Macroeconomic Model Definition

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1 Introduction

This material is based on the Caiani et al. (2016) paper.

2 Model Formal Definition

2.1 The economy

Here we follow the section 2 of Caiani et al. (2016, p.381).

2.2 The Agents

The agents in this economy can be defined as a series of collections as follows.

A collection Φ_H of **Households**:

$$\Phi_H = \{h_1, h_2, \ldots, h_a\} \tag{1}$$

Two collections of firms: producers of **Consumption** goods Φ_C and producers of **Capital** goods Phi_K:

$$\Phi_C = \{c_1, c_2, \ldots, c_b\} \tag{2}$$
$$\Phi_K = \{k_1, k_2, \ldots, k_c\} \tag{3}$$

Consumption firms produce an homogeneous consumption good using the labor supplied by Households and capital goods from Capital firms.

Capital firms produce capital goods characterized by the 2-tuple $\{\mu_{k_\tau}, l_{k_\tau}\}$, where k_τ and l_τ are the capital and labor productivity ratio and τ is the given technology for this capital goods. The capital good only difference is the possibility of different productivity rations given an specific technology.

A collection Φ_B of **Banks**:

$$\Phi_B = \{b_1, b_2, \ldots, b_d\} \tag{4}$$

Banks receive deposits from Households and Firms and pay interests (i_{dep}) on these deposits. They also give loans to Households and Firms and receive interest (i_{loa}) on these loans. They receive advances from Central Bank and buy bonds from the government, receiving interest on bonds in return (i_{bon})

Firms and Banks pay dividends to Households for the shares they have in these business $\{\kappa_F, \kappa_B\}$

Households receive Wages from Firms and Government and Unemployment Benefits (from Government) $\{w_f, w_g, w_u\}$

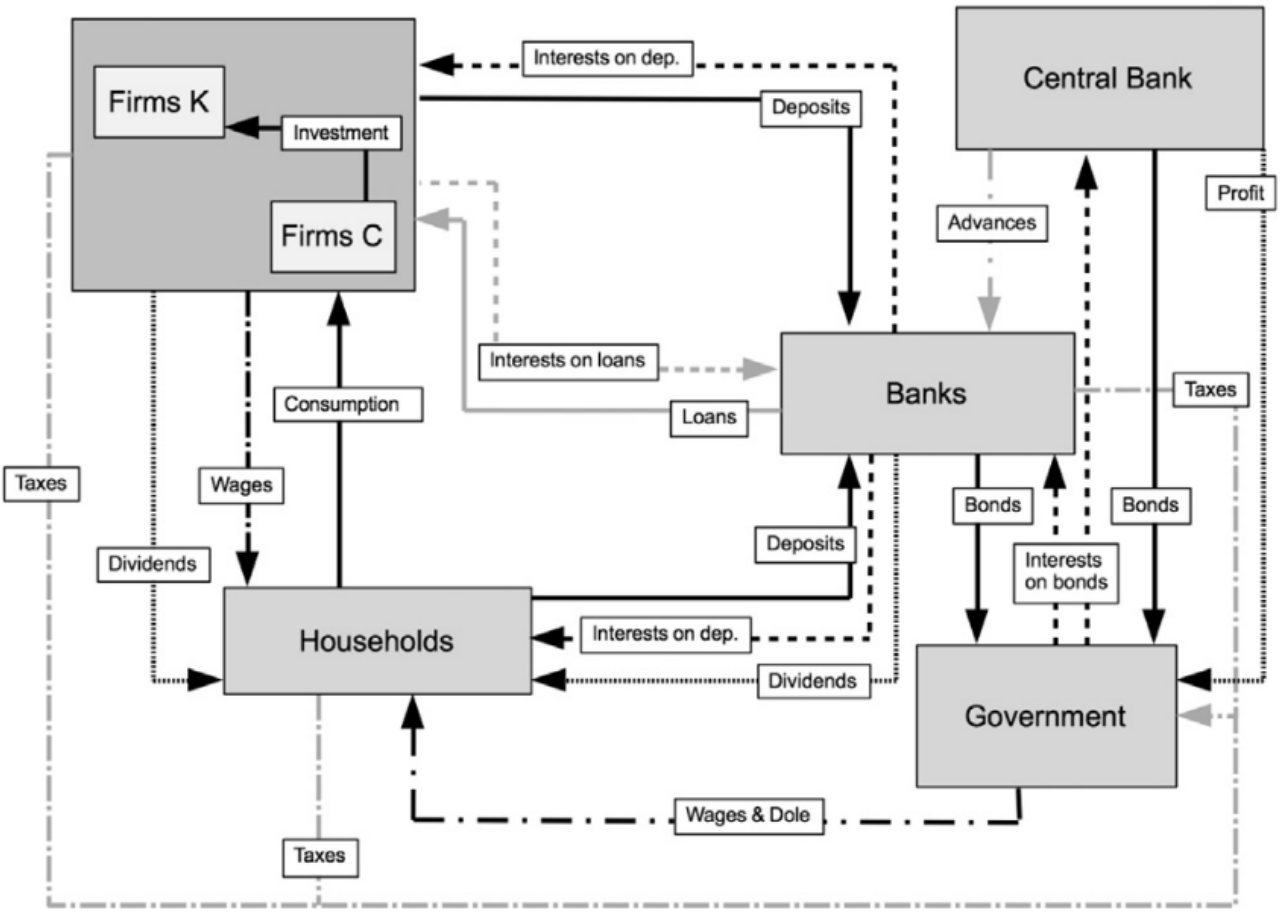

Figure 1: Flow Diagram of the economy (Caiani et al., 2016)

A Government Sector (G) contract workers as a share of the workforce and collects taxes from Firms, Households and Banks $\{t_F, t_H, t_B\}$. Government also issues bonds to cover deficits to the Bank sector and to the Central Bank $\{Bond_F, Bond_{CB}\}$

A Central Bank (CB) that controls the currency (M_1), holds reserve accounts from Banks and Government $\{M_B, M_G\}$, and advances cash to Banks at a fixed discount rate (i_{CB}).

2.3 Markets

In the simulation implementation the markets will be implemented as *Spaces* the markets implemented in Caiani et al. (2016) are:

- A *Consumption Goods* Market (CG_m) that allows the interaction between Households and Consumption Goods Firms ($\Phi_H \times \Phi_C$)
- A *Capital Goods* Market (KG_m) where the Capital and Consumer Goods Firms interact ($\Phi_K \times \Phi_C$)
- A *Labor* Market (L_m) where Households interact with Firms and Government ($\Phi_H \times \{\Phi_C + \Phi_K + G\}$)

- A *Credit* Market (L_m) where Firms interact with Banks ($\Phi_B \times \{\Phi_C + \Phi_K\}$)
- A *Deposits* Market (L_m) where Households and Firms interact with Banks ($\Phi_B \times \{\Phi_C + \Phi_K + \Phi_H\}$)

Following Riccetti et al. (2015), 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 Pr_s which is defined, following Delli Gatti et al. (2010), 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 p_{old} and p_{new}. The shape of this function is governed by the "intensity of choice" parameter $\epsilon > 0$: higher values of $\epsilon > 0$ imply a higher probability of switching.(Caiani et al., 2016, p 382)

2.4 Transactions

Hence, we classify the flows arising in the model as follows:

- ***Deposit transfers**: 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.*
- ***Dividends and deposits interests**: Firms pay dividends through deposit transfers. 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. Otherwise, also a reserve transfer for the dividend amount from the paying bank to the receiver's bank takes place.*
- ***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.*
- ***Taxes**: 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.*
- ***Purchases of bonds, repayment, and interests**: 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.*
- ***Loans creation, repayment, and interests**: 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.*

- ***Cash advances creation, repayment, and interests****: 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.(Caiani et al., 2016, p 382)*

2.5 Sequence of Events

In each period of the simulation, the following sequence of events takes place:

1. ***Production planning****: consumption and capital firms compute their desired output level (**compute_desired_output_level()**).*
2. ***Firms' labor demand****: firms evaluate the number of workers needed to produce.*
3. ***Prices, interest, and Wages****: consumption and capital firms set the price of their output; banks determine the interest rate on loans and deposits. Workers adaptively revise their reservation wages.*
4. ***Investment in capital accumulation****: consumption firms' determine their desired rate of capacity growth and, as a consequence, their real demand for capital goods.*
5. ***Capital goods market** (1): consumption firms choose their capital supplier.*
6. ***Credit demand****: Firms assess their demand for credit and select the lending bank.*
7. ***Credit supply****: Banks evaluate loan requests and supply credit accordingly.*
8. ***Labor market****: unemployed workers interact with firms on the labor market.*
9. ***Production****: capital and consumption firms produce their output.*
10. ***Capital goods market (2)****: consumption firms purchase capital from their supplier. New machineries are employed in the production process starting from the next period.*
11. ***Consumption goods market****: households interact with consumption firms and consume.*
12. ***Interest, bonds and loans repayment****: firms pay interests on loans and repay a (constant) share of each loan principal. The government repays bonds and interest to bonds' holders. Banks pay interest on deposits. Cash advances and related interests, when present, are repaid.*
13. ***Wages and dole****: wages are paid. Unemployed workers receive a dole from the government.*
14. ***Taxes****: taxes on profits and income are paid to the government.*
15. ***Dividends****: dividends are distributed to households.*
16. ***Deposit market interaction****: households an firms select their deposit bank.*
17. ***Bond purchases****: banks and the Central Bank purchase newly issued bonds.*
18. ***Cash Advances****: the Central Bank accommodates cash advances requests by private banks.*

2.6 Agents Behavior

The authors use a series of subscripts to identify the agents variables in the equations. They use c to Consumption Firms, k to Capital Firms h to Households, b to banks and x to variables common to Consumption and Capital Firms.

2.6.1 Expectations

Expectations are formed using a simple scheme for a generic variable z:

$$z^e = z^e_{t-1} + \lambda(z_{t-1} - z^e_{t-1}) \tag{5}$$

2.6.2 Firms

If Firm x wants some **output** in time t, (y^D_{xt}), this will be the **expected sales** in t (s^e_{xt}) plus the **share of sales** (ν) that firms want to have in **inventory** (inv_{xt}).

$$\nu = \frac{inv_{xt}}{s^e_{xt}} \tag{6}$$

$$y^D_{xt} = s^e_{xt} \times (1+\nu) - inv_{xt-1} \; with \; x = \{c, k\} \tag{7}$$

Firms **demand and capacity utilization** are defined as follows:

$$N^D_{kt} = \frac{y^D_{kt}}{\mu_N} \tag{8}$$

$$N^D_{ct} = u^D_{ct}\frac{k_{ct}}{l_k} \tag{9}$$

$$u^D_{ct} = \min\left(1, \frac{y^D_{ct}}{k_{ct}\mu_k}\right) \tag{10}$$

$$\upsilon = \frac{N^D_{xt}}{firing_{xt}} \tag{11}$$

$$firing_{xt} = \frac{N^D_{xt}}{\upsilon} \tag{12}$$

Where:

- N^D_{xt} is the firm labor demmand in time t;
- μ_N is the labor productivity (assumed to be constant and exogenous)
- u^D_{ct} is the capacity utilization for consumer good Firms in t (Capital is produced using only labor)
- k_{ct} is the real capital stock for firm c in time t
- l_k is the capital-labor ratio
- μ_k is the productivity of the capital (assumed constant and exogenous in the model)
- υ is the turnover of firm employees (assumed as a constant and positive rate of the number of workers in the Firm) **Check the formula**

Pricing is determined in this way:

$$p_{xt} = (1 + mu_{xt})\frac{W^E_{xt}N^D_{xt}}{y^D_{xt}} \tag{13}$$

$$mu_{xt} = \begin{cases} mu_{xt-1}(1+FN), \text{if } \frac{inv_{xt-1}}{s_{xt-1}} \leq \nu \\ mu_{xt-1}(1-FN), \text{if } \frac{inv_{xt-1}}{s_{xt-1}} > \nu \end{cases} \tag{14}$$

where:

- p_{xt} is the price of the good for firm x in t
- W^E_{xt} is the average expected wage for x in t
- mu_{xt} is the markup for firm x in t
- when the sales are lower and the inventories increase the firms correct the markup down using a random value from a folded normal distribution (FN) with $\{\mu_{FN}, \sigma^2_{FN}\}$

Consumer Firms profits are:

$$\begin{aligned} \pi_{ct} &= R - C && (15)\\ R &= s_{ct}p_{ct} + i^d_{bt-1}D_{ct-1} + (inv_{ct}uc_{ct} - inv_{ct-1}uc_{ct-1}) && (16)\\ C &= \sum_{n\in n_{ct}} w_{nt} + \sum_{j=t-\eta}^{t-1} i^l_j L_{cj}\frac{\eta - [(t-1)-j]}{\eta} + \sum_{k\in K_{ct-1}} (k^k p^k)\frac{1}{k} && (17) \end{aligned}$$

The total profits of the firm c (π_{ct}) are simply represented by revenues (R) minus costs (C):

- Revenues are composed by:
  - $s_{ct}p_{ct}$ are the total sells revenue where p_{ct} represent the prices of the consumer product
  - i^d_{bt-1} is the amount of interest received by the firms from banks over past period deposits (D_{ct-1})
  - uc_{ct} and $(inv_{ct}uc_{ct} - inv_{ct-1}uc_{ct-1})$ the difference in inventory costs between t and $t-1$. And uc are the unit costs of production
- Total Costs are:
  - w_{nt} is the wage paid to worker n
  - i^l_j is the interest rate paid for the loan L_{cj} for the period j, defined as $j = t-\eta, \ldots, t-1$.
  - p^k is the price of the part of the capital k^k that is in K_{ct-1}.
  - $\eta = k$ is the duration of the capital.

Capital Firms profits are:

$$\begin{aligned} \pi_{kt} &= R - C && (18)\\ R &= s_{kt}p_{kt} + i^d_{bt-1}D_{ct-1} + (inv_{kt}uc_{kt} - inv_{kt-1}uc_{kt-1}) && (19)\\ C &= \sum_{n\in n_{kt}} w_{nt} + \sum_{j=t-\eta}^{t-1} i^l_j L_{kj}\frac{\eta - [(t-1)-j]}{\eta} && (20) \end{aligned}$$

They do not have capital amortization.
Taxes (T_{xt}) and Dividends Div_{xt}:

$$\begin{aligned} T_{xt} &= \max(\tau_\pi \pi_{xt}, 0) && (21)\\ Div_{xt} &= \max(0, \rho_x \pi_{xt}(1-\tau_\pi)) && (22) \end{aligned}$$

- ρ_x is a percentage of profits that is distributed as dividends
- τ_π is the percentage of taxes from profits

Operation Cash Flow (OCF) defined as as after-tax profits plus capital amortization costs (for consumption firms), minus changes inventories and principal repayments. For capital firms, OCF does not have capital amortization:

$$OCF_{ct} = \pi_{ct}(1-\tau_\pi) + \sum_{k \in K_{ct-1}} (k^k p^k)\frac{1}{k} - (inv_{ct}uc_{ct} - inv_{ct-1}uc_{ct-1}) - \sum_{j=t-\eta}^{t-1} L_{cj}\frac{\eta - [(t-1)-j]}{\eta} \tag{23}$$

$$OCF_{kt} = \pi_{kt}(1-\tau_\pi) - (inv_{ct}uc_{ct} - inv_{ct-1}uc_{ct-1}) - \sum_{j=t-\eta}^{t-1} L_{cj}\frac{\eta - [(t-1)-j]}{\eta} \tag{24}$$

> *... an $OCF \geq 0$ implies that the firm is capable of enough generating cash flow to honor the debt service (hedge position). If the OCF is negative, but its absolute value is less than or equal to the principal repayment, the firm is in a speculative position since its cash flows are sufficient to cover the interest due, but the firm must roll over part or all of its debt. Finally, when the OCF is negative and its absolute value is greater than principal payments, the firm is trapped in a Ponzi position. (Caiani et al., 2016, p 384)*

A desired productive capacity growth g_{ct}^D can be defined as follows:

$$g_{ct}^D = \gamma_1 \frac{r_{ct-1} - \overline{r}}{\overline{r}} + \gamma_2 \frac{u_{ct}^D - \overline{u}}{\overline{u}} \tag{25}$$

Depending on past period rate of return (r_{ct-1}) and desired capacity utilization u_{ct}. Folowing, r_ct can be defined as:

$$r_{ct} = \frac{OCF}{\sum_{k \in K_{ct-1}} (k^k p^k)\left(1 - \frac{age_{kt-1}}{k}\right)} \tag{26}$$

Having g_{ct}^D, I_{ct}^D can be determined multipliyng the price of one unity of capital p_{kt} for the number of capital unities required to replace the obsolete capital (**analisar qulitativamente esta parte**)

The Firms finance is organized with imperfect capital markets with high cost for external finances. Because that, firms use external finance only when they do not have enough internal funds over their precautionary reserves (that are maintained based on Firms expectations of revenues and expenses). The demand of credit by consumption firms is:

$$L_{ct}^D = I_{ct}^D + Div_{ct}^e + \sigma W_{ct}^e N_{ct}^D - OCF_{ct}^e \tag{27}$$

For capital firms:

$$L_{kt}^D = Div_{kt}^e + \sigma W_{kt}^e N_{kt}^D - OCF_{kt}^e \tag{28}$$

The Div_{ct}^e are the expected dividends based on expected profits.

Capital firms do not have the investment part (I^e)

2.6.3 Banks

Credit is a consequence of the banks decision about which Firm can have a loan based on the risk of default. *"..., firms will generally have a collection of heterogeneous loans with different banks. Firms' possibility to obtain a loan depend on the credit rationing mechanism employed by banks to evaluate loans request"* (Caiani et al., 2016, p 385).

Banks' credit supply in the model is so based on the following three pillars:

- *Active management of banks' balance sheet through endogenously evolving capital ratio targets and interest rate management strategy.*
- *Case-by-case quantity rationing based on applicants' probability of default and the ensuing loan project expected rate of return.*
- *Credit worthiness based on operating cash flows and collateral value (Caiani et al., 2016).*

Banks capital ratio can be defined by:

$$CR_{bt} = \frac{NW_{bt}}{L_{bt}^{tot}} \tag{29}$$

The interest rates for each bank will depend on the relationship of the target capital ratio (CR_{bt}^{T})[1] and the observed capital ratio (CR_{bt}). So the interest rates on loans will be higher if the banks have the capital ratio below the target and lower otherwise.

$$i_{bt}^{l} = \begin{cases} \bar{i}_{bt-1}^{l}(1+FN), \text{if } CR_{bt} < CR_{t}^{T} \\ \bar{i}_{bt-1}^{l}(1-FN), \text{if } CR_{bt} \geq CR_{t}^{T} \end{cases} \tag{30}$$

Where $\bar{i}_{bt}^{l}$ is the marketing average interest rate in the prior period and FN is a random value from a folded normal distribution with $\{\mu_{FN}, \sigma_{FN}^{2}\}$. Defined as:

$$\bar{i}_{bt}^{l} = \frac{\sum_{b \in \Phi_B} i_{bt-1}^{l}}{size_{\Phi_B}} \tag{31}$$

Debt service to loan is defined as:

$$ds^{L^d} = \left(i_{bt}^{l} + \frac{1}{\eta}\right) L^{d} \tag{32}$$

The loans are defined by default in the model implemented by the authors with 20 periods.

The probability of default is defined as the percentage of the difference between the borrower OCF and the debt service (ds^{L^d}).

$$pr_{x}^{D} = \frac{1}{1 + \exp\left(\frac{OCR_{xt} - \zeta_x ds^{L^d}}{ds^{L^d}}\right)} \tag{33}$$

ζ_x is the risk aversion of the banks to each type of Firm (Consumer and Capital).

δ_x is a part of the loan that banks expect to recover in case of a default ($\delta_x \leq 1$).

Knowing $L^d, i_{bt}^{l}, pr_{x}^{D}, \delta_x$, banks compute the overall expected return of a credit project by summing the payoffs arising from each possible outcome of the decision to grant the loan, each one weighted for its probability of occurrence.

Banks set their interest rates on deposits in a competitive way.

[1] With a mandatory low bound of 0.06 (6%).

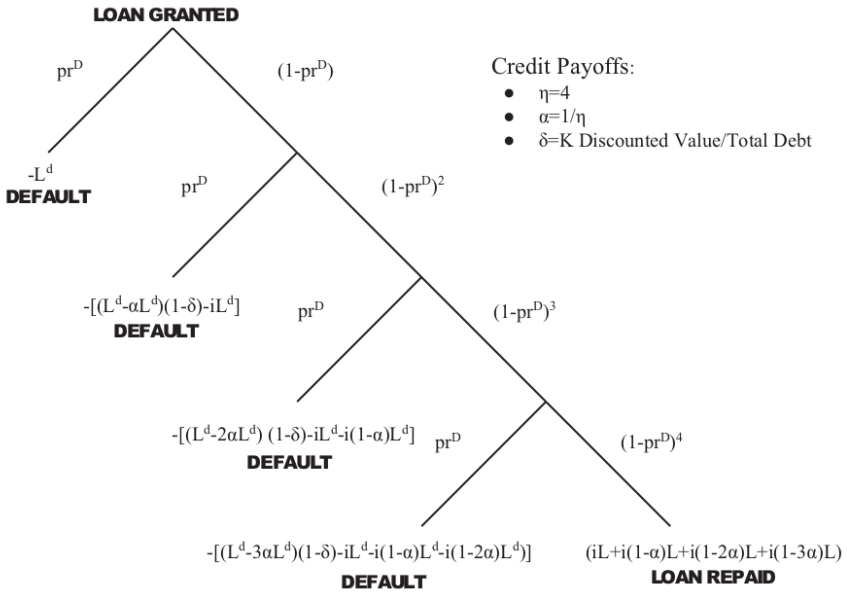

Figure 2: Probability of Default on loans (Caiani et al., 2016)

$$i_{bt}^{d} = \begin{cases} \bar{i}_{bt-1}^{d}(1+FN), \text{if } LR_{bt} < LR_{t}^{T} \\ \bar{i}_{bt-1}^{d}(1-FN), \text{if } LR_{bt} \geq LR_{t}^{T} \end{cases} \tag{34}$$

When Firms go bankrupt the unpaid loans increase the exposure of the Banks. Capital Firms impact more since they do not have any collateral.

2.6.4 Households

Workers follow an adaptive heuristic to set their reservation wage: if over the year (i.e., four periods), they have been unemployed for more than two quarters, they lower the asked wage by a stochastic amount. In the opposite case, they increase their asked wage, provided that the aggregate rate of unemployment in the previous period (u_{t-1}) is sufficiently low. This latter condition is meant to mimic the endogenous evolution of workers' bargaining power in relation to employment dynamics:(Caiani et al., 2016)

$$w_{ht}^{d} = \begin{cases} w_{ht-1}^{d}(1-FN), \text{if } \sum_{n=1}^{4} u_{ht-n} > 2 \\ w_{ht-1}^{d}(1+FN), \text{if } \sum_{n=1}^{4} u_{ht-n} > 2 \wedge u_{t-1} \leq v \end{cases} \tag{35}$$

where $u_{ht} = 1$ if h is unemployed in t, and 0 otherwise.

Workers formulate expectations (Equation 5) on consumer good prices (p_{ht}^{e}) and establish their demand based on their income and consumption propensities.

$$c_{ht}^{D} = \alpha_1 \frac{NI_{ht}}{p_{ht}^{e}} + \alpha_2 \frac{NW_{ht}}{p_{ht}^{e}} \tag{36}$$

And the gross nominal income (y_h) is defined as:

$$y_h = w_{ht} + i^D_{bt-1} D_{ht-1} + Div_{ht} \tag{37}$$

2.6.5 Government and Central Bank

Government contracts a constant share of the workforce (subject to a turnover ϑ) and pays unemployment benefits (U_t). Government collects taxes from households (τ_h), firms and banks (τ_π) and issues bonds at fixed prices ($\overline{p}^b$) interests ($\bar{i}^b$). Government income from taxes is defined as the total amount earned from the total of each class of agent ($Tt = T_{Ht} + T_{Kt} + T_{Ct} + T_{Bt}$). Other part of the government revenues are the Central Bank bonds. These bonds are from the interest rates and cash advances to Banks ($\pi_{CBt} = \bar{i}^b B_{t-1} + \bar{i}^a CA_{cbt}$).

$$\overline{p}^b \Delta b_t = T_t + \sum_{n \in N_{gt}} W_n - U_t d_t - \bar{i}^p b_{t-1} \tag{38}$$

Central Bank pays no interest on reserve accounts.

3 Model Implementation

3.1 Agents

- *Households* - The households
- *CG_Firms* - Consumer Goods Firms
- *KG_Firms* - Capital Goods Firms
- *Banks*
- *Government*
- *Central_Bank*

3.1.1 Agent's variables

Households

Name	Type	Distribution	Initial values	unity	Description
employed	boolean	binary	F	n.a.	boolean informing if the HH is employed
demand	numeric	Normal	tbd	qt	Demand for consumption goods
consumption	numeric	Normal (ass)	tbd	qt	goods consumed
consumption_expected	numeric	Normal (ass)	tbd	qt	expected consumption of goods
workforce	numeric	Normal	1	qt	workers in the HH (always 1)
total_cash	numeric	Normal (ass)	tbd	$	total cash the HH have
deposits_cash	numeric	Normal (ass)	tbd	$	total deposits (cash) the HH have

CG_Firms

Name	Type	Distribution	Initial values	unity	Description
desired_output_cg	numeric	Normal (≥ 0)	tbd	qt	Desired output for the Firm
output_cg	numeric	Normal (≥ 0)	tbd	qt	Real output of the firm
labor_to_contract	numeric	Normal (≥ 0)	tbd	qt	CG Firm desired labor
labor_contracted	numeric	Normal (≥ 0)	tbd	qt	CG Firm contracted labor
unitary_cost	numeric	Normal (≥ 0)	tbd	qt	CG Firm unitary production c
price_cg	numeric	Normal (≥ 0)	tbd	$	price of CG
deposits_cash	numeric	Normal (ass)	tbd	$	total deposits (cash) the HH h
desired_perc_inv	numeric	Normal ($0 \geq 1$)	tbd	%	Expected percentage of invent
perc_inv	numeric	Normal ($0 \geq 1$)	tbd	%	Expected percentage of invent
mark_up	numeric	Normal ($0 \geq 1$)	tbd	%	CG mark up
Alencar et al. (2004) inventory_cg	goods	n.a.	tbd	qt	The firm inventory of goods

KG_Firms
Banks
Government
Central_Bank

3.2 Spaces

- *Labor_market* - The Labor Market
- *CG_market* - The Consumer Goods Market
- *KG_market* - The Capital Goods Market
- *Credit_market* - The Credit Market
- *Deposits_market* - The Deposits Market

3.3 Actions

3.3.1 Common Actions

- *form_expectations* - all agents form expectations to their variables of interest. See equation 5
- *bid* - the agent offer to buy a good or service
- *pay*

3.4 Agent's steps

Each step will represent a week. The agents production interval will be 4 weeks A quarter will be 12 weeks (12 steps)

The agents steps are as follows:

- ***CG_Firms***
    1. *production*
        (a) *compute_desired_output*
        (b) repeat_until_all_labor_is_contracted
            i. *bid_labor_demand (working_hours, hourly_wage)*

        ii. *contract_labor*
    (c) *compute_production_price*
    (d) *produce*
    (e) repeat_until_production_time_ends
        i. *offer_production*
        ii. *sell_production*
2. *compute_sells_revenue*
3. *decide_investment*
4. *contract_credit*
5. *buy_equipment*
6. *pay_salaries*
7. *pay_suppliers*
8. *pay_interest_bonds_and_loans*
9. *pay_taxes*

- ***KG_Firms***

1. *production*
    (a) *compute_desired_output*
    (b) repeat_until_all_labor_is_contracted
        i. *bid_labor_demand (working_hours, hourly_wage)*
        ii. *contract_labor*
    (c) *compute_production_price*
    (d) *produce*
    (e) repeat_until_production_time_ends
        i. *offer_production*
        ii. *sell_production*
2. *compute_sells_revenue*
3. *contract_credit*
4. *pay_salaries*
5. *pay_interest_bonds_and_loans*
6. *pay_taxes*

- ***Banks***

1. *decide_capital_ratio_target*
2. *decide_interest_rate_strategy*
3. repeat_until_period_ends
    (a) *offer_credit*
    (b) *contract_credit*
4. *calculate_exposure*
5. *receive_advances_from_central_bank*

6. *buy_government_bonds*
7. *pay_taxes*

- ***Households***

1. repeat_until_period_ends_or_employed
   (a) *decide_hourly_wage_bid*
   (b) *offer_workforce*
2. *formulate_price_expectations*
3. *calculate_income*
4. *establish_demand*
5. *buy_goods*
6. *pay_taxes*

- ***Government***

1. *calculate_available_resources*
2. *contract_employees*
3. *pay_unemployment_benefits*
4. *pay_wages*
5. *pay_bonds_and_interest*
6. *offer_new_bonds*

- ***Central_Bank***

1. *decide_monetary_policy*
2. *contract_cash_advances*
3. *buy_government_bonds*
4. *transfer_profits_to_government*

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