WORKSHOP ON MACROECONOMICS AND DEVELOPMENT

Regional and state heterogeneity of monetary shocks in Argentina

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* The views and opinions expressed in this presentation are those of the authors and do not necessarily reflect the official policy or position of the agencies they represent.

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Motivation

- Macroeconomic policies are set at **national level**
  - Homogeneous (centralized) and "*blind*" [i.e. Monetary policy]
  - Other [i.e. fiscal policy, financial regulation] can be focused at regional level (place-based).
- **Impact** may be **heterogeneous** (asymmetric) at regional level.
- **How regional economic activity in Argentina responds to monetary policy shocks.**
  - Carlino, G. y DeFina, R. (1998) asymmetric effects of monetary policy in the US.

Model

- We want to analyze the impact of an interest rate shock in each spatial unit
- The impact may be **spatially dependent** and **heterogeneous**
  - differences among spatial units (spatial heterogeneity).
  - impact in a given spatial unit relates to the impact on other spatial units (spatial dependence).
- A conventional VAR has a dimention problem when adding spatial units.

Model – Spatial Structural Var

- **Structural VAR (SVAR)** model with temporal and spatial lags.
- We follow the model by Di Giacinto (2003), Berthana and Haddad (2008)
- Add spatial information in the model (spatial econometrics).
- Spatial SVAR innovation: the *contiguity matrix*.
  - Metric of the relationship (i.e. distances) between geographical units.
  - Any spatial unit directly/indirectly affected by any other unit.
  - Potential effects from commercial, financial, productive and social (migration) relationships.

Model - Variables

- **Macro variables**: $\mathbf{x}_t = [p_t, e_t, g_t]'$ where p_t is CPI inflation (in log differences), e_t is USD/peso exchange rate (in log differences) and g_t is GDP (in log differences, seasonally adjusted).
- **Spatial variables**: $\mathbf{y}_t = [y_{1t}, y_{2t}, \ldots, y_{Nt}]'$ is total formal employment in the N units. The N spatial units are spatially correlated.
- **Interest rate** (monetary policy variable): r_t, 30-59 days term deposits rate.
- Then let $\mathbf{z}_t = [\mathbf{x}_t', \mathbf{y}_t', r_t]'$.

Model - Spatial Structural Var

- **Spatial structural Var** has the following expression

$$\mathbf{C}_0\mathbf{z}_t = \mathbf{C}_1\mathbf{z}_{t-1} + \ldots + \mathbf{C}_p\mathbf{z}_{t-p} + \mathbf{u}_t$$

- Where $\mathbf{u}_t = [u_{1t}^x, u_{1t}^y, \ldots, u_{Nt}^y, u_t^r]$ is an orthogonal multivariate white-noise series, i.e.,

$$E(u_t) = 0,\ E(u_t u'_{t-h}) = \Omega = diag([\sigma_{x1}^2, \sigma_{y1}^2, \ldots, \sigma_{yN}^2, \sigma_r^2]')\ \text{if}\ h = 0$$

- And $E(u_t u'_{t-h}) = 0$ otherwise for $h = (0, 1, \ldots, p)$.
- We set p=2, two lags.

Model - Spatial Structural Var

- The $\mathbf{C}_0$ matrix has the following **block triangular** structure:

$$\mathbf{C}_0 = \begin{bmatrix} \mathbf{I}_3 & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{C}_0^{yy} & \mathbf{0} \\ -\mathbf{C}_0^{rx} & -\mathbf{C}_0^{ry} & 1 \end{bmatrix}$$

- $\mathbf{C}_0^{rx}$ is a (1x 3) vector of unrestricted coefficients relating macro variables.
- $\mathbf{C}_0^{ry}$ is a scalar. Then, $\mathbf{C}_0^{ry} = \mathbf{a}_0^{ry}\omega'$
- Where a_0^{ry} is a scalar parameter to be estimated and ω is a vector of *Nx1*.

Model - Spatial Structural Var

- We follow Berthana and Haddad (2008) for defining the weights vector ω,

$$\omega' = (\omega_1, \omega_2, \ldots, \omega_N)$$

- With $\omega_j = \frac{\sum_{t=1}^{T} (TotEmp_{jt} / NatEmp_t)}{T}$ where $TotEmp_{jt}$ is the total employment in spatial unit *j* at time *t* and $NatEmp_t = \sum_{n=1}^{N} (TotEmp_{nt})$ is the total employment at national level at time *t*.
- The weight of each spatial unit is thus given by its relative importance in terms of national employment.

Model - Spatial Structural Var

- The $\mathbf{C}_0^{yy}$ matrix models simultaneous spatial interdependence by the following structure

$$\mathbf{C}_0^{yy} = \mathbf{I}_N - \phi_0 W,$$

Where $\phi_0 = diag([\phi_0^1, \phi_0^2, \ldots, \phi_0^N]')$ and W is the $N \times N$ spatial weights matrix with typical element $w(i,j) > 0$ if locations i and j are contiguous (in a broad sense) and $w(i,j) = 0$ elsewhere and if $i = j$.

- Spatial interdependence reduces the number of parameters to be estimated.

Model - Spatial Structural Var

- Two types of restriction are imposed on the $\mathbf{c}_h$ matrices.

- Spatial restrictions are imposed on blocks $\mathbf{c}_h^{yy}$ that have structure,

$$\mathbf{c}_h^{yy} = \phi_h W$$

where $\phi_h = diag([\phi_h^1, \phi_h^2, \ldots, \phi_h^N]')$

- Coefficients $\mathbf{c}_h^{xy}$ and $\mathbf{c}_h^{ry}$ relating the macro variables and the monetary instrument to past values of the spatial output series are constrained as follows

$$\mathbf{c}_h^{xy} = \mathbf{a}_h^{xy} \omega'$$
$$\mathbf{c}_h^{ry} = \mathbf{a}_h^{ry} \omega'$$

- All remaining blocks are left unrestricted.

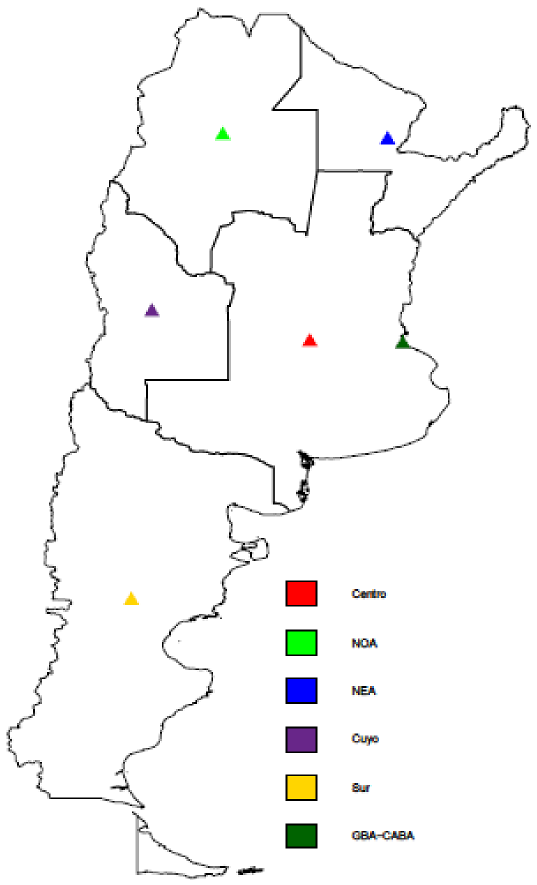
Model - Spatial Structural Var

- Di Giacinto (2003) derives consistent estimators of model parameters applying *Full Information Maximum Likelihood method*.
- We estimate three different models:
  - Aggregate (national-level) SVAR model ignoring spatial heterogeneity. [Christiano et al. (1996)].
  - ***State Model (SM)*** that considers *N = 24* spatial units given by the 23 states plus a conglomerate formed by CABA and GBA.
    - *SM* is a *Queen type* contiguity matrix, that is, two states are considered neighbors if they have a common border.
  - ***Regional Model (RM)*** that considers *N* = 6 spatial units given by 5 regions (Centro, NEA, NOA, Cuyo, Sur) plus CABA - GBA.
    - RM with a distance based contiguity matrix (centroids).

Model – Data - Regions

- Quarterly regional/ state (provincial) formal employment
- Macroeconomic variables
  - GDP
  - Inflation rate
  - Exchange rate
  - Interest rate
- From third quarter 2003 to first quarter 2017, T = 55 observations.

Figure 1: Regions of Argentina



Impulse response functions

- Impulse response functions (IRFs) from a unit shock (i.e., 1% increase in the interest rate) in u_t^r on the y_t regional variables (i.e., regional employment).
- Effect at **provincial/regional level of an aggregate monetary shock (tightening of the monetary policy)**.
- We compute bootstrap standard errors of all parameter estimates. IRFs analysis is evaluated using 20% confidence intervals.

Main results – regional & aggregate

- There is **heterogeneity** in the regional (or provincial) reaction function to the impact of an interest rate shock.
- At aggregate level and regional level, the effects are **negative**, **heterogeneous** and **significant.**
  - Except for the NEA region (not statistically significant).
- SUR and CUYO are the most affected by monetary shocks.
- The impact on the aggregate model for Argentina (no spatial adjustment) is similar to CABA and GBA regions.

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Figure 2: FIR's for non-spatial and regional model

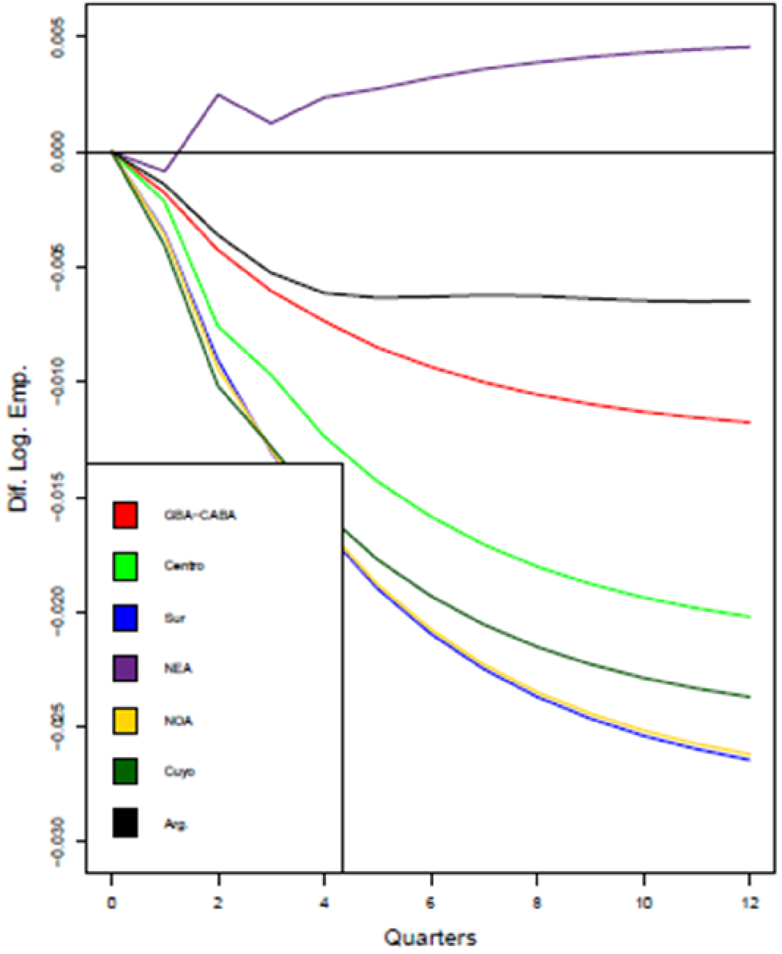
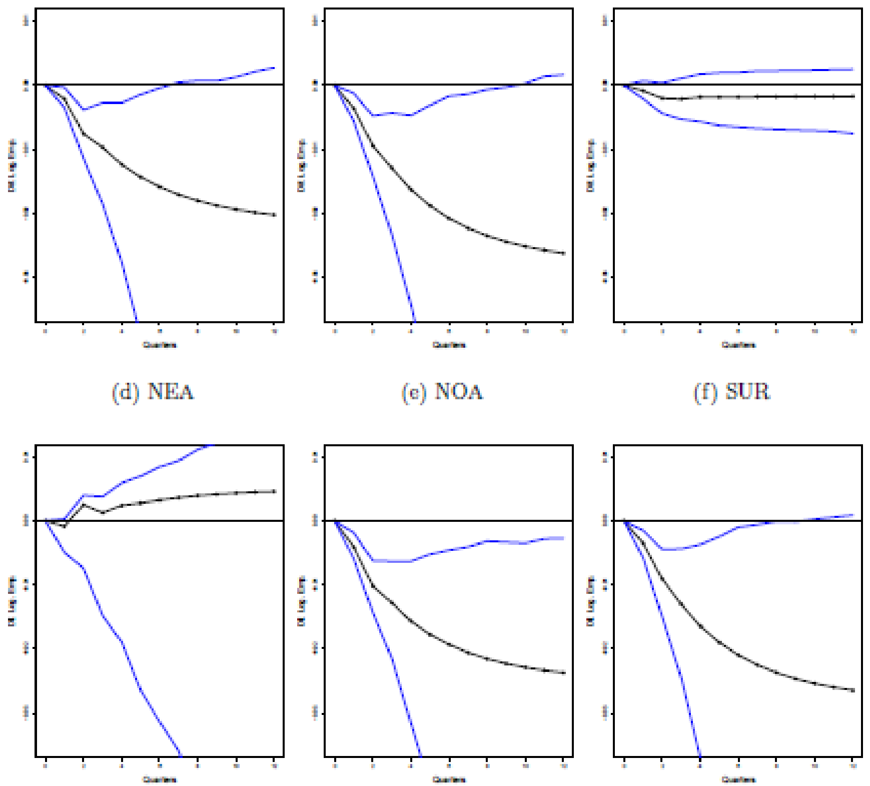


Figure 3: IRFs by Regions

(a) Centro (b) Cuyo (c) GBA-CABA

(d) NEA (e) NOA (f) SUR



Main results - provinces

- **11 provinces show a negative** and **significant** IRFs.
- All the effects are **negative in the short and long term**, except for Neuquén, Santiago del Estero and Tierra del Fuego.
- The rest of the provinces, including GBA-CABA and Buenos Aires (without GBA) do not show results significantly different from zero.
  - Note: limited time scope of our database [these two regions have a significant participation in total employment]

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Figure 4: IRFs by States

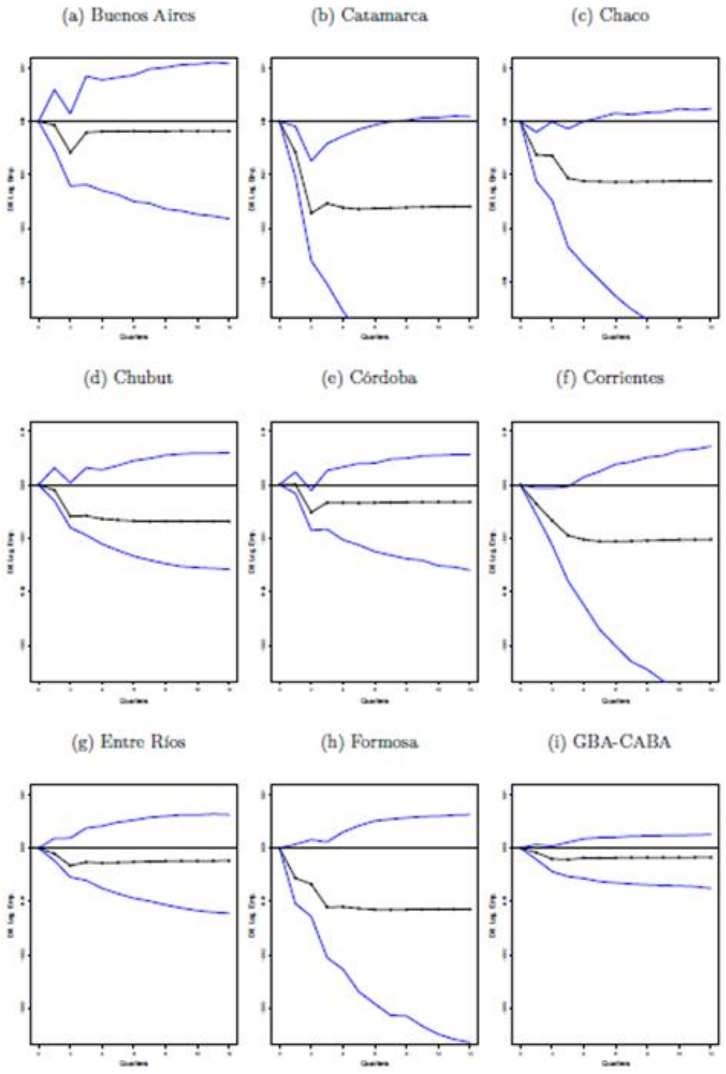

Figure 5: IRFs by States (cont.)

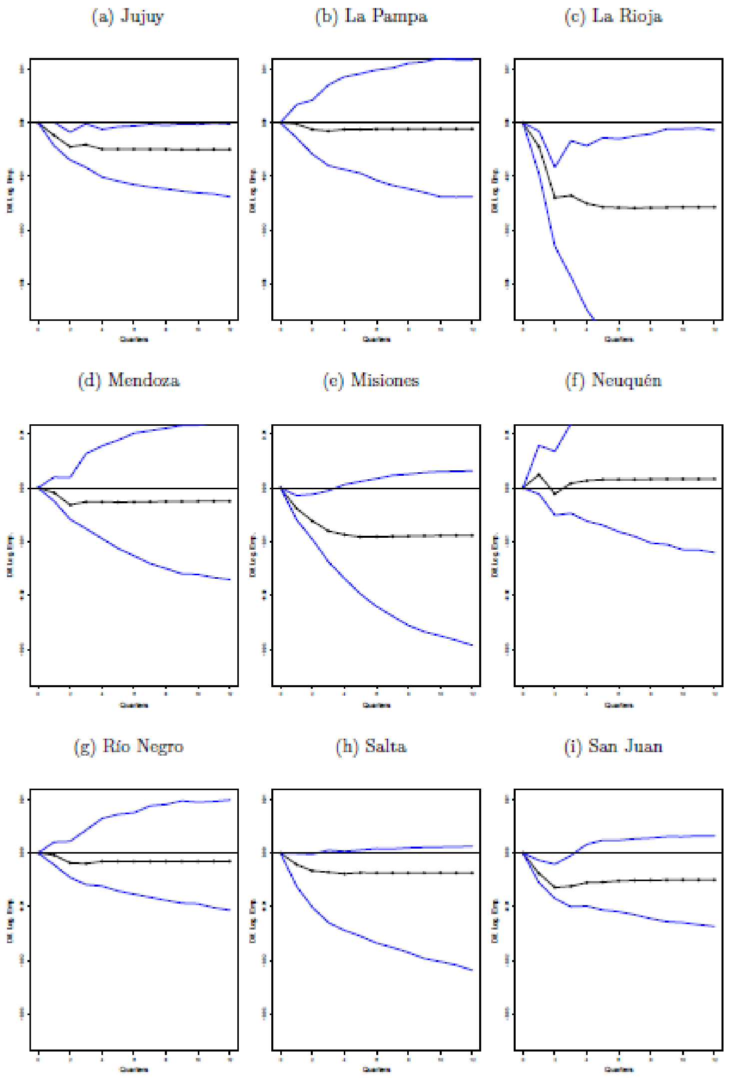

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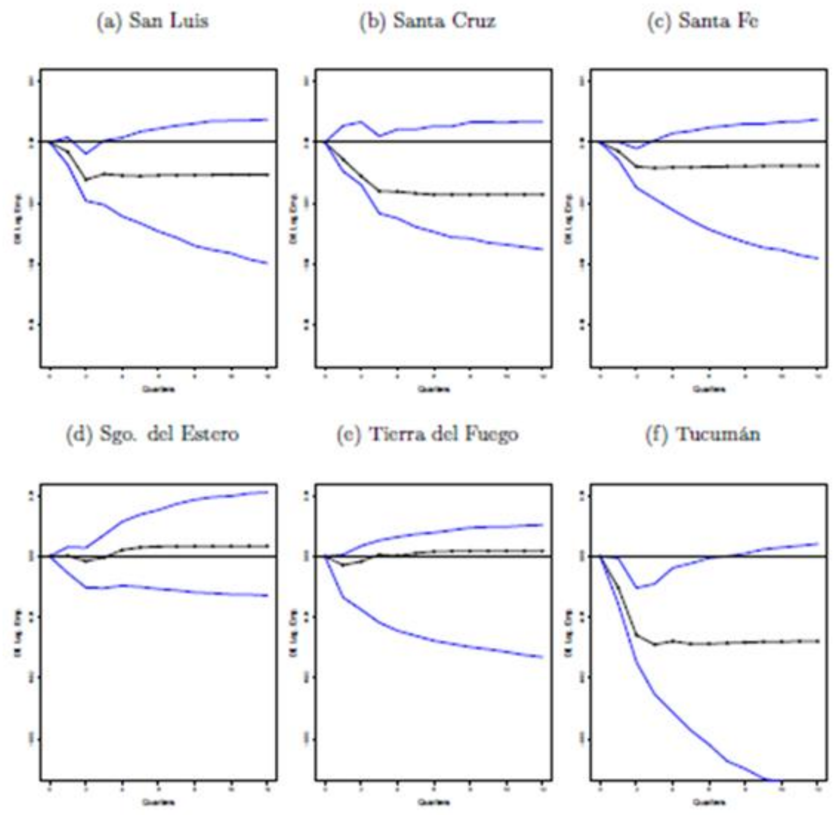
Figure 6: IRFs by States (cont.)



IRFs Provincial Accumulated Shock

What can we say about transmission channels?

- How can we explain the heterogeneity?
  - Local financial services mix.
  - Productive structure mix.
  - Economic and financial provincial situation.
- We use Bayesian Model Averaging (BMA).
- 24 variables and numerous potentially explanatory factors.

Bayesian Model Averaging (BMA) estimation

- IRFs contrasted with transmission mechanisms related variables.
  - Serrano and Nakana (2015) & Zeugner (2011).
- We estimate two models:
  - Accumulated IRFs.
  - Maximum IRFs, (both for 10 periods).
- 12 independent variables including indicators of:
  - productive mix (5 variables),
  - financial services mix (5 variables) and
  - overall provincial economic activity (2 variables)

Table: Bayesian Model Averaging results

	Accummulative Impulse Response (10 periods)				Maximum Impulse Response (10 periods)			
	PIP	Post. Mean	Post. S.D.	Cond. Pos. Sign	PIP	Post. Mean	Post. S.D.	Cond. Pos. Sign
Production Mix								
Industry formal emp	0.2397	0.310	0.920	1.000	0.256	0.380	1.033	1.000
Services formal emp	0.2857	1.002	2.486	0.910	0.295	1.135	2.699	0.910
Public formal emp	0.1816	0.260	1.561	0.890	0.178	0.230	1.605	0.860
Large firm pct	0.2172	0.750	4.540	0.890	0.212	0.800	4.677	0.910
Small firms pct	0.2239	-0.880	3.806	0.020	0.212	-0.740	3.820	0.030
Provincial Economy								
GDP p.c.	0.2449	-1.099	4.335	0.050	0.242	-1.101	4.408	0.060
Exports p.c.	0.1782	-3.891	3.037	0.120	0.178	-3.891	3.037	0.120
Financial Sector								
Loans p.c.	0.2139	0.080	3.861	0.210	0.217	0.000	3.897	0.170
Deposits p.c.	0.2170	-0.460	3.805	0.040	0.220	-0.450	3.874	0.020
Branches p.c.	0.5183	-0.0700	0.0900	0.0000	0.506	-0.080	0.100	0.000
Brances pct	0.2031	-0.070	1.445	0.230	0.201	-0.080	1.471	0.210
Public Bank	0.2009	0.020	0.130	0.630	0.202	0.020	0.140	0.630

Results BMA estimation (cont.)

- Financial Services availability (branches per capita).
  - The highest financial services availability the lower the relative impact.
  - May be related to competition at the local market level.
- Industrial sector share and (to a lesser extent), services share in formal employment widens the heterogeneous effects of monetary policy on regional employment.
- Similar results in Carlino and DeFina (1996) for US., Serrano and Nakana (2015), Runnemark (2013) for Sweden, Ridhwan et. al. 2011 for Indonesia, Arnold et.al. (2002) for Netherlands.

Conclusions

- A greater understanding of the sectoral and regional productive dynamics would be relevant for:
  - (i) The design and implementation of macroeconomic policies in general, and **monetary policy**, in particular.
  - (ii) The implementation of policy measures specifically targeted at the regions (fiscal policy, **financial regulation**, etc.).
  - (iii) The interaction between public policies [(i) & (ii) & at all government levels]
- A greater (broader) consideration of transmission channels is a relevant work agenda.

THANK YOU!

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Table 2: Estimates of ϕ_{01} and ϕ_{11} for RM.

	Centro	Cuyo	GBA-CABA	NEA	NOA	SUR
ϕ_0	0.619	0.749	0.464	-0.969	0.895	0.684
	(0.146)***	(0.296)***	(0.123)***	(0.506)**	(0.136)***	(0.240)***
ϕ_1	0.662	0.388	0.154	0.399	0.558	0.918
	(0.198)***	(0.290)*	(0.147)	(0.384)	(0.259)***	(0.254)***

Notes: Bootstrap standard errors in parenthesis. * Significant at 0.2 level. ** Significant at 0.1 level. *** Significant at 0.05 level. The estimates of ϕ_{21} are only significant for GBA-CABA, Sur and NEA at 0.2 level.

Table 3: Estimates of ϕ_{01} and ϕ_{11} for SM.

States	ϕ_{01}	ϕ_{11}	States	ϕ_{01}	ϕ_{11}
Buenos Aires	0.263	-0.039	Mendoza	0.451	0.699
	(0.833)	(1.316)		(0.118)***	(0.211)***
Córdoba	0.330	0.197	Misiones	0.171	0.276
	(0.162)***	(0.126)*		(0.078)***	(0.124)***
Catamarca	0.979	0.438	Neuquén	0.852	0.344
	(0.285)***	(0.316)*		(0.193)***	(0.300)
Chaco	0.566	0.467	Rï¿œo Negro	0.237	0.424
	(0.468)	(0.472)		(0.138)**	(0.158)***
Chubut	0.420	0.263	Salta	-0.088	-0.097
	(0.114)***	(0.205)*		(0.153)	(0.226)
GBA-CABA	0.001	0.015	San Juan	0.172	-0.031
	(0.034)	(0.024)		(0.072)***	(0.125)
Corrientes	0.588	0.670	San Luis	0.272	0.225
	(0.129)***	(0.218)***		(0.140)**	(0.205)
Entre Ríos	0.301	0.171	Santa Cruz	0.982	-0.065
	(0.062)***	(0.097)**		(0.287)***	(0.325)
Formosa	0.513	0.072	Santa Fe	0.150	0.340
	(0.287)**	(0.402)		(0.110)*	(0.118)**
Jujuy	0.131	0.135	Sgo. del Estero	-0.141	-0.198
	(0.074)**	(0.138)		(0.129)	(0.393)
La Pampa	0.247	0.351	Tierra del Fuego	-0.625	0.320
	(0.163)**	(0.265)*		(0.198)***	(0.158)***
La Rioja	-0.126	0.930	Tucumán	0.506	0.417
	(0.255)	(0.541)**		(0.160)***	(0.325)*

Notes: Bootstrap standard errors in parenthesis. * Significant at 0.2 level. ** Significant at 0.1 level. *** Significant at 0.05 level. The estimates of ϕ_{21} are only significant for Mendoza and San Juan at 0.05 level and for Tierra del Fuego and for Santa Fe at 0.1 and 0.2 level respectively.