Post-Keynesian Stock-Flow Consistent Modelling

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Outline

Motivation: why should you use PK-SFC modelling?

- Highights fundamental *real-financial* interactions
- Powerful *didactical* tool
- Strong *empirical* connection

Sectoral balances

$$Y = C + I + G + X - M$$
$$0 = (Y - T - C - I) + (T - G) + (M - X)$$

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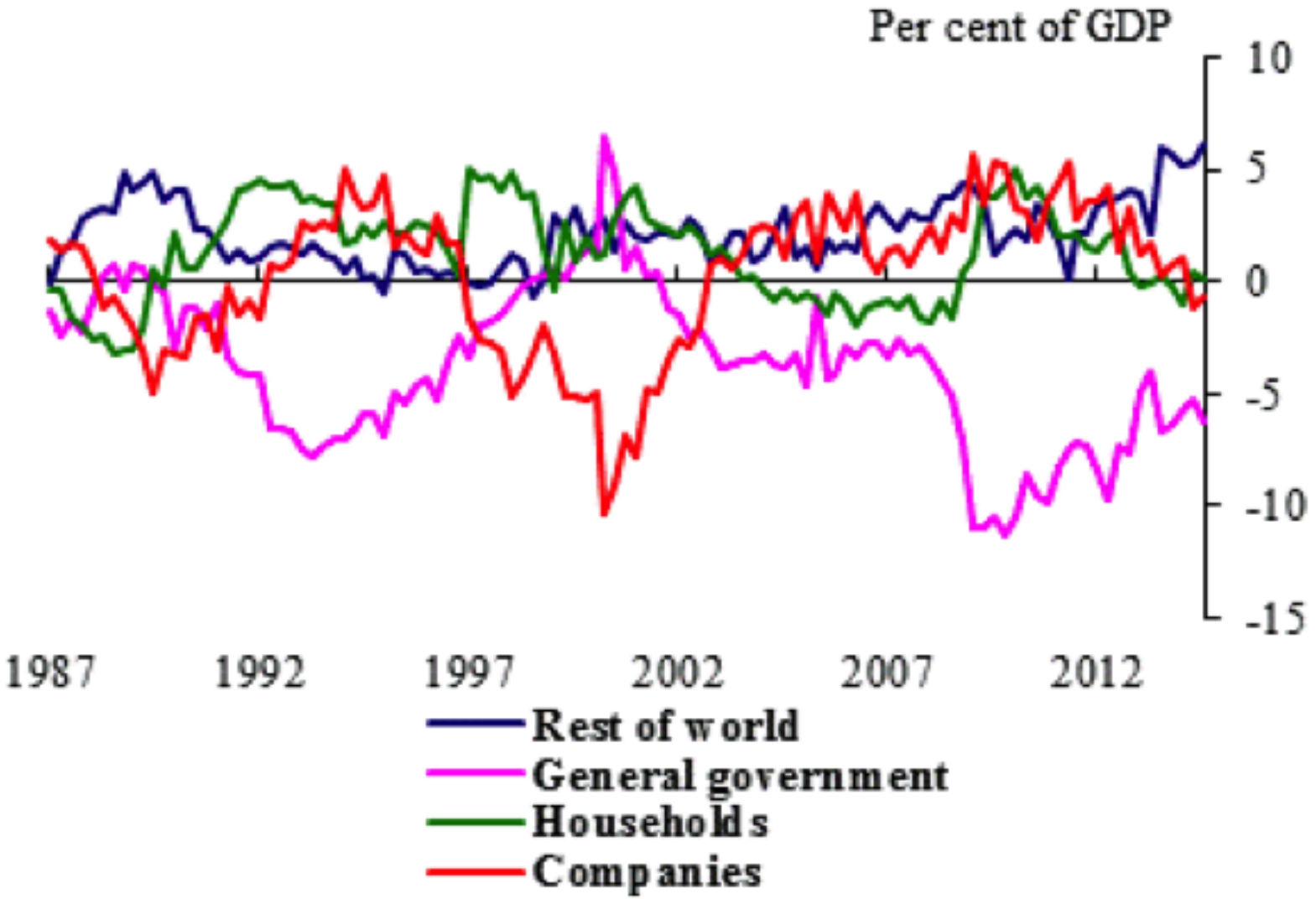
Net saving position from sectors in an economy

$$NLP_{HH} + NLP_{FC} + NLP_{NFC} + NLP_{G} + NLP_{ROW} = 0$$

Net lending position are fundamental as they are the result of agents interactions and will determine the evolution of stocks.

Net lending per sector, UK



Household income statement from 2012-Q4 to 2013-Q4

Flows	2013-Q4
Net savings (Δ net worth)	

Table : Household Flow of funds (EUR Billions), source: ECB Monthly Bulletin May 2014

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Total income (all sources)	7,059
Net social contributions receivable	182
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Gross disposable income	6,279
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Net savings (Δ net worth)	229

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Households financial statement 2012–Q4 and 2013-Q4

Category	Balance	2012-Q4	2013-Q4	Δ
Non Financial assets	Non-financial assets			
	Housing wealth			
Financial assets	Currency and deposits			
	Securities and derivatives			
	Loans			
	Shares and equities			
	Insurance and pension			
	Other			
	Net worth			

Table : Household Balance Sheet (EUR Billions), source: ECB Monthly Bulletin May 2014

Households financial statement 2012–Q4 and 2013-Q4

Category	Balance	2012-Q4	2013-Q4	Δ
Non Financial assets	Non-financial assets	29,625		
	Housing wealth	28.055		
Financial assets	Currency and deposits	7,046		
	Securities and derivatives	1,537		
	Loans	-6,196		
	Shares and equities	4,310		
	Insurance and pension	5,939		
	Other	195		
	Net worth	42,456		

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Category	Balance	2012-Q4	2013-Q4	Δ
Non Financial assets	Non-financial assets	29,625	29,041	
	Housing wealth	28.055	7,435	
Financial assets	Currency and deposits	7,046	7,225	
	Securities and derivatives	1,537	1,365	
	Loans	-6,196	-6,152	
	Shares and equities	4,310	4,858	
	Insurance and pension	5,939	6,184	
	Other	195	169	
	Net worth	42,456	42,685	

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Households financial statement 2012–Q4 and 2013-Q4

Category	Balance	2012-Q4	2013-Q4	Δ
Non Financial assets	Non-financial assets	29,625	29,041	-584
	Housing wealth	28.055	7,435	-620
Financial assets	Currency and deposits	7,046	7,225	179
	Securities and derivatives	1,537	1,365	172
	Loans	-6,196	-6,152	44
	Shares and equities	4,310	4,858	543
	Insurance and pension	5,939	6,184	-245
	Other	195	169	-26
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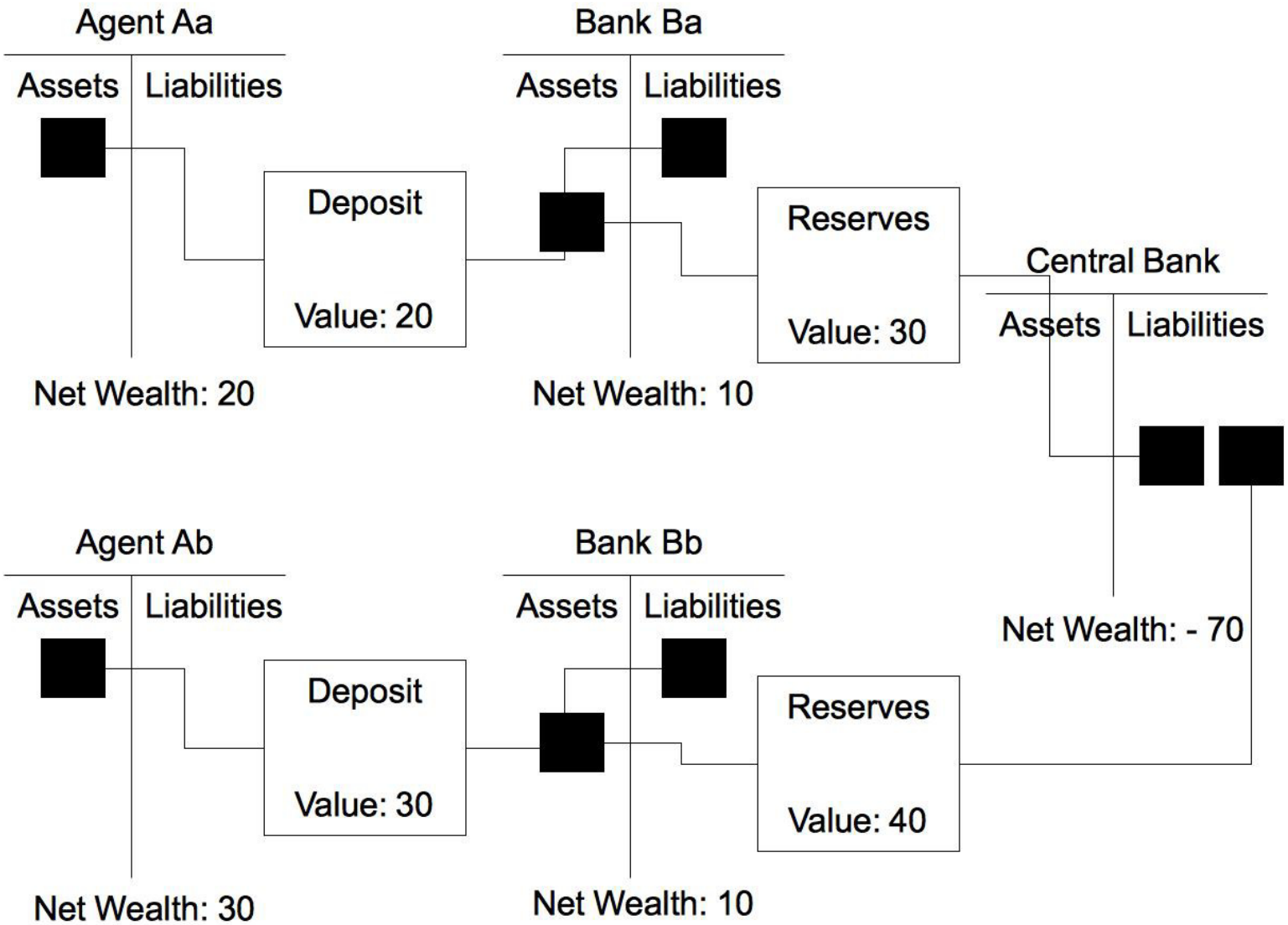
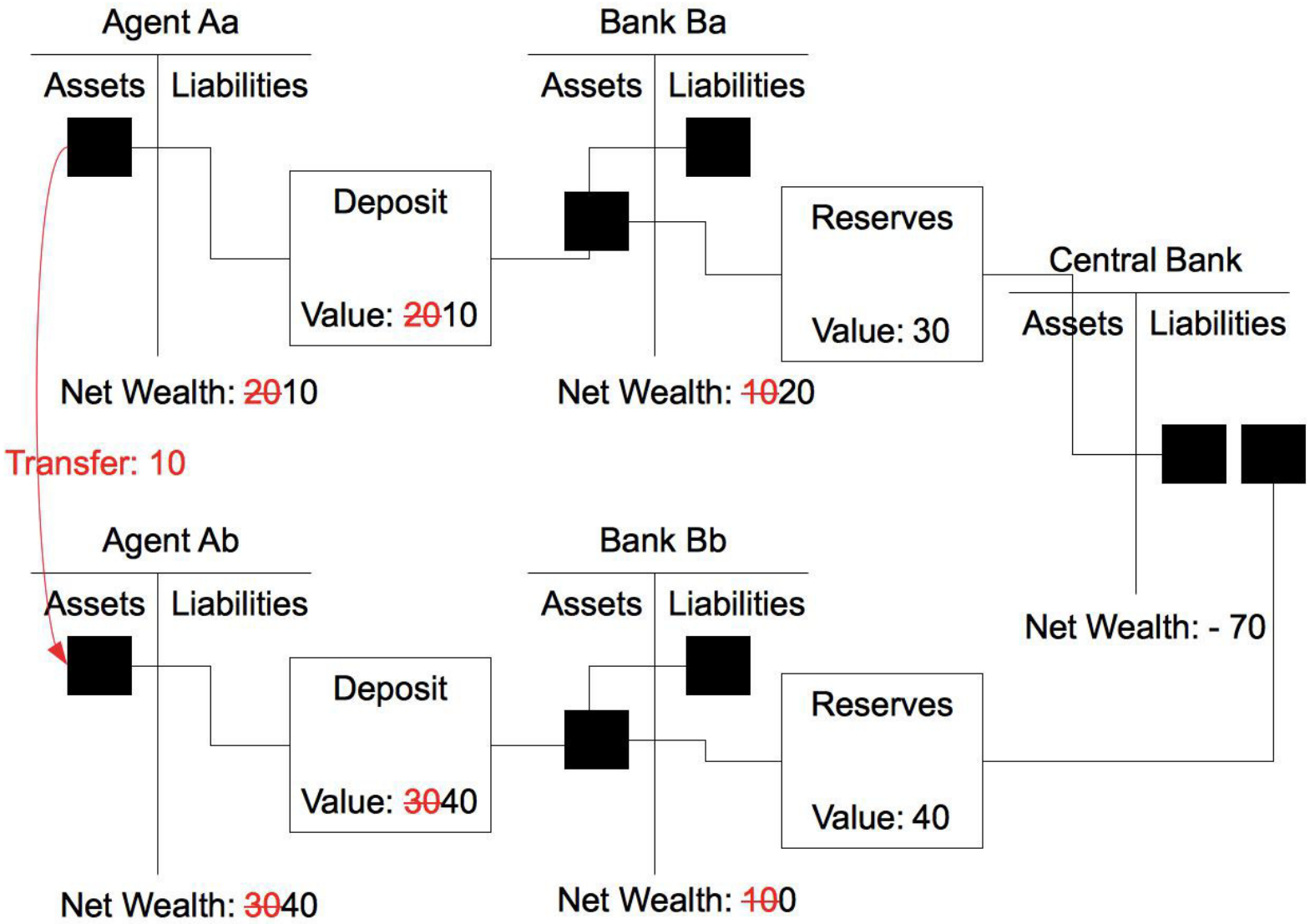
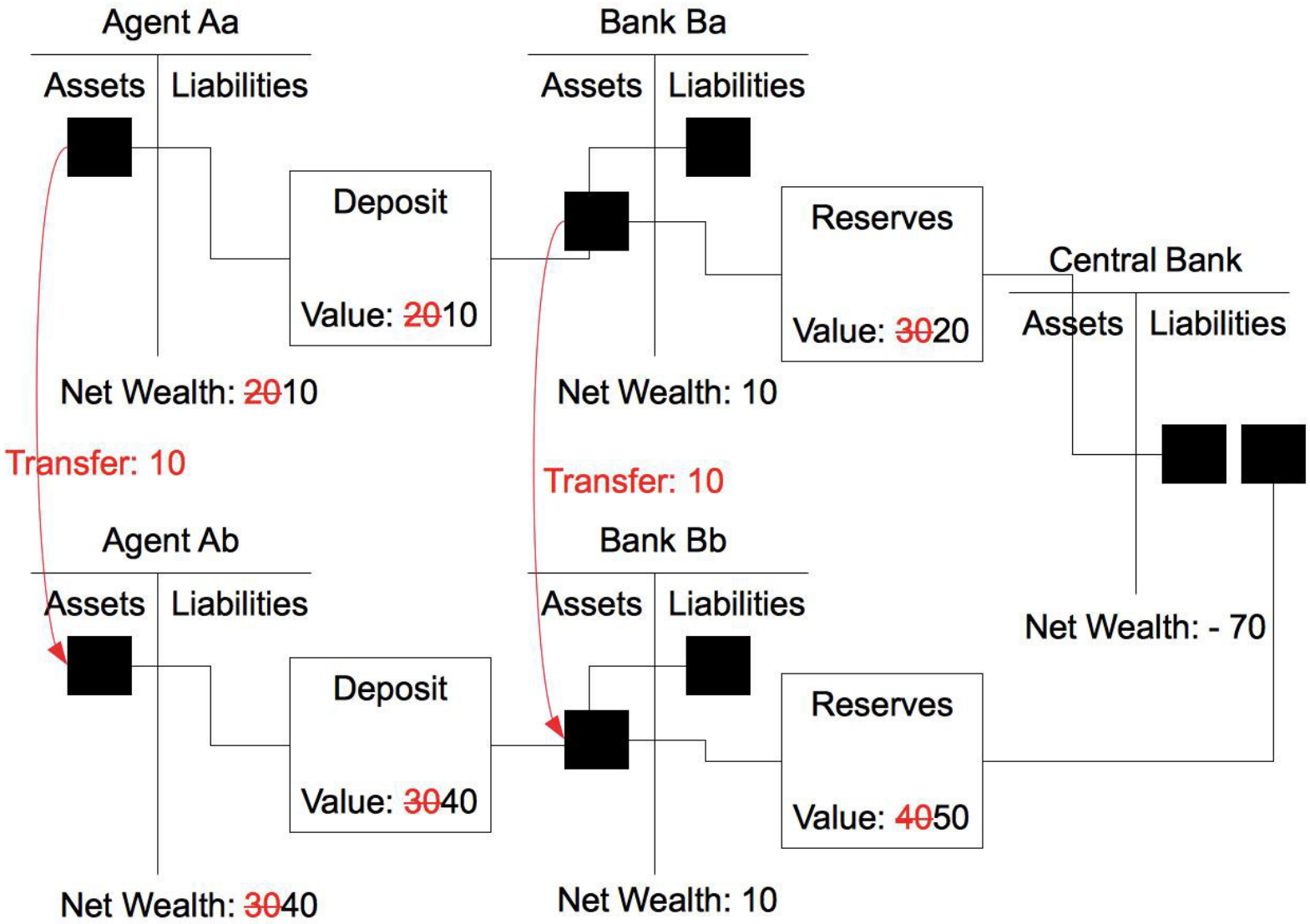
Why are Balance sheets so important?



A transfer from Agent Aa to Agent Ab



Adding the clearing mechanism



Outline

Godley's seven unsustainable processes, 1999

1. Written in 1999 when everything was fine for the US economy. Clinton: "There are no limits to the world we can create, together, in the century to come."
2. Calling for political intervention and expansionary fiscal policies: "*The view taken here, which is built into the Keynesian model later deployed, is that the government's fiscal operations, through their impact on disposable income and expenditure, play a crucial role in determining the level and growth rate of total demand and output.*"
3. Highlighting seven unsustainable processes: "*(1) the fall in private saving into ever deeper negative territory, (2) the rise in the flow of net lending to the private sector, (3) the rise in the growth rate of the real money stock, (4) the rise in asset prices at a rate that far exceeds the growth of profits (or of GDP), (5) the rise in the budget surplus, (6) the rise in the current account deficit, (7) the increase in the United States's net foreign indebtedness relative to GDP.*"

Stock-flow norms

(Turnovsky, 1977, p.3) and (Godley and Lavoie, 2007, p.13)

There are *intrinsic dynamics*, that reflect 'the dynamic behaviour stemming from certain logical relationships which constrain the system; specifically the relationships between stocks and flows'

- *Standards*: (private or public) debt to GDP, capacity utilisation, unemployment rate, etc...

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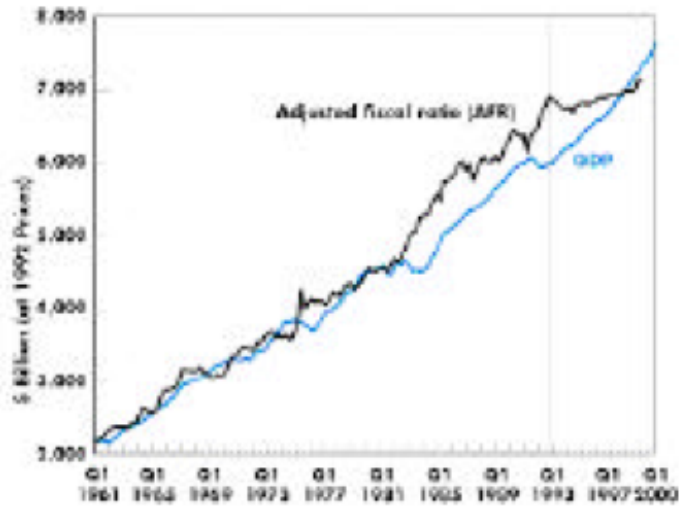
- *Adjusted Trade Ratio*: $\mu = \frac{M}{Y}$ is the average propensity to import, then the trade ratio $\frac{X}{\mu}$ is equal to GDP when $X = M$, adjusted for inflation.
- *Combined Fiscal and Trade Ratio*: $\frac{G+X}{\theta+\mu}$ is equal to GDP when balanced budget and trade balance.

Unsustainable processes (Godley, 1999)

Adjusted Fiscal Ratio and GDP

Figure 2 Adjusted Fiscal Ratio and GDP



Note: In this and the following figures, the vertical line is drawn at 1992Q3 unless otherwise indicated.
Source: Citibase and author's calculations (see text for details).

Adjusted Trade Ratio and GDP

Figure 4 Adjusted Trade Ratio and GDP

Source: Citibase and author's calculations (see text for details).

Conclusion

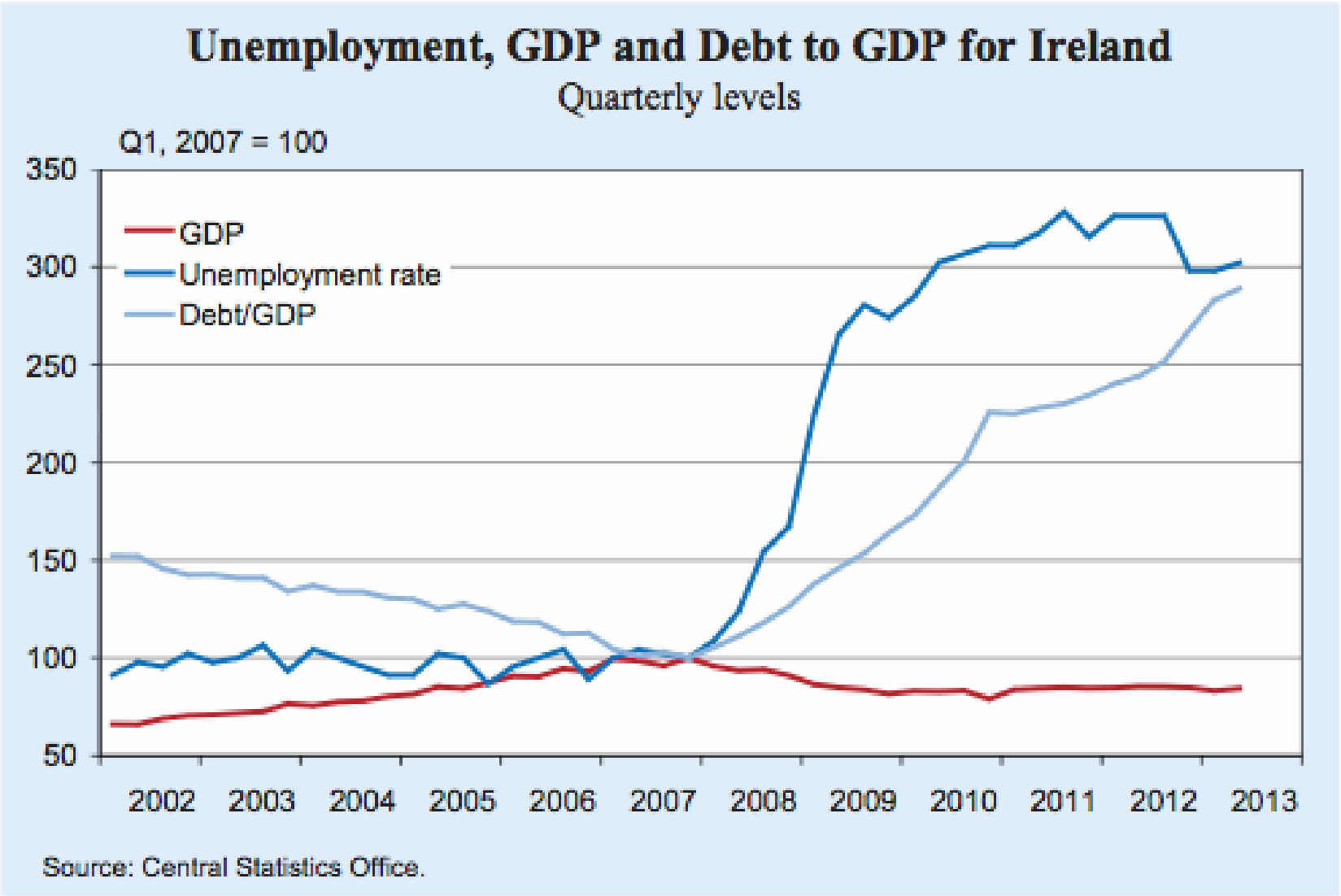
- "Given unchanged fiscal policy and accepting the consensus forecast for growth in the rest of the world, continued expansion of the U.S. economy requires that private expenditure continues to rise relative to income. [...] The growth in net lending to the private sector and the growth in the growth rate of the real money supply cannot continue for an extended period." (p. 5)
- "It will become necessary both to relax the fiscal stance and to increase exports relative to imports [but] it will be difficult to get the timing right." (p. 9)
- He then simulates "whatever fiscal expansion plus (effective) dollar devaluation is necessary to generate the growth of output assumed in the CBO projections (growth just enough to keep unemployment close to its present low level) and an improving balance of payments. Specifically, it was necessary to raise total general government outlays [...] in stages by about 16 percent - corresponding to about $400 billion per annum at current prices - compared with what the CBO is at present projecting." (p. 10)

Ireland is no poster child for austerity (Kinsella, 2014)

1. Ireland is getting better, "clean" exit from EU/IMF bailout program. Poster Child for Austerity measures?
2. Maybe not so much...

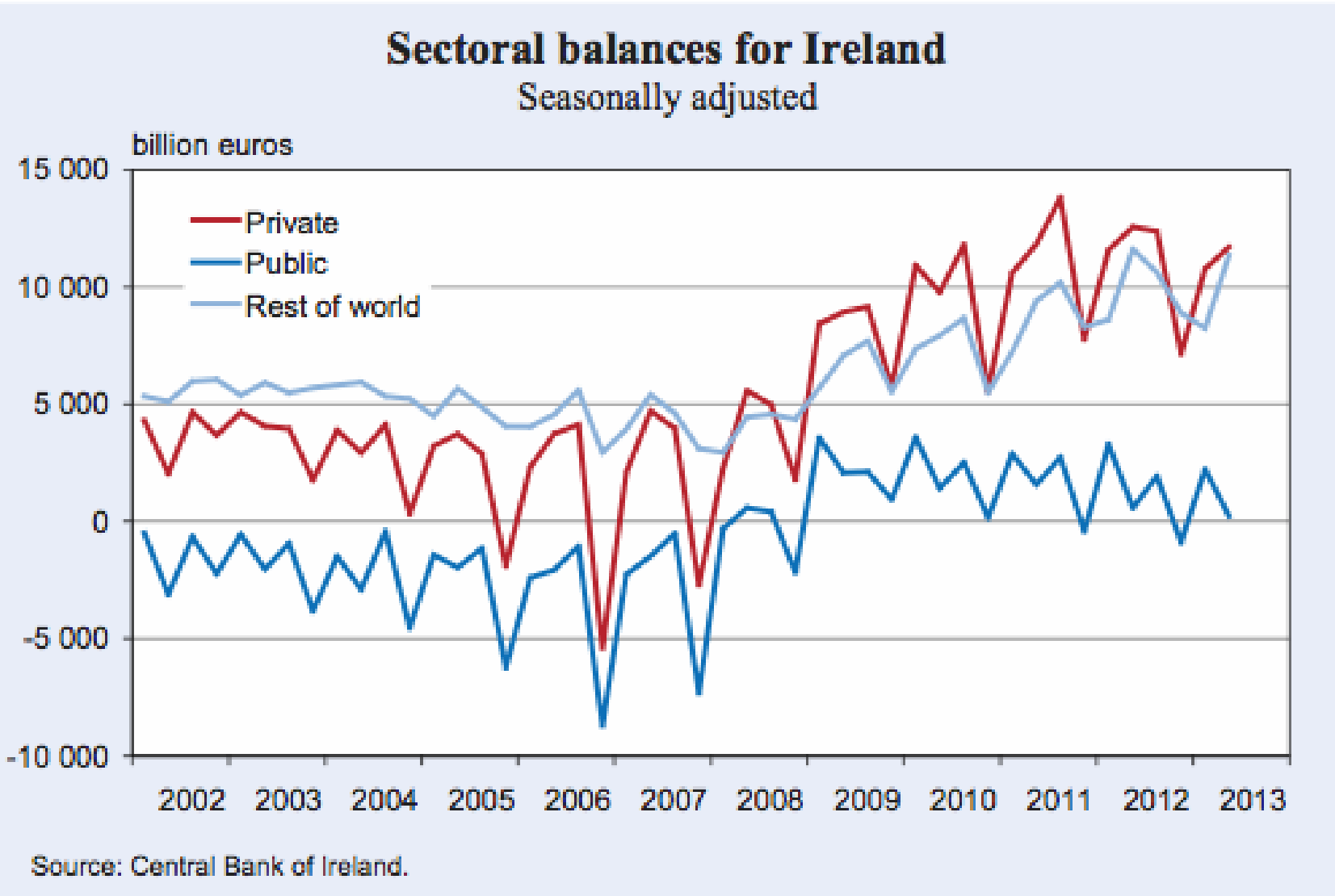
General situation

Figure 1



Sectoral balances

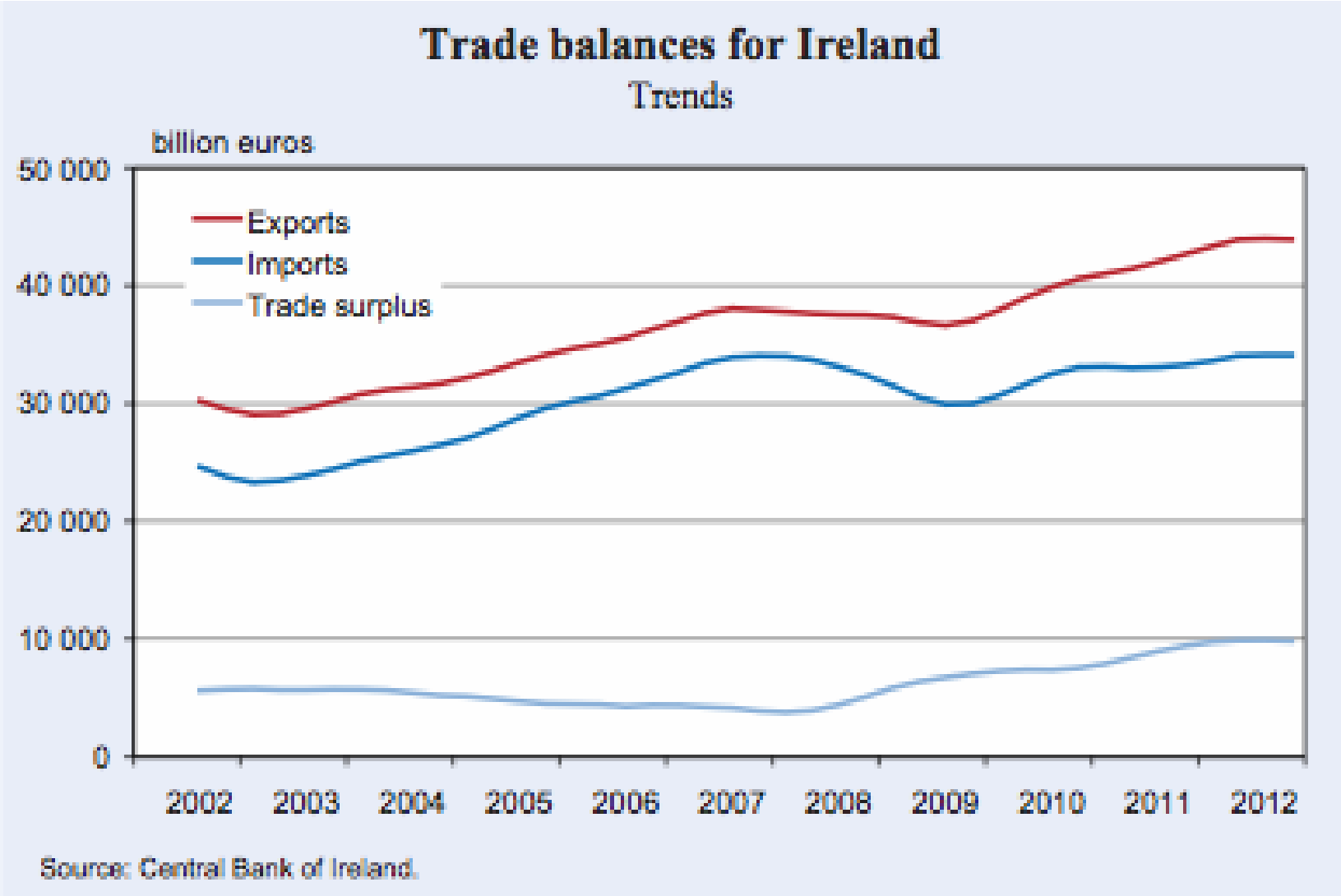
Figure 2



Source: Central Bank of Ireland.

Trade Flows

Figure 3



Conclusions

- Trade balance improved significantly
  - by decreasing the propensity to import via austerity
  - thanks to the pick up in export due to the world (non-EU) recovery
- Ireland's financial openness allowed for a massive change in portfolio allocation of the financial assets to occur between financial and non financial corporations without impacting the households
- "Ireland's post bailout performance in terms of debt dynamics will hinge upon its ability to trade off its trade performance and tax rates" (p. 24)
- "Ireland is still not the poster child for austerity, but, against the odds, as it were, a lucky child. Given the simple fact that as a nation Ireland has been bankrupted three times in 50 years, Ireland's peaceful exit from its bailout programme is all the more remarkable. The post-bailout landscape is fraught with risks to the nascent recovery, but stable debt dynamics and the openness of the economy should be enough to keep Ireland from requiring another bailout in the medium term."(p. 25)

Macro-modelling and the great recession

From the Stockton Report on the Monetary Policy Committee's forecasting capability:

Consider creating a forecast with an extended horizon beyond the current three-year period: a horizon of sufficient length to allow consideration of the development and likely unwinding of major economic and financial imbalances.

Motivation is clear:

- The building up of financial imbalances contributed to the financial crisis and ensuing Great Recession
- If we'd been looking further ahead than two years, we might have seen this coming

Typical DSGE models have little to say about financial balances

- Any wealth to income ratio can be supported as an equilibrium
- Any debt to GDP ratio can be supported as an equilibrium
- The net foreign asset to GDP ratio is typically brought to an arbitrary level by an ad hoc portfolio cost

Mervyn King, 'Twenty Years of Inflation Targeting', The Stamp Memorial Lecture, 2012

The dominant new Keynesian model of monetary economics lacks an account of financial intermediation, so that money, credit and banks play no meaningful role.

Of stocks and flows

1. Importance of balances both in flow and stock levels
2. A seemingly sound situation might hide imbalances building up and leading to unsustainable situation
3. Importance of financial side of economy and feedback from real and finance
4. Need for dynamic model showing path dependency

Outline

Where do the SFC models come from?

1. Morris A. Copeland:
   - *Social Accounting for Moneyflows* (1949)
2. JamesTobin
   - Backus et al. (1980): arguably first complete SFC (matrix approach to accounting + closure).
   - Tobin (1982): Nobel lecture, in part a SFC Manifesto (1. Precision regarding time; 2. Tracking of stocks; 3. Several assets and rates of return; 4. Modeling of financial and monetary policy operations; 5. Walras's Law and adding up constraints.)
3. Wynne Godley
   - formalization and development, thanks to a more appropriate economic approach (money matters..., see Godley and Lavoie, 2007, among many others)

Post-Keynesian SFC modeling

Thanks to the rigorous accounting rules underlying the construction of the accounting matrices SFC models provide a **complete, integrated, and coherent picture of the real and financial sides of an economic system** which allows to address fundamental questions such as:

- What form does personal saving take?
- Where does any excess of sectoral income over expenditure actually go to?
- Which sector provides the counterparty to every transaction in assets?
- Where does the finance for investment come from?
- How are budget deficits financed?

Avoid black boxes in describing stocks and flows dynamics, and real vs monetary variables.

What are we talking about?

1. accounting part
2. behavioral equations

Accounting: the matrix approach

Rules: consistency (stocks and flows, within and between)

- someone's asset is someone else's liability AND someone inflow is someone else's outflow
  - *quadruple entry system* (Copeland, 1949)
- budget constraint for each individual sector and for the economy as a whole ("Walras' law and adding up constraint" Tobin 1982 or "budget constraint or system-wide consistency requirement" Godley and Lavoie 2007)

1. Aggregate balance sheet: starting stocks of the economy.
2. Transaction flows: all the flows of the economy.
3. Flows of funds: how all flows end up in new stocks. End of the current period's stock = starting stocks of the following period.

Accounting part 1

THE INITIAL STOCKS: the aggregate balance sheet

Tab.1 Aggregate Balance Sheets. A (+) sign before a variable denotes an asset while a (-) sign denotes a liability					
	Households	Firms	Banks	Gov.	Tot
Bank Deposits	+CA		-CA		0
Bank Loans		-L	+L		0
Capital		+K			+K
Net worth	Vh	Vf	Vr	Vg	V

Accounting part 2

CURRENT TRANSACTIONS: the transaction flows

Tab. 2 Current Transactions: (+) sign denotes receipt, (-) sign denotes a payment

	Households	Firms		Banks	Gov.	Tot
		current	capital			0
Consumption	-C	+C				0
Investment		$+\Delta K$	$-\Delta K$			0
Memo: Final Sales at market prices = pX = C + I = W + P						
Wages	+W	-W				0
Interests on L		$-rlL_{t-1}$		$+rlL_{t-1}$		0
Interests on CA	$+rcCA_{t-1}$			$-rcCA_{t-1}$		0
Dividends	+Ff	-Ff				0
Totals	SavH	Fu	$-\Delta K$	SavB	SavG	SAV

Accounting part 3

THE FLOW OF FUNDS: from the flows to the end of the period's stocks

Tab.3 Flow of Funds:

(+) sign denotes sources of funds, (-) denotes uses of funds

	Households	Firms	Banks	Gov.	Tot
Current Sav	+Sav H	$+Fu$	SavB	0	+SAV
Δ Bank Deposits	$-\Delta CA$		$+\Delta CA$		0
Δ Bank Loans		$+\Delta L$	$-\Delta L$		0
Δ Fixed K		$-\Delta K$			$-\Delta K$
Total	0	0	0	0	0
Net Worth	SAVH	Fu	Vb	0	SAV

MEMO: The net worth of a sector is increased by its current savings during the period, plus capital gains.

The equations: 2 steps

1. The accounting identities

All the identities and flows implied by the accounting
e.g. for firms (F= total profit)

$$F = +C + \Delta K + rc \cdot CA_{t-1} - W - rl \cdot L_{t-1} \quad (1)$$

$$Ff = F - Fu \quad (2)$$

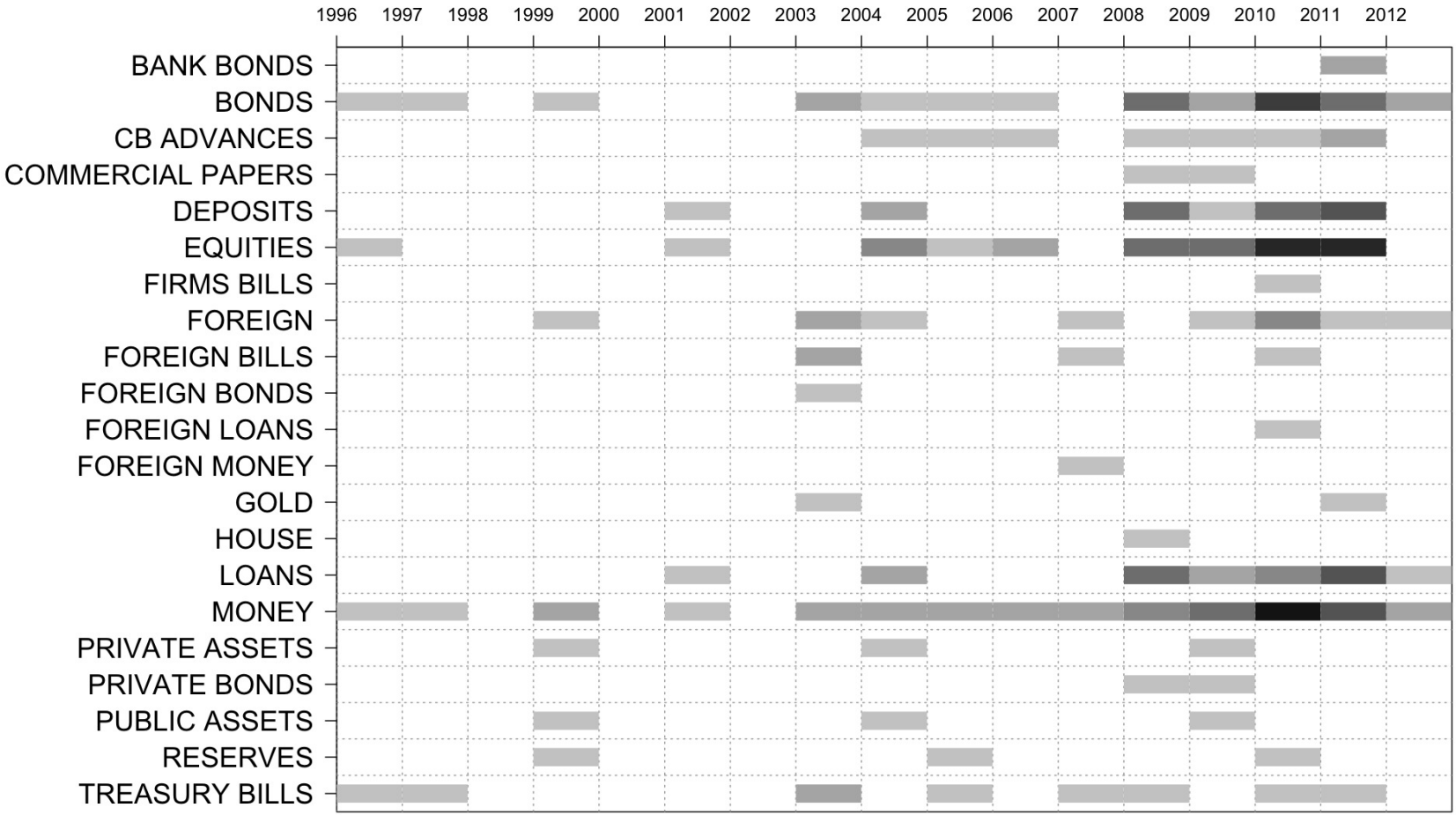
2. The behavioral equations: economic theory comes into play

The closure: through theory we try to find an equation for each variable not directly determined by the accounting making theoretical assumptions on the behavior of the sectors.

$$Fu = \zeta F \quad (3)$$

$$C = \alpha_1 \cdot YD + \alpha_2 \cdot V_{-1} \quad (4)$$

Assets through time (Caverzasi and Godin, 2015)



The darker the more papers oncluded the asset

Outline

The structure of the SIMplest model and the accounting

Hypothesis

1. NO private money
   - no banks
   - no loans and thus no interest payment
2. Closed
   - no import nor export
   - no capital flows
3. Pure labour economy
   - no K
   - no intermediate costs
4. No supply constraint of any kind
5. No inventories
6. Quantity adjustment mechanism: $S = D$

Sectors

1. Households
   - buy consumption goods and pay taxes
   - get wages
   - accumulate assets
2. Producers
   - sell services or goods to households and govt
   - pay wages
3. Government
   - buy goods from firms
   - get taxes

Assets

- high powered money (cash)

The Model part 1: matrices

Transaction Flow Matrix

	Households	Production	Government	$\sum$
Consumption	$-C$	$+C$		0
Govt. expenditures		$+G$	$-G$	0
[Output]		$[Y]$		
Wages	$+WB$	$-WB$		0
Taxes	$-T$		$+T$	0
Savings	S_h	0	S_g	0
Change in money stock	$-\Delta H$		$+\Delta H$	0
$\sum$	0	0	0	0

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Savings	S_h	0	S_g	0
Change in money stock	$-\Delta H$		$+\Delta H$	0
$\sum$	0	0	0	0

Balance Sheet

	Households	Production	Government	Σ
Money	$+H$		$-H$	0

The Model part 2: the behavioral equations

Disposable income (5); Taxes (6); Consumption (7); GDP (8); employment (9)

$$YD = W \cdot N_S - T \tag{5}$$

$$T = \theta \cdot W \cdot N_S \tag{6}$$

$$C = \alpha_1 \cdot YD + \alpha_2 \cdot H_{h-1} \tag{7}$$

$$Y = C_s + G_s \tag{8}$$

$$N = \frac{Y}{W} \tag{9}$$

$$C_s = C_d \tag{10}$$

$$G_s = G_d \tag{11}$$

$$T_s = T_d \tag{12}$$

$$N_s = N_d \tag{13}$$

The Model part 2: accounting identities

$$\Delta H_s = H_s - H_{s-1} = G - T \tag{14}$$

$$\Delta H_h = H_h - H_{h-1} = YD - C \tag{15}$$

The hidden equation

Watertight accounting: Walrasian principle (n^{th} equation implied by the remaining n-1)

$$\Delta H_s = \Delta H_d \tag{16}$$

NB that is our *redundant equation:* when trying to compute a model, it is important to identify one and not include it in the computation, otherwise the model would be overdetermined. Remeber it can always be used to check if the model is correct (e.g. if $\Delta H_s \neq \Delta H_d$ we had a mistake)

R Package PK-SFC

- Written in R
- Internal parser: you need to write (almost) only equations
- Numerical solver: Gauss-Seidel Algorithm (twisted)
- Direct Acyclical Graph (DAG) representation
- Tutorials and download: https://github.com/S120/PKSFC

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Installation

The package can be downloaded in the root folder. Note that the package needs a version of R above or equal to 3.1.1. Furthermore, you will need to install expm and igraph. For those who never installed a package in R, you will need to use the following command.

```
install.packages("expm")
install.packages("igraph")
```

Once those packages have been installed, download the PK-SFC package on your computer and store it in a folder of your choice. Make sure that the name of the package is "PKSFC_1.1.tar.gz". Then run the following comand line. It will install the package from your local folder where 'pathToYourFolder' represent the path to the folder where you downloaded the package.

```
install.packages("~/Dropbox/Research/R projects/PKSFC_1.2.tar.gz",repos = NULL, type="source")
```

```
install.packages("pathToYourFolder/PKSFC_1.2.tar.gz",repos = NULL, type="source")
```

You are almost set, now you need to load the package. In order to do so, you should run the following line. You might have some output but if no error message is being printed this means you are now ready to use the PK-SFC.

```
library(PKSFC)
```

Testing

Keynesian multiplier

Equations

$$C_d = \alpha_1 \cdot YD + \alpha_2 \cdot H_{-1} = \alpha_1 \cdot YD \tag{3.13}$$

$$Y = C + G = \alpha_1 \cdot Y \cdot (1 - \theta) + G$$

$$Y^{\star} = \frac{G}{1 - \alpha_1 \cdot (1 - \theta)} \tag{3.14}$$

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Short run vs. Long run

- (3.14) is the short run multiplier, depends on start-of-period stock values (i.e $H_{-1} = 0$)

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Keynesian multiplier

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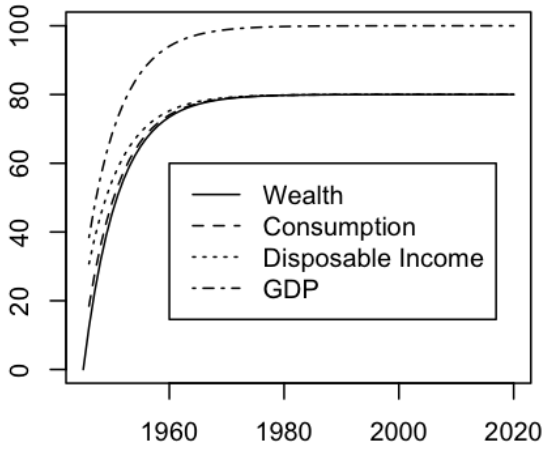
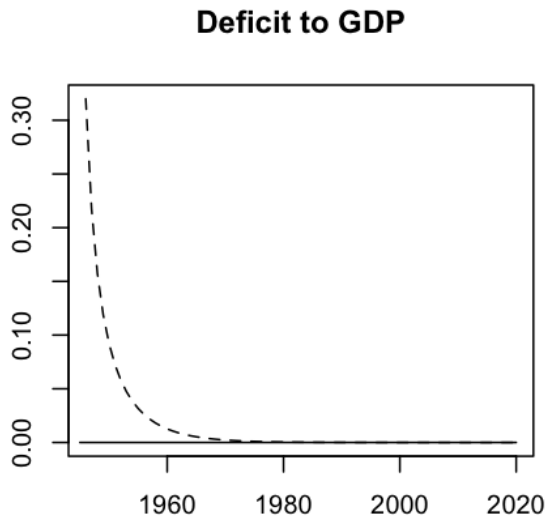
$$Y^{\star} = \frac{G}{1 - \alpha_1 \cdot (1 - \theta)} \tag{3.14}$$

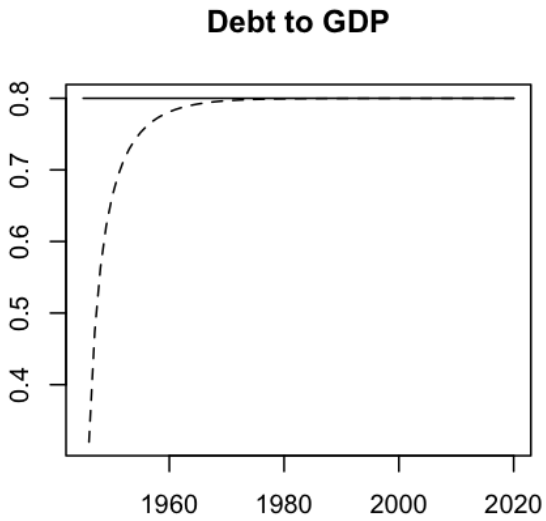
Short run vs. Long run

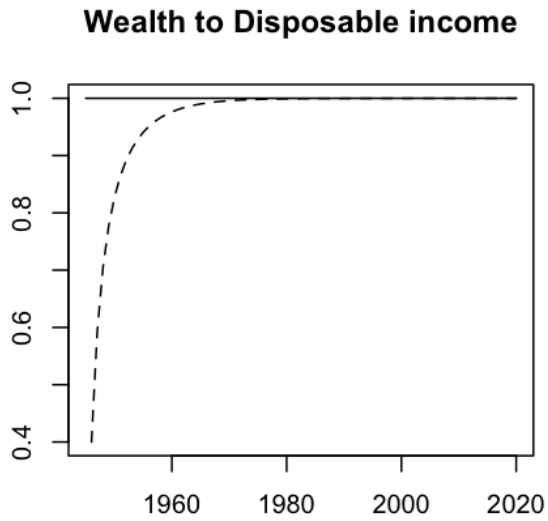
- (3.14) is the short run multiplier, depends on start-of-period stock values (i.e $H_{-1} = 0$)
- Need to obtain the steady state to compute long-run multiplier
- Steady state: $Y^{\star} = \frac{G}{\theta} = \frac{20}{0.2} = 100$

Simulation results









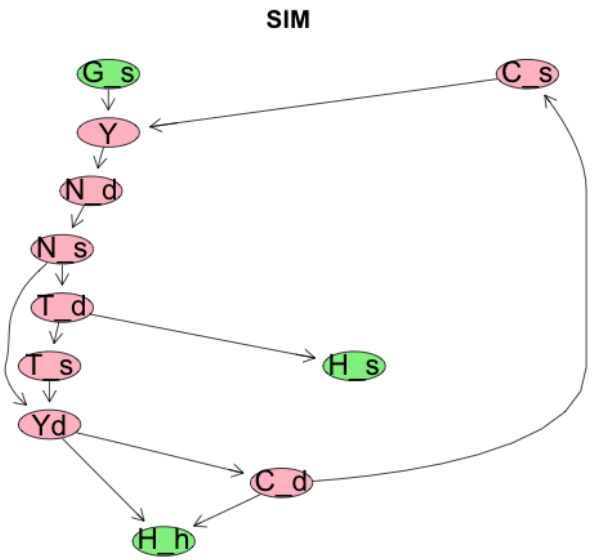
Adding expectations: model SIMEX

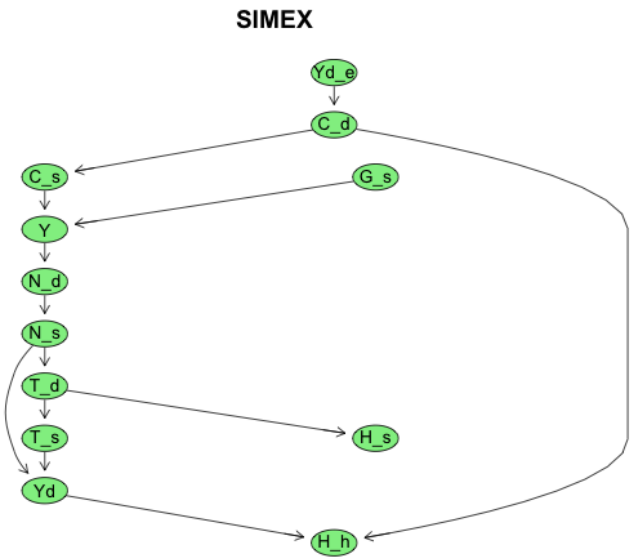
- Consumption depends on *expected* NOT on actual income.
- We discover the *buffer stock*

$$YD = W \cdot N_S - T \tag{17}$$
$$T = \theta \cdot W \cdot N_S \tag{18}$$
$$C = \alpha_1 \cdot YD^e + \alpha_2 \cdot H_{h-1} \tag{19}$$
$$Y = C_s + G_s \tag{20}$$
$$N = \frac{Y}{W} \tag{21}$$
$$YD^e = YD_{t-1} \tag{22}$$

Households can make a wrong estimate of their disposable income. Hence the quantity of money held represents the adjusting mechanism (*i.e. buffer stock*)

DAG representation





Cycle

cycle in the graph, implying that GDP, taxes, disposable income and consumption are determined all together (and that they fully adapt to any shock applied to the economy).

Buffer stocks

$$\Delta H_s = H_s - H_{s-1} = G - T \tag{23}$$
$$\Delta H_h = H_h - H_{h-1} = YD - C_d \tag{24}$$
$$\Delta H_d = H_d - H_{h-1} = YD^e - C_d \tag{25}$$

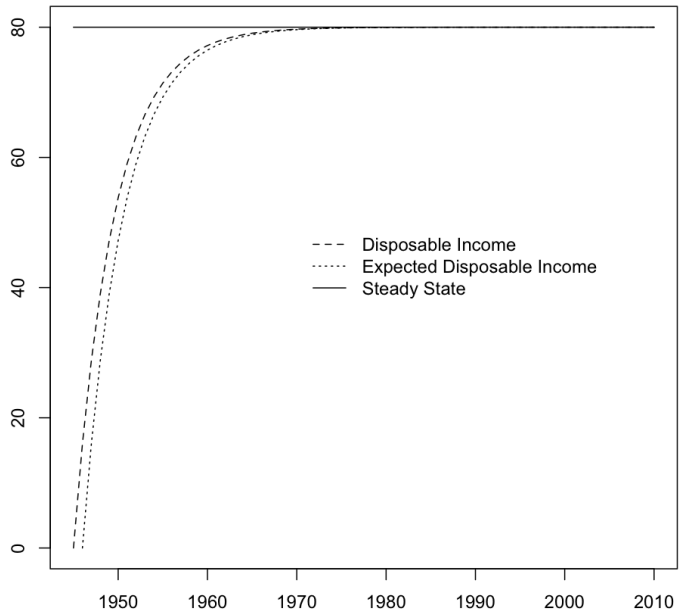
Hence

$$H_h - H_d = YD - YD^e \tag{26}$$

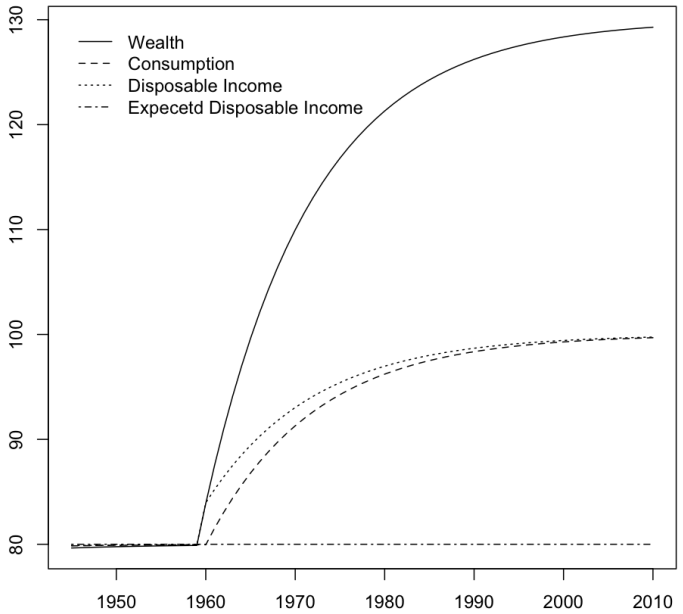
SO: *if realized income is above expected income, households will hold the difference in the form of larger than expected cash money balances.*

Playing with expectations

$$YD^e = YD(-1)$$



$$YD^e = YD^\star$$



Buffer stock

In the case of repeated error on expectations, wealth will absorb the imbalance (consumption is too low with respect to income) until it is large enough to spur consumption.

Outline

Motivation: Inadequate assessment of technological change in macro theory (Dosi et al., 2005)

- Technological change as "neutral": simply improving overall performance of the economic system (Castellacci, 2008)
- Schumpeter: boom and bust cycles are inherent to the rise of innovation (Schumpeter, 1934/1912, 1964/1939; Perez, 2010; Hanusch and Pyka, 2007).

Technological change and finance

- Schumpeter: Credit as the monetary complement to innovation (Schumpeter, 1934/1912)
- Today: a more "financialized" economy (Brown et al., 2009; Perez, 2009; Fumagalli and Lucarelli, 2011).

Motivation II

Instability and financial fragility

The interaction between real and financial dynamics to understand both short term (Junglar) and long-term (Kondratieff) technological cycle

Instability and financial fragility

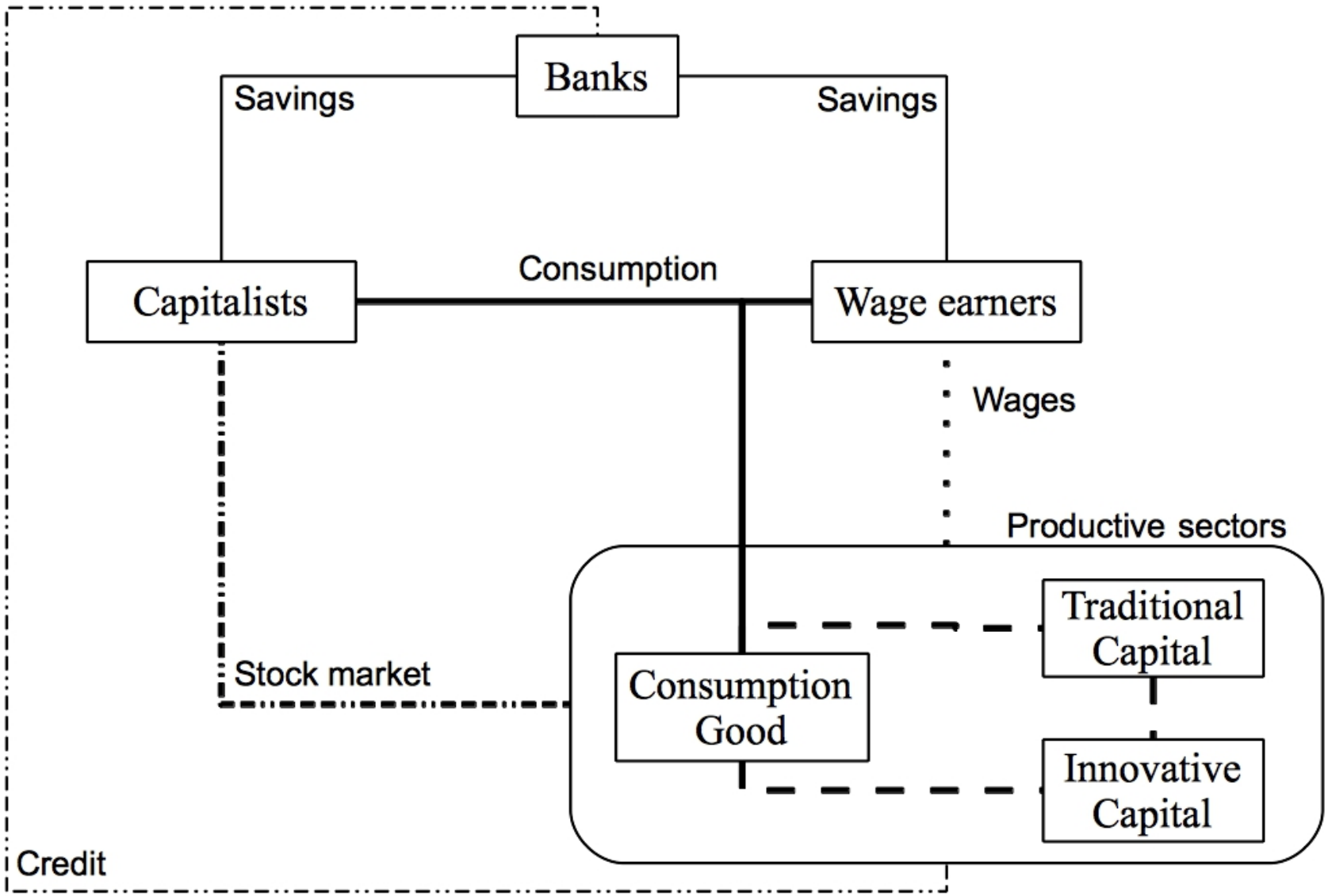
Embedding Minsky's Financial Instability Hypothesis in a more general framework linking financial dynamics to the different phases characterizing the emergence and exploitation of a new techno-economic paradigm (Minsky, 1986).

Our research line

In order to analyze both the structural change process triggered by innovation and its nexus with finance we develop two aggregate models following a Schumpeterian perspective:

- Multi sectorial
- Post-Keynesian Stock Flow Consistent (PK-SFC)

Flow diagram



Structural change - real output

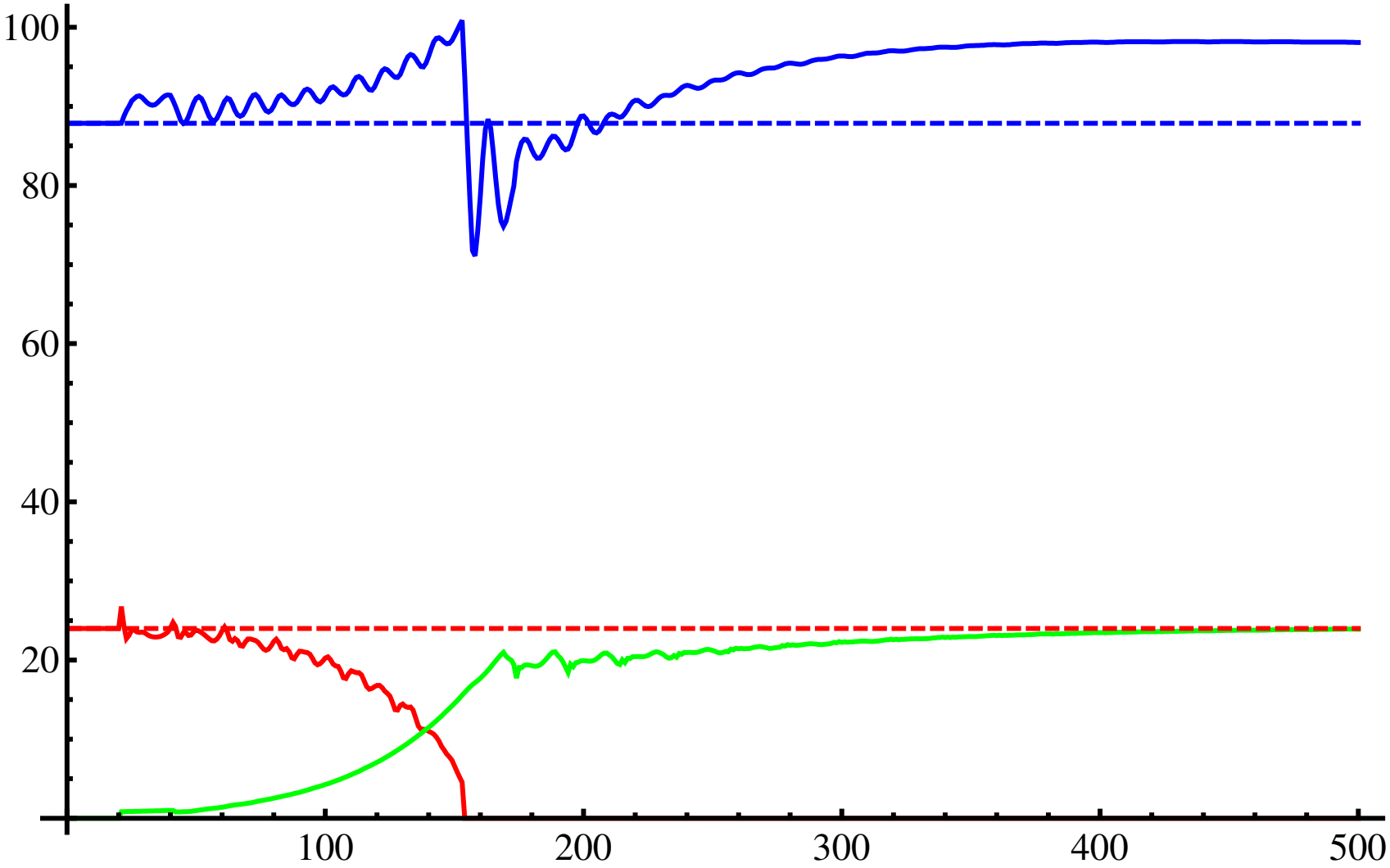


Figure : blue - consumption, red - traditional, yellow - innovative

Financial instability - market capitalization

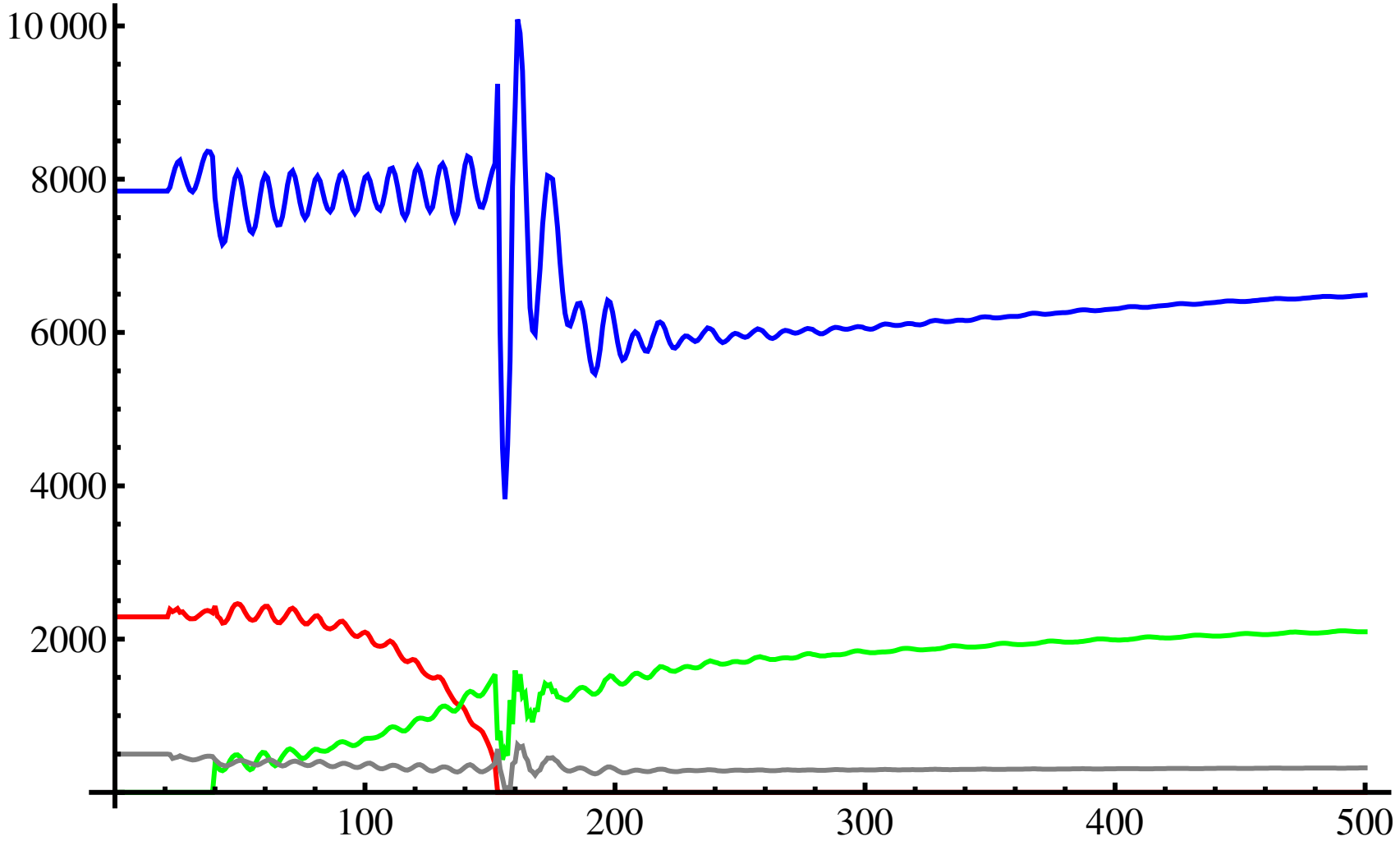


Figure : blue - consumption, red - traditional, yellow - innovative

Results

The model dynamics are driven by two fundamental processes

- The replacement of the old capital by a new, more productive capital (long term)
- Financial instability arising from the emergence of a new sector (short term)

- Financial instability is transmitted to the real sector via two behaviors
  - The consumption decision by capitalists which is based on real wealth and total revenue
  - The investment function where Tobin's q impacts firms decision to increase or not their production capacity
- Real economy affects financial dynamics via
  - Gross and distributed profits
  - Changes in nominal wealth

Transitions

- Technology driven
- Climate change
- Regulation driven

Modeling framework showing:

- Endogenous cycles (Jackson and Victor, 2015)
- Explicit financial-real interactions (Caiani et al., 2014)
- Long-run composed of short-run interactions (Rozenberg et al., 2014; Bassi and Lang, 2015)
- Multi-sectorial, with contagion effects

Why should you use PK-SFC modelling?

- Importance of (im)balances both in flow and stock levels, and of stock-flow norms
  - A seemingly sound situation might hide *imbalances building up* and leading to unsustainable situation
  - Importance of financial side of economy and *feedback* from real and finance
  - Need for dynamic model showing *path dependency*
- The SFC framework based on national accounts allows to spot these imbalances
- The PK-SFC approach offers demand-driven models integrating finance and real sides of the economy

Thank you!

- Comments and questions most welcome to a.godin@kingston.ac.uk
- https://github.com/S120/PKSFC
- http://antoinegodin.eu
- http://fass.kingston.ac.uk/departments/economics/

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