LUBS 5101M

Macroeconomics

UNIVERSITY OF LEEDS

2020/2021

Lecture 13

SFC Models II: Going Deeper

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First section

The paradox of thrift in the PC model

Memo: Lecture 12, Model PC

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Figure M1 - Evolution of total income, disposable income and consumption following an increase in 100 points in the rate of interest on bills

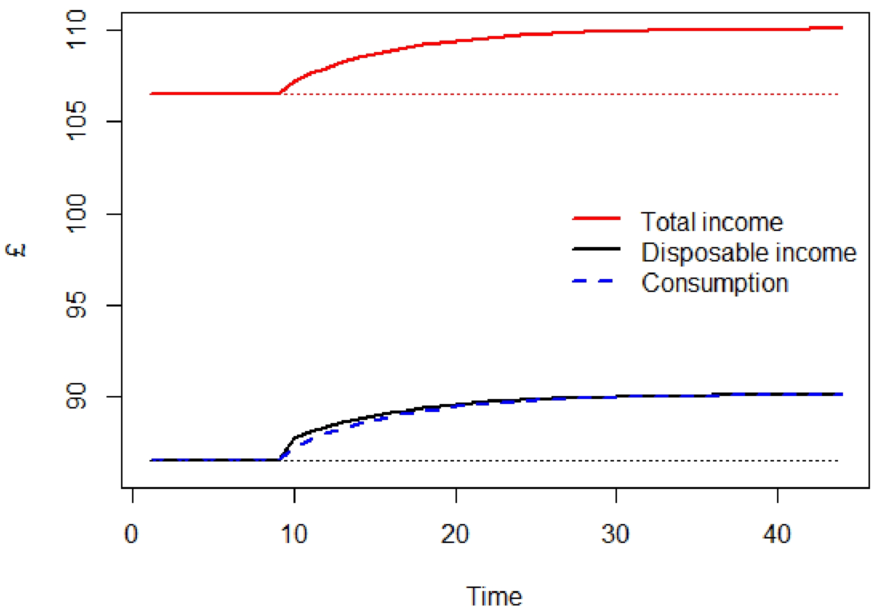
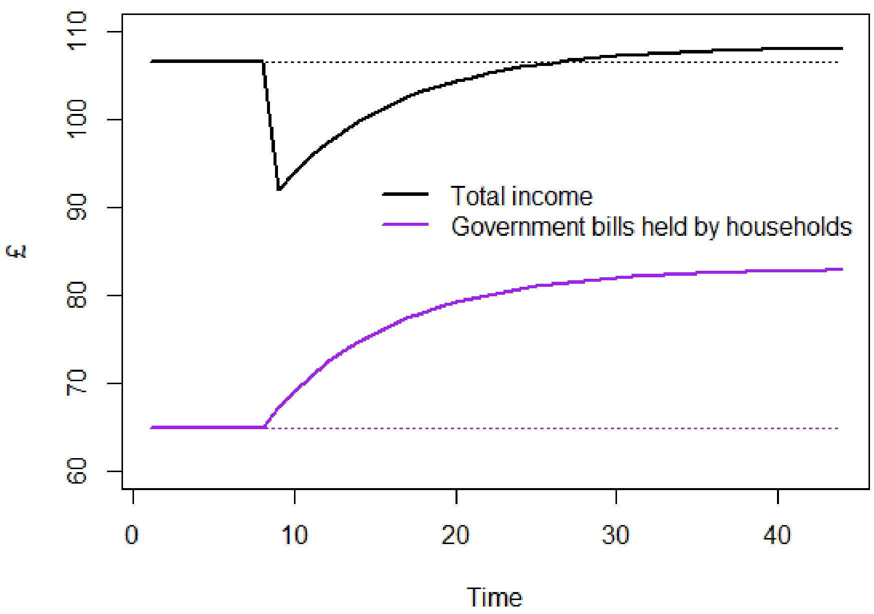


Figure M2 - Evolution of total income and bill holdings of households following an increase in the propensity to save out of income



1. Interest, consumption, saving

In the basic PC model an increase in the interest rate leads to an increase in the steady-state level of income (Figure M1), because it increases the flow of payments from the government to households.

Notice that the propensity to consume out of income is likely to be a negative function of rentiers' share of income. So, let us assume that the propensity to consume is a negative function of the interest rate:

$$\alpha_1 = \alpha_{10} - \alpha_{11} \cdot r_{-1} \qquad (12)$$

If we add equation (12) to equations (1) to (11), national income shrinks following an increase in r. However, this only holds in the short run!

The higher propensity to save (due to the higher interest rate) boosts household wealth, thus generating a higher steady-state income (Figure M2). This contradicts the paradox of thrift!

2. Short- vs long-run effects

Figure 4 - Evolution of national income, consumption, disposable income and wealth following an increase in the interest rate

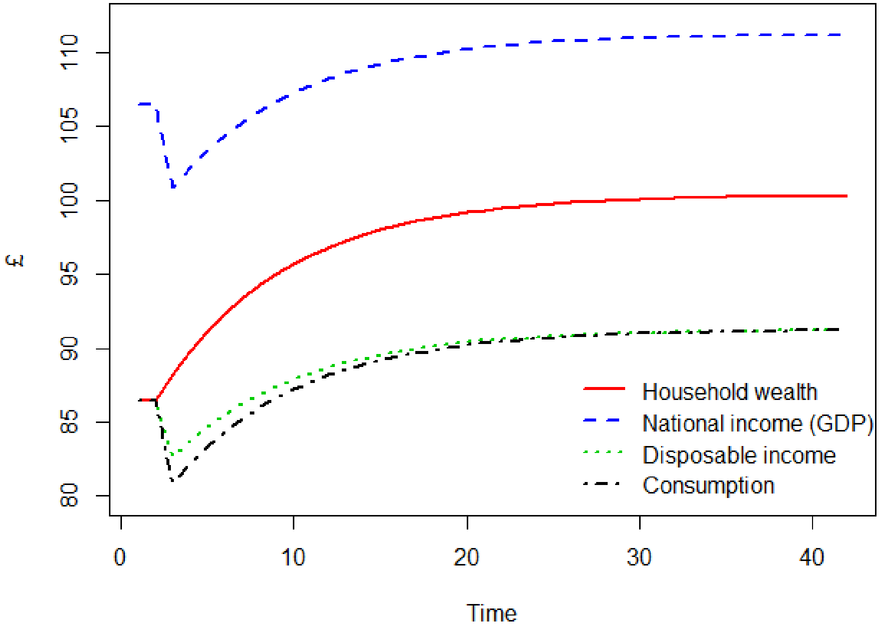
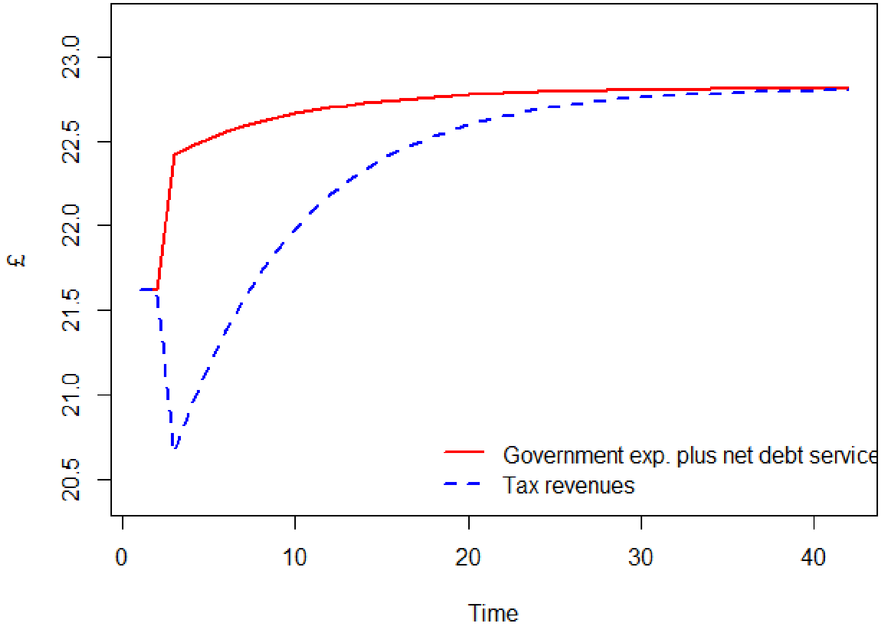


Figure 5 - Evolution of government receipts and expenditures following an increase in the interest rate



3. Are the (Neo)Classics right?

In a simple model where firms do not invest in fixed capital and households can subscribe government bills, a higher saving rate brings about a higher steady-state level of income (or output).

Paradoxically, this neoclassical result arises if and only if private agents (households) hold government bills. By contrast, if government deficit was fully covered by money issues, changes in the propensity to save would entail no effect on the long-run level of output.

Notice that the recessionary impact of a higher interest rate can be recovered in the short run by linking the propensity to consume with income distribution.

Besides, if firms are allowed to invest in fixed capital, and investment is a function of expected demand, the paradox of thrift holds in the long run too. We discuss this point in the next section.

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Second section

A simple SFC model with bank money

1. Model BMW: assumptions

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This is a model developed in chapter 7 of Godley and Lavoie (2007). BMW stands for bank-money world, because there is only one kind of *financial* assets: bank deposits held by households. Firms' investment in fixed capital is (partially) funded by bank loans.

Key assumptions are as follows:

- Closed economy and no ecosystem
- Three agents: households, firms, banks
- A/L: loans, deposits, tangible (or fixed) capital
- Investment funded by loans and internal funds
- Target capital to output ratio
- Zero net profits
- No State, no outside money (cash)

2. Model BMW: balance sheet

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	Households	Production firms	Banks	Σ
Deposits	$+M_h$		$-M_s$	0
Loans		$-L_f$	$+L_s$	0
Fixed capital		$+K$		$+K$
Balance (net worth)	$-V_h$	0	0	$-V_h$
Σ	0	0	0	0

Notes: A '+' before a magnitude denotes an asset; a '–' denotes a liability.

Tip: unlike a financial asset, a real or tangible asset (K) is not matched by a liability, because it is not a claim of someone against someone else!

3. Model BMW: T-F matrix

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	Households	Production firms: Current	Production firms: Capital	Banks: Current	Banks: Capital	Σ
Consumption	$-C_d$	$+C_s$				0
Investment		$+I_d$	$-I_d$ Equation (8)			0
[Production]		$[Y]$				
Wages	$+WB$	$-WB$				0
Depreciation		$-AF$	$+AF$			0
Int. on loans		$-r_{l,-1} \cdot L_{f,-1}$		$+r_{l,-1} \cdot L_{s,-1}$		0
Int. on deposits	$+r_{m,-1} \cdot M_{h,-1}$			$-r_{m,-1} \cdot M_{s,-1}$		0
Δ in loans			$+\Delta L_f$		$-\Delta L_s$	0
Δ in deposits	$-\Delta M_h$				$+\Delta M_s$	0
Σ	0	0	0	0	0	0

Notes: A '+' before a magnitude denotes a receipt or a source of funds; a '–' denotes a payment or a use of funds

4. Model BMW: equations

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Model BMW equations

Supply of consumption goods:	$C_s = C_d$	(1)
Supply of investment goods:	$I_s = I_d$	(2)
Labour supply:	$N_s = N_d$	(3)
Supply of loans:	$L_s = L_{s,-1} + \Delta L_d$	(4)
Total gross production:	$Y = C_s + I_s$	(5)
Wage bill (as residual income):	$WB_d = Y - r_{l,-1} \cdot L_{d,-1} - AF$	(6)
Amortisation funds:	$AF = \delta \cdot K_{-1}$	(7)
Demand for loans:	$L_d = L_{d,-1} + I_d - AF$	(8)
Disposable income:	$YD = WB_s + r_{m,-1} \cdot M_{d,-1}$	(9)
Deposits held by households:	$M_h = M_{h,-1} + YD - C$	(10)
Supply of deposits:	$M_s = M_{s,-1} + \Delta L_s$	(11)
Return rate on deposits:	$r_m = r_l$	(12)
Wage bill:	$WB_s = w \cdot N_s$	(13)

(*cont'd*)

- Identity
- Equilibrium condition
- Behavioural equation

4. Model BMW: equations (cont'd)

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Model BMW equations (*cont'd*)

Demand for labour:	$N_d = \frac{Y}{pr}$	(14)
Wage rate:	$w = \frac{WB_d}{N_d}$	(15)
Consumption:	$C_d = \alpha_0 + \alpha_1 \cdot YD + \alpha_2 \cdot M_{h,-1}$	(16)
Capital stock:	$K = K_{-1} + I_d - DA$	(17)
Depreciation allowances:	$DA = \delta \cdot K_{-1}$	(18)
Target capital stock:	$K^T = \kappa \cdot Y_{-1}$	(19)
Gross investment:	$I_d = \gamma \cdot (K^T - K_{-1}) + DA$	(20)
Interest rate on loans:	$r_l = \bar{r}_l$	(21)
Redundant equation:	$M_h = M_s$	

- Identity
- Equilibrium condition
- Behavioural equation

5. Model BMW: dynamics

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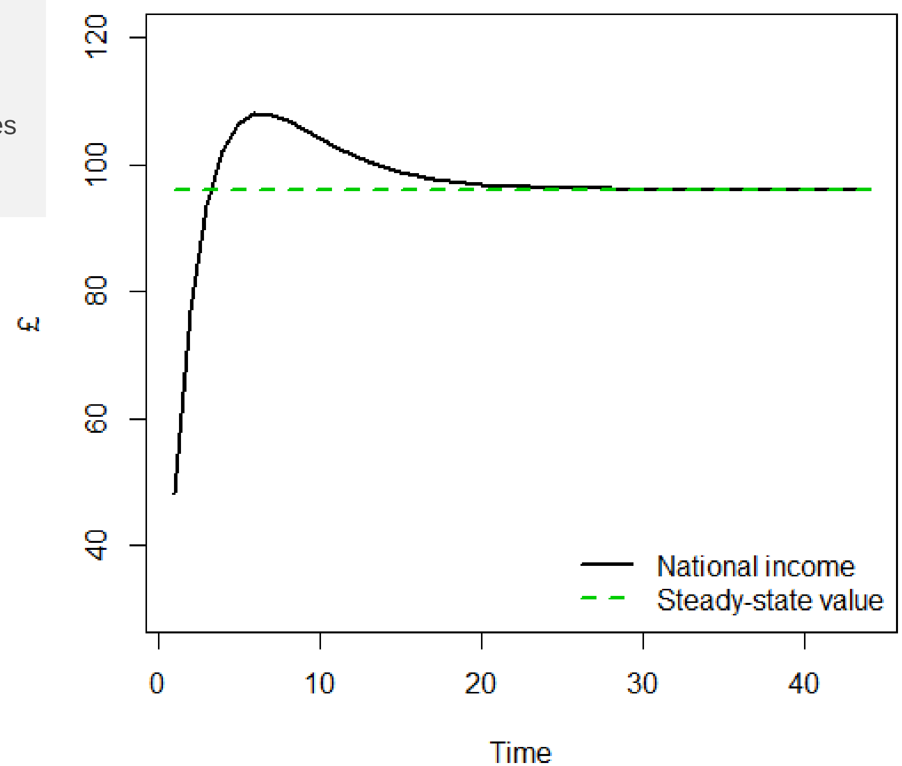
Stationary (steady-state) solution: $Y^* = \dfrac{\alpha_0}{(1-\alpha_1)\cdot(1-\delta\cdot\kappa)-\alpha_2\cdot\kappa}$

Tip: how to find the steady-state

Use equations (1), (2), (16) and (20) in Y identity, that is, equation (5). Next, use equation (9) in Y and equation (6) in equation (9). Notice that $K = K^T = \kappa \cdot Y$ and $M = L = K$, under steady state. Replace variables with respective equations and solve for Y^*.

Figure 6 - Evolution of national income



$\alpha_0 = 12$
$\alpha_1 = 0.75$
$\alpha_2 = 0.40$
$\delta = 0.15$
$\kappa = 1$

$Y^* = 96$

6. BMW BS under steady-state

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	Households	Production firms	Banks	Σ
Deposits	+96		−96	0
Loans		−96	+96	0
Fixed capital		+96		+96
Balance (net worth)	−96	0	0	−96
Σ	0	0	0	0

Notes: A '+' before a magnitude denotes an asset; a '–' denotes a liability.

7. TFM BMW under steady-state

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	Households	Production firms		Banks		Σ
		Current	Capital	Current	Capital	
Consumption	−86.4	+86.4				0
Investment		+9.6	−9.6			0
[Production]		[+96]				
Wages	+82.56	−82.56				0
Depreciation		−9.6	+9.6			0
Int. on loans		−3.84		+3.84		0
Int. on deposits	+3.84			−3.84		0
Δ in loans			0		0	0
Δ in deposits	0				0	0
Σ	0	0	0	0	0	0

Notes: A '+' before a magnitude denotes a receipt or a source of funds; a '–' denotes a payment or a use of funds

8. Model BMW: higher α_0

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Figure 7 - Evolution of household disposable income and consumption, following an increase in autonomous consumption expenditures

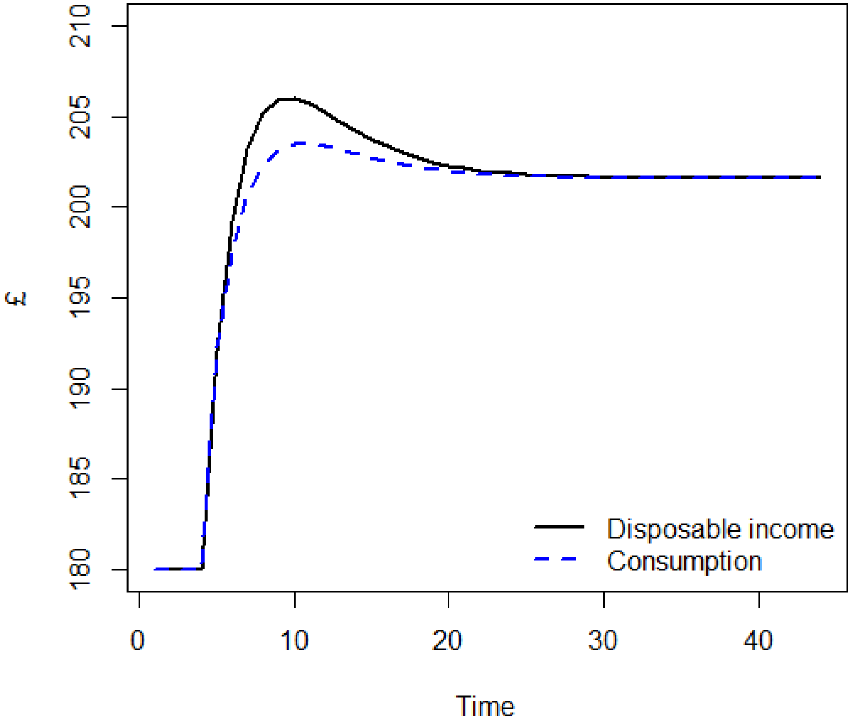
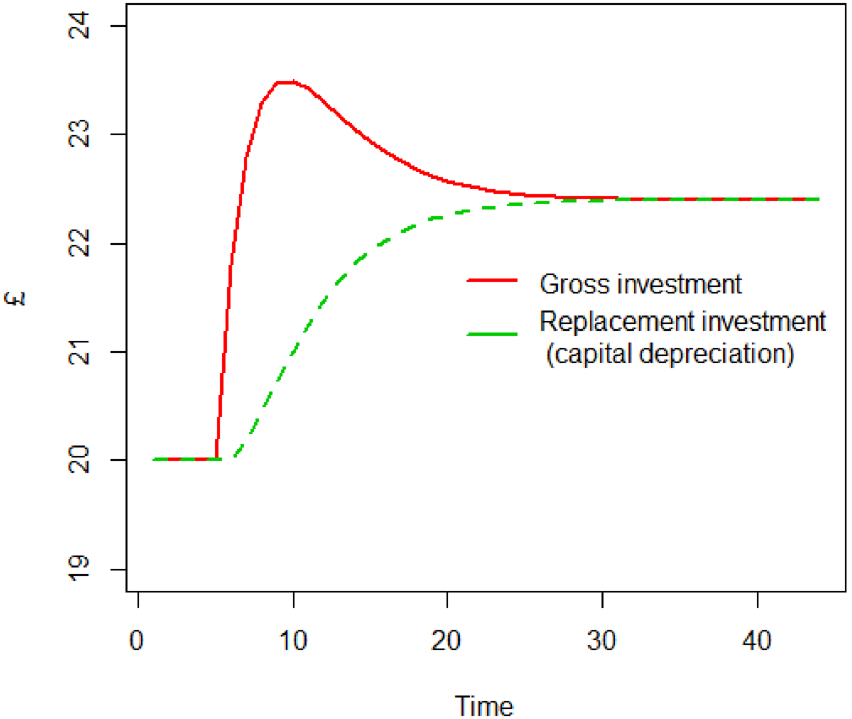


Figure 8 - Evolution of gross investment and depreciation allowances, following an increase in autonomous consumption expenditures



9. Model BMW: higher $s_1 = (1 - \alpha_1)$

Figure 9 - Evolution of household disposable income and consumption, following an increase in the propensity to save out of disposable income

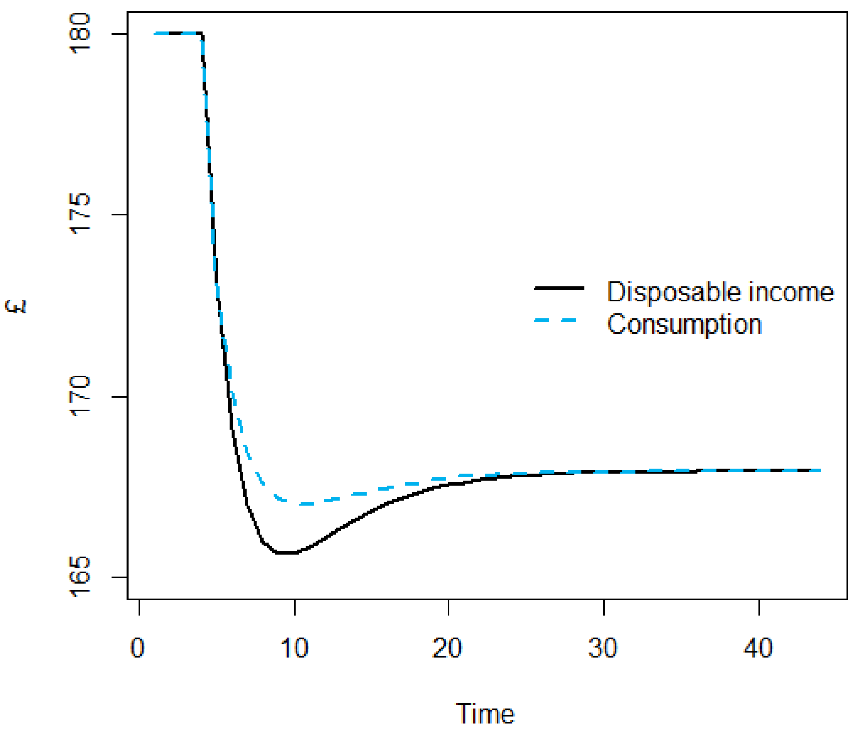
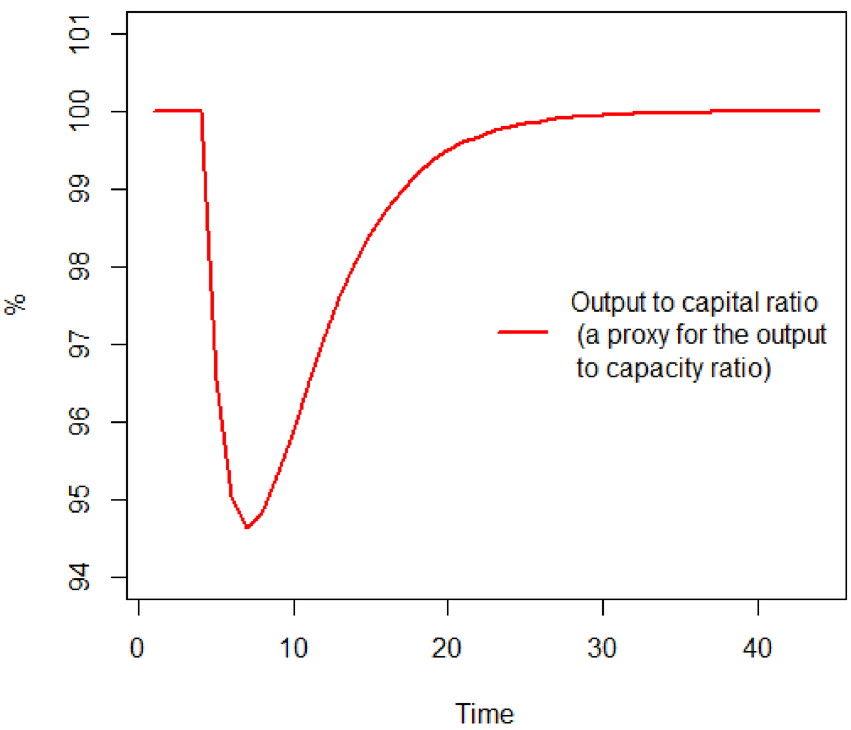


Figure 10 - Evolution of the output to capital ratio following an increase in the propensity to save out of disposable income



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Third section

SFC ecological macroeconomic models: an introduction

1. SFC ecological macro

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"Ecological macroeconomics is an emerging interdisciplinary field that examines the macroeconomy as part of the ecosystem, taking explicitly into account the biophysical limits of a finite planet" (Dafermos et al. 2017, p. 191).

SFC ecological macroeconomics models augment conventional SFC macroeconomic models with a sound physical stock-flow accounting (inspired by the pioneering wok of Georgescu-Roegen) .

This allows examining the impact of economic and financial activities on the ecosystem as well as the impact of global warming, pollution and hazardous waste on social, economic and financial variables.

In line with the post-Keynesian tradition, production is demand-led. However, supply-side constraints arising from environmental changes are also considered.

2. A comprehensive model

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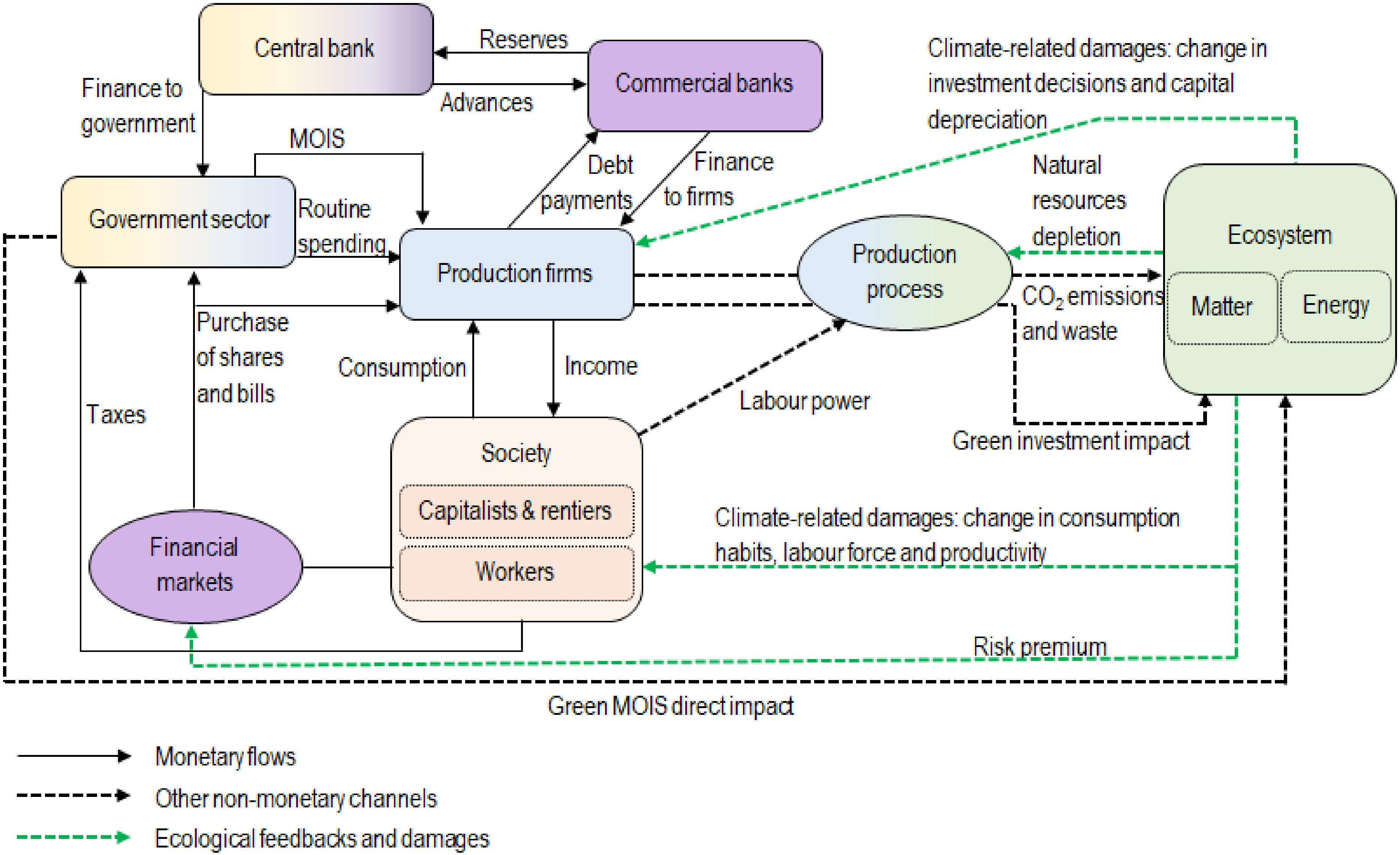

3. Ecological accounting

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Conventional SFC matrices are associated with two physical matrices:

- The physical flow matrix: accounting for the First and the Second Law of Thermodynamics. Matter and energy are transformed (not created or destroyed) by the economic process.
- The physical stock-flow matrix: defining the change in the stocks of things that directly influence human activities, e.g. natural reserves of matter and energy, and the socio-economic stock.

Taken together, these two matrices provide the accounting structure for the ecosystem equations.

4. Physical flow matrix

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	Material balance	Energy balance
Inputs		
Extracted matter	$+MAT$	
Renewable energy		$+ER$
Non-renewable energy	$+CEN$	$+EN$
Oxygen	$+O_2$	
Outputs		
Industrial emissions	$-EMIS_{in}$	
Waste	$-WA$	
Dissipated energy		$-ED$
Change in socio-economic stock	$-\Delta K_{se}$	
Σ	0	0

Source: Dafermos et al. 2017

Notes: Matter is measured in Gt while energy is measured in EJ. A '+' sign denotes inputs in the socio-economic system, whereas '–' denotes outputs.

5. Physical stock-flow matrix

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	Material reserves	Energy reserves	Atmospheric CO_2 concentration	Socio-economic stock	Hazardous waste
Initial stock	$K_{m,-1}$	$K_{en,-1}$	$CO_{2\,AT,-1}$	$K_{se,-1}$	HWS_{-1}
Resources converted into reserves	$+CONV_m$	$+CONV_{en}$			
CO_2 emissions (global)			$+EMIS$		
Production of material goods				$+Y_{mat}$	
Non-recycled hazardous waste					$+haz \cdot WA$
Extraction/use of matter/energy	$-MAT$	$-EN$			
Net transfer to oceans/biosphere			$+TR^*$		
Demolition of socio-economic stock				$-DES$	
Final stock	K_m	K_{en}	$CO_{2\,AT}$	K_{se}	HWS

Source: Dafermos et al. 2017

Notes: Matter is measured in Gt while energy is measured in EJ. A '+' sign denotes additions to the opening stock, whereas '–' denotes reductions; * $TR = +(\phi_{11} - 1) \cdot CO_{2\,AT,-1} + \phi_{21} \cdot CO_{2\,UP,-1}$.

6. Model ECO-PC: assumptions

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The economic side of the model is based on model PC developed in chapter 4 of Godley and Lavoie (2007).

Following Dafermos et al. (2017), the additional assumptions are as follows:

- Climate-related damages affect consumption
- Production requires extraction of matter and use of energy
- Only a share of matter is recycled
- Only a share of energy is renewable
- Industrial emissions are linked with the use of energy
- Atmospheric temperature depends (also) on CO_2 emissions
- Damages depend on atmospheric temperature
- Population growth is affected by hazardous waste
- Potential output is defined by a Leontief function (including matter and energy)
- The price level depends on output gap

7. Model ECO-PC: equations

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Selected Model ECO-PC equations

New consumption function:	$C = (\alpha_1 \cdot YD + \alpha_2 \cdot V_{-1}) \cdot (1 - d_{T,-1})$	(5B)
Energy used:	$E = \epsilon \cdot Y$	(E1)
Renewable energy:	$ER = \eta \cdot E$	(E2)
Non-renewable energy:	$EN = E - ER$	(E3)
Stock of energy reserves:	$K_E = K_{E,-1} + CONV_E - EN$	(E4)
Converted resources:	$CONV_E = \sigma_E \cdot RES_E$	(E5)
Energy resources:	$RES_E = RES_{E,-1} - CONV_E$	(E6)
Industrial emissions:	$EMIS_{IN} = \beta \cdot EN$	(E7)
Climate-related damages:	$d_T = 1 - \frac{1}{1+\eta_1 \cdot T_{AT} + \eta_2 \cdot T_{AT}^2 + \eta_3 \cdot T_{AT}^z}$	(E8)
Potential output:	$Y^L = \min\left(a \cdot LF \cdot h, \frac{K_{M,-1}+REC}{\mu}, \frac{K_{E,-1}}{\epsilon}\right)$	(E9)
Price level:	$p = \pi_0 + \pi_1 \cdot (Y_{-1} - Y_{-1}^L)$	(E10)

Note 1: $0 \leq d_T \leq 1$ and η_3, z are such that: $d_T = 0.5\ if\ T_{AT} = +6\ °C$.

Note 2: Additional equations are necessary to close the model.

- Identity
- Equilibrium condition
- Behavioural equation

8. Matter and energy balances

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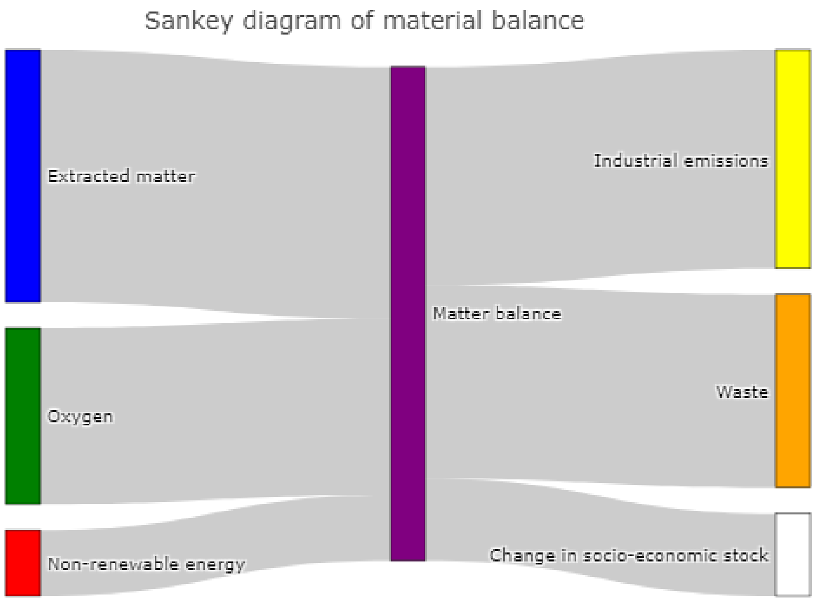

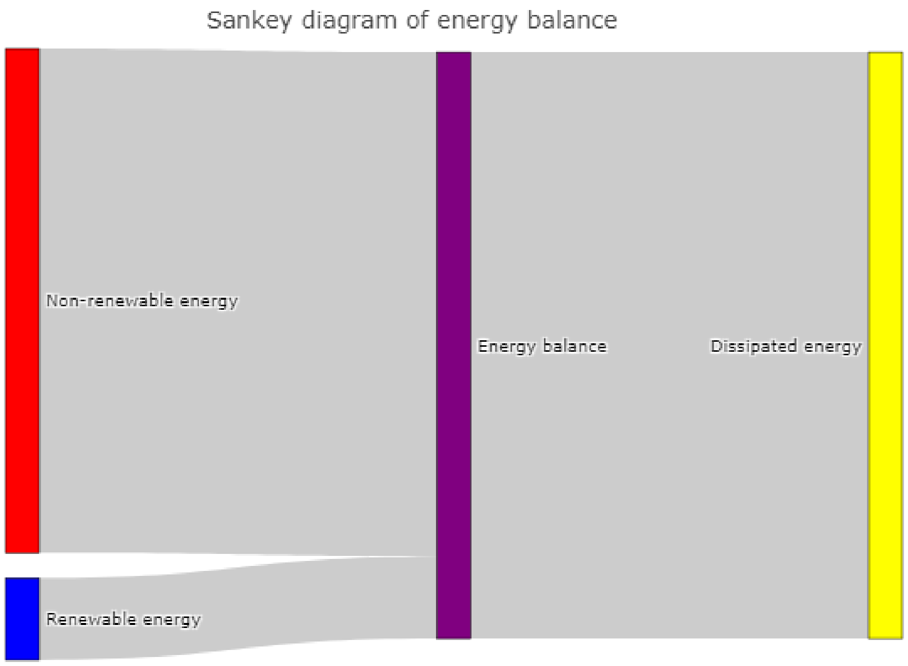

9. CO_2 emissions and temperature

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Figure E.1 - CO2 annual emissions following an increase in 100 points in the rate of interest on bills (difference with baseline value)

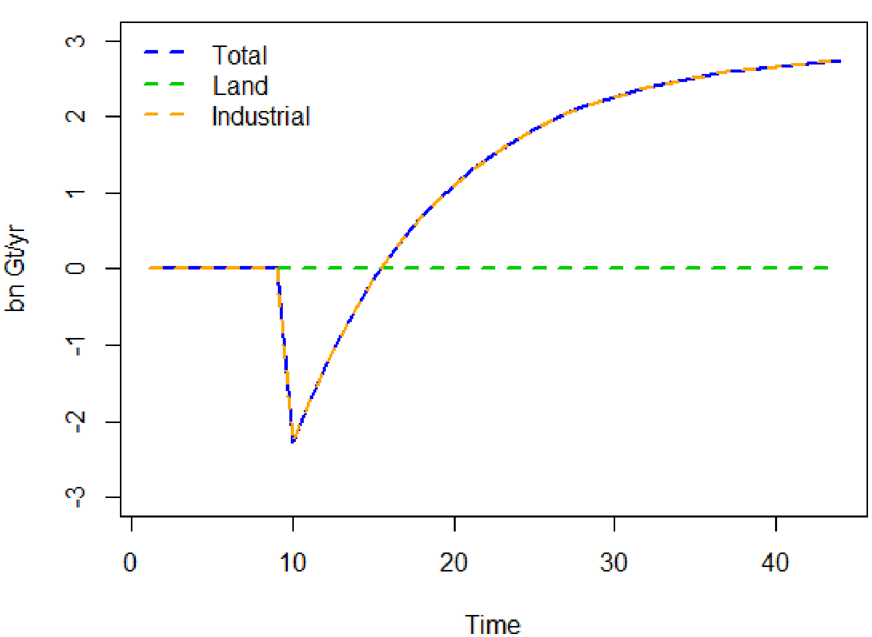
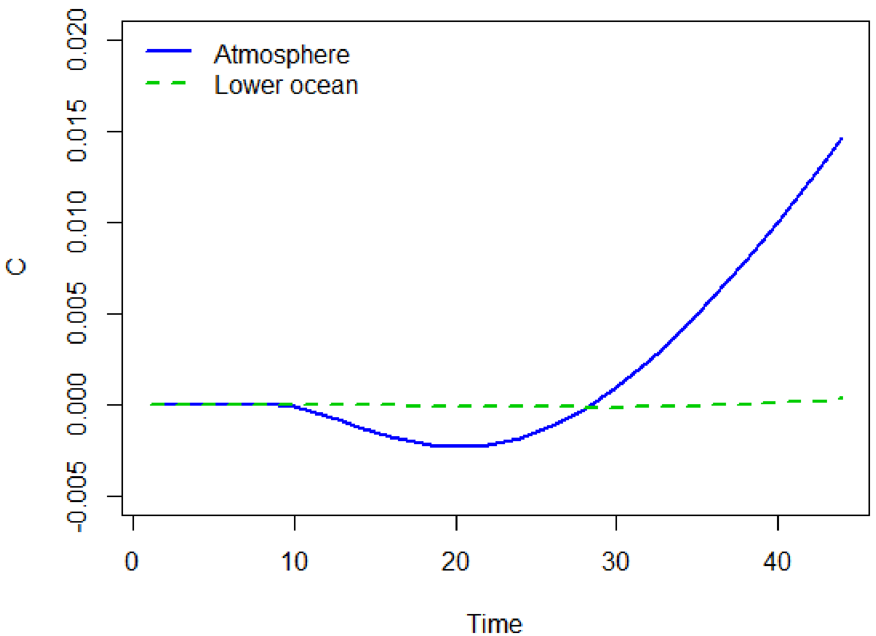


Figure E.2 - Temperature following an increase in 100 points in the rate of interest on bills (difference with baseline)



Note: $\alpha_1 = \alpha_{10} - \alpha_{11} \cdot r_{-1}$

10. Potential output and depletion

Figure E.3 - Depletion rates following an increase in 100 points in the rate of interest on bills (difference with baseline)

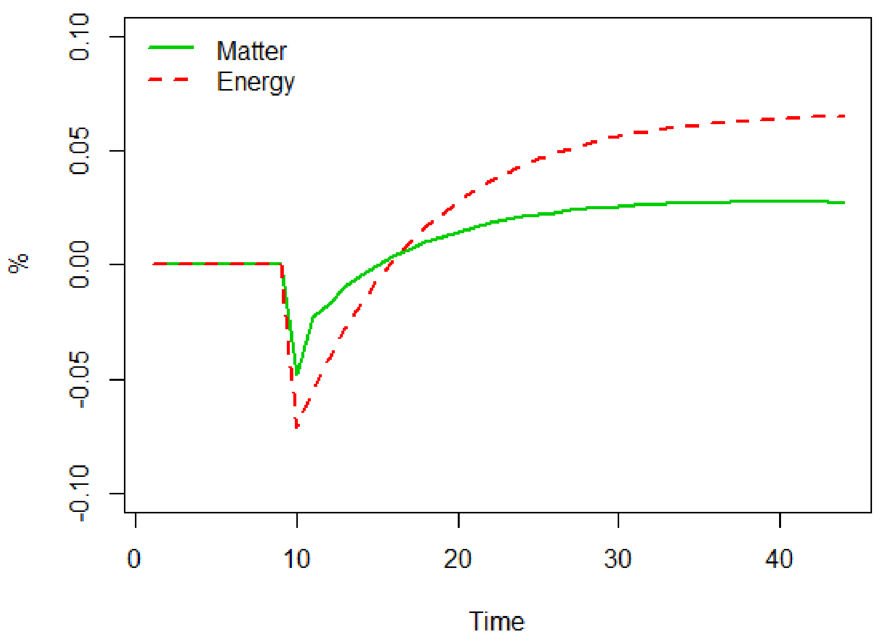
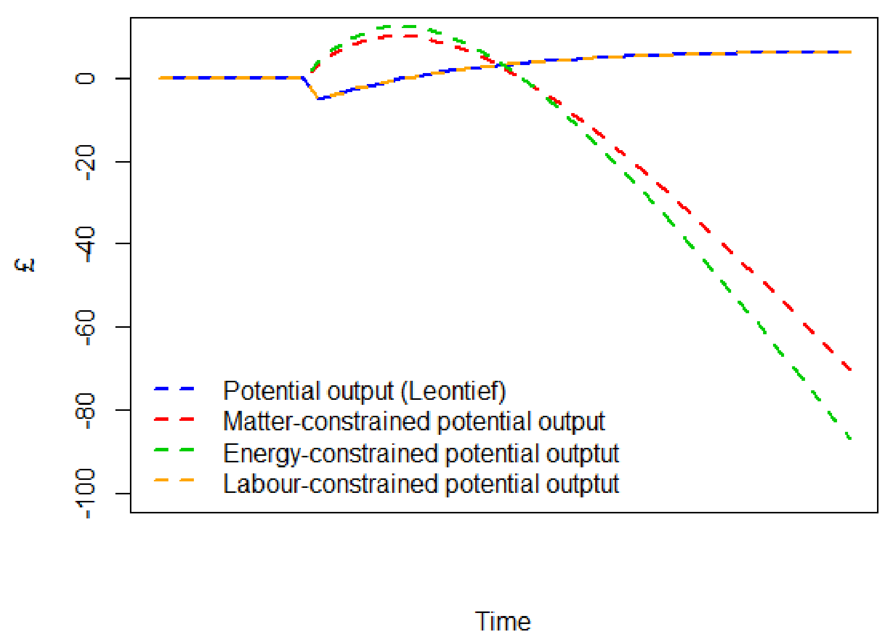


Figure E.4 - potential output following an increase in 100 points in the rate of interest on bills (difference with baseline)



11. Four spheres

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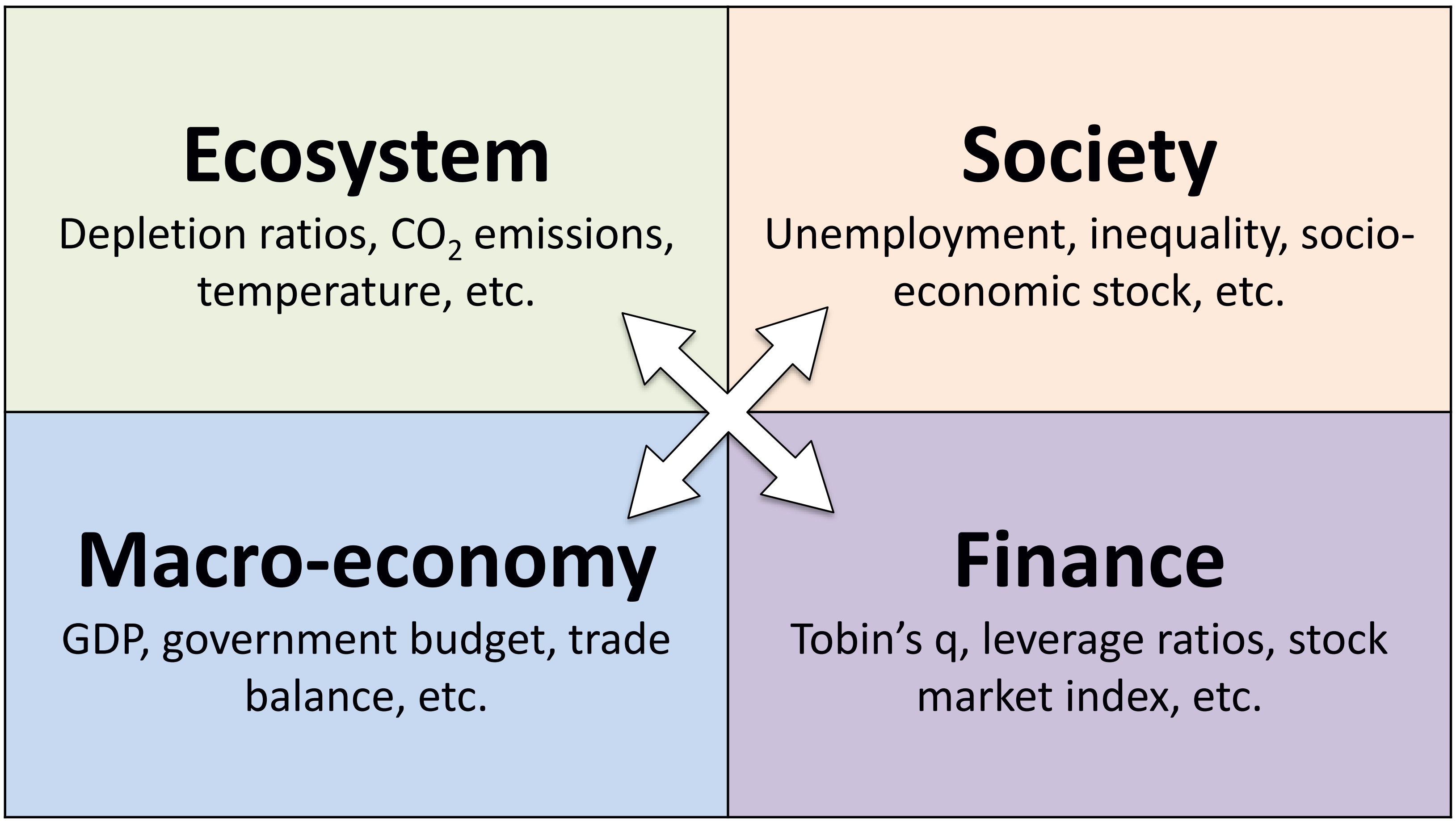
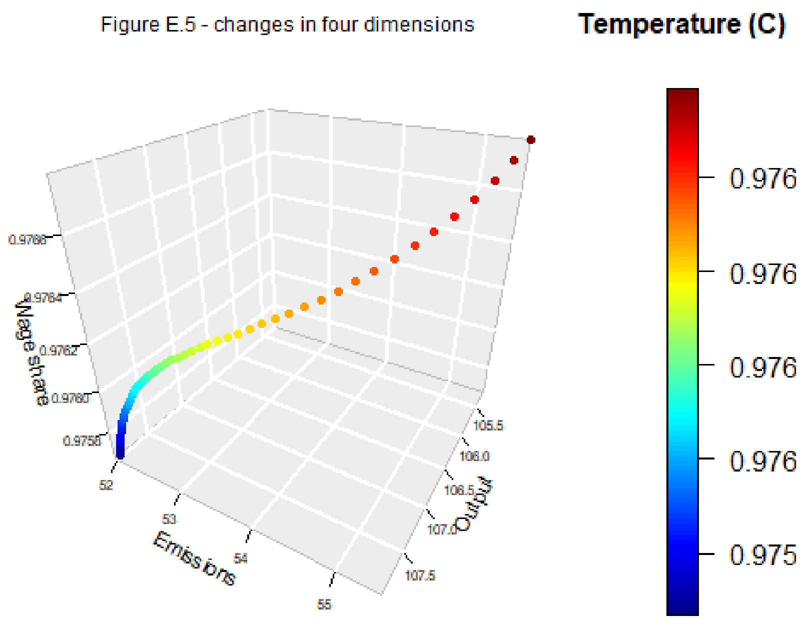
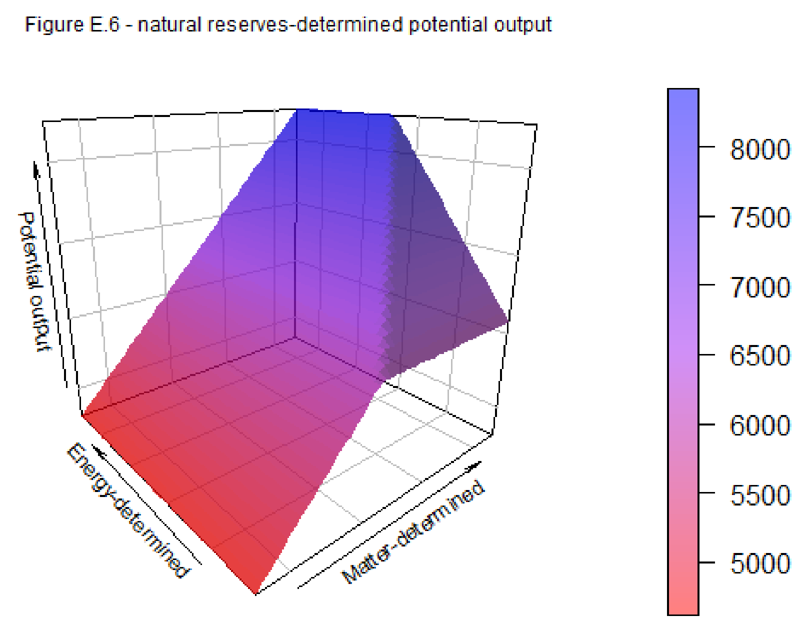


12. Trade-offs





Notes: matter-determined potential output was reduced to highlight the nonlinearities associated with a Leontief production function

References

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KEY READINGS

- W. Godley and M. Lavoie (2007). *Monetary Economics. An Integrated Approach to Credit, Money, Income, Production and Wealth*. Palgrave Macmillan, chapters 1, 2, 3, 4, 7.
- M. Lavoie (2014). Post-Keynesian Economics: New Foundations. Edward Elgar, chapter 1.

ADDITIONAL READINGS

- W. Godley (1999). Seven Unsustainable Processes. *Levy Institute Strategic Analysis*, January 1999.
- Y. Dafermos, M. Nikolaidi and G. Galanis (2017). A Stock-Flow-Fund Ecological Macroeconomic Model. *Ecological Economics*, 131, 191-207.
- C.H. Dos Santos (2006). Keynesian Theorising During Hard Times: Stock-Flow Consistent Models as an Unexplored 'Frontier' of Keynesian Macroeconomics. *Cambridge Journal of Economics*, 30 (4), 541-565.
- M. Nikiforos and G. Zezza (2017). Stock-Flow Consistent macroeconomic Models: A Survey. *Journal of Economic Surveys*, 31 (5), 1204-1239.

Web resources

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- Gennaro Zezza: http://sfc-models.net/people/gennaro-zezza/
- Yannis Dafermos and Maria Nikolaidi: https://yannisdafermos.com/sfc-modelling/
- Antoine Godin: http://www.antoinegodin.eu/
- Marco Veronese Passarella: https://www.marcopassarella.it/en/teaching-2/

The End

Thank you for attending the module!