

Firm Behavior Under Uncertainty, Endogenous Sentiments, and Macroeconomic Fluctuations

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1 Problem Definition

In 1921, both Frank Knight (1921) in *Risk, Uncertainty, and Profit* and Keynes (1921) in *A Treatise on Probability* distinguished the concepts of risk and uncertainty. According to Knight, this distinction is essential because uncertainty brings profit opportunities that would not exist in situations where probability distributions can be assigned (Rakow (2010)). Keynes (1936) argues that it is not possible to represent future outcomes with a probability distribution because an exhaustive list of possible outcomes cannot be known (Dimand (2021)).

In the presence of uncertainty, sentiments play an important role in the decisions of economic agents. Due to the unknowability of the future, Keynes (1936) suggests that rational calculation can only partially justify the decisions and actions of economic agents (Marchionatti (1999)). Instead of objective calculations and optimization, economic agents form their expectations by extrapolation and then complement them with what he calls "animal spirits" (Geiger (2016)).

As firms operate in a complex environment, uncertainty is present at all stages of the production process. Minsky (2008) argue that investors arrange their asset and liability structures to protect themselves against unfavorable events. Indeed, firms use buffering mechanisms to absorb the effects of uncertainties that might disrupt the production process. These buffers may take different forms depending on the type of uncertainty they are designed to address. Firms hold capacity buffers against uncertainties such as machine breakdowns, discontinuities in capacity adjustment, or variability in the amount and composition of demand (Caputo (1996)). Firms also maintain inventories of raw materials, semi-finished goods, and finished goods proportional to their sales (Polak and Tinbergen (2004)). Additionally, firms hold liquid assets as a buffer stock against unexpected declines in cash flow, particularly when they have fixed commitments such as loan payments (Baum, Caglayan, Ozkan, and Talavera (2006)). Apart from buffers on the asset side, firms hold retained earnings on the liability side to keep the company afloat and ensure regular dividend payments in case of unexpected declines in profits (Cyert, Kang, and Kumar (1996)).

This study aims to investigate the interactions between real-sector sentiment and aggregate demand through firms' decisions on the buffer stocks they hold against uncertainty. In the model, there will be three groups of agents: households, firms, and banks. In order to focus on the dynamics resulting from firm behavior, the behaviors of households and banks will be simplified.

Households have a wealth target, which is a certain multiple of their standard of living. To reach this target over a specified period, they save part of their income and spend the rest on consumption. The only asset is bank deposits, and the only good consumed is produced by firms in the economy. We assume there is a minimum level of consumption, referred to as "necessities." If households' remaining income after savings falls below this amount, they demand loans from banks.

On the other hand, banks extend loans demanded by households and firms and issue bank deposits. Bank loans are assumed to be amortized, with a certain fraction paid over a specified time period, with

interest charged on the remaining principal. Banks also pay interest on bank deposits and distribute all their profits to households. Interest rates are assumed to be fixed.

Firms produce a homogeneous nondurable final good using capital and labor as the only inputs, combined in fixed proportions according to a Leontief-type production function. The price of the product and the wage rate are assumed to be fixed. Since the unit cost of firms is constant due to the assumption about the production function, firm profits move in parallel with aggregate demand. Firms distribute some part of their profits to households. Firms hold cash in the form of bank deposits to make payments. They also take out loans as liabilities, which they use to finance their entire capital stock. Firms hold excess capital stock, excess product inventories, excess liquid assets, and retained profits as buffers against uncertainties in the production process. The level of these buffer stocks is a function of the sentiment index. In turn, the sentiment index is endogenous -assumed to be a positive function of the growth rate and a negative function of the volatility of aggregate demand that firms encounter.

Level of Aggregation: This study is aimed at an academic audience. The level of aggregation is determined by the Stock-Flow-Consistent (SFC) framework pioneered by Godley and Lavoie (2006). In the SFC framework, each agent in an economy is represented by a balance sheet. Fund and good flows between agents are recorded according to accounting principles.

Sources of Inertia: Firm capital stock, firm inventories, firm liabilities, firm cash stock, and real-sector sentiment.

Reference Mode: Both aggregate income and real-sector sentiment are expected to exhibit oscillations for a reasonable set of parameter values. Furthermore, the sensitivity parameters of the real-sector sentiment index are expected to have significant impacts on the dynamic behaviors of these two variables.

2 Dynamic Hypothesis

The dynamic hypothesis is given in Figure 1.

3 Model Documentation

There are three groups of agents in the model: households (h), firms (f), and banks (b). In order to focus on the dynamics resulting from firm behavior, the behaviors of households and banks are simplified. Furthermore, the price mechanism is excluded from the model. The price level is normalized to 1, therefore, nominal and real quantities are equal to each other (Equation 1).

$$p = 1 \tag{1}$$

Price variables are kept in the model to preserve unit consistency, but not included in the model documentation below in order to avoid further complication.

Stocks are denoted with boldface font, while flows and constants are denoted with normal font (in terms of Stock-Flow-Consistent Framework)

3.1 Firms

Firms produce a homogenous good, demanded by households for consumption (C) and firms for investment (I). The aggregate demand (AD) is equal to the sum of consumption and investment expenditures (Equation 2).

$$AD = C + I \tag{2}$$

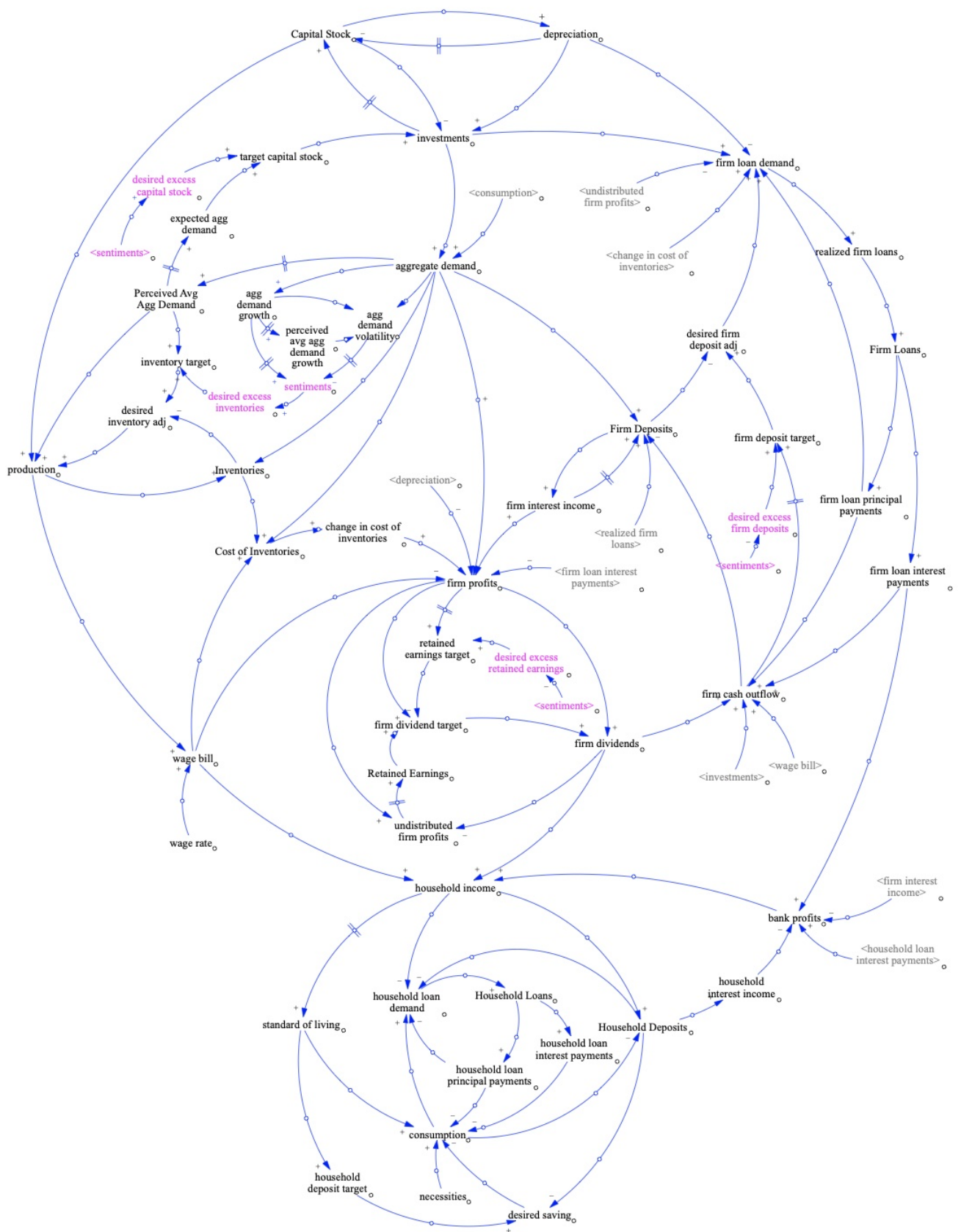


Figure 1: Dynamic Hypothesis

Firms base their production decisions on their perceived average aggregate demand ($\overline{AD}$), which adjusts to actual aggregate demand with a partial adjustment process over a period of T_1 (Equation 3).

$$\frac{d}{dt}\overline{AD} = \frac{1}{T_1} (AD - \overline{AD}) \quad (3)$$

Firms' perceived growth rate (g) is assumed to be equal to the rate of deviance of aggregate demand from the perceived average aggregate demand (Equation 4). The expected growth rate of the perceived average aggregate demand ($\bar{g}$) equals the perceived growth rate of the perceived average aggregate demand, which is updated with a partial adjustment process (Equations 5 and 6).

$$g = \frac{AD}{\overline{AD}} - 1 \quad (4)$$

$$\frac{d}{dt}\bar{g} = \frac{1}{T} (g - \bar{g}) \quad (5)$$

$$E[\overline{AD}] = (1 + \bar{g}) \overline{AD} \quad (6)$$

Firms also observe the volatility of the growth rate of aggregate demand, which is calculated as the squared deviance of realizations from its perceived average and updated with a partial adjustment process as in Eq.7.

$$\sigma = \left[\frac{1}{T_1} (g - \bar{g})^2 \right]^{1/2} \quad (7)$$

'Sentiments' indicate the optimism of entrepreneurs and firm managers about the future of the economy. Here, we assume that the sentiments is a positive function of the perceived growth rate of aggregate demand, and a negative function of its volatility. Sentiments is measured with the Sentiment Index (SI), which is assumed to be an S-shaped logistic function of the expected level and volatility of disposable income growth rate (Eq.8), taking values between 0 and 2, with a normal value of 1.

$$SI = \frac{2}{1 + e^{-\gamma_1[(1+\bar{g})^{\gamma_2}(1+(\bar{\sigma}-\sigma))^{\gamma_3}-1]}} \quad (8)$$

Here, the parameter ($\bar{\sigma} \geq 0$) is the normal level of the perceived volatility of firms' perceived average growth rate of aggregate demand and measures the volatility of aggregate demand that firms deem 'normal.' The parameter $\gamma_1 \geq 0$ determines the steepness of the SI function and $\gamma_2 \geq 0$ and $\gamma_3 \geq 0$ are the sensitivity parameters to the level and volatility of the perceived growth rate of aggregate demand.

Firms target holding a multiple of the perceived average aggregate demand in inventories (Equation 9).

$$\widehat{in} = (1 + \iota) \overline{AD} \quad (9)$$

Here, ι is the excess inventory target coefficient, which indicates how much excess inventories firms want to hold as a buffer due to the inability to predict aggregate demand with precision in the presence of uncertainty. Since firms would expect the aggregate demand to be higher when they are more optimistic about the future, they would be willing to hold more inventories. Therefore, ι is a positive function of the sentiment index (SI) (Equation 10).

$$\iota = \bar{\iota}(SI)^{\gamma_4} \quad (10)$$

Here, $\iota \geq 0$ is the normal level of excess inventory target coefficient when sentiment index equals 1, and $\gamma_4 \geq 0$ is the sensitivity parameter. Firms want to reach their inventory target over a period of T_2 . Therefore, firms' desired production ($\widetilde{PD}$) equals the perceived average aggregate demand plus the inventory adjustment (Equation 11).

$$\widetilde{PD} = \overline{AD} + \frac{1}{T_2} (\widehat{in} - in) \quad (11)$$

Firms use capital ($\mathbf{K}$) and labor (L) as inputs in the production process. These inputs are assumed to be complementary so that the aggregate production technology can be represented with a Leontief production function (Equation 12).

$$f[PD] = \min[\alpha \mathbf{K}, \beta L] \quad (12)$$

Here, $\alpha > 0$ is the productivity of capital and $\beta > 0$ is the productivity of labor.

Labor supply is assumed to be infinitely elastic at the current wage rate, w , which is exogenous to the model. On the other hand, firms cannot change the amount of capital they have immediately; it is fixed for the current period. Therefore, the amount of capital determines the firms' production capacity (Equation 13).

$$PD = \min \left[\frac{\mathbf{K}}{\alpha}, \widetilde{PD} \right] \quad (13)$$

Firms hire the amount of labor just enough to produce the planned production, and wage bill (WB) is the total amount paid to the labor hired (Equations 14 and 15).

$$L = \frac{\widetilde{PD}}{\beta} \quad (14)$$

$$WB = wL \quad (15)$$

The change in inventories is equal to the difference between the aggregate demand and production level (Equation 16).

$$\frac{d}{dt} in = PD - AD \quad (16)$$

Inventories are recorded with their costs on the balance sheet (Godley and Lavoie (2006)). The change in the cost of inventories is equal to the difference between wage bill paid for production in the current period and the cost of goods sold (Equation 17).

$$\frac{d}{dt} \mathbf{IN} = wPD - \frac{\mathbf{IN}}{in} AD \quad (17)$$

Firms target holding enough capital to meet the expected aggregate demand; therefore, they invest in capital. Due to uncertainty in aggregate demand, firms hold an excess amount of capital in order to create some excess capacity (Equations 18 and 19).

$$\widehat{\mathbf{K}} = \frac{(1 + \epsilon)}{\alpha} E[\overline{AD}] \quad (18)$$

$$\epsilon = \bar{\epsilon} (SI)^{\gamma_4} \quad (19)$$

Here, ϵ is the excess capital coefficient; $\bar{\epsilon} \geq 0$ is the normal level of excess capital coefficient when the sentiment index is equal to 1, and $\gamma_4 \geq 0$ is the sensitivity parameter. Firms want to invest in

capital ($\tilde{I}$) to reach the capital target over a period of T_3 , in addition to replacing the depreciated capital (Equation 20).

$$\tilde{I} = \frac{1}{T_3} (\widehat{\mathbf{K}} - \mathbf{K}) + \delta \mathbf{K} \quad (20)$$

Here, $\delta > 0$ is the depreciation rate of capital.

As the price of the product is normalized to 1, firms' revenues from sales are equal to the aggregate demand. In addition to sales revenues, firms receive interest income on their deposits from banks. On the other hand, the cost of products sold equals the wage bill minus the change in inventories (Godley and Lavoie (2006)). Amortization and interest paid on loans are other costs of the firm. Firms' profit (π) is the difference between their revenues and costs (Equation 21).

$$\pi = [AD + r^{dp} \mathbf{D} \mathbf{P}_f] - \left[\left(WB - \frac{d}{dt} \mathbf{I} \mathbf{N} \right) + \delta \mathbf{K} + r^{ln} \mathbf{L} \mathbf{N}^f \right] \quad (21)$$

Firms want to retain some of their earnings against rainy days. Firms target holding a multiple of their perceived average profits ($\bar{\pi}$), which adjusts to actual profits with a partial adjustment mechanism over a period of T_4 (Equation 22 and 23).

$$\frac{d}{dt} \bar{\pi} = \frac{1}{T_4} (\pi - \bar{\pi}) \quad (22)$$

$$\widehat{\mathbf{R} \mathbf{E}} = \rho \bar{\pi} \quad (23)$$

Here, ρ is the retained earnings target coefficient. Firms would want to hold more retained earnings when their expectations about the future state of the economy deteriorate. Therefore, this coefficient is a negative function of the sentiment index (Equation 24).

$$\rho = \bar{\rho} (SI)^{-\gamma_4} \quad (24)$$

Here, $\bar{\rho} \geq 0$ is the normal retained earnings target coefficient when the sentiment index is equal to 1, and $\gamma_4 \geq 0$ is the sensitivity parameter. Firms desire to reach this retained earnings target over a period of T_4 .

On the other hand, they also want to stabilize the dividends they distribute over time (Lintner (1956), Dobrovolsky (1958)). Therefore, the desired dividends ($\widetilde{DV}^f$) reach target dividend ($\widehat{DV}^f$) over a period of T_4 (Equation 25 and 26). If the current level of profits is below the target level of dividend, they can use retained earnings. However, realized dividends (DV^f) cannot exceed the sum of the actual level of retained earnings and profits (Equation 27).

$$\widehat{DV}^f = \max \left[\bar{\pi} - \frac{1}{T_4} (\widehat{\mathbf{R} \mathbf{E}} - \mathbf{R} \mathbf{E}), 0 \right] \quad (25)$$

$$\frac{d}{dt} \widetilde{DV}^f = \frac{1}{T_4} (\widehat{DV}^f - \widetilde{DV}^f) \quad (26)$$

$$DV^f = \min \left[\max (\mathbf{R} \mathbf{E} + \pi, 0), \widetilde{DV}^f \right] \quad (27)$$

Then, undistributed profits (UP^f), which are also equal to the change in the retained earnings, equal the difference between actual profits and realized dividends (Equation 28).

$$UP^f = \frac{d}{dt} \mathbf{R} \mathbf{E} = \pi - DV^f \quad (28)$$

Wage bill, dividends, investment, and principal and interest payments on their outstanding loans (LP^f) constitute the total cash outflow of firms (Equation 29).

$$CO^f = WB + DV^f + LP^f + I \quad (29)$$

Due to uncertainties, firms want to hold some cash in their bank deposits. Firms target holding a multiple of their perceived average cash outflow, which adjusts to the actual cash outflow with a partial adjustment mechanism over a period of T_5 (Equations 30 and 31).

$$\frac{d}{dt}\overline{CO}^f = \frac{1}{T_5} \left(CO^f - \overline{CO}^f \right) \quad (30)$$

$$\widehat{DP}_f = (1 + \lambda) \overline{CO}^f \quad (31)$$

Here, λ is the firm excess deposit target coefficient. Firms would want to hold more in bank deposits when their expectations about the future state of the economy deteriorate. Therefore, λ is a negative function of the sentiment index (Equation 32).

$$\lambda = \bar{\lambda} (SI)^{-\gamma_4} \quad (32)$$

Here, $\bar{\lambda} \geq 0$ is the normal firm excess deposit target coefficient when the sentiment index is equal to 1, and $\gamma_4 \geq 0$ is the sensitivity parameter. Firms want to adjust the level of their bank deposits to the target level ($\widehat{DC}_f$) over a period of T_5 (Equation 33).

$$\widehat{DC}_f = \frac{1}{T_5} \left(\widehat{DP}_f - DP_f \right) \quad (33)$$

Firms demand loans from banks (LD^f) equal to the difference between cash outflows and cash inflows, in case this difference is positive (Equation 34).

$$LD^f = \left[I + \frac{d}{dt}IN + \widehat{DC}_f + \phi LN^f \right] - \left[\delta K + UP^f \right] \quad (34)$$

Firms' equity is equal to the sum of a fixed paid-up capital (PC^f) and retained earnings (Equation 35).

$$EQ^f = PC^f + RE^f \quad (35)$$

Firms' leverage (LV) is calculated as the ratio of liabilities to equity (Equation 36).

$$LV = \frac{LN^f + EQ^f}{EQ^f} \quad (36)$$

Firms' return on equity (ROE) is calculated as the ratio of firm profits to equity (Equation 37).

$$ROE = \frac{\pi^f}{EQ^f} \quad (37)$$

Finally, firms' return on assets (ROA), is calculated as the ratio of firm profits to their assets (Equation 38).

$$ROA = \frac{\pi^f}{K + IN + DP_f} \quad (38)$$

3.2 Households

Households receive wages (WB^f) from firms and interest income on their deposits from banks. As they own firms and banks, their profits accrue to households in the form of dividends (DV^f, DV^b). (Equation 39)

$$Y_h = WB^f + DV_f + DV_b + r^{db} \mathbf{DP}_h \quad (39)$$

As the government is excluded from the model, there is no tax, and household disposable income equals their income (Equation 40).

$$YD_h = Y_h \quad (40)$$

Households' behaviors are based on their standard of living. The standard of living is assumed to be determined by their perceived average disposable income ($\overline{YD}_h$), which adjusts to their actual disposable income with a partial adjustment mechanism over a period of T_6 (Equation 41).

$$\frac{d}{dt} \overline{YD}_h = \frac{1}{T_6} (YD_h - \overline{YD}_h) \quad (41)$$

Households target holding a multiple (ϖ) of their standard of living as their wealth (Equation 42). Households are assumed to preserve their wealth only in the form of bank deposits (Equation 43).

$$\widehat{\mathbf{W}}_h = \varpi \overline{YD}_h \quad (42)$$

$$\widehat{\mathbf{W}}_h = \widehat{\mathbf{DP}}_h \quad (43)$$

Households desire to save ($\tilde{S}$) out of their disposable income to close the gap between their target and actual levels of bank deposits over a period of T_6 (Equation 44).

$$\hat{S} = \frac{1}{T_6} (\widehat{\mathbf{DP}}_h - \mathbf{DP}_h) \quad (44)$$

Households also have to make payments on their loans (LP^h). Consumption demand (C) equals the perceived average disposable income remaining after desired saving and loan payments. However, a minimum amount of consumption for survival is assumed to be necessary for households. These are called necessities (CN), and consumption demand cannot be less than this amount (Equation 45).

$$C = \max \left[\left(\overline{YD}_h - \tilde{S} - LP^h \right), CN \right] \quad (45)$$

Households' total spending (TS^h) equals the sum of consumption and loan payments (Equation 46).

$$TS^h = C + LP^h \quad (46)$$

Realized saving (S) is the difference between household disposable income and total spending (Equation 47).

$$S = \overline{YD}_h - TS^h \quad (47)$$

Households are assumed to be willing to pay their debt as soon as possible. Hence, if realized savings is positive, households first repay their loans and deposit the remaining amount, if any. If realized saving is negative, households first use their deposits for expenditures. In case their deposits are not sufficient, they demand consumer loans from banks for the remaining amount (Equation 48).

$$LD = \begin{cases} \min [S, (1 - \varphi) \mathbf{LN}^h] & , \text{if } S > 0 \\ \min [(S + \mathbf{DP}_h), 0] & , \text{otherwise} \end{cases} \quad (48)$$

3.3 Banks

Banks issue deposits to households and firms and extend loans to them. Banks are assumed to grant all the loans demanded by households and firms (Equation 49).

$$LR_b = LD_f + LD_h \quad (49)$$

Bank loans are amortized loans. A fixed fraction (φ) of the outstanding loans is paid back (Equation 50). Total loan payments due equals the sum of principal payments due and interest payments due (Equations 51 and 52).

$$\widetilde{PP} = \varphi \mathbf{LN} \quad (50)$$

$$\widetilde{IP} = r^{ln} \mathbf{LN} \quad (51)$$

$$\widetilde{LP} = \widetilde{PP} + \widetilde{IP} \quad (52)$$

Here, $\varphi > 0$ is the loan principal payment rate, and r^{ln} is the loan interest rate. The deposit interest rate is assumed to be exogenous to the model, and banks determine the loan interest rate with a markup over the deposit interest rate (Equation 53).

$$r^{ln} = (1 + \mu) r^{dp} \quad (53)$$

Banks collect loan payments and pay interest on deposits. Banks' profits are equal to the difference between loan interest payments and deposit interest payments. As banks are owned by households, they distribute all the profits to households in the form of dividends (Equation 54).

$$DV^b = r^{ln} (\mathbf{LN}^f + \mathbf{LN}^h) - r^{dp} (\mathbf{DP}_f + \mathbf{DP}_h) \quad (54)$$

4 Dynamic Equilibrium Solution

The dynamic equilibrium is the state in which all stocks and flows in the economy are constant.

First, the dynamic equilibrium conditions for the presence of uncertainty case are solved, then the dynamic equilibrium conditions for the perfect information case are derived as a special case of the former.

In what follows, the dynamic equilibrium values of variables are indicated with a single star superscript in the presence of uncertainty case and with a double star superscript in the perfect information case.

4.1 Under Uncertainty

Perceived Average Aggregate Demand is Constant

$$\frac{d}{dt} \overline{AD} = 0$$

$$\Rightarrow AD^* = \overline{AD}^* = E[AD^*]$$

Inventories is Constant and Equal to Its Target Level

$$\frac{d}{dt}in = 0$$

$$\Rightarrow in^* = \widehat{in}^* \Rightarrow in^* = (1 + \iota) \overline{AD}^*$$

$$\Rightarrow AD^* = PD^* \Rightarrow PD^* = \overline{AD}^*$$

Cost of Inventories is Constant

$$\frac{d}{dt}IN^* = 0$$

$$\Rightarrow IN^* = w \frac{\widehat{in}^*}{\beta} \Rightarrow IN^* = \frac{w(1 + \iota)}{\beta} \overline{AD}^*$$

Firm Capital Stock is Constant and Equal to Its Target Level

$$\frac{d}{dt}K = 0$$

$$\Rightarrow K^* = \widehat{K}^* \Rightarrow K^* = \frac{(1 + \epsilon)}{\alpha} E \left[\overline{AD}^* \right] \Rightarrow K^* = \frac{(1 + \epsilon)}{\alpha} \overline{AD}^*$$

$$I^* = \delta K^* \Rightarrow I^* = \frac{\delta(1 + \epsilon)}{\alpha} \overline{AD}^*$$

Firm Loans is Constant

$$\frac{d}{dt}LN^f = 0$$

$$\Rightarrow LR^{f*} = PP^{f*} \Rightarrow I^* = \varphi LN^{f*} \Rightarrow \frac{\delta(1 + \epsilon)}{\alpha} \overline{AD}^* = \varphi LN^{f*} \Rightarrow LN^{f*} = \frac{\delta(1 + \epsilon)}{\alpha \varphi} \overline{AD}^*$$

Firms' Perceived Average Cash Outflow is Constant

$$\frac{d}{dt}\overline{CO}^f = 0$$

$$\Rightarrow \overline{CO}^{f*} = CO^{f*} \Rightarrow \overline{CO}^{f*} = WB^* + DV^{f*} + LP^{f*} + I^*$$

$$\Rightarrow \overline{CO}^{f*} = WB^* + \pi^* + (\varphi + r^{ln}) LN^{f*} + I^*$$

$$\Rightarrow \overline{CO}^{f*} = \frac{wPD^*}{\alpha} + \left(\overline{AD}^* + r^d DP_f^* - \frac{wPD^*}{\alpha} - \delta K^* - r^{ln} LN^{f*} \right) + (\varphi + r^{ln}) LN^{f*} + \delta K^*$$

$$\Rightarrow \overline{CO}^{f*} = \overline{AD}^* + r^d DP_f^* + \varphi LN^{f*}$$

Firm Deposits is Constant and Equal to Its Target Level

$$\begin{aligned}
\frac{d}{dt} \mathbf{DP}_f^* &= 0 \\
\Rightarrow CI_f^* &= CO_f^* \Rightarrow \overline{AD}^* + r^{dp} \mathbf{DP}_f^* + LR_f^* = \overline{AD}^* + r^d \mathbf{DP}_f^* + \varphi \mathbf{LN}_f^* \\
\Rightarrow r^{dp} \mathbf{DP}_f^* + \frac{\delta(1+\epsilon)}{\alpha} \overline{AD}^* &= r^d \mathbf{DP}_f^* + \varphi \frac{\delta(1+\epsilon)}{\alpha\varphi} \overline{AD}^* \Rightarrow 0 = 0 \\
\Rightarrow \mathbf{DP}_f^* &= \widehat{\mathbf{DP}}_f^* \Rightarrow \mathbf{DP}_f^* = (1+\lambda) \overline{CO}_f^* \\
\Rightarrow \mathbf{DP}_f^* &= (1+\lambda) \left[\overline{AD}^* + r^d \mathbf{DP}_f^* + \varphi \mathbf{LN}_f^* \right] \\
\Rightarrow [1 - r^{dp}(1+\lambda)] \mathbf{DP}_f^* &= (1+\lambda) \left[\overline{AD}^* + \varphi \frac{\delta(1+\epsilon)}{\alpha\varphi} \overline{AD}^* \right] \\
\Rightarrow [1 - r^{dp}(1+\lambda)] \mathbf{DP}_f^* &= (1+\lambda) \left[1 + \frac{\delta(1+\epsilon)}{\alpha} \right] \overline{AD}^* \\
\Rightarrow \mathbf{DP}_f^* &= \frac{(1+\lambda) [\alpha + \delta(1+\epsilon)]}{\alpha [1 - r^{dp}(1+\lambda)]} \overline{AD}^*
\end{aligned}$$

Perceived Average Profits is Constant

$$\begin{aligned}
\frac{d}{dt} \bar{\pi} &= 0 \\
\Rightarrow \bar{\pi}^* &= \pi^* \Rightarrow \bar{\pi}^* = \left[\overline{AD}^* + r^{dp} \mathbf{DP}_f^* \right] - \left[\left(WB^* - \frac{d}{dt} \mathbf{IN}^* \right) + \delta \mathbf{K}^* + r^{ln} \mathbf{LN}_f^* \right] \\
\Rightarrow \bar{\pi}^* &= \left[\overline{AD}^* + r^{dp} \frac{(1+\lambda) [\alpha + \delta(1+\epsilon)]}{\alpha [1 - r^{dp}(1+\lambda)]} \overline{AD}^* \right] - \left[\frac{w}{\beta} \overline{AD}^* + \delta \frac{(1+\epsilon)}{\alpha} \overline{AD}^* + r^{ln} \frac{\delta(1+\epsilon)}{\alpha\varphi} \overline{AD}^* \right] \\
\Rightarrow \bar{\pi}^* &= \left[1 + r^{dp} \frac{(1+\lambda) [\alpha + \delta(1+\epsilon)]}{\alpha [1 - r^{dp}(1+\lambda)]} - \frac{w}{\beta} - \delta \frac{(1+\epsilon)}{\alpha} - r^{ln} \frac{\delta(1+\epsilon)}{\alpha\varphi} \right] \overline{AD}^* \\
\Rightarrow \bar{\pi}^* &= \left[1 + \frac{r^{dp}(1+\lambda) [\alpha + \delta(1+\epsilon)]}{\alpha [1 - r^{dp}(1+\lambda)]} - \frac{(\delta\varphi + r^{ln}\delta)(1+\epsilon)}{\alpha\varphi} - \frac{w}{\beta} \right] \overline{AD}^*
\end{aligned}$$

Retained Earnings is Constant and Equal to Its Target Level

$$\begin{aligned}
\frac{d}{dt} \mathbf{RE} &= 0 \\
\Rightarrow \mathbf{RE}^* &= \widehat{\mathbf{RE}}^* = \rho \bar{\pi}^* = \rho \pi^* \\
\Rightarrow UP_f^* &= 0
\end{aligned}$$

Desired Dividends is Constant and Equal to Its Target Level

$$\frac{d}{dt} \widetilde{DV}^f = 0$$

$$\Rightarrow \widehat{DV}^{f*} = \widehat{DV}^{f*} = \bar{\pi}^* = \pi^*$$

Household Loans are Equal to Zero

$$LN^{h*} = 0$$

Household Standard of Living is Constant

$$\frac{d}{dt} \overline{YD}_h = 0$$

$$\overline{YD}_h^* = WB^* + DV^{f*} + DV^{b*} + r^{dp} DP_h^*$$

$$\begin{aligned} \overline{YD}_h^* &= WB^* + [\overline{AD}^* + r^{dp} DP_f^*] - \left[\left(WB^* - \frac{d}{dt} IN^* \right) + \delta K^* + r^{ln} LN^{f*} \right] \\ &+ \left[r^{ln} (LN^{f*} + LN^{h*}) - r^{dp} (DP_f^* + DP_h^*) \right] + r^{dp} DP_h^* \end{aligned}$$

$$\overline{YD}_h^* = [\overline{AD}^*] - [\delta K^*] \Rightarrow \overline{YD}_h^* = \overline{AD}^* - \left[\delta \frac{(1+\epsilon)}{\alpha} \overline{AD}^* \right] \Rightarrow \overline{YD}_h^* = \left[1 - \frac{\delta(1+\epsilon)}{\alpha} \right] \overline{AD}^*$$

Household Deposits are Constant and Equal to Its Target Level

$$DP_h^* = \widehat{DP}_h^* = \varpi \overline{YD}_h^*$$

$$DP_h^* = \varpi \left[1 - \frac{\delta(1+\epsilon)}{\alpha} \right] \overline{AD}^*$$

4.2 Perfect Information

If there is no uncertainty about the future, firms do not hold any excess capacity and inventories. Furthermore, firm deposits and retained earnings are equal to zero. In our model, this situation corresponds to the case in which all excess stock parameters are equal to zero.

$$\epsilon = \iota = \lambda = \rho = 0$$

Then;

$$AD^{**} = \overline{AD}^{**} = E[AD^{**}]$$

$$in^{**} = \overline{AD}^{**}$$

$$IN^{**} = \frac{w}{\beta} \overline{AD}^{**}$$

$$K^{**} = \frac{1}{\alpha} \overline{AD}^{**}$$

$$I^{**} = \frac{\delta}{\alpha} \overline{AD}^{**}$$

$$LN^{f**} = \frac{\delta}{\alpha\varphi} \overline{AD}^{**}$$

$$DP_f^{**} = \frac{\alpha + \delta}{\alpha(1 - r^{dp})} \overline{AD}^{**}$$

$$\overline{\pi}^{**} = \left[1 + \frac{r^{dp}(\alpha + \delta)}{\alpha(1 - r^{dp})} - \frac{(\delta\varphi + r^{ln}\delta)}{\alpha\varphi} - \frac{w}{\beta} \right] \overline{AD}^{**}$$

$$RE^{**} = \widehat{RE}^{**} = 0$$

$$UP^{f**} = 0$$

$$\widehat{DV}^{f**} = \widehat{DV}^{f**} = \overline{\pi}^{**} = \pi^{**}$$

$$LN^{h**} = 0$$

$$\overline{YD}_h^{**} = \left[1 - \frac{\delta}{\alpha} \right] \overline{AD}^{**}$$

$$DP_h^{**} = \widehat{DP}_h^{**} = \varpi \left[1 - \frac{\delta}{\alpha} \right] \overline{AD}^{**}$$

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