LUBS 5101M

Macroeconomics

UNIVERSITY OF LEEDS

2020/2021

Lecture 12

SFC Models I: Theory and Method

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Introduction

The state of macroeconomics

1. Issues with standard models

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

Three main weaknesses:

- Internal consistency issues (production function, utility/preferences, etc.)
- Unrealistic assumptions (full rationality) and irrelevance (e.g. no financial markets, no banks, no classes, no interaction with ecosystem, etc.)
- Poor data fit, outclassed by other models in the S/R

Useless for L/R forecasts: crises are ruled out!

2. Need for alternatives

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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

3. And new packages…

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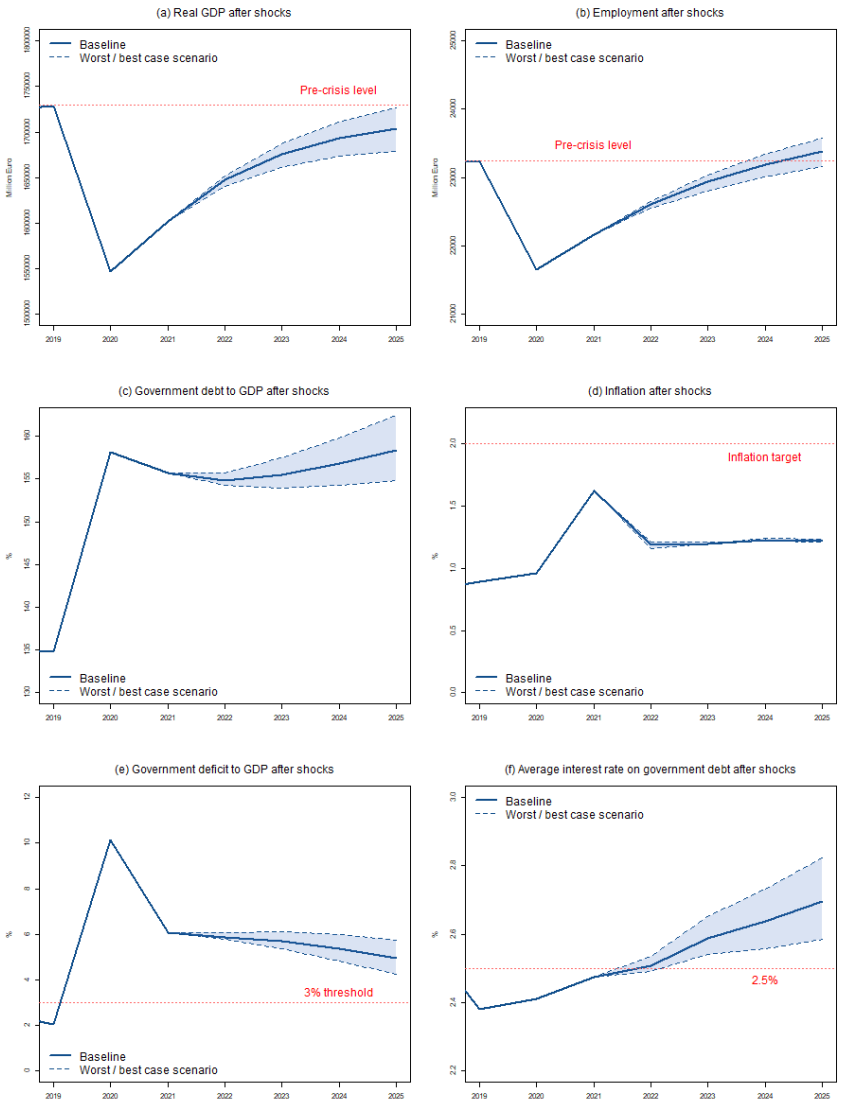
The Bank of Italy is currently developing a new *R* package, named Bimets, for the analysis of time series and macroeconometric modelling.

More precisely, the package allows defining, estimating and simulating of simultaneous equation models.

As such, it can be used to develop and simulate empirical SFC models too (see chart, showing predicted series for the Italian economy following the Covid-19 shock).



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Second section

Heterodox approaches

1. Definitions

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Orthodox macroeconomists: advocate both general equilibrium models (where the equilibrium is unique, stable and optimal) and free-market policies. *Who are they?* New Classics, some New Keynesians.

Heterodox macroeconomists: reject both the general equilibrium model and free market policies. *Who are they?* Post-Keynesians, Marxists, Evolutionists, Early Institutionalists, etc.

Orthodox dissenters: advocate general equilibrium models, but not free-market policies. *Who are they?* Krugman, the *early* Stiglitz, Piketty and some New Keynesians.

Non-dissenting heterodox economists: reject general equilibrium models, but advocate free-market policies. *Who are they?* Neo-Austrians.

2. Two dimensions

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		Positive theory: EEG and other positive presuppositions	
		Orthodox	**Heterodox**
Normative theory: free market	**Non-dissenters**	New Classics, some New Keynesians	~~Neo-Austrians~~
	Dissenters	~~Krugman, the *early* Stiglitz, Piketty, some New Keynesians~~	Post-Keynesians, Marxists, Evolutionists, Early Institutionalists, etc.

3. Presuppositions

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Presupposition	Orthodox Schools	Heterodox schools
Epistemology/Ontology	Instrumentalism	Realism
Rationality	Hyper model-consistent rationality, optimizing agent	Environment-consistent rationality, satisficing agent
Method	Individualism, atomism	Holism, organicism
Economic Core	Exchange, allocation, scarcity	Production, growth, abundance
Political Core	Unfettered markets	Regulated markets

Source: Lavoie (2014, p. 12)

4. Epistemology / Ontology

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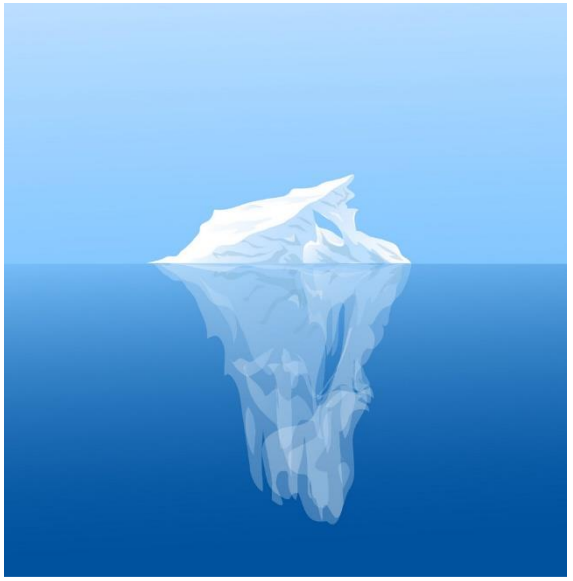
Orthodox: Instrumentalism

The truth of a statement is irrelevant. Only predictive power matters!

Heterodox: Realism

Assumptions must be realistic. Go beneath the surface!



5. Rationality

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Orthodox: Rational expectations

Agents' expectations are correct on average. No systematic errors. They know the "correct" model.

Heterodox: Procedural rationality

Agents use routines, habits, conventions and rules of thumb. In a complex and uncertain world, this is rational!

6.1 Method

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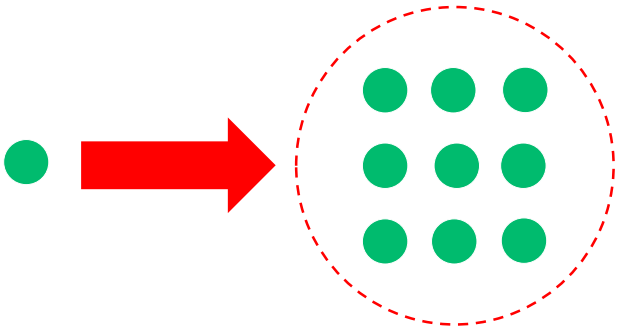
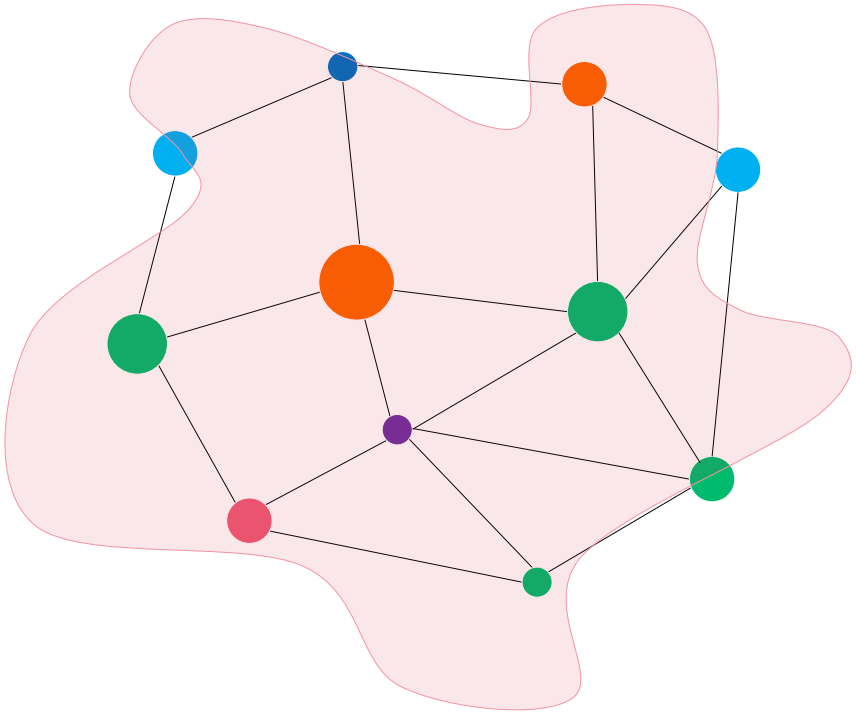
Orthodox: Individualism, atomism

The behaviour of the economic system can be reduced to the behaviour of a representative agent.



Heterodox: Olism, organicism

There are many interacting heterogeneous agents. The system has its own emerging behaviour.



6.2 Paradoxes

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Holism: some paradoxes	
Paradox of thrift	Higher saving rates lead to reduced output
Paradox of costs	Higher real wages lead to higher profit rates
Paradox of public deficits	Government deficits raise private profits
Paradox of deb	Effort to de-leverage might lead to higher leverage ratios
Paradox of tranquillity	Stability is destabilizing
Paradox of liquidity	New ways to create liquidity end up transforming liquid assets into illiquid ones
Paradox of risk	The availability of individual risk cover leads to more risk overall
Paradox of profit-led demand	Generalized wage restrictions lead to a slowdown in growth even when all economies seem to be profit-led

Source: Lavoie (2014, p. 18)

7. Economic core

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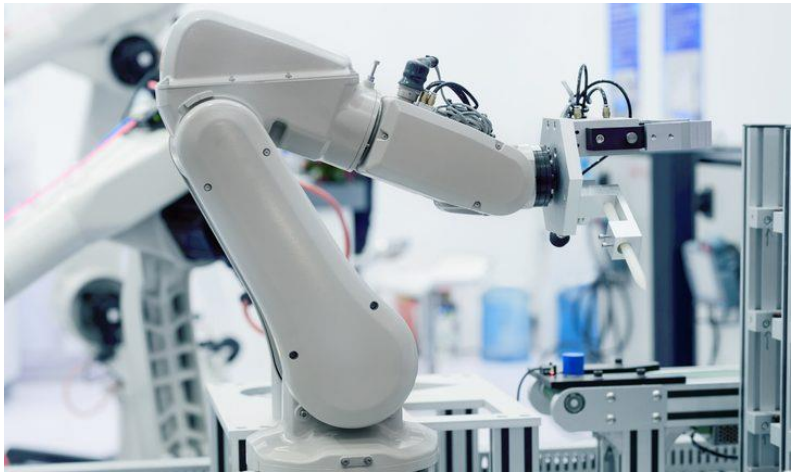
Orthodox: Allocation

Prices are scarcity indices. All resources are efficiently allocated by market forces.

Heterodox: Production

Prices are defined by reproduction conditions (unit costs of production). Inputs are usually not fully employed.



8. Policy core

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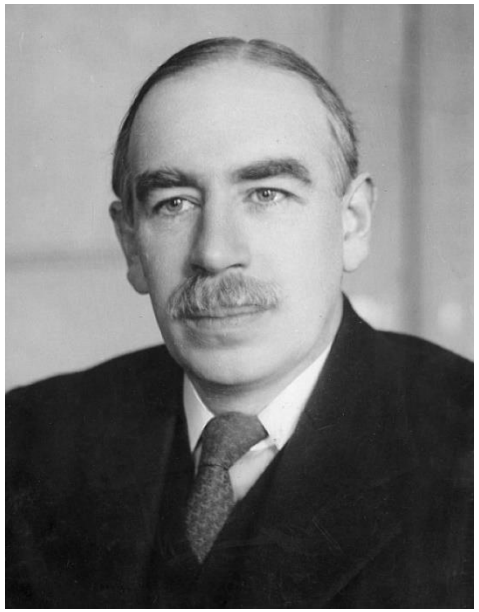
Orthodox: Unfettered markets

Support for free-market policies. Only "scientific" monetary policy (and automatic stabilisers) admitted.

Friedrich August von Hayek (1899-1992)

Heterodox: Regulated markets

Regulation and state intervention are necessary to keep the economy stable, assure full employment and equality.



John Maynard Keynes (1883-1946)

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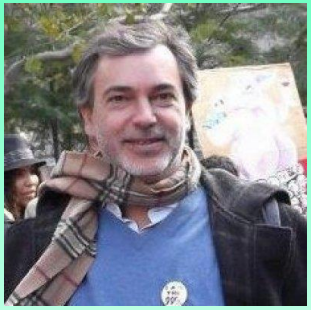
Third section

Introduction to SFC models

Marc Lavoie (born 1959)

Wynne Godley (1926-2010)



Gennaro Zezza (born 1962)

1. Introduction

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SFC models are a family of macro models developed by the broadly-defined post-Keynesian (PK) school of economics (see here and here).

Additional presuppositions of PK school:

1) Principle of effective demand: production is demand-driven both in the short- and log-run.
2) Quantity adjustment: goods supplies adjust to demanded quantities. Exception: stock market (price-adjustment).
3) Reasonable rationality under radical uncertainty: economic uncertainty different from probabilistic risk. Agents relies on rules of thumb, routines and conventions (no rational expectations).
4) Multiple equilibria and path-dependency: there is no natural level of output or employment. Long-run is just a $\sum$ of short runs. Today's position depends on past positions.

1. Introduction (cont'd)

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5) Investment priority: investment generates saving, not vice versa. Similarly, bank loans generate deposits.

6) Money endogeneity: money does not fall from the sky. Firms demand loans to finance production and fund investment plans.

7) Financial assets are not perfect substitutes: capital mobility is usually assumed in the models, but there is no tendency for the return rates to level out.

8) Power matters: income distribution is not defined by natural or technical factors (e.g. marginal productivity). It is mainly defined by social, institutional and political factors.

2. Inception of SFC models

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

So, what about the predictive power of the model?! (instrumentalism)

Besides, someone (Wynne Godley) saw 2001 and 2007 crises coming, using formal models: “there could be a further year or more of robust expansion … [but] current growth is associated with seven unsustainable processes” (Godley 1999, see also here).

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 (expected relative return rates and liquidity preference)

2. Inception … (cont'd)

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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 Kaleckian or Keynesian precepts.

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

It allows integrating the financial and the real side of a financially-complex capitalist 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 of central banks (e.g. Burgess et al. 2016) and world-leading economists have been discussing them (see, for instance, Simon Wray-Lewis vs Martin Wolf).

3. Principles

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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. No black holes!

b) Stock consistency: a liability issued by agent or sector A is held as a financial asset by agent or sector B. No black holes!

c) SF consistency: flows affect stocks, and 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 reduces)
- An increase in assets or a reduction in liabilities (e.g. firm's cash increases)

4. Accounting matrices

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

Accounting principles are incorporated in two matrices, where the economy is usually 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.

5. Balance sheet

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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

Box 1. Balance sheet, Italy, 1998-2019

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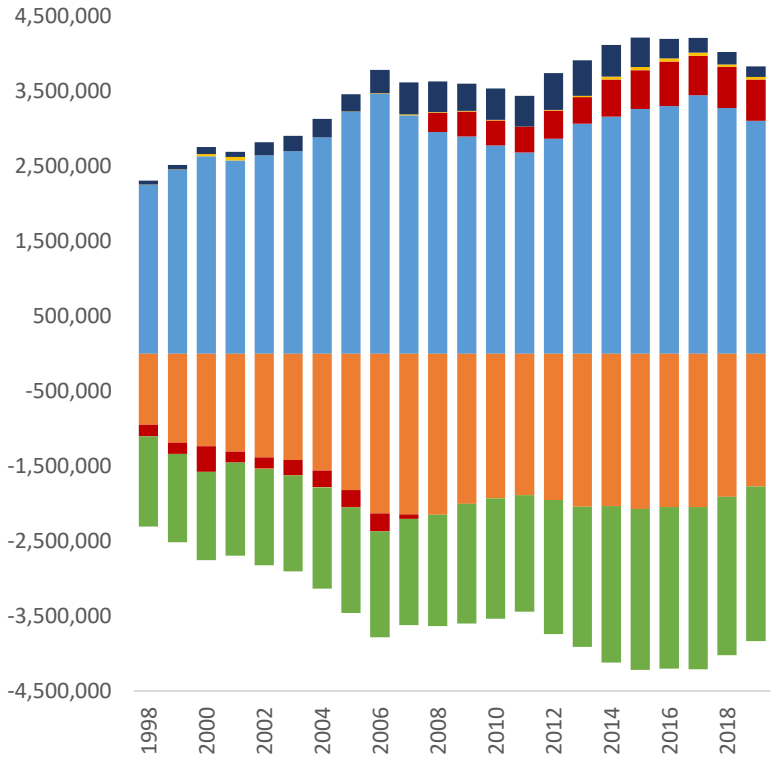
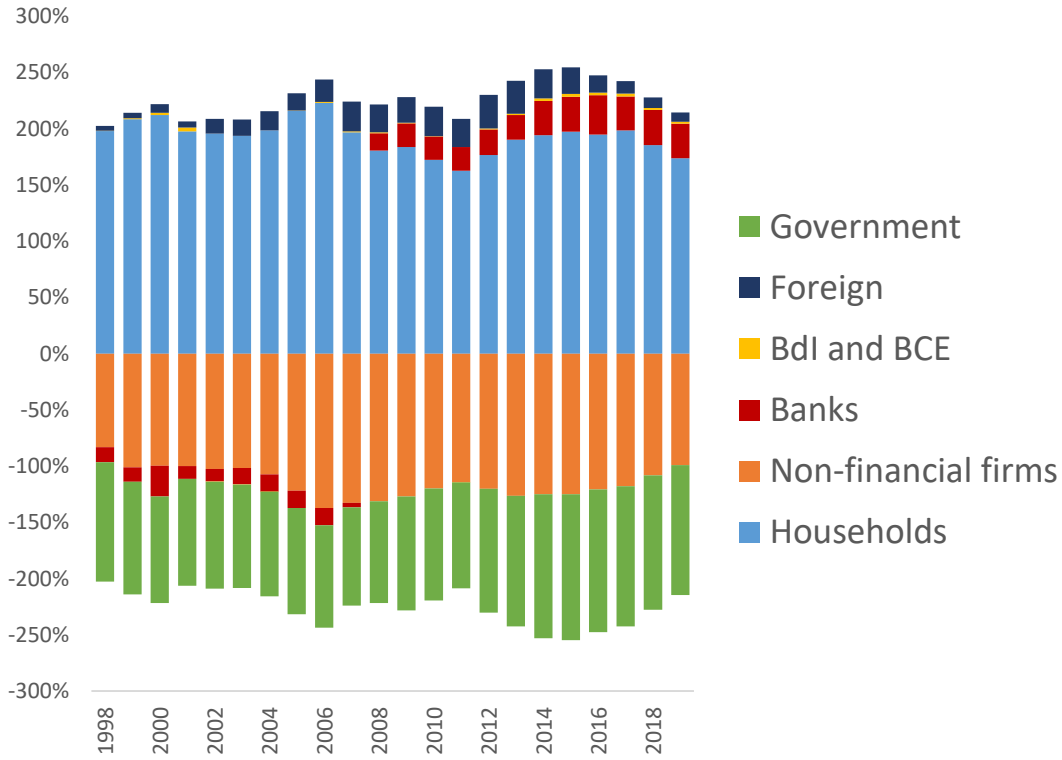
For every asset, there must be a liability, and vice versa!



Source: my elaboration on Eurostat data

Note: net financial assets across sectors, annual, current prices, million €



Source: my elaboration on Eurostat data

Note: net financial assets across sectors, annual, current prices, as % of GDP

6. Transactions-flow matrix

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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.

Box 2. Financial balances, Italy, 1998-2019

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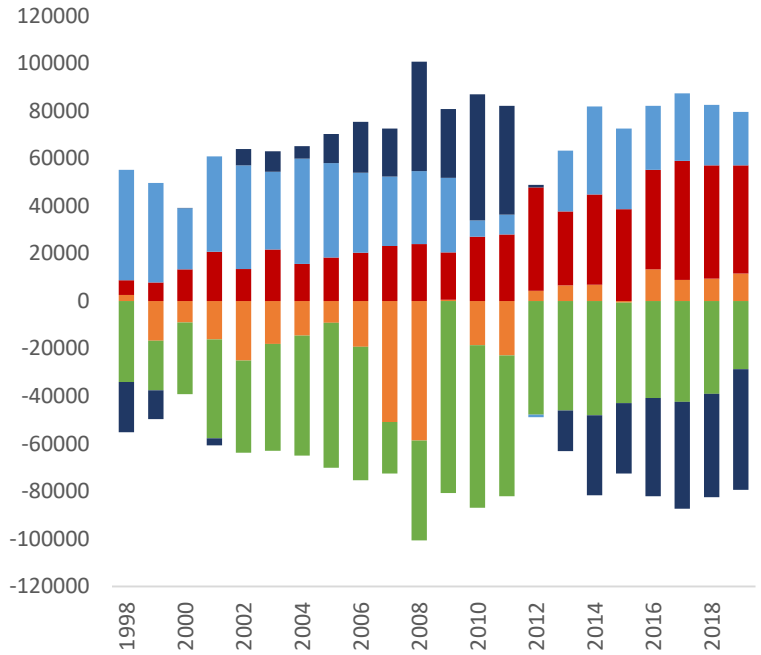
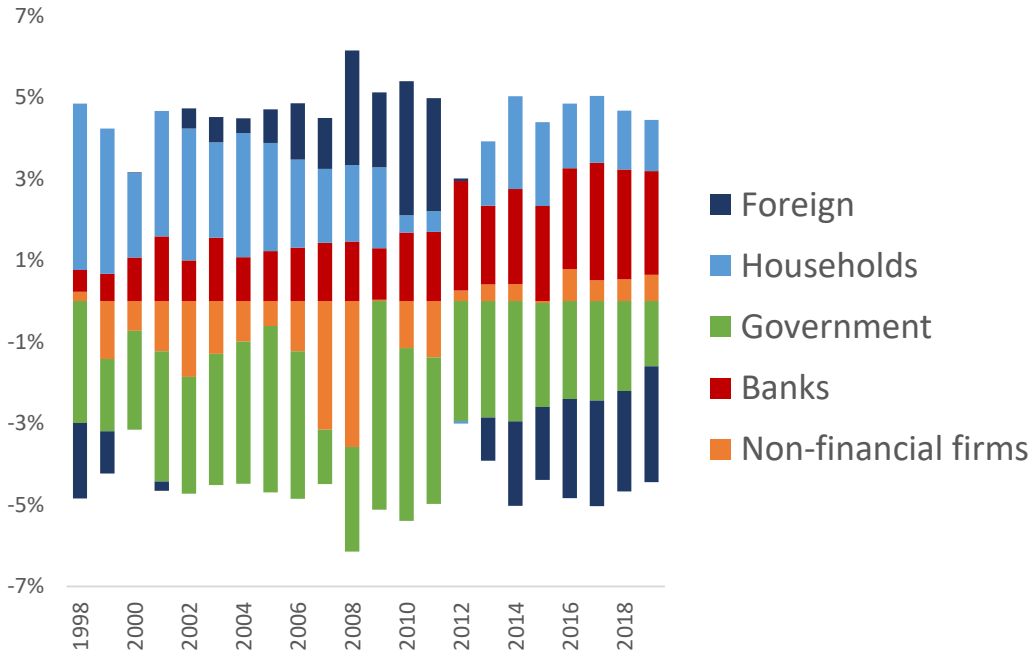
For every lender, there must be a borrower, and vice versa!



Source: my elaboration on Eurostat data

Note: net lending, annual, current prices, million €



Source: my elaboration on Eurostat data

Note: net lending, annual, current prices, as % of GDP

7. Identities and other equations

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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 (e.g. $Y = C + I + G + + X - M$)
- Equilibrium condition: adjustment mechanism that matches demand with supply (e.g. $M_s = M_d$)
- Behavioural (or stochastic) equation: defines the behaviour of a certain variable (e.g. $C = c_0 + c_1 \cdot Y$)

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

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

6. Calibration and simulations

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

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

Corollary 2: monetary policies can bring about paradoxical and counter-intuitive effects (see impact of change in interest rate on Model PC below).

7. Solving the model

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SFC models are medium-scale structural macro-econometric dynamic models. But they can be meso- (IO-SFC) or micro-founded (AB-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 (econometrics: 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

Box 3. How to install *R*

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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

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)

Note: if you prefer *Python*, *Matlab* or *EViews*, you can find the code for the first model (SIM) here

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Fourth section

A simple SFC model with *fiat* money

1. Model PC: assumptions

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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)
- Zero net profits
- No banks, no inside money (bank deposits)
- No ecosystem

Box 4. Steps for developing a SFC model

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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
   - Use columns to derive budget constraints
   - Use also rows with multiple entries
   - Identify buffer variables
5. Define behavioural equations and equilibrium conditions

Source: Dafermos website

2. Model PC: balance sheet

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	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.

3. Model PC: T-F matrix

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	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

4. Model PC: equations

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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

5. Model PC: dynamics

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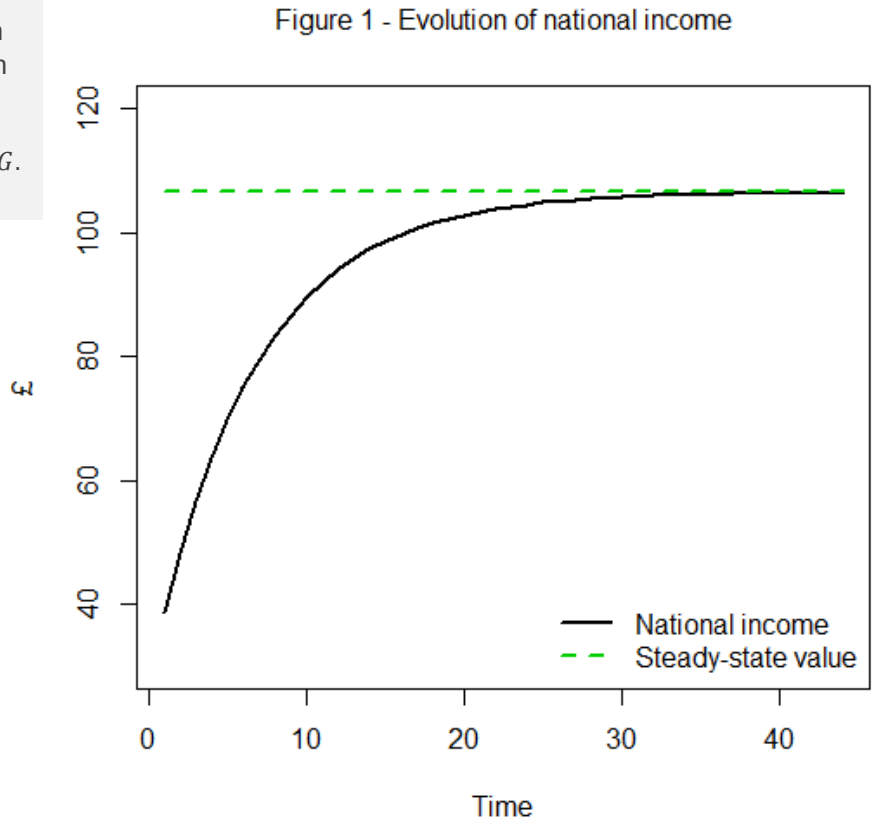
Stationary (quasi steady-state) solution: $Y^* = \dfrac{G + r \cdot B_h^* \cdot (1-\theta)}{\theta}$

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^*.



$G = 20$

$r = 0.025$

$\theta = 0.2$

$B_h^* \sim 64.87$

$Y^* \sim 106.49$

6. PC BS under steady-state

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	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.

7. PC TFM under steady-state

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	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

8. Model PC: higher r

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Figure 2 - Evolution of shares of bills and money balances in the portfolio of households, following an increase in 100 points in the rate of interest on bills

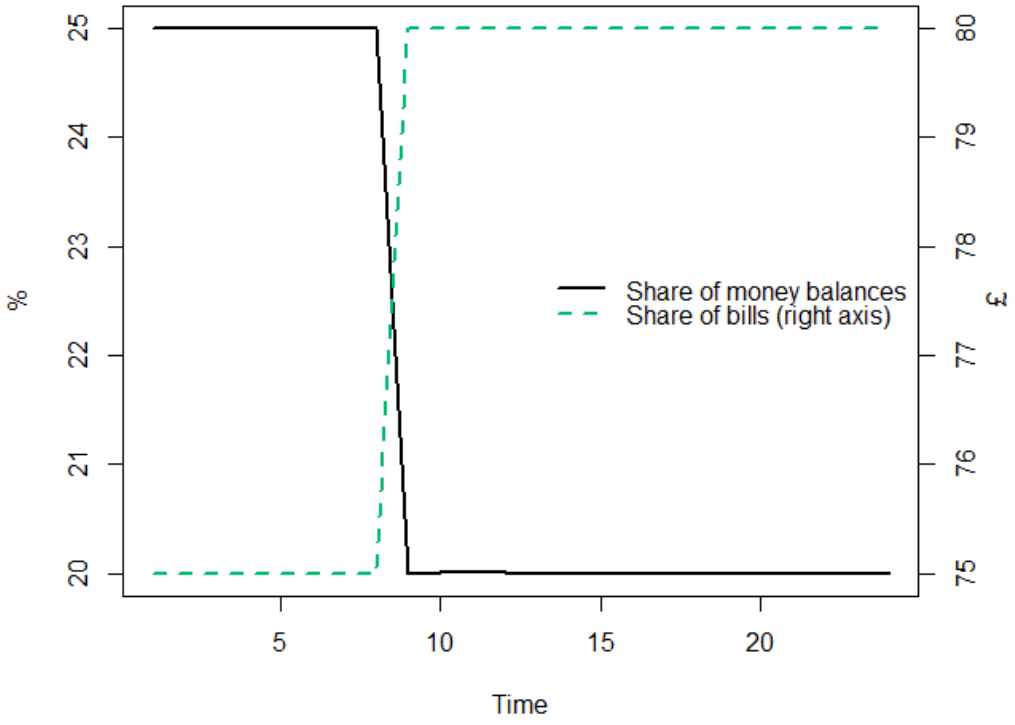
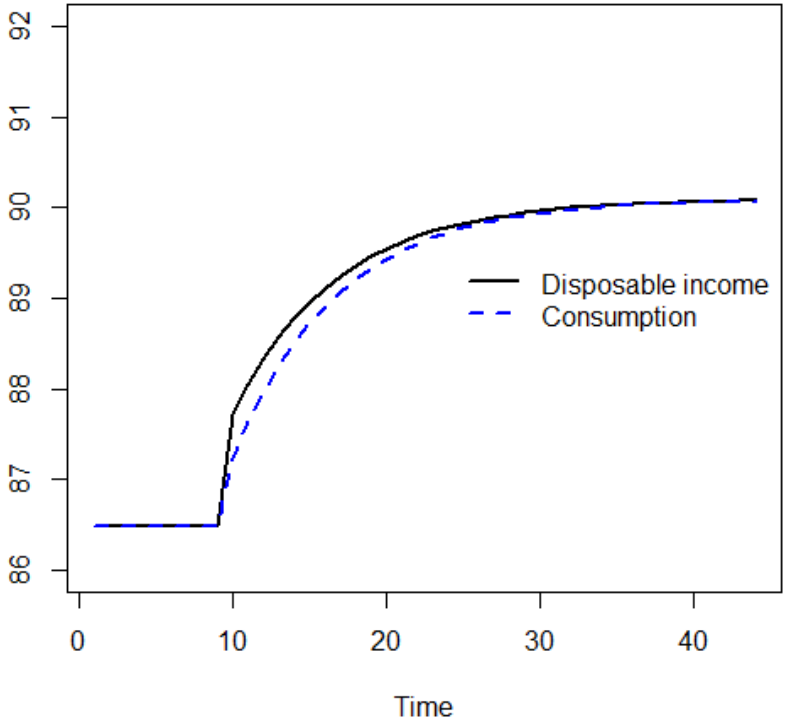


Figure 3 - Evolution of household disposable income and household consumption following an increase in 100 points in the rate of interest on bills



Memo (equation 7): $\frac{B_h}{V_h} = \lambda_0 + \lambda_1 \cdot r - \lambda_2 \cdot \frac{YD}{V_h}$

Box 5. Simulating a SFC model

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Steps in simulating a SFC model:

1. Run the model
2. Check model consistency by using 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)

Notes: points 3 and 4 are for advanced analyses only

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/

Next lecture (13)

SFC Models II: Going Deeper