Towards a Macroeconomics of the Socially Just Transition to a Circular Economy

Stabilizing Unstable Economy-Ecology Interactions

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European Commission Grant, Project 101003491: "A Just Transition to the Circular Economy" (JUST2CE)

Eastern Economics Association
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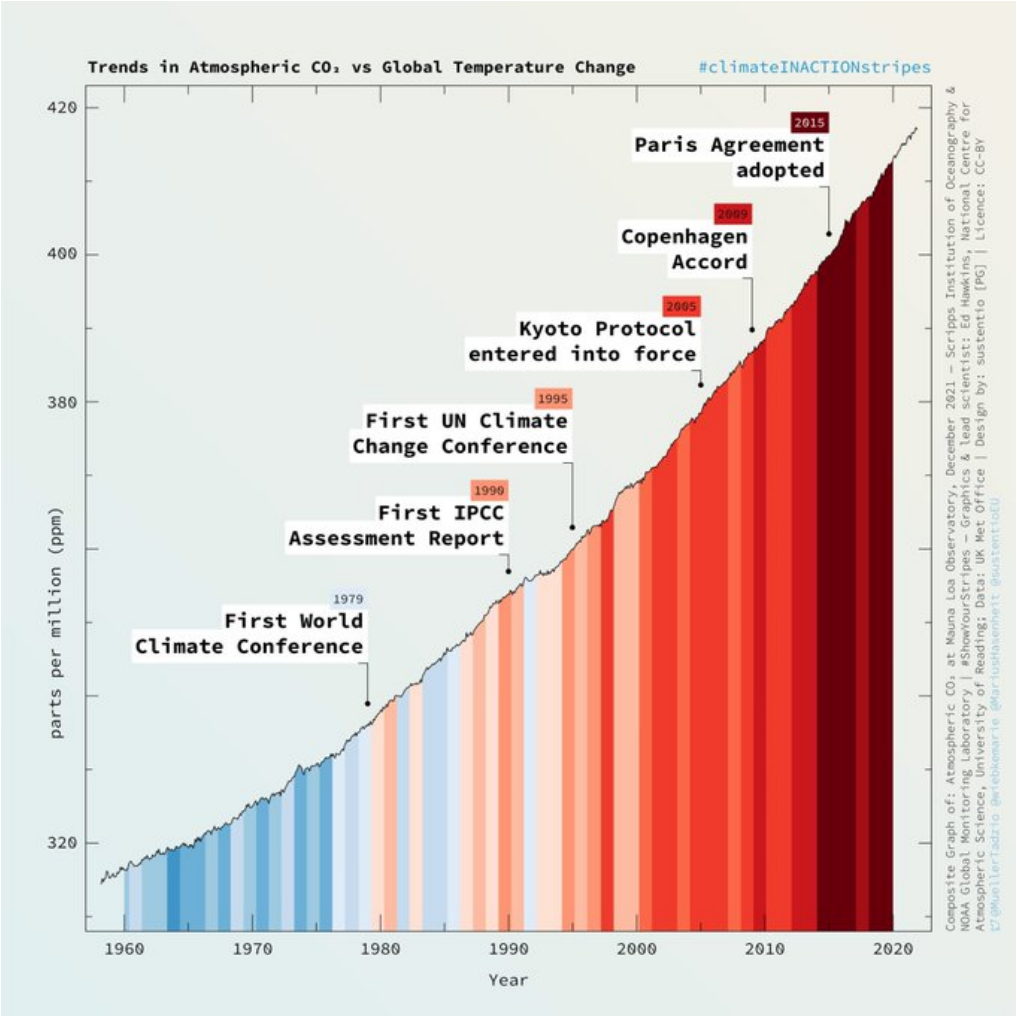
Motivation: Do Climate Accords Drive Carbon Emissions?



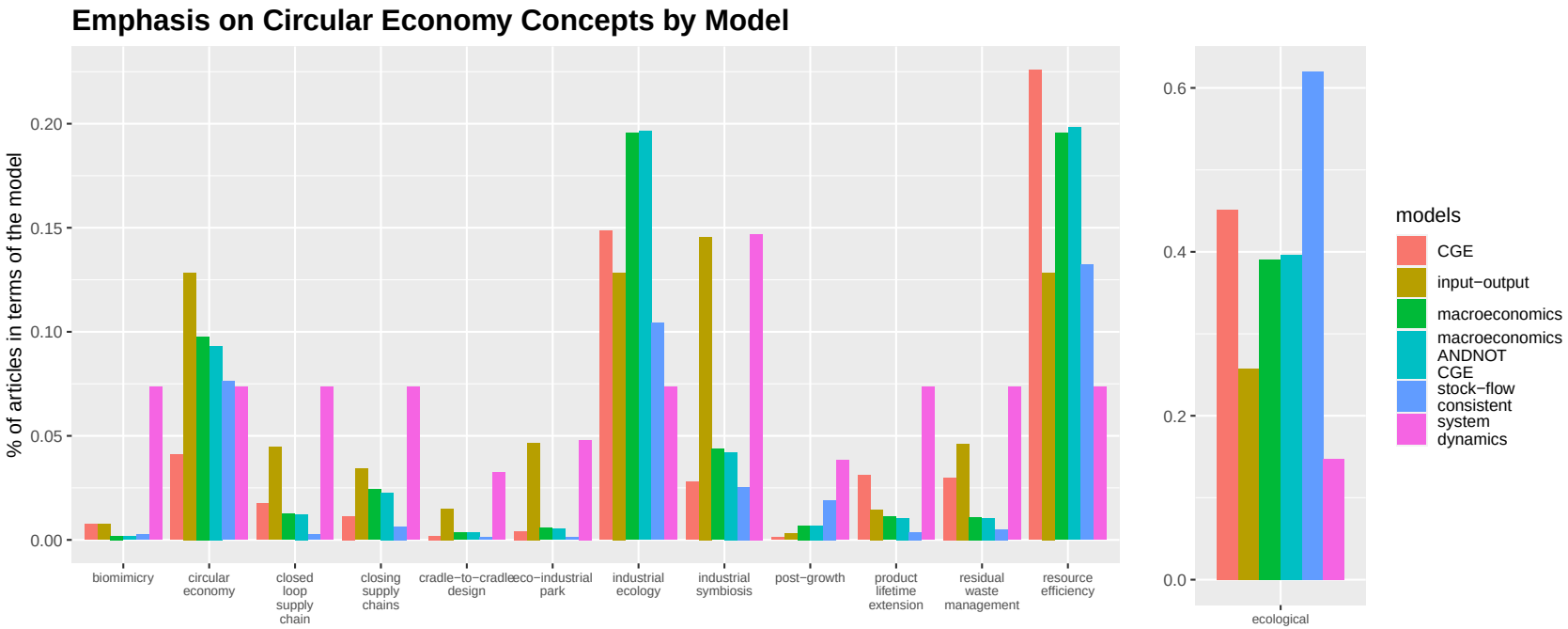
Introduction: What is JUST2CE?

- **JUST2CE** = A Just Transition to the Circular Economy
- It is a EU-funded project proposing an alternative way to looking at CE
- Most projects have focused on *how* to produce circularity. JUSTC2CE focuses on *what* (democracy, participation, gender, global justice)
- Two main milestones / deliverables linked with WP5:
  - a **systematic review** of current literature on macroeconomic models for assessing the transition towards a CE
  - a **formal model** (or set of models) to simulate and compare alternative CE policies and transition scenarios

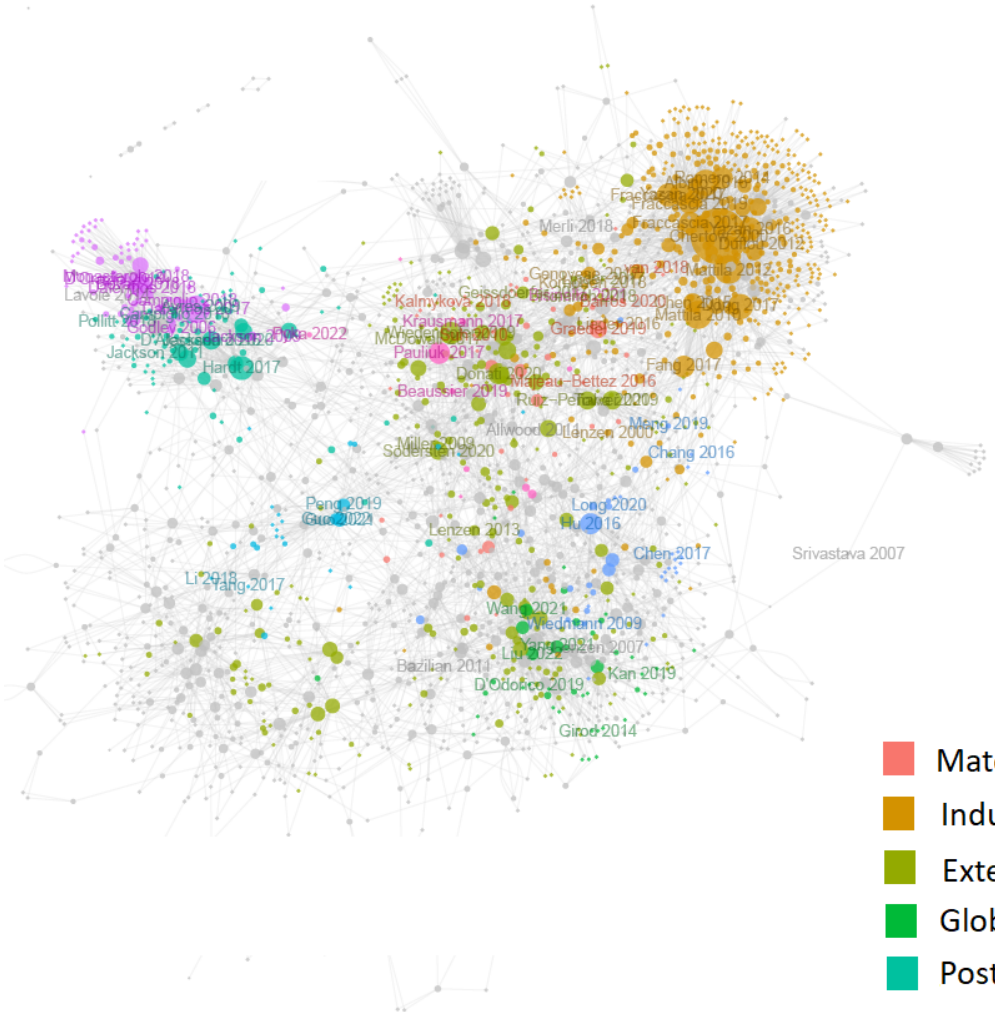
Systematic Literature Review

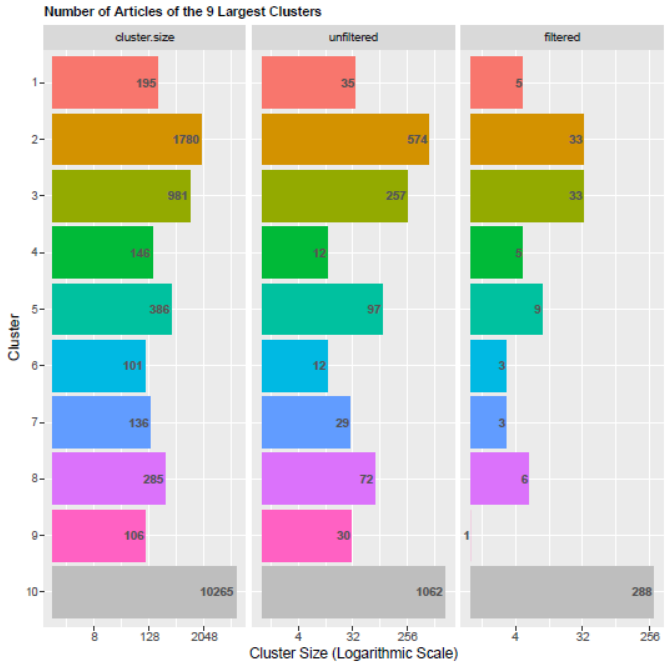
Concepts		
circular economy	closing supply chains	eco-industrial park
ecological	product lifetime extension	cradle-to-cradle design
environmental	resource efficiency	closed loop supply chain
post-growth	industrial symbiosis	biomimicry
residual waste management	industrial ecology	
Models		
input-output	macroeconomics	system dynamics
stock-flow consistent	macroeconomic model ANDNOT CGE	computational general equilibrium
macroeconomic model	macroeconomics ANDNOT CGE	CGE

Systematic Literature Review



Citation Network of Ecological Macroeconomics





- Material flow analysis
- Industrial symbiosis
- Extended IO
- Global value chain
- Post-growth SFC
- CGE (electric vehicles)
- Carbon footprint analysis
- Post-Keynesian SFC
- IAMs

Main Gaps Identified

- **Modelling of Rebound Effects** Current modeling of changes in demand, and consequently in environmental impacts, associated with changes in prices, employment and disposable income is limited.
- **Transitional Dynamics** Most commonly used input-output analysis is a static method.
- **Limited Coverage of Socio-Economic Aspects** Only employment is considered.
- **Technology Innovation and Diffusion + Assumptions in Changes of Demand** Lower-labor-cost technologies may be preferred.
- North-South, Core-Periphery Ecological Unequal Exchange

The model: basic features

- Main tools in (theory-to-data) macroeconomics:
  1) DSGE (and growth) models. Pros: mainstream tool, simple story. Cons: too "small", unique optimal equilibrium
  2) CGE models (and IAMs). Pros: several variables, cross-industry interdependencies. Cons: unique optimal equilibrium

- Cross-breeding the two alternatives (*Hardt and O'Neill 2017*):
  - **Leontief IO Models**. Pros: several variables, cross-industry interdependencies. Cons: static, no financial side
  - **SFC Models**. Pros: dynamics, finance. Cons: homogeneous output

Aim / Research Questions

- However, just a few papers use IO-SFC models, but none focuses on CE:
  - *Berg, Hartley and Richters (2015)*. A stock-flow consistent input-output model with applications to energy price shocks, interest rates, and heat emissions. *New Journal of Physics*.
  - Other contributions: Naqvi (2015), Valdecantos and Valentini (2017), Jackson and Jackson (2021), Cordier et al. (2015), Jackson et al. (2014)

ECO-IO-SFC Model

a) Two-country macro frame taken from standard SFC models *Godley and Lavoie 2007*):

- **Six Sectors** households, production firms, government, commercial banks, central bank
- **Four Assets** cash, bank deposits, shares, and government bills (+ advances)
- Only **loans to firms** (no personal loans)
- **Fixed capital**, but no inventories

b) Simple IO structure: **5 industries** (manufacturing, agriculture, services) + *waste, recycling*

c) Identification: calibration to target final demand components

d) Solution: numerical simulations (*R* code), 100 periods, 100 iterations

Final Demand and Gross Output

- Let us consider a 3×3 production. The **final demand** vector is:

$$\mathbf{d} = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{pmatrix} \cdot c + \begin{pmatrix} \iota_1 \\ \iota_2 \\ \iota_3 \end{pmatrix} \cdot i_d + \begin{pmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \end{pmatrix} \cdot gov + \begin{pmatrix} \eta_1 \\ \eta_2 \\ \eta_3 \end{pmatrix} \cdot exp \quad (1)$$

- The **gross output** vector is:

$$\mathbf{x} = \mathbf{A} \cdot \mathbf{x} + \mathbf{d} = (\mathbf{I} - \mathbf{A})^{-1} \cdot \mathbf{d}, \; with : \mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \quad (2)$$

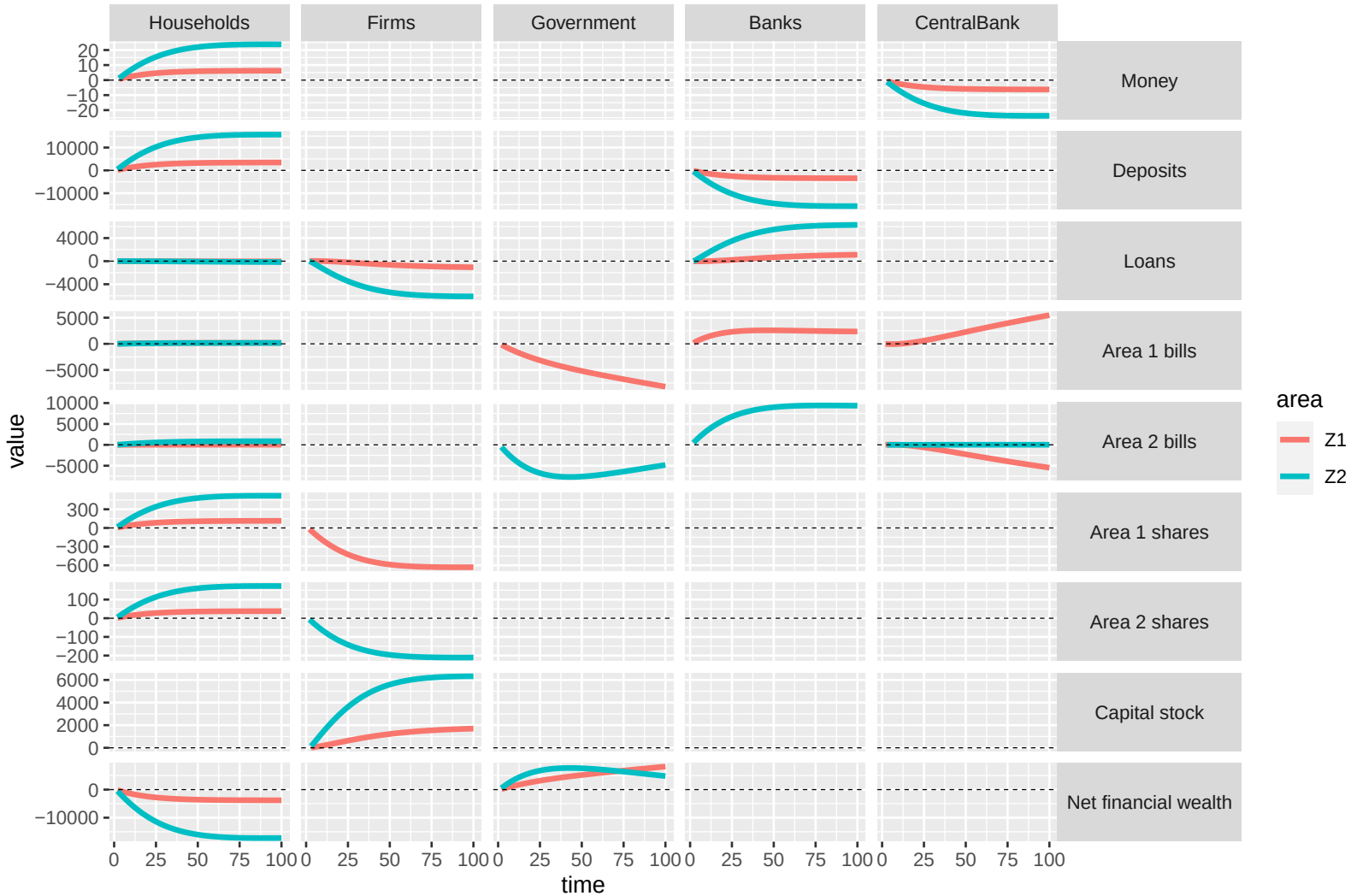
Government-led Transition to a Circular Economy

There is a tendency for current technical coefficients to converge to **target CE values** over time:

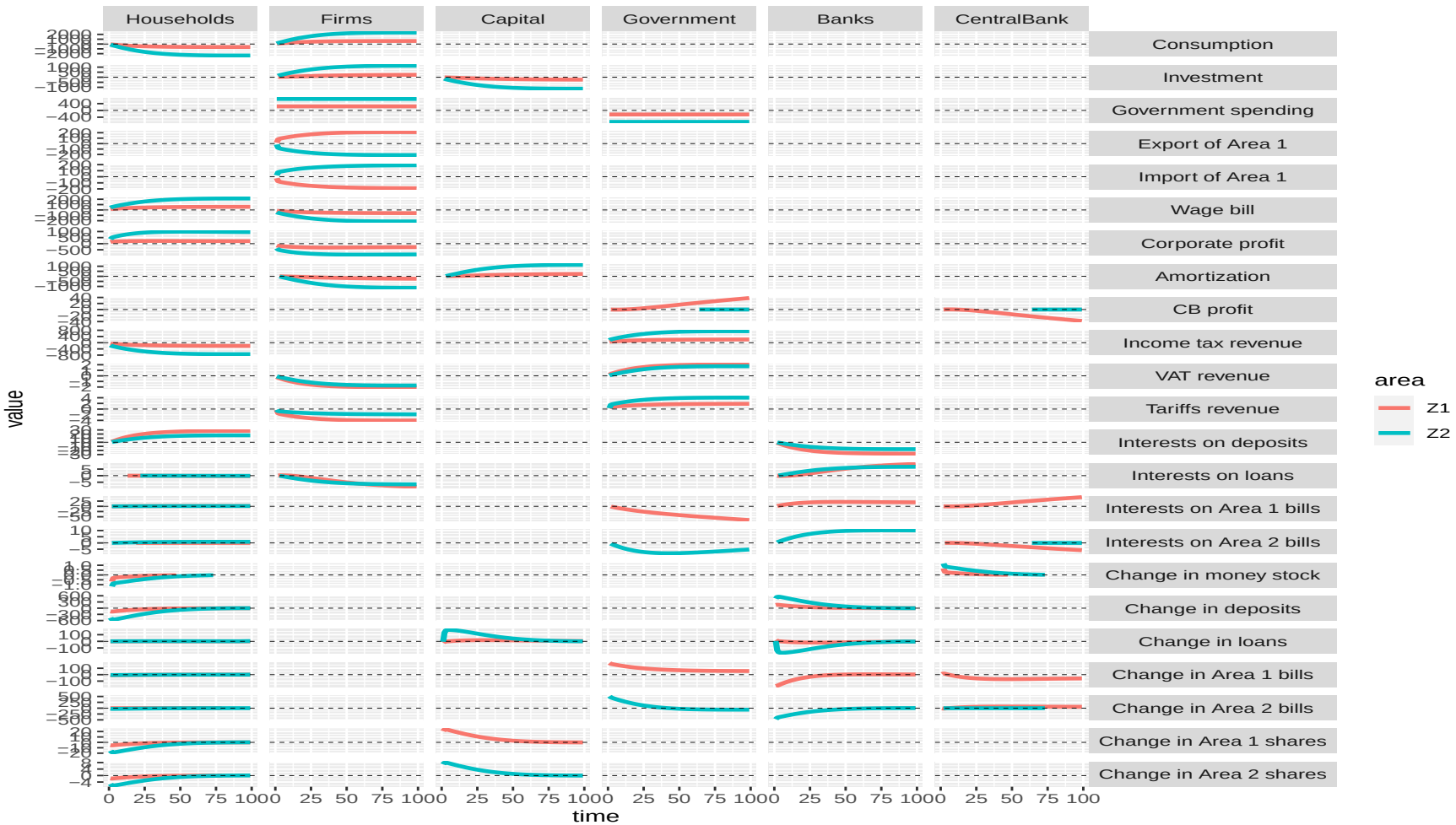
$$a_{ij} = a_{ij,-1} + \gamma_A(g) \cdot (a'_{ij,-1} - a_{ij,-1}) \tag{3}$$

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} & 0 \\ a_{21} & a_{22} & a_{23} & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} a'_{11} \leq a_{11} & a'_{12} \leq a_{12} & a'_{13} \leq a_{13} & a'_{14} \geq 0 \\ a'_{21} \leq a_{21} & a'_{22} \leq a_{22} & a'_{23} \leq a_{23} & a'_{24} \geq 0 \\ a'_{31} \leq a_{31} & a'_{32} \leq a_{32} & a'_{33} \leq a_{33} & a'_{34} \geq 0 \\ a'_{41} \geq 0 & a'_{42} \geq 0 & a'_{43} \geq 0 & 0 \end{pmatrix}$$

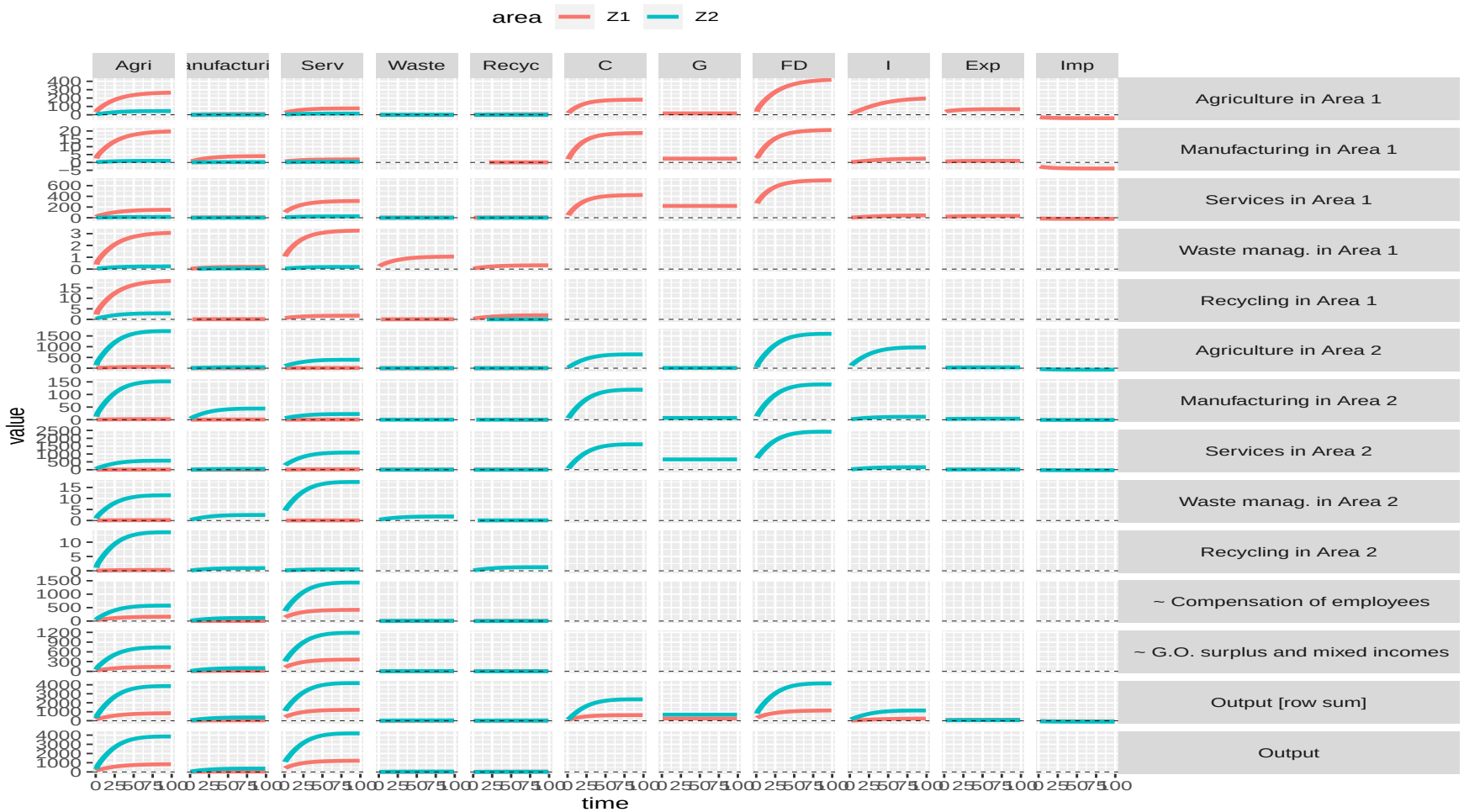
Balance Sheet



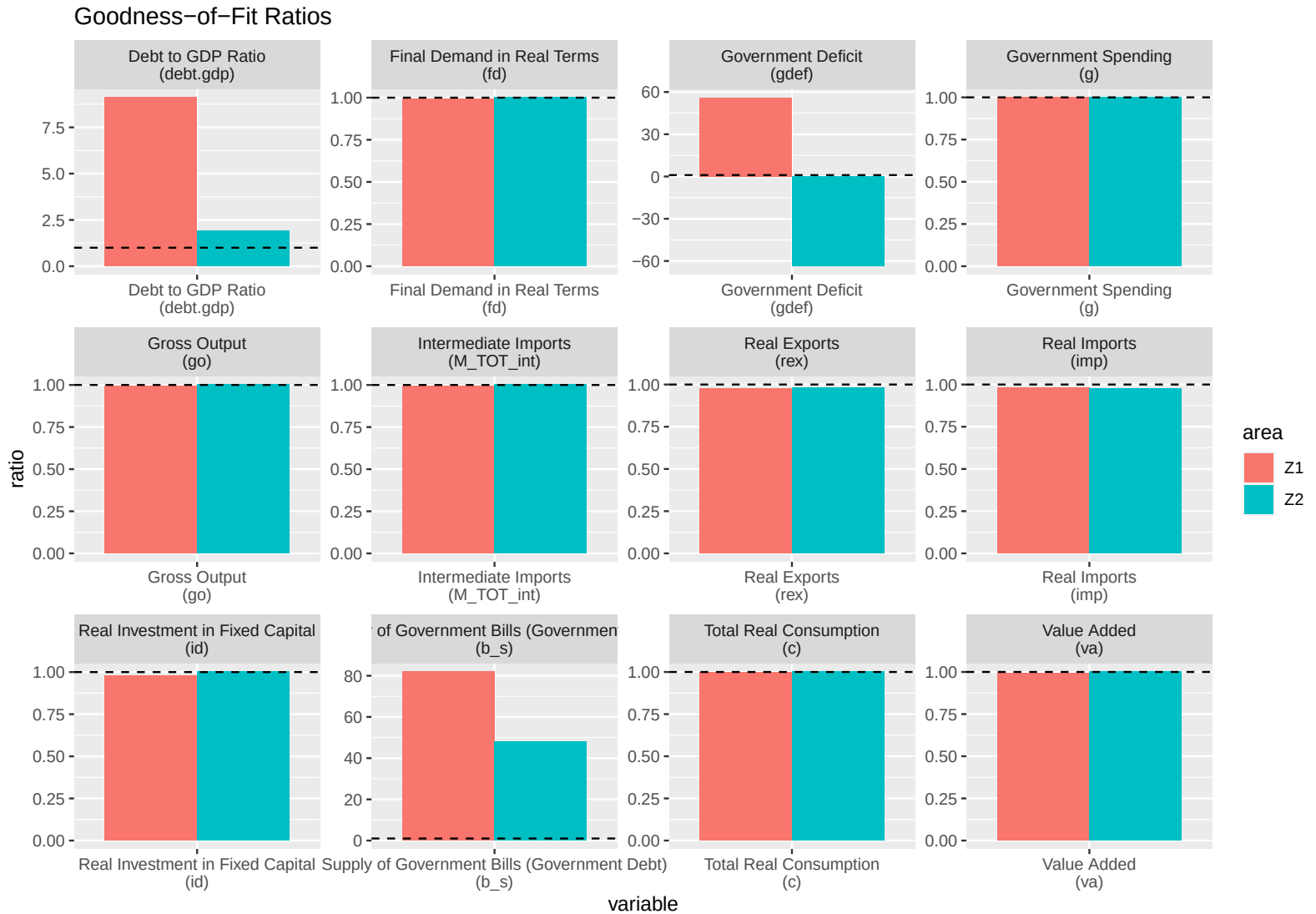
Transaction-Flow Matrix



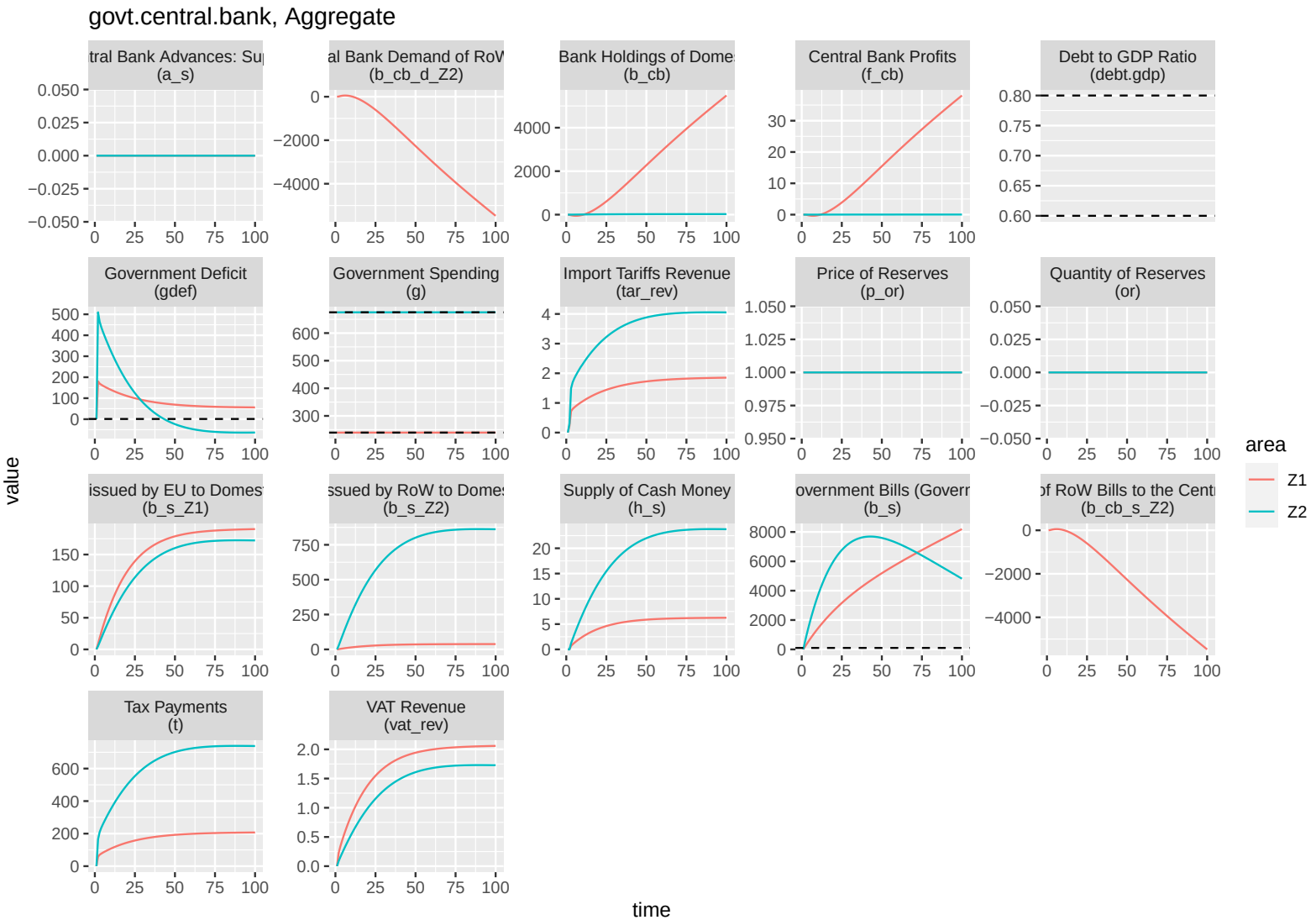
Multi-Region Input-Output



Calibration



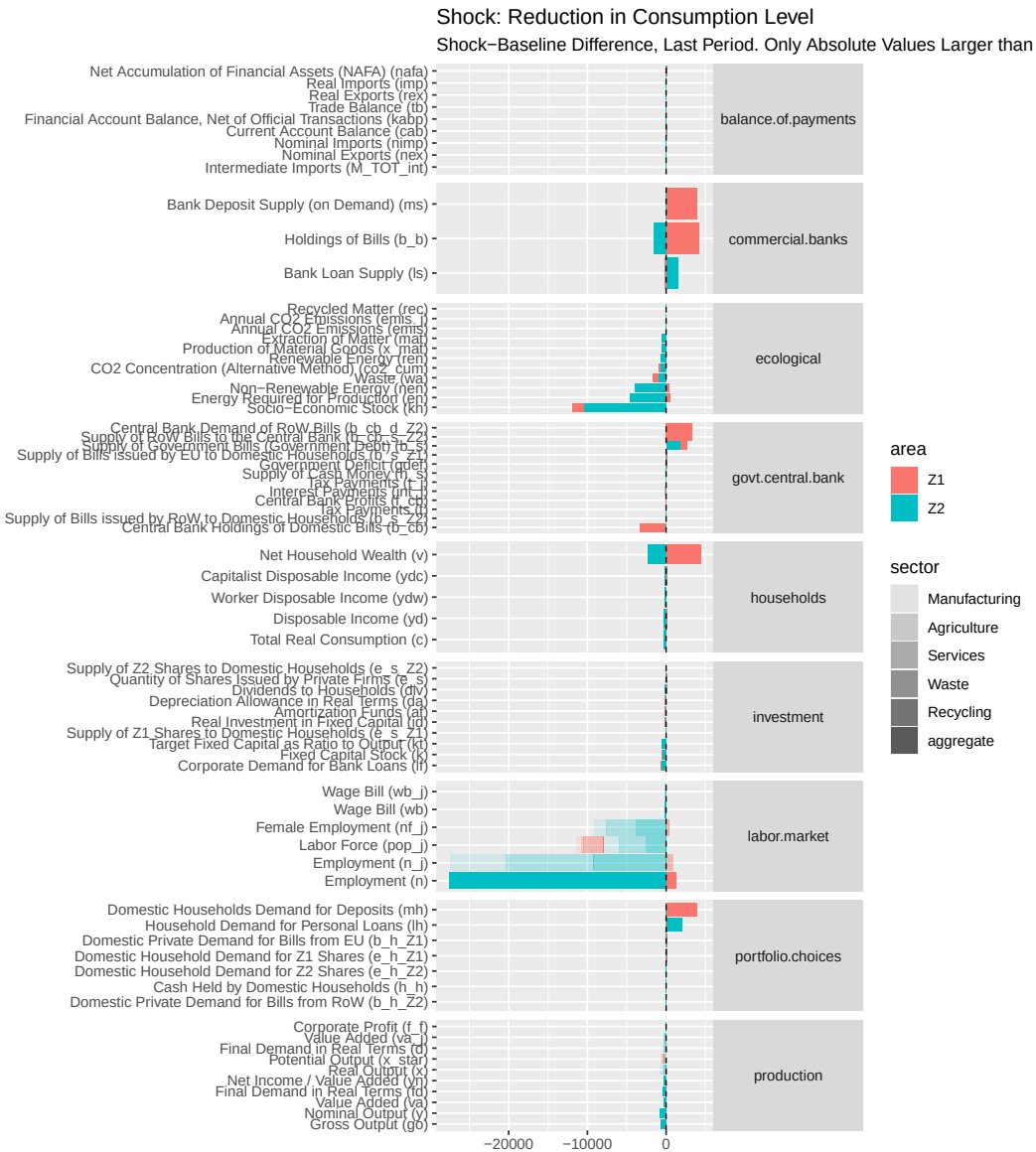
Government and Central Bank



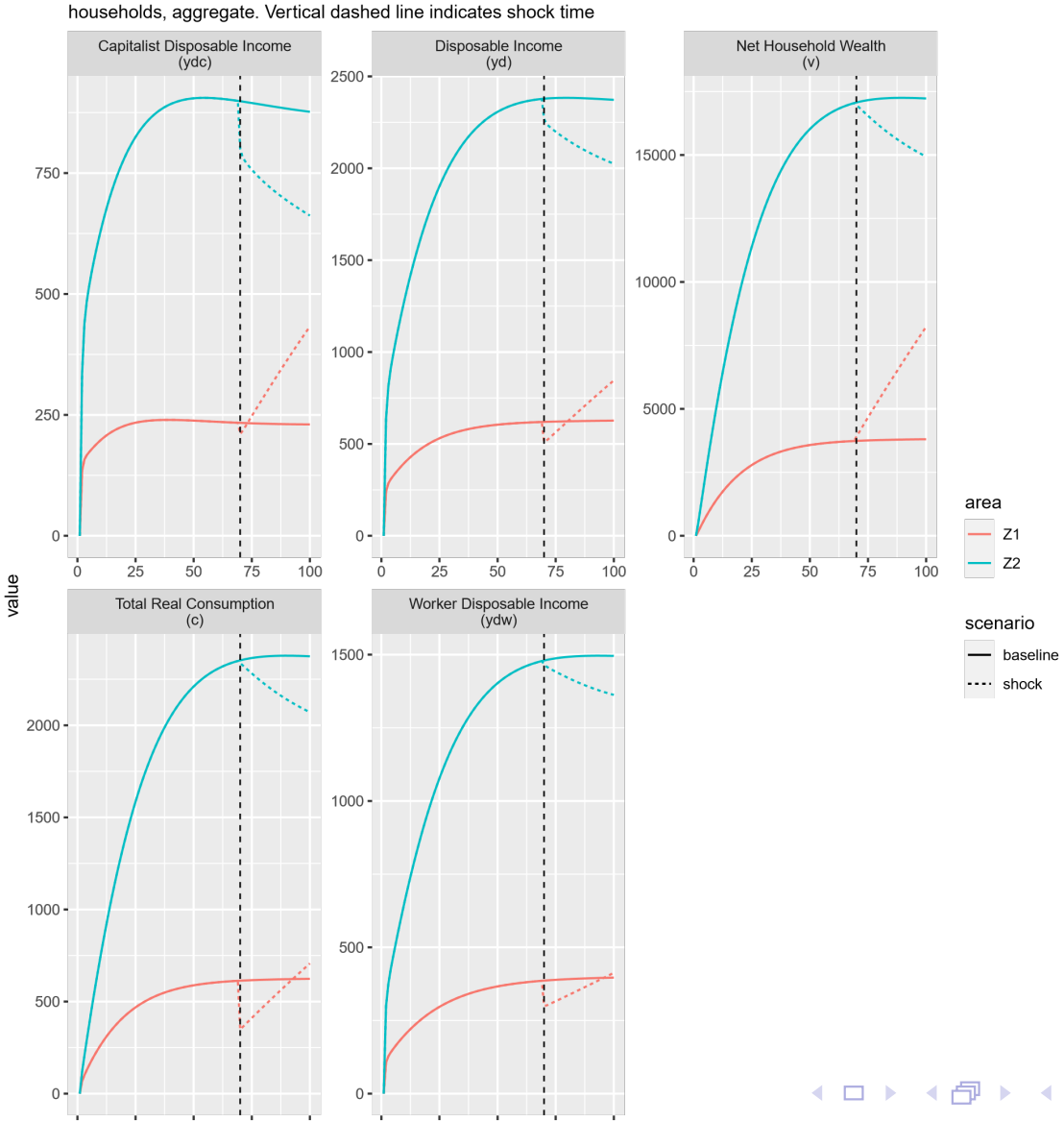
Shocks

Shock
Reduction in Consumption Level
Change in Consumption Composition towards Services
Product Life Time Extension
Higher Recycling Rate
Higher Propensity to Consume Green
Lower Extraction (or Conversion) Rate of Matter
Lower Discarding Rate of Socio-Economic Stock
Higher Renewable Energy Share
Higher Govt Spending towards Efficiency
More Selective Govt Spending towards Recycling Efficiency
More Progressive Taxation

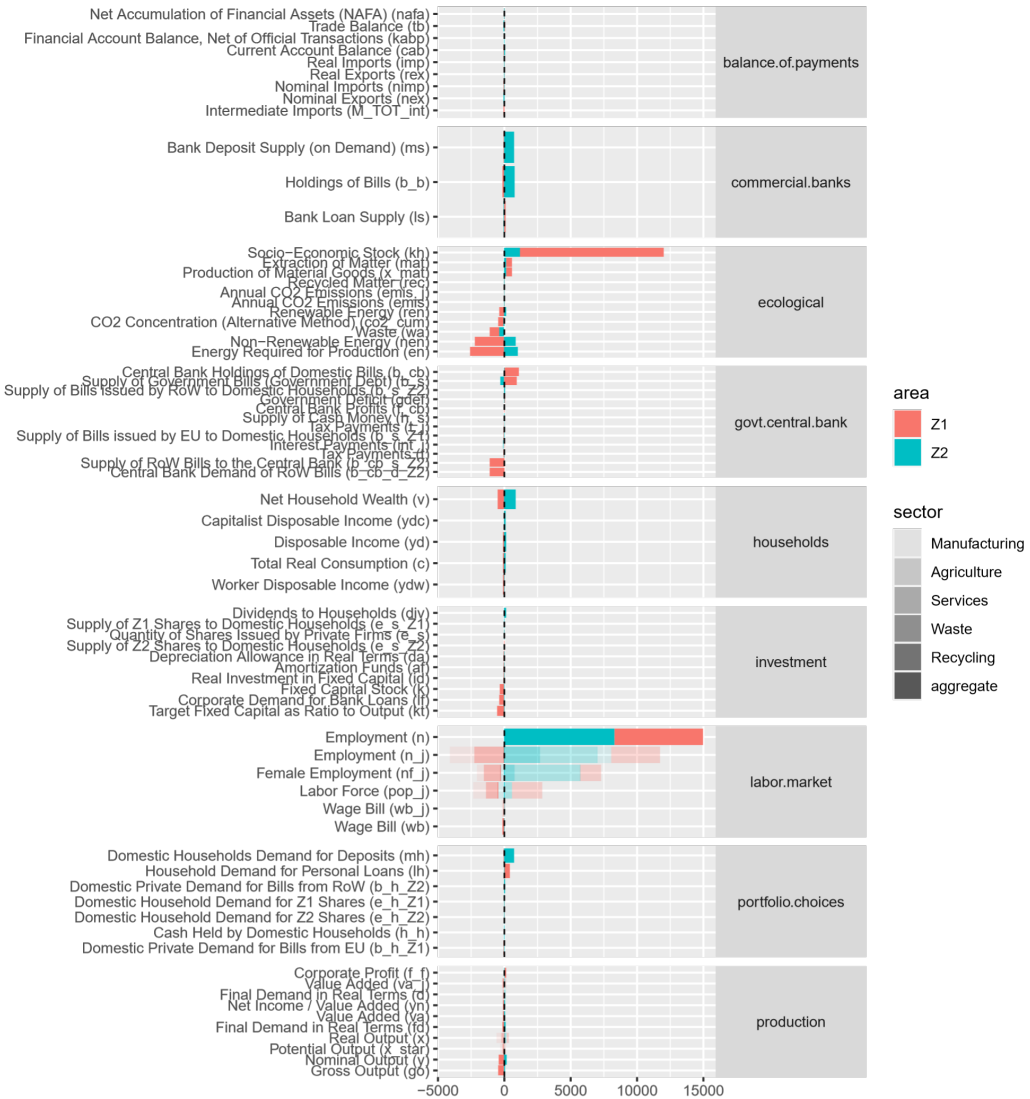
Reduction in Consumption Level



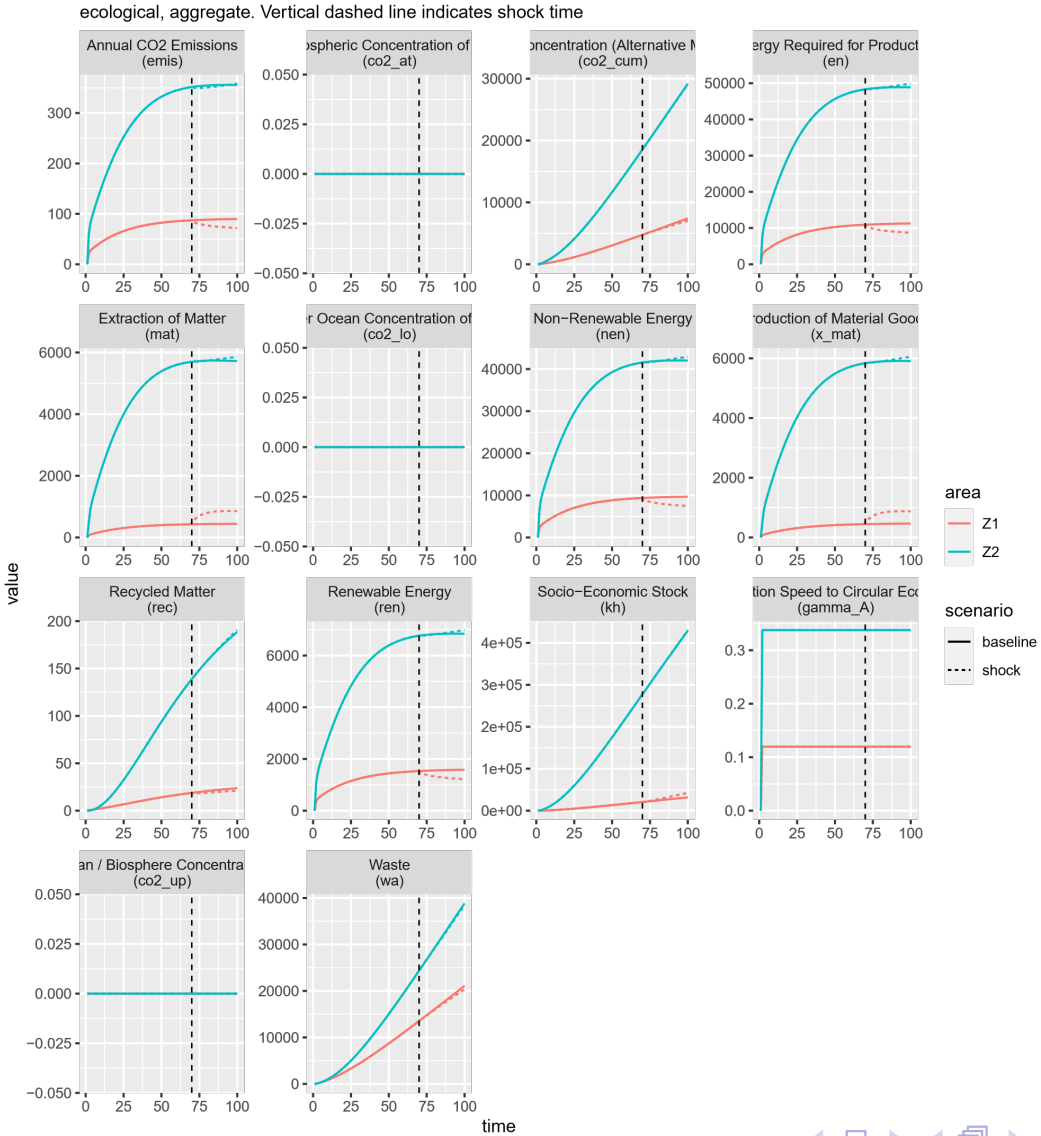
Reduction in Consumption Level: Households



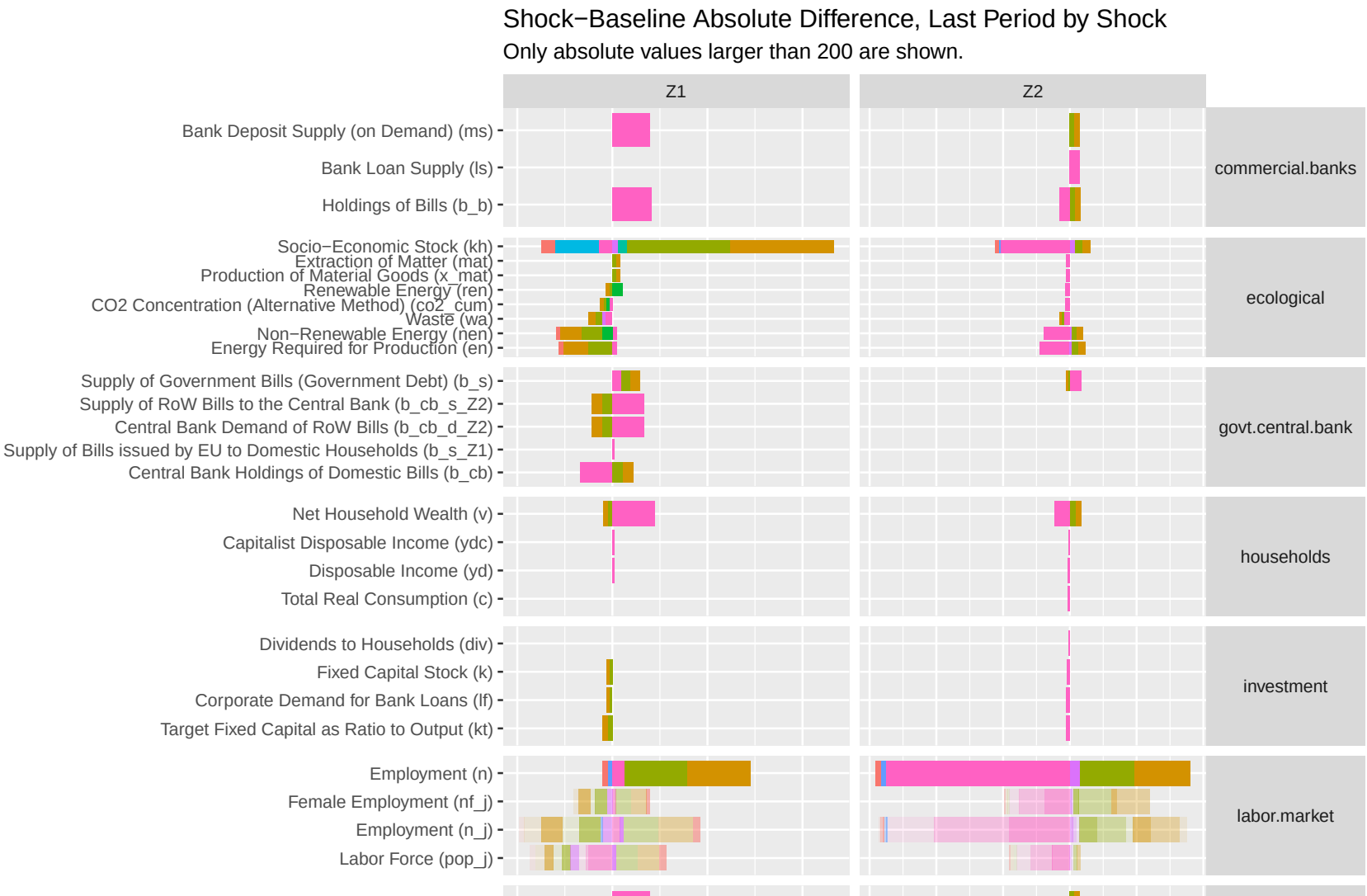
CE Transition



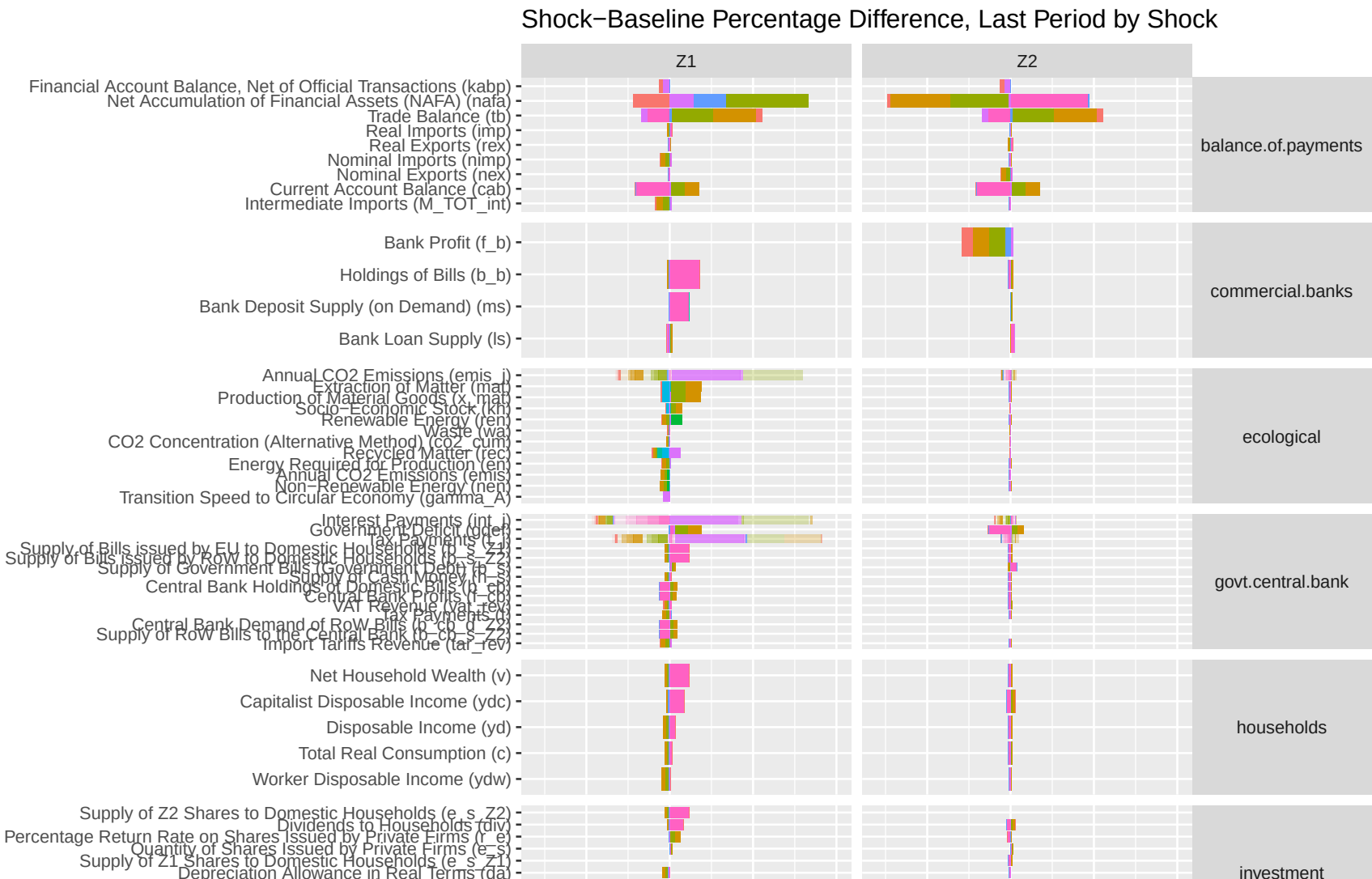
CE Transition: Ecological Indicators



Change by Shock, Difference



Change by Shock, Percent



Thank you!

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References I