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An Empirically Calibrated Prototype IO-SFC Model
of the Italian Economy

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INTRODUCTION

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– Since then, several ECO-SFC models have been developed.

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- Main limitation: high aggregation, little inter-industry detail.

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– Refer to: Hardt and O'Neill (2017); Fevereiro et al. (2025); Thomsen et al. (2025).

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State of the Art and Open Challenges

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– The reason: methodological complexity in integrating IO and SFC frameworks.

– Yet this integration is crucial to study economy-ecosystem interactions in a coherent way.

RECLASS. BALANCE-SHEET OF ITALY IN 2021

	Workers	Rentiers	Firms	Government	Banks	Central bank	Foreign	Total
Cash and reserves	130.44	70.24	0.00	0.00	10.82	-211.5	0.00	0.00
Deposits	1656.88	1355.62	0.00	0.00	-3012.50	0.00	0.00	0.00
Loans	-572.61	-190.87	-871.9	0.00	1635.39	0.00	0.00	0.00
Advances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T-bills	34.99	198.27	0.00	-2678.4	1366.29	211.5	867.34	0.00
Domestic securities	686.26	6041.83	-6728.1	0.00	0.00	0.00	0.00	0.00
Foreign securities	0.00	867.34	0.00	0.00	0.00	0.00	-867.34	0.00
Capital stock	0.00	0.00	7600.00	0.00	0.00	0.00	0.00	7600.00
Net financial wealth	-1935.96	-8342.43	0.00	2678.4	0.00	0.00	0.00	-7600.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Reclass. Transactions-Flow Matrix in 2021

	Workers	Rentiers	Firms		Government	Banks	Central bank	Foreign	Total
			Current	Capital					
Consumption	-407.94	-622.18	1030.12	0.00	0.00	0.00	0.00	0.00	0.00
Investment	0.00	0.00	357.21	-357.21	0.00	0.00	0.00	0.00	0.00
Government spending	0.00	0.00	394.72	0.00	-394.72	0.00	0.00	0.00	0.00
Export	0.00	0.00	582.19	0.00	0.00	0.00	0.00	-582.19	0.00
Import	0.00	0.00	-582.19	0.00	0.00	0.00	0.00	582.19	0.00
[Value added]			[1782.05]						
Wages	624.62	32.88	-657.50	0.00	0.00	0.00	0.00	0.00	0.00
Deprec. / Amort.	0.00	0.00	-357.21	357.21	0.00	0.00	0.00	0.00	0.00
Firms profit	0.00	653.34	-653.34	0.00	0.00	0.00	0.00	0.00	0.00
Banks profit	0.00	38.19	0.00	0.00	0.00	-38.19	0.00	0.00	0.00
Tax revenue	-218.74	-200.65	0.00	0.00	419.39	0.00	0.00	0.00	0.00
Interests on reserves	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interests on deposits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interests on loans	-8.59	-2.86	-13.08	0.00	0.00	24.53	0.00	0.00	0.00
Interests on advances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interests on T-bills	0.35	1.98	0.00	0.00	-26.78	13.66	2.11	8.67	0.00
Interests on domestic sec.s	10.29	90.63	-100.92	0.00	0.00	0.00	0.00	0.00	0.00
Interests on foreign sec.s	0.00	8.67	0.00	0.00	0.00	0.00	0.00	-8.67	0.00
Seigniorage income	0.00	0.00	0.00	0.00	2.11	0.00	-2.11	0.00	0.00
Change in cash and reserves	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in deposits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in loans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in advances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in T-bills	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in domestic sec.s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in foreign sec.s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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SELECTED TECHNICAL COEFFICIENTS

	Ind_1	Ind_2	Ind_3	Ind_4	Ind_5	Ind_6	Ind_7	Ind_8	Ind_9	Ind_10	Ind_11	Ind_12
Ind_1	0.0368797	0.0000007	0.0000007	0.0000013	0.0000007	8.00e-07	0.0000000	6.00e-07	0.0140400	0.0326833	0.0158261	0.0027586
Ind_2	0.0000057	0.0693607	0.0000138	0.0000329	0.0000157	1.66e-05	0.0000521	1.13e-05	0.0121683	0.0023488	0.0002212	0.0012697
Ind_3	0.0000000	0.0000000	0.0148670	0.0000001	0.0000000	0.00e+00	0.0000000	1.00e-07	0.2234907	0.0207926	0.0250413	0.0018627
Ind_4	0.0000000	0.0000000	0.0000000	0.0204673	0.0000000	0.00e+00	0.0000001	0.00e+00	0.0002744	0.0005054	0.0003423	0.0009458
Ind_5	0.0000000	0.0000000	0.0000000	0.0000000	0.0188265	0.00e+00	0.0000000	0.00e+00	0.0000000	0.0000000	0.0000000	0.0000000
Ind_6	0.0000012	0.0000027	0.0000029	0.0000069	0.0000033	3.50e-06	0.0000109	2.30e-06	0.0000031	0.0000045	0.0000028	0.0000003
Ind_7	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.00e+00	0.0001791	0.00e+00	0.0000000	0.0000000	0.0000000	0.0000000
Ind_8	0.0000010	0.0000024	0.0000023	0.0000048	0.0031689	2.90e-06	0.0000011	9.86e-05	0.0012323	0.0004455	0.0003160	0.0000758
Ind_9	0.0000002	0.0000005	0.0000005	0.0000021	0.0000007	5.00e-07	0.0000027	6.00e-07	0.0005523	0.0001243	0.0000024	0.0000138
Ind_10	0.0000014	0.0000040	0.0000037	0.0000080	0.0000041	4.80e-06	0.0000017	3.50e-06	0.0000048	0.0000323	0.0000049	0.0000026
Ind_11	0.0000009	0.0000025	0.0000023	0.0000052	0.0000026	2.90e-06	0.0000013	2.20e-06	0.0000030	0.0000058	0.0000036	0.0000007
Ind_12	0.0000032	0.0000080	0.0000079	0.0000169	0.0000087	9.90e-06	0.0000107	6.90e-06	0.0002764	0.0001950	0.0000705	0.0000342

INDUSTRIAL STRUCTURE

– Input-output relations

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(1) Total output: $\mathbf{x} = [\mathbf{I} - \mathbf{A}]^{-1} \cdot \mathbf{d}$

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(2) Domestic demand: $\mathbf{d} = \beta_w \cdot c_w + \beta_z \cdot c_z + \boldsymbol{\iota} \cdot i_d + \mathbf{gov} + \boldsymbol{\chi} \cdot ex$

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(3) GDP: $Y_n = \mathbf{p}^T \cdot (\mathbf{x} \cdot [\mathbf{I} - \mathbf{A}]) - \mathbf{p}_m^T \cdot \psi \cdot im$

PRICE SETTING

    – Unit prices and mark-ups

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(8) Working-class consumer price index: $p_w = \mathbf{p}^T \cdot \boldsymbol{\beta}_w$

HOUSEHOLDS

    – Income and consumption

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- Income and consumption

    (9) Workers' disposable income:
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(12) Personal loans: $L_w = L_{w,-1} \cdot (1 - \delta_w) + \theta_w \cdot YD_w$

NON-FINANCIAL FIRMS

– Capital and investment decisions

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(18) Retained profits: $\Pi_u = \eta \cdot \Pi_f$

(19) Firms' net borrowing: $L_f = L_{f,-1} + p_{id} \cdot id - AF - \Pi_u - \Delta E_s$

BANKS AND FINANCE

– Loans and Reserves

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– Bank Balance Sheet

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(22) Government securities held by banks: $B_b = M_s - L_d - H_b$

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(21) Bank reserves: $H_b = \rho \cdot M_{s,-1}$

– Bank Balance Sheet

(22) Government securities held by banks: $B_b = M_s - L_d - H_b$

(23) Bank advances: $A_d = -B_b$, if $B_b < 0$

BANKS AND FINANCE

– Loans and Reserves

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- Bank Profits

    (24) Bank profits:
    $\Pi_b = PAYM_b^L + PAYM_b^H + PAYM_b^B + PAYM_b^R - PAYM_b^M$

THE LABOUR MARKET

– Employment and Wages

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(27) Total employment: $N = \sum_{j=1}^{20} \mathbf{n}(j)$

INTEREST RATES AND RISK PREMIA

– Interest rate setting

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(28) Policy rate: $r = r^*$

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(30) Interest payments: $PAYM_f^L = r_{l,-1} \cdot L_{f,-1}$

THE GOVERNMENT

– Government Revenues and Expenditures

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– Government Revenues and Expenditures

(31) Net taxes paid by workers:
$$T_w = \tau_w^w \cdot WB \cdot (1 - \omega) + \tau_z \cdot PAYM_w^A + \tau_v \cdot V_{w,-1}$$

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(34) Government debt accumulation: $B_s = B_{s,-1} + DEF$

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THE CENTRAL BANK

– Central Bank Operations

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– Central Bank Operations

(35) Government securities held by the central bank:
$B_{cb} = B_s - B_h - B_b - B_{row}$

THE CENTRAL BANK

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(35) Government securities held by the central bank:
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(36) Cash issuance by the central bank: $H_s = H_{s,-1} + \Delta B_s$

PORTFOLIO EQUATIONS

– Asset Allocation by Workers

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– Asset Allocation by Workers

(37) Government securities held by workers:
$\frac{B_w}{V_w} = \lambda_{10}^w - \lambda_{11}^w \cdot r_m + \lambda_{12}^w \cdot r_b - \lambda_{13}^w \cdot r_e - \lambda_{14}^w \cdot (r_q + r_{cg}) - \lambda_{15}^w \cdot \frac{YD_w}{V_w}$

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  (39) Bank deposits as a buffer stock:
  $M_w = V_w + L_w - H_w - B_w - E_w$

FOREIGN SECTOR

– Trade balance

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(40) Exports: $ln(ex) = \epsilon_0 - \epsilon_1 \cdot ln(\frac{p_x}{p_m}) + \epsilon_2 \cdot ln(y_f)$

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(45) Long-run exchange rate: $xr^* = xr_{-1}^* - \sigma_{xr}^2 \cdot CAB$

PRICE EXPECTATIONS

– Price expectations:

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(46) Expected inflation rate: $\pi_w^e = \pi_{w,-1} + \sigma_w \cdot (\bar{\pi} - \pi_{w,-1})$

PRICE EXPECTATIONS

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(46) Expected inflation rate: $\pi_w^e = \pi_{w,-1} + \sigma_w \cdot (\bar{\pi} - \pi_{w,-1})$

(47) Expected price level (for working class): $p_w^e = p_{w,-1} \cdot (1 + \pi_w^e)$

ENVIRONMENTAL IMPACT

– Emissions accounting

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(48) Sectoral emissions: $\mathbf{emis} = \boldsymbol{\epsilon} \odot \mathbf{x}$

ENVIRONMENTAL IMPACT

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(48) Sectoral emissions: $\mathbf{emis} = \boldsymbol{\epsilon} \odot \mathbf{x}$

(49) Total emissions: $EMIS = \boldsymbol{\epsilon}^T \cdot \mathbf{x} = \sum_{j=1}^{20} \mathbf{emis}(j)$

HIDDEN EQUATION

– Redundant equation

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(36.B) Cash supply: $H_s = H_w + H_z + H_b$

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MODEL IMPLEMENTATION AND DATA

– Model implemented in an *R* environment.

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MODEL IMPLEMENTATION AND DATA

– Model implemented in an R environment.

– Equations expressed in discrete time.

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CALIBRATION AND SOURCES

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  Italian economy in 2021 (steady-state assumption):

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    - Average tax rate

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– Unit prices normalised to one in 2021.

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CROSS-SECTOR TRANSACTIONS IN 2021
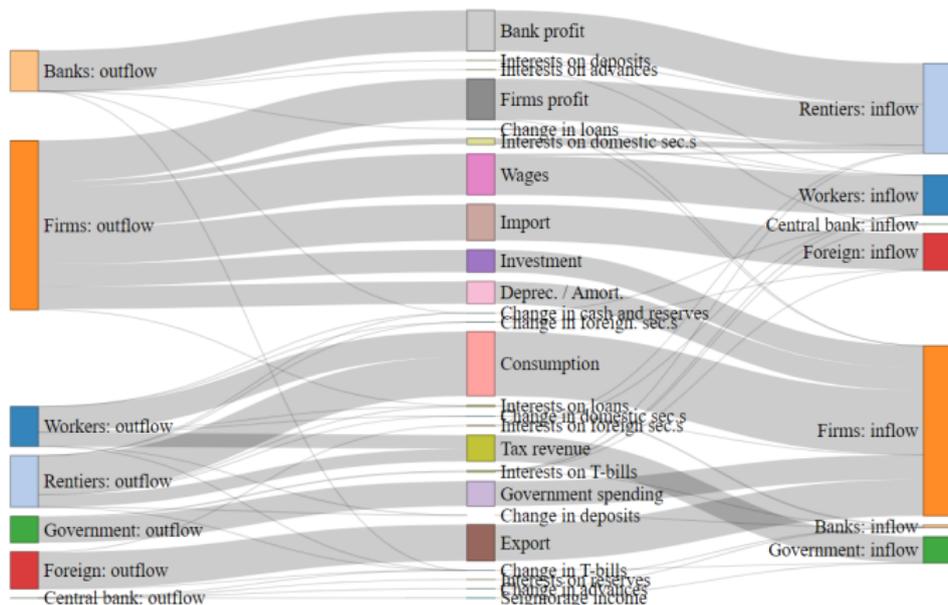
CROSS-INDUSTRY INTERDEPENDENCIES IN 2021
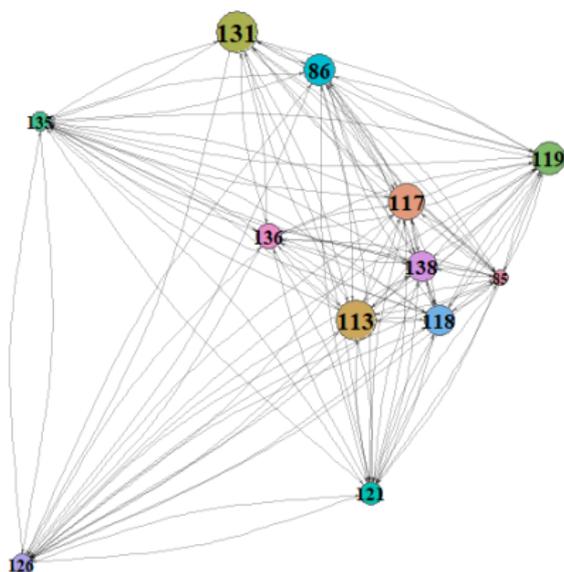
(a) Top 12
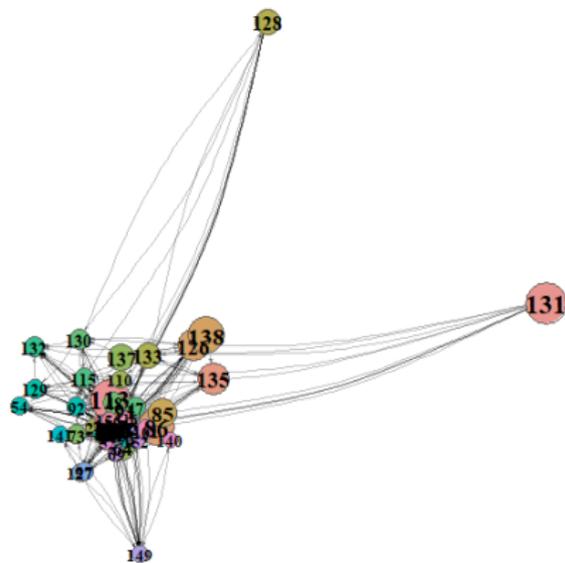
(b) Top 70

BASELINE ASSUMPTIONS AND SHOCKS

– Steady state in 2021: $DEF = 0$, $CAB = 0$, $C = YD$.

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Baseline Assumptions and Shocks

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BASELINE ASSUMPTIONS AND SHOCKS

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- One industry $\rightarrow$ one technique $\rightarrow$ one product.

- Alternative scenario: government spending (100 bn euros over 2025-2040).

- No targeted industries.

- Smooth adjustment of spending.
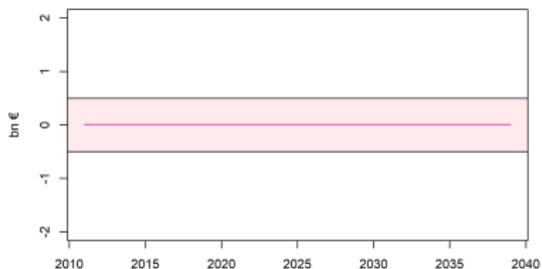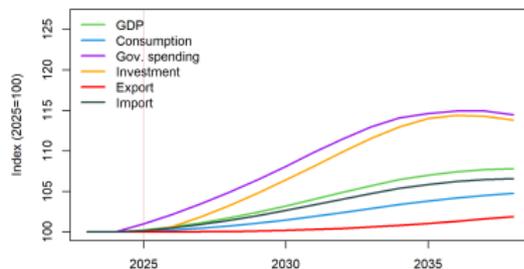
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SELECTED VARIABLES AFTER THE SHOCK

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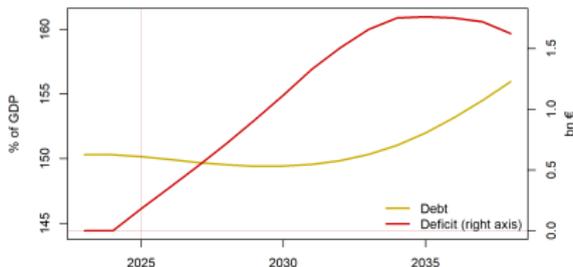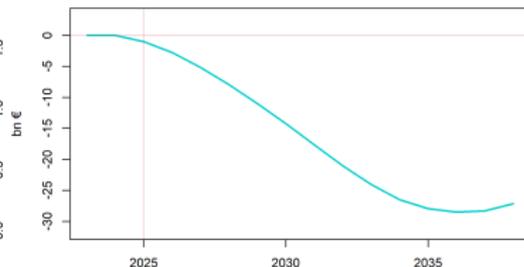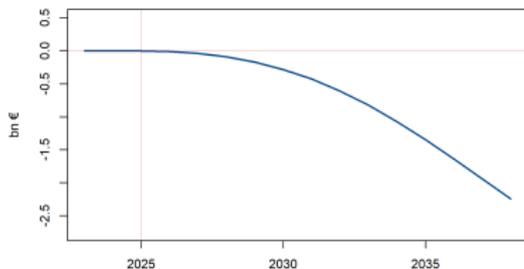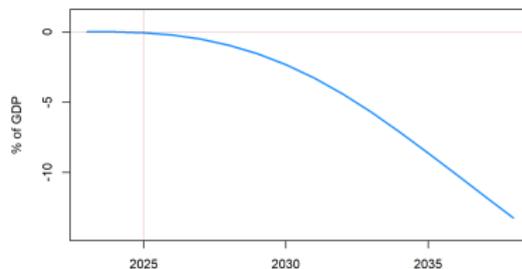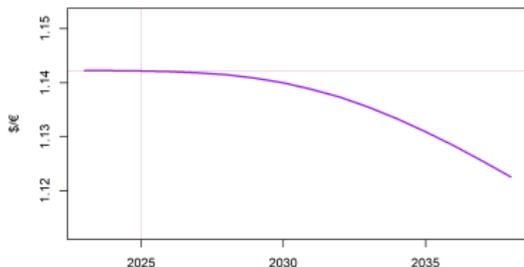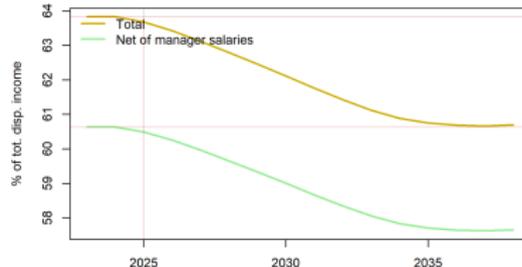
SELECTED VARIABLES AFTER THE SHOCK

Total GHG emissions

Unit prices by industry
- Production of electricity by coal
- Manufacture of basic iron and steel
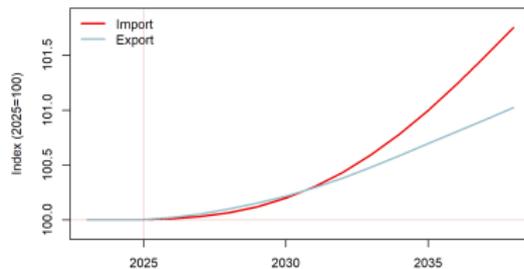- Manufacture and distribution of of gas
- Construction
- Other land transport
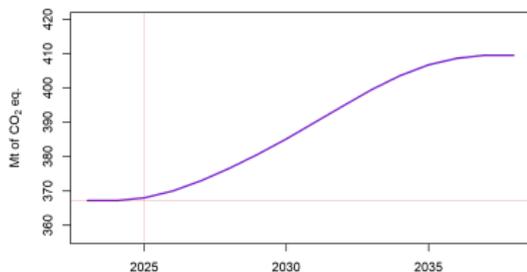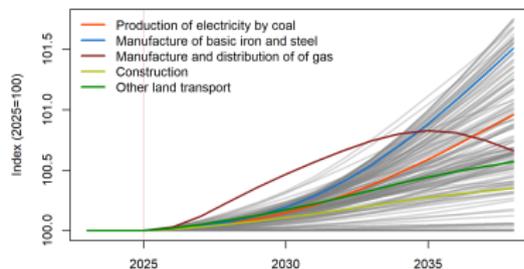
GDP deflator
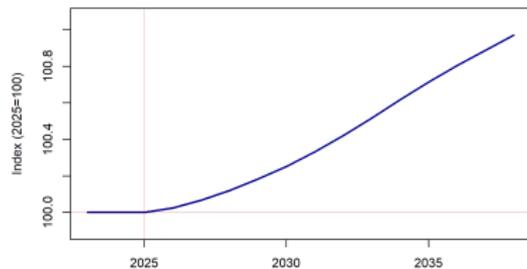
Import / export prices
- Import
- Export

FINAL REMARKS

– The chosen calibration method has drawbacks. However, it is
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simpler, quicker, and more reliable than more complex algorithms.

– The model works smoothly and is watertight. However, IO relations
must be carefully double-checked.

– Key message from early experiments: the transition takes time
(rebound) and is likely to have uneven effects on different social
groups.

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Thank you

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