Circular economy in a simplified input-output stock-flow consistent model

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JUST2CE

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Research questions

– Increasing interest in economy-ecosystem nexus and CE

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    2) To test a simple CE innovation

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- Solution: numerical simulations

Nominal value of assets and liabilities

Table 1: Balance sheet in $t = 20$ (baseline)

	Households	Firms	Government	Central Bank	Total
Money	25.63	0	0.00	-25.63	0
Bills	2.85	0	-28.48	25.63	0
Net financial wealth	-28.48	0	28.48	0	0
Total	0	0	0	0	0

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Money transactions and changes in stocks

TABLE 2: Transactions-flow matrix in $t = 20$ (baseline)

	Households	Firms	Government	Central Bank	Total
Consumption	-25.84	25.84	0	0	0
Government spending	0	9.55	-9.55	0	0
Output	0	[35.39]	0	0	0
Wages and salaries	35.39	-35.39	0	0	0
Taxes	-7.09	0	7.09	0	0
Interest payments	0.05	0	-0.05	0	0
Change in money stock	-2.26	0	0	2.26	0
Change in bills	-0.25	0	2.51	-2.26	0
Total	0	0	0	0	0

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- Total "real" consumption (constant prices) is:

$$c = \alpha_1 \cdot \frac{YD_{-1}}{p_{A,-1}} + \alpha_2 \cdot \frac{V_{-1}}{p_{A,-1}} \qquad (1)$$

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where: $\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$

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- If firms use a mark-up rule, the price vector is:

$$\mathbf{p} = w \cdot \mathbf{l} + \left[\begin{pmatrix} 1 \\ 1 \end{pmatrix} + \mathbf{m} \right] \odot \mathbf{A} \cdot \mathbf{p} \tag{6}$$

- The deflator for household consumption is:

$$p_A = \mathbf{p}^T \cdot \mathbf{b} \qquad (7)$$

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- Households' disposable income is:

$$YD = Y_n + r \cdot B_{h,-1} - T \qquad (10)$$

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- The net wealth of households is:

$$V = V_{-1} + YD - c \cdot p_A \qquad (14)$$

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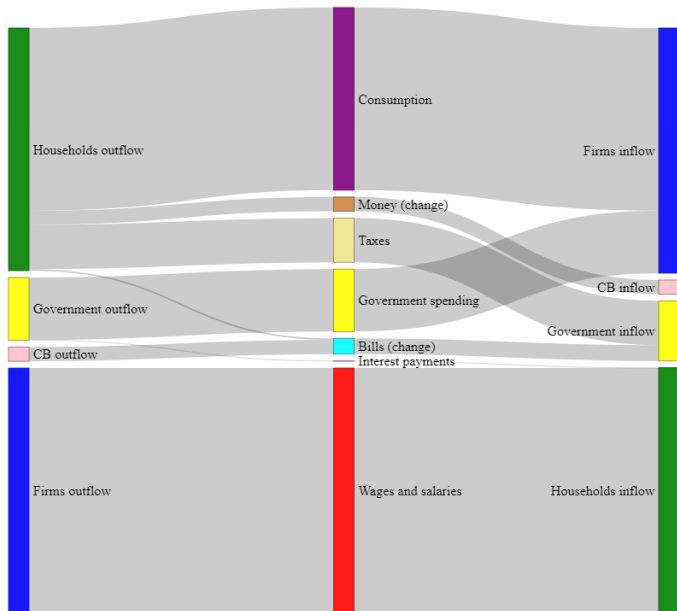
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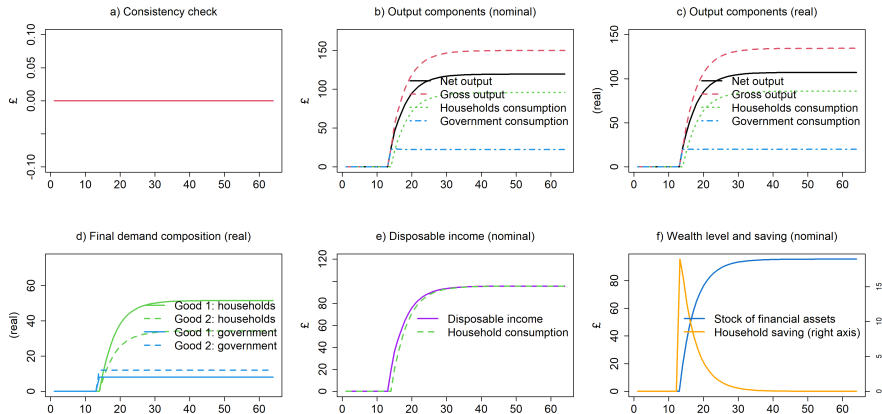$$\Delta H_h = \Delta H_s$$

- Model IO-SIM is complete.

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FIGURE 1. SANKEY DIAGRAM OF TFM (IN $t = 20$)

FIGURE 2. MODEL DYNAMICS: BASELINE

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- We can relax this assumption by noticing that the Leontief inverse can be expressed as a sum of power series:

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where n is the number of rounds and t_0 is the period where the demand changes

- Eq. (3B) shows that the output vector adjusts gradually to demand shocks as the time goes by

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OUTPUT GAPS AND PRICES

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- We can assume that industry gross mark-ups depend on output gaps:

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- This captures temporary demand pressures on supply conditions

FIGURE 3. OUTPUT AND PRICE CHANGES AFTER A DEMAND SHOCK
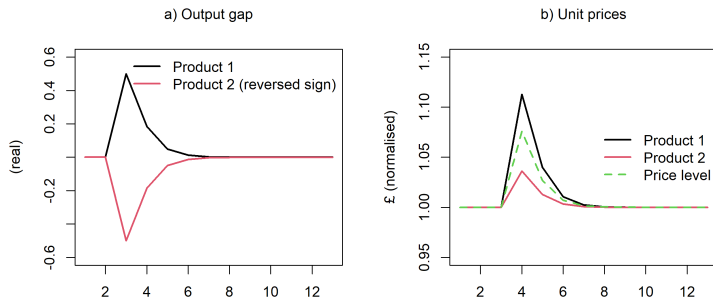
The circular economy

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- Consider a 3-sector economy: 2 goods + waste. If waste is not recycled, the matrix of technical coefficients is:

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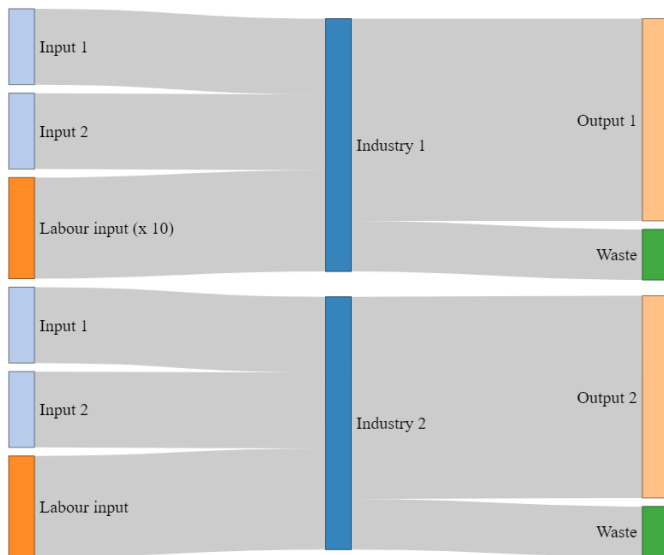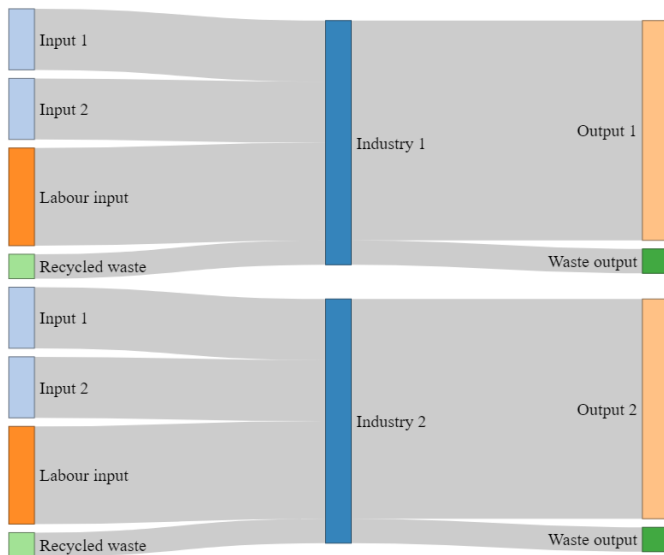
FIGURE 4. PRODUCTION STRUCTURE WITHOUT CE

FIGURE 5. PRODUCTION STRUCTURE WITH (PARTIAL) CE

- The new matrix will be:

$$\mathbf{B} = \begin{pmatrix} b_{11} \leq a_{11} & b_{12} \leq a_{12} & b_{13} \geq 0 \\ b_{21} \leq a_{21} & b_{22} \leq a_{22} & b_{23} \geq 0 \\ b_{31} \geq a_{31} & b_{32} \geq a_{32} & 0 \end{pmatrix}$$

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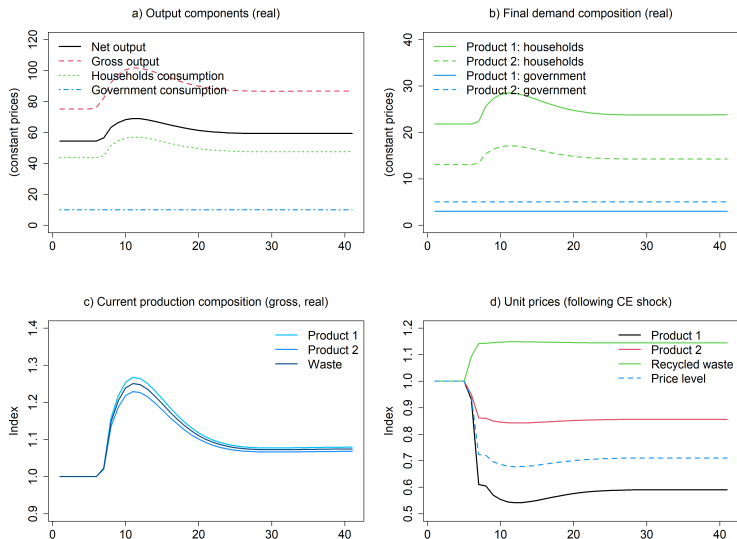- The increase in waste efficiency entails an increase in the related technical coefficients (•)

- Mind the rebound effect!

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FIGURE 6. CE POLICY IN A "2-INDUSTRY + WASTE" MODEL

a) Output components (real)
- Net output
- Gross output
- Households consumption
- Government consumption

b) Final demand composition (real)
- Product 1: households
- Product 2: households
- Product 1: government
- Product 2: government

c) Current production composition (gross, real)
- Product 1
- Product 2
- Waste

d) Unit prices (following CE shock)
- Product 1
- Product 2
- Recycled waste
- Price level

Final remarks

- Simplified though it is, IO-SIM provides the base for more sophisticated models

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- The main issue seems to be the consistency and availability of data...

Thank you

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