An Introduction to SFC Models

WP5 Seminar Series

Marco Veronese Passarella 10/06/2022

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1 The State of Macroeconomics

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Issues with standard models

Increasing dissatisfaction with standard (DSGE) macroeconomic models (Blanchard, Krugman, Mankiw, Romer, Solow, Wren-Lewis, etc.)

Three main weaknesses:

a) Unrealistic assumptions (full rationality, etc.) and irrelevance (no financial markets, no banks, no social classes, no ecosystem)

b) Poor data fit, outclassed by other models in the S/R and useless for M/R forecasts, as crises are ruled out

c) Internal consistency issues (aggregate production function, etc.)

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Countermand!

model and an explicit role for forward-looking expectations. A weakness of DSGE models is that they often do not fit the data as well as other models, and the causal mechanisms do not always correspond to how economists and policymakers think the economy really works. In order to more easily manage these models, they typically focus on only a few key variables, which can limit the range of situations where they are useful.

The key strength of full-system econometric models like MARTIN is that they are flexible enough to incorporate the causal mechanisms that policymakers believe are important and fit the observable relationships in the data reasonably well. They can also be applied very broadly to model a wide range of variables. This flexibility reflects that the model is not derived from a single theoretical framework, which can make causal mechanisms less clear than in DSGE models. The model might capture an empirical relationship that exists in the data, but the cause of this might not be well understood. This means that developments may be more difficult to interpret and assumptions may need to be made about the mechanisms that are at work. If the true causal mechanisms are

Excerpt from Reserve Bank of Australia, March 2018 Bulletin

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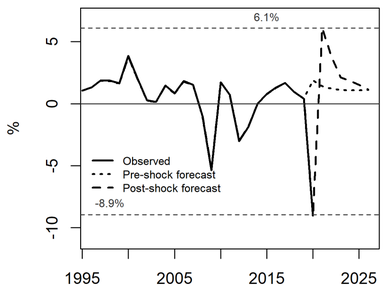
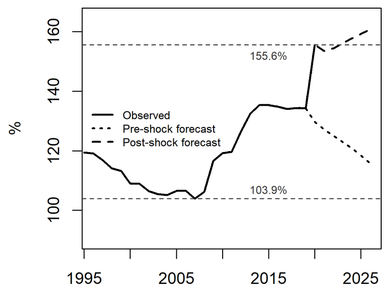
Looking for alternate models

- The Bank of England (2016) and the Italian Ministry of Economy and Finance (2022) have developed their own SFC models.
- Researchers of the Bank of Italy have released a new *R* package, named Bimets, for the analysis of time series and macroeconometric modelling.
- Bimets allows defining, estimating and simulating simultaneous equation models, including SFC models (see Canelli et al. 2021, 2022).

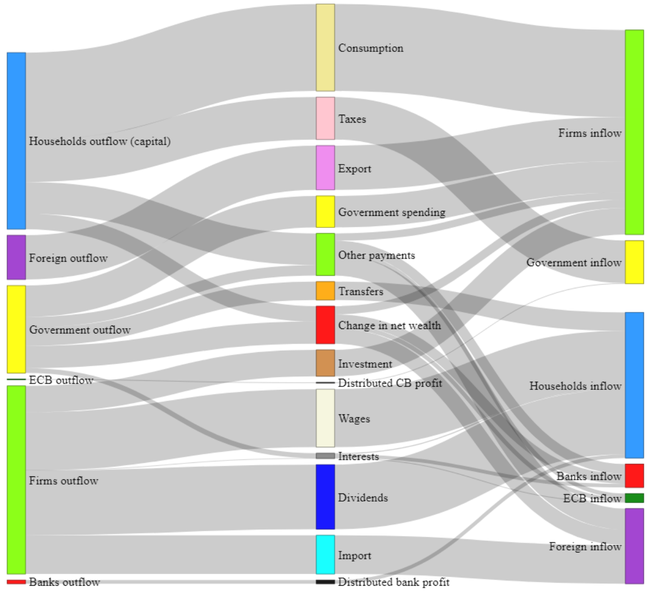
(a) Real growth rate after shock



(b) Government debt to GDP ratio after shock



(c) Sankey diagram of transactions-flow matrix, Italy 2020



My elaborations on Canelli et al. 2022

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2 SFC Models in Macroeconomics

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PKE presuppositions

SFC models are a family of macroeconomic models developed by the broadly-defined post-Keynesian School of Economics (PKE, see also here).

Presuppositions of PKE, hence most SFC models, are:

1. Realism: instead of instrumentalism
2. Olism (or organicism): instead of individualism (and atomism)
3. Reproduction conditions: instead of optimal allocation and subjective scarcity
4. Principle of effective demand: output is demand-driven both in the short- and log-run
5. Quantity adjustment: supplies adjust to demanded quantities (but price-adjustment in stock market)
6. Reasonable rationality: because of uncertainty, agents rely on rules of thumb, routines and conventions. No maximization and no (hyper) rational expectations

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Additional PKE presuppositions

7. Multiple equilibria and path-dependency: no natural level of output or employment. Long-run is just a ∑ of short runs. Today's position depends on past positions
8. Investment priority: investment generates saving, not vice versa
9. Money endogeneity: money does not fall from the sky. Firms demand loans to finance production and fund investment plans. Loans generate deposits, not vice versa
10. Financial assets are not perfect substitutes: capital mobility is usually assumed, but there is no tendency for the rates of return to level out
11. No (or limited) subsitutability of inputs: dedicate equipment, and we cannot replace nature with «capital»
12. Power matters: income distribution is not defined by marginal productivities. It depends on social, institutional and political factors

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The inception of SFC models

Robert Lucas argued that: “The [Global Financial] crisis was not predicted because economic theory predicts that such events cannot be predicted” (*The Economist*, 6/08/2009).

But Wynne Godley saw US crises coming in 2001 and 2007, using formal (SFC) models:

> *There could be a further year or more of robust expansion … [but] current growth is associated with seven unsustainable processes* (Godley 1999)

Godley (and the *Cambridge Economic Policy Group*) built upon the works of:

- Morris Copeland (1949): integrates national income identities with flow of funds through the quadruple accounting principle
- James Tobin (1981,1982) and the *Yale Group*: Keynesian theory and portfolio equations (as functions of expected return rates and liquidity preference)

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Basic principles

SFC models are based on national accounts and flow of funds. They are explicitly designed to meet **four accounting principles**:

a) Flow consistency ▶ every transaction comes from somewhere and goes to somewhere

b) Stock consistency ▶ a liability issued by agent or sector A is held as a financial asset by agent or sector B

c) S-F consistency ▶ flows affect stocks. Capital gains (losses) must be recorded too

d) Quadruple book-keeping ▶ every transaction entails four different entries:

- An outflow (e.g. a household purchases an item)
- An inflow (e.g. a firm sales the item)
- A reduction in assets or an increase in liabilities (e.g. household's cash and/or deposits reduce)
- An increase in assets or a reduction in liabilities (e.g. firm's cash and or deposits increase)

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Integrating finance and production

Godley and Lavoie (2007) incorporated these principles into a model of a monetary production economy, where the supply of money is endogenous and behavioural equations respond to PKE precepts.

Dos Santos (2006) named it the stock-flow consistent (SFC) approach to macroeconomics (but the label is controversial).

It allows integrating the financial and the real side of the economy, thus tracking stock-flow ratios and identifying un-sustainable processes (e.g. a growing debt/income ratio).

SFC approaches are well-known outside economics. Ecological economics and hard scientists use them to assess the impact of anthropic activities on the ecosystem.

Besides, there is an increasing interest from central banks (e.g. Burgess et al. 2016) and world-leading economists (see, for instance, Simon Wray-Lewis vs Martin Wolf).

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Accounting matrices

SFC models are made up of two components: accounting matrices and dynamic equations.

Accounting principles are incorporated in two matrices. The economy is split into a number of sectors (typically, households, non-financial firms, commercial banks, central bank, government, and the foreign sector)

- The balance sheet (BS) displays tangible stocks (fixed capital, housing), financial stocks and financial liabilities of each macro-sector.
- The transactions-flow matrix (TFM) shows financial flows associated with stocks and sectoral budget constraints. It combines the national income equations (identities) with sectoral flow-of-funds accounting.

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The balance sheet

Assets and liabilities (stocks)

Economic sectors or agents

	Households	Firms	Banks	Central Bank	Government	…	Σ
Cash	$+H_h$			$-H_s$		…	0
Deposits	$+M_h$		$-M_s$			…	0
Loans		$-L_f$	$+L_s$			…	0
Bills	$+B_h$			$+B_{cb}$	$-B_s$	…	0
Capital		$+K$				…	$+K$
…	…	…			…	…	0
Balance (net worth)	$-V_h$	$\pm V_f$	0	0	$+V_g$	…	$-\Sigma V$
Σ	0	0	0	0	0	0	0

Consistency across sectors

Accumulation of fixed capital

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

Consistency within sectors

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The transactions-flow matrix

Transactions and Δ in stocks

Capital account

	Households	Firms		Banks	Central Bank	Government	…	Σ
		Current	Capital					
Consumption	$-C$	$+C$					…	0
Investment		$+I$	$-I$				…	0
Wages	$+WB$	$-WB$						0
Interests on loans		$-r_{l,-1} \cdot L_{f,-1}$		$+r_{l,-1} \cdot L_{s,-1}$			…	0
…	…	…	…	…	…	…	…	0
Δ in cash	$-\Delta H_h$				$+\Delta H_s$		…	0
Δ in loans			$+\Delta L_f$	$-\Delta L_s$			…	0
…	…	…	…	…				0
Σ	0	0	0	0	0	0	0	0

Column = budget constraint

Reverse sign

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

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Identities and behavioural equations

BS and TFM allow deriving the first set of model equations, namely accounting identities.

Identities are then coupled with equilibrium conditions and behavioural equations to close the model:

- Identity: accounting definition, which is always true. Example: $Y \equiv C + I + G + X - M$
- Equilibrium condition: adjustment mechanism that matches demand with supply
  Example: $M_s = M_d$
- Behavioural (or stochastic) equation: defines the behaviour of a certain variable
  Example: $C = c_0 + c_1 \cdot Y$

What are behavioural equations based upon (in SFC models)?

No maximisation. Agents have stock-flow targets instead (wealth-to-income ratio, debt-to-income ratio, etc.)

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Theory and policy implications

The long-run dynamics of SFC models is not predetermined by a supply-side exogenous attractor (e.g. NAIRU). It is (partially) constrained by the accounting structure instead.

While Godley was quite confident about the constraining power of an accurate accounting structure, the log-run dynamics of SFC models is defined also by behavioural assumptions.

SFC modellers usually assume that production, income and employment are demand-led both in the short- and long-run.

Policy corollary 1: fiscal policies can imply long-lasting effects. Besides, they are usually more effective than monetary policies.

Policy corollary 2: monetary policies can bring about paradoxical and counter-intuitive effects (e.g. impact of change in interest rate on Model PC).

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Solution and identification

Standard SFC models are medium-scale macro-econometric dynamic models (≈ 30 to 150 eq.s). But they can be meso- (Input-Output SFC) or micro-founded (Agent-Based SFC).

Usually formulated in discrete time (difference equations), but they can also be developed in continuous time (differential equations).

The simplest models can be solved analytically (by finding steady-state solutions). More advanced models must be solved through computer simulations.

Coefficients can be:

a) estimated from observed data (using econometric methods: OLS, cointegration, etc.)

b) calibrated to match the data, based on previous studies or selected from a reasonable range of values

c) fine-tuned to obtain a specific baseline scenario

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Box 1 How to install *R* and run the model

a) Download and install *R* (free software)

b) Download and install *R-Studio Desktop* (free version)

c) Get familiar with *R* using the Cheat Sheet

d) Download my toy models from marxianomics (or from my github repository)

e) Copy and paste the *.txt* code in the main *R* field (top-left)

f) Run the code by clicking Source

g) Check model variables (Data) and coefficients (Values) in the top-right field, named Global Environment

h) Charts are displayed in the Plots field (bottom-right)

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3 A simple SFCM with *fiat* money

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Model PC: assumptions

This is a model developed in chapter 4 of Godley and Lavoie (2007). PC stands for portfolio choice, because households can hold their wealth in terms of cash and/or government bills.

Key assumptions are as follows:

- Closed economy
- Four agents: households, “firms”, government, central bank
- Two financial assets: government bills and outside money (cash)
- No investment (accumulation) and no inventories
- Fixed prices and zero net profits
- No banks, no inside money (bank deposits)
- No ecosystem

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Box 2 Steps for developing a SFC model

1. Identify sectors to be modelled (households, firms, etc.)
2. Create balance-sheet (BS) of the economy
3. Create transactions-flow matrix (TFM)
4. Write down identities from the TFM
    i. Use columns to derive budget constraints
    ii. Use also rows with multiple entries
    iii. Identify buffer variables
5. Define behavioural equations and equilibrium conditions

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Model PC: balance-sheet

	Households	Firms (production)	Central Bank	Government	Σ
Money (cash)	$+H_h$		$-H_s$		0
Bills	$+B_h$		$+B_{cb}$	$-B_s$	0
Balance (net worth)	$-V_h$			$+V_g$	0
Σ	0	0	0	0	0

Equation (6)

Equation (10)

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

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Model PC: transactions-flow matrix

	Households	Firms (production)	Banks	Central Bank	Government	Σ
Consumption	$-C$	$+C$				0
Gov. spending		$+G$			$-G$	0
Income=GDP	$+Y$	$-Y$				0
Interest payments	$+r_{-1} \cdot B_{h,-1}$			$+r_{-1} \cdot B_{cb,-1}$	$-r_{-1} \cdot B_{s,-1}$	0
CB profits				$-r_{-1} \cdot B_{cb,-1}$	$+r_{-1} \cdot B_{cb,-1}$	0
Taxes	$-T$				$+T$	0
Δ in cash	$-\Delta H_h$			$+\Delta H_s$		0
Δ in bills	$-\Delta B_h$			$-\Delta B_{cb}$	$+\Delta B_s$	0
Σ	0	0	0	0	0	0

Equation (1)

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

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Model PC: equations

National income:	$Y = C + G$	(1)
Disposable income:	$YD = Y - T + r_{-1} \cdot B_{h,-1}$	(2)
Tax revenue:	$T = \theta \cdot (Y + r_{-1} \cdot B_{h,-1})$	(3)
Household wealth:	$V_h = V_{h,-1} + YD - C$	(4)
Consumption:	$C = \alpha_1 \cdot YD + \alpha_2 \cdot V_{-1}$	(5)
Cash held by households:	$H_h = V_h - B_h$	(6)
Bills held by households:	$B_h = \lambda_0 \cdot V_h + \lambda_1 \cdot V_h \cdot r - \lambda_2 \cdot YD$	(7)
[Cash held by households:	$H_h = (1 - \lambda_0) \cdot V_h - \lambda_1 \cdot V_h \cdot r + \lambda_2 \cdot YD$	(6A)]
Supply of bills:	$B_s = B_{s,-1} + G - T + r_{-1} \cdot (B_{s,-1} - B_{cb,-1})$	(8)
Supply of cash:	$H_s = H_{s,-1} + \Delta B_{cb}$	(9)
Bills held by the central bank:	$B_{cb} = B_s - B_h$	(10)
Interest rate:	$r = \bar{r}$	(11)
Redundant equation:	$H_h = H_s$	

- Identity
- Equilibrium condition
- Behavioural equation

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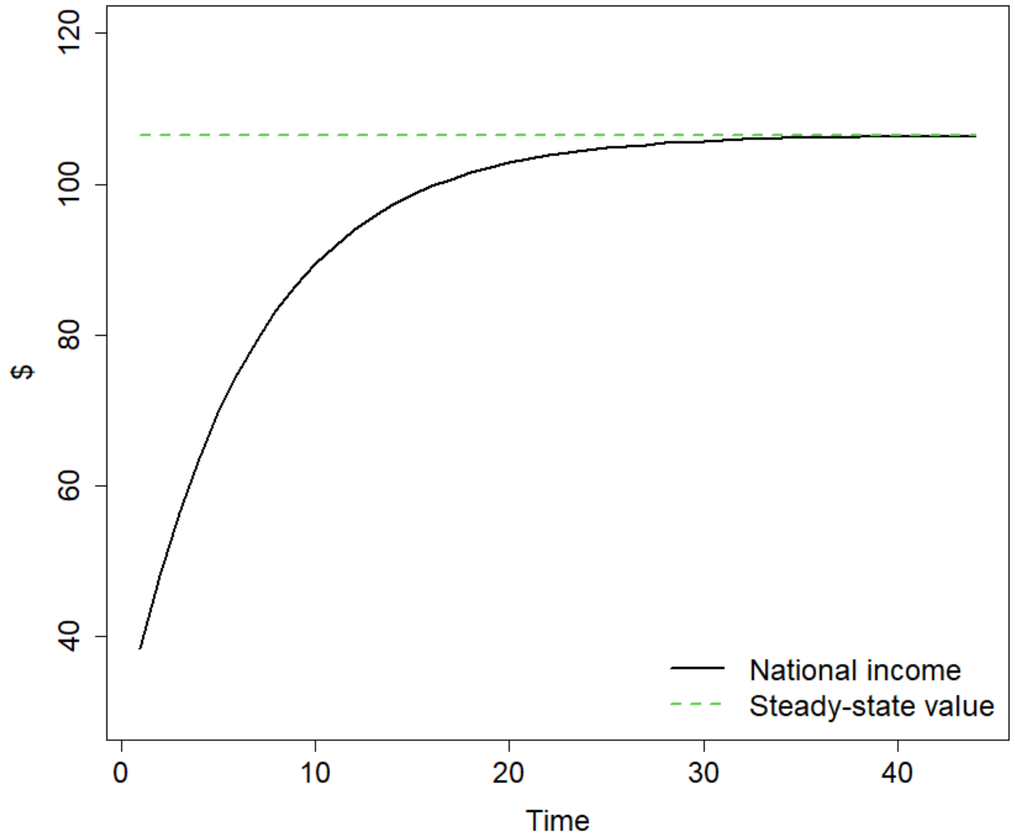
Model PC: dynamics

Stationary (quasi steady-state) solution: $Y^* = \dfrac{G + r \cdot B_h^* \cdot (1-\theta)}{\theta}$

Figure 1 Evolution of national income following initial governemnt spending



$G = 20$

$r = 0.025$

$\theta = 0.2$

$B_h^* \sim 64.87$

$Y^* \sim 106.49$

Tip: how to find the quasi steady-state

Notice that $C = YD$ and $B_{h,-1} = B_h$ in steady state. Use $C = YD$ in equation (1), from which: $Y^* = YD + G$. Next, use equations (2) and (3) in Y, from which: $Y^* = (Y^* + r \cdot B_h^*) \cdot (1-\theta) + G$. Next, solve for Y^*.

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Model PC: BS steady-state values

	Households	Firms (production)	Central Bank	Government	Σ
Money (cash)	$+21.62$		-21.62		0
Bills	$+64.87$		$+21.62$	-86.49	0
Balance (net worth)	-86.49			$+86.49$	0
Σ	0	0	0	0	0

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

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Model PC: TFM steady-state values

	Households	Firms (production)	Banks	Central Bank	Government	Σ
Consumption	-86.49	$+86.49$				0
Gov. spending		$+20$			-20	0
Income=GDP	$+106.49$	-106.49				0
Interest payments	$+1.62$			$+0.54$	-2.16	0
CB profits				-0.54	$+0.54$	0
Taxes	-21.62				$+21.62$	0
Δ in cash	0			0		0
Δ in bills	0			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

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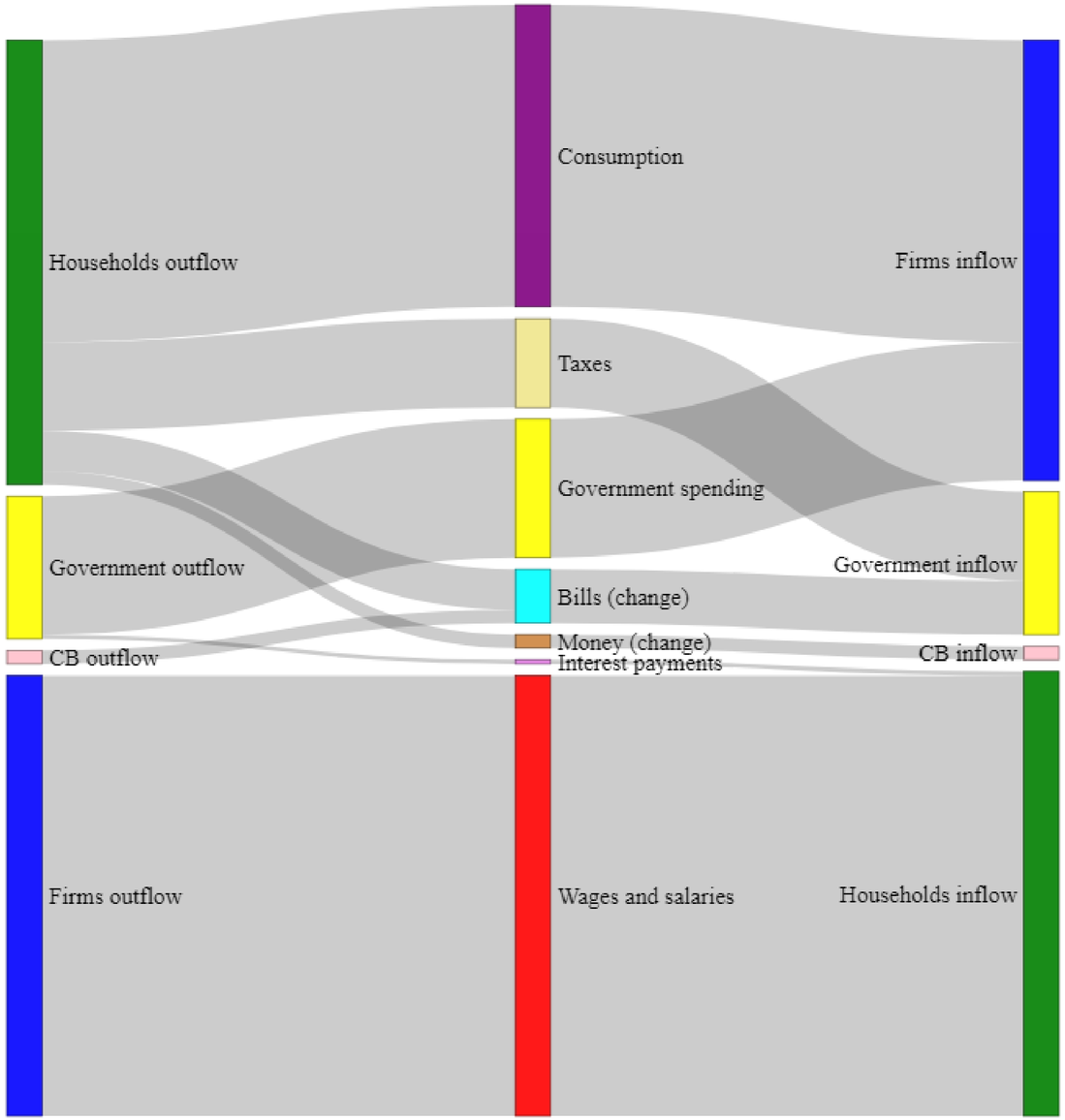
Model PC: Sankey diagram (t=5)



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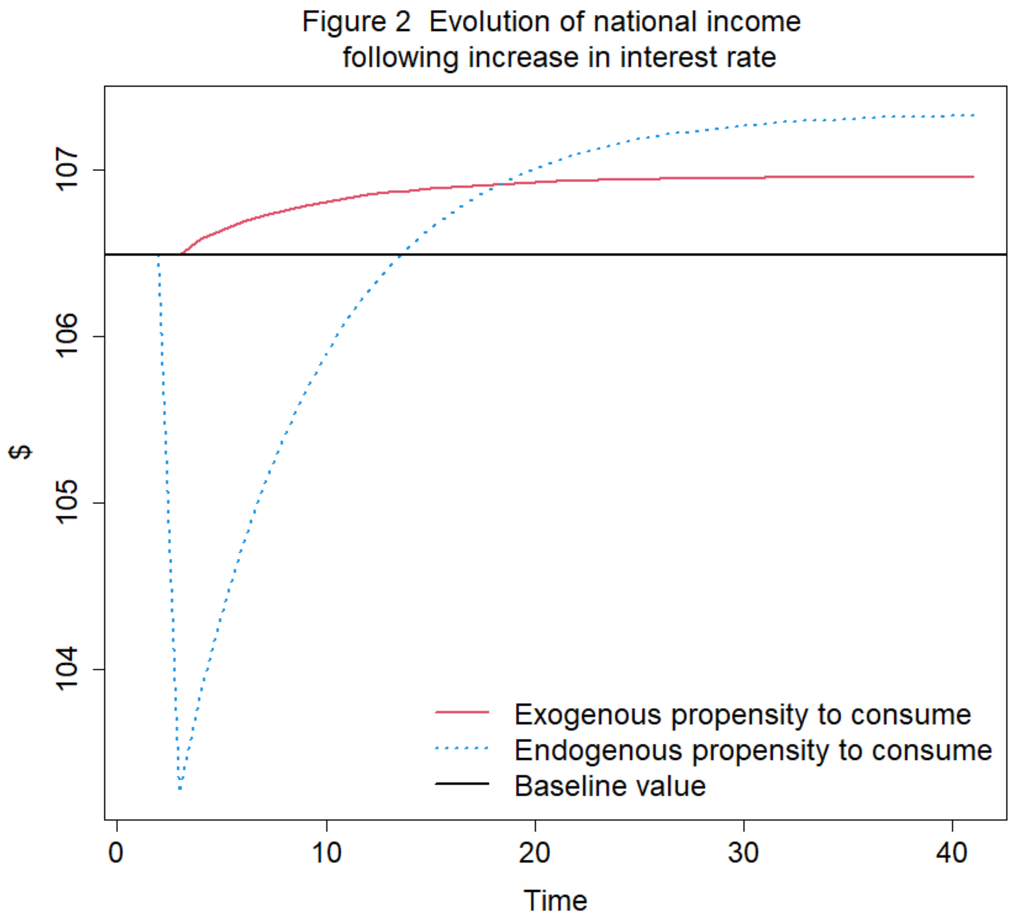
Model PC: experiment

Higher interest rate on government bonds: $r = 0.025 \rightarrow 0.035$



Scenario «blue»

Additional equation:

$\alpha_1 = \alpha_{11} - \alpha_{12} \cdot r$

Coefficient values:

$\alpha_{11} = 0.65$

$\alpha_{12} = 2$

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Box 3 Simulating a SFC model

Steps in simulating a SFC model:

1. Run the model
2. Check model consistency by using the redundant equation
3. Validate results through auto- and cross-correlation analysis of key variables under the baseline
4. Check robustness of findings through sensitivity tests (changing key parameters)
5. Shock key coefficients to obtain alternative scenarios
6. Compare with baseline results (comparative dynamics)

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4 A simple SFCM with bank money

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Model BMW: assumptions

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
- Fixed prices and zero net profits
- No State, no outside money (cash)

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Model BMW: balance-sheet

	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!

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Model BMW: transactions-flow matrix

	Households	Production firms		Banks		Σ
		Current	Capital	Current	Capital	
Consumption	$-C_d$	$+C_s$				0
Investment		$+I_d$	$-I_d$			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

Equation (8)

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

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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)

- Identity
- Equilibrium condition
- Behavioural equation

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Model BMW: equations (cont'd)

Return rate on deposits:	$r_m = r_l$	(12)
Wage bill:	$WB_s = w \cdot N_s$	(13)
Demand for labour:	$N_d = Y/pr$	(14)
Wage rate:	$w = WB_d/N_d$	(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:	$M_h = M_s$	

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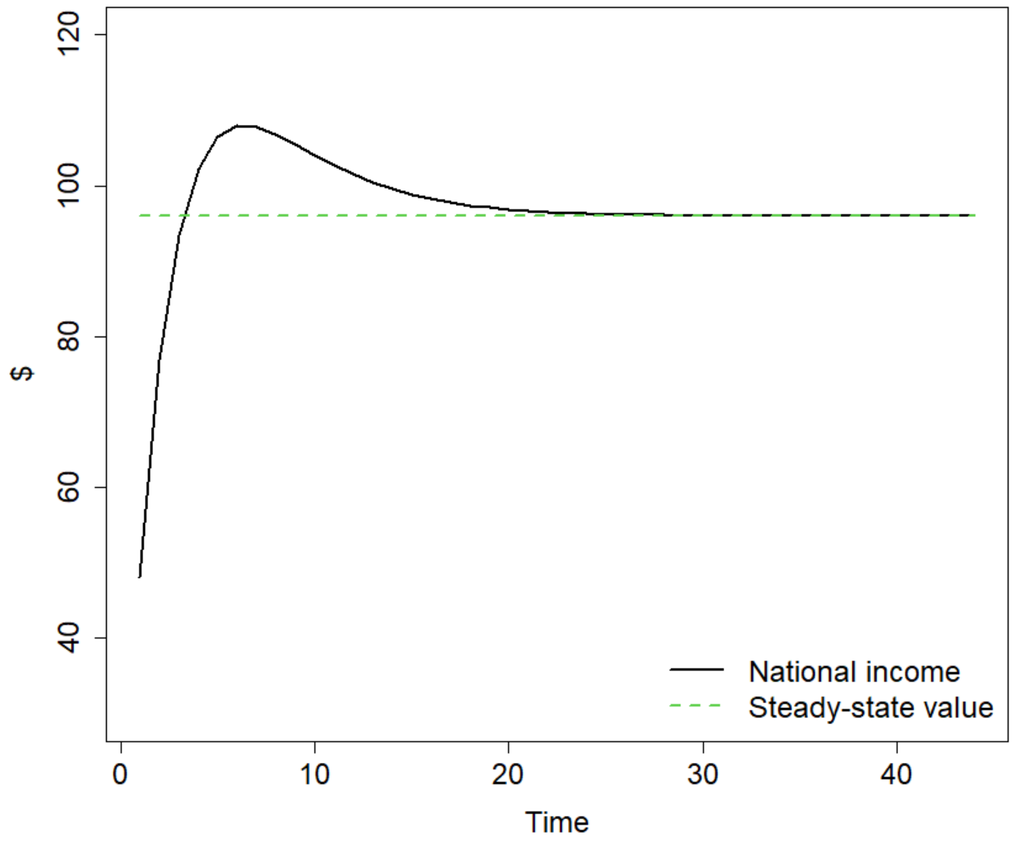
Model BMW: dynamics

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

Figure 3 Evolution of national income following initial autonomous consumption



$\alpha_0 = 12$

$\alpha_1 = 0.75$

$\alpha_2 = 0.40$

$\delta = 0.15$

$\kappa = 1$

$Y^* = 96$

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^*.

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Model BMW: BS steady-state values

	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.

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Model BMW: TFM steady-state values

	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

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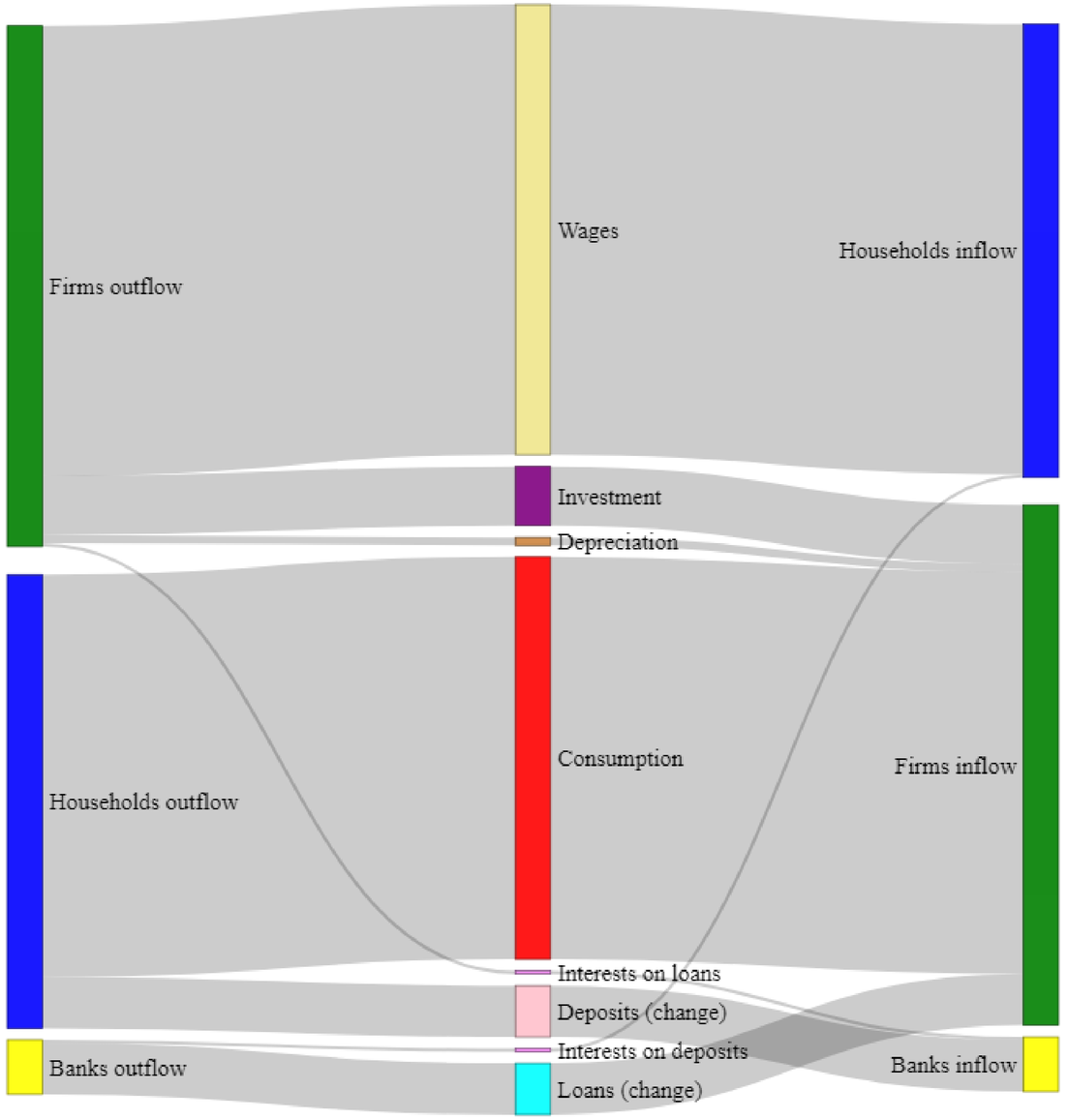
Model BMW: Sankey diagram (t=5)



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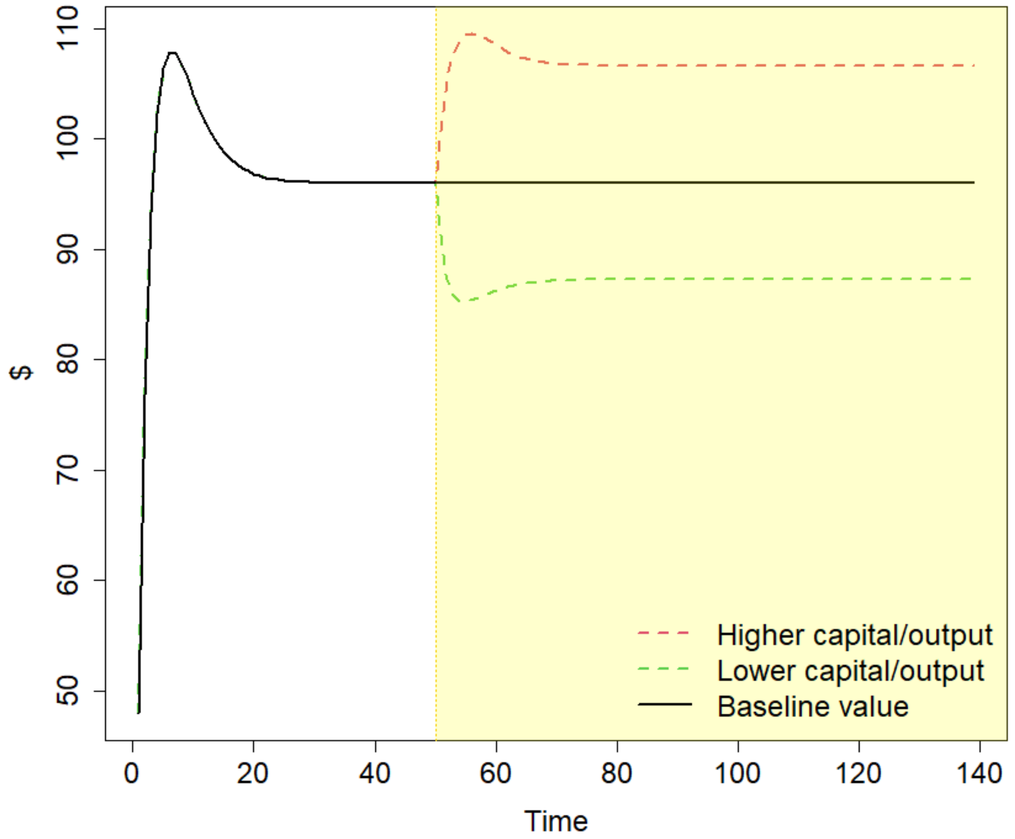
Model BMW: experiment

Higher/lower target capital to output ratio: $\kappa_0 = 1$, $\kappa_1 = 1.1$, $\kappa_2 = 0.9$

Figure 4 Evolution of national income following higher target capital stock



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5 Ecological SFC Models

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Ecological macroeconomics

“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 work 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.

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Ecological accounting

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.

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Physical flow matrix

	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.

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Physical stock-flow matrix

	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; * $TR = +(\phi_{11}-1) \cdot CO_{2_{AT,-1}} + \phi_{21} \cdot CO_{2_{UP,-1}}$.

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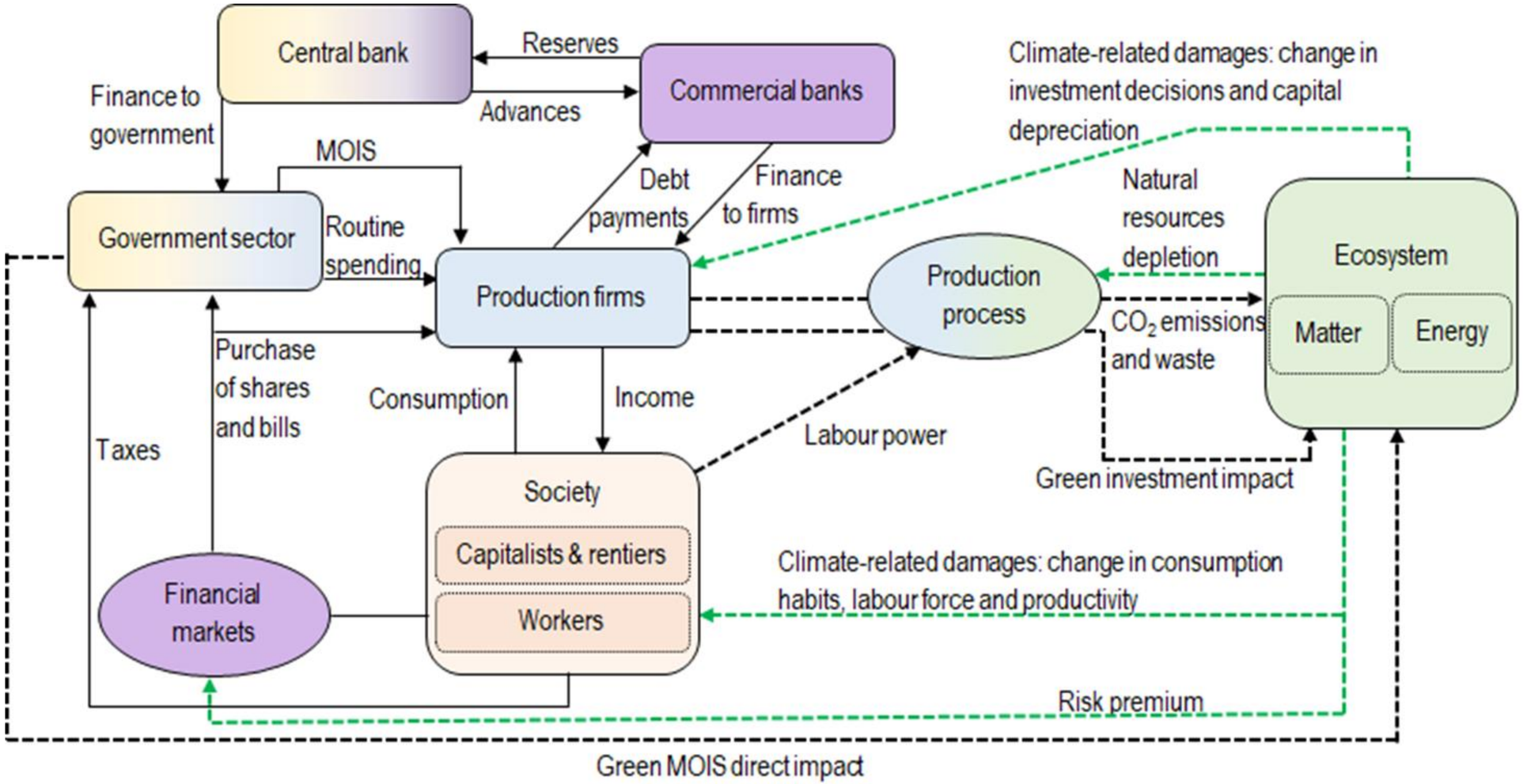
Emissions, depletion, waste and damages



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ADDITIONAL READINGS

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- 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.

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Useful web resources for SFC modellers

- **Yannis Dafermos and Maria Nikolaidi:** https://yannisdafermos.com/sfc-modelling/
- **Antoine Godin:** http://www.antoinegodin.eu/
- **Karsten Kohler:** https://karstenkohler.com/
- **Joao Macalos:** https://joaomacalos.github.io/sfcr/index.html
- **Marco Veronese Passarella:** https://www.marcopassarella.it/en/teaching-2/
- **Gennaro Zezza:** http://sfc-models.net/people/gennaro-zezza/

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Thanks

Marco Veronese Passarella

https://www.marcopassarella.it/en/

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