Introduction to SFC Dynamic Models

Lecture D Multi-Country SFC Models

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Schedule

Box 1 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

Box 2 How to install *R* and run a toy model

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

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

c) Alternatively, use Posit Cloud (free online platform for *R* and *Python*)

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

e) Download toy models from my GitHub repository

f) Open the file and execute the entire code by clicking Source or run it line by line using Run

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

h) Charts are displayed in the Plots tab in the bottom-right pane

i) Tables and Sankey diagrams are displayed in the Viewer tab in the bottom-right pane (note: always re-run the last coding block to visualise them)

1 Introduction

Open-economy models

- General (instead of partial) equilibrium approach, in which two economies trade merchandise with one another.

- The system as a whole is closed, with all flows and all stocks fully accounted for.

- Godley and Lavoie (2007) present and discuss four models:

    a) Model REG: two regions of the same country

    b) Model OPEN: two countries (basic)

    c) Model OPENFIX: two countries (advanced) under fixed exchange rate regime

    d) Model OPENFLEX: two countries (advanced) under floating exchange rate regime

- Here we present and discuss Model REG. We then see some simulation results related to the other models.

2 Model Accounting

Assumptions

Model REG is developed in chapter 6 of Godley and Lavoie (2007). REG stands for regional, as the model considers two regions of the same country.

Model REG is the very same of Model PC. The difference is that the economy is disaggregated into two regions, the 'North' and the 'South'.

Key assumptions are:

• Firms act as intermediaries for imported goods
• 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

Balance-sheet

	North households	South households	Government	Central bank	Σ
Cash	$+H_h^N$	$+H_h^S$		$-H$	0
Bills	$+B_h^N$	$+B_h^S$	$-B$	$+B_{cb}$	0
Balance (wealth)	$-V_h^N$	$-V_h^S$	$-V_g$	0	0
Σ	0	0	0	0	0

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

Transactions-flow matrix

	North households	North production	South households	South production	Government	Central bank	Σ
Consumption	$-C^N$	$+C^N$	$-C^S$	$+C^S$			0
Government expenditure		$+G^N$		$+G^S$	$-G$		0
North exports to South		$+X^N$		$-IM^S$			0
South exports to North		$-IM^N$		$+X^S$			0
GDP	$+Y^N$	$-Y^N$	$+Y^S$	$-Y^S$			0
Interest payments	$+r_{-1} \cdot B^N_{h,-1}$		$+r_{-1} \cdot B^S_{h,-1}$		$-r_{-1} \cdot B_{-1}$	$+r_{-1} \cdot B_{cb,-1}$	0
Profits of central bank					$+r_{-1} \cdot B_{cb,-1}$	$-r_{-1} \cdot B_{cb,-1}$	0
Taxes	$-T^N$		$-T^S$		$+T$		0
Change in cash	$-\Delta H^N_h$		$-\Delta H^S_h$			$+\Delta H$	0
Change in bills	$-\Delta B^N_h$		$-\Delta B^S_h$		$+\Delta B$	$-\Delta B_{cb}$	0
Σ	0	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

Equations

North GDP: $Y^N = C^N + G^N + X^N - IM^N$ (1)

South GDP: $Y^S = C^S + G^S + X^S - IM^S$ (2)

North import: $IM^N = \mu^N \cdot Y^N$ (3)

South import: $IM^S = \mu^S \cdot Y^S$ (4)

North export: $X^N = IM^N$ (5)

South export: $X^S = IM^S$ (6)

North disposable income: $YD^N = Y^N - T^N + r_{-1} \cdot B_{h,-1}^N$ (7)

South disposable income: $YD^S = Y^S - T^S + r_{-1} \cdot B_{h,-1}^S$ (8)

North taxes: $T^N = \theta \cdot \left(Y^N + r_{-1} \cdot B_{h,-1}^N \right)$ (9)

South taxes: $T^S = \theta \cdot \left(Y^S + r_{-1} \cdot B_{h,-1}^S \right)$ (10)

North wealth: $V^N = V_{-1}^N + YD^N - C^N$ (11)

■ Identity
■ Equilibrium condition
■ Behavioural equation

Equations (cont'd)

South wealth: $\qquad$ $V^S = V^S_{-1} + YD^S - C^S$ $\qquad$ (12)

North consumption: $\qquad$ $C^N = \alpha_1^N \cdot YD^N + \alpha_2^N \cdot V^N_{-1}$ $\qquad$ (13)

South consumption: $\qquad$ $C^S = \alpha_1^S \cdot YD^S + \alpha_2^S \cdot V^S_{-1}$ $\qquad$ (14)

North households cash: $\qquad$ $H_h^N = V^N - B_h^N$ $\qquad$ (15)

South households cash: $\qquad$ $H_h^S = V^S - B_h^S$ $\qquad$ (16)

North households bills: $\qquad$ $\dfrac{B_n^N}{V^N} = \lambda_0^N + \lambda_1^N \cdot r - \lambda_2^N \cdot \left(\dfrac{YD^N}{V^N}\right)$ $\qquad$ (17)

South households bills: $\qquad$ $\dfrac{B_n^S}{V^S} = \lambda_0^S + \lambda_1^S \cdot r - \lambda_2^S \cdot \left(\dfrac{YD^S}{V^S}\right)$ $\qquad$ (18)

Total tax revenue: $\qquad$ $T = T^N + T^S$ $\qquad$ (19)

Government expenditure: $\qquad$ $G = G^N + G^S$ $\qquad$ (20)

Equations (cont'd)

Total households bills: $\quad B_h = B_h^N + B_h^N$ $\qquad$ (21)

Total households cash: $\quad H_h = H_h^N + H_h^N$ $\qquad$ (22)

New bills supply: $\quad \Delta B_s = G + r_{-1} \cdot \left(B_{s,-1} - B_{cb,-1} \right) - T$ $\qquad$ (23)

New cash supply: $\quad \Delta H_s = \Delta B_{cb}$ $\qquad$ (24)

CB bills: $\quad B_{cb} = B_s - B_h$ $\qquad$ (25)

Interest rate: $\quad r = \bar{r}$ $\qquad$ (26)

Redundant equation: $\quad H_s = H_h$

3 Simulations

Dynamics (adjustment after shock)

Figure 1 Evolution of GDP in the N and S Region following an increase in the import propensity of the S Region
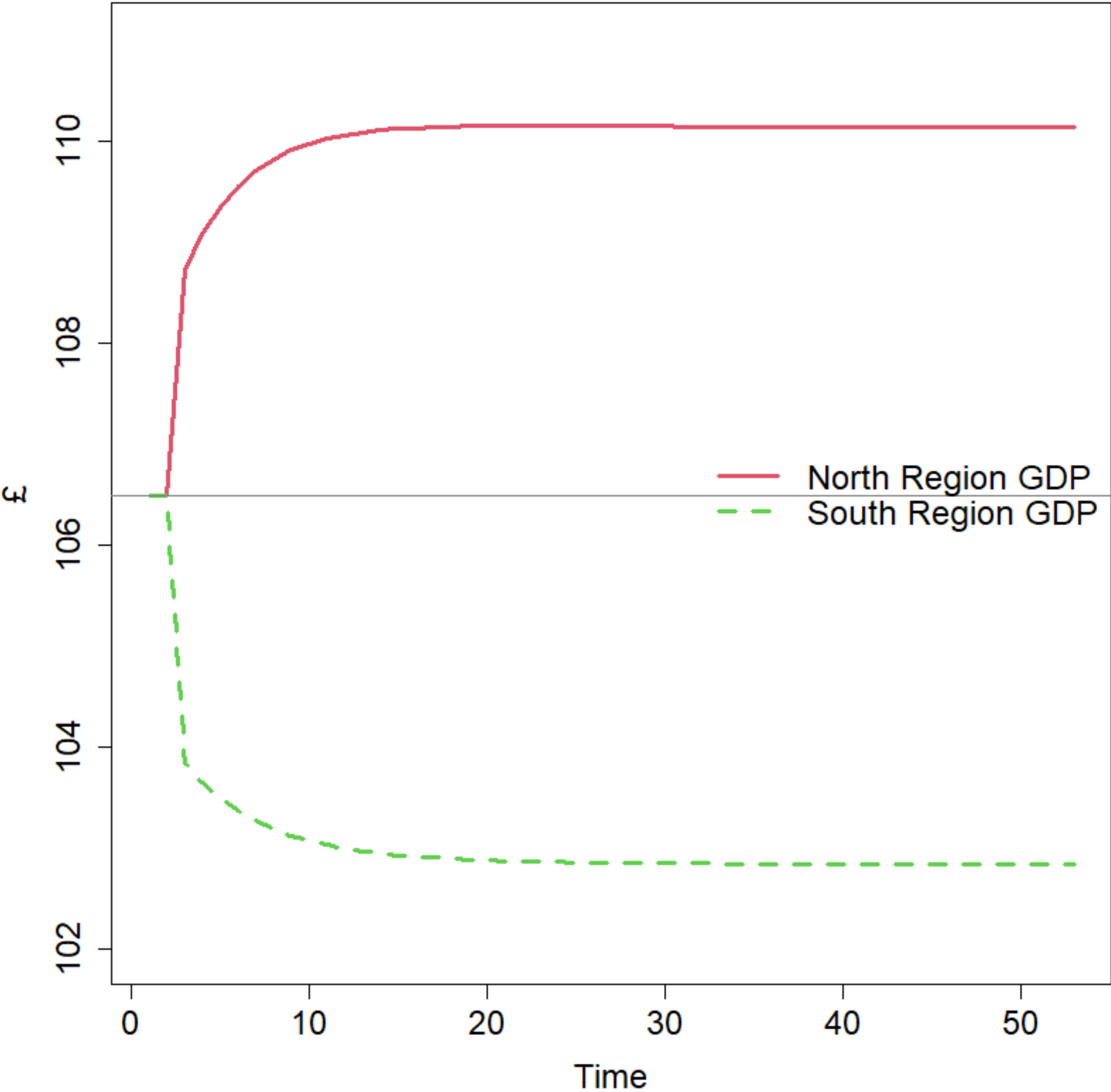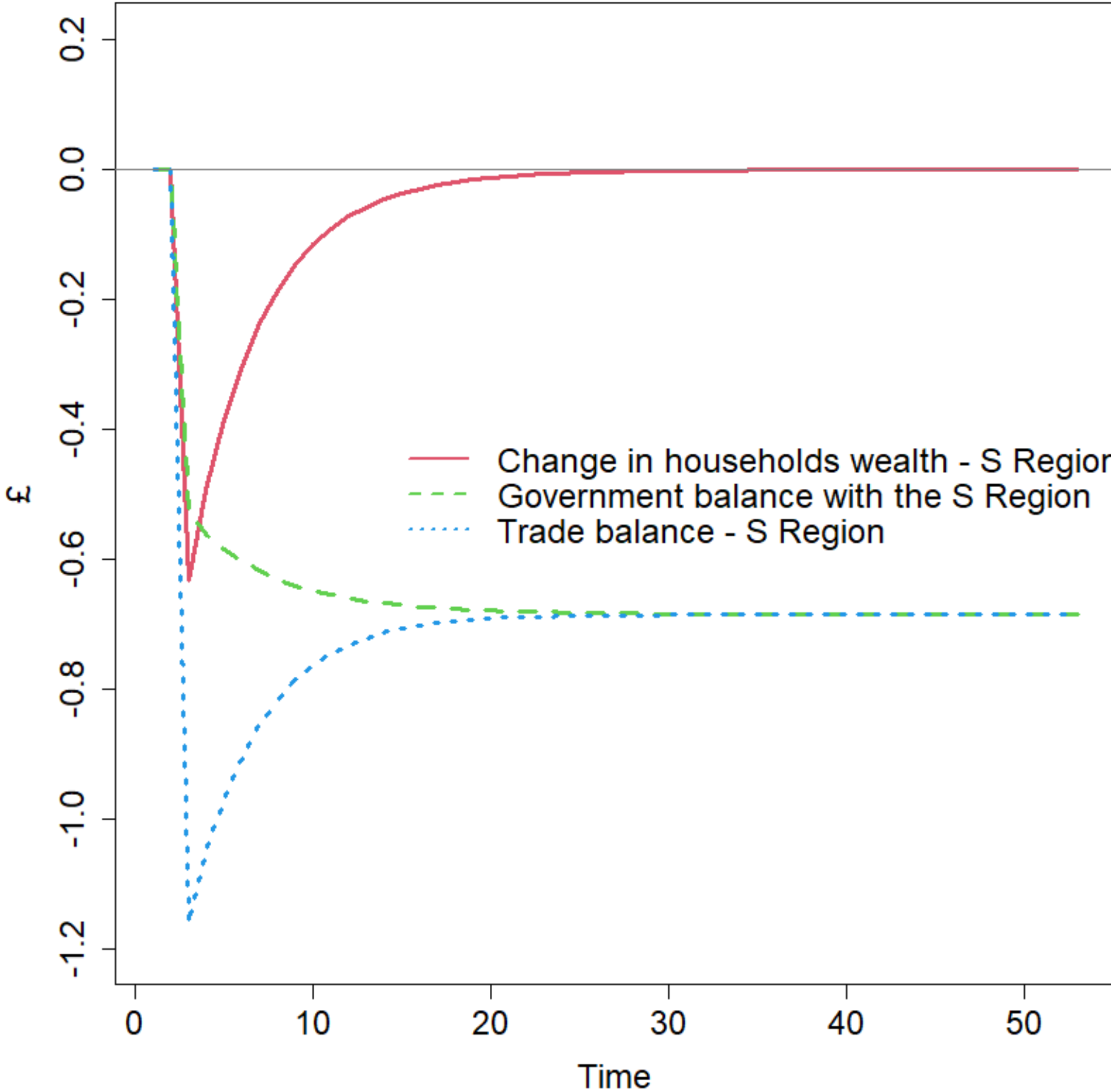
Figure 2 Evolution of balances in the S Region following an increase in import propensity of the S region

BS steady-state values

|	North households	South households	Government	Central bank	Σ
Cash	+21.62	+21.62		−43.23	0
Bills	+64.85	+64.85	−172.93	+43.23	0
Balance (wealth)	−86.46	−86.46	+172.93	0	0
Σ	0	0	0	0	0

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

TFM steady-state values

	North households	North production	South households	South production	Government	Central bank	Σ
Consumption	−86.47	+86.47	−86.47	+86.47			0
Government expenditure		+20		+20	−40		0
North exports to South		+20		−20			0
South exports to North		−20		+20			0
GDP	+106.47	−106.47	+106.47	−106.47			0
Interest payments	+1.62		+1.62		−4.32	+1.08	0
Profits of central bank					+1.08	−1.08	0
Taxes	−21.62		−21.62		+43.24		0
Change in cash	0		0			0	0
Change in bills	0		0		0	0	0
Σ	0	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

Sankey diagram of transactions (t=5)
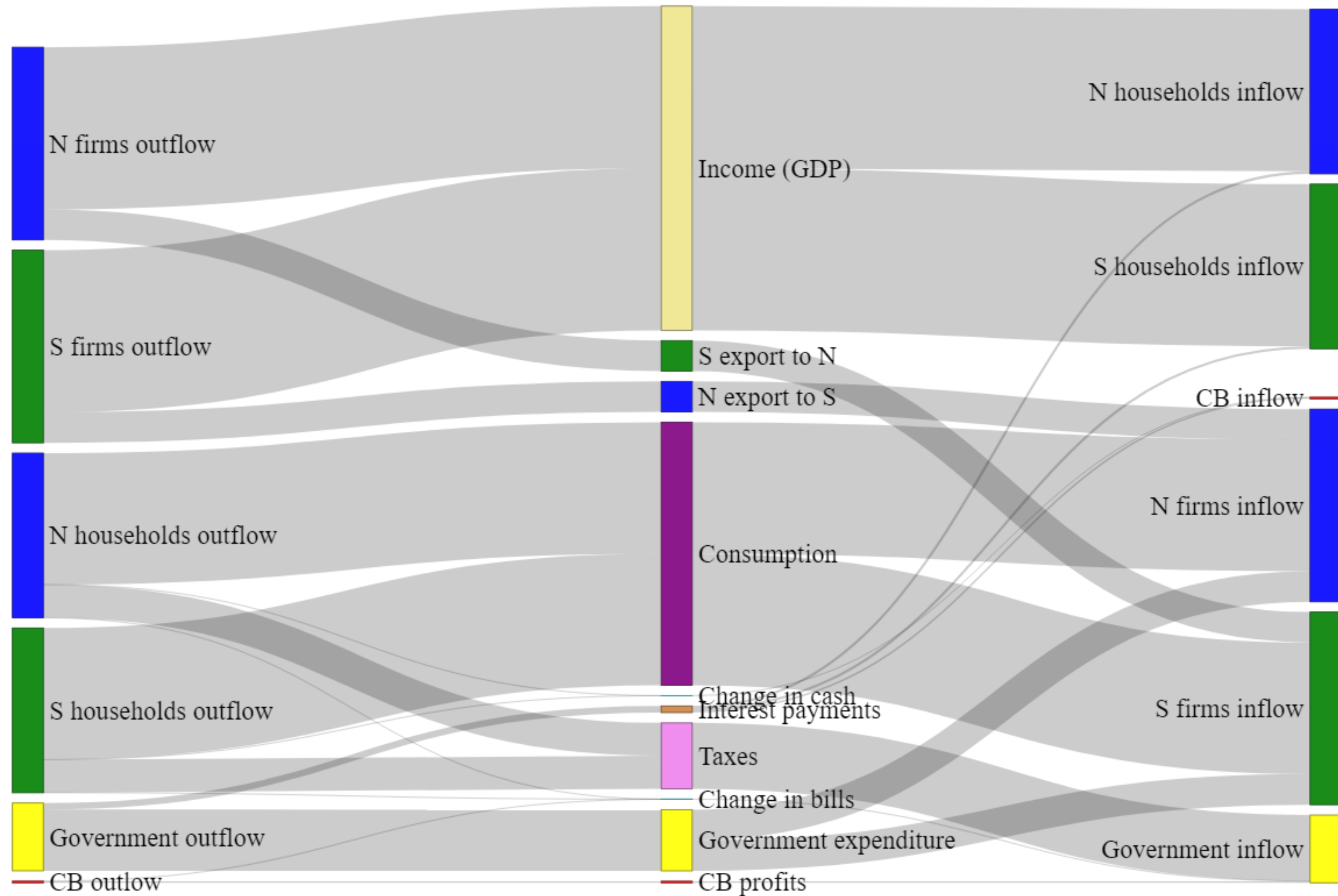
Other experiments: increase in G^S

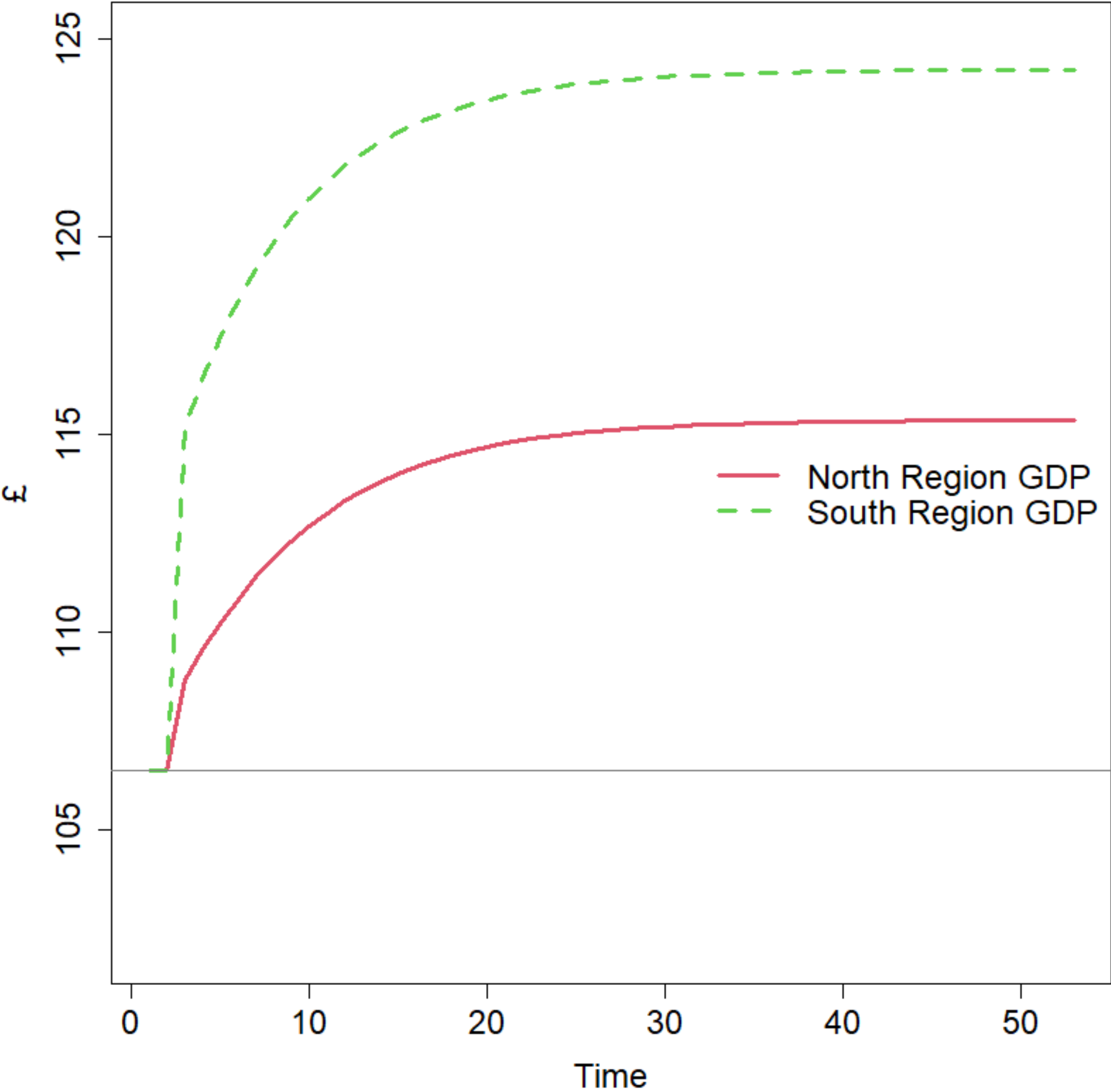Figure 3 Evolution of GDP in the N and S Region following an increase in govt. expenditure of the S Region
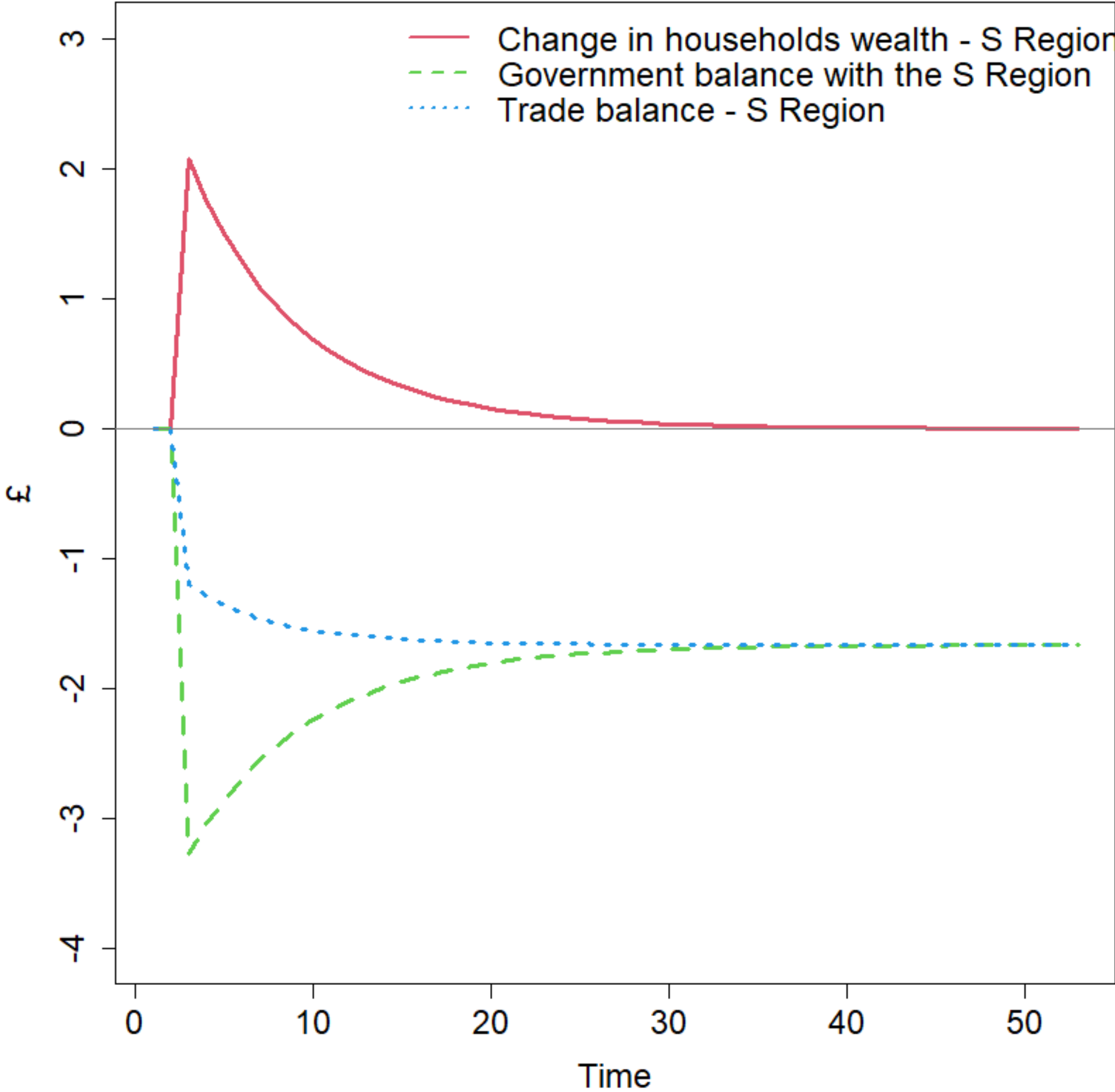
Figure 4 Evolution of balances in the S Region following an increase in govt. expenditure of the S Region

Other experiments: fall in α_1^S

Figure 5 Evolution of GDP in the N and S Region following an increase in the saving propensity of the S Region
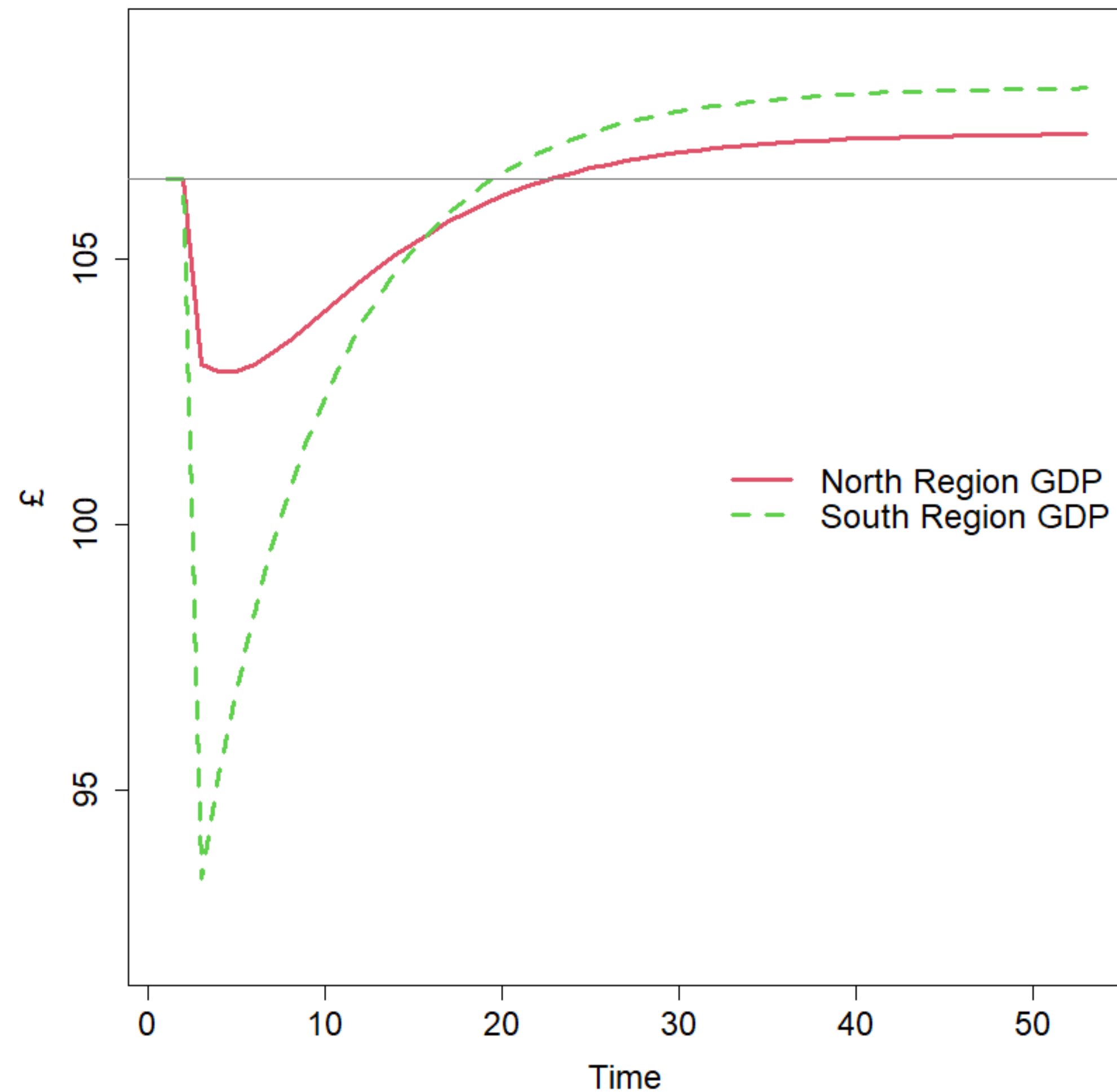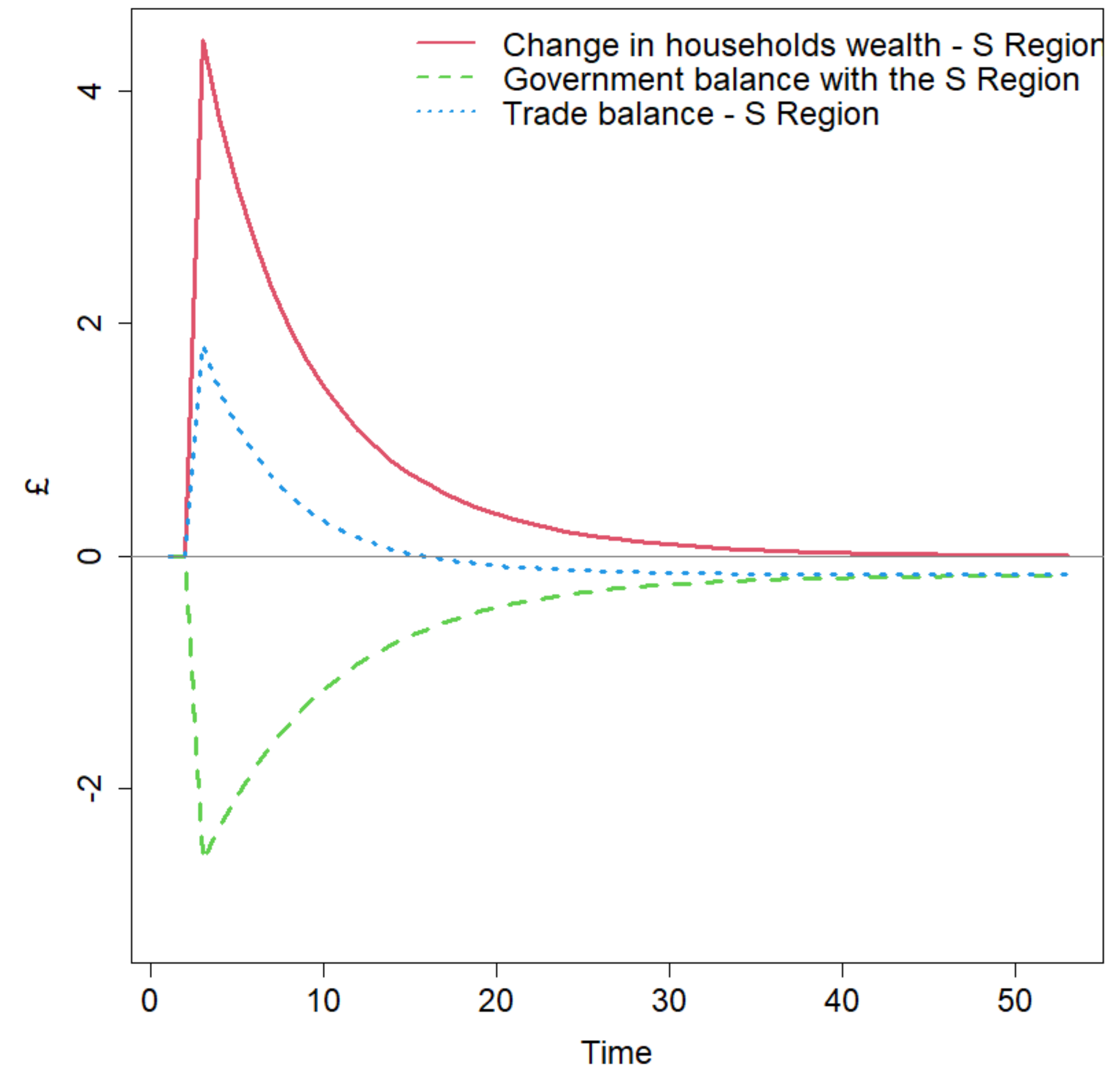
Figure 6 Evolution of balances in the S Region following an increase in the saving propensity of the S Region

Useful web resources for SFC modellers

Authors	Description	Link
Alessandro Bramucci	**Interactive Macro** - Website collecting a series of simulators programmed in R and Shiny of some famous macroeconomic textbook models.	Link
Alessandro Caiani	**JMAB** - Simulation tool designed (with Antoine Godin) for AB-SFC macroeconomic modeling.	Link
Yannis Dafermos	**DEFINE** - Ecological stock-flow consistent model that analyses the interactions between the ecosystem, the financial system and the macroeconomy (developed with Maria Nikolaidi and Giorgos Galanis).	Link
Michal Gamrot	**Godley package** - R package for simulating SFC (stock-flow consistent) models.	Link
Antoine Godin	**SFC codes** - R and Python codes collected from seminars and lectures.	Link
Andrea Luciani	**Bimets package** - R package developed with the aim to ease time series analysis and to build up a framework that facilitates the definition, estimation, and simulation of simultaneous equation models.	Link
Joao Macalos	**SFCR package** - R package providing an intuitive and tidy way to estimate stock-flow consistent models.	Link
Jo Michell	**SFC codes** - R and Python codes collected from seminars and lectures.	Link
Franz Prante and Karsten Kohler	**DIY Macroeconomic Model Simulation** - Platform providing an open source code repository and online script for macroeconomic model simulation.	Link
Marco Veronese Passarella (marxianomics)	**SFC codes** - R, Python, Matlab and EViews codes collected from papers, seminars and lectures.	Link
Marco Veronese Passarella (GitHub)	**SFC codes** - R, Python, Matlab and EViews codes collected from papers, seminars and lectures.	Link
Gennaro Zezza	**sfc.models.net** - Repository containing original EViews (and Excel) codes that replicate experiments from Godley and Lavoie's "Monetary Economics", and additional (R and EViews) codes from the SFC literature.	Link

Selected references

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.

ADDITIONAL READINGS

- W. Godley (1999). Seven Unsustainable Processes. *Levy Institute Strategic Analysis*, January 1999.

- 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.

- Emilio Carnevali, Matteo Deleidi, Riccardo Pariboni, Marco Veronese Passarella (2019). Stock-Flow Consistent Dynamic Models: Features, Limitations and Developments. In: Philip Arestis, Malcolm Sawyer (eds.): *Frontiers of Heterodox Macroeconomics*, Palgrave Macmillan, 2019, pp. 223-276.

Download lectures' material from:

https://github.com/marcoverpas/Six_lectures_on_sfc_models

Thanks

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