# Overview

on considere une economie constituee de:

- 02 secteurs: rural et urbain

- 02 secteurs urbains: formel et informel

- 02 secteurs informels: avance et retarde

les formes de dualismes considerees sont:

- le dualisme geographique (urbain/rural)

- le dualisme technologique (avancee/retarde)

- le dualisme du marche du travail (formel/informel)

On a donc 04 secteurs $k$ dans lequel sont regroupes les entreprises:

- un secteur rural ($k = 1$)

- un secteur urbain formel ($k = 2$)

- un secteur urbain informel avancee ($k = 3$)

- un secteur urbain informel retardee ($k = 4$)

| | Secteur 1 | Secteur 2 | Secteur 3 | Secteur 4 |

| --- | --- | --- | --- | --- |

| Region | Rural | Urbain | Urbain | Urbain |

| Type de travail | Informel | Formel | Informel | Informel |

| Acces au credit | Non | Oui | Oui | Non |

| Biens produits | Agricoles | Manufacturees | Manufacturees | Intermediaires |

| Technologie | Retardee | Avancee | Avancee | Retardee |

On a egalement 06 categories $z$ de menages:

| Categorie | Secteur | Statut | Description |

|:-:| --- | --- | --- |

| 1 | rural | entrepreneur | paysans |

| 2 | urbain formel | entrepreneur | entrepreneurs formels |

| 3 | urbain informel | entrepreneur | entrepreneurs informels |

| 4 | urbain formel | salaries | salaries formels |

| 5 | urbain informel | salaries | salaries informels |

| 6 | urbain | \*aucun\* | chomeurs |

Une approche en termes d'informalite base sur le concept de degre d'informalite.

On regroupe des les normes qui sont les regles formelles que doivent resspecter une entreprise dans un cadre institutionnel donne. Distinguons alors deux normes:

- les normes du travail (regles formelles regissant la relation salariale)

- les normes de credit (regles formelles regissant l'acces au credit bancaire)

on peut alors segmenter le marche du travail en deux segments:

- le marche du travail formel (ou les participants respectent les normes du travail)

- le marche du travail informel (ou les participants respectent les normes du travail)

on peut egalement segmenter le marche du credit en deux segments:

- le marche du credit formel (ou les participants respectent les normes du credit)

- le marche du credit informel (ou les participants respectent les normes du credit)

les niveaux d'informalite sont alors:

| Niveaux | Respect des normes |

|---| ---|

|Informel (0)| Ne respecte aucune norme|

|Semi-formel (1)| Ne respecte qu'un groupe de normes |

|Formel (2) | Respecte toutes les normes |

si l'on note:

- $n$ le degre d'informalite

- $n^N$ le respect des normes du travail

- $n^L$ le respect des normes du credit

on a:

$$

n = n^N + n^L

$$

Pour l'emploi on peut donc definir une structure de l'emploi comme un repartition des emploi entre le secteur prive et public et le segment formel et informel du marche du travail:

| |Travail Formel|Travail Informel| $\Sigma$ |

|--- | :-: | :-: | :-: |

| Secteur Prive | $N\_{F1}$ | $N\_{F2}$ | $N\_{F}$ |

| Secteur Public | $N\_{G}$ | | $N\_{G}$ |

| $\Sigma$ | $N\_1$ | $N\_2$ | $N$ |

Pour l'informalite on peut egalement definir une repartition des firmes dans un secteur $k$ comme suit:

| |Travail Formel|Travail Informel| $\Sigma$ |

|--- | :-: | :-: | :-: |

|Credit Formel | $Z\_{Fk11}$ | $Z\_{Fk12}$ | $Z\_{Fk1.}$ |

|Credit Informel | $Z\_{Fk21}$ | $Z\_{Fk22}$ | $Z\_{Fk2.}$ |

| $\Sigma$ | $Z\_{Fk.1}$ | $Z\_{Fk.2}$ | $Z\_{Fk}$ |

## Purpose and Patterns

## Entities, State Variables, and Scales

### Households

Farms are agents that integrate the economic concepts of firms and households. They are characterized by their capital and investment strategy. These variables guide the farms in their investment, production, consumption, and their utility evaluation. We distinguish three types of farms depending on their investment strategy: collaborative farms (represented by value 0), ignorant farms (represented by value 1), and witty farms. Witty farms use expectations, they either follow an adaptive rule (represented by value 2), or a trend-follower rule (represented by value 3). When a witty farm follows an adaptive rule, the value of the adaptive constant can take two values. Similarly, the trend following rule can also take two values. The variables and parameters characterizing these agents are listed in the following tables

Table 1. Household state variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Variable** | **Domain** | **Description** |
|  | s\_U |  | indicator variable of unemployed |
|  | s\_W |  | indicator variable of employee |
|  | s\_WG |  | indicator variable of civil servant |
|  | s\_E |  | indicator variable of entrepreneur |
|  | s\_EB |  | indicator variable of bank owner |
|  | s\_Y |  | sector of production |
|  | n\_W |  | degree of formality of job |
|  | W |  | wage received |
|  | M |  | cash |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

### Firms

Farms are agents that integrate the economic concepts of firms and households. They are characterized by their capital and investment strategy. These variables guide the farms in their investment, production, consumption, and their utility evaluation. We distinguish three types of farms depending on their investment strategy: collaborative farms (represented by value 0), ignorant farms (represented by value 1), and witty farms. Witty farms use expectations, they either follow an adaptive rule (represented by value 2), or a trend-follower rule (represented by value 3). When a witty farm follows an adaptive rule, the value of the adaptive constant can take two values. Similarly, the trend following rule can also take two values. The variables and parameters characterizing these agents are listed in the following tables

Table 1. Firm state variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Variable** | **Domain** | **Description** |
|  | s\_Y |  | sector of production |
|  | n\_W |  | degree of formality on labor market |
|  | n\_T |  | degree of formality on credit market |
|  | N\_J |  | number of vacant job opened |
|  | W |  | wage bill |
|  | M |  | cash |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Process overview and scheduling

We conclude this section dedicated to agents’ behaviors by sketching out the sequence of events taking place during each round of the simulation:

1. **Production planning** : firms determine their desired production, their labor demand, the price of their output and the wage offered.
2. **Loans and cash advances**: firms interact with banks on the credit market and possibly receive loans. Banks possibly ask cash advances to the Central Bank to satisfy the mandatory liquidity ratio.
3. **Labor market matching** : Firms interact with workers on the labor market.
4. **Wages, dividends and taxes payments**: Workers are paid. Dividends generated in the previous period are distributed to equity holders, summing up to their current income. Taxes are paid (on past period profits and current period households’ income). Firms and banks update their net worth and shareholders’ equity after dividends and tax payment.
5. **Public expenditures** **and policies** : Governments calculate revenues from taxes, determine the level of public spending and the tax rate for the next period, repay bonds plus interests to bond holders, and determine the quantity of bonds to be issued.
6. **Bonds purchases** : Bonds are put on the bond market where commercial banks buy it. The possible residual part is purchased by national Central Banks.
7. **Good production and consumption** : After having paid taxes and received the tax-exempt monetary transfer from the government, households compute their demand for consumption goods and interact with firms on the correspondent good markets.
8. **Interests and loans repayments** : Deposits repayment, Loans repaymnts and cash advances repayments.
9. **Entry-exit** : Firms and banks compute their profits. Defaulted firms and banks exit the market. Household equity investment takes place and, if enough financial resources are collected, new firms and banks are created.

# Design Concepts

## Basic Principles

## Emergence

## Adaptation

## Objectives

## Learning

## Prediction

## Sensing

## Interaction

During each period of the simulation agents interact on six types of spaces:

* Regions: all agents interact with neighbors;
* Goods markets: households interact with firms;
* Labor markets: households interact with government and firms;
* Credit market: firms interact with banks;
* Deposit market: households and firms interact with banks;
* Bonds market: government interact with banks and central banks.

Following Riccetti et al. (2014), we explicitly model agents' dispersed interactions by assuming that agents on the demand and supply sides of each market interact through a common matching protocol. In each period of the simulation, ‘demand’ agents are allowed to observe the prices or the interest rates charged by a random subset of suppliers (whose size depends on a parameter χ reflecting the degree of imperfect information). Agents' switch from the old partner to the best potential partner selected in this random subset with a probability Prs which is defined, following Delli Gatti et al. (2010a), as a non-linear (decreasing when the price/interest represents a disbursement for the demander, increasing otherwise) function of the percentage difference in their prices pold and pnew. The shape of this function is governed by the ‘intensity of choice’ parameter ε 4 0: higher values of ε 4 0 imply a higher probability of switching.11 In some cases, some suppliers exhaust inventories available for sale, possibly leaving some customers with a positive residual demand. We then allow demand agents to look for other suppliers within the original random subset of potential partners in order to fulfill it. Markets interactions are ‘closed’ when demand agents have fulfilled their demand, when there are no supply agents willing or able to satisfy their demand, or if demanders run out of deposits to pay for demanded goods.

Agents' interactions generate several types of economic transactions and financial transfers. As argued before, a clear-cut description of the types of real and financial flows taking place in the model is a key aspect for assessing the accounting and logical consistency of a model. Hence, we classify the flows arising in the model as follows:

* Deposit transfers (see section 3.2.3.1)
* Dividends and Profits transfers (see section 3.2.3.2)
* Wages and dole (see section 3.2.3.3)
* Taxes payment (see section 3.2.3.4)
* Purchases of real goods (see section 3.2.3.5)
* Purchases of bonds, repayment, and interests (see section 3.2.3.6)
* Loans creation, repayment, and interests (see section 3.2.3.7)
* Cash advances creation and repayment (see section 3.2.3.8)
* Equities investments and reimbursements (see section 3.2.3.9)

## Stochasticity

## Collectives

## Observation

# Details

## Initialization

We adopted the six-step strategy proposed by Caiani et al. [1]. First, the procedure have to define the initial values of the different types of stocks and flows held by each sector, so that they respect Copeland's quadruple entry principle (see section 3.2.1 for details on these stocks and flows). Second, aggregates stocks should then be distributed across agents within each specific sector, thus characterizing their overall balance sheet. As described in the previous sections, agents balance sheets are sometimes characterized by the presence of multiple stocks of the same type, which differ in terms of quantity, age, maturity, prices, and liability and asset counterparts. In our model, this is the case for loans in firms' and banks' balance sheets, and capital goods in consumption firms' balance sheets (see Sections 3.2 and 3.1.4). The third task thus consists in finding a strategy to characterize each specific stock in these collections and assign it to agents who hold it as an asset or a liability.

For this sake, we adopted the following six-step strategy:

1. We derive an aggregate version of the model.
2. We constrain the aggregate model to be in a real stationary state associated with a nominal steady growth equal to gss. This imply that while all real quantities are constant, all prices and wages are growing at the same rate gss.19
3. We numerically solve the constrained model by setting exogenously reasonable values for the parameters for which some empirical information is available (e.g. unemployment rate, mark-ups, interest rates, and income and profit tax rates) or that we want to control (e.g. technological coefficients, number of agents in each sector, distribution of workers across sectors, loans and capital durations). We then obtain the initial values for each stock and flow variable of the aggregate steady state, as well as the values of some behavioral parameters, which are hence compatible with the steady/stationary state (e.g. the propensity to consume out of income, target capacity utilization and profit rates, initial capital and liquidity targets for banks).
4. We distribute each sector's aggregate values uniformly across agents' in that sector. In this way we derive the total value of each type of stock held by agents (e.g. households' and firms' deposits, total outstanding loans and real capital for each firm, total loans, and reserves and bonds for individual banks) and agents' past values to be used for expectations (e.g. past sales, past wages, and past profits).
5. To determine the original amount, outstanding values, age of durable stocks we assume that, in each of the periods before the simulation starts, firms have obtained a loan and consumption firms have also acquired new capital batches to replace old capital and maintain their productive capacity. We further assume that the real value (i.e. corrected for inflation) of each of these loans and capital batches was constant. Knowing the constant inflation rate gss and the amortization schedules for capital goods and loans, we can then derive the outstanding value for each of these stocks, so that the sum of these values is exactly equal to the amount determined in the previous step.
6. In order to set the initial network configuration, we randomly assign a previous period supplier (required for the matching mechanism) to each demand agent on each market, ensuring that each supplier has the same number of customers. Similarly, we assign to households' and firms' deposits, and to firms' loans a randomly selected bank, so that each bank has the same number (and amount) of deposits and loans with the same number of agents.

The procedure20 just explained generates an important symmetry condition on agents' initial characteristics: that is, we start from a situation of perfect homogeneity between agents in order to limit as much as possible any possible bias embedded in asymmetric initial conditions, and we let heterogeneity emerge as a consequence of cumulative effects triggered by the stochastic factors embedded in agents' adaptive rules. Furthermore, by setting initial values based on SS stock-flow norms, we aim to achieve the threefold objective of limiting our arbitrariness in defining agents' initial endowments, restricting the number of free behavioral parameters in the simulation, and find a criterion to set the values of several others.

## Submodels

### Stock-Flow consistent matrices

The model deployed here is an adaptation GROWTH de Godley et Lavoie [2]. describes a growing economy which does not spontaneously find a steady state even in the long run, but which requires active management of fiscal and monetary policy if full employment without inflation is to be achieved. Its main new features are as follows. As the model describes a growing economy, firms now undertake fixed investment and their pricing mark-up is endogenous, depending on the rate at which dividends are paid and the proportion of investment that firms wish to finance through retained earnings. Second, firms now issue stock market shares – equities.1 Third, there is now a distinction between unit costs and normal unit costs, the former being actual labour costs per unit produced. When production is above normal, actual unit costs will be lower than normal unit costs, which depend on trend productivity. It will now be assumed that households as well as firms borrow from banks, and that the gross flow of new personal loans (before repayments) is exogenously determined as a proportion of disposable income.2 As a result, consumption will depend on net lending as well as real disposable income and wealth. Finally banks will have to face the fact that some corporate borrowers default on their loans. As a result, banks retain part of their profits, accumulating own funds that allow them to absorb capital losses while fulfilling regulation obligations related to capital adequacy ratios. The loan rate will once more be determined endogenously as a mark-up on the deposit rate. As in any growth model, some of the most crucial equations are those determining how growth arises. First, we assume an exogenous – unexplained trend rate of growth in labour productivity, while the potential labour force is assumed to be constant. Second, we initially assume that real pure government expenditure (excluding interest payments) – grows at a constant rate, initially the same rate at which labour productivity is growing. Third, we assume that the rate of accumulation of fixed capital is a function of the rate of capacity utilisation and of the real rate of interest. The rate of growth of fixed capital is thus an endogenous variable, which adjusts to the growth rate of pure government expenditures.

On suppose qu’il n’y a pas de changement dans la valeur des fonds propres (on suppose que les marches financiers sont inexistants)

#### Balance sheet

As always, we start the description of the model with its balance sheet and transactions-flow matrices to which we add a revaluation matrix. provides the balance-sheet of the model, which we shall call Model GROWTH. The economy is again divided into five sections – households, firms, banks, a central bank and a government, each of which has distinct functions and objectives. The household column has three new features. First, households are now indebted to banks. Second, they now hold stock market equities (or shares) issued by firms, e shares each valued at price pe. The third new feature of this column is the term OF which describes the own funds of banks the value of their equity. It is assumed that whereas production firms are corporations valued by the stock market, banks are privately held companies, which do not issue stocks. As a result, the net worth of these banks belongs to the private owners of the banks, and must appear as part of the net wealth of households. It may be useful to recall some accounting issues which were discussed at the beginning of Chapter 2. The description of the Firms column here corresponds with that in Table 2.2 where the net worth of firms is defined as the difference between all their assets and all their liabilities including the market value of equities. As a consequence the net worth of firms Vf can be either positive or negative. By contrast, the Banks column corresponds to the one in Table 2.3 where the net worth of banks is calculated as the difference between all assets and liabilities, excluding equities (since we assumed away their existence!). This is the own funds of banks, or their equity capital. For the bank to be solvent, this net worth must be positive. However these own funds of the bank, OFb, belong to the owners of the banks, and for this reason, while they enter with a negative sign in the balance sheet of the banks they also enter with a plus sign in the balance sheet of households. The other components of the balance sheet have already been introduced in previous models. Firms own both kinds of tangible asset needed for production – inventories and fixed capital.

Table 2. Balance sheet of Dual Monetary Economy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | Central bank |  |
| HP Money |  |  |  |  |  |  |
| Cash Advances |  |  |  |  |  |  |
| Deposits |  |  |  |  |  |  |
| Bonds |  |  |  |  |  |  |
| Loans |  |  |  |  |  |  |
| Equities |  |  |  |  |  |  |
| Balance |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Transactions Matrix

We now move to a new matrix, the revaluation matrix, given by Table 11.2 which was also discussed in Chapter 2. In previous models, the revaluation matrix comprised only one entry, the capital gains or capital losses on holdings of long-term bonds. In the GROWTH model, four components may be revalued. Besides bonds, stock market equities are also liable to capital gains and losses. Third, banks accumulate own funds, but these funds belong to the owners of the banks, so that they are treated as a liability of the banks. From the standpoint of the bank owners, since this is a closed rather than a publicly owned corporation, the own funds accumulated by the bank during a period are treated as a capital gain. From a Haig–Simons point of view, the bank’s own funds are part of the wealth of household owners, because if the bank were to be liquidated, their owners would be left with the bank capital the own funds of the bank. Finally, the fourth line of the matrix shows an automatic revaluation of the value of firms’ fixed capital, arising from price inflation.

Table 3. Transactions matrix of Dual Monetary Economy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Consumption |  |  |  |  |  |  |
| Wages |  |  |  |  |  |  |
| Transfers |  |  |  |  |  |  |
| Taxes |  |  |  |  |  |  |
| Interests on advances |  |  |  |  |  |  |
| Interests on bonds |  |  |  |  |  |  |
| Interests on loans |  |  |  |  |  |  |
| Interests on deposits |  |  |  |  |  |  |
| Entrepreneurial profits |  |  |  |  |  |  |
| Central Bank profits |  |  |  |  |  |  |
| Change in advances |  |  |  |  |  |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in loans |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
| Change in equities |  |  |  |  |  |  |
| Loan defaults |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table 11.3 describes net transactions between all five sectors in some given period of time, measured at current prices. Start with the first seven items in the top half of the second column, written in bold characters. This list is the national income identity comprising the major expenditure categories (government expenditure, personal consumption and investment) and flows of factor income (wages and profits). Every item in this column is a transaction with another sector or with a different part of the same sector (e.g. when firms buy investment goods from other firms or profits are retained in the business), so a new column, the capital account column has been created to record these capital transactions.

The columns describing the government and central bank are no different from those of Table 10.2. Indeed, every entry in the top half of the matrix has already been encountered in previous chapters and is self-explanatory, except for two unusual features relating to national income accounting conventions. First, in the row called ‘financing cost of inventories’, in column 2, the loan rate of interest multiplied by the opening stock of inventories has been substituted for conventional stock appreciation (or IVA). Second, interest payments by firms, other than with respect to loans for the finance of inventories, are included in line seven as a component of distributed profits. The reasons for making these entries have already been explained in detail in Chapter 8, where we dealt with various possible definitions of profits, and the distinction between the requirements of business and national accounts. Banks and producing firms distribute dividends to their owners (FDb and FDf ), and keep part of their profits undistributed, in the form of retained earnings (FUb and FUf ).

The bottom of the first half of the Table describes the various interest payments on deposits, bills, bonds and personal loans. The latter is a new entry. It is assumed that households obtain personal loans from banks (Lh) on which they make interest payments. These payments carry a negative sign, since they are a use of funds, being subtracted from the personal income of households.

The lower part of the transactions-flow matrix describes the flow-of-funds. Checking the first column, that of households, there are two new items. Besides acquiring cash balances, money deposits, bills and bonds, households purchase stock market shares newly issued ( e). In addition, when households increase their borrowing, they have a new source of funds in the form of personal bank loans. The other new entry is ‘Loan defaults’ (NPL) which describe non-performing loans. It is assumed that a certain proportion of loans made to firms turn bad. The new loans ( Lf ) that firms obtain as residual finance for changes in inventories and fixed investment will be reduced by the amount of defaulted loans. These non-performing loans will also appear in the capital account of banks.

### Initial steady state relations

We divided the SS system of equations of the aggregated model in four sub-systems or block. As explained in Section 4 our procedure is based on the imposition of a real stationary state coupled with a nominal steady state growth (i.e. inflation) at the macroeconomic level. More precisely, we first declare a set of exogenous parameters, aggregate variables, and stock-flow norms that we fix at reasonable values (see Section A.4). Then we employ the accounting identities and the steady state (SS hereafter) conditions to find a numerical solution to the system. For tractability and explanatory reasons we divided the SS system of equations in three sub-systems: the first block contains the equations which refer to capital good producers (Section A.1), the second presents the set of equations related to consumption firms (Section A.2), and the third (Section A.3) refers to households, banks and the public sector (government and central bank). Once the first block of the system is solved, its solution are employed to solve the second subsystem, whose solutions in turn are used to solve the third one.

let x be the variation and y the rate, such that:





#### Primary sector initial state

The first block contains the equations which refer to firms of the primary sector.

In the equations, letters in bold type indicate the dependent variables of the system. All other variables and parameter values are set exogenously to characterize numerically the SS. The first block is a system of ten equations in ten unknowns referring to capital firms and, indirectly, to banks, as far as loans and deposits in the capital sector balance sheet are concerned. Eq. (A.1) states that workers employed in the capital sector Nk should be equal to the real output of capital firms yk divided by labor productivity μN. Prices of capital goods pk (Eq. (A.3)) are a markup muk over unit (variable) costs, which are equal to wages W over labor productivity (Eq. (A.2)). Capital firms want to hold an amount of deposits Dk equal to a fraction sigma of wages paid to workers (Eq. (A.4)). Since we have stationary state in real terms, capital firms' real output is exactly equal to replacement investment realized by consumption firms' ic in order to replace obsolete capital. This in turn is equal to total real capital k over real capital duration κ (Eq. (A.5). Real capital inventories (Eq. (A.6)) are constant and equal to a share ν of real output (i.e. sales). Profits of capital firms are revenues from sales plus interests on previous period deposits, plus the variation of nominal inventories (evaluated at their unit costs of production uck), minus wages and interests paid on the previous-period stock of loans (Eq. (A.7)). Notice that past period values of nominal variables will be equal to the current value divided by ð1 þ gSSÞ, gSS being the exogenously imposed SS nominal rate of growth. A fraction τk of profits goes to pay taxes (Eq. (A.8)), while a share ρk of remaining net profits is distributed as dividends to households (Eq. (A.9)). Finally, for accounting reasons the variation of loans (Eq. (A.10)) should be equal to the sum of the variation in the nominal value of inventories and the variation of deposits, minus retained earnings (see the KA column for the capital sector in the Transaction Flow Matrix presented in Appendix A)



























#### Secondary sector initial state

The second block of equations refers to consumption firms. Workers employed in the consumption sector are computed by dividing output for labor productivity in the consumption sector (Eq. (A.11)). By definition, labor productivity in the case of a technology which employs labor and capital fixed coefficients is equal to the product of capital productivity μk and the fixed capital-labor ratio lK. Prices are a markup muc over unit variable costs (Eq. (A.15)), defined as wages paid to workers over output (Eq. (A.12)). Unit costs are computed as overall production costs, including the financial amortization of capital, divided by output (Eq. (A.13)). Since we are in a real stationary state and given the assumption that capital lasts for κ periods, consumption firms invest in each period to buy an amount of k=κ capital goods in order to replace the batch of obsolete capital (purchased κ periods ahead) thus keeping the total stock of capital k constant. Since we further assume a linear financial amortization of capital, consumption firms register an amortization cost equal to a share 1=κ of the disbursement originally incurred to buy each batch of capital. This disbursement was equal to k κ pk ð1 þ gSSÞt for each batch purchased t 1⁄4 1; ...; κ periods ahead. Therefore amortization costs are equal to pkk κ2 Pj 1⁄4 1 κ1 ð1 þ gSSÞj. Following the same reasoning, we can determine the nominal value of the stock of capital held by consumption firms Kc as expressed by Eq. (A.14). Consumption firms want to hold a share σ of wages as deposits (Eq. (A.16)). Output is given by the stock of capital multiplied by the rate of capacity utilization u and by the productivity of capital (Eq. (A.17)). Real inventories are a share of real sales, which in the SS are equal to output (Eq. (A.18)). Profits in the case of consumption good producers differ from those of capital firms, as they also include the amortization cost of previously purchased capital batches (Eq. (A.19)). Taxes and dividends are then defined as in the case of capital good producers (Eqs. (A.20) and (A.21)). The variation of loans granted to consumption firms can be obtained by exploiting the capital account identity (see column KA for the consumption sector in the Transaction Flow Matrix presented in Appendix A) for the consumption sector. The difference with respect to the correspondent equation for capital firms is the inclusion of the investment and amortization flows (Eq. (A.22)):























#### Banks sector initial state

The third block of equations encompasses the relations referring to the households and banking sectors, plus those related to the public sector which is composed of the general government and the central bank.

Profits by banks are the sum of interests on the previous period outstanding stock of loans, plus interests paid by the government on the stock of bonds held by banks, minus interests paid on deposits of households and firms (Eq. (A.22)).48 Banks pay taxes (Eq. (A.32)) and distribute a share of net-profits to households (Eq. (A.33)). Banks' net worth is defined as the difference between assets, that is loans, bonds, and reserves, and liabilities, which are represented by customers' deposits (Eq. (A.34)). Given the structure of the economy banks reserves (Eq. (A.35)) are exactly equal to central bank's holdings of government bonds (see the Balance Sheet Matrix of the economy presented in the Appendix A), which are defined as the a residual (Eq. (A.36)).

the third refers to banks and the public sector (government and central bank).





















#### Households initial state

Total employment is given by the sum of workers hired by the consumption, capital, and public sectors (Eq. (A.23)). Households' income is composed of wages, interests on deposits, dividends and the tax-exent dole ωW that unemployed workers receive from the government. Dividends are distributed by firms and bank to households at the end of the period, after households have consumed and firms and banks have paid taxes. Therefore, we assume that dividends from period t 1 enter in the (behavioral) definition of the gross income of households of period t (although they have already increased the amount of deposits held by households in period t 1, see equation ...). Net income is then defined by Eq. (A.24), whereas taxes paid by households are given by Eq. (A.25). Real consumption is a function of real net income and the real net-wealth inherited from the previous period (Eq. (A.26)). Given the stationary state condition real consumption is exactly equal to the amount of goods produced by consumption firms (Eq. (A.27)). Nominal consumption is obtained by multiplying real consumption for the price of consumption good (Eq. (A.28)). The variation of households' net worth obviously depends on the difference between net-income, as defined above, and consumption. However, since the definition of net income given above includes a the flow of dividends paid at the end of the previous period (thus already increasing households' net worth), while neglecting current period dividends, we respectively subtract and add them in the equation to get the right dynamics for households' net worth (Eq. (A.29)). Households' net wealth takes the form of banks' deposits (Eq. (A.30)):

urban households:





















#### Public sector initial state

The variation of government debt is given by the difference between government outlays for wages of public servants, unemployment benefits and interests on past period public debt, and government revenues from taxes and central bank's profits (Eq. (A.37)). This latter are just represented by interest on bonds held by the central bank, which are promptly returned to the government (Eq. (A.38)):

















### Economic transactions

Agents' interactions generate several types of economic transactions and financial transfers. As argued before, a clear-cut description of the types of real and financial flows taking place in the model is a key aspect for assessing the accounting and logical consistency of a model.

#### Deposits transfers and interests

If agents involved hold their deposits at the same bank, payer's deposit is decreased and receiver's increased. Otherwise, also a reserve transfer for the same amount from the payer's bank to the receiver's bank takes place. The same occurs when an agent decides to move its deposits to a new bank.

Household make deposits

Table 4. Accounting of deposits made by households

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Firm make deposits

Table 5. Accounting of deposits made by firms

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Household withdraw deposits

Table 6. Accounting of deposit withdrawals by households

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Firm withdraw deposits

Table 7. Accounting of deposit withdrawals by firms

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Interests on deposits are paid by simply increasing customers' deposits by the required amount. The same occurs for dividends, when the receiver holds a deposit at the paying bank.

Bank pay interests to household

Table 8.Accounting of payments of interests on households deposits

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on deposits |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Bank pay interests to firm

Table 9.Accounting of payments of interests on firm deposits

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on deposits |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Profits distribution

Firms pay dividends through deposit transfers.

Firm pay dividends to households

Table 10. Accounting of dividend payment by firms

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Entrepreneurial profits |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Bank pay dividends to households

Table 11. Accounting of dividend payment by households

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Entrepreneurial profits |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Central bank transfer profits to Government

Table 12. Accounting of profit transfers by Central bank

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Central Bank profits |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Wages and doles

Private workers' wages: wages of private workers by firms are paid via a deposit transfer, as explained above. Public servants' wages and dole: public workers' wages and unemployment benefits give rise to the same type of transfers. The receiver's deposit is increased while reserves are subtracted to the government account at the Central Bank and transferred to the receiver's bank.

Firm pay wage to households

Table 13. Accounting of wage payment by firms

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Wages |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Government pay wage to households

Table 14. Accounting of wage payment by Government

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Wages |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Government pay doles to households

Table 15. Accounting of doles payments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Transfers |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Taxes payments

firms' and households pay taxes using their deposits. Accordingly, the payer's bank transfers reserves for the same amount to the government account at the Central Bank. Banks pay taxes by transferring reserves to the government account at the Central Bank.

Household pay taxes

Table 16. Accounting of taxes payment by households

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Taxes |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Firm pay taxes

Table 17. Accounting of taxes payment by firms

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Taxes |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Bank pay taxes

Table 18. Accounting of taxes payment by banks

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Taxes |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Purchases of real goods

transactions in real goods are cleared via a deposit transfer. Contextually, also real goods motivating the transaction are transferred from the seller's to the buyer's asset side.

Household consume goods using only cash

Table 19. Accounting of goods purchases

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Consumption |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Purchases and repayments of bonds

Bonds are a liability for the government and an asset for banks and the Central Bank. Central Bank's purchases increases its liabilities (i.e. reserves, that is legal money) while also increasing the government account at the Central Bank. Interests on bonds are immediately re-distributed to the government. Commercial banks purchases of bonds are cleared via a transfer of reserves from banks to the government current account at the Central Bank. Bonds repayments and bonds interest payments give rise to the opposite flows.

bank buy bonds

Table 20. Accounting of bonds purchases by banks

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

central bank buy bonds

Table 21. Accounting of bonds purchases by Central Bank

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Government repay bank bonds

Table 22. Accounting of bonds repayments to banks

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on bonds |  |  |  |  |  |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Government repay central bank bonds

Table 23. Accounting of bonds repayments to Central bank

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on bonds |  |  |  |  |  |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

bank transfer bonds to central bank

Table 24. Accounting of bonds tranfers between banks and Central Bank

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in bonds |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Loans creation and repayments

Loans and matching deposits are created endogenously and ex-nihilo as explained above. Interest payments and principal repayments (reducing the stock of loans) give rise to the same type of transfers. If borrower's deposit bank coincides with the lending bank, the payment is realized by lowering the borrower's deposit. If the borrower's moved his deposits to another bank, also a corresponding reserves transfer from the borrower's bank to the lending bank takes place.

Bank give loans to firm

Table 25. Accounting of loans

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in loans |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Firm reimburse loans to bank (capital + interests)

Table 26. Accounting of loans repayments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on loans |  |  |  |  |  |  |
| Change in loans |  |  |  |  |  |  |
| Change in deposits |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

bank make default loans

Table 27. Accounting of default loans

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in loans |  |  |  |  |  |  |
| Loan defaults |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Cash advances creation and repayments

Cash advances are a loan extended by the Central Bank to commercial banks which is matched by a temporary increase of banks' reserves (a liability for the Central Bank). Conversely, cash advances repayments extinguished the loan while reducing commercial banks' reserve accordingly. Interest payments give rise to the same type of transfer, reducing private banks' reserves. Interests on cash advances are distributed to the government by increasing its deposit account at the Central Bank.

when central bank give cash advance

Table 28. Accounting of cash advances

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in advances |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

bank repay cash advance

Table 29. Accounting of cash advance repayments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Interests on advances |  |  |  |  |  |  |
| Change in advances |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

#### Equities investment and reimbursements

household invest in firm equities (firm entry)

Table 30. Accounting of investments on firm equities

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in equities |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

household invest in bank equities (bank entry)

Table 31. Accounting of investments on bank equities

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in equities |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

firm close by transferring residual money

Table 32. Accounting of reimbursements of firm equities

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Households | Firms | Banks | Government | C. bank |  |
| Entrepreneurial profits |  |  |  |  |  |  |
| Change in HP Money |  |  |  |  |  |  |
| Change in equities |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

### Bank behaviors

#### Credit supply

In addition, banks endogenously create means of payment by providing credit to firms. As it happens in reality, every new loan granted by a bank, which is an asset for it, is immediately balanced by the creation of a matching liability in the form of a deposit for the borrower, both being created ex nihilo. This implies that banks’ credit supply is not constrained by the amount of deposits already in circulation nor by the amount of reserves they hold. However, we assume that to avoid taking excessive risks, the maximum amount of credit that banks are willing to supply in any given period is a multiple l1 of their equity Azt:



For each firm that is a client, the bank calculates the probability  of satisfying its loan demand. Furthermore, banks also discriminate borrowers by applying different interest rates . The probability and the interest rate charged  are, respectively, a decreasing and increasing function of the borrowers’ target leverage, computed as the ratio between their demand for loans () and their net worth () :





#### Cash advances demand

Banks are subject to minimal reserve requirements, expressed as a share  of their deposits:



Reserves are held at the national Central Bank and yield no interest rate. Whenever reserves RzMt are below the minimum level, banks apply to the Central Bank lending facility, asking cash advances (LzCBt) to restore the mandated liquidity ratio. National Central Banks accommodate these requests, receiving the discount rate rt on funds lent to banks.



#### Bonds purchases

If instead banks have reserves in excess with respect to the mandatory level, these can be invested in the purchase of bonds (BzDt) issued by any member country k, which bring an interest rate rbkt computed following equation (45). In each period of the simulation, all the bond tranches issued by governments of the Monetary Union (Section 2.1.5) are piled up and shuffled. Then, commercial banks enter the bond market in a random order and go through this pile, having a probability of purchasing each tranche which depends on the riskiness associated to the country and defined as:



#### Profit computation

Therefore banks’ profits (pzt) are equal to:



#### Tax payment

When profits are positive (pzt > 0), banks pay taxes (Tipt) and distribute to equity holders a share q of net profits (Divzpt). As for firms, dividends are distributed among investors proportionally to the share of the bank’s equity they own.



#### Dividends payment

When profits are positive (pzt > 0), banks pay taxes (Tipt) and distribute to equity holders a share q of net profits (Divzpt). As for firms, dividends are distributed among investors proportionally to the share of the bank’s equity they own.



#### Net worth update

Retained profits after taxes then increase banks’ net worth: Az;tþ1 1⁄4 Azt þ pzt Tp zt Divp zt: (35) As Az;tþ1 varies, also households’ participation in the bank, and thus households’ net worth, is revised accordingly.



#### Failure

Banks default when their net-worth turns negative. Defaults by banks instead do not directly affect households and firms, as the government totally bears the loss by issuing additional bonds to reimburse depositors (Section 2.1.5). However, in this way banks’ failures affect public debt dynamics. In addition, banks’ failures may eventually cause a reduction of the total credit supply in the economy. Finally, even before causing a default, negative profits of firms and banks prevent them from paying dividends and decrease their equity, thereby affecting the net worth of equity holders.

## Input Data

parametres

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Code** | **Description** |
|  | g\_ss | Grow rate of prices and wages in stationary state |
|  | N\_E1 | Number of entrepreneurs in sector 1 |
|  | N\_E2 | Number of entrepreneurs in sector 2 |
|  | N\_E3 | Number of entrepreneurs in sector 3 |
|  | N\_W1 | Number of employees in sector 1 |
|  | N\_W2 | Number of employees in sector 2 |
|  | N\_W3 | Number of employees in sector 3 |
|  | N\_WG | Number of employees in public sector |
|  | N\_U | Number of unemployed |
|  | phi1 | Productivity in sector 1 |
|  | phi2 | Productivity in sector 2 |
|  | phi3 | Productivity in sector 3 |
|  | w1 | Initial wage in sector 1 |
|  | w2 | Initial wage in sector 2 |
|  | w3 | Initial wage in sector 3 |
|  | w\_G | Initial wage in public sector |
|  | w\_min | Minimum wage |
|  | Tau | Tax rate |
|  | Rho | Dividend policy |
|  | M | Markup rate |
|  | alpha\_b1 | Propension to consume goods 1 in urban region |
|  | alpha\_a2 | Propension to consume goods 2 in rural region |
|  | theta\_W | Desired liquidity share of wage bill |
|  | theta\_E | Initial equity share of banks assets |
|  | theta\_M | Initial bank liquidity ratio |
|  | theta\_Zbar | Reglementary portion of minimum wage dedicated to dole |
|  | r\_D | Interest rate on deposits |
|  | r\_L | Interest rate on loans |
|  | r\_B | Interest rate on bonds |
|  | r\_A | Interest rate on cash advances |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

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