



# COFORCE - COPPER FORECASTING CHILE

**Methodology and Design of a Macro-Econometric Input-Output Model for the Chilean Economy**

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# 1. Motivation

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# Motivation

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- ▶ Joint research project  
„**Development of sustainable strategies in the Chilean mining sector through a regionalized national model**“
- ▶ Overall aim: Analysis of socio-economic impact of copper on the Chilean economy
- ▶ Choice of instrument: macro-econometric input-output model of Chile
  - ⇒ national level – completed 2018
  - ⇒ regional level – upcoming work in 2018/2019

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## 2. Methodology Overview

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# Methodology Overview

	Characteristics
Type	INFORUM type of model
Focus	Macro / meso economy
Derived assumptions	Bounded rationality of economic actors Imperfect markets Price rigidities Equal importance of supply and use
Implementation of modelling	Econometric estimation of parameters and their elasticity values using OLS
Technology	Variable input coefficient
Basic dataset	IO Tables + National Accounts
Modelling approach	Bottom-up (73 products and industries) Total integration („closed system“; double accounting; intersectoral dependencies)
Solution procedure	Iterative; simultaneous solution of total system
Time	Irreversible; path dependency; dynamic (until 2035)

# Methodology Overview

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## ► Strengths

- ⇒ Allows for the analysis of **complex socio-economic structures** and interdependencies.
- ⇒ Identification of **direct and indirect** impacts and interdependencies.
- ⇒ **Low sectoral aggregation** level by goods and industries
- ⇒ Differentiation of **institutional sectors** according to SNA
- ⇒ Amplification of model is possible („**modularization**“)
- ⇒ **Update on yearly** basis
- ⇒ Well-suited for **scenario analysis**

## ► Weaknesses

- ⇒ Large and **complex system**; „black box“
- ⇒ **Quality** of historical dataset is decisive
- ⇒ Making-off is **time-intense**
- ⇒ High number of interdependencies and the interrelation between definition and regression functions constitute a **sensitive system**
  - Excellent regression test values do not mean automatically a good forecasting performance

# Methodology Overview

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## ► Interdependencies

### ⇒ Intermediate demand

- Supply and use between industrial sectors

### ⇒ Price model

- Unit cost calculation and mark-up pricing

### ⇒ Income circulation

- Wages and surplus for disposable income

### ⇒ Foreign trade

- Export demand determined by demand of trading partners

### ⇒ Labor market

- Production, wages & prices → labor demand and wage income



# Methodology Overview

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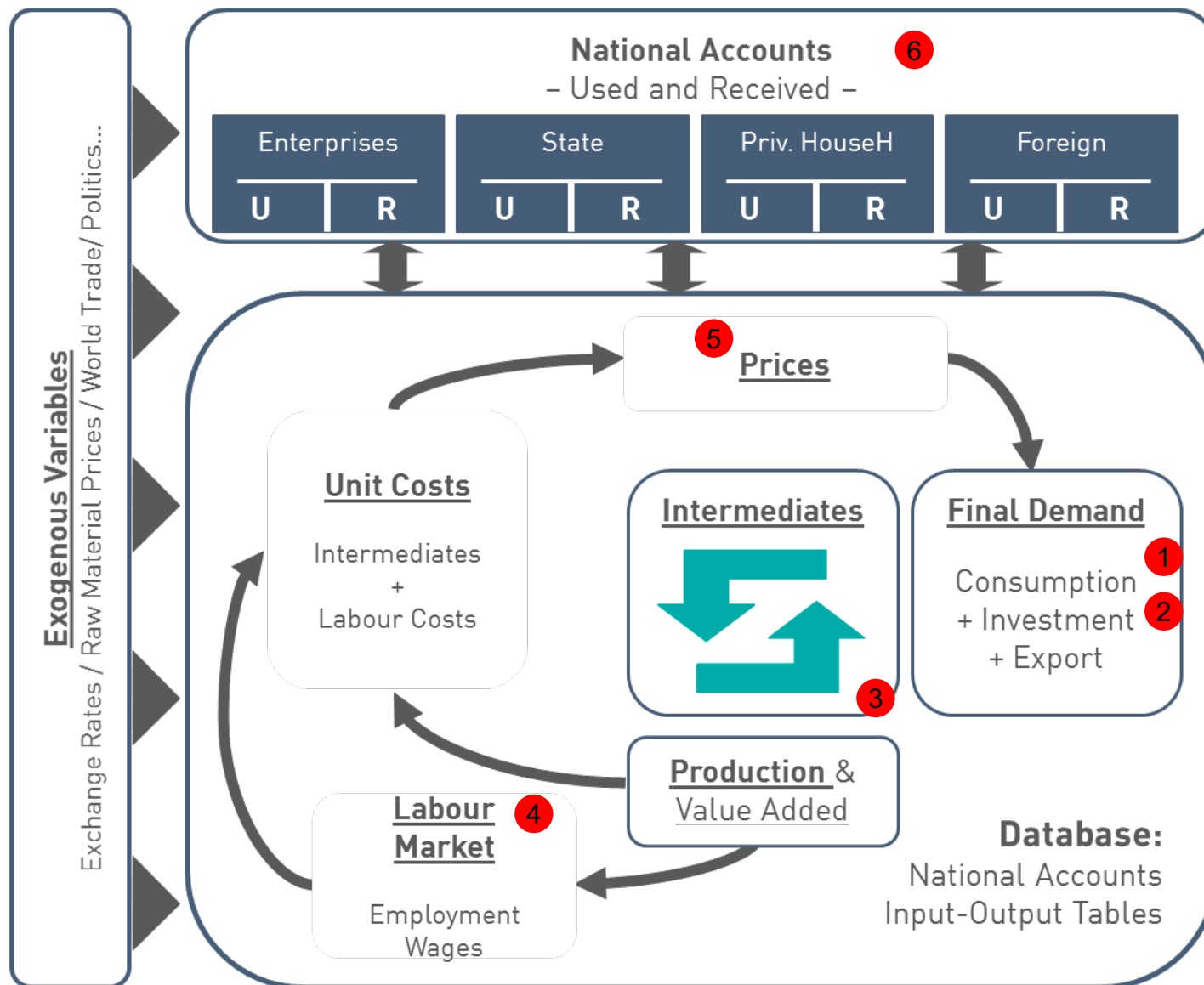
- ▶ Important output variables
  - ⇒ Foreign trade (import/export by products)
  - ⇒ Final demand components by products
  - ⇒ Production by industrial sectors
  - ⇒ Employment by industrial sectors
  - ⇒ Price development
  - ⇒ Income and expenses of state, corporations and private households
  - ⇒ Macroeconomic development
  
- ▶ Important assumptions
  - ⇒ Population
  - ⇒ Interest rates, exchange rates
  - ⇒ Import prices
  - ⇒ World trade development

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## 3. Selected Specification of COFORCE

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# Methodology Overview



# 1 Private household consumption

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- ▶ Most important contributor to economic growth
- ▶ Estimated bottom-up on product level and in real terms as a function of
  - ⇒ real personal income (+)
  - ⇒ relative commodity prices (-)
  - ⇒  $hcesr = hcesr\left(\frac{DB6000RH}{HCPPOP}, \frac{ppil_i}{HCPPOP}\right), i \in (1, \dots, 73)$
- ▶ Overall price inflation and relative price shifts as limitation for consumption expansion
- ▶ Savings are a residual between disposable income and consumption expenditure

## 2 Gross fixed capital formation

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- ▶ No differentiation between investment in machinery and equipment and investment in buildings
- ▶ Bottom-up estimation on the level of investment products (!= investing industries)
  - ⇒ production groups either total production or production of manufacturing industry (+)
  - ⇒ real disposable income of non-financial institutions (+)
  - ⇒  $gicnr_i = gicnr_i(YSR, YSRMI, B^{6000RN}/PS), i \in (1, \dots, 73)$

# Intermediate transaction and production

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- ▶ (Domestic) input coefficient are estimated with an autonomous time trend
  - ⇒ 5329 coefficients exist
  - ⇒ Only those coefficients are estimated that belong to the 100 largest intermediate input combination
  - ⇒ They represent 45% of all domestic input in year 2013
  - ⇒  $DINCT_{i,j} = DINCT_{i,j}(1/TIME), i \in (1, \dots, 73), j \in (1, \dots, 73)$
  
- ▶ Production via Leontief equation
  - ⇒  $ygn_t = (IL - DINCT)^{-1} \cdot (fdnb_t)$

# Primary inputs

► **Value added** retrieved by definition

$$\Rightarrow vadd_i = ygn_i - dimni_i - iimn_i, i \in (1, \dots, 73)$$

► **Wages** determined on the labour market

$\Rightarrow$  Average wage level estimated according to Philip curve approach: real GDP per capita (+) and labour scarcity factor (+)

$$\Rightarrow WAGE = WAGE^{(GDPTR/EMPL * HCPOP, EMPL/LFCE)}$$

$\Rightarrow$  Sectoral wages influenced by overall wage level (+) and sectoral productivity (+)

$$\Rightarrow wage_i = wage_i(WAGE, ysn_i/empl_i), i \in (1, \dots, 73)$$

► **Indirect taxes** grow with real production

$$\Rightarrow idxn_i = idxn_i[t-1] * (ysn_i/ppil_i) / (ysn_i[t-1]/ppil_i[t-1]), i \in (1, \dots, 73)$$

► **Profits** retrieved by definition

$$\Rightarrow protn_i = vadd_i - wage_i - idxn_i, i \in (1, \dots, 73)$$

## 5 Modelling prices

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- ▶ Production prices follow a unit cost approach
  - ⇒ Unit costs = cost per unit of real production
  
- ▶ COFORCE differentiates between 4 unit costs:
  - ⇒ unit labour costs,
  - ⇒ unit indirect tax costs,
  - ⇒ unit imported intermediate costs
  - ⇒ and unit domestic intermediate costs
  
- ▶ Production prices determined by unit costs (+) and mark-up pricing
  - ⇒ Price stickiness is signaled by an elasticity  $< 1$
  - ⇒  $ppil_i = ppil_i(uc_i)$  ,  $i \in (1, \dots, 73)$



# System of National Accounts

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- ▶ SNA shows the origin, its reallocation and use of income by institutional sectors
- ▶ Economic activities are dedicated to different phases of economic cycle (functional transaction)
  - ⇒ (i) production,
  - ⇒ (ii) income generation,
  - ⇒ (iii) income distribution,
  - ⇒ (iv) use of income
  - ⇒ (v) capital accumulation.
- ▶ The forecasting model combines IOT and SNA to a consistent booking system
  - ⇒ The linkages are among others **production, value added, intermediate demand and income**
  - ⇒ “Used” elements of SNA are estimated, “received” items are defined according to the accounting system and under consideration of the rest of world

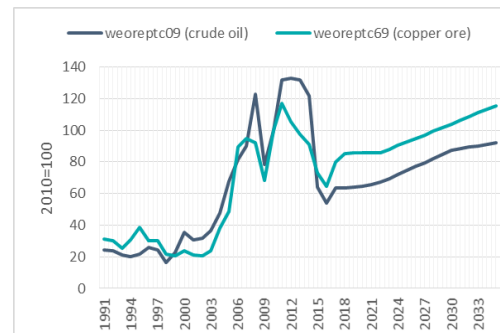
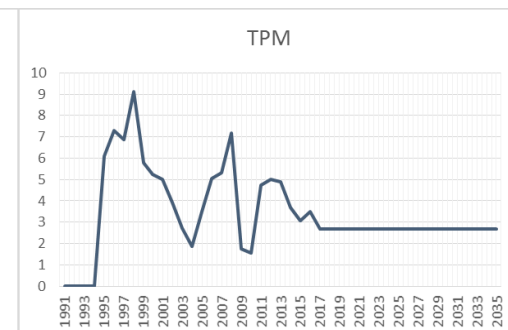
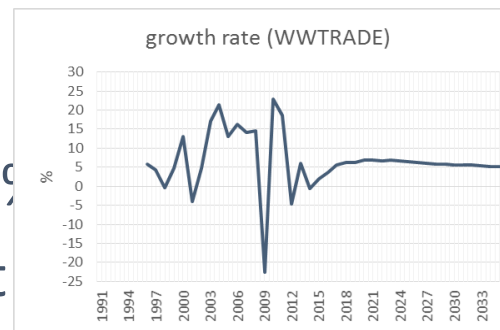
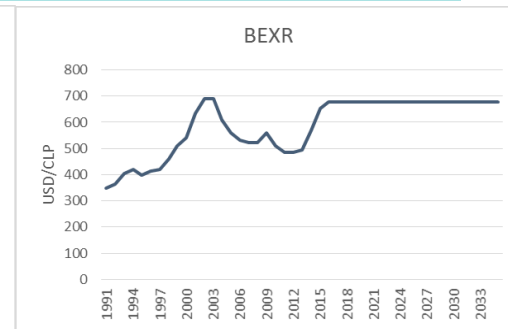
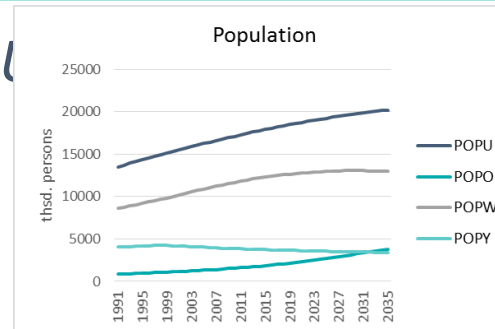
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## 4. Outcome

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# Main assumptions

- Constant population *POP* increase. Accelerating increase of older population *POPO*
- Exchange rate *BEXR* remains constant
- World trade growth *WWTRADE* in average >5%
- Main refinancing interest rate *TPM* remains constant
- Raw material prices increase constantly



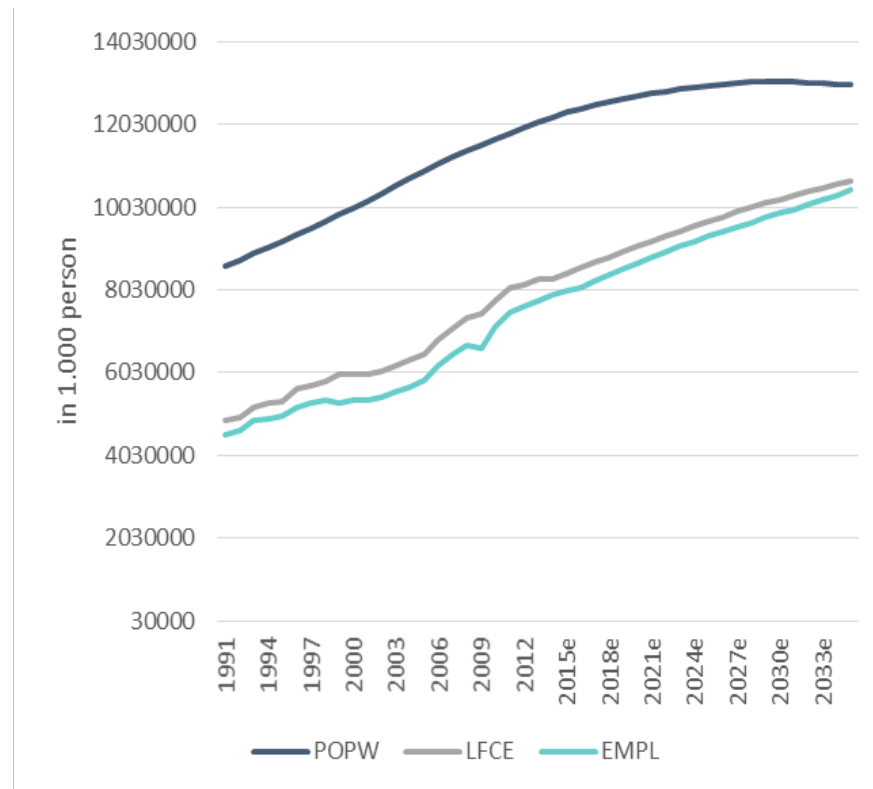
# GDP and components

	2005-2010	2010-2015	2015-2020e	2020-2025e	2025-2030e	2030-2035e
Gross domestic product	3,8	4,7	2,3	2,9	3,0	3,1
Private consumption	5,6	5,4	3,3	3,3	3,4	4,1
State consumption	5,2	3,9	2,8	2,1	1,8	1,3
Investment	6,4	4,7	2,0	3,4	3,1	2,8
Exports	0,9	1,8	2,3	3,6	2,9	2,9
Imports	7,9	1,5	3,1	3,0	3,2	4,1

- ⇒ Until 2035, average growth rate can be increased.
- ⇒ Mainly driven by a **constantly high demand of private households**.
- ⇒ This can be explained by the **growing population**.
- ⇒ Chile's foreign **trade balance** will turn **positive only temporarily**

# Labour market

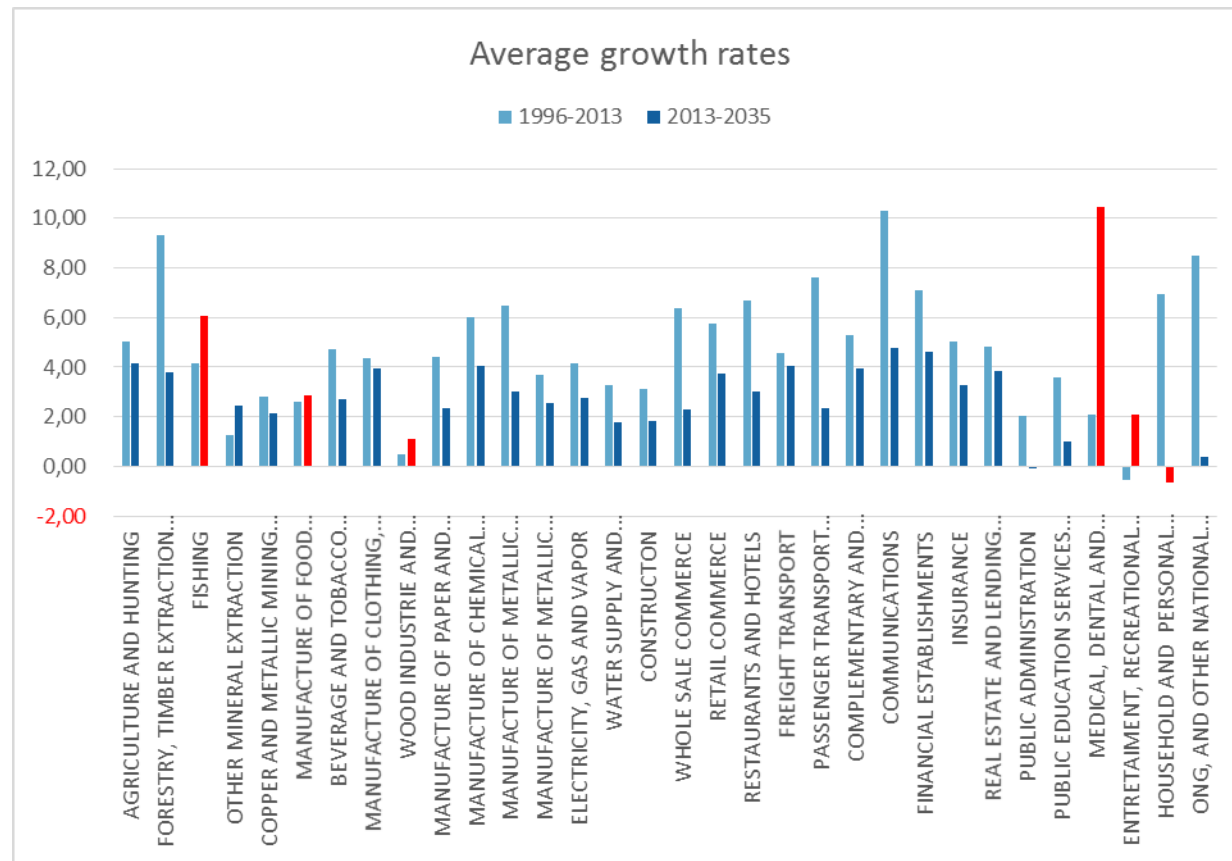
- ▶ Positive growth perspective are transmitted to the labour market
- ▶ Gap between labour force and labour demand declines → labour becomes more scarce



# Structural development

## ► Real production

- ⇒ In average, growth slower than in the past
- ⇒ Except for some sectors; especially for „medical, dental and sanitation services“ a much higher growth path is expected



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## 5. Next steps ahead

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# Next steps ahead

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- ▶ COFORCE on national level finalized
  - ⇒ but: update on new data possible
  - ⇒ depends on resources (personell, time) but may be sensible
  - ⇒ some improvements in modelling approach to be considered
    - include volume of work on labour market to account better for part-time work
    - ...
  
- ▶ Next step ahead: regionalization of COFORCE
  - ⇒ the how of regionalization still open
  - ⇒ depends on data availability



# Thank you for your attention.

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