THE NEW SCHOOL

The Stock-Flow-Consistent Framework

Gennaro Zezza

Course outline

1. The state of *mainstream* macro
2. Principles of SFC modeling
3. Closures
4. A simple SFC model
5. Empirical SFC modeling
6. Financial balances

Module #1

The state of *mainstream* macroeconomics

The state of (mainstream) macro

- I understand a presentation of mainstream macro has already been provided in previous lectures. I will be very brief!
- Blanchard (2008) 'The state of macro' was an excellent summary of the «state of the art» of macroeconomic theory before the Great Recession
- It may be identified with the New Keynesian model, with a DSGE model as the empirical counterpart
- In a closed economy, such model is reduced to three equations

The NK model of a closed economy

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^*)$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t$$

$$i_t = i_t^* + \gamma_\pi(\pi_t - \pi^*) + \gamma_x(x_t - x^*)$$

Where x = output gap; π = inflation rate; i = nominal interest rate; r^* = natural rate of interest

A more recent model

- Searching google scholar for more recent DSGE models for an open economy >> Adolfson et al. (2014)
- No perfect competition in markets for goods and labor
- Firms need external finance to pay production costs in advance
- But…
- Government assumed to clear its budget, i.e. no government debt
- Model determines 15 variables
- Still very weak links between financial markets and the «real» economy

A critical assessment of DSGE

- Fair (2012)
- DSGE are *ad hoc* empirical counterparts of theoretical models
- The alternative, according to Fair, is work in the tradition of the Cowles Commission:

  "Theory is used to guide the choice of left-hand-side and right-hand-side variables for the stochastic equations in a model, and the resulting equations are estimated using a consistent estimation technique" Fair (2013, p.2)
- Need to represent all the major components of GDP (consumption of durables/non-durables, etc.)

The Fair model

- The current Fair model for the US can be accessed at http://fairmodel.econ.yale.edu/mmm2.htm
- Developed in the tradition of the Cowles Commission Approach, adopting several of the mainstream more recent theories
- Probably unique in the public domain, although some Central Banks still have their «old» models available
- The Fair model is not inconsistent, but is not stock-flow consistent

Module #2

Principles of Stock-Flow-Consistent modeling

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
- It has been found to be effective to understand/predict financial or economic crisis (Bezemer 2010)

Origins

- Copeland (1947)
- Godley and Cripps (1983)
- Tobin (1969)
- Main reference: Godley and Lavoie (2007)

Main principles: #1

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

This is principle is relative to monetary flows.

Variables which are meaningful only in an interval of time are «flows». An example is monthly income.

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

A simple Social Accounting Matrix

	Prod.	Hous.	Non-fin.	Fin.I firms	Gov.	RoW	C/A	Total
Production		C			G	E	I	Q
Households	W		TRfh	TRbh	TRgh	TRwh		Yh
Non-fin.firms	Π			TRbf	TRgf	TRwf		Yf
Fin.firms		TRhb	TRfb		TRgb	TRwb		Yb
Government	Ti	TRhg	TRfg	TRbg		TRg		Yg
Rest of world	M	TRhw	TRfw	TRbw	TRgw			Yw
Capital acc.		**Sh**	**Sf**	**Sb**	**Sg**	**Sw**		S
Total	Q	Yh	Yf	Yb	Yg	Yw	I	

Flow accounting

Note that the SAM incorporates the first sections of National Accounting, but to a greater level of detail

A good example of a complete set of national accounts which follows the SNA conventions (see E.C. et al. 2009) is the U.S. Integrated Macroeconomic Accounts (US_IMA), available at http://www.bea.gov/national/nipaweb/Ni_FedBeaSna/Index.asp

Flow accounting

The SAM represents:

- Production Account
- Primary income account
- Secondary income account
- Use of income account
- Saving account (with no detail)

But in the US_IMA we have, for example, total receipts of interest payments by households, but we don't know who is paying them out, among the government, banks, non-financial firms or foreigners

However, more detailed data can be obtained or estimated to go from the published US_IMA to the SAM

The capital account

Receipts and expenditure for each sector are detailed in the National Income and Product Accounts (NIPA) in the Capital account

- Gross saving -
- Gross investment +
- Net incoming capital transfers =
- Net lending/borrowing

Net lending is also called *Financial balance*. The analysis of financial balances has played a crucial role in Godley's approach to understanding crisis.

Basic SFC principles: #2 & #3

2. Every transaction implies a quadruple entry in the accounting: when a U.S. firm imports goods from Japan, say, the accounting registers an increase in income in Japan, an increase in expenditure in the U.S., as well as an increase in Japanese bank deposits and a corresponding decrease in U.S. bank deposits. Current account payments and receipts imply a change in at least one stock of real of financial assets/liabilities.
3. From (2) – and from logic! – it follows that every financial asset for a sector is a liability for a different sector: net financial wealth for the system as a whole is zero;

Flow of funds

Net lending/borrowing implies a change in holdings of some financial asset/liability.

These are detailed in the Flow of funds matrix

Note that for each asset we should be able to identify which sector is issuing it (borrowing funds) and which sectors are acquiring it (lending funds).

Borrowing and lending for each asset must be equal

The Flow of funds matrix can be read vertically to identify the sources of funds for real investment

A simple Flow of funds matrix

	Hous.	Non-fin. firms	Financial firms	Gov.	Rest of the world	Total
Real assets	+Ih	+If		+Ig		+I
Deposits	+ΔD		-ΔD			0
Loans	-ΔLh	-ΔLf	+ΔL			0
Government debt	+ΔBh		+ΔBb	-ΔB	+ΔBw	0
Equities	+pe*ΔEh	-pe*ΔE	+pe*ΔEb		+pe*ΔEw	0
Foreign debt			+ΔFb		-ΔF	0
Total	Sh	Sf	Sb	Sg	Sw	+I

Basic SFC principles: #4

4. End-of-period stocks are obtained by cumulating the relevant flows, eventually taking capital gains into account. In general, $St = St\text{-}1 + Ft + CGt$, where S is the end-period monetary value of a stock, F the corresponding flow during the period, and CG net capital gains given by the change in the market value of S over the period

These flows-to-stocks identities provide the first dynamic component of any SFC model.

From the Flow of funds and capital gains we can therefore build the balance sheet for each sector in the economy

A simple Balance sheet matrix

	Hous.	Non-fin. firms	Financial firms	Gov.	Rest of the world	Total
Real assets	+Kh	+Kf		+Kg		+K
Deposits	+D		-D			0
Loans	-Lh	-Lf	+L			0
Government debt	+Bh		+Bb	-B	+Bw	0
Equities	+pe*Eh	-pe*E	+pe*Eb		+pe*Ew	0
Foreign debt			+Fb		-F	0
Total	Vh	Vf	Vb	Vg	Vw	+K

Implications

- Wealth for the world as a whole is only composed of real assets
- Wealth for a single country is given by real wealth plus foreign assets, less foreign debt

Basic SFC principles: #5

5. Financial assets imply future income streams (financial liabilities imply future income payments)

These stocks-to-flow links provide a second dynamic component to any SFC model.

Example: when a country has foreign debt, its future interest payments made abroad will worsen its current account balance

Example: an increase in government debt held domestically implies larger future interest payments to domestic creditors (not necessarily a problem)

Basic SFC principles: #6

5. All stock variables in a SFC model should feed back on some behavior

Assume that we model the economy so that the financial sector has non-zero net wealth.

If we don't include any implication from the level of net wealth on the sector's expenditure or portfolio decisions, the model may generate ever increasing (decreasing) net wealth

Module #3

Model closures

Closing the model

Steps to follow in developing a SFC model:

1. Take a decision on the level of detail, depending on your research question
2. Lay down the matrices: SAM, FoF, Balance sheets
3. Write down the corresponding identities.
4. At least one identity for each matrix is implied by the others: it should be dropped by the model (*hidden equation*)
5. Verify which variables are determined by the model at this stage, and which are not

Simple, general linear model

All (linear) models can be expressed in matrix form as

$$B \cdot Y_t = G(L) \cdot Y_t + F(L) \cdot X_t + u_t$$

which is the structural form of the model

Here *L* is the lag operator such that

$$L \cdot Y_t = Y_{t-1}$$

A first problem is how to determine if a variable can be treated as exogenous (in *X*) or should be determined by the model (in *Y*)

A common solution – not adopted as such in the PK-SFC world – is to treat all variables as potentially endogenous

Simple, general linear model #2

$$B \cdot Y_t = G(L) \cdot Y_t + F(L) \cdot X_t + u$$

If the B matrix is triangular, the model is called recursive, and we can find a solution one equation at a time.

This results extends to the case of random shocks *u*

If we have simultaneity, the B matrix has one or more elements above the diagonal which are non-zero

Closures

$$B \cdot Y_t = G(L) \cdot Y_t + F(L) \cdot X_t + u$$

A *closure* implies the choice of a methodology for finding parameter values in the B, G and F matrices

One possibility is calibration

Godley's line of research has always been empirical. He used a «pragmatic» approach based on econometrics, which we still adopt in our work at the Levy Institute for our models of the United States and Greece

Closures (continued)

In theoretical models, Godley & Lavoie choose parameters loosely based on econometric estimates

Parameter choice is also guided by logical consistency

An example is the determination of parameters for portfolio choice in a theoretical model

Portfolio choice

Assume three financial assets: Money M, Bonds B, Equities E

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

Divide everything by V (the stock of wealth), and the three equations determine the share of each asset in the ex-post (expected) stock of wealth (while the liquidity prefrence terms will depend on the income-to-wealth ratio)

Portfolio choice #2

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

$$\lambda_{i0}\ represent \text{ normal } shares$$

$$\lambda_{11}; \lambda_{22}; \lambda_{33} > 0$$

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

$$\lambda_{14} > 0; \lambda_{24} < 0; \lambda_{34} < 0$$

Portfolio choice #3

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

$$\begin{aligned} \lambda_{10} + \lambda_{20} + \lambda_{30} &= 1 \\ \lambda_{11} + \lambda_{21} + \lambda_{31} &= 0 \\ \lambda_{12} + \lambda_{22} + \lambda_{32} &= 0 \\ \lambda_{13} + \lambda_{23} + \lambda_{33} &= 0 \\ \lambda_{14} + \lambda_{24} + \lambda_{34} &= 0 \end{aligned}$$

Vertical constraints

Portfolio choice #4

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

$$\lambda_{11} + \lambda_{12} + \lambda_{13} = 0$$
$$\lambda_{21} + \lambda_{22} + \lambda_{23} = 0$$
$$\lambda_{31} + \lambda_{32} + \lambda_{33} = 0$$

Horizontal constraints

Post-Keynesian closure

The closures adopted by Godley – Lavoie are usually based on an out-of-equilibrium approach

Each sector has a target level for the variable to be determined, based on expectations

In each period expectations may not be fulfilled, so that at least one variable will differ from target

Some variables therefore act as *buffers*

Other closures

SFC models can obviously be closed through other adjustment processes.

However, our experience with price clearing markets shows that models exhibit too much volatility to be realistic

References

- Adolfson M., Laséen S., Lindé J., Svensson L.E.O. (2014) 'Monetary Policy Trade-Off in an Estimated Open-Economy DSGE Model', Journal of Economic Dynamics and Control, vol. 42, May, p.33-49
- Bezemer, D.J. (2010) 'Understanding financial crisis through accounting models', *Accounting, Organizations and Society*, 35(7), 676-688.
- Blanchard, O.J. (2008) 'The State of Macro', *NBER Working Papers*, No 14259, August
- Blanchard, O.J. (2014) 'Where Danger Lurks', *Finance and development*, 51(3), September
- Copeland, M.A. (1947) 'Tracing Money Flows Through the United States Economy', *The American Economic Review*, 37(2), 31-49.
- Fair, R.C. (2012) 'Has Macro Progressed?' *Journal of Macroeconomics*, 34, pp.2-10
- Fair, R. C. (2013) *Macroeconometric modeling*, available at http://fairmodel.econ.yale.edu/mmm2/mm.pdf
- Godley, W. and Cripps. F. (1983) *Macroeconomics*, Oxford, UK: Oxford University Press.
- Godley, W. and Lavoie, M. (2007) *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*, Palgrave MacMillan, Basingstoke.
- European Commission, International Monetary Fund, Oecd, United Nations, World Bank (2009), *System of National Accounts 2008*, available at http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf
- Tobin, J. (1969) 'A General Equilibrium Approach To Monetary Theory' *Journal of Money, Credit and Banking*, 1(1) Feb., pp. 15-29

References

- http://sfc-models.net
- http://ius.unicas.it/ATutor