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Article

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JEOD

Reference: Albanese, Marina/Cisco, Gianluigi (2024). Worker cooperatives and development : a business cycle analysis. In: JEOD 13 (2), S. 13 - 38.
https://jeodonline.com/wp-content/themes/jeod/download.php?pid=13029.
doi:10.5947/jeod.2024.007.

JEOD JOURNAL OF ENTREPRENEURIAL AND ORGANIZATIONAL DIVERSITY

Volume 13, Issue 2 (2024) 13-38 | Published online 18 December 2024

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Worker Cooperatives and Development: A Business Cycle Analysis

ABSTRACT

The 2030 Agenda for Sustainable Development and the achievement of sustainable development goals represent a new challenge for economic systems, directly involving productive sectors in this process. Alternative organizational models of production could play an important role in promoting sustainable development. This paper conducts a comparative analysis of traditional capitalist firms and workers' cooperatives within a general equilibrium framework. We investigate whether cooperative firms are more sustainable than capitalist firms and how governance models impact voluntary abatement activity throughout the business cycle. To address this, we employ two distinct Dynamic Stochastic General Equilibrium models: one populated by cooperative firms and the other by capitalist firms. Our findings indicate that, after a productivity shock, cooperative firms prioritize immediate consumption and environmental goals, demonstrating a higher initial increase in both consumption and abatement efforts. In contrast, capitalist firms focus on increasing labor hours and investment, resulting in a more significant immediate rise in production.

KEY-WORDS

WORKER COOPERATIVES, EMPLOYEE OWNERSHIP, ENVIRONMENTAL AWARENESS, SUSTAINABLE DEVELOPMENT

JEL Classification: P13, P18, O12 **| DOI:** http://dx.doi.org/10.5947/jeod.2024.007

1. Introduction

Sustainable development has garnered significant attention in recent years. In 2015, the United Nations introduced 17 sustainable development goals (SDGs), which provide a comprehensive framework aimed at fostering global sustainable development in social, economic, and environmental dimensions by 2030 (Biermann et al., 2022). Within this broader context, the entire production system is intricately linked to this process. Among the various sectors, the professional industries, which include both producers and distributors, play a crucial role in driving progress toward the realization of the SDGs (Lafont, Saura and Ribeiro-Soriano, 2023). Companies are key actors in socioeconomic scenarios and their characteristics can play a significant role in development processes. Institutions and governments have increasingly emphasized the need for companies to adopt sustainable business models that align economic growth with responsible development. In response, both the European Union and the United Nations have incorporated the concept of the social economy into their respective agendas, highlighting its prospective advantages for societal betterment.

Alternative production models can significantly promote sustainable development. This is acknowledged by the United Nations Task Force on Social and Solidarity Economy (UNTFSSE), the International Co-operative Alliance (ICA), and the International Labour Organization (ILO), which state that cooperatives can significantly contribute to economic, social, and environmental goals due to their strategic position.[1]

Furthermore, the economic literature highlights that cooperatives are well-suited to meet the increasing demand for a more sustainable local economy while contributing to the achievement of the SDGs (Bianchi and Vieta, 2019; Albanese, 2020; Fernandez-Guadaño, Lopez-Millan and Sarria-Pedroza, 2020). The ability to adapt and remain resilient in the face of new socioeconomic conditions and challenges is crucial to promote social and environmental sustainability (Tortia and Troisi, 2021; Colombo, Bailey and Gomes, 2024). Bickford (2020) argued that cooperatives can play an important role in addressing environmental crises and that cooperative principles should be modified to recognize the inextricable links of humanity with the natural world (Duguid and Rixon, 2023). According to Sacchetti and Borzaga (2021), cooperatives can help build a sustainable society and produce social value for future generations. Manera and Serrano (2022) show that worker cooperatives are a management model in line with the new vision of the economy, as production is a means of satisfying human and planetary needs.

Despite this growing body of literature, this topic remains relatively unexplored in relation to its macroeconomic implications. No previous studies have examined the role of cooperatives and

[1] The ICA posits that the cooperative business model is founded on ethics, values, and principles, which prioritize the needs and aspirations of members above the objective of profit maximization. Recently, the ICA has disseminated a report presenting a comprehensive SDG framework applicable for cooperatives (Beishenaly and Eum, 2021).

governance models in promoting sustainable practices with a specific focus on their interactions with economic fluctuations. To investigate these dynamics, we employ a general equilibrium model. This theoretical framework allows for an analysis of firms' pro-environmental behaviors in response to macroeconomic shocks that influence overall economic activity. This paper seeks to examine the impact of cooperatives on the attainment of SDGs across different phases of the business cycle. It offers a novel perspective by comparing cooperative and capitalist firms and examining their roles in promoting sustainable development within a business cycle framework. This topic is relatively unexplored within the macroeconomic literature. No prior studies have examined the role of governance models in driving pro-environmental behaviors after a positive shock on productivity. A productivity shock serves as a proxy for positive fluctuations in the business cycle, capturing a phase of economic expansion. This framework allows us to assess how firms alter their attitudes towards environmental issues during phases of economic development and to observe the differences in governance behaviors among various firms.

Given these premises, this paper presents a comparative analysis between capitalist and cooperative firms within a business cycle framework to address the following research questions (RQs):

- RQ1: Are cooperative firms more inclined to pursue sustainable development than capitalist firms?
- RQ2: How do governance models impact voluntary abatement activity during short-term economic expansions?

To explore these questions, we employ two distinct Dynamic Stochastic General Equilibrium (DSGE) models: one populated by cooperative firms and the other by capitalist firms. The first model aligns with the standard environmental DSGE (E-DSGE) framework, in which representative households work, provide capital to firms, and receive profits. This model assumes that workers are also the owners of the firms. Conversely, the capitalist model is constructed in line with Cantore and Freund (2021). In this setup, only capitalist firms receive profits, while workers offer labor services, with wages being their sole source of income. In both models, the households owning the firms can allocate part of their resources to voluntary emission abatement activities, used as a proxy for environmental awareness[2]. To model voluntary emission abatement activities, we build on Zhang et al. (2019) and previous literature on environmental DSGE models (see, e.g., Annicchiarico and Di Dio, 2015; Khan et al., 2019). Specifically, following Zhang et al. (2019), we assume that the representative household maximizes its lifetime utility by optimally choosing its consumption, leisure time, and environmental investments, which serve as a proxy for environmental awareness. Additionally, as in Annicchiarico and Di Dio (2015), we model abatement activities as costly, incorporating a technology function similar to the Dynamic Integrated Climate-Economy (DICE)

[2] In this paper, we examine voluntary abatement activities, which are actions aimed at reducing pollutant emissions from consumption and production that are not driven by coercive policies. Thus, the decision to reduce emissions is directly linked to environmental awareness.

model of Nordhaus (2008) to represent the abatement process.

This feature enables us to assess whether cooperative firms are more inclined towards non-coercive sustainable investments compared to their capitalist counterparts.

Our paper makes a twofold contribution to the literature. First, it offers a different perspective from existing studies on cooperatives and sustainability objectives by focusing on short-term issues within a general equilibrium context. Second, it adds a discussion on governance issues and the business cycle to the general equilibrium literature focusing on environmental issues (the so-called E-DSGE models). Within this literature, Fischer and Springborn (2011) made the first significant contribution in this area by using DSGE models to evaluate three climate policy instruments for emission reduction: tax, cap, and intensity target. Heutel (2012) examines the optimal environmental policy dynamics, while Angelopoulos, Economides and Philippopoulos (2013) investigate the impact of uncertainty on macroeconomic outcomes, environmental quality, and social welfare in both second-best and first-best frameworks. Annicchiarico and Di Dio (2015) examine the macroeconomic consequences of different environmental policies in the presence of sticky prices.

To the best of our knowledge, this paper is the first to analyze voluntary abatement efforts in the context of cooperative and capitalist firms. First, we extend the literature on E-DSGE models by incorporating the possibility of investment in abatement activities independently of imposed environmental policies. This extension allows us to analyze how factors such as environmental awareness and voluntary efforts can influence household decisions. Second, we utilize the framework presented by Cantore and Freund (2021) to compare the behavior of an economy where workers are the owners of firms to an economy characterized by heterogeneity, where only capitalists influence production decisions[3].

Our results can be summarized as follows. After a productivity shock, which serves as a proxy for an economic expansion: (i) cooperative firms prioritize environmental sustainability by immediately investing in abatement efforts, resulting in a higher initial impact on reducing emissions compared to capitalist firms; (ii) cooperative firms exhibit a higher initial increase in consumption, reflecting a dual focus on improving household welfare and achieving environmental goals; (iii) capitalistic firms prioritize increasing hours worked and investment, leading to a more significant immediate rise in production. However, their abatement efforts are delayed, indicating that environmental sustainability is a secondary consideration.

The structure of the paper is as follows. Section 2 provides a review of the literature on environmental awareness in worker cooperatives. Section 3 describes the key characteristics of the DSGE model. Section 4 focuses on the calibration process, while section 5 discusses the results. Finally, section 6 offers concluding remarks.

[3] In DSGE models, household decisions are linked to firm dynamics, as households supply labor and capital, while firms' production and investment choices influence household income, shaping consumption and savings behavior. Aggregating these micro-level decisions reveals macroeconomic outcomes such as growth and income distribution, with heterogeneity (e.g., capitalists) allowing the study of inequality.

2. Background

The relationship between the participation of workers in decision making and sustainable development has been widely examined in economic research. Askildsen, Jirjahn and Smith (2006) found that employee involvement in decision-making through work councils promotes environmental investments. This is because employees, being more directly impacted by production-related externalities and often living locally, are more likely to be affected by their firm's pollution compared to traditional owners. Fakhfakh and FitzRoy (2018) discovered that financial participation enhances communication and decision making within a company, resulting in a Pareto improvement. Filippi, Bidet and Richez-Battesti (2023) emphasized that among the various challenges cooperatives face in relation to the SDGs, environmental sustainability in response to climate change is of particular importance. In contrast, from an empirical perspective, the literature shows limited evidence of widespread cooperative reporting on SDG performance. Duguid and Balkan (2016) discovered that only a small number of cooperatives used sustainability reporting tools, none adopting tools specifically designed for cooperatives. Instead, the most commonly discussed indicator among cooperatives was community donations.

Disappointingly, environmental indicators ranked very low. The absence of a standardized reporting framework and clear guidelines can negatively affect the quality of SDG reporting. From this perspective, Rowlston and Duguid (2020) identified a stratification framework for stakeholder interests, mission, and organizational activity and impact. A conceptual model for value alignment and impact measurement was developed, grounded in cooperative principles, to support organizational performance reporting and to define metrics for evaluating social and environmental value. Furthermore, Duguid and Rixon (2023) proposed a research methodology aimed at helping the cooperative sector develop meaningful metrics to assess performance in relation to the SDGs and cooperative principles, thus highlighting the unique characteristics of cooperatives. The impact of democracy on enhancing environmental quality has garnered growing interest in both environmental studies and political economy research (Tsur, 2024). The hypothesis of this approach is the supposed high concern about environmental degradation due to the greater involvement of people in the decisions that impact their lives (Boillat, Gerber and Funes-Monzote, 2012). Bayon (2015) argued that if workers had authority over their labor, it would likely be more environmentally sustainable. However, under the capitalist system, where property ownership and the need for growth dominate, workers are often compelled to engage in activities that harm the environment. Debord (2004) argued that, unlike capitalist firms driven by the profit motive, democratic economic enterprises have the potential to prioritize environmental goals over purely economic ones. Similarly, Gunderson (2019) demonstrated that worker cooperatives can aid in climate change mitigation due to their reduced focus on constant growth compared to traditional capitalist firms. This leads to lower energy and material consumption, ultimately resulting in reduced greenhouse gas emissions (Preluca, Hakelius and Mark-Herbert, 2022). Despite the significance of the topic, the literature addressing the environmental sustainability of worker cooperatives remains limited (Preluca, Hakelius and Mark-Herbert, 2022). In the next section, we develop a theoretical model to assess that worker cooperatives, characterized by their unique organizational form, can effectively pursue sustainable development aligned with environmental care, provided that workers have a positive propensity toward environmental awareness.

3. DSGE model

In this section, we present two models to compare the voluntary abatement efforts of capitalist and cooperative firms. The first model depicts an economy populated by cooperative firms, whereas the second model consists exclusively of capitalist firms.The model with cooperative firms is represented by a standard DSGE model of the New Keynesian family, augmented to include the possibility of voluntary abatement efforts. In this model, households own the firms, supply labor and capital, receive profits[4], and invest voluntarily in emission abatement. In contrast, the model with capitalist firms aligns with Cantore and Freund (2021). We assume two types of households: (i) workers and (ii) capitalists. The former are treated as hand-to-mouth households; thus, they only supply labor and consume their labor income. The capitalists, who own the firms, provide labor and invest in physical capital. In addition, they can voluntarily invest in reduction activities. Next, we present the two types of households. The production sector remains the same in both models. Table 1 presents a comprehensive overview of the model structure.

The choice of these two DSGE models is motivated by their ability to effectively capture the impact of firm structure on voluntary abatement efforts. The cooperative firm model, based on a standard New Keynesian framework, allows for the exploration of how shared ownership and profit distribution might incentivize greater environmental responsibility. In contrast, the capitalist firm model, following Cantore and Freund (2021), introduces heterogeneous households—workers and capitalists—to reflect real-world income disparities and their influence on abatement investments. By using these models, we can comprehensively compare how voluntary abatement is shaped by differences in firm ownership and economic decision-making.

[4] In worker cooperatives, the workers also own the enterprise. In the analyses based on the traditional cooperative model (Vanek, 1970), the maximised value is the average income, and the value of the residual that is realised is distributed in full among the members. Profits should be considered in this sense.

Table 1. DSGE models structure

Model	Households	Budget constraint
Cooperative	- Representative households (RA)	Income (RA): wages, profits and investment returns Expenses (RA): consumption and investment
Capitalists-workers	- Capitalists (C) - Workers (W)	Income (C): wages, profits and investment returns Expenses (C): consumption and investment Income (W): wages Expenses (W): consumption

Source: authors' own elaboration.

3.1. Households

3.1.1. Households with cooperative firms

The representative cooperative household maximizes the expected sum of utilities discounted by $\beta \in [0,1]$:

$$\max_{\{c_t, i_t, h_t, k_t, b_t, \mu_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} - \kappa_L \frac{h_t^{1+\varphi}}{1+\varphi} + \kappa_Q \frac{Q_t^{1+\varphi_Q}}{1+\varphi_Q} \right) \tag{1}$$

In this context, c_t denotes consumption, contributing positively to household utility. The term h_t represents the hours worked, reflecting the labor effort provided by the household. This labor effort generates income, but also incurs disutility. The parameter σ represents the coefficient of relative risk aversion, κ_L is the labor disutility parameter, and φ is the inverse of the Frisch elasticity, indicating the responsiveness of the labor supply to changes in wages.

A distinctive feature of the utility function is the incorporation of environmental quality Q_t. The household utility is adversely affected by emissions, which implies that a reduction in emissions flow leads to a lower stock of carbon emissions, thus improving environmental quality. The parameter φ_Q governs the scale elasticity. Fluctuations in κ_Q are referred to as preferences for environmental quality, reflecting the degree of awareness of households about environmental quality. This approach aligns with the methodologies of Angelopoulos, Economides and Philippopoulos (2013), Delis and Iosifidi (2020), and Chan and Punzi (2023), who use environmental quality stock as indicators of environmental awareness in the utility function.

The cooperative households maximize their utility subject to the budget constraint (equation 2), the law of motion of capital (equation 3) and the environmental quality (equation 4):

$$c_t + i_t + b_t + ac_t = r_t^k p_t k_{t-1} + r_{t-1} b_{t-1} + w_t h_t + t_t + d_t \tag{2}$$

$$k_t = (1-\delta)k_{t-1} + \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right] i_t \tag{3}$$

$$Q_t = \bar{Q} + (1-\delta_q)Q_{t-1} - (1-\mu_t)\varepsilon_E y_t \tag{4}$$

Households consume (c_t) and invest (i_t); b_t refers to the amount of a one-period nominal risk-free bond held at time *t*; this bond pays a nominal interest rate and provides a way for the household to save or borrow; k_t is the sector capital stock. Household income comprises labor income, determined by the real wage ($w_{j,t}^s$) in each sector, along with income from the capital rental rate ($r_{k,t}$) and real profits from firms (d_t); t_t are lump-sum transfers; k_t is the capital stock and represents the accumulated assets that can be used for production in subsequent periods; ac_t represent the abatement cost, that are in line with the formulation of Nordhaus (2008):

$$ac_t = \theta_1 \mu_t^{\theta 2} y_t \tag{5}$$

where $\theta_1, \theta_2 > 0$ are technological parameters.

Equation 4 illustrates the link between the production sector and the carbon cycle. Carbon emissions (e_t) are a by-product of output ($e_t = (1-\mu_t)\varepsilon_E y_t$), and households can voluntarily reduce carbon emissions by investing in abatement activities (μ_t). In addition, carbon emissions have negative implications for environmental quality, as discussed in Angelopoulos, Economides and Philippopoulos (2013).

First-order conditions with respect to consumption, labor, bonds, capital, investment, and voluntary abatement effort are the following:

$$c_t^{-\sigma} = \lambda_t \tag{6}$$

$$\kappa_L h_t^{\varphi} = \lambda_t w_t \tag{7}$$

$$\lambda_t = \beta E_t\left(\lambda_{t+1} \frac{r_t}{\pi_{t+1}}\right) \tag{8}$$

$$q_t = \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[r_{t+1}^k + (1-\delta) q_{t+1} \right] \right\} \tag{9}$$

$$1 = q_t \left[1 - \frac{\kappa_I}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 - \kappa_I \left(\frac{i_t}{i_{t-1}} \right) \left(\frac{i_t}{i_{t-1}} - 1 \right) \right] + \kappa_I \beta E_t \left\{ q_{t+1} \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{i_{t+1}}{i_t} \right)^2 \left(\frac{i_{t+1}}{i_t} - 1 \right) \right\} \tag{10}$$

$$\mu_t = \left(\frac{Q_t^{\varphi_Q} \varepsilon_E \kappa_Q}{\lambda_t \theta_1 \theta_2} \right)^{\frac{1}{\theta_2 - 1}} \tag{11}$$

where $\pi_t \equiv \frac{p_t}{p_{t-1}}$ is the gross inflation rate.

Equation 11 shows the factors affecting the environmental effort. μt is directly influenced by consumption, emissions, ε_E, and κ_Q, and inversely by θ_1 and θ_2. This implies that the voluntary abatement effort depends on the available resources for consumption, elasticity, efficiency, and specific model constants.

3.1.2. Households with capitalistic firms

The model incorporating capitalistic firms differentiates between two types of households: capitalists and workers. Capitalist households primarily derive their income from returns on capital and investments, whereas worker households earn their income through wages from labor. Although the optimization problem for capitalist households bears resemblance to that of cooperative households, the model distinctly separates the roles of workers and firm owners. In this framework, workers are employed by firms but do not participate in production decisions nor receive profits. This section focuses solely on the optimization problem faced by worker households. For a comprehensive set of equations, please refer to the Appendix.

3.1.3. Worker households

Worker households maximize the following utility function:

$$\max_{\{c_t^w, h_t^w, b_t^w\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t^w)^{1-\sigma^w}}{1-\sigma^w} - \kappa_L^w \frac{(h_t^w)^{1+\varphi^w}}{1+\varphi^w} \right) \tag{12}$$

where c_t^w denotes consumption and h_t^w represents hours worked by the worker household.

To provide a proper comparison with firms' voluntary abatement efforts, we assume that worker households are not able to invest in abatement activities due to their limited resources.

Worker households maximize their utility subject to the following budget constraint:

$$c_t^w = w_t^w h_t^w + t_t \tag{13}$$

where t_t represents lump sum transfers.

First-order conditions with respect to consumption and labor are as follows:

$$(c_t^w)^{-\sigma^w} = \lambda_t^w \tag{14}$$

$$\kappa_L^w (h_t^w)^{\varphi^w} = \lambda_t^w w_t \tag{15}$$

3.2. Final-good firms

The representative final-good firm uses the following constant elasticity of substitution aggregator to produce y_t:

$$y_t = \left(\int_0^1 y_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{16}$$

where $y_t(i)$ is an intermediate input produced by the intermediate firm i, and $p_t(i)$ is its price. The problem of the final-good firm is to maximize profit:

$$\max_{y_t, \{y_t(i)\}_{i\in[0,1]}} p_t y_t - \int_0^1 p_t(i) y_t(i) di \tag{17}$$

subject to the constraint:

$$y_t = \left(\int_0^1 y_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{18}$$

The first order condition with respect to the generic input i is:

$$y_t(i) = y_t \left(\frac{p_t(i)}{p_t}\right)^{-\varepsilon} \tag{19}$$

We now derive the price level in terms of the prices of intermediate goods. The price level is characterized as the cost of a single unit of the final good:

$$p_t = \left(\int_0^1 p_t(i)^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}} \tag{20}$$

3.3. Intermediate-good firms

A continuum of firms, each represented by an index i, produces a differentiated input using a Cobb-Douglas production function. These firms collectively form a unit measure.

$$y_t(i) = a_t(k_{t-1}(i))^{\alpha}(h_t(i))^{1-\alpha} \tag{21}$$

Here, a_t represents the total factor productivity, which evolves according to an autoregressive process:

$$\log(a_t) = (1-\rho_a)\log(\bar{a}) + \rho_a \log(a_{t-1}) + v_{a,t} \tag{22}$$

with $v_{a,t} \sim N(0, \sigma_a^2)$ being a technology shock. Firms operate under monopolistic competition, determining the price of their goods based on the demand from the final-good firm (equation 7). Moreover, firms face quadratic adjustment costs, $AC_t^P(i)$ expressed in nominal terms following Rotemberg (1982), when adjusting prices relative to the inflation target π:

$$AC_t^P(i) = \frac{\kappa_P}{2}\left(\frac{p_t(i)}{p_{t-1}(i)} - \pi\right)^2 p_t y_t \tag{23}$$

The profit maximization problem of a representative firm *i* is formulated in terms of the domestic price index. This framework considers the firm's objective to maximize its profits by choosing the optimal price for its goods while taking into account the demand it faces from the final-good firm, as well as the costs incurred. Specifically, the firm must balance its revenue, which is influenced by its pricing decisions and market demand, against its production costs and quadratic adjustment costs associated with price changes.

$$\max_{\{p_t(i),h_t(i),k_{t-1}(i),y_t(i)\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0}\left[\frac{p_t(i)}{p_t} y_t(i) - w_t h_t(i) - r_t^k k_{t-1}(i) - \frac{\kappa_P}{2}\left(\frac{p_t(i)}{p_{t-1}(i)} - \pi\right)^2 y_t\right] \quad (24)$$

subject to:

$$y_t(i) = y_t \left(\frac{p_t(i)}{p_t}\right)^{-\varepsilon} \quad (25)$$

$$y_t(i) = a_t (k_{t-1}(i))^{\alpha} (h_t(i))^{1-\alpha} \quad (26)$$

In a symmetric equilibrium, all firms set identical prices, use the same inputs, and produce the same output. Based on the production function, the first-order conditions with respect to capital, labor, and prices are as follows:

$$r_t^k = m_t^c \alpha \frac{y_t}{k_{t-1}} \quad (27)$$

$$w_t = m_t^c (1-\alpha) \frac{y_t}{h_t} \quad (28)$$

$$\pi_t(\pi_t - \pi) = \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t} \pi_{t+1}(\pi_{t+1} - \pi) \frac{y_{t+1}}{y_t}\right] + \frac{\varepsilon}{\kappa_P}\left(m_t^c - \frac{\varepsilon - 1}{\varepsilon}\right) \quad (29)$$

where $m_t^c(i)$ denotes the Lagrangian multiplier, which represents the firm's real marginal cost associated with the decision to produce an additional unit of goods.

3.4. Policy

The government finances public expenditure g_t by raising lump-sum taxes:

$$g_t = t_t \tag{30}$$

where g_t is a fraction g_y of the ouput.

Moreover, the monetary authority sets the nominal interest rate according to the following Taylor rule:

$$\frac{r_t}{\bar{r}} = \left(\frac{r_{t-1}}{\bar{r}}\right)^{\rho_r} \left(\frac{\pi_t}{\pi}\right)^{\phi_\pi(1-\rho_r)} \left(\frac{y_t}{\bar{y}}\right)^{\phi_y(1-\rho_r)} \tag{31}$$

3.5. Market clearing

Clearing in the goods market implies:

$$y_t = c_t + i_t + g_t + ac_t + \frac{\kappa_P}{2}(\pi_t - \pi)^2 y_t \tag{32}$$

In the case of capitalist-workers model aggregation for consumption, investments, capital and hours worked are as follows:

$$c_t = \gamma^c c_t^c + (1-\gamma_t) c_t^w \tag{33}$$

$$i_t = \gamma^c i_t^c \tag{34}$$

$$k_t = \gamma^c k_t^c \tag{35}$$

$$h_t = \gamma^c h_t^c + (1-\gamma) h_t^w \tag{36}$$

where γ^c is the share of capitalists in the model.

4. Calibration

The model is calibrated to reflect the U.S. economy, using a quarterly frequency to capture economic dynamics over shorter time intervals. For the calibration process, we rely on established literature related to DSGE models (e.g., Smets and Wouters, 2007; Annicchiarico and Di Dio, 2015). The key parameters of the model are outlined in Table 2, providing a detailed overview of the values and descriptions.

The choice of parameters follows established conventions in the literature on DSGE models. According to Cantore and Freund (2021), the discount factor β^j is set to 0.99, with the aim of achieving an annual real (and nominal) interest rate of 4. The risk aversion parameter σ^j is selected to represent the standard risk aversion, as commonly used in various studies. The inverse Frisch elasticity φ is set to 1.0, reflecting a typical labor supply elasticity. The capital depreciation rate δ is set at 0.025, consistent with the quarterly capital depreciation. Following Annicchiarico and Diluiso (2019), the parameter κ_I is set to 3, and κ_P, which reflects the adjustment costs of investment and prices, is set to 58.25. The elasticity of substitution for intermediate goods is set to 6.

In accordance with Heutel (2012), the technological parameters in the abatement cost function, θ_1^j and θ_2^j, are set to 1 and 2.8, respectively. The parameters for the interest rate and the Taylor rule (ρ_r=0.5, ϕ_π=1.5, ϕ_y=0.125) are chosen to replicate the observed behavior of monetary policy. The emission per unit of output ε_E is set to 0.38, as in Annicchiarico and Diluiso (2019). Regarding the parameters in the motion for environmental quality, we follow Angelopoulos, Economides and Philippopoulos (2013) and set a high persistence parameter δ_q=0.9. Additionally, we normalize the constant term, representing the level of environmental quality without economic activity, to unit[5].

Finally, the parameter γ^c, representing the share of capitalists in the model, is set to 0.4, aligning with the observed distribution of wealth in developed economies. The auto-regressive parameter for the TFP shock is set to 0.95, and the share of public spending over output is 0.20, as in Annicchiarico and Di Dio (2015).

5 Parameters κ_L and κ_Q are calibrated endogenously in the steady state and function as scale parameters.

Table 2. Model calibration parameters

Parameter	Description	Value
βj	Discount factor	0.99
σj	Risk aversion parameter	1.5
φj	Inverse Frisch elasticity	1.0
φ_Q^j	Elasticity of environmental quality	1.5
κ_I	Investment adjustment cost parameter	3.0
κ_P	Price adjustment cost parameter	58.25
ε	Elasticity of substitution between intermediate goods	6.0
δ	Depreciation rate of capital	0.025
θ_1^j	Abatement cost parameter	1.0
θ_2^j	Abatement cost parameter	2.8
ρ_r	Interest rate smoothing parameter	0.5
ϕ_π	Inflation response coefficient	1.5
ϕ_y	Output gap response coefficient	0.125
ε_E	Emission per unit of output	0.38
ρ_a	AR(1) coefficient for TFP shock	0.95
g_y	Government spending to output ratio	0.2
γ^c	Share of capitalists in the model	0.4
δ_q	Persistence of environmental quality	0.9
$\bar{Q}$	Environmental quality without pollution	1

Note: *j* refers to the different types of households: cooperative, capitalistic, and workers.

Source: authors' own elaboration.

5. Results

This section aims to understand whether cooperative firms are more inclined to pursue sustainable development than capitalist firms and how governance models impact voluntary abatement activity during short-term economic expansions. We simulate a productivity shock, the primary driver of macroeconomic fluctuations within the general equilibrium framework, to examine and compare the responses of these two types of firm and their pro-environmental behaviors, as indicated by voluntary abatement activity. This productivity shock serves as a proxy for economic expansion. Additionally, we conduct robustness checks under alternative calibrations to ensure the validity of our results and to provide a deeper examination of the transmission mechanisms at play.

5.1. Productivity shock

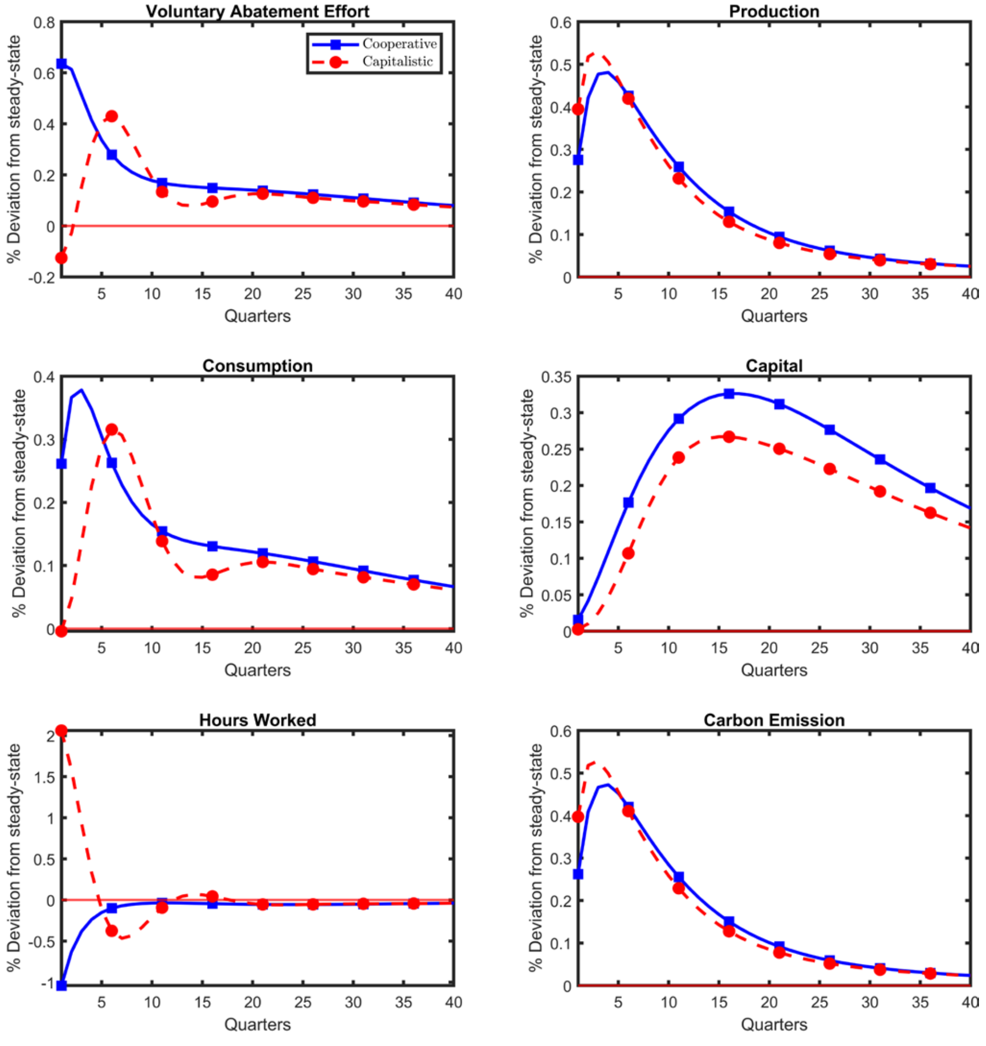
Figure 1 illustrates the impulse response functions following a 1% technology shock. Following a positive technological shock, production, consumption, and capital all increase in both types of economic context (i.e., cooperative and capitalistic). However, the response of labor differs between the two models. In the cooperative model, hours worked decrease by approximately 1%. In contrast, in the model with capitalist owners and workers, the hours worked by the owners of the firms increase by 2%.

Since the shock is temporary, households choose to invest in physical capital to benefit from the resulting increase in firms' productivity. As income rises, consumption also increases, displaying a hump-shaped dynamic that mirrors the evolution of capital over time. As a result, the rise in productivity leads to a corresponding increase in emissions, based on the assumption of a proportional relationship between output and emissions.

In terms of comparative analysis between the two governance structures, the voluntary abatement effort increased in both cases. However, cooperative firms respond immediately during a positive economic expansion, with abatement investment increasing by about 0.8%. In contrast, capitalistic firms are more production-oriented, increasing both hours worked and investment to benefit from higher productivity while reducing and postponing consumption and abatement investment. Consequently, production in the capitalistic case increases more at impact (0.4 vs. 0.3%). Consumption in both models follows a hump-shaped pattern in response to the technological shock, aligning with the earlier discussion on optimal capital stock build-up by households. Cooperative firms experience an initial increase in consumption higher than capitalistic firms, which is consistent with the immediate response to voluntary abatement efforts. Both models show an increase in carbon emissions following the shock as a result of the proportional relationship with the output. Finally, in the cooperative model, emissions respond less to a technology shock due to the positive abatement effort.

The comparative analysis highlights the distinct responses of cooperative and capitalistic firms to a positive technological shock. Cooperative firms prioritize immediate reduction efforts and consumption, leading to a greater initial impact on both variables. Capitalistic firms, on the other hand, focus on increasing hours worked and investment, resulting in a more significant immediate increase in production and a delayed abatement effort. These differences underscore the varying priorities and strategies adopted by different governance structures in response to economic expansions.

Figure 1. Impulse response functions to a 1% technology shock

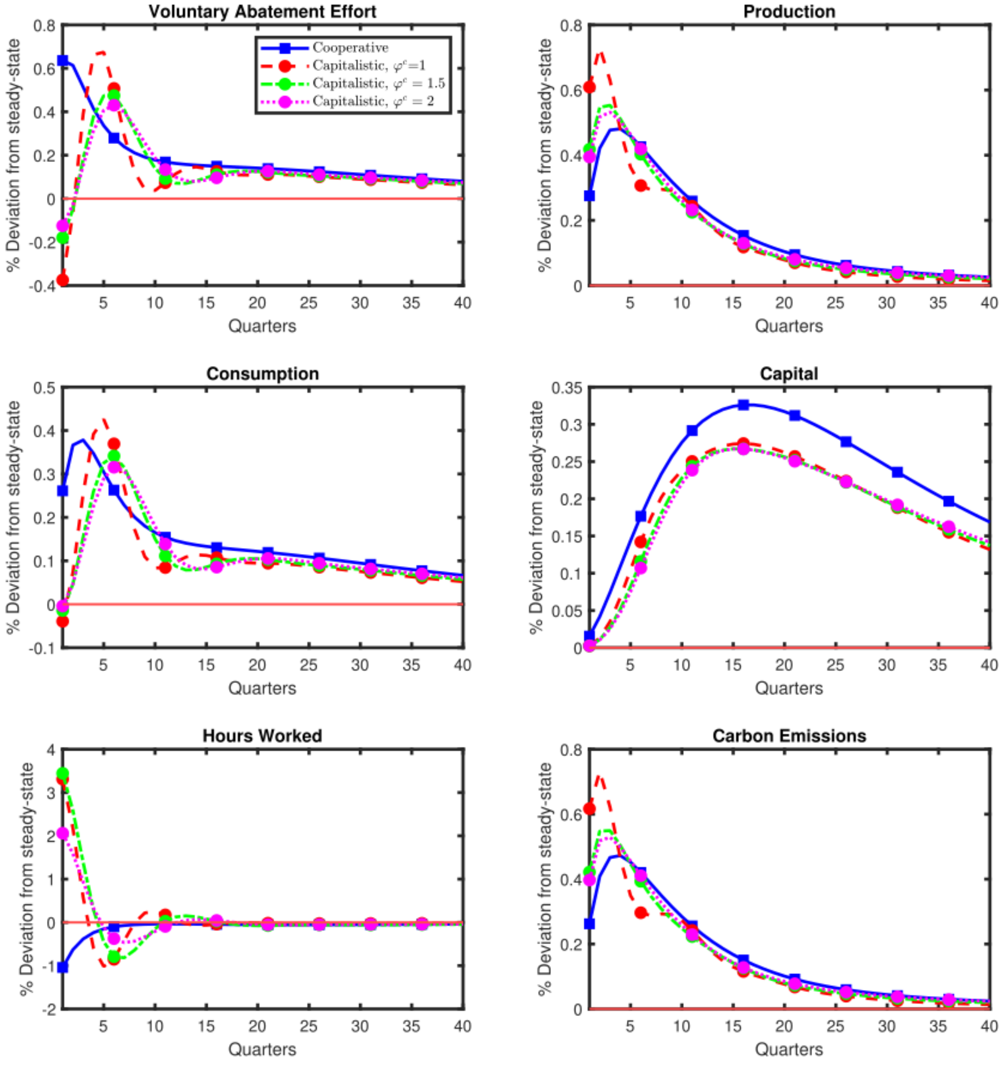


Source: authors' own elaboration.

5.2. Robustness check

This section presents results for alternative baseline calibrations of the model, assuming: (i) a lower proportion of capitalists in the economy (γ^c); and (ii) a lower elasticity of labor supply for capitalists (φ^c). The findings confirm that our main conclusions remain robust. In detail, Figure 2 displays the impulse response functionsto a 1% productivity shock under varying proportions of capitalist households in the economy: γ^c=0.4, γ^c=0.3 and γ^c=0.2. In more detail, the response of voluntary abatement effort initially increases across all calibrations but shows a more pronounced increase when the proportion of capitalist households is lower. This effort stabilizes over time, reflecting long-term adjustments in the economy.

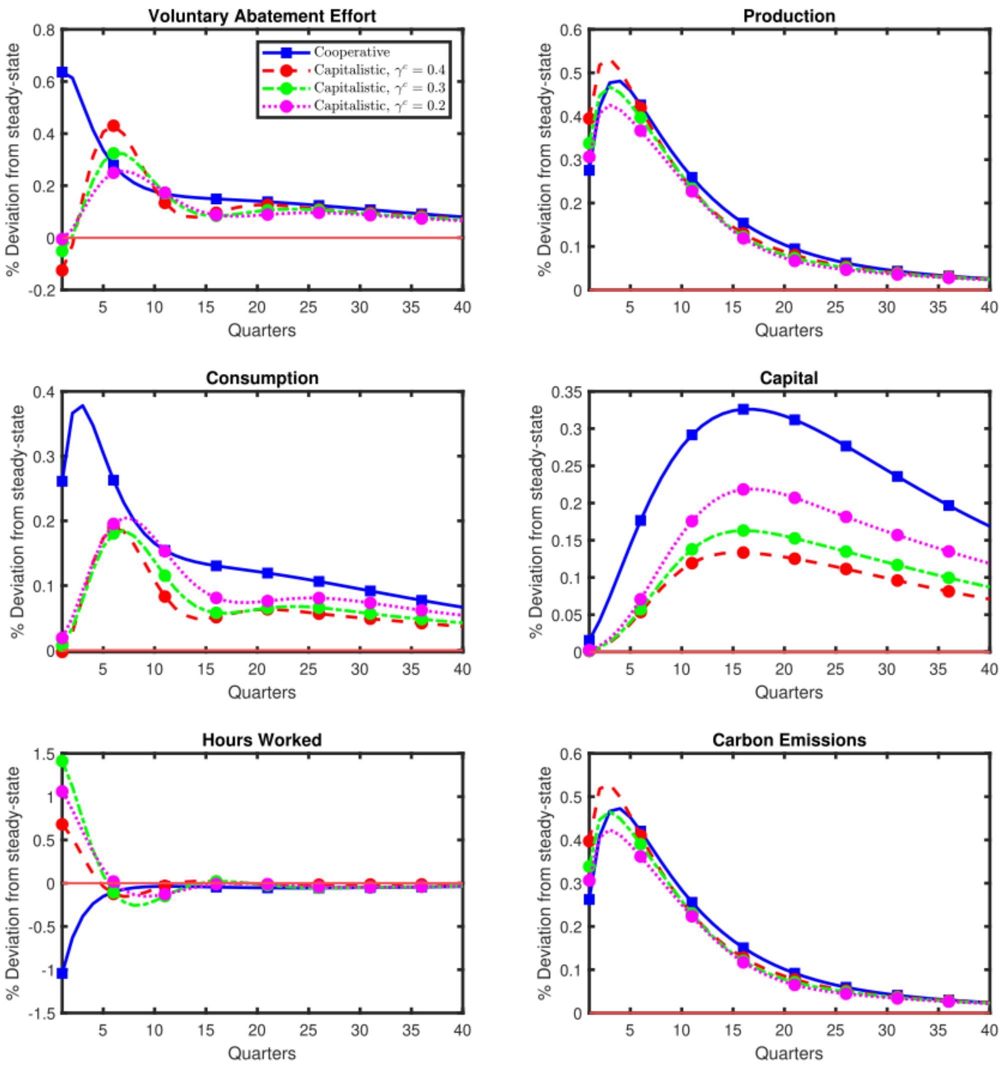
Figure 2. Impulse response functions to a 1% technology shock under alternative values of capitalist share



Source: authors' own elaboration.

A decline in the proportion of capitalist households results in a diminished positive effect on production, with lower peaks occurring in scenarios with fewer capitalist households compared to those with a higher proportion or the cooperative scenario. Consumption rises more markedly when the proportion of capitalist households decreases, suggesting that households alter their consumption behavior in response to shifts in production and income distribution. The stock of capital shows a greater increase in scenarios with a lower proportion of capitalist households, suggesting more significant capital accumulation in these cases. The impact on hours worked is positive under each calibration, with a notable increase in the initial periods following the productivity shock.

Figure 3. Impulse response functions to a 1% technology shock under alternative labor supply elasticity parameters



Source: authors' own elaboration.

The effect on hours worked is not linear, as evidenced by the differing shapes of the impulse response functions. Carbon emissions initially increase in response to the productivity shock, but the rise is more subdued in scenarios with a lower proportion of capitalist households. The impulse response functions indicate that voluntary abatement efforts and changes in production and consumption patterns contribute to mitigating the increase in emissions over time.

Similarly, Figure 3 illustrates the impulse response functions to a 1% productivity shock under different parameters of the elasticity of the labor supply for capitalist households: $\varphi^c=2$, $\varphi^c=1.5$, and $\varphi^c=1$. In more detail, the response of the voluntary abatement effort initially increases across all calibrations but shows a more pronounced increase when the elasticity of the labor supply is higher. This effort stabilizes over time, reflecting long-term adjustments in the economy. A decrease in the elasticity of the labor supply leads to a reduction in the positive impact on production, with lower peaks observed in scenarios with lower elasticity compared to those with higher elasticity and the cooperative scenario. Consumption experiences a more pronounced increase when labor supply elasticity is higher, suggesting that households adjust their consumption behavior more actively in response to variations in production and income distribution. The capital stock shows a greater increase in scenarios with greater elasticity of the labor supply, suggesting a greater accumulation of capital in these cases. The impact on hours worked is positive under each calibration, with a notable increase in the initial periods following the productivity shock. The effect on hours worked is not linear, as evidenced by the differing shapes of the impulse response functions. Carbon emissions initially increase in response to the productivity shock, but the rise is more subdued in scenarios with higher labor supply elasticity.

6. Conclusions and policy implications

This paper presented a novel approach to evaluating the role of cooperative firms in achieving sustainable development goals. To this end, we compared cooperative and capitalist firms, examining their roles in promoting sustainable development within a business cycle framework. The primary objective was to determine whether cooperative firms are more inclined to pursue sustainable development than capitalist firms and to understand how different governance models impact voluntary abatement activity during short-term economic expansions. To achieve this, we used two distinct E-DSGE models: one representing cooperative firms and the other representing capitalist firms.

Our findings reveal that cooperative firms prioritize environmental sustainability by promptly investing in abatement activities following a productivity shock. These firms also show a higher initial increase in consumption, indicating a balance between improving household welfare and achieving environmental objectives. In contrast, capitalist firms focus on increasing work hours and investment, leading to a substantial immediate increase in production. However, their efforts in environmental abatement are delayed, suggesting that sustainability is a secondary concern. These findings are valuable because they underscore the crucial role of governance structures in shaping firm behavior toward sustainable development. The propensity of cooperative firms to engage in voluntary environmental efforts during the phases of economic growth highlights their potential to promote sustainable practices, which has significant policy implications.

The findings of this study offer critical insights for policy makers aiming to promote sustainable development through effective governance structures in companies. First, the demonstrated ability of cooperative firms to prioritize environmental sustainability suggests that policies supporting the establishment and expansion of cooperatives could contribute significantly to reducing greenhouse gas emissions. Governments can promote the development of cooperatives by implementing legislation that simplifies their operations and by offering financial support, such as tax incentives or grants, tied to sustainability-focused initiatives. In this context, creating a supportive regulatory framework for cooperatives can enhance their positive environmental impact. Furthermore, the study's observation that cooperative firms are more responsive to environmental goals during periods of economic growth highlights the importance of integrating sustainability into broader business cycle management policies. Policymakers might consider implementing counter-cyclical measures that incentivize firms, irrespective of their governance structure, to adopt environmentally responsible practices during economic upswings. For example, green investment subsidies or penalties for delayed environmental action could encourage firms to adopt proactive strategies during periods of economic expansion, while increased support during recessions could help ensure ongoing progress toward sustainability goals. The slow abatement response observed in capitalist firms highlights the importance of implementing stronger regulatory frameworks and market-based instruments, such as carbon pricing or emissions trading systems. These tools could help ensure that firms remain responsible for their environmental impacts, even when their primary focus is production efficiency and profit maximization. This finding underscores the need for differentiated environmental policies that consider varying governance structures, ensuring that all firms are encouraged to align their operations with long-term sustainability objectives. Finally, the study emphasizes the importance of diversity in governance in the advancement of sustainable development. Policymakers should strive to foster a balanced economic landscape that includes a variety of ownership and governance models. This diversity promotes economic growth and encourages a more comprehensive approach to achieving environmental sustainability. By supporting a mix of cooperative, capitalist and alternative governance structures, policymakers can cultivate a more resilient and adaptable economy, better equipped to address both economic and environmental challenges.

Nevertheless, our study has limitations. Our DSGE models are based on specific behavioral and market assumptions that may not fully capture the real-world complexities between different types of governance. In addition, our analysis is confined to short-term economic expansions, and different results may emerge under varied economic conditions or longer-term perspectives. Future research should address these limitations by investigating the long-term effects of governance models on sustainable development and exploring the impacts of various economic shocks and market scenarios. Furthermore, empirical validation would enhance the practical relevance of our theoretical findings. These avenues of inquiry are essential for furthering our understanding and are left for future research.

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Appendix. Model equations

1. Cooperative households

$$c_t^{-\sigma} = \lambda_t \tag{37}$$

$$\kappa_L h_t^{\varphi} = \lambda_t w_t \tag{38}$$

$$\lambda_t = \beta E_t \left(\lambda_{t+1} \frac{r_t}{\pi_{t+1}}\right) \tag{39}$$

$$q_t = \beta E_t \left\{\frac{\lambda_{t+1}}{\lambda_t}\left[r_{t+1}^k + (1-\delta) q_{t+1}\right]\right\} \tag{40}$$

$$1 = q_t \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - \kappa_I \left(\frac{i_t}{i_{t-1}}\right)\left(\frac{i_t}{i_{t-1}} - 1\right)\right] + \kappa_I \beta E_t \left\{q_{t+1} \frac{\lambda_{t+1}}{\lambda_t}\left(\frac{i_{t+1}}{i_t}\right)^2 \left(\frac{i_{t+1}}{i_t} - 1\right)\right\} \tag{41}$$

$$\mu_t = \left(\frac{Q_t^{\varphi_Q} \varepsilon_E \kappa_Q}{\lambda_t \theta_1 \theta_2}\right)^{\frac{1}{\theta_2 - 1}} \tag{42}$$

$$k_t = (1-\delta) k_{t-1} + \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right] i_t \tag{43}$$

2. Capitalistic households

$$c_t^{c,-\sigma} = \lambda_t^c \tag{44}$$

$$\kappa_L^c h_t^{c,\varphi} = \lambda_t^c w_t^c \tag{45}$$

$$\lambda_t^c = \beta^c E_t^c \left(\lambda_{t+1}^c \frac{r_t^c}{\pi_{t+1}^c}\right) \tag{46}$$

$$q_t^c = \beta^c E_t^c \left\{\frac{\lambda_{t+1}^c}{\lambda_t^c}\left[r_{t+1}^{c,k} + (1-\delta^c) q_{t+1}^c\right]\right\} \tag{47}$$

$$1 = q_t^c \left[1 - \frac{\kappa_I^c}{2}\left(\frac{i_t^c}{i_{t-1}^c} - 1\right)^2 - \kappa_I^c \left(\frac{i_t^c}{i_{t-1}^c}\right)\left(\frac{i_t^c}{i_{t-1}^c} - 1\right)\right] + \kappa_I^c \beta^c E_t^c \left\{q_{t+1}^c \frac{\lambda_{t+1}^c}{\lambda_t^c}\left(\frac{i_{t+1}^c}{i_t^c}\right)^2 \left(\frac{i_{t+1}^c}{i_t^c} - 1\right)\right\} \quad (48)$$

$$\mu_t^c = \left(\frac{Q_t^{\varphi_Q} \varepsilon_E^c \kappa_Q^c}{\lambda_t^c \theta_1^c \theta_2^c}\right)^{\frac{1}{\theta_2^c - 1}} \quad (49)$$

$$k_t^c = (1 - \delta^c) k_{t-1}^c + \left[1 - \frac{\kappa_I^c}{2}\left(\frac{i_t^c}{i_{t-1}^c} - 1\right)^2\right] i_t^c \quad (50)$$

3. Worker households

$$(c_t^w)^{-\sigma^w} = \lambda_t^w \quad (51)$$

$$\kappa_L (h_t^w)^{\varphi^w} = \lambda_t^w w_t^w \quad (52)$$

$$c_t^w = w_t^w h_t^w + t_t \quad (53)$$

4. Firms

$$y_t(i) = a_t (k_{t-1}(i))^{\alpha} (h_t(i))^{1-\alpha} \quad (54)$$

$$\log(a_t) = (1 - \rho_a)\log(\bar{a}) + \rho_a \log(a_{t-1}) + v_{a,t} \quad (55)$$

$$r_t^k = m_t^c \alpha \frac{y_t}{k_{t-1}} \quad (56)$$

$$w_t = m_t^c (1 - \alpha) \frac{y_t}{h_t} \quad (57)$$

$$\pi_t(\pi_t - \pi) = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \pi_{t+1}(\pi_{t+1} - \pi) \frac{y_{t+1}}{y_t}\right] + \frac{\varepsilon}{\kappa_P}\left(m_t^c - \frac{\varepsilon - 1}{\varepsilon}\right) \quad (58)$$

5. Environmental sector

$$e_t = (1-\mu_t)\varepsilon_E y_t \tag{59}$$

$$ac_t = \theta_1 \mu^{\theta 2} y_t \tag{60}$$

6. Policy

$$g_t = t_t \tag{61}$$

$$\frac{r_t}{\bar{r}} = \left(\frac{r_{t-1}}{\bar{r}}\right)^{\rho_r} \left(\frac{\pi_t}{\pi}\right)^{\phi_\pi (1-\rho_r)} \left(\frac{y_t}{\bar{y}}\right)^{\phi_y (1-\rho_r)} \tag{62}$$

7. Market clearing

$$y_t = c_t + i_t + g_t + \frac{\kappa_P}{2}(\pi_t - \pi)^2 y_t \tag{63}$$

$$c_t = \gamma^c c_t^c + (1-\gamma_t) c_t^w \tag{64}$$

$$i_t = \gamma^c i_t^c \tag{65}$$

$$k_t = \gamma^c k_t^c \tag{66}$$

$$h_t = \gamma^c h_t^c + (1-\gamma_t) h_t^w \tag{67}$$