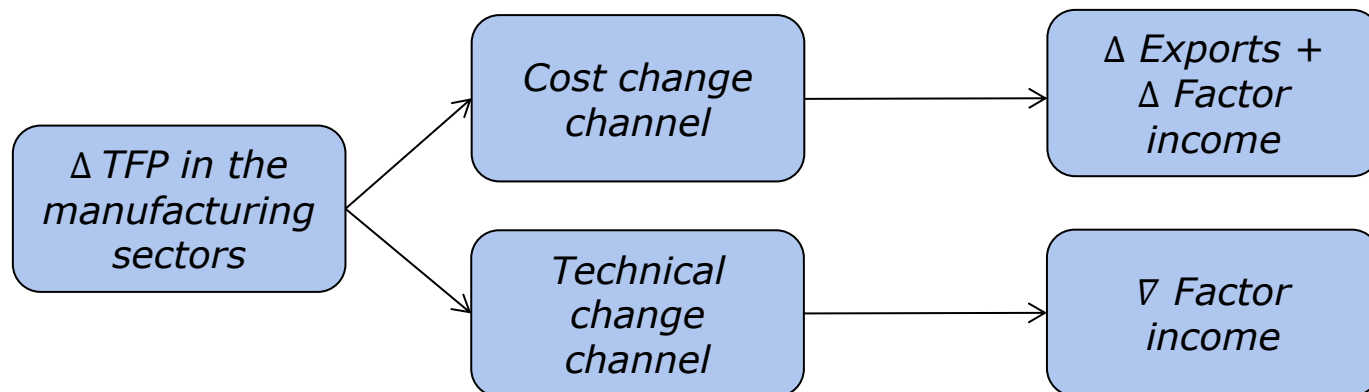| Department	GDP	Low	Medium	High
Bogotá D.C.	25%	20%	19%	16%
Antioquia	14%	20%	19%	21%
Valle del Cauca	10%	14%	15%	11%
TOTAL	49%	54%	53%	47%

Input-output network in Colombia
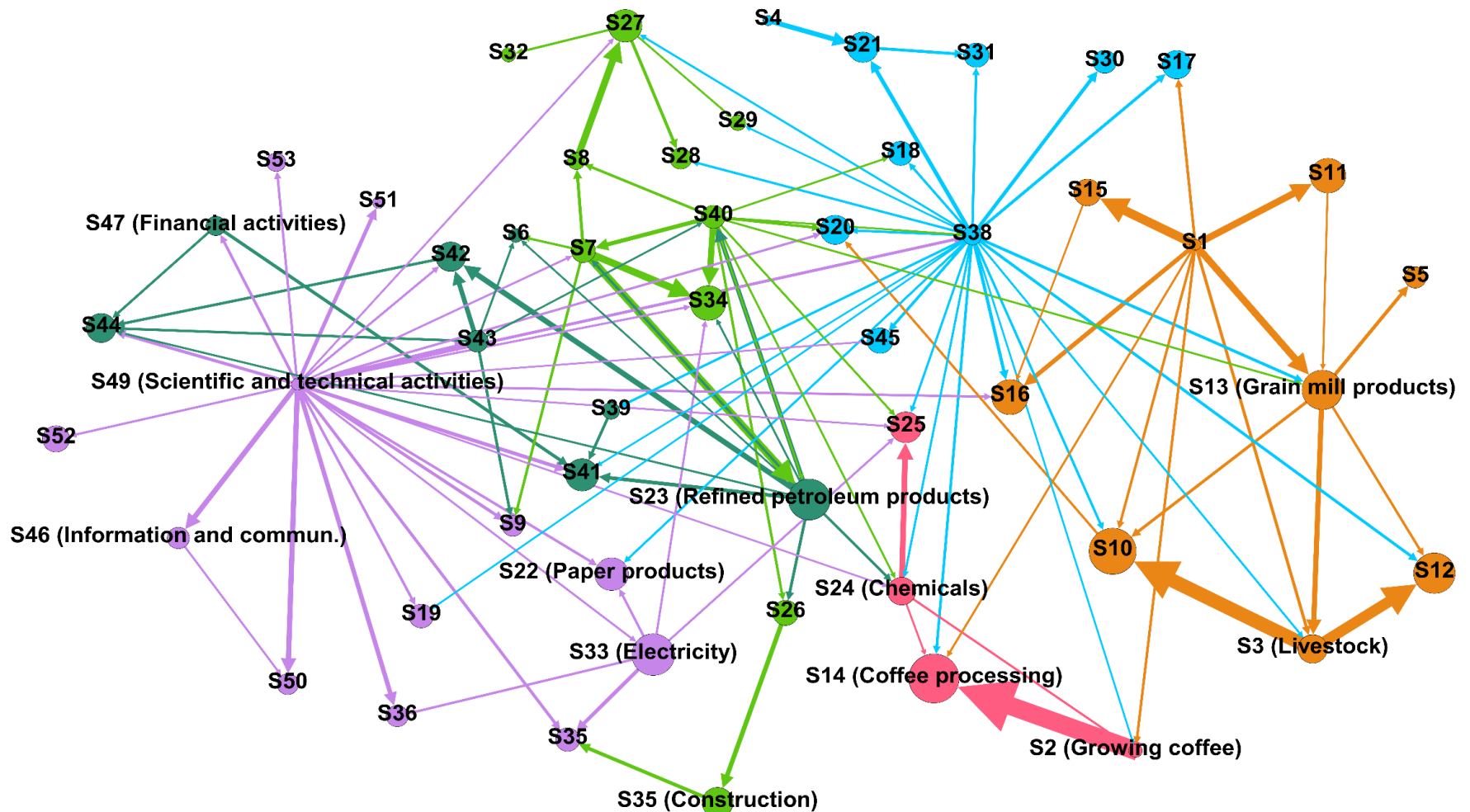
How do sectoral TFP changes in the manufacturing sectors propagate to the whole economy?
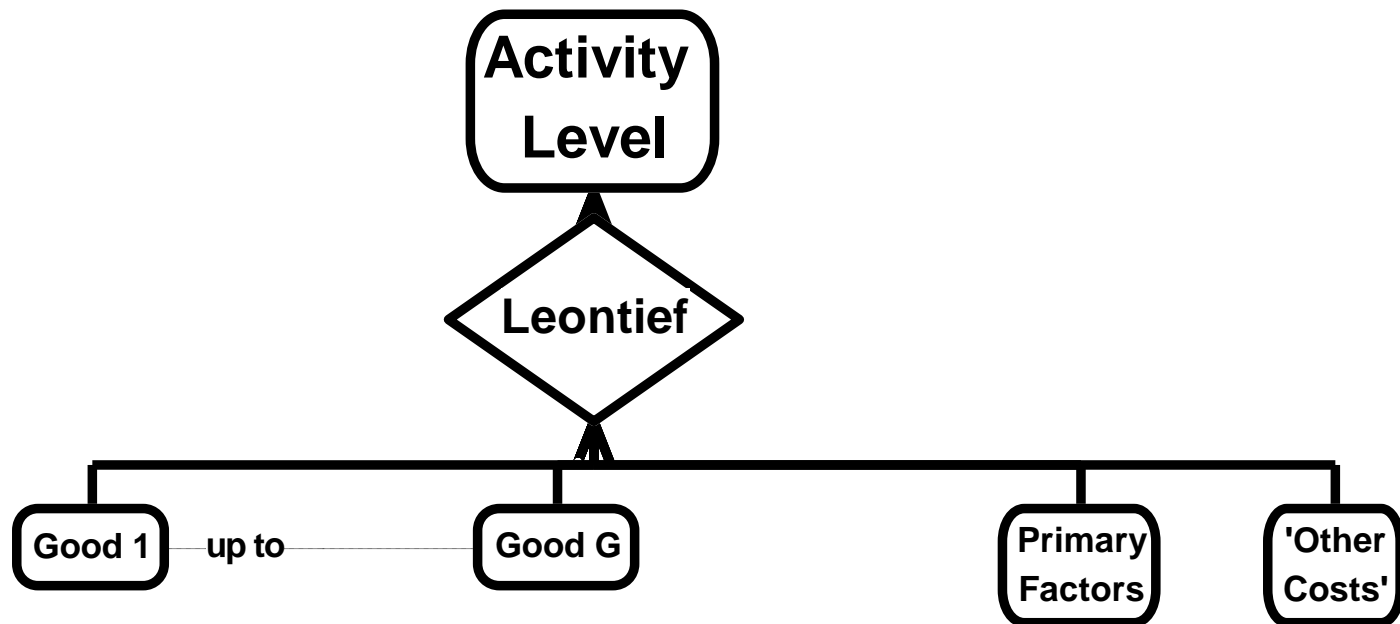
BM-COL CGE Model
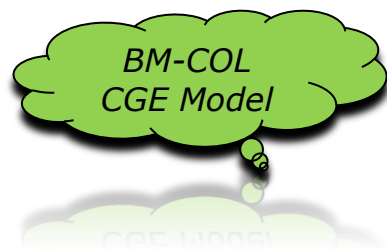
Exports effect relevant, provided relatively large share of sales to exports and/or to export sectors with sufficiently elastic export demand

Our approach:

Δ TFP in the manufacturing sectors → Cost change channel → Δ Exports + Δ Factor income

Δ TFP in the manufacturing sectors → Technical change channel → ∇ Factor income

Top nest of industry inputs

X1TOT(i) =
MIN(All,c,COM: X1_S(c,i)/[A1_S(c,s,i)*A1TOT(i)],
      X1PRIM(i)/[A1PRIM(i)*A1TOT(i)],
      X1OCT(i)/[A1OCT(i)*A1TOT(i)])

What if TFP in manufacturing increased by 1% across the country?

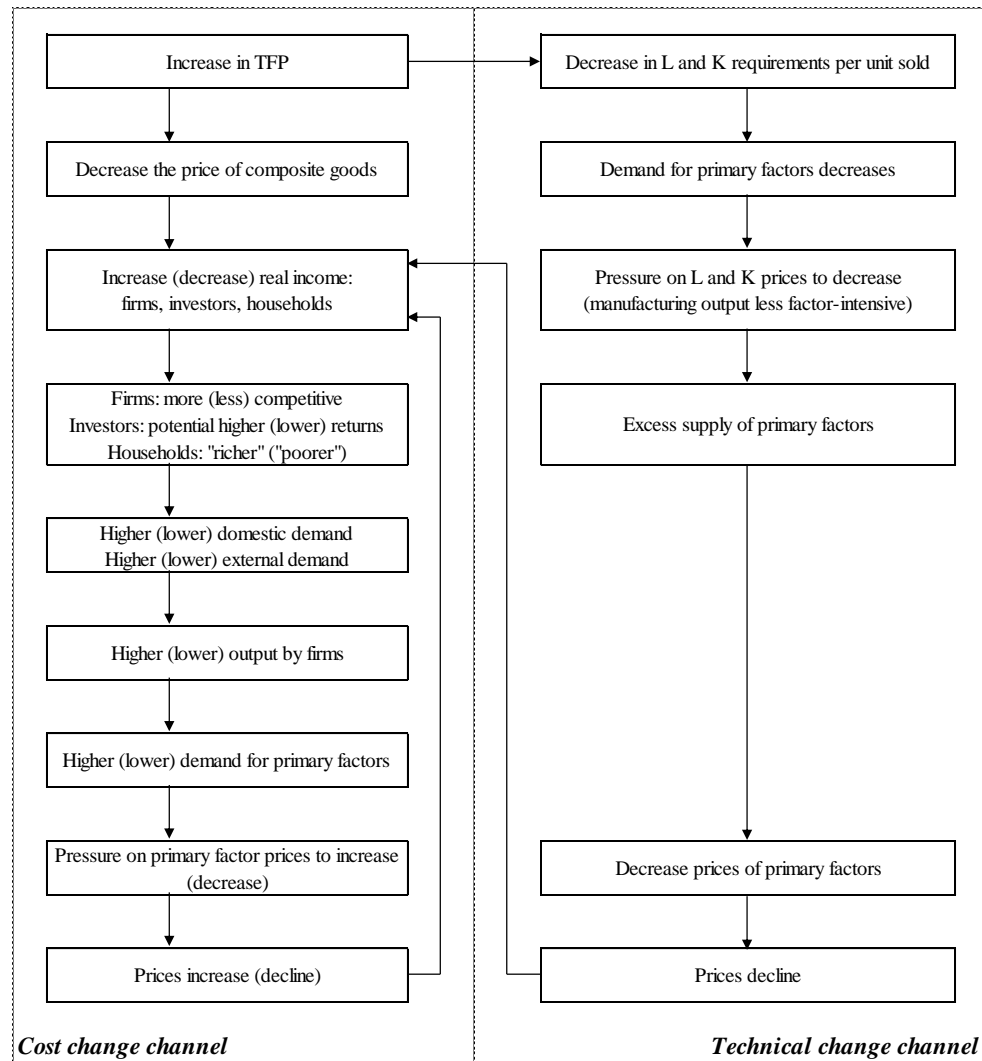***How do we implement TFP increase in manufacturing?***

Which industries affected?

Shock a1prim("S10",REGDEST) = uniform -1;
Shock a1prim("S11",REGDEST) = uniform -1;
(...)
Shock a1prim("S32",REGDEST) = uniform -1;

1% less primary inputs needed to produce same level of output

Productivity of primary inputs to production

Causal relations underlying the simulation results

Causation in short-run

Exogenous Endogenous

Real Wage → Employment

Tech Change

Capital Stocks → Rate of return on capital

GDP = HH Cons + Investment + GOV Cons + Trade balance

Follows factors income

Follows tax revenue
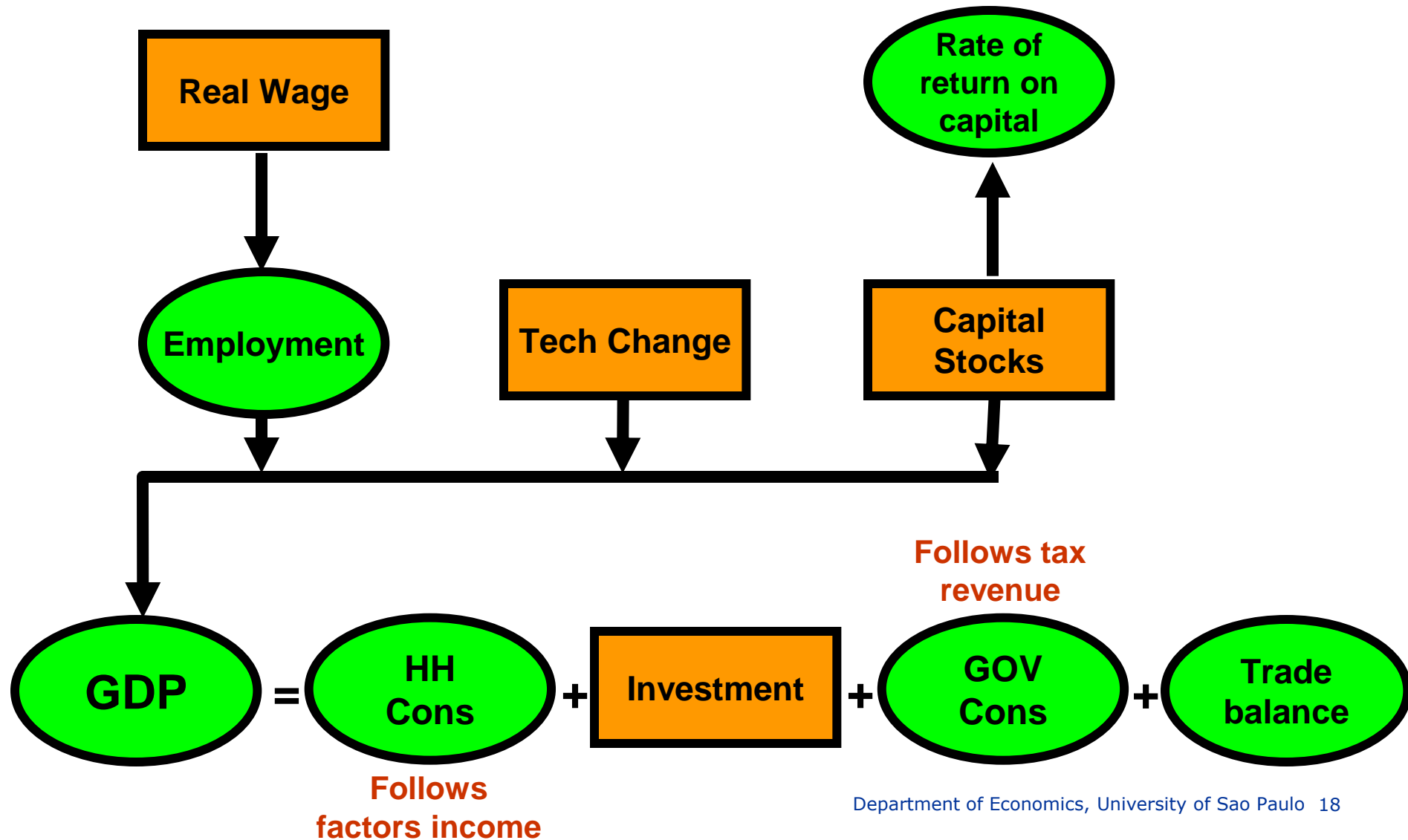
Macroeconomic effects (short-run)

-0.011

RoR

K **0**

A1TOT   L   *-0.009*

0.119   *0.018*   tax

-0.009   0   -0.034   0.324   -0.427

0.128   GDP = C + I + G + X-M   BOT/GDP

-0.006   0   -0.005   0.048   0.091
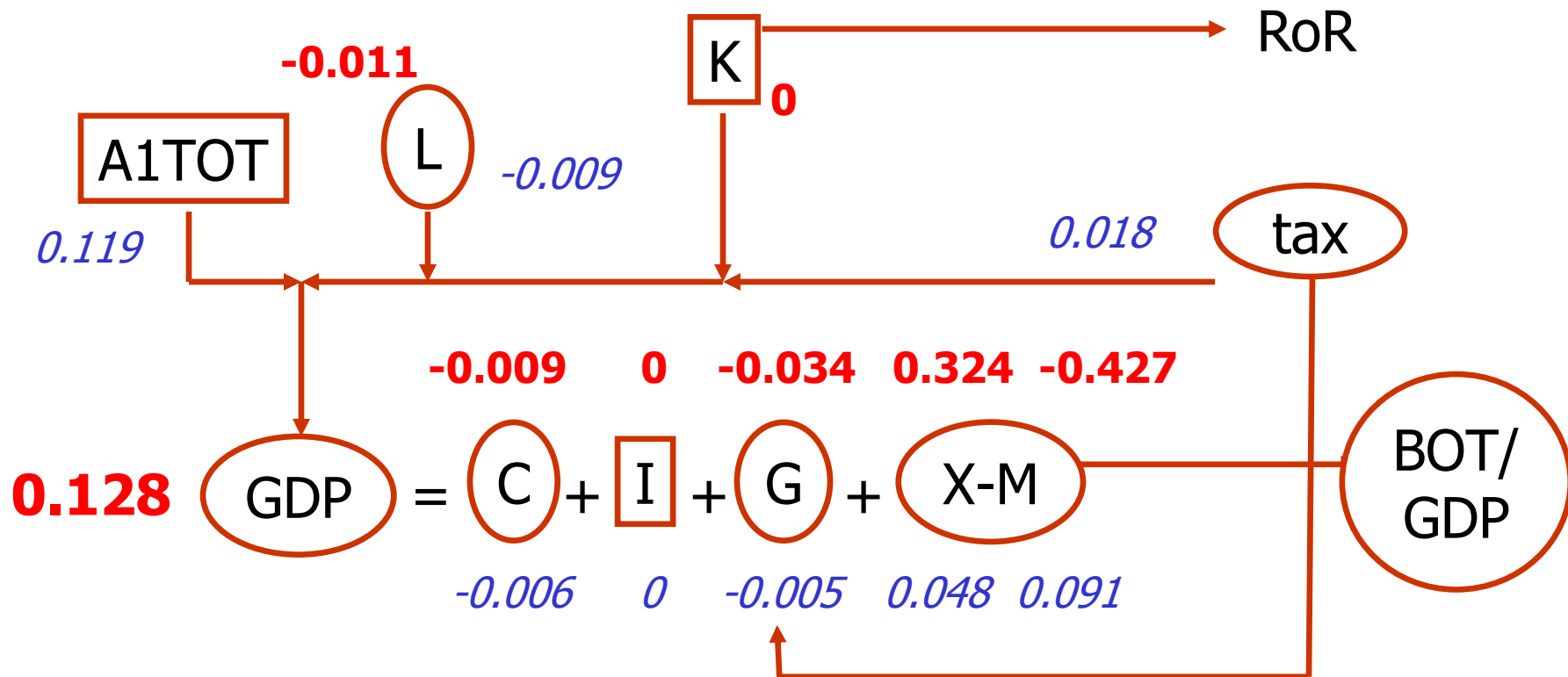
Endogenous

Exogenous

Percent Change
Contribution to %GDP

Causation in long-run closure

Macroeconomic effects (long-run)

Percent Change
Contribution to %GDP

Is there a regional equity-efficiency trade-off?

Empirical strategy: decomposition of simulation results into subtotals

3 groups of sectors (*i*) x 33 regions (*j*)= 99 subtotals

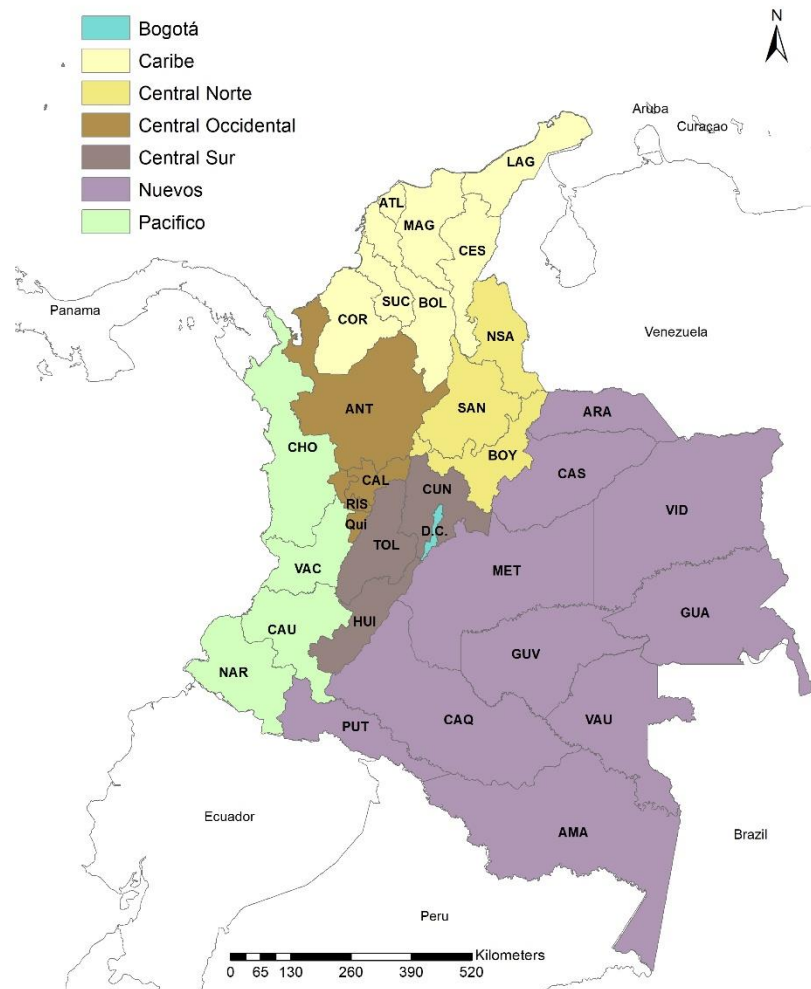General equilibrium model-consistent TFP-elasticities:

$$\varepsilon_{i,j} = \frac{\partial y_{i,j}}{\partial TFP_{i,j}} \cdot \frac{TFP_{i,j}}{y_{i,j}} = \frac{\partial y_{i,j}}{y_{i,j}} \cdot \frac{\partial TFP_{i,j}}{TFP_{i,j}} \Rightarrow \varepsilon_{i,j} \cong \frac{\Delta\% \ of \ y_{i,j}}{\Delta\% \ of \ TFP_{i,j}}$$

$y_{i,j}$: variables of interest (***real GDP*** ad $\boldsymbol{C_w}$)
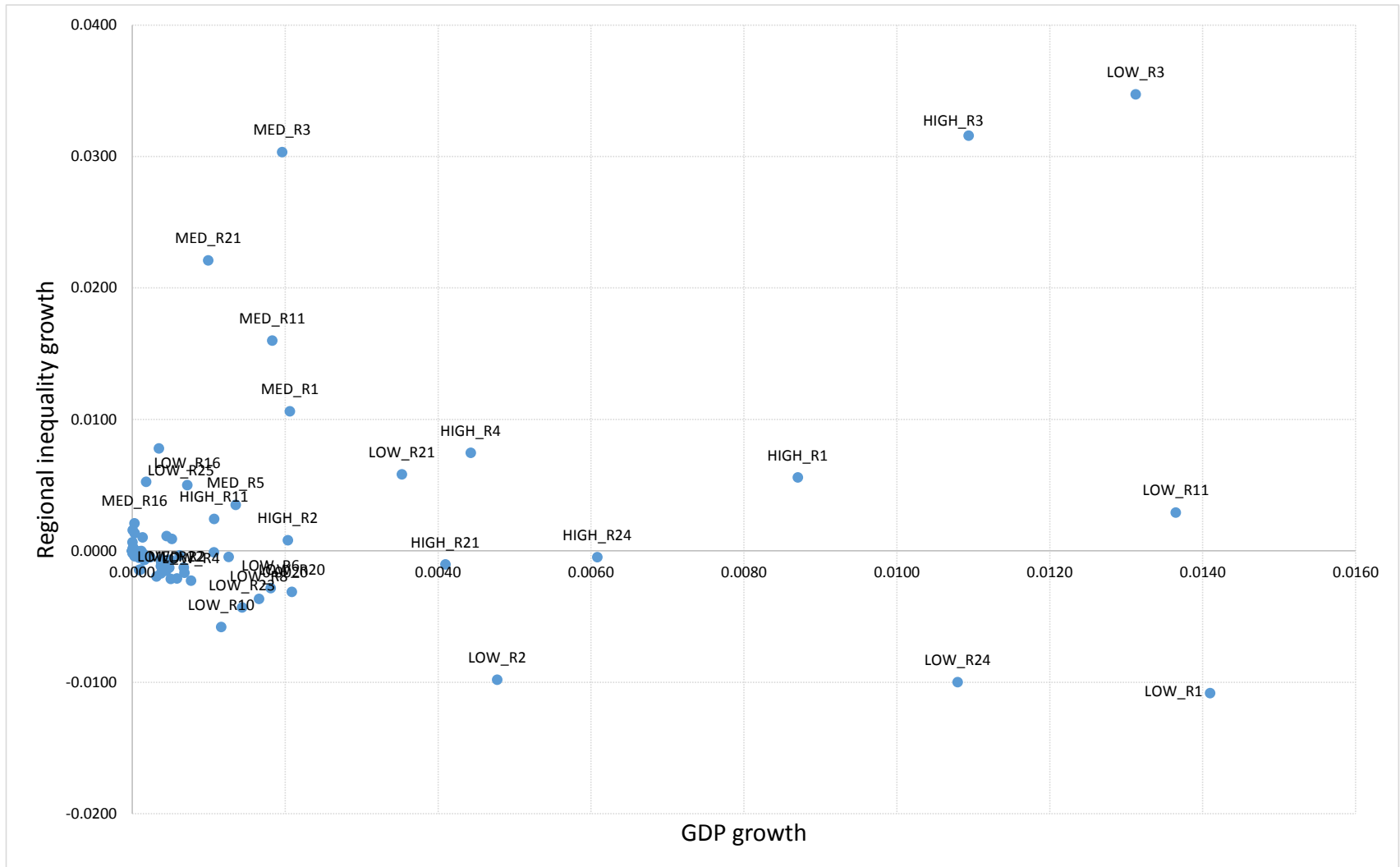
Endogenous variable
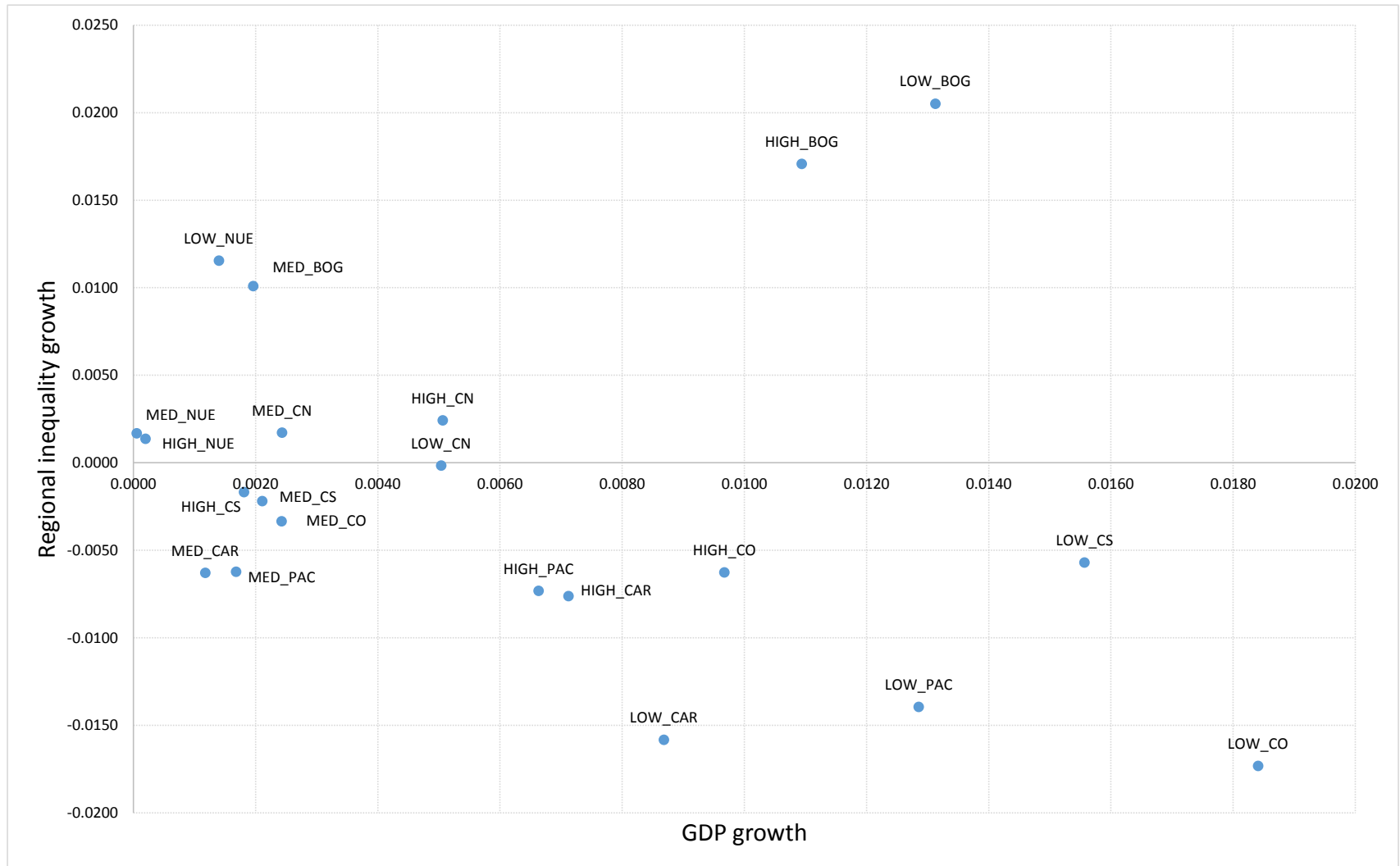
Exogenous shock
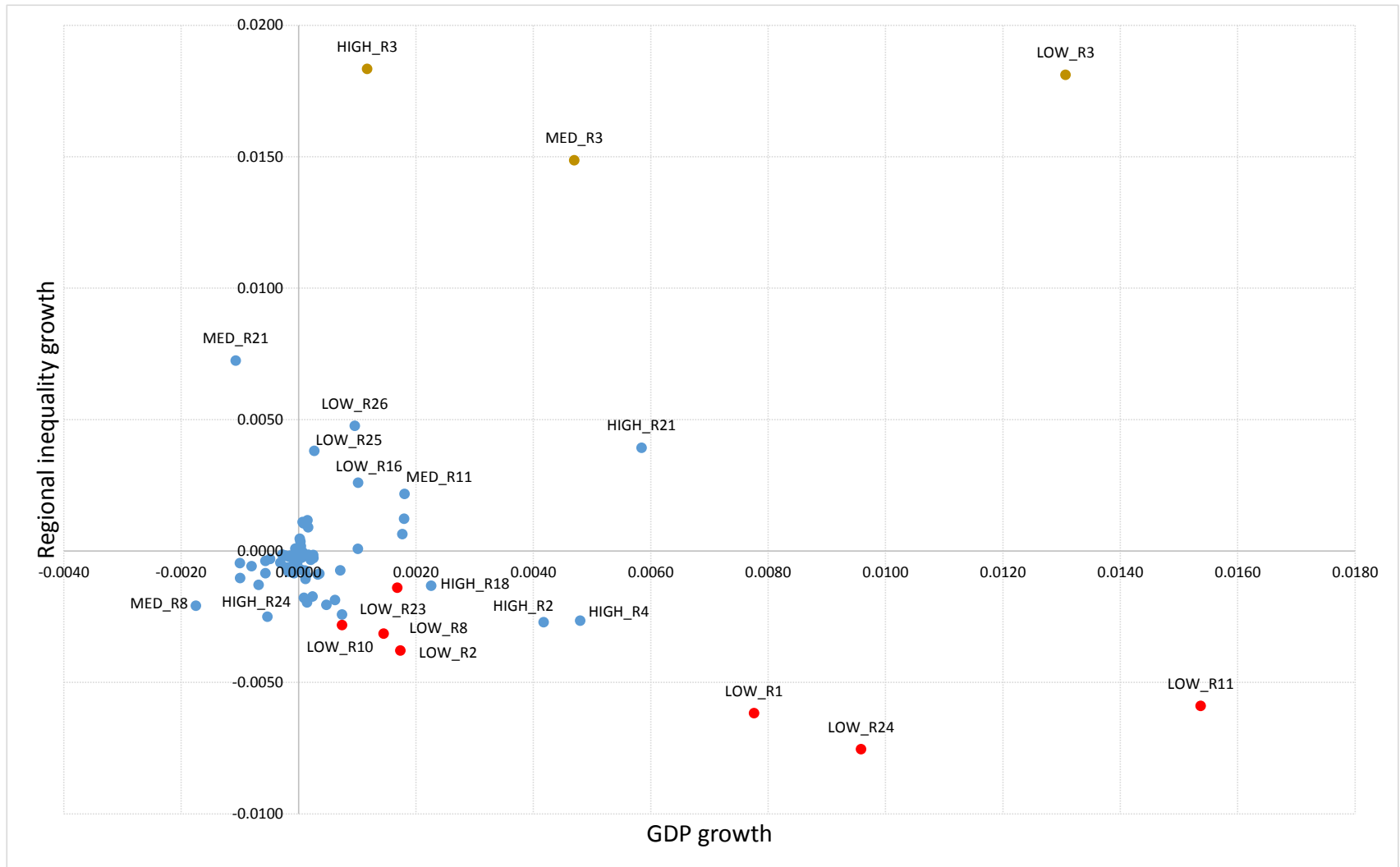
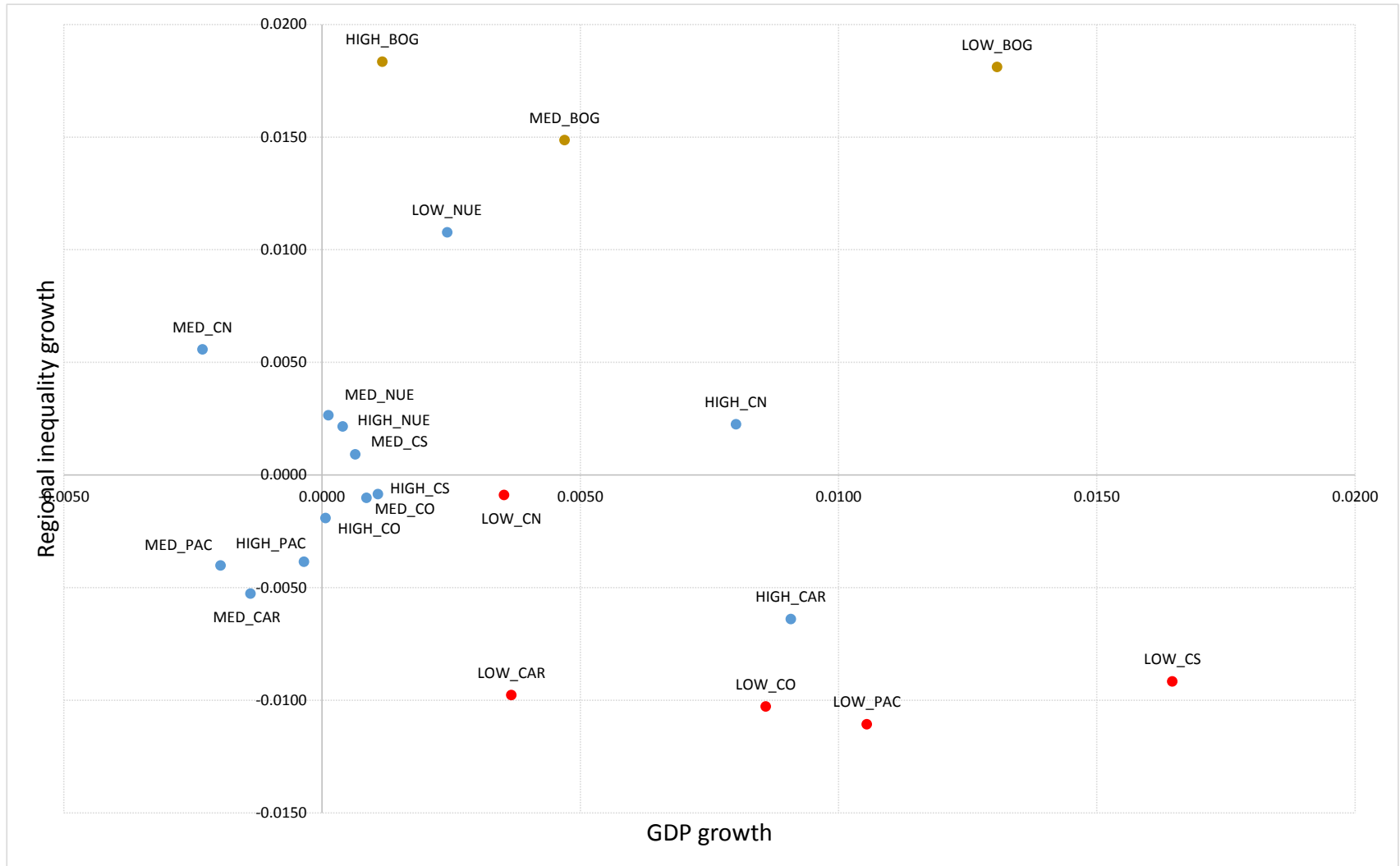# Regional aggregation

Regional equity *vs.* efficiency – SR

Regional equity *vs.* efficiency – SR

Regional equity *vs.* efficiency − LR

Regional equity *vs.* efficiency − LR

Regional competition *vs.* complementarity – SR

		Productivity shock in manufacturing (origin)						
		Bogotá	Caribe	Central Norte	Central Occidental	Central Sur	Nuevos	Pacifico
Effect on GRP	Bogotá	+	-	-	-	+	-	-
	Caribe	-	+	-	-	+	-	+
	Central Norte	-	-	+	-	-	+	-
	Central Occidental	-	-	-	+	-	-	-
	Central Sur	+	-	-	-	+	-	-
	Nuevos	+	+	+	+	+	+	+
	Pacifico	-	-	-	-	+	-	+

Regional competition *vs.* complementarity − LR

	Productivity shock in manufacturing (origin)						
Effect on GRP		Bogotá	Caribe	Central Norte	Central Occidental	Central Sur	Nuevos	Pacifico
	Bogotá	+	-	-	-	+	+	-
	Caribe	-	+	-	-	-	+	-
	Central Norte	-	-	+	-	-	+	-
	Central Occidental	-	-	-	+	-	-	-
	Central Sur	+	-	-	-	+	-	-
	Nuevos	+	+	+	+	+	+	+
	Pacifico	-	-	-	-	-	+	+

Next steps (room for collaboration)

Calculate the implicit TFP elasticities for a broader range of sectors, analyzing their implications for national and regional output growth in the long run

Map the potential outcome of TFP-enhancing policies

- Visualization techniques

Check sensitivity of model's results to different closures (e.g. short run vs. long run)

"Reach the planner": develop a simple tool for helping policymakers in the decision-making process (e.g. Excel-based simulator using results from a large number of CGE simulations)

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