From Abstract to Concrete
Some Tips to Develop an Empirical SFC Model

Marco Veronese Passarella

University of Leeds

m.passarella@leeds.ac.uk

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Overview

Aim & model type

Tips to develop a medium-scale empirical SFC model. A theory-constrained but data-driven method is used. Inspired by Godley & Lavoie (2006) and Burgess et al. (2016).

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Project

Data for Italy are used, but it can be replicated for other countries. Aim: create network of interacting 'personal' SFC models (using *R*).

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Bridging the gap...

...using Eurostat data: *a*) available and downloadable through *pdfetch*; *b*) uniform across countries; *c*) useful reclassification proposed by Godin (2016).

Reclassification (cont'd)

First step: the full TFM

Matching SFC TFM with Eurostat accounting.

Entries (Italy, 2015)	Eurostat Code	Non-Financial Corporation S11	Financial Corporations S12	Government S13	Households S14_S15	Rest of World S2	Total economy (row total) S1
Gross Output	P1	2095694	130440	306245	580440	0	3112819
Intermediate Consumption	P2	-1360170	-54429	-90092	-129658	0	-1634349
Taxes on Product	D21	0	0	189354	0	2251	191605
Subsidies on Products	D31	0	0	-24469	0	-167	-24636
Memo: GDP		735524	76011	381038	450782	2084	1645439
Consumption	P3	0	0	-311639	-1001014		-1312653
Exports	P6	0	0	0	0	-493934	-493934
Imports	P7	0	0	0	0	446042	446042
Investment	P5 (G)	-149558	-4429	-36959	-93949		-284895
Total Production		585966	71582	32440	-644181	-45808	0
Wages	D1	-411085	-32356	-161998	609723	-4284	0
Taxes on Production and Imports	D2***	-26528	-5735	240236	-18620	-189354	0
Subsidies on Production	D3	4347	4	-28481	3929	20201	0
Dividends	D42	-109941	-1633	4271	114625	-7322	0
Interests payments	D41	-5209	18574	-65237	30759	21113	0
Other property income	D4G*	-11995	-17221	3924	23481	1812	0
Taxes on Income and Wealth	D5	-27869	-6022	241582	-206485	-1206	0
Social Benefits (net of social contributions)	D6**	1273	2461	-113732	112607	-2609	0
Other Current Transfers	D7	-5061	-1075	-6476	-6232	18844	0
Adjustments in Pension Funds	D8	-1272	-2461	0	3733	0	0
Capital Transfers	D9	18031	8294	-25421	2889	-3792	0
Total Transfers		-575309	-37170	88668	670409	-146597	0
Sum Production and Transfers		10657	34412	121108	26228	-192405	0
Acquisition less consumption of NPNFP	NP	-1535	-18	-420	789	1184	0
Tax - subsidies on product	-D21+D31	0	0	-164885	0	164885	0
Computed Net Lending Position		9123	34394	-44197	27017	-26336	0
Net Lending Position	B9	9123	34394	-44197	27017	-26336	0
Total by sector (column total)		0	0	0	0	0	0

Note: Italy, 2015, current prices, million euro.

Second step: 'who pays whom'

Address issues with Figure 1: *a*) Lines 6 to 9 do no sum up to zero; *b*) too many entries. Assume firms produce it all!

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Reclassification (cont'd)

Third step: merging entries

Merge taxes, transfers and other 'secondary' entries to get the accounting structure of the model.

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Total Taxes	D2+D5-D21	-54397		-11757	292464	-225105	-1206	0
Dividends	D42	-109941		-1633	4271	114625	-7322	0
Interests payments	D41	-5209		18574	-65237	30759	21113	0
Other property income	D4G	-11995		-17221	3924	23481	1812	0
Transfers (subsidies, benefits, etc.)	D3+D6+D7-D31	559		1390	-124220	110304	11967	0
(Change in) funds	D8+D9+NP	15224		5815	-25841	7411	-2608	0
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Fourth step: the balance sheet

Narrowed down creating 'other financial assets' composite entry (insurance tech. reserves, derivatives and other).

Entries (Italy, 2015)	Eurostat code	Non-Financial Corporations			Financial Corporations			Government			Households		
		Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net	Assets	Liabilities	Net
Non-financial assets (dwellings)	N1N+N2N	180,249.6	0.0	180,249.6	4,781.2	0.0	4,781.2	54,401.6	0.0	54,401.6	2,518,103.0	0.0	2,518,103.0
Currency and deposits	F2	308,930.0	32,763.0	276,167.0	326,009.0	2,027,611.0	-1,701,602.0	75,877.0	239,722.0	-163,845.0	1,273,045.0	0.0	1,273,045.0
Securities other than shares	F3	57,048.0	145,902.0	-88,854.0	1,675,684.0	540,827.0	1,134,857.0	27,908.0	2,097,250.0	-2,069,342.0	413,008.0	0.0	413,008.0
Loans	F4	18,947.0	1,067,001.0	-1,048,054.0	1,823,350.0	109,846.0	1,713,504.0	94,284.0	177,240.0	-82,956.0	13,707.0	691,961.0	-678,254.0
Shares and other equity	F5	525,651.0	1,666,671.0	-1,141,020.0	632,959.0	475,698.0	157,261.0	128,934.0	0.0	128,934.0	1,447,540.0	0.0	1,447,540.0
Other financial assets													
- Insurance technical reserves	F6	16,896.0	101,556.0	-84,660.0	6,358.0	758,730.0	-752,372.0	1,278.0	3,803.0	-2,525.0	862,636.0	0.0	862,636.0
- Derivatives and empl. stock options	F7	15,425.0	14,307.0	1,118.0	125,954.0	138,737.0	-12,783.0	0.0	31,899.0	-31,899.0	738.0	68.0	670.0
- Other accounts receivable/payable	F8	147,171.0	91,326.0	55,845.0	26,448.0	5,664.0	20,784.0	115,005.0	74,245.0	40,760.0	13,286.0	93,518.0	-80,232.0
Net Worth	BF90			-1,849,208.4			564,430.2			-2,126,471.4			5,756,516.0

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Features and assumptions

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- Each sector is marked by either a portfolio function or a simple financial investment rule

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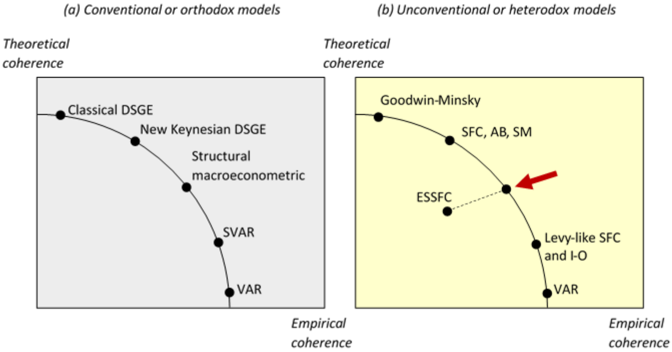
- Central bank, commercial banks and NBFIs: integrated and consolidated sector

Developing the model (cont'd)

ESSFC position along Pagan's 'best practice' frontier of models



Households: selected identities

Households disposable income (from TFM)

$$YD = GDP_H + WB - \tau_H + INT_H + T_H + ANN_H$$

where: $GDP_H = \beta_H \cdot GDP$.

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Net lending by households (key variable)

$$NL_H = YD + NFUNDS - CONS_H - INV_H$$

Households: selected behavioural

Consumption function

$$C_H = c_0 + c_1 \cdot E(YD) + c_2 \cdot NW_{H,-1} + c_3 \cdot C_{H,-1}$$

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Household investment

$$INV_H = \vartheta_1 \cdot INV_{H,-1} + \vartheta_2 \cdot L_{H,-1} + \vartheta_3 \cdot HOUSE_{H,-1} + \\ + \vartheta_4 \cdot YD_{H,-1} + \vartheta_5 \cdot E(r_H)$$

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Demand for mortgages & other loans

$$L_H = L_{H,-1} + \phi_1 \cdot YD_{-1} + \phi_2 \cdot HOUSE_{H,-1} + \phi_3 \cdot INV_{H,-1}$$

Households: portfolio choice

Equity & shares

$$\frac{V_H}{E(NFW_H)} = \lambda^H_{1,0} + \lambda^H_{1,1} \cdot E(r_V) + \lambda^H_{1,2} \cdot \frac{E(YD_H)}{E(NFW_H)} + \lambda^H_{1,3} \cdot E(r_{BA})$$

where $\lambda_{1,j}$ are empirically estimated. The same goes for D_H and B_H. Note: $r_D = 0$.

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Other financial assets

$$OFIN_H = \sigma^H_{OFIN} \cdot NW_H$$

When residual correction mechanism is used, $OFIN_H$ is redefined as the residual share (σ^H_{OFIN}) of net wealth.

NFCs: selected identities

Gross domestic product

$$GDP = Y - CONS_{INT} + \tau_P^{NET}$$

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Aggregate demand

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Net lending by NFCs

$$NL_F = \Pi_{FU} - INV_F$$

NFCs: selected behavioural

Total investment

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Growth rate of capital

$$g_K = \gamma_Y + \gamma_U \cdot E\left(\frac{Y}{K}\right) + \gamma_\Pi \cdot E\left(\frac{\Pi_F}{K}\right) - \gamma_Z \cdot E(r_Z) - \gamma_R \cdot E(r_{L,F})$$

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Import

$$IMP = IMP_{-1} \cdot exp\left(\mu_1 + \mu_2 \cdot ln\left(\frac{Y}{Y_{-1}}\right) + \mu_3 \cdot (NER - NER_{-1})\right)$$

NFCs: supply side?

Leontief function

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Note: 'normal times'; used to determine p_Y and p_K, not Y.

Net lending by other sectors

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Rest of the world

$$NL_{RoW} = -(NL_H + NL_F + NL_G + NL_B)$$

Who holds what

Sectoral portfolios are different in terms of asset types' composition (shares, securities, deposits). However, each sector i (e.g. government) holds the same proportion of x-type assets (e.g. bonds) issued by j to total x. Coherent with the hypothesis that x-type assets carry all the same average return rate.

Cross-sector holdings and payments

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Who pays whom

Seldom dividends received by i mirror its holdings. Two steps: *a*) total dividends received by i are corrected to fit empirical evidence ($DIV_i = \epsilon_i \cdot DIV_{TOT} \cdot V_i / V_{TOT}$, where ϵ_i is the correction coefficient); *b*) each 'issuing' sector j pays the same proportion ($\delta_j = DIV_j / DIV_{TOT}$) of total dividends to every other sector (so: $DIV_{j,i} = \delta_j \cdot DIV_i$). The same goes for interest payments.

Methods

Initial stocks & lagged variables are set at 1996 value. Unknown coefficients can be: *a*) estimated; *b*) calibrated = data; *c*) calibrated = literature; *d*) fine-tuned to create baseline. Theoretical SFCMs are set up via *c* and *d*. ESSFC coefficients are defined by *a* and *b*.

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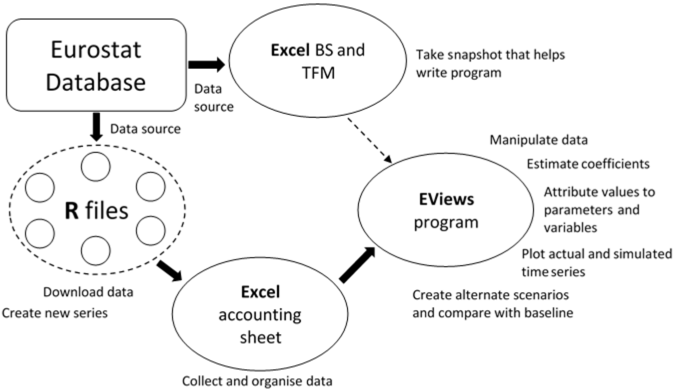
Estimation

Key equations: coefficients estimated one at time by simple OLS. *Pros*: simplify coding (intermediate step). *Cons*: endogeneity, spurious correlation. Note: MOVAV for several key exogenous ratios.

PROGRAMS' STRUCTURE



Fitting past data and forecasting

Residuals assumed to reduce steadily up until t_0 and are unwound afterwards. For $t \leq t_0$, the estimate value of x, corrected to improve the fit, is:

$$x_t^* = e^{-\mu \cdot \frac{t}{t_0 - t}} \cdot (x_t^f - \bar{x}_t) + \bar{x}_t \tag{1}$$

where x_t^f is the forecast value of x at t and $\bar{x}_t$ is the actual (average) value of x.

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So, $x_t^* \to x_t^f$, for $t \to 0$; while $x_t^* \to \bar{x}_t$ (or x_t) for $t \to t_0$.

Fitting past data and forecasting (cont'd)

For $t > t_0$, the estimate value of x, corrected to smooth the transition, is:

$$x_t^* = e^{-\mu \cdot (t - t_0)} \cdot (\bar{x}_t - x_t^f) + x_t^f \qquad (2)$$

So, $x_t^* \to \bar{x}_t$ for $t \to t_0$; while $x_t^* \to x_t^f$, for $t \to +\infty$.

Fitting past data and forecasting (cont'd)

For $t > t_0$, the estimate value of x, corrected to smooth the transition, is:

$$x_t^* = e^{-\mu\cdot(t-t_0)} \cdot (\bar{x}_t - x_t^f) + x_t^f \qquad (2)$$

So, $x_t^* \to \bar{x}_t$ for $t \to t_0$; while $x_t^* \to x_t^f$, for $t \to +\infty$.

Future (predicted) residuals are allowed to increase gradually. Model's forecast value departs gradually from the last observed (average) value.

FITTING PAST DATA AND FORECASTING (CONT'D)

This simple mechanism creates a moving ceiling for residuals, which: *a*) improve artificially estimates of stochastic variables; *b*) reset identities (e.g. net lending).

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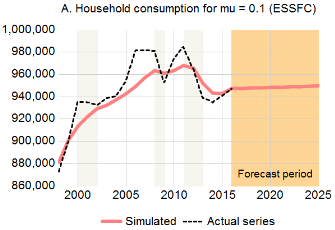
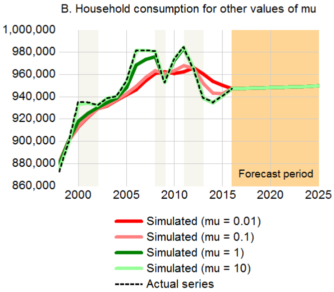
Note: option (*b*) requires identifying a 'residual' or 'buffer' variable to absorb the estimation difference (i.e. $x_t^* - x_t^f$). 'Adjustment in funds' is used by ESSFC.

Fitting past data and forecasting (cont'd)



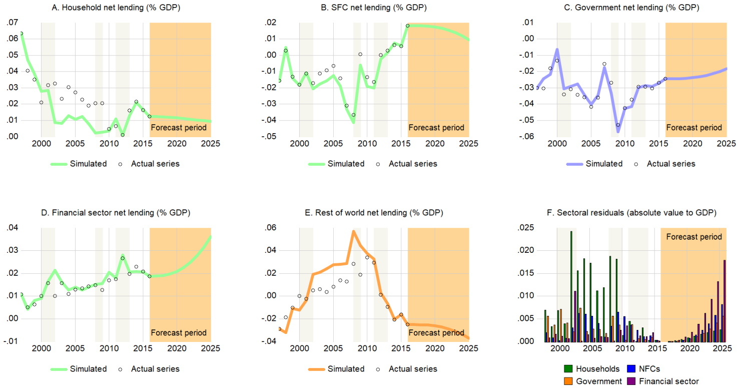


Fitting past data and forecasting (cont'd)

Possible capital gains/losses (revaluation effect) are assumed away on government bonds. As for other financial and real assets, the revaluation effect is automatically accounted for, as stocks at time t are defined as stocks at time $t-1$ *plus* changes in stocks' value from $t-1$ to t.

Running the simulations

Cross-sector financial balances since 1996 (percentage of GDP)



Data fit and forecast

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- Middle ground: dynamic simulation, but ceiling for residuals and moving averages
- Medium-run forecast: additional hypotheses on coefficients are required
- Useful to impose and compare different scenarios

Alternative scenarios

Three alternative scenarios about government spending:

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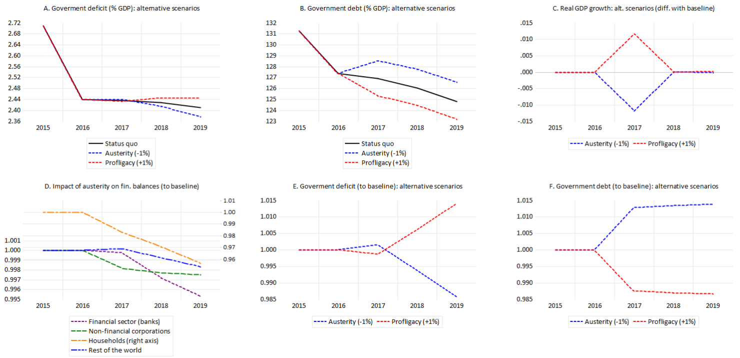
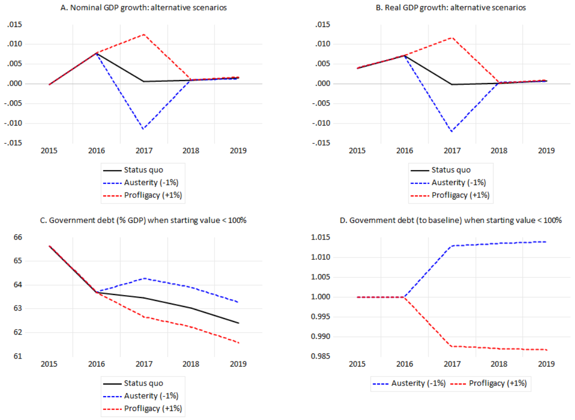
- Baseline scenario: historical trend (**black line**)
- Austerity: permanent cut in government consumption (-1% of GDP, **blue line**)
- Profligacy: increase in government consumption (+1% of GDP, **red line**)

Running the simulations

ESSFC reaction following shocks to government spending



ESSFC reaction following shocks to government spending (cont'd)



Developments and limitations

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- Microfoundations?

Final remarks

- Despite limitations above, ESSFC can be replicated for a variety of sub-sectors, variables, shocks and alternative scenarios. It allows monitoring stock-flow norms, which can possibly help detect early signs of economic & financial fragility and crises.

Final remarks

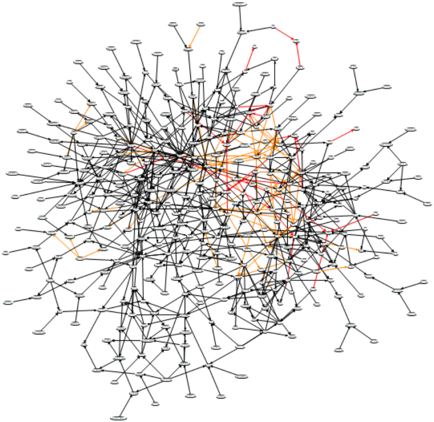
- Despite limitations above, ESSFC can be replicated for a variety of sub-sectors, variables, shocks and alternative scenarios. It allows monitoring stock-flow norms, which can possibly help detect early signs of economic & financial fragility and crises.
- Useful benchmark for PhD students, early-career researchers, non-neoclassical macro-modellers, and the practitioners who want to expand their own set of analytical tools.

Thank You

m.passarella@leeds.ac.uk

Download presentation's material from *marxianomics*:
www.marcopassarella.it/en/

Appendix A: Dependency graph



Lags Only
Lags + Contemporaneous
Contemporaneous Only
Dashed lines indicate the presence of lags/leads of length four or more.

Appendix B: Housing market

Housing price index is a function of households' debt to income ratio ($m_H = MORT_H / YD_H$):

$$p_H = h \cdot m_H \cdot \frac{E(YD_H)}{HOUSE_H}$$

where $h =$ sensitivity of housing prices to household debt. Capital gains/losses on housing are:

$$CG_H = HOUSE_{H,-1} \cdot \frac{d(p_H)}{p_{H,-1}}$$

Housing investment can be now re-defined:

$$INV_H = \vartheta_0 + \vartheta_1 \cdot INV_{H,-1} + \vartheta_2 \cdot MORT_{H,-1} + \vartheta_3 \cdot p_{H,-1}$$

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