Stock-Flow-Consistent Macro Models: An Overview

Gennaro Zezza
Gennaro Zezza – SFC modeling: an overview

Outline

1. Reasons to be interested
2. SFC & current debate on macroeconomics
3. Historical background
4. Main principles of SFC modeling
5. Model closures
6. Open economy models
7. Applications
Why is it of interest?

- The SFC approach provides a tight framework for modeling the interactions between real and financial markets.
- It has a rigorous, yet flexible structure to accommodate alternative theoretical – and empirical – closures.
- In its post-Keynesian version, it has been found to be effective to understand/predict financial or economic crisis (Bezemer 2010).
Examples

Godley (1999) “Seven unsustainable processes”
*Predicted the 2001 recessions*

*Predicted the 2007 recessions*

*Better projections of Greek depression vs IMF, etc.*
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The debate on macro


“a largely shared vision both of fluctuations and of methodology has emerged … the state of macro is good”


“If macroeconomic policy and financial regulation are set in such a way as to maintain a healthy distance from dark corners, then our models that portray normal times may still be largely appropriate … Trying to create a model that integrates normal times and systemic risks may be beyond the profession’s conceptual and technical reach at this stage.”
The debate on macro #2


“If the macro 2 message is not sensible or its methodology is not feasible for estimating realistic models, it is perhaps time to move back to macro 1 (the Cowles Commission approach)”


“In the last three decades, the methods and conclusions of macroeconomics have deteriorated to the point that much of the work in this area no longer qualifies as scientific research”
Ricardo Reis (2017) “Is something really wrong with macroeconomics?”, forthcoming

“most critiques of the state of macroeconomics are off target … (but) perhaps that there is too little discussion of which models to teach”


Compares SEMs to DSGE, suggests coexistence
Where does the SFC approach stand?

Methodology similar to the Cowles Commission approach
The economy is demand-driven, even in the long run
Disequilibria in the short term imply adjustments
Emphasis on the analysis of stock-flow and flow-flow norms
(example: debt/income ratio, debt burden/income)
SFC approach ignored so far, but...


Michael G. Miess - Stefan Schmelzer (2016) “Stock-flow Consistent Modelling of Real-Financial Cycles and Balance Sheet Dynamics” (model for Austria)

Citations start to appear in ECB staff papers

Three projects devoted to build a SFC model for Italy…
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Origins

- Copeland (1947)
- Godley and Cripps (1983)
- Tobin (1969)
- Others include Davidson (1968); Eichner (1987); Taylor (1983); Skott (1989); Foley (1982)
- Main reference: Godley and Lavoie (2007)
- Recent survey in Nikiforos – Zezza (2017)
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Main principles: #1

Horizontal consistency

1) Everything comes from somewhere and goes somewhere: no black holes (income for somebody is a payment from somebody else)

This principle is relative to monetary flows.

A Social Accounting Matrix (SAM) is a good way to ensure that the first principle is respected.

An alternative is the Transaction Matrix
Main principles: #2

Vertical consistency

2) Every transaction involves at least two entries within each unit

Example: consumer expenditure implies, say, a reduction in the consumer’s cash balance

(link between real side and financial side of the economy, or between income-expenditure accounts and flow of funds)
Main principles: #3

Flows-to-stocks consistency

3) Every flow implies the change in one or more stocks

\[ S_t = S_{t-1} + F_t + CG_t \]

Where net capital gains \( CG \) are given by

\[ CG_t = \Delta p \cdot s_{t-1} \]

Where \( p \) is the market price of the stock, and \( S = p \cdot s \)

Introduces dynamics and possibly path-dependency
Main principles: #4

Stocks consistency

4) The financial liabilities of an agent or sector are the financial assets of some other agent or sector.

Net financial wealth for all sectors (including the foreign sector) must be zero.
Main principles

Quadruple entry

These principles, taken together, imply that every transaction involves a quadruple entry in accounting (Copeland)

For example, when a household purchases a product from a firm, the accounting registers an increase in the revenues of the firm and the expenditure of the household, and at the same time a decrease in at least one asset (or increase in a liability) of the household and correspondingly an increase in at least one asset of the firm.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
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<th>(3)</th>
<th>(4)</th>
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<tbody>
<tr>
<td></td>
<td>Households</td>
<td>Production Firms</td>
<td>Government</td>
<td>Central Bank</td>
<td>Banks</td>
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<td>(A) Fixed capital</td>
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<td>(B) HPM</td>
<td>+$H_h$</td>
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<td>$-L_h$</td>
<td>$-L_c$</td>
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<tr>
<td>(E) Bills</td>
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<td>0</td>
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<tr>
<td>(F) Bonds</td>
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<td>(G) Equities</td>
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<td>(H) Balance (net worth)</td>
<td>$-V_h$</td>
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<td>$-V_g$</td>
<td>$-V_{cb}$</td>
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<td>-PK</td>
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Gennaro Zezza – SFC modeling: an overview
<table>
<thead>
<tr>
<th>Transactions</th>
<th>(1) Households</th>
<th>(2) NFC</th>
<th>(3) Capital</th>
<th>(4) Government</th>
<th>(5) Central Bank</th>
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<th>(7) Total</th>
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<tr>
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<td>−PI</td>
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<td>(H) C.B. Profits</td>
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<td>(K) Interest on Bills</td>
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<td>+r_{bl-1}BL_{cb-1}</td>
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<table>
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<tr>
<th>Flow of Funds</th>
<th>(M) [memo: Net Lending]</th>
<th>[NL_{h}]</th>
<th>[NL_{c}]</th>
<th>[NL_{g}]</th>
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<td>(O) Δ in Deposits</td>
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<td>(P) Δ in Loans</td>
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<tr>
<td>(Q) Δ in Bills</td>
<td>−ΔB_{h}</td>
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<td>−ΔB_{cb}</td>
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<tr>
<td>(R) Δ in Bonds</td>
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<td>+p_{bl}ΔBL_{g}</td>
<td>−p_{bl}ΔBL_{cb}</td>
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<tr>
<td>(S) Δ in Equities</td>
<td>−p_{e}ΔE_{h}</td>
<td>+p_{e}ΔE_{c}</td>
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<td>−p_{e}ΔE_{b}</td>
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<tr>
<td>(T) Sum</td>
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<td>0</td>
<td>0</td>
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</tbody>
</table>
Main principles #5

**Stocks-to-flows feedbacks**

In the accounting (i.e. interest payments depend on the opening stock of debt)

In “behavioral” assumptions:
Real wealth affects consumption
The stock of capital affects investment, etc.

Steady-growth requires **stable stock-flow norms**
Main principles

**Emphasis on consistency**

\[ NL_h + NL_c + NL_b + NL_g = 0 \]

For example, a government surplus \((NL_h > 0)\) implies that at least another sector is a net borrower.
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Closing the model

By “model closure” we mean how we set the direction of causality among the macroeconomic variables

- Components of expenditure
- How is expenditure financed
- How sectors manage their financial portfolio
- Behavioral rules for the financial sector
- How are wages/prices determined

General rule: stocks feed back on flows
Consumption

A simple approach

\[ C_t = \alpha_1 \cdot YD_t^e + \alpha_2 \cdot \frac{Vh_{t-1}}{p_t} \]

When

\[ YD_t^e = YD_t \]

Implies simultaneity between \( C \) and \( YD \), while

\[ YD_t^e = YD_{t-1} \]

Makes the system possibly recursive

Note the dynamics between \( YD-C=\text{Saving} \) \( \gg \Delta Vh \)

\( (C=\text{real consumption}, YD=\text{real disposable income}, Vh=\text{nominal stock of wealth}) \)
Investment

\[ g_t = \frac{I_t}{K_{t-1}} = \beta_0 + \beta_1 \cdot \frac{RP_t}{p_t \cdot K_{t-1}} - \beta_2 \cdot \frac{L_{t-1}}{p_t \cdot K_{t-1}} + \beta_3 \cdot u_{t-1} \]

(possibly plus additional effects)

(I=real investment, K=real stock of capital, RP=retained profits; L=stock of debt outstanding; \(u\)=utilization rate)

Where

\[ u_t = \frac{Y_t}{K_t} \]

(Y=real output)
Portfolio choice

Example

\[
\begin{bmatrix} M \\ B \\ E \end{bmatrix} = \begin{bmatrix} \lambda_{10} \\ \lambda_{20} \\ \lambda_{30} \end{bmatrix} \cdot V + \begin{bmatrix} \lambda_{11} & \lambda_{12} & \lambda_{13} \\ \lambda_{21} & \lambda_{22} & \lambda_{23} \\ \lambda_{31} & \lambda_{32} & \lambda_{33} \end{bmatrix} \cdot \begin{bmatrix} 0 \\ r \end{bmatrix} \cdot V + \begin{bmatrix} \lambda_{14} \\ \lambda_{24} \\ \lambda_{34} \end{bmatrix} \cdot Y
\]

\(\lambda_{i0}\) represent normal shares

\(\lambda_{11}; \lambda_{22}; \lambda_{33} > 0\)

\(\lambda_{12} = \lambda_{21}; \lambda_{13} = \lambda_{31}; \lambda_{23} = \lambda_{32} < 0\)

\(\lambda_{14} > 0; \lambda_{24} < 0; \lambda_{34} < 0\)
Banks and monetary policy

In a simple setting, money is endogenous at the given target interest rate.

The Central Bank sets the target rate for refinancing. Banks are willing to lend at a premium over the target rate.

But other closures are possible.
Supply side

- Productivity usually exogenous, or dependent on production
- Prices given by a mark-up over direct unit costs
- Employment level given by the level of output
- Unemployment rate determined by employment level and demographics
- Wages influenced by unemployment
Parameters

Different approaches: estimation, calibration
The identification problem of structural models
- ECMs
- A pragmatic approach
Short-run equilibrium

When adopting the Tobinesque closure for portfolio management, financial markets are cleared by price movements. But demand is based on expected relative returns on the asset, so one stock acts as a buffer when expectations are not fulfilled.

Output movement ensures that aggregate saving equals investment.
Long-run equilibrium

Long-run equilibrium is the result of the sequence of short-term adjustments

Not necessarily at a NAIRU

Different closures based on the assumptions about the rate of capacity. Do firms have a fixed target rate of capacity? Or is the target rate adjusting?

In any case, long-run model behavior is examined through stock-flow norms and how they react to shocks
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Open economy SFC models

Full S-F consistency requires that the open economy is modeled taking into account the willingness of other countries to accommodate imbalances in the domestic economy.

In some cases, through a fully specified model for each country

A CA surplus for X implies a CA deficit for someone else

Export-led strategy for all is not feasible
Open economy: the role of CBs

Godley and Lavoie (2007) present a three-country model that discusses the eurozone economy. In a somewhat prophetic manner, they stress that the situation in the eurozone in the presence of imbalances would be sustainable as long as the ECB was willing to accumulate an ever-rising quantity of bills from the “weak” country (the country with external deficits). If not, interest rates in the weak country would keep on rising. The only alternative would be for the government of the weak country to endogenize fiscal policy: essentially to create a recession that would decrease imports and rebalance the current account.
The role of the exchange rate

In open economy models, consistency between the CA balances on one side, and supply and demand for financial assets on the other, allow for sophisticated determination of the exchange rate.

An endogenous exchange rate provides additional feedbacks from financial markets to real markets.
The three balances

Godley’s empirical models introduced the analysis of the three balances, which has become influential

\[
\{NL_h + NL_c + NL_b\} + NL_g + NL_f = 0
\]

\[
+NL_P = DEF + CA
\]
Financial balances in the U.S.
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Financialization

Analysis of the growing role of finance, of the shadow banking system, etc.

Minsky moment

The housing bubble

Role of income distribution
Agent-based models

Does macro need micro-foundations?

ABMs allow for addressing a rich set of research questions with heterogeneous agents

SFC requirements make sure that micro ABMs fulfill appropriate budget constraints at the macro level
Whole-country models

Levy macro group: U.S.; Greece; Ecuador

Limerick-Kingston: Ireland; U.K.

Others: Austria
Environment

Integration of I-O analysis into SFC models

Interaction with the environment (emissions, use of natural resources, etc.)
Links

- [http://sfc-models.net](http://sfc-models.net)

- FB group: Stock-Flow Consistent (SFC) Modeling