

Regionalisation of the Chilean Model COFORCE – an IRIO Approach

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Overview

- ▶ Aim
- ▶ Data
- ▶ Modelling approach
- ▶ Data analysis and conclusions
- ▶ Future work: scenario analysis

Aim

- ▶ Regionalizing the national macro-econometric IO model COFORCE to:
 - ⇒ Find out the economic significance of the copper industry for the regional economy
 - ⇒ Find out how vulnerable the Chilean economy and its regions are with respect to the copper industry
 - ⇒ Determine the impact of the regional industry structure
 - ⇒ Quantify labor market and income effects
 - ⇒ Suggest alternative/diversification strategies

Data

- **IRIO 2014** (Reference: Haddad, E. A., Aroca, P. A., Arantes, S. M., Dias, L. C. C., Fernandes, R. P., Li, D. L., Pimenta, B. P. P., Rocha, A. A. M., Sass, K. S., Ussami, K. A. (2018). Interregional Input-Output System for Chile, 2014, The University of São Paulo Regional and Urban Economics Lab (NEREUS), mimeo)

⇒ 15 regions

| | | |
|----|------|---|
| 1 | XV | De Arica y Parinacota |
| 2 | I | De Tarapacá |
| 3 | II | De Antofagasta |
| 4 | III | De Atacama |
| 5 | IV | De Coquimbo |
| 6 | V | De Valparaíso |
| 7 | RMS | Región Metropolitana de Santiago |
| 8 | VI | Del Libertador General Bernardo O'Higgins |
| 9 | VII | Del Maule |
| 10 | VIII | Del Biobío |
| 11 | IX | De La Araucanía |
| 12 | XIV | De Los Ríos |
| 13 | X | De Los Lagos |
| 14 | XI | Aysén del General Carlos Ibáñez del Campo |
| 15 | XII | De Magallanes y de la Antártica Chilena |

⇒ 12 industries

| | | |
|----|-----|---|
| 1 | S1 | Agropecuario-silvícola y Pesca |
| 2 | S2 | Minería |
| 3 | S3 | Industria manufacturera |
| 4 | S4 | Electricidad, gas, agua y gestión de desechos |
| 5 | S5 | Construcción |
| 6 | S6 | Comercio, hoteles y restaurantes |
| 7 | S7 | Transporte, comunicaciones y servicios de información |
| 8 | S8 | Intermediación financiera |
| 9 | S9 | Servicios inmobiliarios y de vivienda |
| 10 | S10 | Servicios empresariales |
| 11 | S11 | Servicios personales |
| 12 | S12 | Administración pública |

- Population by 15 regions
- Employment by 15 regions and 12 industries

Data

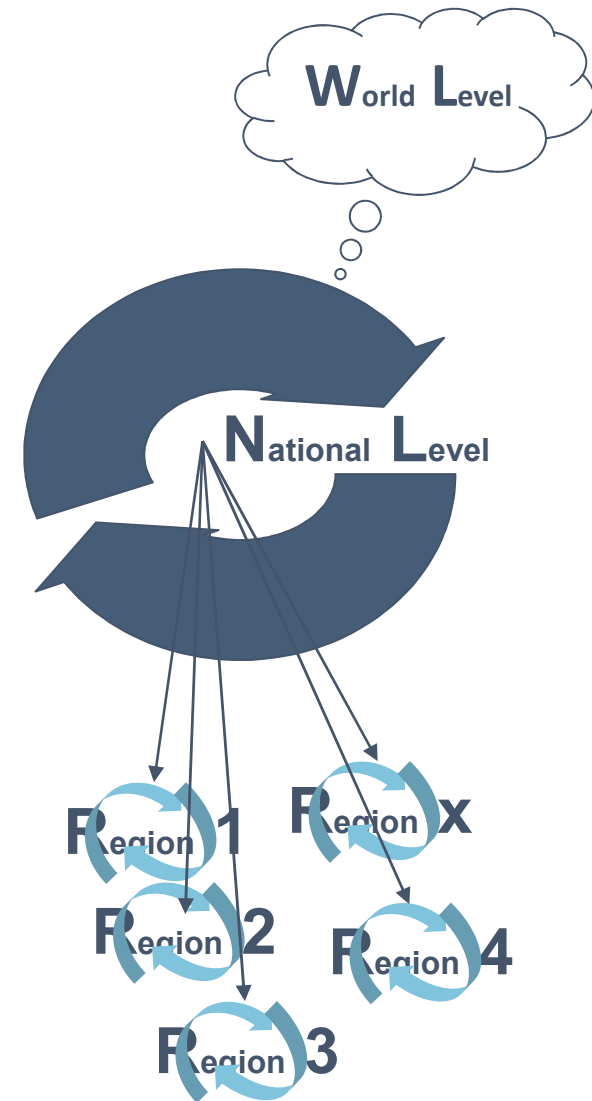
Region of
Destination

Region
of Origin

| Region Origin | INTERMEDIATE DEMAND (for 12 industries) | | | | | | | | | | | | | | FINAL DEMAND (for 12 industries) | | | | | | | | | | | | | | | |
|------------------|--|---|----|-----|----|---|-----|----|-----|------|----|-----|---|----|--|----|---|----|-----|----|---|-----|----|-----|------|----|-----|---|---------|-----|
| | XV | I | II | III | IV | V | RMS | VI | VII | VIII | IX | XIV | X | XI | XII | XV | I | II | III | IV | V | RMS | VI | VII | VIII | IX | XIV | X | XI | XII |
| XV | <div>Domestic</div> <div>Interregional Exports = Interregional Imports</div> | | | | | | | | | | | | | | <div>Domestic</div> <div>Interregional Exports = Interregional Imports</div> | | | | | | | | | | | | | | Exports | |
| I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| II | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| III | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| V | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RMS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VII | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VIII | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| XIV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| XI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| XII | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ROW | Foreign Exports = Regional Imports | | | | | | | | | | | | | | Foreign Exports = Regional Imports | | | | | | | | | | | | | | | |
| | Net Taxes On Production | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Valued Added | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Gross Output | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Modelling approach

- ▶ **World model**
 - ⇒ Determines world trade
 - ⇒ „Tiny“ Chile model included
- ▶ **National COFORCE model**
 - ⇒ Receives export demand and import prices from world model
 - ⇒ Comprehensive economic model
- ▶ **Regional models**
 - ⇒ Economic development of regional models determined by the national model (top-down)
 - ⇒ Differences in regional growth determined by industry and population structure



Modelling approach

► IRIO theory – Multi Country Case (Miller/Blair 2009)

$$\begin{array}{c} \text{Output } x \\ \left(\begin{array}{cccc} x_{1,1} & x_{1,2} & \cdots & x_{1,15} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,15} \\ \vdots & \vdots & \ddots & \vdots \\ x_{15,1} & x_{15,2} & \cdots & x_{15,15} \end{array} \right) \end{array} = \begin{array}{c} \text{Leontief } I \\ \left(\begin{array}{cccc} I - A_{1,1} & I - A_{1,2} & \cdots & I - A_{1,15} \\ I - A_{2,1} & I - A_{2,2} & \cdots & I - A_{2,15} \\ \vdots & \vdots & \ddots & \vdots \\ I - A_{15,1} & I - A_{15,2} & \cdots & I - A_{15,15} \end{array} \right)^{-1} \end{array} \begin{array}{c} \text{Total Final Demand } y \\ \left(\begin{array}{cccc} y_{1,1} & y_{1,2} & \cdots & y_{1,15} \\ y_{2,1} & y_{2,2} & \cdots & y_{2,15} \\ \vdots & \vdots & \ddots & \vdots \\ y_{15,1} & y_{15,2} & \cdots & y_{15,15} \end{array} \right) \end{array}$$

$$\begin{array}{c} \text{Gross Output by Regions} \\ \left(\begin{array}{cccc} \sum x_1 & \sum x_2 & \cdots & \sum x_{15} \end{array} \right) \end{array} = \begin{array}{c} \text{Regional Input Coefficients} \\ \left(\begin{array}{cccc} I - A_{1,1} & I - A_{1,2} & \cdots & I - A_{1,15} \\ I - A_{2,1} & I - A_{2,2} & \cdots & I - A_{2,15} \\ \vdots & \vdots & \ddots & \vdots \\ I - A_{15,1} & I - A_{15,2} & \cdots & I - A_{15,15} \end{array} \right)^{-1} \end{array} \begin{array}{c} \text{Total Final Demand by Regions} \\ \left(\begin{array}{c} \sum y_1 \\ \sum y_2 \\ \vdots \\ \sum y_{15} \end{array} \right) \end{array}$$

Interregional Input Coefficients

Modelling approach

- ▶ Linking the national model and the IRIO system
 - ⇒ By final demand components
 - ⇒ Assumptions (current state):
 - Top-down: from the national to the regional level
 - Regional share by final demand components and industries
→ Demand indicator of a region
 - “Market share” of a region
→ Competitiveness indicator by industries of a region

Modelling approach

► Linking the national model and the IRIO system (cont'd)

⇒ Assumptions (to do):

- Flexible shares, e.g.
 - Consumption depends on regional population
 - Policy decisions (with regard to investments and government demand)
 - Market shares by industries of regions (competitiveness)
- Flexible regional and interregional input coefficients (e.g. linked to the input coefficients at the national level)

Data analysis and conclusions

- Total (interregional) trade coefficients (% , 2014)

$$= \frac{\text{total (interregional) trade flows}}{\text{gross production}} \cdot 100$$

Degree of a region's self-sufficiency

Export dependency

| Regions | Interregional Imports | Imports from RoW | Interregional Exports | Exports to RoW |
|---|-----------------------|------------------|-----------------------|----------------|
| De Arica y Parinacota | 13,8 | 9,5 | 14,3 | 10,2 |
| De Tarapacá | 14,2 | 9,0 | 8,0 | 34,9 |
| De Antofagasta | 14,4 | 8,8 | 10,1 | 44,5 |
| De Atacama | 14,3 | 8,4 | 13,7 | 30,6 |
| De Coquimbo | 19,0 | 8,4 | 13,2 | 28,9 |
| De Valparaíso | 20,2 | 11,9 | 17,6 | 18,0 |
| Región Metropolitana de Santiago | 9,9 | 9,4 | 12,9 | 11,1 |
| Del Libertador General Bernardo O'Higgins | 22,4 | 10,3 | 21,5 | 25,4 |
| Del Maule | 20,1 | 11,7 | 20,8 | 11,1 |
| Del Biobío | 17,6 | 13,1 | 16,6 | 13,0 |
| De La Araucanía | 20,1 | 10,6 | 14,3 | 9,6 |
| De Los Ríos | 19,7 | 12,9 | 17,2 | 13,1 |
| De Los Lagos | 19,1 | 12,6 | 17,9 | 13,5 |
| Aysén del General Carlos Ibáñez del Campo | 22,6 | 9,5 | 33,4 | 12,3 |
| De Magallanes y de la Antártica Chilena | 11,5 | 11,3 | 7,7 | 18,2 |

Import dependency increases

Export dependency increases

Data analysis and conclusions

- Trade coefficients (**exports to RoW**) by industries (% , 2014)
 - ⇒ (Highly) dependent on world markets, esp. **minerals**, manufactured and **agricultural products**

| Regions | TOP 1 | | TOP 2 | | TOP 3 | |
|---|-------|------|-------|-----|-------|-----|
| | IND | % | IND | % | IND | % |
| De Arica y Parinacota | S3 | 3,4 | S7 | 2,1 | S2 | 2,0 |
| De Tarapacá | S2 | 29,0 | S3 | 3,0 | S6 | 1,4 |
| De Antofagasta | S2 | 40,7 | S3 | 2,4 | S7 | 0,6 |
| De Atacama | S2 | 27,8 | S3 | 0,8 | S7 | 0,6 |
| De Coquimbo | S2 | 24,1 | S1 | 1,3 | S3 | 1,2 |
| De Valparaíso | S3 | 7,9 | S2 | 6,8 | S7 | 1,6 |
| Región Metropolitana de Santiago | S3 | 5,2 | S6 | 2,4 | S2 | 1,5 |
| Del Libertador General Bernardo O'Higgins | S2 | 16,4 | S3 | 4,9 | S1 | 2,4 |
| Del Maule | S3 | 6,2 | S1 | 2,1 | S7 | 0,9 |
| Del Biobío | S3 | 10,0 | S1 | 1,0 | S7 | 1,0 |
| De La Araucanía | S3 | 5,3 | S1 | 1,9 | S6 | 1,1 |
| De Los Ríos | S3 | 9,2 | S1 | 2,0 | S7 | 0,9 |
| De Los Lagos | S3 | 8,6 | S1 | 2,8 | S7 | 1,0 |
| Aysén del General Carlos Ibáñez del Campo | S1 | 7,3 | S2 | 1,8 | S3 | 1,7 |
| De Magallanes y de la Antártica Chilena | S3 | 7,8 | S2 | 7,4 | S7 | 1,0 |

S1 agriculture, fishery, **S2** minerals, **S3** manufacturing, **S4** electricity, gas, water, sewage, **S5** construction, **S6** commerce, hotels, restaurants, S7 transport, communication, information, **S8** Intermediación financiera, **S9** real estate, **S10** business services, **S11** personal services, **S12** administration

Data analysis and conclusions

- Trade coefficients (**interregional imports**) by industries (% , 2014)
 - ⇒ Business services and manufactured products are mainly traded between regions

| Regions | TOP 1 | | TOP 2 | | TOP 3 | |
|---|-------|-----|-------|-----|-------|-----|
| | IND | % | IND | % | IND | % |
| De Arica y Parinacota | S3 | 4,7 | S10 | 2,4 | S8 | 1,7 |
| De Tarapacá | S3 | 3,8 | S10 | 3,0 | S4 | 2,0 |
| De Antofagasta | S3 | 4,5 | S10 | 2,3 | S6 | 2,2 |
| De Atacama | S3 | 6,8 | S6 | 2,3 | S7 | 1,2 |
| De Coquimbo | S3 | 5,8 | S10 | 3,2 | S6 | 2,2 |
| De Valparaíso | S3 | 4,9 | S10 | 3,7 | S1 | 3,6 |
| Región Metropolitana de Santiago | S3 | 2,9 | S1 | 2,8 | S2 | 0,9 |
| Del Libertador General Bernardo O'Higgins | S3 | 6,0 | S10 | 4,4 | S1 | 2,5 |
| Del Maule | S3 | 5,0 | S10 | 3,7 | S6 | 2,6 |
| Del Biobío | S10 | 3,4 | S3 | 3,4 | S1 | 3,3 |
| De La Araucanía | S3 | 4,9 | S10 | 3,7 | S6 | 2,6 |
| De Los Ríos | S10 | 4,4 | S3 | 3,8 | S1 | 2,8 |
| De Los Lagos | S10 | 3,9 | S3 | 3,7 | S6 | 2,8 |
| Aysén del General Carlos Ibáñez del Campo | S3 | 9,2 | S10 | 3,9 | S6 | 3,1 |
| De Magallanes y de la Antártica Chilena | S10 | 2,2 | S1 | 2,0 | S6 | 1,9 |

S1 agriculture, fishery, **S2** minerals, **S3** manufacturing, **S4** electricity, gas, water, sewage, **S5** construction, **S6** commerce, hotels, restaurants, **S7** transport, communication, information, **S8** Intermediación financiera, **S9** real estate, **S10** business services, **S11** personal services, **S12** administration

Data analysis and conclusions

► Regional output multiplier by industries (2014)

⇒ Business services and manufactured products are mainly traded between regions

| Regions | S1 | | S2 | | S3 | |
|---|----|--|----|--|----|--|
| | | | | | | |
| De Arica y Parinacota | | | | | | |
| De Tarapacá | | | | | | |
| De Antofagasta | | | | | | |
| De Atacama | | | | | | |
| De Coquimbo | | | | | | |
| De Valparaíso | | | | | | |
| Región Metropolitana de Santiago | | | | | | |
| Del Libertador General Bernardo O'Higgins | | | | | | |
| Del Maule | | | | | | |
| Del Biobío | | | | | | |
| De La Araucanía | | | | | | |
| De Los Ríos | | | | | | |
| De Los Lagos | | | | | | |
| Aysén del General Carlos Ibáñez del Campo | | | | | | |
| De Magallanes y de la Antártica Chilena | | | | | | |

S1 agriculture, fishery, **S2** minerals, **S3** manufacturing, **S4** electricity, gas, water, sewage, **S5** construction, **S6** commerce, hotels, restaurants, **S7** transport, communication, information, **S8** Intermediación financiera, **S9** real estate, **S10** business services, **S11** personal services, **S12** administration

Future work: scenario analysis

- ▶ Questions that could be answered:
 - ⇒ How vulnerable is the Chilean economy and its regions to copper demand and price shocks?
 - Impact of regional industry structure
 - Labour market and income effects
 - ⇒ What are the main transmission channels?
 - ⇒ What kind of strategies can be developed to reduce vulnerability and increase sustainability?
 - Diversification strategies (industry policy)
 - ⇒ Population/Demand shocks
 - ⇒ Export-induced labour effects

Thank you for your attention!

Comments? Questions?

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