System of National Accounts in EURACE

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Abstract

This document provides an overview of the system of interlinked balance sheets in the EURACE Model. We set up a system of national accounts and a SAM (Social Accounting Matrix) in which all monetary stock-flow relationships are summarized. This system provides the backbone for the integration of the EURACE Model. In a next step, we provide a list of accounting identities that must always hold for all monetary and physical flows, both in and out of equilibrium. Finally, certain time-invariants can be identified that serve as economic conservation rules.

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1 Introduction: Stock-flow consistent models

An important part of the testing and verification process will be the verification of the internal consistency of the model. For this task we need a stock-flow consistent (SFC) model, that can be defined as:

> "[...] models that identify economic agents with the main social categories/institutional sectors of actual capitalist economies – thoroughly describe these agents' short-period behaviors and consistently model the 'period by period' balance sheet dynamics implied by the latter." (Macedo e Silva and Dos Santos (2008, p. 2))

Using a SFC model we need to check that all monetary flows are accounted for, and that all changes to stock variables are consistent with these flows. This can be accomplished by tracking the time evolution of the balance sheets across the different sectors of the economy. This could be done by constructing a Social Accounting Matrix (SAM) that contains all the monetary flows and changes to the balance sheet between the beginning and end of an accounting period. A SAM consists of a double-entry accounting system in which each flow comes from somewhere and goes to somewhere. It shows how the balance sheets of the different economic sectors (agents) are interlinked, and it also shows how the period-by-period balance sheets change dynamically over time. Such an accounting system at the macro level provides us with a number of accounting identities that should always hold and this can be tested by an external invariant detector such as Daikon.

This provides us with a solid and economically well-founded methodology to test the consistency of the model and it increases the credibility that can be attached to the model's results. Thereby it is not only part of the testing and verification procedure, but is also part of the accreditation process. It will help to raise the acceptability and trust in the model.

2 Balance sheets

Below we list for each agent type the items on its balance sheet. The cash flows indicated only relate to the financing activities.

2.1 Household

Refer to Tables 1 and 2.

Households can have bank deposits (M^h) but they do not receive any interest ($r^m M^h = 0$). They can purchase government bonds (B^h) and private equity shares (E^h). They do not take out bank loans. They receive interest on the government bonds ($+r^g B^h$) and dividends on the shares ($+Div^h$). The equity transactions are denoted in this text as a share purchase by the household ($-SP^h$) or a share repurchase by the firm ($+SR^h$).

2.2 Firm - CGP and IGP

Refer to Tables 3,4 and 5.

Firms can have bank deposits (M^f) and bank loans (L^f). They do not receive any interest on the deposits ($r^m M^f = 0$), but do have to pay interest on the loans ($r^b L^f$). They can also issue equity shares (E^f) on which they pay dividends ($-Div^f$). They can also do a share repurchase (SR^f). They they do not purchase government bonds, or shares of other firms.

2.3 Bank

Refer to Tables 6 and 7.

Banks can issue equity shares on which they pay dividends (E^b, $-Div^b$). They have a portfolio of outstanding loans (L^b) on which they receive interest ($+r^b L^b$) and debt instalment payments ($-\Delta L^b$). They do not purchase government bonds, and they do not purchase shares in other firms or banks. The banks have a standing facility with the Central Bank from which they can draw advances freely (A^b), on which they have to pay an interest to the Central Bank ($-r^{cb} A^b$).

2.4 Government

Refer to Tables 8 and 9.

The government has a bank account at the Central Bank. If there are any changes to the payment account of the government (i.e. withdrawals to pay for unemployment benefits or subsidies) this is recorded as a change in the stock of the asset M^g ($-\Delta M^g$), with a counterpart liability on the balance sheet of the Central Bank ($+\Delta M^g$). The government also has a standing facility at the Central Bank that allows it to have a negative payment account. The government has a liability that is given by the stock of currently outstanding government bonds (B^g) on which it pays the interest rate ($-r^g B^g$).

2.5 Central Bank

Refer to Tables 11 and 10.

The Central Bank can purchase government bonds (B^{cb}) on which it receives interest ($+r^g B^{cb}$). The Central Bank gives advances to the banks ($-\Delta A^{cb}$), on which the banks have to pay an interest ($+r^{cb} A^{cb}$). Since the Central Bank is not allowed to make a profit, its revenues from government bonds and bank advances ($+r^g B^{cb}$, $+r^{cb} A^{cb}$) are distributed to the government in the form of a dividend ($-Div^{cb}$). In case of multiple governments, the total dividend payment is equally divided among the governments.

Table 1: Household balance sheet.

Assets	Liabilities
Cash deposits	(none)
Government bonds	
Firm stocks	

Table 2: Household cash flow.

Positive cash flows	Negative cash flows
Cash flow from employment activities:	
Salary	Consumption expenditure
Benefits	Tax payments
Subsidies	
Transfers	
Cash flow from financing activities:	
Interest on gov bonds	Gov bond purchases
Firm share sales	Firm share purchases
Dividend income	
Total income	Total expenses

Table 3: Firm income statement (CGP/IGP).

Revenues from sales of goods and services
Operating expenses:
– total payroll
– investment payments (CGP) or energy costs (IGP)
= Operating income (earnings before interest and taxes)
Non-operating expenses:
– interest payments
– debt repayments
= Gross income (earnings before taxes)
– tax payments
= Net income (net profit)

Table 4: Firm balance sheet.

Assets	Liabilities
Cash deposits	Total debt
Total value physical capital stock	Shareholder equity
Total value local inventory stocks	

Table 5: Firm cash flow (CGP and IGP differ only in the item Investment costs or Energy costs).

Positive cash flows	Negative cash flows
Cash flow from operating activities:	
Sales revenues	Total payroll
	Investment costs (CGP)
	Energy costs (IGP)
	Tax payments
Cash flow from financing activities:	
New loans	Debt installment payments
	Interest payments
New share issues	Dividend payout
Total income	Total expenses

Table 6: Bank balance sheet.

Assets	Liabilities
Cash	Total deposits
Loans to firms	ECB debt
	Shareholder equity

Table 7: Bank cash flow.

Positive cash flows	Negative cash flows
Loan installments	New loans to firms
Interest payments	Interest on ECB debt
	Dividend payout
	Tax payment
Total income	Total expenses

Table 8: Government balance sheet.

Assets	Liabilities
Gov. cash holdings	Outstanding bonds

Table 9: Government cash flow.

Positive cash flows	Negative cash flows
Cash flow from public sector activities:	
Tax revenues	Investments
	Consumption
	Total unemployment benefit payments
	Total subsidy payments
	Total transfer payments
Cash flow from financing activities:	
New bond issues	Bond interest payments
Total income	Total expenses

Table 10: Central Bank balance sheet.

Assets	Liabilities
Loans to banks	Payment accounts of banks and govs
Gov bond holdings	Fiat money
	ECB equity

Table 11: Central Bank cash flow.

Positive cash flows	Negative cash flows
Interest on ECB loans to banks	New ECB loans to banks
Gov bond interest payment	Gov bond purchases
Gov cash deposits	
Bank cash deposits	
Total income	Total expenses

3 Social accounting matrix

The social accounting matrix in Table 12 is based on the following set of assumptions:

- There are four types of financial assets: cash holdings in the form of bank deposits, bank loans, government bonds, and private equity shares (issued by firms and banks). There is no cash hoarding since all money is held inside the banking sector.
- Every agent has a current account and a capital account. All flows (income and payments) are on the current account while all changes in asset holdings are on the capital account.
- Pure capital gains from holdings of equity must be added separately, since there are no transactions underlying them.
- All rows sum to zero, except current savings, which indicates a net wealth creation by the private sector and the public sector combined.

Account	Household		Firm I (CGP)		Firm II (IGP)		Bank		Government		CB		Total
	current	capital	current	capital	current	capital	current	capital	current	capital	current	capital	
Real economic activity													
Consumption	$-C$		$+C$										0
Gov. cons			$+G$						$-G$				0
Investment			$-I^{fI}$		$+I^{fI}+I^{g}$				$-I^{g}$				0
Salaries	$+W$		$-W^{fI}$		$-W^{fII}$								0
Taxes	$-T^{h}$		$-T^{fI}$		$-T^{fII}$				$+T$				0
Financing activity													
Share purchase	$-SP^{h}$		$+SP^{fI}$		$+SP^{fII}$		$+SP^{b}$						0
Share repurchase	$+SR^{h}$		$-SR^{fI}$		$-SR^{fII}$		$-SR^{b}$						0
Dividend on stocks	$+Div^{h}$		$-Div^{fI}$		$-Div^{fII}$		$-Div^{b}$		$+Div^{cb}$		$-Div^{cb}$		0
Interest on deposits	$r^{m}M^{h}=0$		$r^{m}M^{fI}=0$		$r^{m}M^{fII}=0$		$r^{m}M=0$						0
Interest on bank loans			$-r^{b}L^{fI}$		$-r^{b}L^{fII}$		$+r^{b}L^{b}-r^{cb}A^{b}$				$+r^{cb}A^{cb}$		0
Interest on gov. bonds	$+r^{g}B^{h}$								$-r^{g}B^{g}$		$+r^{g}B^{cb}$		0
Public sector activity													
Benefits	$+Ben^{h}$								$-Ben$				0
Subsidies	$+Sub^{h}$		$+Sub^{fI}$		$+Sub^{fII}$				$-Sub$				0
Transfers	$+Tr^{h}$		$+Tr^{fI}$		$+Tr^{fII}$				$-Tr$				0
Current savings	Sav^{h}		$Prof^{fI}$		$Prof^{fII}$		$Prof^{b}$		Sav^{g}		0		$+SAV$
Changes in asset stocks													
ΔBank deposits		$-\Delta M^{h}$		$-\Delta M^{fI}$		$-\Delta M^{fII}$		$+\Delta M^{b}$		$-\Delta M^{g}$		$+\Delta M^{g}$	0
ΔBank loans to firms				$+\Delta L^{fI}$		$+\Delta L^{fII}$		$-\Delta L^{b}$					0
ΔCB loans to banks								$+\Delta A^{b}$				$-\Delta A^{cb}$	0
ΔGov. bonds		$-\Delta B^{h}$								$+\Delta B^{g}$		$-\Delta B^{cb}$	0
ΔFirm shares		$-\Delta E^{h}$		$+\Delta E^{fI}$		$+\Delta E^{fII}$		$+\Delta E^{b}$					0
Current savings													
+ net capital transactions	0		0		0		0		0		0		$+SAV$

Table 12: Social accounting matrix (SAM) of monetary flows between different sectors of the economy. The variables denote sums over all agents in each sector. The top section of the table indicates the cash flows, the bottom half denotes the changes in asset holdings. A (+) sign denotes a receipt while a (−) sign denotes a payment.

4 Validation rules

To validate the internal consistency of the model we list 20 rules that we have successfully tested. On the one hand these rules are balance sheet accounting identities, and on the other they are conservation rules for material quantities and monetary values. Having thus validated the model we are confident that the EURACE model is stock-flow consistent, and can form a solid basis for further extensions in the future.

Balance sheet identities

RULE 1

Firm balance sheet: assets and liabilities.

```
firm_payment_account+firm_total_value_local_inventory+firm_total_value_
capital_stock=firm_total_debt+firm_equity
```

RULE 2

IGFirm balance sheet: assets and liabilities, all net profits are paid in dividends.

```
igfirm_net_profit=igfirm_dividend_per_share*igfirm_shares_outstanding
```

RULE 3

Bank balance sheet: assets and liabilities.

```
bank_cash+bank_credit=bank_equity+bank_ecb_debt+bank_deposits
```

RULE 4

Government total debt is the value of its outstanding bonds.

```
gov_total_debt=gov_value_bonds*govt_outstanding_bonds
```

RULE 5

ECB: The issued fiat money to government(s) equals the total value of bond holdings of the ECB.

```
ecb_bond_holdings_value+ecb_cash=ecb_fiat_money_govs+ecb_fiat_money_banks
```

Aggregates across sectors

RULE 6

Payment accounts: aggregate bank deposits equals the sum of payment accounts in agent memory.

```
bank_deposits=firm_payment_account+igfirm_payment_account+hh_payment_account
```

RULE 7

Credit money: aggregate Bank credit outstand equals total loans to firms.

```
bank_credit=firms_total_loans
```

RULE 8

Definition of GDP.

```
eurostat_monthly_gdp=eurostat_monthly_investment_value+household_expenditure+
govt_monthly_cons_expenditure
```

RULE 9

Total number of shares outstanding equals the total number of shares in household portfolios.

```
household_assets=firm_current_shares_outstanding+igfirm_shares_outstanding+
bank_current_shares_outstanding+govt_outstanding_bonds
```

RULE 10

Debt installment payments by firms to banks and received by banks are equal. `firm_debt_installments=bank_loan_installments`

RULE 11

Interest payments by firms to banks and received by banks are equal.

```
firm_interest_payments_to_banks=bank_interest_payments_from_firms
```

RULE 12

Taxes paid and received are equal.

```
govt_monthly_tax_revenues=firm_tax_payment+igfirm_tax_payment+household_
tax_payment+bank_tax_payment
```

RULE 13

Deposits at ECB.

```
ecb_deposits=bank_payment_account+gov_payment_account
```

RULE 14

Check the number of active firms.

```
eurostat_no_firms=firm_active+eurostat_no_firm_bankruptcies
```

RULE 15

Daily dividend payments send and received are equal.

`firm_total_dividends+igfirm_total_dividends+bank_total_dividends=household_dividend_daily`

RULE 16

Material quantity conservation rule: Eurostat total sold quantity compared with firm data on number of goods sold (in volume).

`eurostat_monthly_sold_quantity=firm_total_sold_quantity_volume`

RULE 17

Investments in monetary value: Eurostat data (aggregated across the firms' investment costs) equals the IGFirm revenues.

`eurostat_monthly_investment_value=igfirm_revenues`

RULE 18

The Banks' aggregate ECB debt is found on the ECB balance sheet (`fiat_money_banks`, LHS), and on the banks' balance sheet (`bank_ecb_debt`, RHS). Similarly, the governments' debts are on the ECB balance sheet (`fiat_money_govs`, LHS), and equals the value of the ECB bond holdings (`bond_holdings_value`, RHS).

`ecb_fiat_money_banks+ecb_fiat_money_govs=ecb_bond_holdings_value+bank_ecb_debt`

RULE 19

ECB fiat money is by definition the sum of the fiat money created for governments and for banks.

`ecb_fiat_money=ecb_fiat_money_govs+ecb_fiat_money_banks`

RULE 20

Monetary conservation rule All deposits in the banking sector plus bank equity, plus the money in the public sector (government payment account), should equal the credit money created by the banks plus the fiat money created by the central bank.

`bank_deposits+bank_equity+gov_payment_account+ecb_cash==bank_credit+ecb_fiat_money`

References

Macedo e Silva, A., Dos Santos, C. H., 2008. The Keynesian roots of stock-flow consistent macroeconomic models. Levy Institute of Economics of Bard College, Working Paper no. 537, online: `http://www.levy.org/pub/wp_537.pdf`.